CHAPTER 2

THE ENVIRONMENT AND ITS RESOURCES

Virtually all archaeological and most ethnohistorical indications are that the indigenous people of the Galveston Bay area were non-agricultural hunter-gatherers. Since hunter-gatherer groups generally acquire key subsistence resources through some degree of seasonal settlement mobility within more or less defined territories (e.g. Lee and DeVore 1968; Harpending and Davis 1977; Binford 1980), it is highly probable that occupation at Mitchell Ridge was temporary and recurred on a seasonal basis. As will be shown further on, the archaeological evidence does in fact point to a seasonal use of the site. It follows, therefore, that the adaptive system that included use of the island and its resources must have involved some degree of movement through a larger, containing environment or operational area (*sensu* Butzer 1982). Ethnohistoric documentation, to be discussed further on, indicates that such mobility involved use of both the island and the mainland. Our consideration of the environment looks, therefore, at the mosaic of resources which would have been available throughout the Galveston Bay area.

Climate

The climate of Galveston Island and the surrounding region is warm temperate, with a mean annual temperature at Galveston of 21° C. Summers are hot, though high temperatures on Galveston Island are slightly moderated by proximity to the open Gulf of Mexico. Winters are generally mild, but temperatures can dip to freezing as arctic cold fronts push into the region. Precipitation is fairly high, averaging 134 cm/year in the Trinity Bay area and 107 cm/year on Galveston Island (Shew et al. 1981:12). There is a net moisture surplus of 10-20 cm/year, in contrast to more southerly parts of the Texas coast, which generally experience moisture deficits. Seasonal precipitation varies in the Galveston Bay area, with a unimodal summer peak on Galveston Island and more even precipitation throughout the year in inland areas (Shew et al. 1981:13).

Geology

The Gulf coastal plain is a nearly flat physiographic unit made up of sandy clays and clayey sands deposited as channel fill and overbank sediments by Pleistocene riverine and deltaic systems. In the aggregate, these sediments comprise the Beaumont Formation, the main geological unit along the entire Texas coast (Fisher et al. 1972; McGowen et al. 1976). The various barrier systems of the upper Texas coast-- including Follett's Island, Galveston Island and Bolivar Peninsula-- formed during the latter part of the Holocene as waves and longshore currents deposited sands and shell under sea level conditions approximating those of the present.

During the Wisconsin glacial maximum, sea level was approximately 100 meters below its modern position, and coastal river systems downcut into the older Pleistocene deposits, creating a series of valleys along the coast. As global temperature warmed after ca. 18,000 B.P., sea level rose rapidly. By 10,000-9,000 B.P. the coastal river valleys were inundated, creating a series of long embayments. The present configuration of Galveston Bay is the result of the inundation of the Pleistocene valleys of the Trinity and San Jacinto Rivers.

Sea level rise during the Holocene was not continuous, but was marked by periods of rapid rise and intervening periods of markedly slowed rise, stillstand or even slight reversal. Although interpretations vary in detail, all posit rapid sea level rise after ca. 18,000 B.P. and a stillstand or temporary regression between ca. 15,000 and 10,000 B.P. Around 10,000 B.P. sea level once again rose rapidly and attained another stillstand or slight regression between about 9000 and 7000 B.P. Transgression resumed between ca. 7000 and 6000 B.P. and reached a mid Holocene stillstand ca. 6000-4500 B.P. After a final period of sea level rise, modern stillstand was attained ca. 3000-2500 B.P. (see Curray 1960, Nelson and Bray 1970; Frazier 1974; Paine 1991).

Recently, J. Paine (1987, 1991) has proposed a highstand on the Texas coast of approximately 1 meter sometime after 5300 B.P. and before 2600 B.P. Paine's inference is based on radiocarbon dating of geologic strata of bay shells and organics in clay dunes on Copano Bay, north of Corpus Christi. Paine

also considers information from corings of Copano Bay bottom fill, whose alternating coarse and fine sediments are interpreted to represent shifts from marine-influenced depositional regimes to riverine-influenced deposition. The former are thought to correspond to periods of sea level rise, while the latter represent periods of sea level stillstand. Chronologically, the periods of marine-influenced sedimentation are estimated by Paine to correspond to rapid sea level rise prior to 9000 B.P., again from ca. 7000-6000 B.P. and finally between 5000 and 4000 B.P.

Radiocarbon data from stratigraphically discrete site components in the Corpus Christi Bay area indicate a hiatus in major use of estuarine resources between ca. 4200 and 3000 B.P. (Ricklis 1993). This is inferred to correspond to rapid sea level rise and attendant reduction of estuarine productivity as highly photosynthetic and nutrient-rich bay/lagoon shallows were inundated. This interpretation of the data from the central Texas coast narrows the time frame of final sea level rise, and Paine's postulated highstand, to after 4200 B.P. Geoarchaeological data from Site 41SP177 on Nueces Bay (Ricklis 1993:36-44) suggest that sea level had approximated its modern position by ca. 3700 B.P. and that relatively high estuarine biotic productivity was re-established by ca. 3000 B.P. A dramatic increase in the quantities of fish remains in site components dating to after ca. 2000 B.P. is inferred to reflect markedly rising estuarine productivity associated with the establishment of extensive, high-productivity shallows behind the modern barrier island chain, believed to have formed by 2500-2000 B.P.

