APÉNDICE K

ESTUDIO ARQUEOLÓGICO SUB-ACUÁTICO

SUBMERGED CULTURAL RESOURCES SURVEY
CENTRAL GUANICA ECO-RESORT
GUANICA BAY, PUERTO RICO

STAGE IA
BACKGROUND LITERATURE SEARCH
& FIELD INSPECTION

SUBMITTED TO:

CSA ARCHITECTS & ENGINEERS
MERCANTIL PLAZA, MEZZANINE SUITE
SAN JUAN, PUERTO RICO 00918
&
PUERTO ENSENADA DEVELOPMENT CORPORATION (PEDC)

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REQUESTED BY THE STATE HISTORIC CONSERVATION OFFICE
AND THE COUNCIL FOR UNDERWATER ARCHAEOLOGY
SAN JUAN, PUERTO RICO

AUGUST 2001

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Acknowledgements

The Submerged Cultural Resources Survey, Stage IA, Central Guánica Eco-Resort, Guánica Bay, Puerto Rico, was made possible by the support of CSA Architects and Engineers, particularly archaeologists Norma Medina and Raquel del C. Camacho Hernández, Project Manager Brenda Guzmán, and Technical Manager Wilbur Martinez;, also assistant researchers Erik Rivera Marchand and Juan C. Román Castañer, William Pérez and Samuel Velez, Puerto Rico Land Authority, and computer consultant José Pérez. To all, thank you for your support.

JV

Executive Summary

Submerged Cultural Resources Survey, Stage IA
Central Guánica Eco-Resort
Guánica Bay, Puerto Rico

Jesus Vega, Ph.D.

The Submerged Cultural Resources Survey, Stage IA, Central Guánica Eco-Resort, was conducted on behalf of CSA Architects and Engineers, per request of the State Historic Conservation Office and the Council for Underwater Archaeology, Commonwealth of Puerto Rico.

The purpose of the study was to evaluate the project's potential impact on submerged cultural resources, historic and prehistoric. The proposed project is the restoration and waterfront development of the Central Guánica, or the Historic Guánica Sugar Mill, including construction of a marina and yacht club, the excavation of a navigational channel on the W side of Punta Pera, a ferry dock and boat slip, sport diving and kayaking tours, etc. The proposed docking facilities will extend from the south side of Punta Pera, to the NW corner of Bahía Noroeste.

The evaluation was based on extensive historic and environmental background data, with a preliminary field photo-inspection. The study was completed on August 7, 2001.

Results:

Extensive coastal and maritime human activity has taken place at Guánica Bay and at the now submerged insular shelf since early prehistoric times.

Preliminary environmental reconstruction indicates that, as late as 6,000 yrs BP, Guánica Bay was a coastal valley of the Río Loco. These lands were probably oocupied by preceramic peoples. Afterwards, marine transgression created a huge, shallow, estuarine environment, almost certainly exploited by late preceramic peoples. The present configuration of the bay (excluding modern fill and dredging) probably occurred around 4,000 yrs BP, followed by the arrival of prehistoric ceramic peoples about 2,000 yrs BP.

Significant historic events include the exploration of the bay since1508; an incipient settlement and salt works in 1510; the aboriginal attack of 1580; the English attack of 1743, resulting in the shipwreck of a packet boat or paquebot; the entry of contraband vessels throughout the 17th, 18th and 19th centuries, and the intensive shipping activity of the Central Guánica since1901. Construction of the Guánica sugar mill included an industrial pier, and the filling of the shallow channel between

Puercos Islet and the west coast of the bay (thus forming the shipping area of Punta Pera).

Other significant historic events include the escape of Ramón Emeterio Betances and Segundo Ruíz Belvis through Guánica Bay in 1867, and the U.S. invasion during the Spanish-American War in 1898.

The geoarchaeological and historical background data indicates that Guánica Bay is highly sensitive to submerged cultural resources, both historic and prehistoric.

In terms of actual sites within the Study Area, the previous conclusion simply states a high probability of potentially significant resources, potentially eligible to the National Register of Historic Places, including the following:

- Submerged prehistoric sites due to eustatic changes in sea level
- Aboriginal canoes, including prehistoric and historic eras
- Historic shipwrecks, 16th to mid-20th centuries
- Historic port discards, primarily early to mid-20th century.

Recommendations:

In order to test the probability of submerged cultural resources within the Study Area, it is necessary to conduct a combined methodology of marine remote sensing, underwater coring and visual inspection.

The recommended primary instrumentation for the remote sensing is a proton magnetometer. This is the standard tool for locating historic shipwreck sites, by detecting magnetic anomalies caused by ferrous objects such as cannon, anchors, chains, and other iron items generally found in historic shipwrecks. Significant magnetic anomalies should be inspected with underwater cameras, hand-held metal detectors and other underwater survey tools.

For detecting aboriginal watercraft and submerged prehistoric sites, both lacking in iron objects, a combination of sub-bottom profiling, visual inspection and underwater coring is recommended. This methodology is also effective for detecting historic port discards, generally including bottles and glass fragments, ceramics, shell, bones, etc.

At present, the Study Area is polluted beyond safe levels of standard scuba diving. Therefore, dry suits are considered essential for diving work. Underwater coring in shallow areas (<3m) may also be conducted from a boat. This method has been used by the author for underwater archaeological coring at Condado Lagoon and at San Juan Bay.

The recommended methodology is part of the Stage I level of investigation, but is often labeled as Stage IB, in order to differentiate between the background investigation, which defines sensitivity or probability (Stage IA, this report), and the field testing which defines actual sites within the area of potential adverse effects.

In conclusion, the recommendations for the IB marine survey include a magnetometer and sub-bottom profile survey of the Study Area, followed by diving inspection of anomalies and underwater coring of selected areas, at 10m intervals.

1. Introduction

This report documents the methodology and results of the Submerged Cultural Resources Survey, Stage IA, Background Literature Search and Field Inspection, for the Central Guánica Eco-Resort, Guánica Bay, on the south coast of Puerto Rico (Figure 1).

The investigation reported herein was conducted on behalf of CSA Architects and Engineers, San Juan, Puerto Rico, per request of the State Historic Conservation Office and the Council for Underwater Archaeology, San Juan, Puerto Rico.

This report is limited to the study of submerged cultural resources, prehistoric and historic, with a separate report for terrestrial cultural resources. The separation between terrestrial and maritime cultural resources is strictly logistical, with possible integration of data as the evaluation process is narrowed down to specific historic periods and archaeological sites.

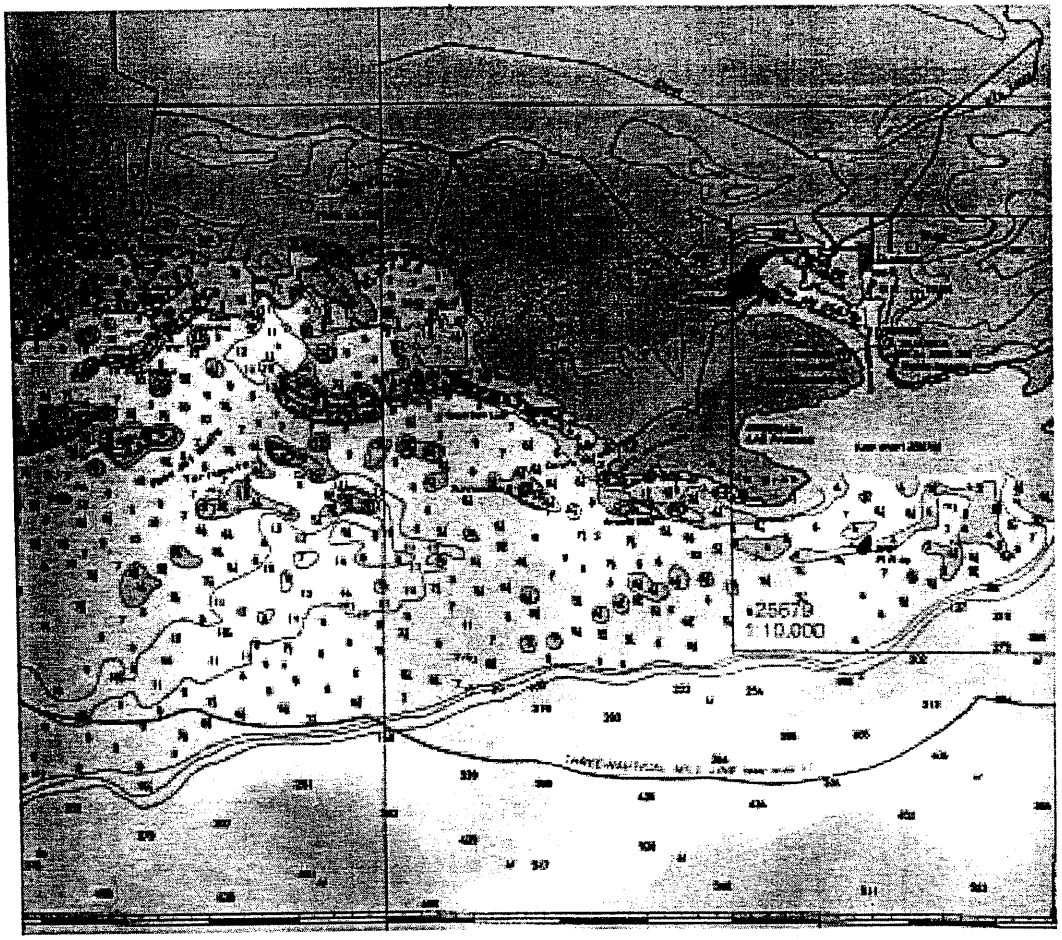

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Figure 1. Location Map, Guánica, south coast of Puerto Rico.
From left to right: Parguera, Bahía Montalva, Caleta Salinas, Ensenada Las Pardas and Guánica Bay. NOAA 25671,17th Ed., 1992.

1.1 Study Area

The Study Area includes the pier and submerged lands off the Central Guánica, from the south side of Punta Pera to the NW corner of Bahía Noroeste, on the west side of Guánica Bay, south coast of Puerto Rico (Figures 2 and 3).

The sediments at the Study Area are mostly fine sand and silt. The maximum existing depth at Guánica Bay is 29 ft. (8.8m). At present, the Study Area is polluted beyond safe levels of standard scuba diving. Therefore, dry suits are considered essential for diving work. An in-depth description of the Study Area is provided in subsequent sections of this report.

1.2 Proposed Project

The proposed project is the Central Guánica Eco-Resort, to be developed by Punta Ensenada Development Corporation (PEDC), San Juan, Puerto Rico. The project will preserve the historic zone of the Central Guánica, through the creation of a Marine Village along the west side of Bahía Noroeste and around Punta Pera. As presented in the PEDC Development Proposal, the Marine Village will include six (6) pier areas for yachts and smaller recreational vessels (Figure 4).

As part of the undertaking, the Central Guánica Eco-Resort must comply with all Commonwealth and Federal regulations, including the detection, evaluation and preservation of historic and archaeological resources.

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Figure 2. Guánica Bay, Topographic Map, Guánica Quadrangle, USGS 7.5 Minute Series,1966.

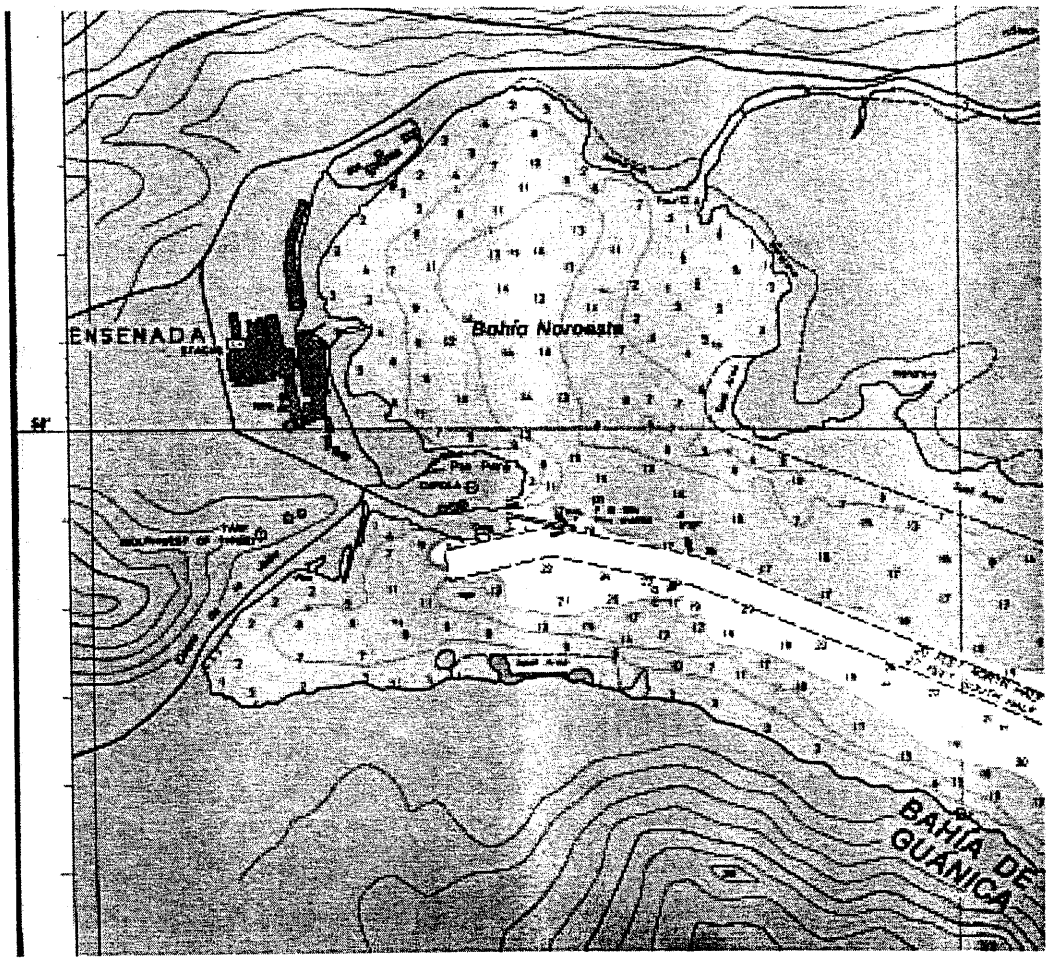

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Figure 3. Study Area, East Guánica Bay. NOAA 25679, Bahía de Guánica, 9th Ed., 1990. Soundings in Feet.

