PACIFIC LATIN AMERICA IN PREHISTORY

The Evolution of Archaic and Formative Cultures

Edited by Michael Blake

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Precolumbian Fishing on the Pacific Coast of Panama

Richard G. Cooke and Anthony J. Ranere

Introduction: Estuarine Fishing in the Eastern Tropical Pacific

It is well known that the productivity, biotic diversity and geological heterogeneity of large estuary-lagoon systems along the Pacific coast of tropical America were causally related to the precocity and intensity of sedentism and civilization in Precolumbian times. Most archaeologists are aware that the abundance, variety and accessibility of estuarine animals offered pre-Spanish hunter-gatherers and farmers many alternatives for exploitation. Intrinsic resource diversity is conducive to intensification from within a biome. Each estuarine system, however, has its own biological, physical and historical peculiarities. Many eastern tropical Pacific (henceforth ETP) estuaries are quite extensive. They harbored contemporary human groups with different social and cultural histories. Therefore it is important to inventory resource distribution in space and time within specific estuarine systems in order to determine their relevance to local, regional and universal correlates of economic development.

In recent years, archaeologists have benefitted from improving standards of archaeofaunal and geoarchaeological field and laboratory techniques. Nevertheless, reports on animal exploitation in the ETP are still biased towards invertebrates and large terrestrial vertebrates. Molluscs and mammal and bird bones are easier to see and collect than tiny fish bones. Furthermore, they generally represent fewer utilized species, whose skeletons and shells are stored in accessible reference collections. Many archaeologists have learnt to handle identifications themselves with the help of practical guidebooks.

ETP fish faunas are a different matter. Many families and genera that live in or enter estuaries are "speciose," i.e., they contain several species. Although they often resemble each other morphologically, these species partition particular estuarine systems in subtle ways. This diversity means that archaeozoologists must collect large numbers of skeletons in ontogenetic series (i.e., representing different life stages) in order to identify their ichthyofaunas to the satisfaction of the archaeologists who recover them so painstakingly in the field. Objective interpretation of human exploitation requires baseline biological data on how individual species behave and are distributed in the many different sectors of an estuary. This is a tricky task because ETP estuarine fish have been surprisingly poorly studied (Cooke 1992). Fisheries research has concentrated on commercially important non-estuarine fish, such as tunnies, big jack, and groupers. Field biologists have emphasized fish that live on reefs or near rocks because they are easier to observe than species that swim in turbid waters subjected to strong tidal influences.

Research Rationale

Our chapter refers to the Santa María estuary on the central Pacific Coast of Panama (Figure 1). This is the region where the "Coclé" culture developed, now more prosaically known as the "Central Region" of Panama (Cooke and Ranere 1992b; Lothrop 1937, 1942). This culture is considered to be typical of complex and stratified chiefdoms in the lowlands of tropical America (Helms 1979; Linares 1977; Willey 1971). The regional chronology has been well-defined. However, Precolumbian settlement patterns in the region are imperfectly understood (Cooke 1984a; Cooke and Ranere 1992b).

Investigations into regional subsistence economies are still in an interim stage. We cannot collate all the relevant bodies of data to the satisfaction of a demanding cultural historian. For this reason, we have chosen a topic that the existing information can address reasonably objectively, if not completely: the degree to which the taxonomic composition and proportionality of dietary fish remains from two sites with different ^{14}C ages and topographies within the Santa María estuary can be used to infer cultural parameters (i.e., habitat use, capture techniques and foraging ranges) as

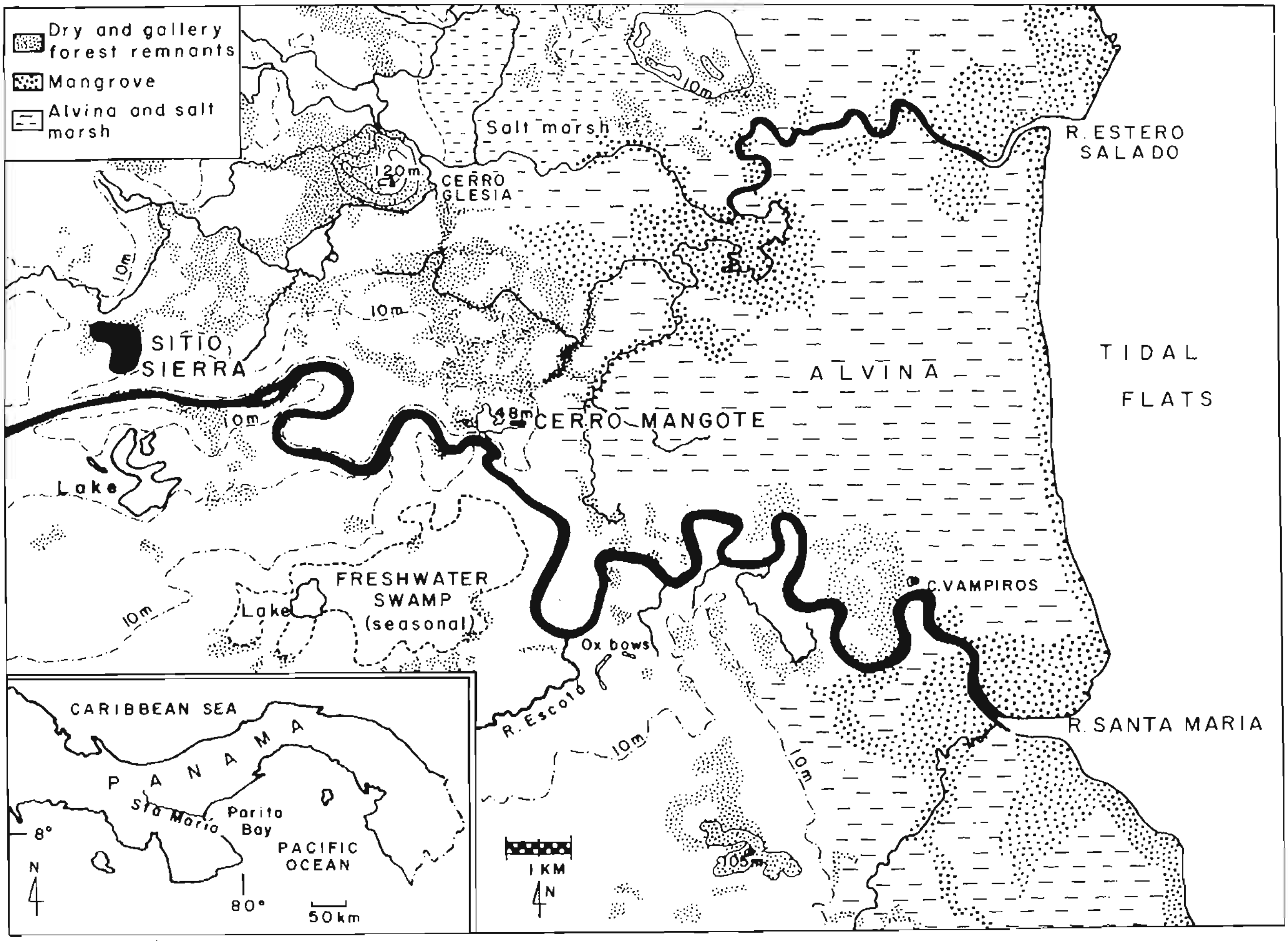

Figure 1. The Middle Estuary of the Santa María River in Central Panama, Showing the Locations of Cerro Mangote and Sitio Sierra.

well as topographical ones (i.e., site location vis-à-vis the evolving coastline).