The highly important relations between sea level change, biotic productivity and patterns of human ecology have not been systematically investigated along the upper Texas coast. Most investigated archaeological sites have been dated to the late preceramic or ceramic periods, after ca. 3000 B.P. However, there are some earlier shell midden components (e.g. Gadus and Howard 1990; Hines 1993), and a long term periodicity of coastal occupation and estuarine resource use, similar to that apparent for the central coast, may eventually be defined.

Galveston Bay, and its two inland extensions, Trinity and San Jacinto Bays, reached their modern configurations after sea level stabilized at its modern position. Deposition of the relatively heavy sediment load of the Trinity River resulted in the creation of extensive brackish and freshwater marshes at the head of Trinity Bay. At the same time, longshore currents and wave action deposited sands and shells off the mainland shore to create Bolivar Peninsula and Galveston Island.

Galveston island is considered a "textbook" example of a prograding barrier island, in that beach sediments have gradually accumulated along the shoreface to build the island seaward. Radiocarbon dates on core-derived shell hash reflect this process, with the oldest dates (6th-7th millennium B.P.) at the leeward side of the island and the youngest (ca. 1000 B.P) under the modern beachfront (e.g. Morton 1977; see Figure 2.1.). The dated shells pertain to estuarine and possibly marine species which have been reworked by wave action and redeposited, along with sand, to form the island. The shells are thus believed to date significantly older than the actual time of deposition, and the core of Galveston Island is estimated to be about 3,000-4,000 years old. As the island prograded seaward, sequential deposition of beach sediments resulted in a ridge and swale topography, with relief generally on the order of about 2 meters.

Geologic Processes at the Mitchell Ridge Site

A limited, but quite informative, geologic profile was obtained at the Mitchell Ridge Site during the course of the 1992 investigations (Figure 2.2). Subsequent to our archaeological field investigations in the west part of the site, construction resumed in that area, and a sedimentary cross-section, 2-3 meters deep, was created through the ridge that forms the core of Galveston Island at this point. An approximately 15-meter-long stretch of the machine cut, where it transected the crest of the ridge, was cleaned with hand tools, photographed and drawn to scale. Two samples of geologic shell hash, one from near the top of the exposed sedimentary profile and one from near the bottom, were extracted for radiocarbon dating.

As may be seen in Figure 2.2, the sedimentary profile contains several discrete deposits. The lowermost consists of a massive deposit of light tan, medium sand, the base of which was not reached by the machine cut. Overlying this material is a series of laminations of light-colored medium-grained sands and shell hash of varying particle sizes. The laminations in the western part of the profile (at the left of Figure 2.2), as well as the eastern part of the exposed underlying sand stratum, have been beveled off, where they are partially overlain by a subsequent set of sand/shell hash laminations representing a facies change in the deposits. All of these sediments are unconformably overlain by the dark brown, organically
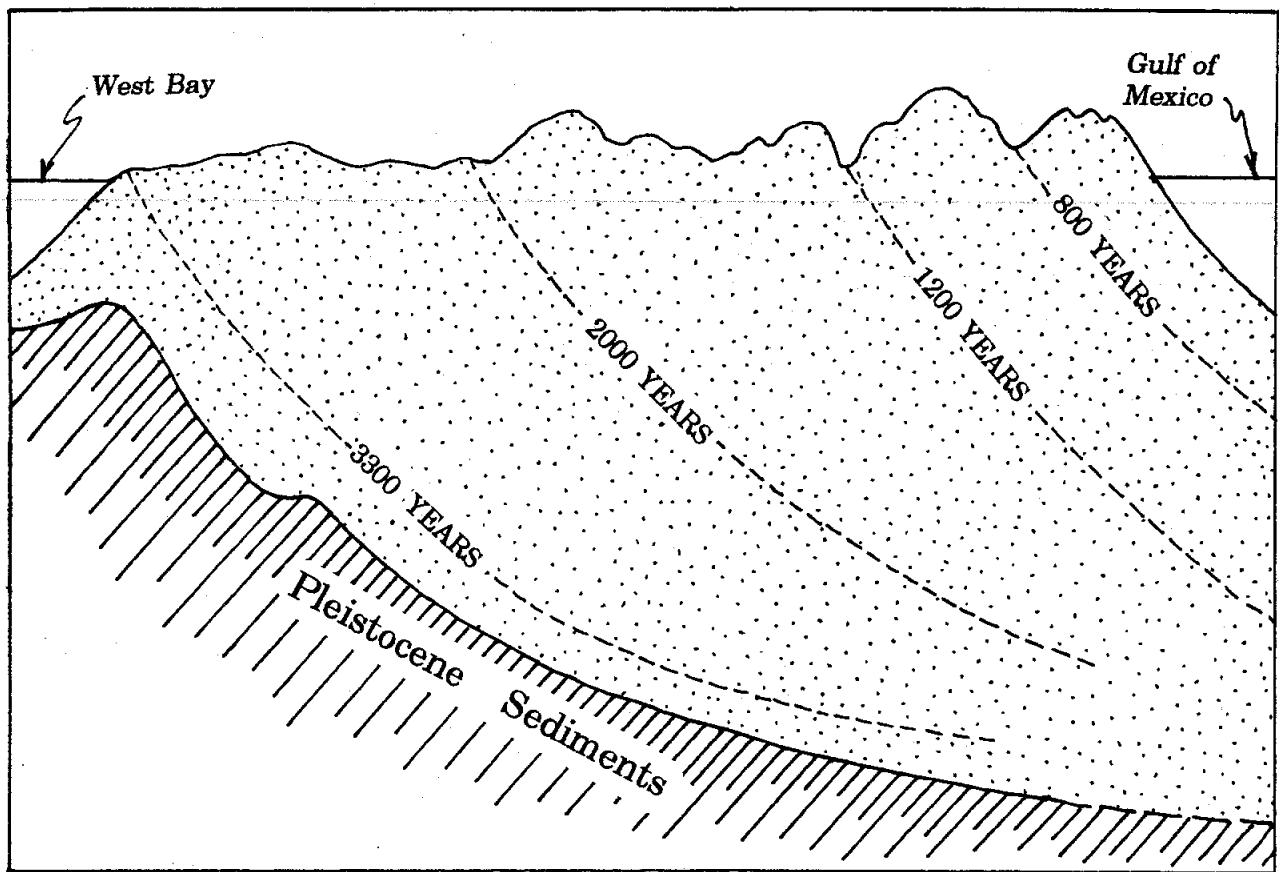
Figure 2.1 Geologic cross-section of Galveston Island (adpated from Fisk et al. 1972). Note seaward accretion of island, with estimated ages of sediments based on radiocarbon dated shell hash (see discussion in text).