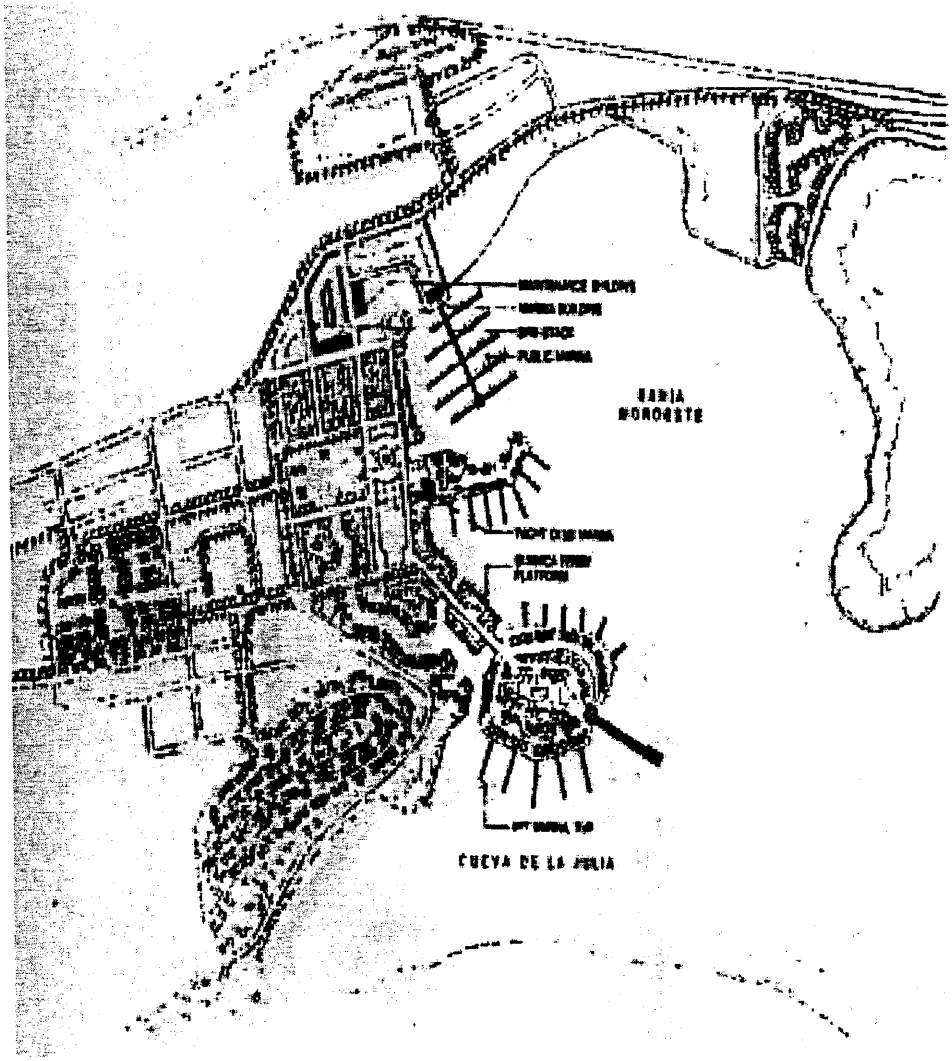

Figure 4. Preliminary sketch of marina facilities, Central Guánica Eco-Resort.

1.3 Objective of the Study

As part of the evaluation process of the Central Guánica Eco-Resort, and in compliance with Section 106 of the National Historic Preservation Act of 1966 as amended (16 U.S.C. 470) and Puerto Rico Law Number 10 of 1987, a Submerged Cultural Resources Survey, Stage IA, was conducted for CSA Architects & Engineers, per requirements of the State Historic Conservation Office and the Council for Underwater Archaeology, Institute of Puerto Rican Culture.

The purpose of the study was to conduct a background literature search on known and potential submerged archaeological sites, historic or prehistoric, within the Study Area, with a preliminary coastline inspection.

The information generated by the Stage I assessment determines the sensitivity of an area to specific types of cultural resources, providing a first-line research design or framework for cultural resource management (CRM), and recommending additional studies, if necessary.

The initial research may include a Reconnaissance Survey (Stage IB), designed to locate actual archaeological sites or features in the field. In most marine projects, the standard methodology involves a magnetometer survey with inspection of diving anomalies. This methodology is highly effective for detecting historic shipwreck sites, but will not detect prehistoric sites or aboriginal canoes, because these sites do not contain iron objects detected by the magnetometer. In order to account for both historic and prehistoric sites under water, predictive models are essential. Models help us define areas of

high probability, as well as predict the probable size, shape and materials of our target sites. Armed with this theoretical information, researchers may then test the sensitive areas with a combination of remote sensing, visual inspection, and underwater coring.

1.4 Dates of the Study

Library and archival research was conducted through the month of July, 2001. The initial field inspection was conducted on August 6, 2001. The Final Report was completed on August 7, 2001.

1. Environmental Background

This section provides environmental data on the Study Area, with emphasis on physical geography, coastal geomorphology, and oceanography. Environmental information is essential to archaeology, both to understand present conditions and their potential for preserving or destroying the archaeological record, and as the first step for reconstructing past environmental conditions. As a general rule, the further we travel into the past, the greater the possibility of environmental changes.

All human activity, past or present, occurs within a dynamic biophysical setting, involving a complex interrelationship of solar radiation, climate, geological structures and rocks, ocean currents, rivers, soils, plants, animals, microorganisms, etc. From the perspective of the environmental sciences, all of these organic and inorganic variables may be grouped within four basic components: atmosphere, hydrosphere, lithosphere and biosphere (Butzer 1982:16). By considering all past human activity within these four components, archaeology becomes an extremely complicated and difficult

discipline, with nearly unlimited questions about how our species interacts with the world around us.

2.1 Physical Geography of Puerto Rico

Puerto Rico is approximately 161 km (100 miles) long and 56 km (35 miles) wide. The island is divided north-south by a central mountain chain of volcanic and plutonic igneous rocks. About 40% of Puerto Rico is mountain terrain, with 35% hill and 25% level (Picó 1974:26). The highest elevation is Cerro Punta, towards the center of the island, with an altitude of 1,338m (4,390 ft.). Prominent peaks also rise on the northeastern section of the island, at the Luquillo Range, reaching a maximum elevation of 1,074 m (3,532 ft.).

Although the size and elevation of islands might seem like "hard facts" which remain constant through time, in fact both are relative to the global or eustatic sea level. As discussed in detail in section 3 of this report, periods of lower sea level imply larger islands with higher peaks. Thus, even something as "simple" and "well known" as the size and elevation of Puerto Rico, will not apply to the prehistoric environment of 10,000 years ago.

Puerto Rico's insular shelf is narrow off the north (N) coast, and wide off the east (E) and southwest (SW) coasts. The composition of the coastline ranges from unconsolidated sediments, to limestone and igneous rock formations. Of 740 km of coastline, 20% are beaches, which are generally short and divided into separate systems with little interaction (Morelock and Trumbull 1985:187). Tides average about 30 cm (1 ft.). Shorelines exhibit

great variation, with five generalized types in six separate sections (Kaye 1959:51).

The north coast is characterized by high energy beaches and limestone cliffs. In contrast, the south coast is mostly low-energy mangrove. Both the east and west coasts exhibit fault control (Morelock and Trumbull 1985).

Sea surface temperatures range from 82.5°F in September, to 77.9°F in February. Largely due to the moderating effect of the sea, Puerto Rico's median temperature of 79°F at sea level varies within the relatively narrow range of 5.9°F through the year. This narrow temperature range leads many people, archaeologists included, to the idea that Puerto Rico lacks seasonal variation: the land of eternal summer. On the contrary, if we try to reconstruct the lifeways of people who were navigators, fishermen, hunters, gatherers or planters, we must recognize significant seasonal variations in winds, currents, waves, air and sea temperatures, rain, etc. This is true both for the aboriginal peoples of prehistory, and for the Spanish and criollo farmers and fishermen of history.

Most rainfall and river discharge is to the north, with a semi-arid south coast. Rain is most abundant at El Yunque Rain Forest on the northeast, with over 5 m (200 inches) of annual rainfall. The southwest is the driest part of the island, with an average annual rainfall pf 1 m (40 inches).

Puerto Rico's position on the northeast corner of the Caribbean Basin exposes it to the mainstream of the Great Northern Equatorial Current (GNEC). This powerful ocean current originates off the West African coast

and crosses the Atlantic Ocean in clockwise fashion, veering north as it touches the Caribbean.

The influence of the GNEC provides an additional element of humidity to the island's tropical climate. The sea-land breezes generally blow offshore at night and a dawn (when the land is cooler than the surrounding ocean), ad inshore during the daytime (when the sea is cooler).

The island is also affected by hurricane winds, which are frequent in the Caribbean during the warmest months, from June to November. In general, hurricanes follow the WNW path of the trade winds.

From the perspective of maritime archaeology, hurricanes are extremely important as a primary cause of shipwreck. In fact, the earliest known historic shipwrecks potentially found in Puerto Rico's waters, are the ships of Francisco de Bobadilla's fleet of 1502, with up to sixteen vessels destroyed by hurricane winds somewhere within Mona Passage, between Puerto Rico and the Dominican Republic (Cardona 1989:23-39).

Puerto Rico has approximately 1,300 streams, of which seventeen (17) form true river systems. The largest rivers flow to the north, where low drainage results in swamps and march lagoons. At face value, there appears to be a spatial relationship between rivers and aboriginal chiefdoms, or *cacicazgos*. Many of the primary settlements were located near large rivers, which provided water, diverse sources of food and natural "water roads" between the coast and the interior. Consider, for instance, the names Bayamón, Loíza, Canóbanas, Turabo, Humacao, Maunabo, Guaraní,

Guayanilla, Yauco, Guanajibo, Gurabo, Yagüez, Guajataca, Camuy, Tanamá, Arecibo, Manatí and Cibuco, all names of rivers associated with aboriginal *caciques*.

Puerto Rico's soils show great variation. Only about 6% or 129,000 acres are classified at present as first rate. About 75% of the island's soils are considered of inferior quality, located mostly in the mountainous interior (Picó 1974:214).

2.2 The South Coast

The south coast of Puerto Rico is mostly indented, low energy, with alternating limestone headlands and alluvial embayments. Beginning on the SE at Punta Guayanés and moving west, the south coast includes the bays of Yabucoa, Patillas, Jobos, Salinas, Rincón, Ponce, Tallaboa, Guayanilla, Guánica, Montalva, Parguera, Sucia and finally Salinas at the SW tip of Puerto Rico.

The south coast is also characterized by numerous islets and shallow reefs, including, moving east to west, Arrecife Sargent, Arrecife Guayama, Bajo Guilarte, Arrecife Mareas, Cayos Caribes, Cayos de Barca, Cayos de Pájaros, Cayo Morillo, Cayos de Ratones, Arrecife Media Luna, Cayo Alfeñique, Cayos de Caracoles, Cayos Cabezazos, Cayo Berbería, Isla Caja de Muertos, Isla del Frío, Isla de Cardona, Cayo Arenas, Isla de Ratones, Cayo Parguera, Cayo Caribe, Cayo Río, Cayo Palomas, Cayo María Langa, Arrecife Guayanilla, Arrecife Fanduco, Arrecife Unitas, Cayos de Caña Gorda,

Arrecife Baúl, Turrumote II, Cayo Don Luis, Arrecife Romero, Arrecife Enmedio, Turrumote I, Arrecife Media Luna, Isla Magueyes, Arrecife Margarita, El Palo, isla Guayacán, Isla Cueva, and other minor, nameless reefs and islets. Most of these islets and reefs are potential locations of archaeological sites, including historic shipwrecks and submerged or intertidal shell middens. Prehistoric archaeological sites on the south coast and offshore islets are discussed in section 3, followed by historic ports in section 4, and historic shipwrecks in section 5.

Unlike the north coast, which is characterized by a prevalence of eolianite and beachrock, the south coast has no reported eolianite and only a minor presence of beachrock on the present shoreline (Kaye 1959:67-101).

Eolianite is wind-deposited sand cemented by calcium carbonate ($CaCO_3$). In Puerto Rico, eolianite or cemented dunes may reach a height of 30 m (100 ft.) or more. On the north coast, San Juan's fortresses of El Morro and San Cristobal rise atop eolianite, of which four generations of cemented dunes are recognizable (E1-E4), each separated by a layer of ancient soils or peleosols.

Beachrock is cemented sand or shingle. As in eolianite, the cementing agent is calcium carbonate, with rare instances of cementation by iron oxides. Beachrock forms a hard pavement along the shore. When found under water, it clearly indicates that marine transgression or has taken place. The pavement generally dips at a slight angle towards the sea, and may reach a

width of 60 m (200 ft.) or more. Frills or grooves perpendicular to the shore are often formed on the pavement, produced by mechanical abrasion.