The two sites are: Cerro Mangote and Sitio Sierra. Cerro Mangote was a preceramic camp or hamlet occupied between ca. 5650 and 3600 cal B.C. and, during this period, located about 1.2-5.5 km from the coastline. Sitio Sierra was a nucleated farming village which would have been about 12 km inland between approximately cal A.D. 1 and 400.[1]

Summaries of the peculiarities of ETP estuarine fish diversity, ecology and distribution are presented elsewhere (Cooke 1992, 1993a, 1993b; Cooke and Tapia 1994a, 1994b). Even so, the following text contains detailed information about fish. In case some readers find this tedious, we employ the scientific binomial the first time we mention a taxon, and thereafter rely on English common names. Our marine fish reference is Allen and Robertson's *Fishes of the Eastern Tropical Pacific* (1994). Their nomenclature differs from that of other monographs (e.g., Bussing and López 1993; FAO 1995; Thomson et al. 1979), but since we applaud their attempt to standardize vernacular names, we follow their lead. Where we cannot find an English name, we have invented one (for example, we translate *amblops* as "bluntnosed"). Table 1 lists all the fish taxa recorded in the archaeological bone samples so that readers can cross-check popular and biological nomenclature.

The Santa María River Estuary

Our multidisciplinary project in the Santa María basin began in the early 1980s (Cooke and Ranere 1984, 1992a, 1992b). The eponymous river enters the sea at Parita Bay. Geological sediment cores extracted with a "Vibracore" allow us to correlate some aspects of the evolution of its delta with sea-level change (Barber 1981; Clary et al. 1984) and, thence, with archaeological sites where fish bones are important components of middens (Cooke and Ranere 1984, 1989; Cooke 1992, 1993b).

To compensate for the scant information about ETP estuarine fish faunas, we sponsored three parallel investigations into modern fish distribution and fishing techniques within this system (localities are identified in Figure 1): (1)

the ethnology of fishing at two Parita Bay coastal villages (El Rompío, Aguadulce, and Boca de Parita, Monagrillo) (directed by John Bort), (2) a taxonomic and quantitative evaluation of the nektonic (i.e., free swimming) fauna captured in an intertidal net-and-pole trap in the Estero Palo Blanco, Aguadulce, a mangrove-fringed inlet just north of the Estero Salado channel (Cooke and Tapia 1994b), and (3) a survey of marine fish amphidromy (i.e., periodic upward and downward movements) in the middle (mixing) and upper (fluvial) estuary of the Santa María River, based on bi-monthly captures made with different fishing techniques at four stations located between .8 and 20 km from the mouth (Table 1; Cooke and Tapia 1994a).

Although this research promises to fine-tune our interpretations of Precolumbian fishing, there remain several unresolved problems. The first is insoluble: the native population in this part of Panama was exterminated, hybridized or radically hispanicized soon after initial contact (Romoli 1987). Hence we cannot assume continuity between pre- and post-contact fishing methods. All that our "middle range research" (Trigger 1989:362-7) has achieved so far is to point out which fishing techniques may have been used, and in which estuarine habitats the fish taxa identified in the archaeological bone samples may have been caught. It is possible that some modern techniques were actually used in Precolumbian times—e.g., intertidal traps like the one we are studying—but we may never be able to prove this.

Another defect is recovery bias. Using .25 inch mesh screen for recovering large mammal bones is in some situations methodologically defensible (Shaffer 1992). However, it is not viable for recovering fish remains (Wheeler and Jones 1989:38-43). The samples to which we refer herein represent the fraction recovered using .125 inch mesh screen. Bones recovered beneath this mesh size have not been analyzed to our satisfaction. These comprise mostly tiny individuals of the taxa identified with larger meshes. So their absence from our quantifications affects appreciations of fish size ranges to a greater degree than fish taxonomic richness and diversity.

Present-day Environment

This section is based on descriptions in Barber (1981) and Clary et al. (1984) and on personal observations. It is quite long; but the detail is necessary to emphasize two particularly relevant features of tropical estuaries: (1) the variety and patchiness of terrestrial and aquatic habitats, and (2) the jigsaw-like, temporally unpredictable juxtaposition of freshwater, brackish and saline habitats. Illustrations of some of the habitats and landforms can be found in Clary et al. (1984).

Day et al. (1989:3) define estuaries as "that portion of the earth's coastal zone where there is interaction of ocean water, fresh water, land, and atmosphere." Fairbridge (1980) divides estuaries into three sectors: (1) *marine* or

Table 1. List of Fish Taxa Identified at Cerro Mangote and Sitio Sierra.

Genus and species	English name	Synthesis of fishing records
Elasmobranchs		
CARCHARHINIDAE:		
Carcharhinus altimus[a]	bignose shark	
C. leucas	bull shark	
C. limbatus	blacktip shark	R
Rhizoprionodon longurio	Pacific sharpnose shark	
DASYATIDAE:		
Dasyatis longus	long-tailed stingray	O
MYLIOBATIDAE:		
Aeteobatus narinari	spotted eagle ray	1
PRISTIDAE:		
Pristis	sawfish	2, 4
SPHYRNIDAE:		
Sphyrna lewini	scalloped hammer-head	R
Sphyrna tiburo	bonnethead	
UROLOPHIDAE:		
Urotrygon asterias	stingray	O
Teleosts		
ALBULIDAE:		
Albula neoguinaica	Pacific bonefish	
ARIIDAE[b]:		
"Arius" dasycephalus	broadhead catfish	
"*A.*" species B[c]	widemouthed catfish	1, 2, 3, 4
"A." kessleri	Kessler's catfish	A, 1, 2
"A". lentiginosus	Panamanian catfish	
"A". "osculus"[d]	thick-lipped catfish	O, 1
"A". platypogon	slender-spined catfish	R
"A." seemanni	Seemann's catfish	A, 1, 2
Bagre panamensis	chihuil catfish	R
B. pinnimaculatus	long-barbled catfish	O, 1, 2
Cathorops hypophthalmus	gloomy catfish	A, 1, 2
C. multiradiatus	many-rayed catfish	O, 1
C. species A[e]	congo catfish?	O, 1, 2
C. species B	Taylor's catfish?	A, 1
C. tuyra	Tuyra catfish	A, 1, 2, 3
Sciadeops troscheli	chili catfish	
Sciadeichthys dowii	flap-nosed catfish	O, 1, 2
AUCHENIPTERIDAE:		
Parauchenipterus amblops	blunt-nosed driftcat	1, 2, 3, 4
BATRACHOIDIDAE:		
Batrachoides[f]	toadfish	O, 1
Daector	toadfish	A
BELONIDAE:		
Strongylura scapularis	yellowfin needlefish	O, 2
Tylosurus crocodilus	crocodile needlefish	R
BOTHIDAE:		
Citharichthys gilberti	Gilbert's flounder	O, 1, 2, 4
CARANGIDAE:		
Alectis ciliaris	African pompano	

Table 1. (Continued)