rich fine sand soil which contains all intact deposits of prehistoric occupational debris at the site (although burials and deeper pit features intrude into the underlying sand/hash sediments).

Various kinds of available information permit a tentative reconstruction of the sequence of geologic and other environmental events and processes which produced the observed sedimentary stratigraphy. Significant is the fact that the shell hash in the laminations between the basal sand and the fine sand soil consists entirely of common estuarine species such as oyster, bay scallop, lightning whelk and cross-barred venus; high-salinity marine species were not observed in samples obtained from the various laminations of shell hash. It can be concluded, therefore, that the shell hash, which is consistently mixed with fine-to-medium grained quartz sand, represents deposition of reworked lagoonal sediments rather than beach sediments deposited by wave action along the open Gulf. The radiocarbon dates on two shell hash samples, corrected for the 13C fraction (Figure 2.2), 5050+/-90 B.P. and 4650+/-80 B.P., are both of mid-Holocene age, suggesting the presence of a protected lagoonal estuarine environment during the mid-Holocene. The various laminations of sand and shell hash thus inferably represent later Holocene redeposition, and the medium to coarse size of the hash points to high energy transport of sediments. Most likely, each lamination represents episodic deposition by a storm surge, so that the profile, in effect, presents a cross-sectional sequence of storm washover fans.