Both brachrock and eolinaite are associated with high energy coasts, which appears to be the best explanation for their absence or limited presence on the south coast, which is mostly low-energy. Other geomorphological and biological factors might also be involved in this significant difference between Puerto Rico's Atlantic north coast and the Caribbean south coast.

The south coast of Puerto Rico generally consists of a narrow plain, often associated with faults and folds of sedimentary rocks. This is in marked contrast to the wide coastal plain of the north coast. Thus, the distance from shore to the hills tends to be smaller along the south coast, and the hills tend to be steeper as well (Bush et al. 1995:1-6).

The geology of the south coast consists primarily of Quaternary alluvial deposits and Miocene to Oligocene limestone, with Tertiary and Cretaceous volcanic deposits towards the west end of the island (Morelock 1978; Morelock and Trumbull 1985).

The geology of Guánica is characterized by the Juana Diaz Formation and the overlying Ponce Limestone (Tpj), undivided at present, and the Parguera Limestone (upper member Kpu and lower member Kpl). The Juana Diaz Formation and Ponce Limestone are dated in the Miocene and Oligocene Epoch of the Tertiary Period, roughly 25 to 30 million yrs BP. The Parguera Limestone is dated in the Cretaceous, about 66 million yrs BP.

The Juana Diaz Formation is reddish-brown to reddish-orange, ith interbedded sand and medium-to-coarse grained gravel, sand and cobbles, poorly cemented with calcite and hematite, generally overlain by sandy mudstone grading into limestone and chalk, and underlain in angular unconformity by volcanic and sedimentary rocks.

The Ponce Limestone is yellowish-white to yellowish-orange, made up of poorly cemented calcidurite and calcarenite, rich in oyster shells, with minor corals and gastropods. A layer of caliche or calcium carbonate crust (1-3m) is common, generally containing fragments of the underlying calcidurite and calcarenite.

The Parguera Limestone is exposed south of the Lajas Valley. This formation lies on serpentines, cherts and amphibolites of the Bermeja Complex, and locally on volcanic rocks of the Lajas Formation and Boquerón Basalt.

The Río Loco controls the hydrology of Guánica. Originating in the hills of Sabana Grande, the Loco River is about 22km long. This river originally flowed into Guánica Lagoon, which dried out after constructin of the Lajas Valley Irrigation Works in 1949. At present, the Río Loco flows into the Caño de Los Negros, which connects to the NE corner of Bahía Noroeste. The Loco River Dam was built in 1954, in Lajas.

The Loco River was called the Guánica River in the 16th century, the cacique River in the 19th century, the Susua River in the early 20th century, and finally Loco or "Crazy River" in modern times (Rivera Fontán 1995:8).

According to local folklore, the river's name is due to its erratic behavior, presumably changing course at least once.

The final run of the Loco River along the east side of the Abra Hills is a significant feature, exposing outcrops of the Juana Diaz Formation, eroding various prehistoric archaeological sites, providing a natural barrier on the west side of the river, and increasing the flood potential to the east of the river, including the towns of Guánica and La Luna. The alluvium deposits of the Loco River consist of clay, sand, gravel and boulders of volcanic rock (Monroe 1977).

2.3 The South Insular Shelf

The insular shelf is the submerged land that extends from the shoreline to the insular slope, where the coastal waters more or less abruptly deepen into the open ocean. The frontier between the relatively shallow shelf and the slope is sometimes called the shelf break. In Puerto Rico, the shelf break may be defined from about 50 to 100 m. To the north, the slope descends steeply towards the Puerto Rico Trench, the deepest area of the Atlantic Ocean. Ninety-five miles north of Puerto Rico, the Trench reaches a depth of 9,219 m (30,245 ft.), with enough vertical space to accommodate Mount Everest. To the south, the Puerto Rico slope descends towards the depths of the Venezuelan Basin, among the deepest areas of the Caribbean Sea, with an average depth of 5000 m.

The insular shelf must not be confused with the territorial sea, which is measured at three nautical miles from the shoreline. The territorial sea is a legal and geopolitical concept, where nations have exclusive rights to marine resources. In some areas, the territorial sea and the insular shelf might coincide, but the latter is an oceanographic concept.

From a geoarchaeological perspective, the insular shelf may be defined as the submerged lands that were exposed during the Wisconsin glacial maxima, and were actually or potentially occupied by prehistoric peoples whose sites were later flooded by the rising sea level.

From the perspective of historical archaeology, the insular shelf is where most historic shipwrecks were lost, mostly due to groundings, storms and hurricanes, battles or fire. Although many important sites lie in deep waters, the insular and continental shelves are likely to remain the primary areas of undersea archaeological research during the 21st century.

According to the marine geologic map for the Puerto Rico Insular Shelf, Guánica to Ponce (Trías1991), the insular shelf off Guánica is defined at the 50 m contour. For this area, the most prominent feature of the insular shelf is the Guayanilla submarine canyon system.

The Guayanilla submarine canyon system includes Guánica, Guayanilla, Cuchara and Muertos Canyons (Trumbull and Garrison 1973). The system is also fed by the smaller, tributary canyons of Punta Ventana and Tallaboa Canyons (Trías 1991). All of these submarine canyons are found opposite existing rivers on the south coast.

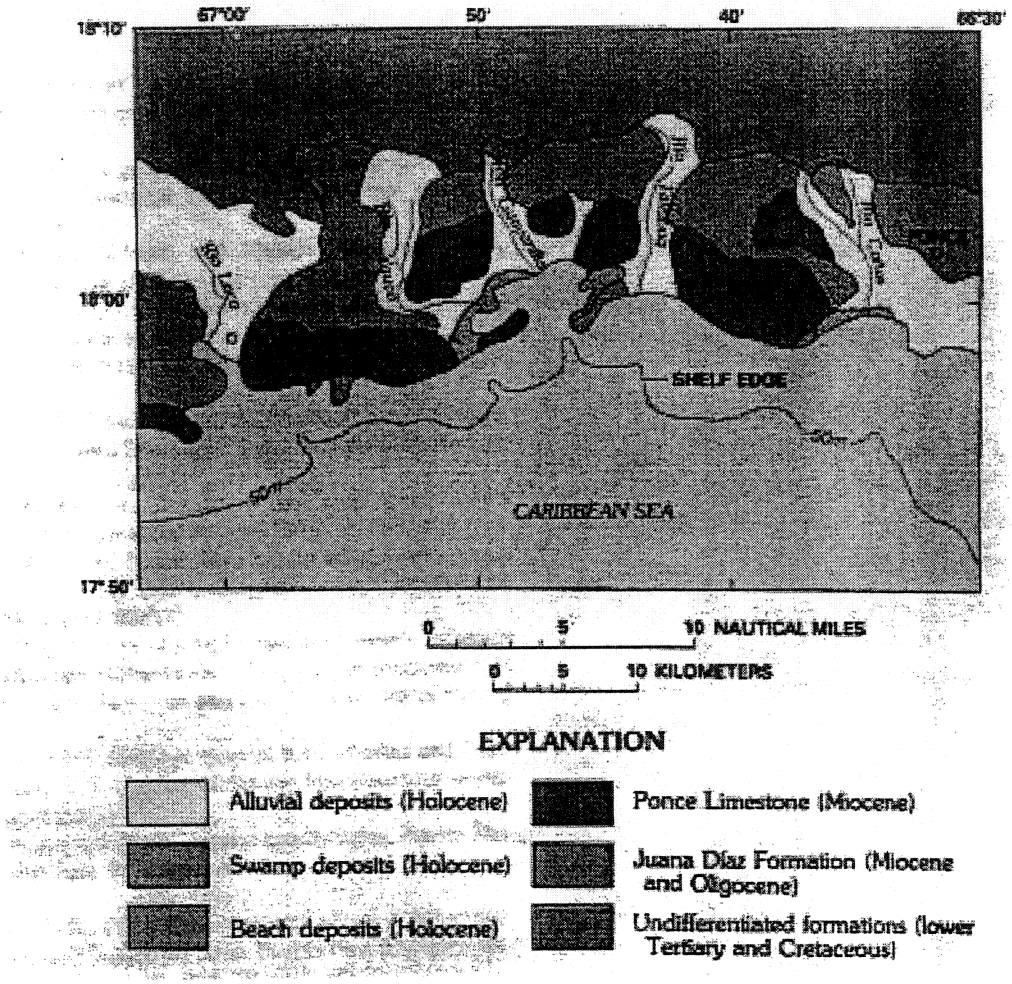

Figure 5. Generalized geology of Guánica and Ponce. Marine Geology Map of the Puerto Rico Insular Shelf, Guánica to Ponce Area (Trías 1991).

Trumbull and Garrison (1973) have postulated that the shallow parts of the submarine canyons have a subaerial origin, formed when the insular shelf was exposed by a lower sea level of the Wisconsin glaciation. At that time, Puerto Rico's shoreline was located on the present insular shelf. Cuchara Canyon may be an older extension of the Río Cañas system, but was closed by uplift.

At the west end of the submarine canyon system is Guánica Canyon. This canyon is presumed to be the submerged extension or paleo-channel of the Loco River in Guánica. During the Wisconsin glaciation and early to mid-Holocene, Guánica Bay was a coastal valley with the Río Loco running through it.

The presence of the Guayanilla submarine canyon system is highly significant to this investigation, for it provides clear, geomorphological evidence that Puerto Rico's insular shelf was exposed during the Wisconsin glaciation and inundated in the Holocene Epoch. The secondary influence of tectonic uplift is also suggested, but on a much smaller scale than the eustatic or global sea level changes. The archaeological implications of these processes are discussed in section 3 of this report.

2.3 Guánica Bay

Guánica Bay is regarded as one of the best hurricane harbors in Puerto Rico. Located 16 nautical miles east (E) of Cabo Rojo Light, Guánica Bay is protected by an elevated coast on the east and west sides, and by coastal hills to the north. To the east is Cerro Caprón, to the west is Monte Las Pardas,

and to the north is the Cerro de Abra, which is known to archaeologists as an area of numerous prehistoric sites.

Guánca Bay is the only pouch-shaped harbor in Puerto Rico. This type of bay is particularly common in Cuba. Some researchers have suggested that pouch-shaped bays are the product of drowned river mouths (Kaye 1959:53).

The entrance to the bay is located about 2km south of the town of Guánica, and is protected by the steep shores of Punta Meseta to the east, and Punta Pescadores to the west. The most prominent cultural feature at the entrance is Guánca Light (17°57.2'N., 66°54.3'W.), and 132 ft. (40.23m) above mean sea level (MSL). A second, abandoned lighthouse tower is located about 100m SE of the operating light (NOAA 1991:312-313). Another operating light is found at the northeast end of the bay, at Playa de Guánica.

Both sides of the entrance have inshore reefs. The entrance channel was privately dredged for the Central Guánica, which operated from 1901 to 1981 (Ramos 1999). The channel's controlling depths for 1970 were 21 ft. in the turning basin, 26 ft. for the north channel leading towards the town of Guánica, and 2t ft. for the west channel towards the Central Guánica's pier at Punta Pera (ibid.).

The principal anchorage is 0.6 mile E of the Central Guánica pier. The fishing pier is located at Playa de Guánica. Parts of the south shore of Cueva de la Julia, about 300m S of Punta Pera, have been informally occupied by house boats, gradually creating an anhorage of recreational boats. The pilots and boats of Guayanilla Bay also serve Guánica Bay.

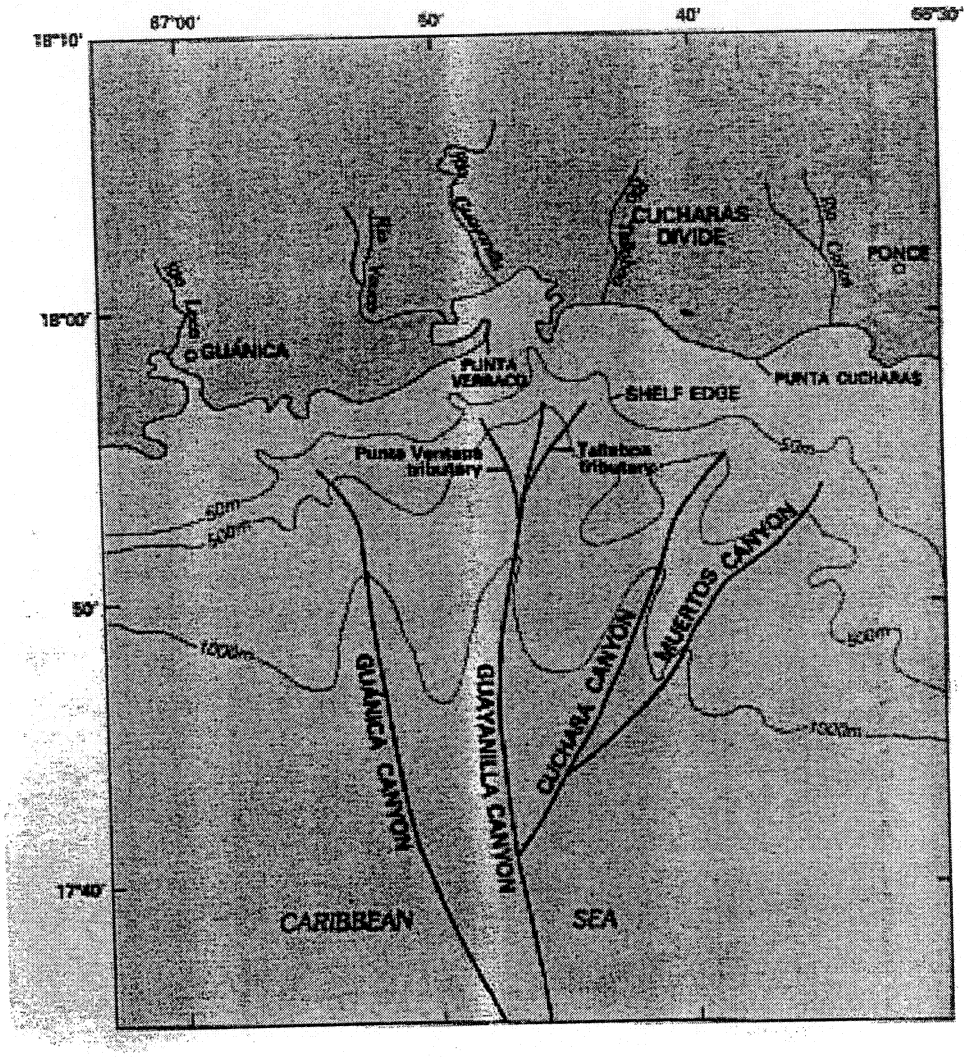

Figure 6. Guayanilla submarine canyon system (Trías 1991). Notice Guánica Canyon leading towards the entrance of Guánica Bay. This canyon is presumed to be the paleo-stream of the Río Loco during the Wisconsin Glaciation, across the now submerged insular shelf. Just as prehistoric ceramic sites clustered around the Río Loco, preceramic sites probably clustered around its paleo-stream, then running along Guánica Bay and into the insular shelf.