Genus and species	English name	Synthesis of fishing records
Carangoides otrynter	threadfin jack	
Caranx caballus	green jack	R
C. caninus	Pacific crevalle jack	O, 1
Chloroscombrus orqueta	Pacific bumper	A
Oligoplites altus	longjaw leatherjacket	A, 1
O. refulgens	shortjaw leatherjacket	O
O. saurus	yellowtail leatherjacket	O
Selar crumenophthalmus	purse-eyed scad	
Selene brevoortii	Pacific lookdown	O (juv)
S. oerstedii	hairfin lookdown	O (juv)
S. peruviana	Pacific moonfish	R (juv)
Trachinotus kennedyi	blackblotch pompano	O, 1
CENTROPOMIDAE:		
Centropomus armatus	longspine snook	A, 1, 2
C. medius	bigeye snook	O, 1
C. nigrescens	black snook	O, 1, 2, 3, 4
C. robalito	little snook	A, 1-4 (juv)
C. unionensis	humpback snook	A, 2
C. viridis	white snook	A, 1, 2, 3, 4
CICHLIDAE:		
Aequidens coeruleopunctatus	blue-spotted cichlid	3, 4
CLUPEIDAE:		
Opisthonema libertate[g]	Pacific thread-herring	R
CTENOLUCIIDAE:		
Ctenolucius hujeta	pike characin	3, 4
CURIMATIDAE:		
Curimata magdalenae	Magdalena curimata	2, 3, 4
ELOPIDAE:		
Elops affinis	machete	O, 1, 2, 3, 4
ENGRAULIDAE:		
Anchoa	anchovy	O, 1, 2
Cetengraulis mysticetus	Pacific anchoveta	A, 1
EPHIPPIDAE:		
Parapsettus panamensis	Panama spadefish	O
ERYTHRINIDAE:		
Hoplias sp.[h]	Santa Maria trahira	2, 3
GERREIDAE:		
Diapterus peruvianus	Peruvian mojarra	A
Eucinostomus currani	blackspot mojarra	O, 3, 4 (juv)
Eugerres brevimanus	short-finned mojarra	O, 2
E. lineatus	striped mojarra	O
Gerres cinereus	yellowfin mojarra	O
GOBIIDAE/ELEOTRIDIDAE:		
Bathygobius cf. *andrei*	estuary frillfin	O, 1
Dormitator latifrons	spotted sleeper	2
Eleotris picta	painted gudgeon	2, 3
Gobioides peruanus	Peruvian eelgoby	2
Gobiomorus maculatus	pike gudgeon	2, 3, 4
HAEMULIDAE:		
Anisotremus dovii	blackbarred grunt[i]	
A. pacifici	Pacific grunt	O, 1, 2
Haemulon flaviguttatum	Cortez grunt	
Orthopristis chalceus	brassy grunt	R
Pomadasys bayanus	freshwater grunt	O, 1, 2[j]

Table 1. (Continued)

Genus and species	English name	Synthesis of fishing records
P. macracanthus	bigspine grunt	O, 1, 2
P. panamensis	Panamanian grunt	
Pomadasys (H.) elongatus	elongate grunt	A
P. (H.) leuciscus	white grunt	A
P. (H.) nitidus	silver grunt	R
LOBOTIDAE:		
Lobotes surinamensis	tripletail	O, 1, 2
LORICARIIDAE:		
Hypostomus panamensis	Panamanian armored cat	1, 2, 3, 4
LUTJANIDAE:		
Lutjanus argentiventris	yellow snapper	R[k]
L. colorado	colorado snapper	O, 1
L. guttatus	spotted rose snapper	
L. novemfasciatus	dog snapper	O, 1, 3, 4
MUGILIDAE:		
Mugil curema	white mullet	A, 1, 2, 3
PIMELODIDAE:		
Rhamdia guatemalensis[l]	Guatemalan rivercat	2
POLYNEMIDAE:		
Polydactylus approximans	blue bobo	O
P. opercularis	yellow bobo	A
PRISTIGASTERIDAE:		
Ilisha furthii	Pacific ilisha	A, 1, 2
Opisthopterus	longfin herring	A, 1 (*O. dovii*)
SCIAENIDAE:		
Bairdiella. armata	armed croaker	O, 1
B. ensifera	swordspine croaker	A, 1, 2
Cynoscion albus	white corvina	A, 1, 2
C. squamipinnis	scalefin weakfish	
C. stolzmanni	Stolzmann's weakfish	O
Menticirrhus panamensis	Panama kingcroaker	O
Micropogonias altipinnis	high-fin corvina	R (juv)
Ophioscion scierus	tuza croaker	O
O. typicus	point-nosed croaker	A, 1
O. vermicularis	worm-lined croaker	
Paralonchurus dumerilii	suco croaker	O
Stellifer chrysoleuca	shortnose stardrum	O
S. oscitans	yawning stardrum	A, 1
SCOMBRIDAE:		
Euthynnus lineatus	black skipjack tuna	
Scomberomorus sierra	sierra mackerel	R
SERRANIDAE:		
Epinephelus analogus	spotted cabrilla	R
SPHYRAENIDAE:		
Sphyraena ensis	Pacific barracuda	
STERNARCHIDAE:		
Sternopygus dariensis	Darien knifefish	2, 3, 4
STROMATEIDAE:		
Peprilus snyderi	Snyder's butterfly-fish	O
SYNBRANCHIDAE:		
Synbranchus marmoratus	freshwater eel	
TETRAODONTIDAE:		
Sphoeroides annulatus	bullseye puffer	A, 1
Guentheridia formosa	Guenther's puffer	A

Table 1. (Continued)

Note: Taxa are presented together with their English names and information on their presence in an intertidal fish trap in the Estero Palo Blanco, Aguadulce and at four collection stations up the Santa María River (Figure 1). Trap records: A—abundant, O—occasional, R—rare. River collection stations: 1—Mouth (0.8 km), 2—París (7 km), 3—El Rincón (12 km), 4—Santa María (20 km) (Cooke 1993b; Cooke and Tapia 1994a, 1994b).

[a] Our collection contains two Parita Bay skeletons identified as this species. Confusion with *C. obscurus* (also with a dorsal ridge) is possible. This species is more likely to enter ETP inshore waters.

[b] The sea catfish family (Ariidae) is under revision. The genus "*Arius*" comprises species of distinct phylogenetic origins (hence our use of inverted commas). Lapillus morphology suggests that "*Arius*" *seemanni* and "*A.*" platypogon are divergent from the other "*Arius*" species (Cooke, 1996).

[c] This appears to be the species that was erroneously assigned by Meek and Hildebrand (1923:120-22) to their "*Netuma oscula*." See Bussing and López (1993:62-63).

[d] The type specimen of this species has been lost.

[e] We believe that our *Cathorops* species A corresponds to *C. furthii* and *C.* species B, to *C. taylori* (Allen and Robertson 1994:69, Plate V-7), which Bussing and López (1993) consider to be synonymous with *C. steindachneri*. See also Cooke (1996).

[f] Both *Batrachoides boulengeri* (estuary toadfish) and *B. pacifici* (Pacific toadfish) are captured frequently in the Santa María estuary. We have identified the former 22 km from the mouth in freshwater. They are difficult (but not impossible) to separate osteologically.

[g] We do not possess skeletons of *Opisthonema bulleri* or *O. medirastre*. Both species occur in Panama, but not, as far as we know, in turbid shallow waters in Parita Bay.

[h] Two species are known from Panama: *Hoplias malabaricus* and *H. microlepis*. A. Martin (personal communication), who is investigating mtDNA in Panamanian freshwater fish, believes that the Santa María population may be a distinct species.

[i] This species is abundant at the mouth of the Estero Salado inlet near the fishing village of El Rompío (Cooke, personal observation).

[j] We have recorded this species 60 km from the coast at 300 m elevation (Cooke and Tapia 1994a).

[k] Although rare in the intertidal trap, young adults are abundant at the edge of mangrove-fringed inlets where they can be readily caught with hook and line (Cooke, personal observation).

[l] This is the only *Rhamdia* species that has been reported in the Santa María lower drainage. It is also the only *Rhamdia* in our reference collection. Other species may occur, however.

lower estuary, in free connection with the open sea, (2) *middle estuary*, subject to strong salt and fresh water *mixing*, and (3) *upper* or *fluvial estuary*, characterized by fresh water but subject to daily tidal action (emphasis ours).

These definitions are germane to regional-historical studies because they stress the fact that an archaeological site can be a considerable distance from the sea yet still be technically estuarine (Day et al. 1989:6; Day and Yáñez A. 1982). Sitio Sierra's location and large size between cal A.D. 1 and 400 can be viewed as a topographical compromise between proximity to fertile colluvium for maize-dominated agriculture (Cooke 1984a), and access to the rich nektonic and littoral resources of the middle and upper estuary. Although the Santa María River now flows fresh about 12 km inland, it is still weakly tidal at this point. Hence, sensu Day et.al. (1989) and Fairbridge (1980), Sitio Sierra is an estuarine site. As we shall see, its fishing practices were markedly estuary-dependent.