The maximum age of the fine sand soil cannot be precisely determined. However, as will be shown further on, our investigations established that all intact cultural debris deposits occurred within this soil, usually in the middle part of the soil stratum. Since all radiocarbon data on occupational chronology indicate that occupation falls within the last two millennia, it seems reasonable to infer that the soil began
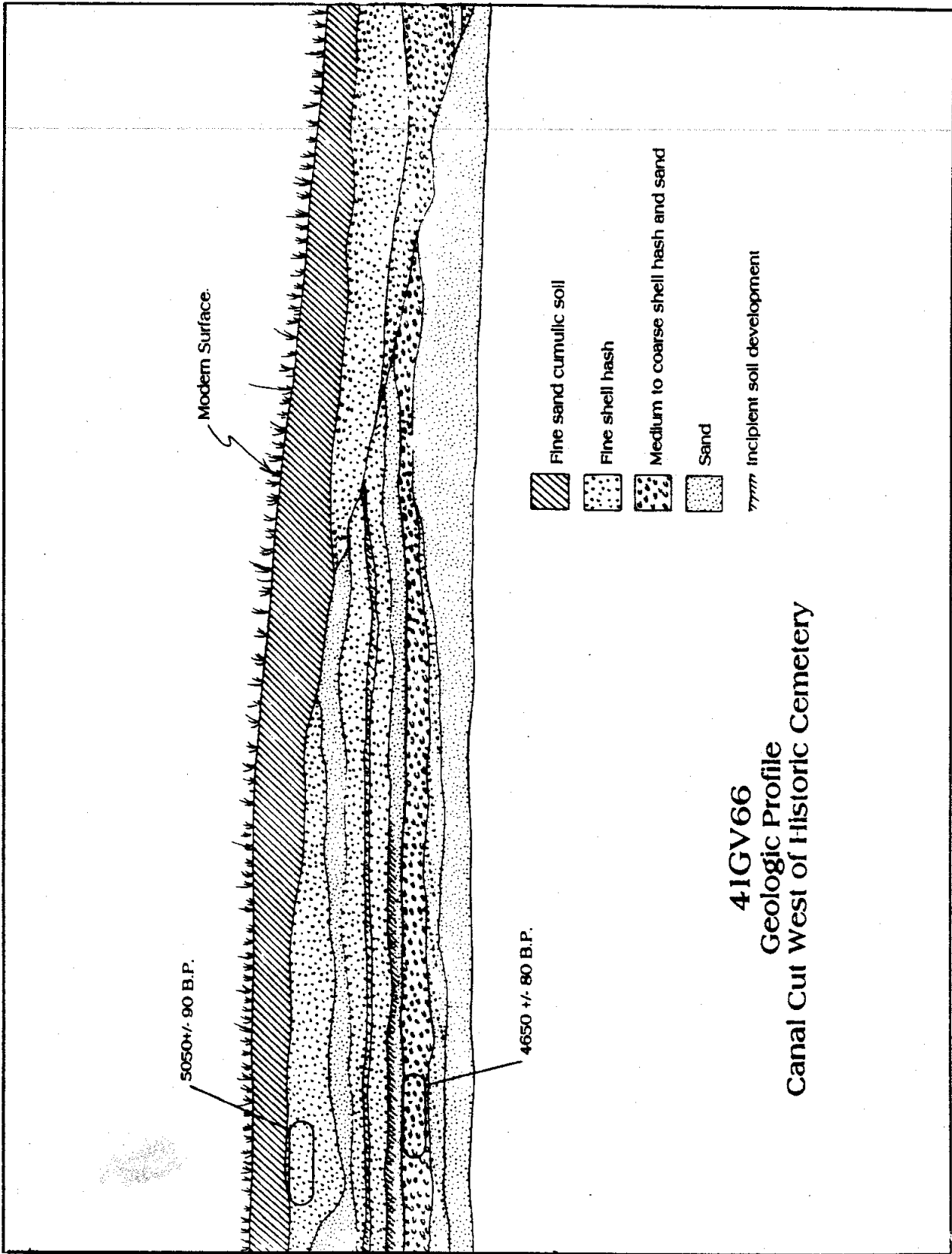
Figure 2.2. Profile of geologic sediments along canal cut at west end of Mitchell Ridge Site. Locations of radiocarbon-dated shell hash samples are shown, with uncalibrated ages. Fine sand topsoil ranges in thickness between 40 and 60 cm.

to form ca. 2000 B.P. or somewhat earlier. Thus, the deposition of the sand/shell hash laminations must fall between the mid Holocene, ca. 5000/6000 B.P., and 2000 B.P.

The fine sand, organically-rich soil represents a significant change in the sedimentary depositional regime at the site. The soil contains no shell hash, except for minor amounts upwardly displaced from the underlying strata through bioturbation, and the sand in the soil is of a finer texture than that in the underlying strata. For these reasons, high energy wave action is ruled out as a possible depositional agent. Further, the high organic content of the soil indicates slow deposition of the fine sand, as organic plant matter was gradually incorporated into the soil.

Given these lines of information, the following sequence of geologic events and processes is suggested for this part of the island:

1. A mid-Holocene barrier probably existed offshore during the mid Holocene, ca. 5000-6000 B.P. The shell species present in the hash laminations are estuarine rather than marine, indicating at least partial protection from direct wave and tidal influence of the high-salinity, open Gulf of Mexico. The presence of lightning whelk suggests that salinities were higher than in modern Galveston Bay and West Bay, where this moderate-to-high salinity bivalve is uncommon and where the moderate-salinity oyster (*Crassostrea Virginica*) predominates. This may indicate that the mid-Holocene barrier system was only partially developed, with disconnected islands and shoals and wide, intervening tidal passes that allowed greater influx of marine waters that is the case in the modern bay-lagoon environment. Alternatively, it is possible that mid-Holocene aridity in the interior (e.g. Aten 1983a; Meltzer and Collins 1987; Toomey et al. 1993) resulted in reduced stream flow and concomitant reduction in freshwater discharge into the coastal estuaries.

2. Sometime after 5000 B.P., the mid-Holocene lagoonal systems experienced a major modification or perhaps complete destruction, as bottom sediments were reworked and transported by high-energy wave action, to become redeposited as storm washover fans. The destruction of mid-Holocene estuarine lagoonal environments implies a period of sea level rise, as the transgressive Gulf waters pushed older coastal sediments landward.

3. Later, probably by ca. 2000 B.P., there was a significant change in the depositional regime at Mitchell Ridge. Washover fans were no longer deposited, perhaps due to a slight fall in sea level. Paine's (1987; 1991) postulated sea level highstand, between ca. 5300 and 2600, discussed briefly above, may have increased the susceptibility of the ridge to storm surge washover, and as sea level fell to its modern position at perhaps ca. 3000 B.P. (Paine 1991), high-energy transport of sediments failed to reach the elevation of the ridge. As modern sea level stabilized, the island prograded seaward, and the developing ridge-swale landforms provided an immediate source for eolian deposition of the fine sands, under the dominant easterly-to-southerly coastal wind regime (Fisher et al. 1972:17). The high organic content of the soil indicates the presence of vegetation cover; probably the grasses which characterize the island's modern vegetation were established by this time.