The bottom sediments within Guánica Bay are primarily silt and clay (Unit 1) and silt and fine sand (Unit 2). Unit 1 contains fine rock fragments, and carbonate constituent such as pelecypods and echinoderms (Trías 1991).

Dangers to navigation include the Cayos de Caña Gorda and Arrecife Coral, both located E of the entrance; Corona La Laja, located SSE of the entrance; the reefs at Ensenada Las Pardas, W of the entrance, and the inshore reefs on both sides of the entrance itself. Some of these reefs offer good to excellent locations for scuba diving, as well as the possibility of historic shipwrecks.

Punta Pera has two small wharves on the south side, as well as pipelines for water, fuel and molasses, and a conveyor system for bulk sugar. The long pier off the E end of Punta Pera is called the Dominican Dock by the U.S. Coastal Pilot, and was built specifically for loading sugar cane from the Central Guánica, on ships bound for the Dominican Republic.

3. Submerged Prehistoric Sites

This section addresses the probability of submerged prehistoric sites within Guánica Bay, including the separate but related topic of aboriginal watercraft. Submerged terrestrial sites may include shell middens, lithic quarries and workshops, human burials, post molds of thatched houses, hearths, or the remnants of entire villages, originally built on the coast and subsequently flooded by the rising sea.

Archaeological modeling and field research indicate the possibility of submerged prehistoric ceramic sites in shallow water (tidal zone to 3 m), as well as older, preceramc sites (tidal zone to 20 m+). The maximum age of preceramic sites in Puerto Rico is unknown, since most of these sites are presently under water and the first one was only recently discovered off the north coast.

3.1 Changing Levels of Land and Sea

Marine transgressions, the technical term for the flooding of coastal areas by the sea, may occur due to a variety of local, regional, or global processes. Land may be eroded or subside due to tectonic movement, isostatic depression or sediment compaction. In higher latitudes, postglacial rebound may gradually lift the coast.

Sea level may rise due to changes in the volume of ocean water or ocean ridges (Donovan and Jones 1979). Following current theory, the major agent of coastal change has been a global or eustatic sea level rise due to the melting of land-blocked ice, resulting from cyclical variations in the earth's orbit (Hays et al. 1976:1121).

According to the glacio-eustatic model, low sea levels are associated with land ice advances called stadials, while high sea levels are associated with the retreat of land ice sheets called interstadials. The more ice on land, the lower the sea level.

Numerous ice ages have occurred as far back as 93 million years ago, but our concern is with the last ice age so far. Beginning about 80,000 yrs BP (before the present), the more recent ice age is defined as the Wisconsin glaciation in North America, and the Würm glaciation in Europe. This glacial episode played a central role in the migration of our species, *Homo sapiens sapiens*, to the principal archipelagoes of the world, including the Caribbean, by reducing the distances between continental masses and offshore islands world-wide.

There is general consensus that the sea was near its present level by about 35,000 yrs BP. Then the sea level began to drop as the Laurentide and other Pelistocene ice sheets expanded over the Northern Hemisphere.

By 20,000 to 15,000 yrs BP, sea level reached its lowest point in the Wisconsin glaciation. Estimates for this lowest sea level stand include minus 60 m (Blackwelder et al. 1979), minus 85-90 m (Morner 1971), and minus 130 m (Milliman and Emery 1968).

Around17,000 to 15,000 yrs BP, the Holocene marine transgression began. During the most rapid stage of deglaciation, beginning about 10,000 yrs BP, sea level probably rose at a rate of 10mm per year. By 7,000 yrs BP, sea level may have been some 10 m (32 ft.) below present level (Shepard 1963). By that time, much of the Caribbean Archipelago had been reached by preceramic navigators.

From 7,000 yrs BP onwards, the sea continued rising at a much slower pace. At this stage, there are significant disagreements among researchers. Van Andel and Laborel (1964), Fairbridge (1961) and others have proposed sea level oscillations with higher-than-present sea levels in the late Holocene, while Curray (1961), Scholl and Stuiver (1969), Shepard (1963) and others have reported evidence of a smooth sea level curve approaching the present level by about 4,000 to 2,000 B.P. Indirect corroboration from oxygen isotopic analysis of glacial history supports slightly higher, late Holocene sea levels than at present, but the problem remains an open question.

The rising seas were marked by interruptions or stillstands. These periods of stationary sea levels allowed the development of marine terraces, which may be observed under water. Prominent submarine terraces are found in the Caribbean, the Gulf of Mexico, and the Pacific Ocean at the average depths of 15 m (49 ft.) and 40-45 m (130-165 ft.). The depth of marine terraces may vary due to local tectonism, so that Pleistocene terraces may be found in shallower water, and even above present sea level.

Stillstands also allowed the formation of sea caves, beaches, and associated geomorphological features. From an archaeological perspective, stationary sea levels also made possible the formation of permanent, or semi-permanent, stratified coastal sites (Vega 1990, 1995).

Since the early 1930's, archaeologists speculated that prehistoric peoples lived on portions of the now submerged, continental and insular shelves. However, most researchers assumed that such sites would have been destroyed by the rising seas of the Holocene transgression. Today, the archaeological community has finally begun to realize that the traditional "sand castle hypothesis" is false (Vega 1990). During the last three decades, diving researchers have proven that submerged land sites of virtually any age may survive inundation in both fresh and salt-water environments, and be systematically studied under water.

Submerged land sites of prehistoric, classical or historic cultures have already been found world-wide, including Florida, California, Maine, Canada, Jamiaca, Puerto Rico, Cuba, Virgin Gorda, Nevis, St. Eustatius, Denmark,,

Russia, Yugoslavia, Sweeden, France, England, Spain, Portugal, Gibraltar, Italy, Greece, Turkey, Israel, Lebanon, Tasmania, The Philippines, etc. (Masters and Flemming 1983; Muckelroy 1980, etc.).

Searching for submerged prehistoric sites was first proposed in the United States by Goggin (1960), with early discussions by Solecki (1961), Shepard (1964), Emery and Edwards (1966), Salwen (1967), Bullen (1969) and Warren (1964). During this time, the archaeological community was not ready for diving and sea level research, and the problem remained more theoretical than practical.

In the Caribbean, the search for submerged prehistoric sites was first proposed by Nicholson (1976a), following a survey of Antigua, which indicated that shell middens on the NE coast are undergoing marine transgression, while middens on the SW coast are now inland.

More recently, Ruppé (1980b) has also encouraged a search for drowned Caribbean sites, based on his own successful underwater research in West Florida.

The first excavation of a submerged prehistoric site in the Caribbean was conducted by the author, at isle Verde Site, off Puerto Rico's north coast (Vega 1981, 1982). Geoarchaeological modeling indicates that all four coasts of Puerto Rico may yield submerged prehistoric sites, with the highest probability off the NE coast (Vega 1990b). Another submerged prehistoric site has been identified off Joyuda, off the W coast (Vega 1995).

More recently, a submerged preceramic site, probably the first in the Caribbean, was detected off Condado Beach, San Juan, Puerto Rico (Vega 1999).

3.1 Prehistory of Puerto Rico

According to Rouse and Allaire (1978:465), people started migrating into the West Indies as early as 7,000 yrs BP. This entry is backed by Pina (1971), Veloz and Ortega (1976), and others. Raggi (1973) suggests a possible entry between 6,000 and 15,000 yrs BP. Nicholson (1976) suggests possible migrations as early as 17,000 yrs BP.

Regardless of the time and reasons of the first Caribbean migrations, it is clear that the first prehistoric explorers used some type of watercraft to cross the passages from the mainland(s), and then from island to island. The first West Indians were navigators in a semi-enclosed sea.

The earliest inhabitants of Puerto Rico and the Caribbean were preceramic peoples. Although there are significant variations within the preceramic cultures, the following criteria are applicable to most groups:

- small population units (<100 individuals per band)
- tendency towards nomadism
- hunting, coastal gathering and fishing
- no use of agricultue
- watercraft without sails
- often assocated with coastal middens.

It is important to keep in mind that preceramic peoples were fishermen and coastal hunter-gatherers not because they had yet to invent agriculture and ceramics, but rather because their small numbers and available resources allowed them to live off the land and the sea without the toil of agriculture.

Formal preceramic typologies have been produced by Kozlowski (1974), Pina et al. (1976), Rouse and Allaire (1978), and others. Although there are significant discrepancies, most researchers would agree that there are three primary typological patterns in the archaeological assemblages of preceramic cultures. Pattern 1 is characterized by ground stone artifacts, including stone balls, mortars and grinders. Pattern 2 is characterized by stone artifacts produced by percussion and pressure flaking, including choppers, scrapers, lanceolate points, flint knives, blades and microblades. Finally, Pattern 3 is characterized by shell artifacts, including conch picks and vessels, shell hammers, scrapers and gouges.

Preceramic peoples survived into the Ceramic Age of Arawak and Carib migrations from South America. Moreover, some preceramic bands survived into the early historic period, at least in Cuba, as reported by Spanish geographers Andrés Morales and Alonso de Santa Cruz (Sauer 1969:48).

Ceramic-producing peoples started migrating from South America into the Caribbean about 2,500 yrs BP or more, moving north along the Lesser Antilles and arriving in Puerto Rico as early as 300 BC (before Christ).

Originating of Arawak stock, these peoples were characterized by the following traits:

- horticulture
- ceramics
- permanent villages
- watercraft without sails until historic times
- originally settled in coastal areas
- often associated with large shell middens
- sophisticated stone sculptures
- increased dependence on agriculture
- absorption of previous, preceramic peoples
- construction of plazas and ball courts
- eventual development of ceremonial centers
- culmination in regional chiefdoms

At the time of the Spanish arrival in the so-called New World, the aboriginal ceramic cultures of Puerto Rico were exploiting all ecozones, including the sea, the coast, mangrove lagoons, rivers, inland valleys and the rugged mountain interior.

Aboriginal ceramic sites in Puerto Rico are generally grouped into three principal, pottery-making traditions. In chronological order, these include the Saladoid, Ostionoid and Chicoid series or traditions. Again, there are

differences of interpretation and stylistic variations within these traditions, but the main traits may be described as follows:

Saladoid: white-on-red wares, often including modeling ans incision. Often associated with land-based foods, particularly crabs. Related traits include *zemis* or three-pointed stones, cohoba pipes, etc. Saladoid sites in Puerto Rico range approximately from 300 BC (before Christ) to 600 AD (after Christ). A distinct Huecoid series has been proposed by Chanlatte, which other researchers interpret as a Saladoid sub-series (Rouse 1992).

Ostionoid: use of red paint on entire surfaces of vessels, evolving into a red slip. Emergence of ball couts and ceremonial centers in Puerto Rico, and apparent increase in the production of *zemis*, have been related to the Ostionoid series. Often associated with large shell middens. Ostionoid sites in Puerto Rico range approximately from 600 to 1200 AD.

Chicoid: also called Chican-Ostionoid by some authors. Elaborate pottery with smooth surfaces and modeled-incised designs, but little use of paint. Chicoid ceramics are associated with the Taíno chiefdoms encountered by the first Spanish explorers and settlers (Rouse 1992). Chicoid sites in Puerto Rico range approximately from 1200 AD to the mid-16th century.

The coast of Guánica is highly sensitive to prehistoric, terrestrial archaeological sites. Over twenty-three (23) prehistoric archaeological sites have been reported around Guánica Bay and at nearby Ensenada Las Pardas, Salinas Providencia, and Bahía La Ballena. These numbers are likely to increase with additional field research.

The first report of archaeological sites in Guánica was written by Lothrop (1915), who explored two caves. One of the caves had petroglyphs, which were cut from the rock and send to the Smithsonian Institute (Rivera Fontán 1995:24).

In the 1920's and early 30's, Guenard explored the large site at the Municipal Cemetery (Britton 1930). The site is located about one km NW of the town of Guánica and about 850m N of the mouth of the Río Loco at Bahía Noroeste. In 1934, Rainey also conducted a preliminary survey of the site (Rainey 1940). Known as Los Indios, Abra, Cemetery and now formally classified as Guánica 9 or G-9, the site was excavated by Rouse in 1937.