By global standards, the Santa María River is small, about 145 km from source to mouth (Weiland 1984:34). Nevertheless, the basin it drains (3315 km^2) is the second largest in Panama and the largest in the Central Region. Its delta is one of the driest zones in Central America with an average annual rainfall between 1000 and 1400 mm and an intense 4-5 month dry season. But the mountains and foothills through which it descends are humid: annual precipitation is 3800 mm at one well-known station (La Yeguada, 650 m elevation [Estadística Panameña 1975]) and even more above 1000 m, where orography causes more constant dry season precipitation.

The flood-plain drainage systems to the north and south of the main river channel are poorly integrated: during the heaviest floods, water flows northwards in front of Cerro Iglesia and crosses into the drainage of the Estero Salado, which is probably an ancient primary channel of the Santa María. Here the landscape is dotted with meander scars, elbows of capture, swamps and some freshwater ponds, which expand after floods and retract rapidly in the dry season. Evanescent bodies of freshwater are often dammed up close to the *alvina* (see below), covered with water lilies and crowded with herons, woodstorks and other aquatic birds.

Seasonal pools are important to modern fishing because when they evaporate during dry periods, they concentrate freshwater and euryhaline species (i.e., tolerant of a wide range of salinity), facilitating their capture in large quantities with simple fishing methods.

We shall see that freshwater species were fished frequently at Sitio Sierra, but not at Cerro Mangote.

The C-shaped coastline of Parita Bay is a recent marine invasion of the Pacific continental shelf. Its tidal range averages 4.5 m during most of the year and 6 m during spring tides (Fleming 1938). However, the low angle of the coastal slope, weak wave action, and the lack of a restricted channel for tides make it a low energy environment, heavily colonized by mangrove. Intertidal mudflats extend for 2-3 km into Parita Bay, criss-crossed by runnels and channels.

Where the Santa María River discharges into the marine environment, it breaches the strandline *Rhizophora* mangroves. These often extend inland along tidal and run-off channels for as much as 8 km enabling some marine organisms to penetrate almost to the foot of the hill upon which the site of Cerro Mangote is located. Further inland stretch the coastal *alvinas*. These comprise mid-tidal, high-tidal and supra-tidal zones. Near its seaward edge, the mid-tidal zone contains patches of *Avicennia* mangroves. At its widest point, the high-tidal *alvina* is a barren plain surface. It supports algal growth when moist, becomes a quagmire during heavy rains, and desiccates during the dry season when patches are covered with a dazzling film of salt. The supra-tidal *alvina* supports sparse grassy vegetation, xerophilous trees, and cacti. This grades into anthropogenically altered tropical dry forest. Woods present in 1955 are shown in Figure 1. Their vegetational composition is probably quite different from that of Precolumbian woods; but they may approximate the extent of continuous vegetative cover when the two sites were occupied. According to sediment core data from Lake La Yeguada, the premontane forest of the upper Santa María drainage had been extensively cleared by ca. 2000 B.C. (Piperno et al. 1991). By A.D. 1, the lower course of the river was well settled by farming peoples. The terrestrial vertebrates identified alongside the fish at Cerro Mangote and Sitio Sierra are, with very few exceptions, denizens of grassland, marsh-swamp, and secondary or dry woods (Cooke 1984a, 1984b; Cooke and Ranere 1989, 1992c; Cooke et al. 1996).

Site History and Paleogeography

Cerro Mangote's refuse covers 1750 m^2 of a prominent flat-topped hill of the same name. This is 1.2 km long and .2 km from the Santa María River's present north bank. Its eastern edge is now 8 km from the shoreline of Parita Bay. First recognized and excavated by McGimsey (1956), it was re-tested in 1979 by Ranere (Cooke 1984a). Seven acceptable dates range (at the 2 sigma level) from 5930 (5660-5640) 5450 cal B.C. to 3834 (3623) 3348 cal B.C.[1]

Five strata (McGimsey 1956) represent two distinguishable events. A basal "red zone" of laterized clay has fewer cultural materials per sediment unit than an overlying "brown zone". This is an organically rich refuse deposit that probably accumulated rapidly. The fish bone sample to which we refer comes from .45 m^3 of this "brown zone" (1.25-2.05 m below surface). The distribution of ^{14}C dates suggests that it was deposited sometime between 5000 and 3600 cal B.C.

Barber (1981) summarized Cerro Mangote's relation to continental and marine sediments on the basis of two 2.6 m "Vibracore" samples. By correlating sedimentology, ^{14}C dates and sea-level curves for Panama (Bartlett and Barghoorn 1973; Golik 1968), he proposed a facies change model, which related archaeological sites to coastline mechanics (Cooke and Ranere 1992a). He inferred that Cerro Mangote's initial occupation (ca. 5600 cal B.C.) coincided with the closest approach of a marine setting (1.2 km) and its abandonment (ca. 3600 cal B.C.) with the end of a period of rapid delta progradation. At this time, a marine setting would have been about 5 km distant.

We took salinometer readings during 1992-3 in the lower course of the Santa María River. Surface salinity at the mouth varies from 0‰ to 30‰ in a single tide cycle. This is the archetypal mesohaline "mixing" zone of a tropical estuary where riverine and marine influences are constantly and often violently juxtaposed.

Seven kilometers upstream, at París, surface salinity was generally 0-1‰ and occasionally 3-5‰. In this sector, the highest tides create a strong bore and turbid water. During rainy season floods, the downriver current is very strong: the water turns orange-brown with suspended sediments. This location represents the inward edge of the oligohaline section of the "middle estuary."

Twelve and 20 km upriver we recorded zero salinity although weak tidal influences cause the water level to fluctuate slightly (1.5 m at El Rincón and .5 m at Santa María). These locations correspond to Fairbridge's (1980) "upper or fluvial estuary" and Day et al.'s (1989:50) "tidal river zone."

If Cerro Mangote was between 1.2 and 5.5 km from the Santa María outlet during its Late Preceramic occupation, it would have been alongside the mesohaline mixing zone of the middle estuary. It is possible, however, that it was not actually along the primary river channel.

Sitio Sierra occupies a low knoll 10-15 m above sea level. It is .4-1.2 km north of the main channel of the Santa María River and 14 km from the mouth. A farming village with a maximum surveyed extent of 45 ha, it was occupied between ca. 200 cal B.C. and the Spanish Conquest. The fish bone sample presented herein comes from a 3.5 m^2 (1.4 m^3) cut, excavated into a 20 m^2 refuse midden that has not been dated by ^{14}C. Two domestic features lying directly beneath it were associated with two charcoal dates whose 2 sigma maximum range is 195 cal B.C. to cal A.D. 233 (with means of cal A.D. 2 to cal A.D. 29-56)(Cooke 1979, 1984a; Isaza-Aizuprúa 1993). The Aristide pottery (Cooke 1985) contained in the midden suggests that it was laid down before cal A.D. 400. Deposition seems to have been rapid.

If we apply an average sedimentation rate of 3 mm/1000 years (Clary et al. 1984:61) to Barber's facies change model, the central portion of the Santa María has prograded approximately 1 km/1000 years for the last four millennia. This is a "smoothed" estimate that does not take into account fluctuations in sedimentation rates due to deforestation, changes in precipitation patterns or local tectonic events. Nevertheless, Pb-210 dating of marine cores elsewhere in Panama Bay gives sedimentation rates which are similar to Barber's (Suman 1983:71). Hence, the active shoreline was probably 12-12.5 km away from Sitio Sierra at cal A.D. 1-400.

The Fish Bone Samples

We compare fish bones collected over a .125 inch standard metal mesh, laid flat. The Cerro Mangote sample

Table 2. Ratio of Fish Bone Elements (E) to Volume, and MNI, and the Estimated Average. Weight.