Biota

Estuarine

Galveston Bay and its associated secondary bays and lagoonal extensions comprise an extensive and highly productive estuarine environment. Waters are shallow and thus characterized by high photosynthetic primary productivity. The barriers of Galveston Island and Bolivar Peninsula protect the estuarine environment from high energy wave action from the Gulf, and maintain moderate salinities. The shallow, photosynthetic bays provide excellent conditions for establishment of grass beds and salt and brackish marshes, which in turn are the basis for large populations of primary consumers, such as the various molluscan species, as well as a range of secondary consumers, including economically important fishes. This kind of low relief, protected estuarine environment is among the most biotically productive in the world, rivaled only by the tropical rainforests (e.g. Odum 1971; Whittaker 1975).

Submerged grassbeds, consisting mainly of shoal grass (*Halodule beaudettei*) and widgeongrass (*Ruppia maritima*) are found along bay margins, usually in waters less than 1.5 meters deep (Fisher et al. 1972; Texas Parks and Wildlife Department 1972). These areas (see Figure 2.3) are ecologically significant in providing habitats for various molluscs and crustaceans, which are important food sources for fishes (Hoese 1960; Shew et al. 1981). Saltmarshes are extensive along the leeward shores of the
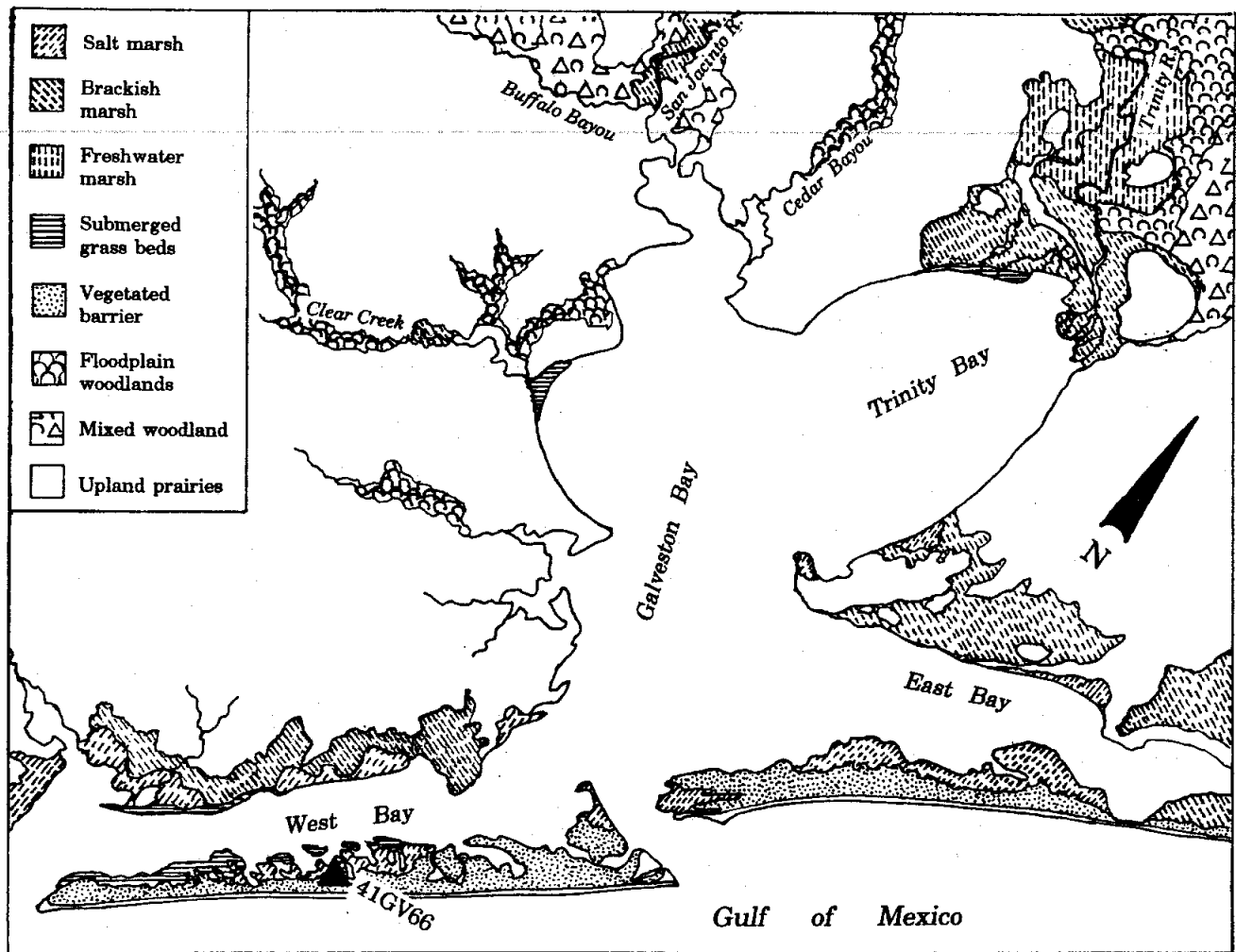
Figure 2.3. Map of Galveston Bay area, showing various environmental zones (based on Fisher et al. 1972).

barriers, as well as the mainland shores of East and West Bays (Shew et al. 1981:32). Brackish marshes dominate the delta areas of the Trinity and San Jacinto Rivers. Fairly extensive stands of cattails (Typhus sp.) occur in both salt and brackish marsh areas.