The site of Abra (G-2) consisted of five shell middens, ranging in depth from 1 to 1.5m, with Ostiones shards detected in all levels of the test excavatons (Rouse1954:517). This site is significant to our investigation, as it offered the first published evidence of long-term prehistoric occupation along the Loco River. Without question, the people of Abra exploited the marine resources at Guánica Bay, including the use of canoes.

In 1980, a ceramic site was excavated at Playa Santa by the Fundación Arqueológica del Suroeste. As is often the case, the results of the excavation were never published, and the technical report, if ever written, has been lost. A summary of this investigation was produced by Rámos Vélez (1996), based on interviews with some of the excavation members. The excavation detected numerous hearths, as well as Saladoid and Ostionoid ceramics.

Also in 1980, an island-wide archaeological inventory was attempted by J. Gonzalez, who reported six prehistoric sites for Guánica to the Institute of Puerto Rican Culture.

In 1984, J. Walker conducted a systematic archaeological investigation of the Río Loco. This survey detected a new prehistoric site on the SE end of the Abra Hills (G-8), and another about 100m E of the river. Other prehistoric sites in Guánica have been reported by Maíz and Questell (1984), Questell (1987), Ramos y Ramirez de Arellano (1990), Ramos velez (1996), Rodriguez Miranda (1997), and Rivera Fontán (1995).

According to early Spanish sources, the principal cacique Agueybaná lived in Guánica, but his settlement has never been identified. According to Montalvo Guenard, the word Guánica drives from the Taíno Guanin-quen, which means the land of gold (de Hostos 1992:699). According to Alvarez Nazario (1999:101), Guanica derives from Huanicoy, a minor Taíno chief or cacique.

Although prehistoric sites on land do not necessarily imply the presence of submerged prehistoric sites, they nonetheless indicate extensive aboriginal activity in and around the bay. This classifies Guánica Bay as a sensitive area for all prehistoric archaeological sites, including intertidal and submerged middens, prehistoric watercraft and fish weirs.

A submerged, preceramic site was recently detected off Condado Beach, San Juan, by the author and oceanographer Vance Vicente, during the installation of a fiber-optic, trans-oceanic cable (Vega 1999). Vega-Vicente Site is a shell midden about 205 m (671 ft.) from shore, at a depth of 6.7 m (22 ft.), behind a submerged beachrock pavement. This discovery supports the author's model for submerged prehistoric middens (Vega 1990b:13, Fig. 18).

According to mid-to-late Holoene sea level curves for the Caribbean, based on extensive coring and radiocarbon dating of wetlands in Jamaica (Diggerfeldt and Hendry 1987), the depth of the site suggests a tentative dating of 6,250 yrs BP. The site is characterized by large lithic tools, numerous shell points, absence of pottery, *Strombus* conchs with their tips removed, and diverse species of gastropod and bivalve shells.

About the time that Vega-Vicente Site was occupied off Condado Beach, Guánica Bay was a coastal valley. Considering the presence of the Loco River, a paleo-estuarine environment at nearby Ensenada Las Pardas with abundant shelfish and inshore fishing areas, excellent resources for lithic workshops at the nearby Abra Hills,and the presence of coastal caverns, there is a very high probability that the paleo-valley of Guánica Bay was occupied by preceramic peoples.

Due to the erosion of archaeological sites by the Loco River, prehistoric artifacts may also be transported to Guánica Bay, potentially creating the illusion of a submerged prehistoric site. Although rediposited materials may

3.3 Submerged Prehistoric Sites

Puerto Rico's first submerged prehistoric site was discovered by the author and geologist Arturo Camacho, in the late 1970's, off the north coast (Vega 1981). Located 6 km E of San Juan Islet, Isla Verde Site is a submerged midden off Punta el Medio, Carolina. The site is located in shallow water, between an inshore reef and Puerto Rico's north shore.

Following a preliminary survey in 1979, underwater test excavations were conducted in 1980. The site has been subsequently visited for additional observations, up to the present.

Underwater excavations revealed a compact midden, submerged in place. Located at the median point of a compound lunate embayment, Isla Verde was submerged as the embayment expanded. During transgression, the midden was partly protected from surf by the reef and a small islet.

The 1980 excavations yielded Ostionoid and a few Eelenoid pottery shards, petaloid stone celts made of mudstone and volcanic breccia, shell picks and gouges, human bones, turtle and manatee bones, and diverse species of gastropod and bivalve shellfish.

Another possible, submerged prehistoric site has been detected off Joyuda, on the W coast. Numerous other sites are presently at the edge of the sea, including Caño de los Indios in Ceiba, Cayo Cofresí in Jobos, Cayito in Santa Isabel, Magueyes in Lajas, Joyuda in Cabo Rojo, Mar Chiquita in Manatí, Maisabel and Cerro Gordo in Vega Baja. etc. (Vega 1990).

also yield clues to the past, these river-transported artifacts have lost their original context and are not as significant as an actual, submerged archaeological site found in-situ. Evidence of rediposited artifacts, particularly lithics, has been detected by the author in the river's flood plain, as far as 250m E of the river (Vega 1998a).

During a survey at Caleta Salinas, SW of Ensenada, the author detected evidence of a prograding coast, suggesting minor tectonic uplift (Vega 1998b). The integration of tectonic and eustatic factors of sea level change is extremely complex. In the case of Puerto Rico's southeast coast, the tectonic factor appears to be very small, but significant enough to prograde lowland coasts in periods of minimal or zero eustatic rise of mean sea level (MSL). This probably occurred about 4,000 to 2,000 yrs BP, potentially prograding the preceramic coast of Guánica Bay, and resulting in preceramic middens slightly inland of the present shoreline.

3.4 Aboriginal Watercraft

The primary aboriginal method of water transport was the canoe, with possible, secondary use of rafts. The antiquity of canoes is well established. In Florida, prehistoric dugout canoes dating back to 3,000 yrs BP have been excavated in wet sites.

In the Bahamas, Columbus saw canoes "all of one piece hollowed like a tray from the trunk of one tree . . . so large as to contain forty or forty-five men, while others were so small as to hold one person" (McKusick 1970:8).

In Jamaica, Columbus measured on finely decorated canoe at 29 m (96 ft.) and 1.8 m (6 ft.) wide (Sauer 1969:82). This was surpassed by another canoe at the Bay Islands, off Honduras, "as great as a galley, eigth feet wide, all of a single trunk" (ibid:128).

Coppier describes a Lesser Antillean canoe that was 27 m (90 ft.) long, which he estimated could carry up to eighty-five persons plus cargo (Cárdenas 1981:143). Columbus reports that the largest canoes traveled with great speed, strictly be paddling. None of the Eurpean explorers mention the use of aboriginal sail. According to the Spanish Friar Blasius, rescued by the British at Dominica in 1606, all of his companions were killed by Carib Indians, who spared him for teaching them how to rig sails to their canoes (Mckusick 1970:5).

Aboriginal canoes were built of mahogany (*Swistenia mahogany*), cedar (*Cedrale odorata* Gomier), silk cotton (*Ceiba pentranda*), and other fine woods. The construction process often included the use of fire. Prehistoric Caribbean navigation is discussed in detail by Robiou (1993). The structural difference between river and seagoing canoes is discussed by Vega (1990, 1995), including the possible aboriginal invention of the pirogue or keeled canoe.

The use of canoes extended well into the historic period, with rigged pirogues used as late as the 19th century. Prehistoric or historic, the discovery of a canoe in Puerto Rico's waters would be of primary significance, because not one has been systematically excavated. Such a discovery might occur

practically anywhere in Puerto Rico's coastal waters, including beaches, coastal shallows, river mouths, reefs, lagoons, ports and under modern piers.

Considering the presence of woodland areas with fine trees around Guánica Bay in historic times (Ramos 1999:35), plus the numerous archaeological sites, including the historically documented village of Agueybaná, it is highly probable that prehistoric canoes were frequently built in Guánica Bay. The wrecks of some of these canoes, either destroyed by hurricanes or burned by the Spaniards, may be found almost anywhere in the soft sediments of Guánica Bay.

4. Historic Ports

4.1 Maritime History of Puerto Rico

Puerto Rico was "discovered" in 1493, during Christopher Columbus' second voyage. Proposed landfalls have included Guayanilla Bay, Cabo Rojo, Mayaguez, Añasco, Aguada and Aguadilla. Current research indicates that Columbus almost certainly landed at Añasco Bay (Delgado et al. 1996).

In 1504, Vicente Yanés Pinzón briefly explored the island, introducing goats, pigs and horses. The following year, Yanés Pinzón was granted the title of "Capitán General y Gobernador" of Puerto Rico, but afterwards decided to move his colonial enterprise to Brazil.

During the early 16th century, Puerto Rico was at the core of the Spanish colonial enterprise. The island had excellent harbors, abundant rivers, fertile soil and the promise of gold. Sonn, however, the mining decayed, and the island lost much of its initial attraction. By the early 17th century, Puerto Rico and the Caribbean had become peripheral to the main colonial enterprise.

Still, the island retained great strategic importance in relation to the Spanish fleets (Cardona 1989).

At the time of Columbus' discoveries, Spain was hindered by a weak economy. Financial difficulties were largely due to the 1492 conquest of Granada, the last Islamic bastion in Spain. Thus, the conquest of the Americas became an open door for private investors and adventurers. Their contract with the crown was know as a capitulación. This royal license could be sold or exchanged.

In 1508, already a hero of the Indian wars in Hispaniola, Juan Ponce de León signed a capitulación to settle Puerto Rico. The following year, he founded the settlement of Caparra on the north coast, while Cristobal de Sotomayor founded Guánica on the south coast.

Caparra was built about 3km inland from San Juan Bay (measured as the bird flies, with an estimated walking distance of about 4 km). The settlement was named after the Roman city of Caparra or Capera, near Cáceres, Spain, by Nicolás de Ovado, Governor General of the Indies, who was born in Cáceres (Sepúlveda 1989:33-51).

The new Caparra, described as a ciudad or city in some documents, included various stone houses, a plaza, a church, a small hospital, dozens of *bohíos* or thatched houses, warehouses, a brick furnance for gold production, farms, a blacksmith's shop, wells, etc. The town was was close to various aboriginal settlements, which provided labor for the mining and agricultural enterprises.

At the south end of San Juan Bay, the settlers of Caparra built a small port, connected to the city by a dirt road. The location of the port, or desembarcadero, is depicted in a map of 1519, by Rodrigo de Figueroa (Archivo General de Indias, Mapas y Planos, Santo Domingo 1). Cartographic analysis of over 50 maps, including more recent historic maps up to the early 20th century, clearly identify the port of Caparra at the site of the present-day Army Terminal, on the south end of San Juan Bay (Vega 2001).

Caprarra lasted from 1509 to about 1521, when the settlement was abandoned in favor of San Juan. The significance of Caparra to this study, is that a similar colonization strategy was employed by Spaniards on the south coast, but only limited historical data is available, and the archaeological research has yet to begin.

During the early 16th century, ships en route to Hispaniola (Dominican Republic) and New Spain (Mexico) generally sailed along the south coast of Puerto Rico, making a watering stop at San Germán Antiguo (present-day Añasco Bay). This derrotero or sea route would place the Spanish fleets off Guánica Bay on a regular basis.

In 1556, the regional government of San Germán was moved to Guayanilla. This change would have increased the entry of Spanish vessels with official correspondence from the crown (Cardona 1989:147).

By the 17th century, the route from Spain to Mexico was changed, with the fleet sailing along the north coast of Puerto Rico, stopping at San Juan if

necessary. Upon leaving San Juan en route to Mexico, the ships would sail west past Punta Borinquen, then southwest, between Puerto Rico and Desecheo Island, stopping at the aguadas or watering places of the west coast.

On average, sailing from Spain to Mexico lasted seventy-nine days, or two and a half months, including a five-day feria on the west coast of Puerto Rico. To appreciate the significance of the Spanish fleet system, of which only a segment has been described here, this was the first global communication network in history. However difficult and rudimentary the Spanish fleet system was, it fused the ports and politics of Europe, Africa, the Americas and Asia into one global history.

4.1 Pirates, Smugglers and Fishermen

The maritime history of Puerto Rico is not limited to the Spanish fleets and the great invasions of San Juan in 1595, 1597, 1625 and 1797. Countless minor invasions occurred throughout the island, as well as extensive contraband.

The nearby port of Guayanilla, or Guadianilla, east of Guánica, was attacked by the French in 1565, by Carib Indians in 1567, by the French again in 1576, by pirates in 1702, by the Dutch in 1703, and by the British in 1797 (Sievens 1983:12-17). The Carib attack of 1567 is particularly siginificant, as it resulted in the loss of a Spanish ship near shore

In addition to these attacks, the anchorages of Guánica, Guayanilla and Ponce Bays were frequently visited by smugglers, particularly British, who

traded with the locals without the restrictions and taxes of the Spanish government. Very little is known about the outlaw history of smuggling, but it was certainly a primary activity in Puerto Rico's economic history.

While San Juan became the center of Spanish colonial bureaucracy, the south coast grew on a more informal basis. This allowed contraband to flourish. In the"Juicios de Residencia" or evaluations of Spanish governors of Puerto Rico, which the author had the opportunity to read in the archives of Seville, contraband in Ponce, the principal city on the south coast, is a recurrent theme.

In 1693, the Governor moved against a large contraband ring in Ponce, which included the town's vicar. A similar operation was conducted in 1701 (López Cantos 1975:265-268).

Contraband imports included coffee, hides, cattle, fruits and fine timber. In turn, the smugglers traded wine, cloth, tools, firearms, gunpowder, etc. Most contraband vessels in Ponce Bay were from the Danish colony of St. Thomas and British colony of Jamaica.

Cotraband in Guánica was partly due to its relative isolation, excellent harbor, the large number of foreign settlers in Yauco, and the presence of a local militia in Ponce, instead of royal Spanish troops.