Site	Fish E per m^3	Fish E/ MNI	Average estimated weight of teleosts (kg)
Cerro Mangote	7,100	12.6	.723
Sitio Sierra (all fish)	14,094	26.5	.325
Sitio Sierra (marine fish)			.407

comprises 3,195 skeletal elements: 3,107 (97.2 percent) are teleost (bony fish) and 88 (2.8 percent) elasmobranch (shark and ray). The Sitio Sierra sample totals 19,731 elements, of which 19,623 (99.5 percent) are teleost, and 108 (.5 percent) elasmobranch.

The two samples were buried in organic-rich soils with similar crumb structure. They were recovered over the same kinds of screen. This validates their comparison. Sitio Sierra's sample, however, was taken after the retained sediments were hosed down with water. This action surely influenced the differences exhibited by the two samples with regard to (1) the ratio of fish bone elements (E) to estimated numbers of individuals (MNI), and (2) the estimated average size of the identified fish (Table 2). We summarize identifications in Table 3 (Cerro Mangote) and Table 4 (Sitio Sierra). Table 1 includes simplified comments on the distribution of each identified taxon within the Santa María estuary based on our actualistic studies in Parita Bay.

Taxonomically secure identifications of bones are fundamental to the significance of this research. So some comments on our procedures are not out of place. These are not at the cutting edge of modern archaeozoology! Rather, they are subservient to the complexities generated by large, fragmented and diverse fish bone samples, which include many species of the same ETP genus or family—sometimes, *all* the currently recorded species (Cooke 1992, 1993b).

Our strategy consisted of three stages: (1) the assignment of body parts (fish E) identified with a binocular microscope to the most exact category on the taxonomic scale (i.e., Order, Family, Genus, Species), (2) the calculation of minimum numbers of individuals (MNI) based on size groups estimated by reference to specimens in the Smithsonian Tropical Research Institute's comparative skeletal collection, and (3) the calculation of the "estimated dietary biomass" (EDBM). This is the sum of the inferred body masses of all the individuals identified in each taxon.[2]

Readers with a modicum of experience in archaeozoology may be concerned about the imprecision of this procedure.

Table 3. Distribution of Fish Bones Recovered Using .125 Inch Metal Mesh Screen in a Refuse Deposit at Cerro Mangote, Panama. E—skeletal parts. MNI—minimum number of individuals. EDBM—estimated dietary biomass.

Genus and species	E	MNI	EDBM (kg)
Elasmobranchs			
Shark	10		
Shark, unid. species[a]	4	1	>2
CARCHARHINIDAE:			
Carcharhinus cf *altimus*	7	1	5
C. leucas	59	1	3.5
Ray	2		
Ray, unid. species	1	1	?
DASYATIDAE:			
Dasyatis	2	1	>10
PRISTIDAE:			
Pristis	1	1	?
UROLOPHIDAE:			
Urotrygon cf *asterias*	2	2	15
Teleosts			
ALBULIDAE:			
Albula neoguinaica	10	2	.7
ARIIDAE:	747		
"*Arius*"	28		
"*A.*" species B	20	4	3.15
"*A.*" *kessleri*	39	8	4.3
"*A.*" cf *kessleri*	3		
"*A.*" *kessleri* or "*A.*" sp. B	14		
"*A.*" *lentiginosus*	3	1	.45
"A." cf *lentiginosus*	1		
"*A.*" "*osculus*"	1	1	.45
"*A.*" cf "*osculus*"	1		
"*A.*" *osculus* or "*A.*" species B	2		
"*A.*" *platypogon*	4	2	1.15
"*A.*" *seemanni*	112	15	3.73
Bagre panamensis	2	1	.45
B. pinnimaculatus	7	3	2.95
Cathorops	39		
Cathorops, not species A	2		
C. species A	31	6	1.3
C. cf species A	6		
C. hypophthalmus	2	1	.45
C. cf *hypophthalmus*	2		
C. multiradiatus	2	2	.55
C. tuyra	7	3	1.2
C. cf *tuyra*	1		
C. species A or *C. tuyra*	1		
Sciadeichthys dowii	339	24	46.6
cf *S. dowii*	6		
BATRACHOIDIDAE:			
Batrachoides	63	15	7.275
BELONIDAE:			
Strongylura cf *scapularis*	1	1	.15
CARANGIDAE:	4		

Table 3. (Continued)

Genus and species	E	MNI	EDBM (kg)
Carangoides otrynter	1	1	.25
Caranx caninus	8	5	3.9
C. cf *caninus*	3	1	.25
Chloroscombrus orqueta	2	1	.075
Oligoplites altus	3	2	.9
O. altus or *O. saurus*	2	1	.15
Selene peruviana	3	2	.425
CENTROPOMIDAE:			
Centropomus	19		
Centropomus ("gualajo" group[b])	11	1	.075
Centropomus armatus	18	5	2.2
C. cf *armatus*	2		
C. armatus or *C. unionensis*	1		
C. robalito	4	3	1.1
C. cf *robalito*	1		
C. robalito or *C. unionensis*	1		
Centropomus ("elongate")	25	3	5.58
C. medius	16	5	4
C. nigrescens	1	1	1.5
C. viridis	5	4	4.475
C. nigrescens or *C. viridis*	21	1	.55
CLUPEIFORMES:	1		
CLUPEIDAE:			
Opisthonema cf *libertate*	16	2	.2
PRISTIGASTERIDAE:			
Ilisha furthii	6	3	.7
Opisthopterus	1	1	.03
ELOPIDAE:			
Elops affinis	1	1	.075
ENGRAULIDAE:			
cf *Cetengraulis mysticetus*	2	1	.01
GERREIDAE:	9		
Diapterus peruvianus	9	3	.8
cf *D. peruvianus*	4		
Eucinostomus currani	1	1	.15
Eugerres	8		
E. brevimanus	2	1	.15
E. lineatus	8	3	1.25
Gerres cinereus	3	1	.15
GOBIIDAE/ELEOTRIDIDAE:	1		
Bathygobius cf *andrei*	2	1	.03
Dormitator latifrons	388	20	2.775
Eleotris picta	3	2	.6
Gobioides peruanus	11	3	.325
Gobiomorus maculatus	3	2	.2
HAEMULIDAE:	5		
Anisotremus	1	1	.25
Anisotremus dovii	1	1	.15
Haemulon flaviguttatum	1	1	.15
Orthopristis chalceus	21	5	1.225
cf *O. chalceus*	1		
Pomadasys	2		
Pomadasys macracanthus	18	4	2.65
P. cf *macracanthus*	5		
Pomadasys (Haemuliopsis)	3		

Table 3. (Continued)

Genus and species	E	MNI	EDBM (kg)
Pomadasys (H.) cf *elongatus*	1	1	.2
P. (H.) leuciscus	1	1	1
P. (H.) cf leuciscus	2		
P. (H.) nitidus	2	1	.25
LOBOTIDAE:			
Lobotes surinamensis	9	4	7.65
LUTJANIDAE:	7	3	1.15
Lutjanus argentiventris	2	2	3.5
L. cf *argentiventris*	1	1	.45
L. colorado	1	1	.5
L. guttatus	1	1	.45
L. novemfasciatus	2	2	3.5
MUGILIDAE:			
Mugil cf *curema*	15	5	1.325
POLYNEMIDAE:			
Polydactylus approximans	2	1	.35
P. opercularis	35	7	2.025
SCIAENIDAE:	8		
Bairdiella	1		
B. armata	4	2	.3
B. ensifera	2	1	.2
Cynoscion	3		
C. albus	17	4	11
C. albus or *C. stolzmanni*	7		
C. squamipinnis	1	1	3.5
C. stolzmanni	7	4	3.55
Menticirrhus panamensis	1	1	1
M. cf panamensis	1	1	.25
Micropogonias altipinnis	8	5	10.35
cf *M. altipinnis*	2		
Ophioscion scierus	2	1	.25
Ophioscion typicus	8	3	.275
O. cf typicus	1		
O. vermicularis	1	1	.15
Stellifer oscitans	3	2	.2
Paralonchurus dumerilii	2	2	.7
SERRANIDAE:			
Epinephelus analogus	1	1	1.75
E. cf *analogus*	6	2	8
TETRAODONTIDAE:			
Sphoeroides annulatus	7	3	1.95
Total, Elasmobranch:	88	8	>35.5
Total, Teleost:	3107	246	177.93
Total, Fish:	3195	254	213.43

[a] unid.—unidentified; a taxon that is not present in the Smithsonian Tropical Research Institute's comparative skeletal collection.