Organic detritus from the shoreline marshes, and from riverine inflow into the bays, supports the most abundant supply of commercial shellfish of any bay system on the Texas coast. Reefs of the American oyster (*Crassostrea virginica*) are both large and abundant in Galveston and East Bays, where average salinity falls within the moderate level conducive to optimal oyster growth (see Figure 2.4). Oyster reefs are small and few in West Bay, since average salinity is relatively high due to influx of marine waters through Bolivar and San Luis Passes and distance from the mouths of large streams. Oyster reefs are absent in proximity to the mouths of the Trinity and San Jacinto Rivers, where salinities are low due to freshwater discharge.

The brackish water clam, *Rangia cuneata,* found in profusion in many Galveston Bay area shell midden sites, can survive temporarily in salinities up to 20 parts per thousand (ppt) (Andrews 1977). However, optimal salinity range for healthy populations may be as low as 2 ppt (Godcharles and Japp 1973,

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cited in La Salle and de la Cruz 1985:9). Rangia live in shallow-water "beds" in which clam density can be up to several hundred individuals per square meter. The accessibility and concentration of this protein-rich food source doubtless accounts for the abundance of large prehistoric rangia middens along the brackish estuarine zones of the northwest Gulf coast.

Other molluscan species of potential economic value are moderate-salinity bivalves such as bay scallop (*Argopectin irradians*), southern quahog (*Mercenaria campechensis*), cross-barred venus (*Chione cancellata*) and relatively high-salinity gastropods such as lightning whelk (*Busycon perversum*) and shark eye (*Polinices duplicatus*). Archaeological findings reported to date for the Galveston Bay area do not indicate significant economic reliance on these various species, which is not surprising in view of the fact that most excavations have focused on sites in proximity to brackish water zones. As will be seen further on, however, these species are not common even at the Mitchell Ridge Site, which offered ready access to the generally higher-salinity waters of West Bay. Our findings clearly show that oysters were utilized at Mitchell Ridge, and it seems likely that other economically useful species would be present in some numbers had they been readily available in the local environment. These various moderate-to-high salinity molluscs become increasingly common in archaeological deposits moving further down the Texas coast (e.g. Steele 1988) and this correlates with a clinal decrease in precipitation from north to south. It is inferable, therefore, that frequent and heavy precipitation commonly pushed salinity levels below the viability threshold of the higher salinity molluscs, preventing the establishment of high and extensive populations.

A variety of fish abound in the waters of the Galveston Bay area, and the modern commercial fishing industry has relied heavily on the area for hauls of table fish such as seatrout, black drum and redfish. Fish bones have been abundantly documented at archaeological sites in the area, and the Mitchell Ridge Site is no exception. Since fish were clearly a major economic staple for aboriginal populations, and the spatial and seasonal patterns of concentration may have influenced their economic value, the salient features of species ecology and behavior are very briefly summarized here.

Black drum (*Pogonias cromis*) is a relatively large sciaenid, adults measuring 40-60 cm in length and weighing several kilograms (Matlock and Weaver 1979; Harrington et al. 1979). Older individuals can attain lengths over 100 cm and weigh in excess of 30 kg. Adult black drum are mainly bottom feeders, and prey upon molluscs, whose shells they grind with heavy, blunt molars. Spawning takes place in the winter and early spring, mainly from January through March and sometimes into April (Simmons and Breuer 1962; Sutter et al. 1986). By far the largest commercial hauls of this species made in Galveston Bay and other Texas bays are during these months (e.g. Gunter 1945; Quast et al. 1988), and it seems likely that this reflects aggregation associated with spawning.

Redfish, or red drum (*Sciaenops ocellata*) is about the same size as black drum (Simmons and Breuer 1962; Reagan 1985), though the largest specimens may not be quite as large. Redfish spawn in the early fall, when they move in large numbers through tidal passes, near which spawning takes place (Simmons and Breuer 1962; Perret et al. 1980; Matlock 1990). The species is most abundantly harvested during the fall (Quast et al. 1988), suggesting a correlation between spawning and population aggregation. Larvae have been observed most often in shallow water grass beds, and nursery areas are in grassy estuarine and shallow water marsh areas. Adults commonly inhabit seagrass meadows and cordgrass wetlands, where food is abundant and vegetation provides cover from predators. Adult redfish commonly feed on shrimp, small fish and crabs (Simmons and Breuer 1962; Reagan 1985).