In 1805, in a radical change of policy, the Spanish crown instructed the Governor of Puerto Rico to open the pots of Fajardo, Ponce, Cabo Rojo, Mayaguez and Aguadilla. The goal was to promote trade with other Spanish-

American ports and reduce contraband with non-Spanish vessels (Morales Carrión 1974:121).

Another significant area of maritime activity is fishing. In the case of Guánica Bay, we have a virtually uninterrupted history of sailing and fishing activity since the late16th century. The potential archaeological record includes port structures and discards, discussed below, and shipwrecks, discussed in section 5 of this report.

Since prehistoric times, the people of Puerto Rico built fish weirs to capture and hold large quantities of fish. The practice was adapted by Spanish settlers and their criollo descendants, with evidence of fish weirs until the early 20th century (Vega 1995:116). Particularly in silt and mud bottoms, the poles of fish weirs may be preserved for centuries, frail but significant features of our maritime past.

4.3 The Archaeology of Ports and Anchorages

Non-maritime researchers often believe that underwater archaeology is limited to shipwrecks. In fact, a historic port is an archaeological site in itself, with or without shipwrecks (Vega 1995:99-108).

A wide variety of archaeological materials may be found in areas of port activity. In addition to abandoned piers and boat yards, a historic port might yield surprising amounts of garbage, including hulks, shell middens, abandoned anchors and chains, ballast piles, bottles and ceramic shards, etc.

Historic anchorages also produce great amounts of archaeological materials, including all sorts of discards, as well as cargo accidentally lost during loading or unloading operations.

In recent years, entire towns and cities have been discovered in coastal waters, including Alexandria in Egypt and numerous other Mediterranean ports.

If we consider the countless ships and boats that have operated out of Guánica Bay since the16th century, all the storms and hurricanes, invasions, smuggling and fishing operations, it is evident that there is a rich undersea archaeological heritage to be discovered within the bay.

In many instances, port materials may be deposited in stratigraphic context (or chronological layering of sediments). Dredging, piling, sedimentation and fill might destroy or alter the stratigraphic context, but one cannot assume that the cultural resources of an entire bay have been destroyed by dredging operations in specific areas.

The detection of historic port materials might be difficult, particularly in silty and polluted environments. On the other hand, the potential for preservation and data recovery may be very high.

4.4 The Historic Ports of Guánica Bay

The historic ports of Guánica include the incipient settlement founded by Cristobal de Sotomayor in 1510; the port immediately south of the town of

Guánica, operating as early as 1577 and still in use, and the pier of the Central Guánica at Punta Pera, operating from 1901 to 1981.

The exact location of Sotomayor's settlement is unknown, with both Punta Pera and the town of Guánica as possible sites. Prior to the fill of the Central Guánica, Punta Pera was an islet known as Isla de los Puercos or Hog Islet (Ramos 1999:34).

In 1505, Vicente Yanes Pinzón explored Puerto Rico, leaving hogs and goats at various locations. Along the south coast, one of these locations was Hog Islet (ibid).

Although this information has not been verified, Hog Islet is the only islet within Guánica Bay. Considering also the traditional name of the islet, plus the description of Yanes Pinzón of an islet about 200 yards offshore, and the islet's central location within the west side of the bay as the easiest approach for a sailing caravel, it is highly probable that Columbus' partner landed exactly where the Central Guánica's wharf and pier were built nearly four centuries later.

In 1510, while Juan Ponce de León developed his gold mining enterprise on the north coast of Puerto Rico, Cristobal de Sotomayor founded Guánica on the south coast, with the same industry in mind.

In 1511, while traveling with his nephew Diego Sotomayor and three other Spaniards, Cristobal de Sotomayor was ambushed and killed by the aborigines, who then razed the settlement of Guánica. That same year, the village of Santa María de Guadianilla was built, somewhere in Guayanilla

Bay. The primary incentives for the settlement of Guayanilla were the mining operations in the Hills of Santa Marta (present-day San Germán), and to maintain control of the salinas or salt works at the nearby coast of Guánica (Cardona 1989:146). In the 16th century, the salt works of Guánica were often called Salinas de Agueybana, and considered among the best of the island.

The settlement of Guánica was also called Sotomayor, Tavora and possibly Guanía and San Germán. As discussed in detail in Section 5 of this report, San Germán meant various ports throughout history, as well as the partido of San Germán, which included the western half of Puerto Rico. Although some writers have indicated that the first settlement of Guánica was abandoned because of mosquitoes, it is more likely that the place was attacked by the aborigines (Tió 1956:45).

In 1535, the Spanish chronicler Oviedo described Guánica as one of the best harbors in the world. Still, the bay remained undeveloped until the late 18th century, used primarily by local fishermen and smugglers. In 1580, the port of Guánica was attacked by aborigines.

In 1743, English pirates entered Guánica Bay in small ships, including one described as a paquebot in Spanish documents (de Hostos 1992:701). Anchoring near Caño de los Negros, they landed and marched into San Germán. The attack was soon repelled by the Spaniards, who managed to destroy the paquebot. Since some of the pirates escaped, t is assumed that they had more than one vessel, or else they stole a local canoe.

The town of Guánica was built in the1840's. Its original name was the Nuestra Señora del Socorro y San Vicente Ferrer de Guánica.

Until 1875, Guánica was a barrio of San Germán. Afterwards, it became a barrio of Yauco until 1914, when it achieved municipal status, largely due to the presence of the Central Guánica, or Guánica Centrale.

In 1898, war broke between Spain and the United States, followed by the invasion of Cuba, Puerto Rico, and the Philippines. In Puerto Rico, the primary landing site was the port of Guánica. According to the reports received by General Nelson A. Miles, Commander in Chief of the U.S. Army, at the time there were numerous large boats and a few sailing ships in Ponce and Guánica (Rivero 1998:183). This indicates regular maritime activity in Guánica Bay, before construction of the Central Guánica. The port itself, however, was very small and separated from the town by over 300 m of salt marsh (Figure 10).

At 5:20 am, July 25, 1898, the USS *Massachusetts* reached the coast of Guánica with all lights out. At daybreak, the USS *Gloucester*, ex-*Corsair*, entered the bay, reporting a depth of five fathoms. The *Gloucester* anchored at 600 yards off the port, sending a boat with an officer, 28 marines and a Colt machine gun. Raising the U.S. flag at the wooden office of the *cabo de mar*, the marines were fired at a Spanish troop of thirty men hidden in the nearby woodland. As the *Gloucester* opened fire, the Spanish troops retired inland. Without any further opposition, the U.S. fleet entered the bay and General Nelson Miles gave the order to land.

At least eleven ships entered Guánica Bay, with a total of 3,300 men landing at the small port, excluding 115 soldiers who were sick. Although the invasion occurred without any large-scale conflict, the sheer size of the fleet and its invading army suggests a high probability of garbage as well as small items accidentally falling into the water. Given the circulation of currents within the bay, some floatsam and slightly negative items might have drifted into the Study Area.

The primary event int eStudy Area's maritime past, is the construction and shipping activity of the Central Guánica, beginning three years after the invasion.

In 1901, Hog Islet was connected with the mainland coast of Ensenada with rock fill, followed by construction of the wharf, pier and other structures of the Central Guánica. As the fill gave the islet the shape of a pear, the area became known as Punta Pera.

The construction and operation of the Central Guánica depended on intensive shipping activity, both to import materials and machinery, and to export its sugar cane and sugar products. At Punta Pera, a Customs Office was built specifically for the sugar mill's intensive shipping activity.

In 1911, the Porto Rico Sugar Company began importing sugar cane from La Romana, in the Dominican Republic, for processing in the Central Guánica. Two of the steam ships used at the time were the *Santiago de Cuba* and *El Romanita* (Ramos 1999:94).

In 1918, the area was hit by a strong earthquake, with the sea invading the lowlands of Guánica Bay and causing damage to the Central Guánica (Ramos 1999:124). This was due to a tsunami or tidal wave, which also destroyed parts of Aguadilla on the west coast (Vega 1990:90).

In the 1930's, a private beach was built at Caleta Salinas for the upper-level managers of the Central Guánic. This beach was segmented with a cyclone fence. A second beach club was built, adjacent to the first one, for members of the Club Puertorriqueño (Ramos 1999:149).

In 1932, the Central Guánica bought the USS *Cape Mohican* from the U.S. Navy, for shipping duty-free sugar from Guánica to the mainland United States.

During World War II, various ships operating out of Central Guánica were lost at sea, including the *San Jacinto*, *Romanita* and *Mariana*, attacked by German submarines (ibid. 192).

In the mid-1950's, various large-scale improvements were made to the Central Guánica, including dredging of the navigational channel (ibid. 209). This was a private dredging project, probably among the largest of its kind in Puerto Rico.

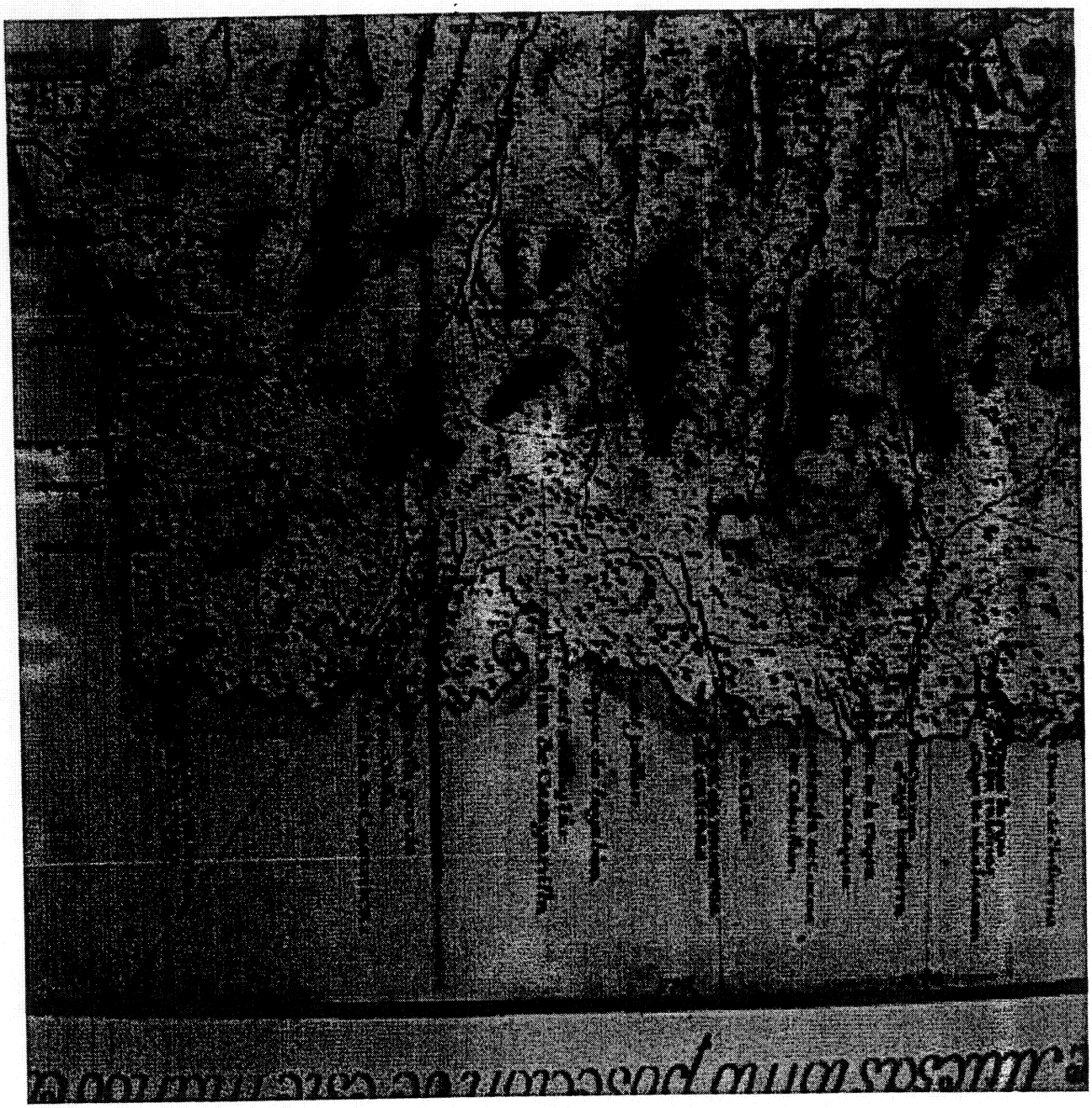

Figure 7. Detail, Historic map of Puerto Rico, by Miguel de Muesas, 1769, Archivo Genral de Indias, Santo Domingo 2396.

Notice the tip of Cabo Rojo, the SW corner of Puerto Rico, on the left side. Moving east (to the right), we find the anchorages of Guánica, Guayanilla and Ponce, marked with small anchors.

Figure 8. Map of 1632, depicting salt works on St. Martin, AGI, Seville.

A similar situation probably occurred on the salinas or salt works at Ensenada Las Pardas, Caleta Salinas and Bahía Montalva. The presence of salt works would have increased the probability of Spanish vessels in Guánica Bay, particularly during storms and hurricanes, as none of these salinas were located in hurricane harbors.