[b] The following three species are known as "gualajos" by Parita Bay fisherfolk. Osteologically, they are somewhat distinct from the three "elongated" species. Hence specifically undiagnostic bones can sometimes be assigned to either group.

Table 4. Distribution of Fish Bones Recovered Using a .125 Inch Metal Mesh Screen in a Refuse Deposit at Sitio Sierra, Panama. E—skeletal parts. MNI—minimum number of individuals. EDBM—estimated dietary biomass. *—primary freshwater taxon.

Genus and species	E	MNI	EDBM (kg)
Elasmobranchs			
Elasmobranch, unid. species	25	1	?
Elasmobranch, unid. species	10	1	?
CARCHARHINIDAE:			
Carcharhinus cf *altimus*	2	1	1
C. leucas	6	2	11
C. limbatus	1	1	?
Rhizoprionodon longurio	33	2	1
Ray	1		
DASYATIDAE:			
Dasyatis cf *longus*	1	1	?
MYLIOBATIDAE:			
Aeteobatus narinari	4	1	3
SPHYRNIDAE:			
Sphyrna	1	1	
cf *Sphyrna*	1	1	>10
Sphyrna cf *tiburo*	19	1	1
PRISTIDAE:			
Pristis	3	1	?
UROLOPHIDAE:	1	1	?
Teleosts	3320		
Teleost, unid. species	1	1	.1
SILURIFORMES:	52		
ARIIDAE:	1529		
"Arius"	85	1	.025
"Arius" dasycephalus	2	1	.15
"A." cf *dasycephalus*	1		
"A." species B	89	10	9.5
"A." cf species B	5		
"A." kessleri	111	13	9.3
"A." cf *kessleri*	11		
"A." "osculus"	14	3	1.5
"A." cf *"osculus"*	1		
"A." platypogon	1	1	.9
"A." cf *platypogon*	1		
"A." seemanni	80	8	2.05
cf *"A." seemanni*	5		
Bagre	12		
B. panamensis	48	6	2.6
B. pinnimaculatus	35	5	6.825
Cathorops	114		
Cathorops (not species A or *hypophthalmus*)	1		
C. species A	13	3	.85
C. cf species A	1	1	.03
C. sp. A or *hypophthalmus*	1		
C. species B	8	4	.575
C. cf species B	3		

Table 4. (Continued)

Genus and species	E	MNI	EDBM (kg)
Cathorops species A or *C. tuyra*		1	
C. multiradiatus	5	2	.35
C. cf *multiradiatus*	1		
C. tuyra	20	4	1.15
C. cf *tuyra*	4		
Sciadeops troscheli	3	2	.8
Sciadeichthys dowii	333	18	35.45
cf *S. dowii*	8		
AUCHENIPTERIDAE:			
*Parauchenipterus amblops**	863	112	3.84
PIMELODIDAE:			
Rhamdia cf *guatemalensis**	509	23	5.15
LORICARIIDAE:			
*Hypostomus panamensis**	3	1	.3
cf ALBULIDAE unid. species	6	1	.5
ALBULIDAE:			
Albula neoguinaica	52	2	1.1
cf BATRACHOIDIDAE:	1		
BATRACHOIDIDAE:			
Batrachoides pacifici	1	1	.75
Daector	1	1	.275
cf BELONIDAE unid. species	1	1	.2
BELONIDAE:	2		
Strongylura	1	1	.25
Tylosurus	2	2	.65
BOTHIDAE:			
Citharichthys gilberti	1	1	.05
CARANGIDAE:	194		
Alectis ciliaris	1	1	.15
Carangoides otrynter	10	2	.85
Caranx	4		
C. caballus	39	4	.7
C. caninus	29	6	18.9
Chloroscombrus orqueta	251	13	1.075
cf *C. orqueta*	2		
Oligoplites	51		
O. altus	9	1	1
O. refulgens	25	5	1
O. cf *refulgens*	1		
O. saurus	1	1	.25
Selar crumenophthalmus	25	2	.35
Selene	354		
Selene brevoortii	54	4	2.075
S. oerstedii	2	1	.2
S. peruviana	1154	50	7.5
Trachinotus kennedyi	2	1	3
CENTROPOMIDAE:			
Centropomus	21		
C. medius	3	1	.075
Centropomus cf *medius*	2	1	.8
C. nigrescens/viridis[a]	47	9	14.55
C. robalito	1	1	.075
CHARACIFORMES:	2		
CTENOLUCIIDAE:			
*Ctenolucius hujeta**	17	3	.225
CURIMATIDAE:			
Curimata magdalenae*	26	7	.355

Table 4. (Continued)

Genus and species	E	MNI	EDBM (kg)
ERYTHRINIDAE:			
Hoplias sp*	2090	50	15.55
CICHLIDAE:			
*Aequidens coeruleopunctatus**	26	9	.4
CLUPEIFORMES:	105		
CLUPEIDAE:			
Opisthonema cf *libertate*	3263	119	11.9
ENGRAULIDAE:			
cf *Anchoa*	3	1	.1
PRISTIGASTERIDAE:			
Ilisha furthii	76	5	1.95
EPHIPPIDAE:			
Parapsettus panamensis	1	1	.15
GERREIDAE:		1	
cf *Diapterus peruvianus*	1	1	.15
GOBIIDAE/ELEOTRIDIDAE:			
Dormitator latifrons	223	15	3.575
Eleotris picta	18	4	1.225
Gobiomorus maculatus	2	1	.075
cf *G. maculatus*	2	1	.15
HAEMULIDAE:	467		
Anisotremus	3		
Anisotremus dovii	16	2	.9
A. pacifici	13	4	1.45
Orthopristis chalceus	2967	87	13.25
cf *O. chalceus*	3		
Pomadasys	6		
Pomadasys bayanus	7	2	1.8
P. cf *bayanus*	1	1	.2
P. macracanthus	32	6	4.15
P. panamensis	2	2	1.2
P. cf *panamensis*	1	1	.5
Pomadasys (Haemuliopsis)	19	2	.45
Pomadasys (H.) elongatus	3	2	.35
P. (H.) cf *elongatus*	1		
cf *P. (H.) elongatus*	3		
P. (H.) leuciscus	6	2	.75
P. (H.) cf *leuciscus*	2	1	.1
P. (H.) cf *nitidus*	1	1	.25
LOBOTIDAE:			
Lobotes surinamensis	8	3	7.25
LUTJANIDAE:			
Lutjanus cf *colorado*	1	1	.5
MUGILIDAE:			
Mugil cf *curema*	2	1	.45
POLYNEMIDAE:			
Polydactylus	1		
P. approximans	1	1	.4
P. opercularis	109	10	4.2
SCIAENIDAE:	20		
Bairdiella	1		
B. ensifera	3	2	.375
Cynoscion	18		
C. albus	17	3	5.35
C. albus or *C. stolzmanni*	1	1	2.75
C. stolzmanni	27	4	1.6
C. cf *stolzmanni*	2	2	.225

Table 4. (Continued)

Genus and species	E	MNI	EDBM (kg)
Menticirrhus panamensis	1	1	.55
Micropogonias altipinnis	22	4	4.15
Ophioscion	1		
Ophioscion scierus	7	3	.55
O. typicus	13	3	.4
O. cf *typicus*	5		
Paralonchurus dumerilii	1	1	.8
Stellifer chrysoleuca	1	1	.2
SCOMBRIDAE:			
Euthynnus lineatus	5	1	.8
Scomberomorus sierra	7	4	1.95
SPHYRAENIDAE:			
Sphyraena ensis	2	2	.95
STERNARCHIDAE:			
*Sternopygus dariensis**	161	9	2.4
STROMATEIDAE:			
Peprilus snyderi	2	2	.35
SYNBRANCHIDAE:			
*Synbranchus marmoratus**	117	4	.725
TETRAODONTIDAE:	6	1	.15
Sphoeroides	3		
Sphoeroides annulatus	1	1	.35
Guentheridia formosa	4	2	.5
Total, Elasmobranch:	108	15	>27
Total, Teleost:	19,623	729	236.8
Freshwater:	3,812	218	28.945
Marine (incl. gobiids):	12,436	510	207.805[b]
Total, Fish:	19,731	744	263.850

[a] 3—*C. nigrescens*, 1—*C.* cf *nigrescens*, 1—*C. nigrescens* or *C. viridis*, 4—*C. viridis*.