Spotted seatrout (*Cynoscion nebulosa*) is another sciaenid that is, on the average, much smaller than either black drum or redfish. Adults commonly are between 30 and 40 cm in length and weigh less than 1 kg (Matlock and Weaver 1979; Harrington et al. 1979). Though found in the open Gulf, spotted seatrout are more abundant in the bays and lagoons behind the protective barrier islands. Spawning is during from the spring to early fall, and occurs in shallow water grassy areas (Pearson 1929). The larval stage of the life cycle is not well understood, but post-larvae and juveniles are known to prefer shallow, vegetated estuarine areas as nurseries (Lassuy 1983). These areas are also preferred by adult fish as protected feeding grounds (Lorio and Perret 1980).

The sea catfish (*Arius felis*) is a slender, scaleless fish that reaches lengths of 60 cm and usually weighs less than 1 kg (Hoese and Moore 1977). Spawning takes place in shallow waters, mainly during the summer. Sea catfish are bottom feeders; diet consists largely of organic detritus.

Sheepshead (*Archosargus probatocephalus*) is a moderate-sized fish, with adults commonly reaching lengths of about 40 cm and weighing 1-2 kg (Pearsall 1966; Hoese and Moore 1977). The species is a bottom feeder, and the adult diet consists of plants, molluscs and small vertebrates (Jennings 1985).
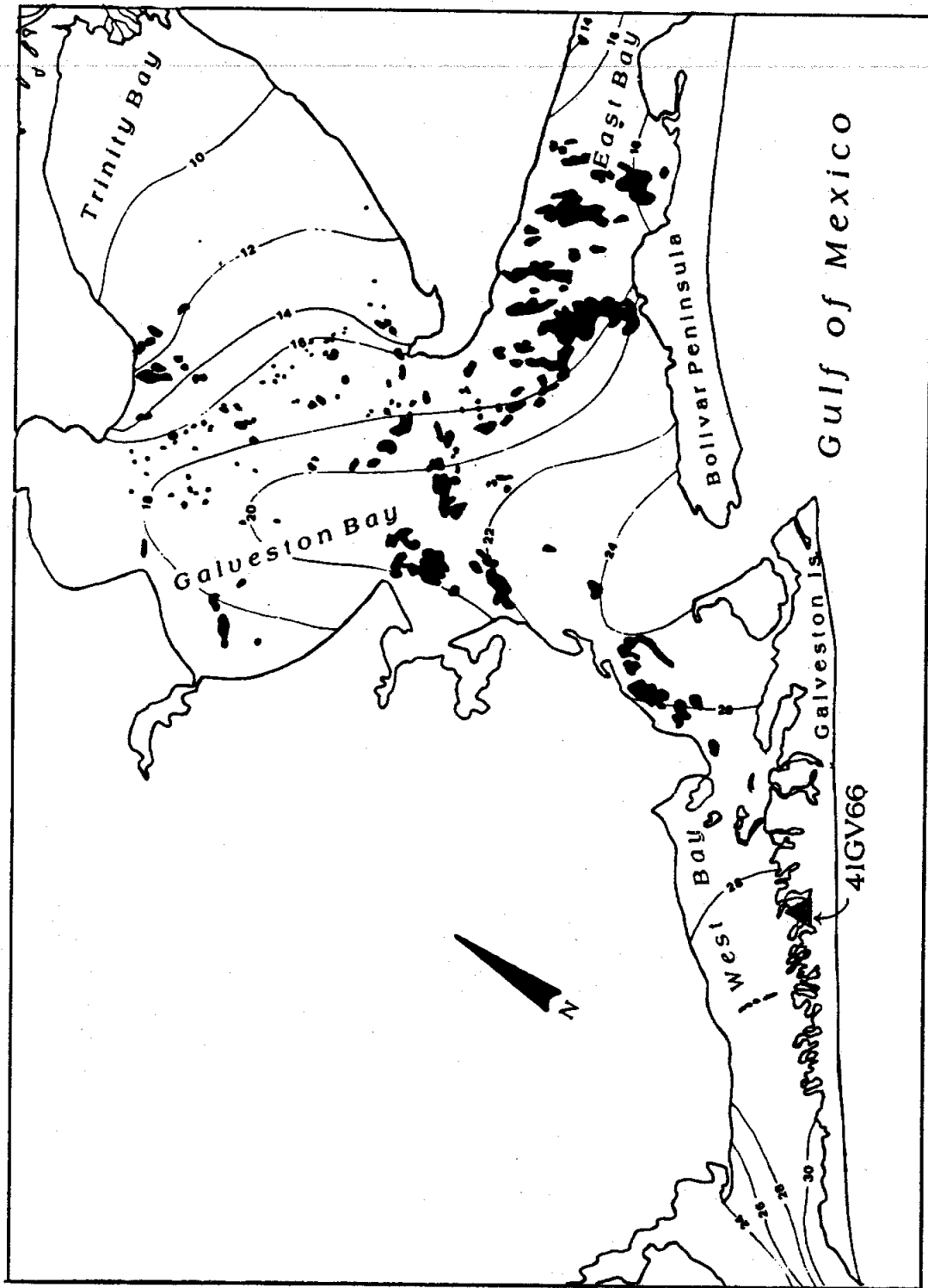
Figure 2.4. Map of Galveston Bay area, showing average surface salinities for 1965-67 and locations of modern oyster reefs (from Fisher et al. 1972). Note that distribution of reefs parallels moderate salinity isohets.