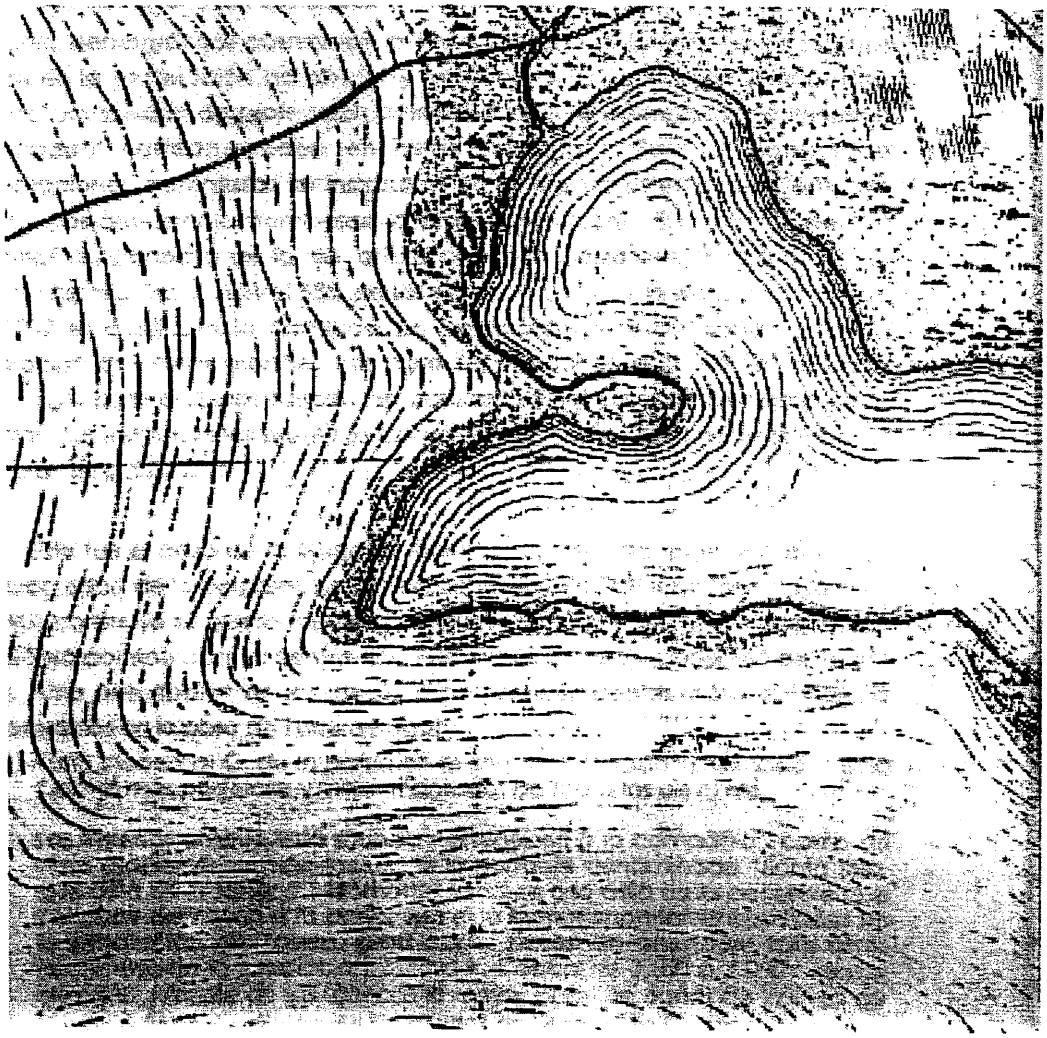

Figure 9. West side of Guánica Bay. Detail from 1866 map of Guánica Bay, by Pedro A. Bisbal (AGPR, Obras Públicas, Muelles y Puertos, Legajo 109).

4. Historic Shipwrecks

4.1 Historic Ships and Boats

Potential shipwrecks at Guánica Bay cover the entire range of Puerto Rican history, from the early 16th century to modern times. Within this 500-year time span, numerous types of ships and boats were developed for diverse uses, including scouting, warfare, commerce, fishing, coast guarding, dredging, pleasure sailing, passenger service, mail service, etc.

Vessels known to have sailed along the south coast of Puerto Rico include caravels, pataches, galleons, naos, felipots, urcas, frigates, navíos, schooners, corvettes, barques, polacres, brigs, tartans, pirogues, lighters, clippers, sloops, steamers, etc.

Ships were built with wooden hulls until the late 19th century. The first Spanish liner built with a steel hull was the steamship *Antonio López*, built in Scotland in 1881 and lost off Dorado,Puerto Rico in 1898 (Vega 1993). This vessel was the first Puerto Rico shipwreck nominated to the National Register of Historic Places, and the first to become a National Landmark in 1998.

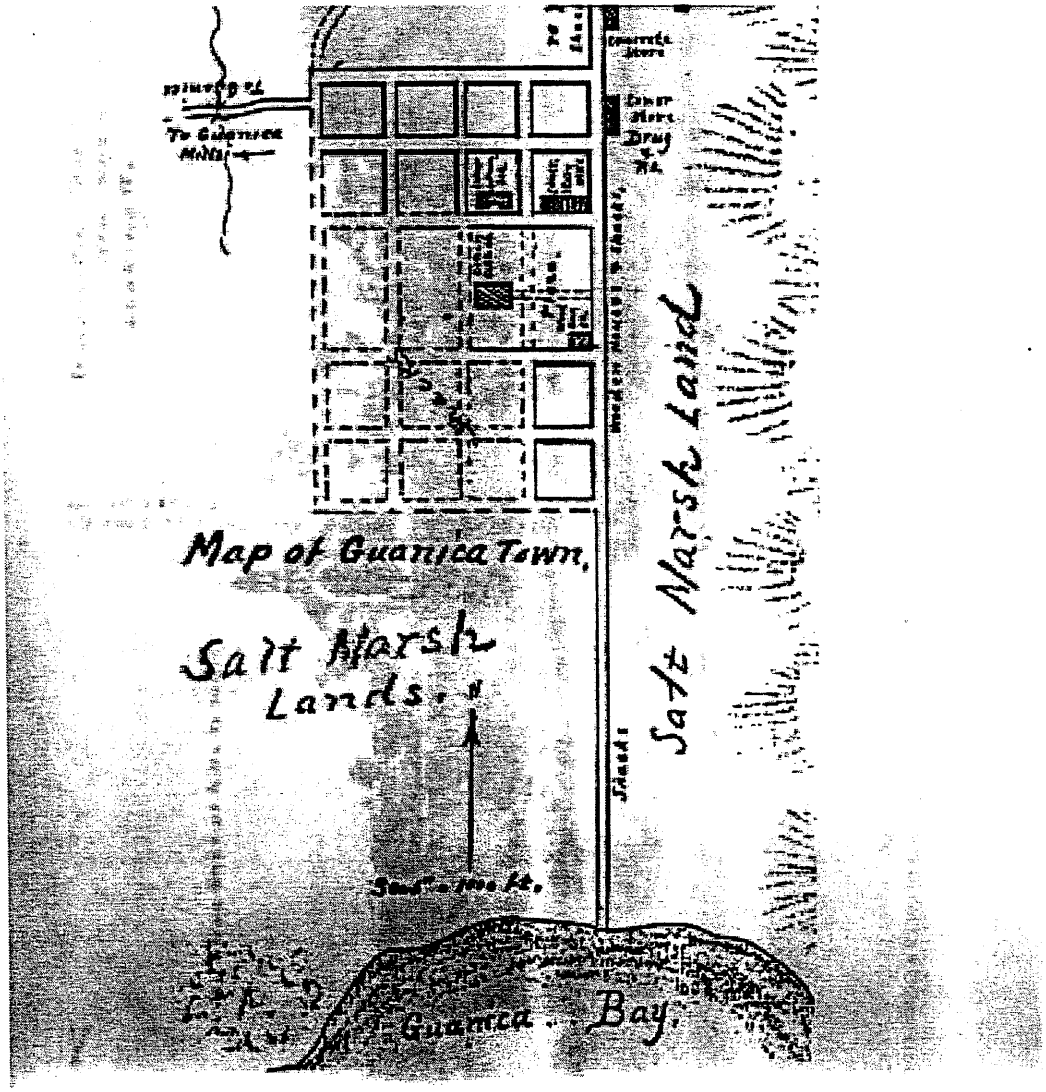

Figure 10. Town of Guánica, NE of the bay (Armstrong 1909-1912).

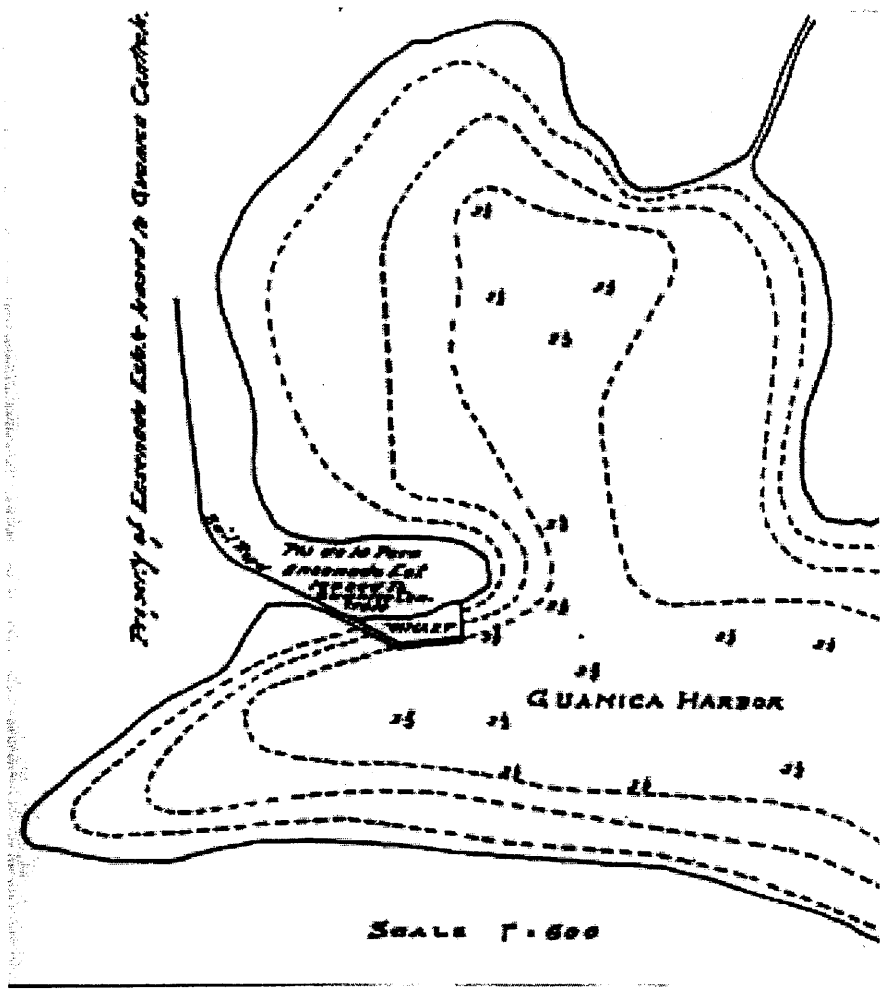

Figure 11. Wharf construction plan, Central Guánica, dated Sept. 6, 1901 (AGPR, Obras Públicas, Muelles y Puertos, Legajo 169).

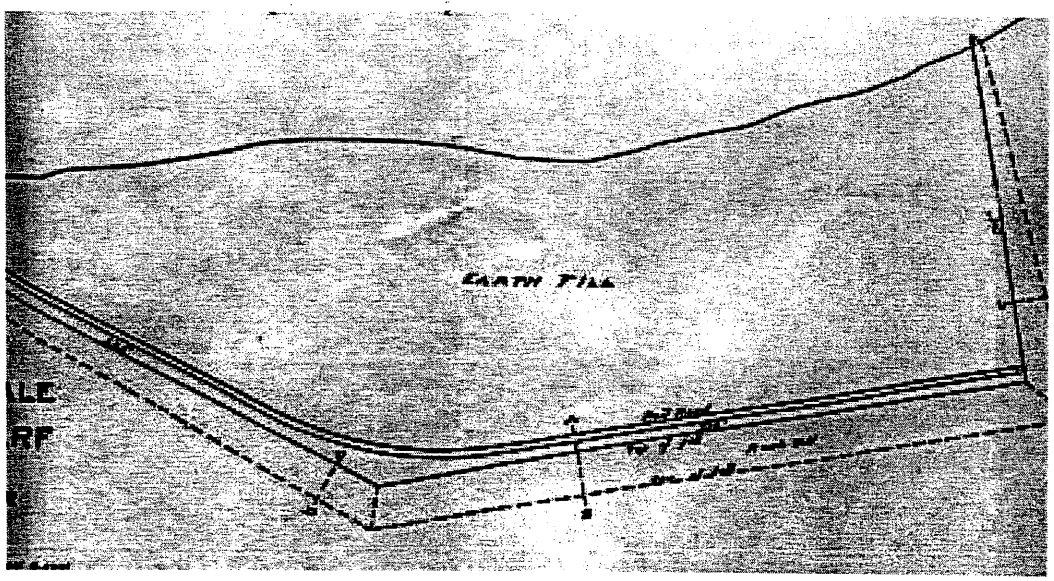

Figure 12. Wharf plan, south side of Punta Pera, Central Guánica, 1901 (AGPR).