[b] One individual of an unidentified species could be either marine or freshwater.

Allometry (i.e., estimating the size of archaeological individuals by plotting accurate measurements of whole bones against biometric data acquired from fresh specimens) is a much more reliable way of calculating the size of individuals and, it follows, the relative importance of each taxon.

Statistically meaningful allometry, however, requires well preserved archaeological bones and ontogenically complete series of modern skeletons. Very few bones that survived in our samples are measurable. Very few identified species were represented by numerically meaningful groups of measurable bones. Individual sizes within a taxon were often estimated from different body parts. In two cases, we verified our EDBM with allometric calculations. The results were statistically identical. In this situation, the comparative method is far from perfect, but is practical. We will present allometric reconstructions of fish size when the comparative skeletal collection has been expanded.

Molecular biology is casting doubts on the significance of some current taxonomic treatments of ETP fish, especially freshwater taxa. Even so, we believe that archaeo-ichthyologists should strive to identify species as rationally as their ancient and modern fish samples permit (Cooke 1992). Of course, this is easier said than done. Osteological differentiation at the species level is variable and unpredictable. Externally, the two ETP bobos (*Polydactylus approximans* and *P. opercularis*) are distinguished only by different fin coloration and pelvic fin ray counts. Skeletally, however, they are strikingly dissimilar. The ETP sea catfish of the Ariidae family comprise about 20 poorly categorized species. Even freshly caught specimens are notoriously tricky to identify (Cooke 1993b). Their head bones, however, can be differentiated accurately (Cooke, 1996).[3]

Our final methodological point is that it is much easier to infer MNI and EDBM for teleosts than for elasmobranchs, which have fewer and morphologically more homogeneous ossified elements. At both sites, the dietary contribution of sharks and rays appears to be disproportionate to the abundance of their bones. Our current reconstructions, whose accuracy is affected by our not possessing skeletons of a few unidentified taxa, suggest that at Cerro Mangote eight elasmobranch individuals (3.2 percent fish MNI) supplied at least 16.6 percent EDBM. At Sitio Sierra, 15 sharks and rays (2.1 percent fish MNI) represent 10.2 percent EDBM. Sharks and rays, then, were important food items. However, from a cultural-ecological perspective, their archaeofaunal distribution is broadly consistent with the inferences we derive from the teleost samples. All the positively identified taxa enter shallow meso/oligohaline waters; the bull shark (*Carcharhinus leucas*) and sawfish (*Pristis* spp.) are capable of spending long periods of time in freshwater (Table 1; Vásquez and Thorson 1982). For these reasons, we focus the following discussion on bony fish whose levels of "identifiability" are presented in Table 5.

Table 5. Bone Identified to Family, Genus, and Species.

Site	Family	Genus	Species[a]
	% = proportion of teleost E		
Cerro Mangote	2,357 (76%)	1,576 (51%)	1,226 (40%)
Sitio Sierra	16,135 (82%)	13,903 (71%)	6,988 (36%)[b]

[a] Only incontrovertible identifications according to our criteria.

[b] If we assume that *Hoplias* and *Opisthonema* bones represent single species—as they probably do—this figure would be 12,341 (63%).

Fish Taxa Found in Freshwater

Loftin (1965:193) collected only 21 primary freshwater fish in the Santa María River basin, a species poverty that is typical of the fish fauna of the Central American landbridge (Miller 1966). Our own collections have added two species: the Darien knifefish (*Sternopygus dariensis*) and the bluntnosed driftcat (*Parauchenipterus [=Trachycorystes] amblops*). Both are common to abundant in the freshwater and oligohaline stretches of the river (Cooke and Tapia 1994a).

The Santa María River basin also harbors some secondary (or peripheral) sleepers and gobies. These evolved in the sea, but have adapted to spending all or part of their lives in freshwater. We have collected 25 genuinely marine species in the oligohaline (less than 1‰ to less than 5‰) riverine zone (París collection station), and ten in the freshwater fluvial estuary (Figure 1; Cooke and Tapia 1994a).

In spite of their low diversity in nature and in the archaeological bone samples (nine families, genera and species), primary freshwater fish are quite abundant in the lower stretches of the Santa María River. Not surprisingly, Sitio Sierra's inhabitants regularly caught and ate them (together they represent 19 percent E, 30 percent MNI and 12 percent EDBM). The Santa María trahira ranks third for E, fourth for MNI and third for EDBM. Four of the listed species—Santa María trahira, Darien knifefish, Panamanian armored cat, and Guatemalan rivercat—grow to more than .5 kg. The others, though very small, can occur in large shoals, so that biomass compensates for low body mass. For example, the bluntnosed driftcat, whose maximum recorded adult weight is 80 gm, is the second most abundant teleost at Sitio Sierra. These frenetic little cats are difficult to extricate from nets because they have serrated and poisonous pectoral spines that can inflict nasty wounds. They are also most active at night, which complicates handling. A large proportion of the pectoral spines found at Sitio Sierra were intact, suggesting that these fish were captured with baskets or poison, rather than with nets.

In contrast, no primary freshwater fish occurred at Cerro Mangote. Our present-day sampling program shows that curimatas, knifefish, tahiras and driftcats thrive in oligohaline waters 7 km upriver, seaward of Cerro Mangote's current location. But we caught only two primary freshwater fish in one year at the river mouth: one driftcat and one Panamanian armored catfish (*Hypostomus panamensis*). These were probably washed down by strong wet season currents. Therefore, the absence of these freshwater species in the "brown zone" refuse provides indirect support for geomorphological indications that Late Preceramic Cerro Mangote was close to the mesohaline (mixing) zone of the estuary.

But what if Cerro Mangote was not, in fact, adjacent to the main channel of the Santa María River? Perhaps the absence of primary freshwater fish indicates this. This question can only be answered satisfactorily with continued geomorphological research. Nevertheless, the archaeofaunal distribution of two marine teleosts suggests that it may have been near a major channel. One is the wide-mouthed catfish (*"Arius"* species B, the eighth ranked teleost taxon [MNI]). Although this species is still undescribed, it is very common in the Santa María River, but only in the main channel, where it occurs from the mouth to at least 20 km inland. We have not recorded it in the Estero Palo Blanco fish trap where salinity ranges from 15‰ to 34‰. It probably spends its entire life cycle within the main channel where it attains a large size (640 mm standard length, 4.8 kg [Cooke 1993b; Cooke and Tapia 1994a, b]).

The other relevant species is the Peruvian eelgoby (*Gobioides peruanus*). This fossorial fish is most unlikely to be caught away from the main river channel since it lives in burrows in the muddy banks of the tidal river to at least 8 km upstream. Local fishermen cut eelgobies up with machetes and use the pieces to bait hooks. They think they are repugnant and inedible. But since Cerro Mangote lies on top of a hill, up quite a steep slope, it is likely that the bones deposited in the Late Preceramic middens are food remains.