Plate of large, heavy molars, very similar to those of black drum, facilitate crushing of mollusc shell. Sheepshead are believed to move into deep waters during the coldest part of winter, and to return to shallows in the late winter and early spring.

Terrestrial

The terrestrial environment in the Galveston Bay area can be subdivided into three distinct zones on the basis of plant associations, and, to a lesser extent, on the basis of faunal assemblages. These zones are the coastal uplands or coastal prairies, riverine floodplains and deltas, and the barrier island. The coastal uplands are topographically nearly flat, and reach elevations of only a few meters above mean sea level. The generally clayey soils support various coastal prairie grasses, including big bluestem (*Andropogon perardi*), indiangrass (*Sorghastrum dactyloides*), switchgrass (*Panicum virgatum*), and eastern gamagrass (*Tripsacum dactyloides*). Coastal bluestem (*Scizachyrium scoparium littoralis*) is common in the sandy areas along the mainland shoreline (Fisher et al. 1972; Shew et al. 1981).

The uplands provide habitats for a variety of mammals, including white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), jackrabbit (*Lepus californicaus*), red fox (*Vulpes*), gray fox (*Urocyon cinereoargenteus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), spotted and striped skunks (*Spilogate putorius, Mephitis*), opossum (*Didelphis virginiana*) and bobcat (*Lynx rufus*) (Shew et al. 1981; Schmidly 1983). Bison (*Bison*) were present on the coastal prairies in the Galveston Bay area during Early Historic times, when they were hunted by native peoples (e.g. Folmer 1940).

The floodplains of major streams such as the San Jacinto and Trinity Rivers are biotically rich and diverse. Along stream banks are found rushes (*Juncus* spp.) cattails (*Typus* spp) and willows (*Salix* spp.) (Fisher et al. 1972). Various arboreal species grow on floodplains, including water oak (*Quercus nigra*), cedar elm (*Ulms crassifolia*), and sugarberry (*Celtis* spp.). Frequently flooded areas support extensive stands of dwarf palmetto (*Sabal minor*). Bald cypress (*Taxodium distichum*) grows in low-lying, swampy areas. Higher floodplain terraces support oak-pine forests consisting of water oak, southern red oak (*Quercus falcata*), hickory (*Carya* spp.) and loblolly pine (*Pinus taeda*) (Fisher et al. 1972; Shew et al. 1981).

White-tailed deer are abundant in the mixed forests of the floodplain environment. A variety of fur-bearing mammals also inhabit this environmental zone, including the eastern gray squirrel (*Sciurus carolinensis*), the fox squirrel (*Sciurus niger*), mink (*Mestela vison*), raccoon, opossum and muskrat (*Ondatra zibethicus*). The beaver (*Castor canadensis*) was common in the Trinity watershed prior to virtual extinction from trapping by the early twentieth century (Shew et al. 1981). Also present in the rivers is the river otter (*Lutra canadensis texensis*). Reptiles common in riverine and floodplain habitats include a variety of snakes, hardshell turtles and the American alligator (*Alligator Mississippiensis*). Upstream of the brackish waters or river deltas, many species of freshwater fish are found, including bowfin (*Amia calva*), shiners (*Notropis* spp.), lake chubsucker (*Erimyzon sucetta*), yellow bullhead (*Ictalurus natalis*), largemouth bass (*Micropterus salmoides*) and sunfish (*Lepomis* spp.).

The barrier islands of the upper Texas coast, comprised of Bolivar Peninsula, Galveston Island and Follett's Island, are for the most part treeless. Vegetation consists largely of various salt-tolerant grasses such as seacoast bluestem (*Schizachyrium scoparium littoralis*), singlespike paspalum (*Paspalum monostachyum*) and sea oats (*Uniola paniculata*). Small mottes of live oak (*Quercus virginiana*) and clumps of mesquite (*Prosopis* spp.) are scattered along ridges on Galveston Island and Bolivar Peninsula. The lagoonal shorelines of the islands support saltmarsh species such as cordgrass (*Spartina* spp.), glasswort (*Salicornia* spp.), saltwort (*Batis maritima*) and, in places, cattails (*Typhus* spp.). Terrestrial fauna on the islands are characterized by low species diversity. The most common mammal on the barrier islands is the hispid cotton rat (*Sigmodon hispidus*), an animal which was, according to the findings at Mitchell Ridge, a significant source of meat for aboriginal occupants of Galveston Island. White-tailed deer have also been reported on Galveston Island, though they are no longer present. Opossum are fairly common. Reptilian species include the ornate box turtle (*Terrepene ornata*) and snakes such as the speckled kingsnake (*Lampropeltis getulus*), eastern hognose (*Heterodon playthinos*), western diamondback rattlesnake (*Crotalus atrox*) and cottonmouth (*Agkistrodon piscivorus leucostoma*).