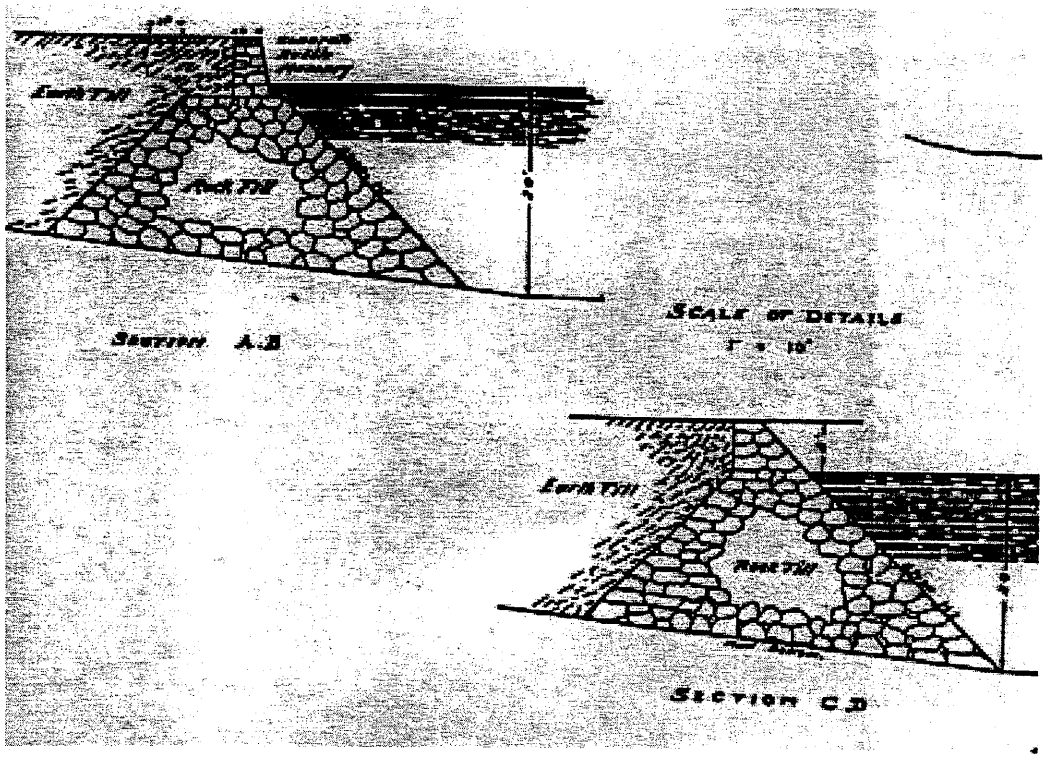

Figure 13. Wharf sections, Punta Pera, Cetral Guánica, 1901 (AGPR).

In theory, historic shipwrecks at or near Guánica Bay may include wooden-hulled vessels from the early 16th century onwards, and metal-hulled vessels of the late 19th and early 20th centuries. By the late 1890's, dozens of steamers operated out of Puerto Rico's principal ports, including San Juan, Ponce and Mayaguez, with frequent calls at Guánica.

5.2 The Archaeology of Shipwrecks

The importance of shipwreck archaeology has been demonstrated by dozens of studies around the world (Bass 1988; Konstam 1999; Muckelroy 1980, etc.). Shipwrecks may yield unique information on ship construction, exploration, colonization, trade, warfare, piracy, contraband, slavery, fishing, and numerous other areas of past human activity.

While terrestrial archaeology consists mostly of what people discarded as garbage hundreds or thousands of years ago, shipwrecks often involve cargo and personal items abandoned intact in a survival crisis. Although some artifacts may be damaged by long-term immersion in salt water, others are preserved in soft sediments.

In addition to providing unique information on the maritime lifeways of sailors, pirates, whalers, fishermen, etc., shipwreck may also provide fine-dated artifacts, which allow archaeologists to date similar finds on land. Unlike terrestrial sites, which might represent dozens or hundreds of years of occupation, shipwrecks occur at a specific moment in history, the moment of sinking.

To nautical archaeologists, every shipwreck is a time capsule, a frozen moment in time that in many cases can be dated down to the day and the hour. For instance, the study of bronze and iron cannon in a dated shipwreck will provide important information on the history of technology.

In the Mediterranean, shipwrecks as early as 3,500 yrs BP have been excavated, yielding extensive information on trade, ship construction, navigation, and the daily life of sailors and merchants.

In the case of Puerto Rico, some 2,000 ships were lost prior to 1900 (Vega 1995). Each of these shipwrecks represents a moment in time in Puerto Rico's history. Prior to the invention of commercial airplanes, in the late 1920's, ships were the only contact between Puerto Rico and the rest of the world. Additionally, as late as the 1850's, travel between Puerto Rico's coastal cities and towns was often by sea, in order to avoid the narrow roads across the rugged mountain interior.

4.1 Shipwrecks off the South Coast

Shipwreck documents often provide limited location data, which make it necessary to separate potential and actual shipwrecks. In many instances, archival documents might report a ship loss off the south coast, or en route from Ponce to Mayaguez, without providing the specific area of sinking. Historic documents might report ship losses off San Germán, but it might not be clear if the scrivener meant the first port of San Germán within present-day Añasco Bay, the port of the second San Germán at Guayanilla Bay, or the

partido of San Germán, which included all of the west coast, parts of the north coast west of the Camuy River, and parts of the south coast west of the Jacaguas River (Santana y Torrech1988:20). On the south coast, the partido of San Germán included the modern municipalities of Juana Diaz, Ponce, Peñuelas, Guayanilla, Yauco, Guánica, Lajas and Cabo Rojo. Thus,a shipwreck within the partido of San Germán could mean Guánica, but it could also mean Guayanilla, Cabo Rojo, etc. A shipwreck reported after 1556 at the nueva Villa de San Germán, or the New San Germán, would indicate a ship loss within Guayanilla Bay.

Shipwreck location errors are frequent in the literature. For instance, Marx (1975:401) mentions the loss of a French ship in 1673, off the Guadianilla Islets. This was *L'Ecueil*, a pirate ship from Tortuga, under the command of the legendary Bertrand d'Ogeron, which actually sank off Arecibo, on the north coast of Puerto Rico. The author was able to corroborate this loss both in the archives of Spain, and by diving off Barrio Islote, Arecibo.

Off Cabo Rojo, the SW tip of Puerto Rico, the Spanish Frigate *San José*, alias *El Gallardo*, was grounded and lost in 1780.

Off La Parguera, roughly halfway between Guánica Bay and Cabo Rojo, the Spanish steamer *Alicante* was lost at Margarita Reef in 1881. Other known shipwrecks off Lajas include the French schooner *Alerta*, lost in 1846, and an unidentified Spanish shipwreck lost in the mid-17th century.

Off the coast of Guánica, the *Astra*, a three-masted, 119-ft. schooner, was lost near Cayo Turrumote in 1962. Two unidentified shipwrecks, off Punta Jorobado and Baúl Reef, have also been reported by professional divers Jaime Braulio and Pili Pagán (Fritz and Pilkey 1976:18).

Shipwrecks in Guánica Bay

Numerous hurricanes have hit the south coast of Puerto Rico during the last 500 years. The hurricanes of 1827, 1855, 1899 and 1928 were particularly damaging, including the loss of small vessels (Salivia 1972). For instance, in the 1827 hurricane of San Jacinto, five ships were lost in Ponce, three in Guayama, two in Humacao, one in Mayagüez, one in San Juan and four in Naguabo (Salivia 1972:166). Considering that Guánica Bay was considered the best hurricane harbor in Puerto Rico, it likely that many ships and boats in distress would have attempted to reach her protected harbor.

Future research is likely to reveal additional losses of many small boats within Guánica Bay. Many other losses went unreported, and will only be known though archaeological work. Even today, with radio, television, numerous newspapers and magazines, boats are lost with little or no news coverage.

Potential shipwrecks at or near Guánica Bay are listed in Table 1. It is important to keep in mind that many shipwrecks were minimally reported, or not reported at all. Three or four hundred years later, no archival data might exist on the loss of even a large ship. If we consider the potential losses of

pirates and smugglers, who operated outside of the law, and of fishermen in their small boats, it is evident that most historic shipwrecks are not documented in the archives.

Of the shipwrecks in Table 1, the pirate vessel of 1743 is the most significant. This vessel is presumed lost within Guánica Bay. The other wrecks before1900 are known losses at or near the coast of San Germán, or near the coast of Puerto Rico.

The list includes four (4) modern shipwrecks after 1950. Two of these are reported on the Nautical Chart for Bahía de Guánica (NOAA 25679, 9th Ed., 1990). The metal wreck at Punta Pera was observed by the author during the field inspection (Section 6). The other metal wreck is located on the east side of the bay, south of Playa de Guánica. Older wooden vessels are almost never reported in modern nautical charts.

On July 13, 1964, the SS *Daniel Pierce* began reacting with its cargo of sulfuric acid, and was intentionally beached at Guánica Harbor. In 1971, the grounded ship was described by the Mayor of Guánica as a "floating brothel" frequented by drug users. Soon after, the *Daniel Pierce* was towed away "to be sunk at greater depths" (Fritz and Pilkey 1976:2). At present, it is not clear if the *Daniel Pierce*, which remained abandoned seven years in Guánica Bay, is the wreck reported on the E side of the bay. In addition to the listed wrecks, it is assumed that dozens of fishing boats, contraband vessels and canoes have been lost at or just outside of Guánica Bay in the last 500 years.

TABLE 1

ACTUAL AND POTENTIAL SHIPWRECKS AT GUANICA BAY

Year	Vessel Type	Nation	Place of Loss	Cause of Loss
1528	Caravel	Spain	San Germán	Blazed
1528	Caravel	Spain	San Germán	Blazed
1537	Nao	Spain	Puerto Rico	Grounding
1577	Navío	Portugal	San Germán	Unknown
1720	Ship	Spain	Puerto Rico	Blazed
1720	Ship	Great Britain	Puerto Rico	Blazed
1742	Ship	Spain	Puerto Rico	Unknown
1743	Paquebot	British pirates	Guánica Bay	Combat
1822	Ship	U.S.A.	Puerto Rico	Unknown
1855	Boat	Puerto Rico	South coast	Hurricane
1855	Schooner	Puerto Rico	Punta Ballena	Hurricane
1855	Schooner	Puerto Rico	South coast	Hurricane
1855	Schooner	Puerto Rico	South coast	Hurricane
1899	Many boats	Puerto Rico	South coast	Hurricane
1962	*Astra*	U.S.A.	C. Turrumote	Grounded
1971	*Daniel Pierce*	U.S.A.	Guánica Bay	Grounding
20th century	Metal wreck	U.S.A.	Punta Pera	Unknown
20th century	Metal wreck	U.S.A.	Playa Guánica	Unknown

Sources: Cardona (1989); Fritz and Pilkey (1976); Marx (1987); Salivia (1972); Potter (1988), Vega (1995), Archivo General de Puerto Rico; NOAA Chart 25679 for Bahía de Guánica, and material from Spanish archives in author's personal library.

6. Field Inspection

6.1 Previous Research

No previous maritime research has been conducted at Guánica Bay. The closest investigation, in terms of maritime research, is a Stage II archaeological evaluation at Caleta Salinas, conducted by the author for the Puerto Rico Aqueduct and Sewer Authority (Vega 1998b). Previously discussed in Section 3, this study detected evidence of a prograding coast.

6.1 Field Inspection

The field inspection was conducted on August 6, 2001. The inspection was conducted by the author and assistant archaeologist Erik Rivera. Access to the site was provided by William Pérez, Director of the Guánica Office, Land Authority of Puerto Rico.

At present, the old sugar mill appears to be a ghost town. Horses roam along the silent roads. Many of the processing and loading facilities are still standing, including the three-story high loading tower at Punta Pera.

The Dominican Pier is the most prominent marine feature at Punta Pera. Most of the pier's superstructure was destroyed by fire about a year ago, presumably by vandalism.

According to our informant, many boats take refuge in Guánica during hurricanes. This is significant, because a similar behavior probably occurred among the fishermen and sailors of history.

A large barge was sunk on the north side of the Dominican Pier and adjacent to the shore. Some of the ribs are visible at the water line. The barge was lost after 1950 and is not considered historic. Still, a brief underwater inspection is recommended as part of the IB marine survey, as the barge is associated with the late years of the Central Guánica.

During Hurricane Georges, a large pleasure boat was anchored between the wharf and the mooring piles. This is probably the most dangerous hurricane anchorage within the harbor. Hurricane waves repeatedly pushed the boat against the concrete wharf, finally sinking the vessel. After the hurricane, the vessel was salvaged and repaired.

Contrary to what our anonymous boat owner thought, the safest place in the bay in a storm is close to the mangrove. Here the roots of the mangrove trees dissipate much of the force of the surf. A boat moored against a solid wharf receives the power of the incoming surf, as well as the rebounding wave.

From the perspective of diving research, the Study Area is far from ideal. The water is murky, polluted and unprotected from the wind. As far as diving

conditions are concerned, the area somewhat resembles the south end of San Juan Bay.

The loading tower provided an excellent station for photographing the bay. However, parts of the wooden floors are rotten, including the interior floor. Researchers and visitors should be extremely careful where they step, as a fall from the high tower could be fatal. The metallic staircase is in much better condition, but the entire structure should be carefully evaluated for safety.

The south coast of Cueva de la Julia has been largely occupied by informal constructions, including the houses and wooden piers of local fishermen, as well as summer houses and houseboats of upper and upper-middle class owners.

During our inspection, we found several beams of the Dominican Pier on the shore of Cueva de la Julia. It is not clear if these beams were transported here in a hurricane, or if they were retrieved by the local fishermen. In any case, the circulation within the bay runs counterclockwise, moving north and west along Bahía Noroeste, continuing south along Punta Pera, and then exiting along the shore of Monte las Pardas.

Much of the coast north and south of Punta Pera is surrounded by mangrove. The shore of Punta Pera is mostly fill, with some mangrove trees presently reclaiming the area. The winds and currents are probably more complex than might seem at first sight, and should be carefully evaluated before the final design of the marina and coastal structures.