The three local euryhaline sleepers—the spotted sleeper, painted gudgeon, and pike-gudgeon (*Gobiomorus maculatus*)— are also indicators of estuarine topography. Their absence in the Estero Palo Blanco fish trap suggests that they reject salinities greater than 15‰. The least salt-tolerant is the pike-gudgeon, which is found in quite fast-flowing streams. We have collected large adult painted gudgeons and spotted sleepers (.5-1.5 kg) in oxbows and in the freshwater and oligohaline zones of the main river channel. Smaller spotted sleepers are also abundant in shallow coastal pools where they can be caught in large numbers when water levels drop. This species is the second-ranked teleost at Cerro Mangote (8 percent MNI). Average individual weight is ca. 140 gm, in contrast to ca. 240 gm at Sitio Sierra. It is reasonable to suppose, then, that Cerro Mangote's spotted sleepers were collected, possibly by women and children, in mangrove channels or pockets of water in the *alvina*.

Marine Teleosts

At a macro-ecological level, the marine archaeo-ichthyofaunas from Cerro Mangote and Sitio Sierra are similar. Their estuarine nature is underscored by the fact that we have observed all of the recorded taxa in the middle and/or upper estuary at least once. Both samples lack many widespread and popular foodfish taxa that are associated by preference or obligation with coral reefs, the offshore epipelagic zone, and deeper, clearer water around rocks. The best known examples are: tunnies, wahoos and their allies (*Thunnus, Katsuwonus, Auxis, Acanthocybium*); dolphinfish (*Coryphaena*); tilefish (*Caulolatilus*); brotulas (*Brotula*) (a popular food fish in Ecuador); moray eels (Muraenidae); parrotfish (*Scarus*); damselfishes (Pomacentridae); and wrasses (Labridae) (Allen and Robertson 1994; Cooke 1992; Phillips and Pérez-Cruet 1984; Thomson et al. 1979).

"Estuarineness" is also underlined by the presence or absence of individual species that belong to ethologically and ecologically heterogeneous families and genera. For example, the only grouper recorded at the two study sites—the spotted cabrilla (*Epinephelus analogus*)—is acknowledged to be the most estuarine ETP species. The most deep-water and most coralline snappers (*Lutjanus peru* and *L. viridis*) are absent. So are the least estuarine corvina (*Cynoscion reticulatus*), and carangids that prefer to swim offshore in clear water, such as amberjacks (*Seriola*), and rainbow runners (*Elagatis bipinnulata*).

Taxonomic Richness

Table 6 presents the numbers of positively identified marine families, genera and species (excluding gobies and sleepers). The two samples are similarly diverse; the slightly greater richness at Sitio Sierra reflects larger sample size.

Table 6. Numbers of Positively Identified Marine Fish Families, Genera and Species (Excluding Gobies and Sleepers).

Site	Families	Genera	Species
Cerro Mangote	19	40	59
Sitio Sierra	22	43	72

Table 7 shows that 10 genera and 19 species are recorded only at Cerro Mangote and 13 genera and 19 species exclusively at Sitio Sierra. At first sight, this "mutual taxonomic exclusivity," appears to be a significant difference between the samples. All these taxa, however, represent 1 percent E or less, except for the longspine snook (*Centropomus armatus*) (more than 2 percent MNI at Cerro Mangote). Hence, some of this variability can be explained by the randomness of fish behavior, fishing, taphonomy, and archaeological sampling procedures.

We have not captured 12 of the 38 mutually exclusive species in the stationary fish trap nor in the main channel of the tidal river. These are: broadhead catfish (*"Arius" dasycephalus*), Panamanian catfish (*"A." lentiginosus*), chili catfish (*Sciadeops troscheli*), African pompano (*Alectis ciliaris*), purse-eyed scad (*Selar crumenophthalmus*), spotted rose snapper (*Lutjanus guttatus*), Cortez grunt (*Haemulon flaviguttatum*), Panamanian grunt (*Pomadasys panamensis*), scalefin weakfish (*Cynoscion squamipinnis*), worm-lined croaker (*Ophioscion vermicularis*), Pacific

Table 7. Genera and Species of Marine Teleosts Reported in only One of the Two Analyzed Archaeological Fish Bone Samples (Cerro Mangote and Sitio Sierra, Panama). Mutually exclusive genera are underlined.

Cerro Mangote	%E	%MNI	Sitio Sierra	%E	%MNI
			"Arius"	.02	.20
"Arius" lentiginosus	.13	.41	*Sciadeops troschelii*	.02	.40
Centropomus armatus	.64	2.03	*Daector*	<.01	.20
Opisthopterus	.03	.41	*Tylosurus*	.01	.40
Elops affinis	.03	.41	*Citharichthys gilberti*	<.01	.20
Cetengraulis mysticetus	.06	.41	*Alectis ciliaris*	<.01	.20
Eucinostomus currani	.03	.41	*Caranx caballus*	.31	.78
Eugerres	.03	.41	*Oligoplites refulgens*	.21	.97
E. lineatus	.26	1.22	*Selar crumenophthalmus*	.20	.40
Gerres cinereus	.10	.41	*Selene brevoortii*	.43	.78
Bathygobius andrei	.06	.41	*S. oerstedii*	<.01	.20
Gobioides peruanus	.35	1.22	*Trachinotus kennedyi*	.01	.20
Haemulon flaviguttatum	.03	.41	*Anchoa*	<.01	.20
Lutjanus argentiventris	.10	1.22	*Parapsettus panamensis*	<.01	.20
L. guttatus	.03	.41	*Anisotremus pacifici*	.10	.78
L. novemfasciatus	.06	.82	*Pomadasys bayanus*	.32	.59
Bairdiella armata	.13	.41	*Stellifer chrysoleuca*	<.01	.20
Cynoscion squamipinnis	.03	.41	*Euthynnus lineatus*	.04	.20
Ophioscion vermicularis	.03	.41	*Scomberomorus sierra*	.06	.78
Stellifer oscitans	.10	.41	*Sphyraena ensis*	.01	.56
Epinephelus analogus	.23	1.22	*Peprilus snyderi*	.01	.40
			Guentheridia formosa	.03	.40

barracuda (*Sphyraena ensis*), and black skipjack tuna (*Euthynnus lineatus*).

Cooke (1992) argued that the African pompano, Pacific barracuda, and black skipjack tuna belong to a "transitional or outer (lower) estuarine" species cluster: "the component taxa probably move into estuaries opportunistically to feed or when salinity and/or visibility is unusually high, i.e., at the end of dry season." These, and three other species in this hypothetical grouping, including green jack (*Caranx caballus*), Panama spadefish (*Parapsettus panamensis*) and sierra mackerel (*Scomberomorus sierra*), were recorded only at Sitio Sierra where together they represent .5 percent marine teleost E and 3 percent MNI.[4]

The above distributions, both archaeofaunal and contemporary, suggest that Sitio Sierra had more regular, albeit sporadic, access to fish caught at the seaward edge of the marine (or lower) estuary than did Cerro Mangote. Even so, a few fish species (when adults) at Cerro Mangote appear to avoid shallow muddy bottoms close to shore, according to our actualistic research, e.g., slender-spined catfish ("*Arius*" *platypogon*), chihuil catfish (*Bagre panamensis*), Pacific bonefish (*Albula neoguinaica*), highfin corvina (*Micropogonias altipinnis*), Cortez grunt (*Haemulon flaviguttatum*), Pacific moonfish (*Selene peruviana*), spotted rose snapper, and scalefin weakfish. The Cortez grunt is usually associated with reefs and rocks, although juveniles sometimes occur in mangroves (Cooke 1992). Fisheries data suggest that the scalefin corvina is commonest in the deeper waters of the marine estuary (Bartels et al. 1983, 1984; Cooke 1992). In sum, this cluster of species could indicate that Cerro Mangote's inhabitants fished occasionally from watercraft in the marine estuary; but it is also possible that Parita Bay inshore waters were less sedimented (and less turbid) at the time of this site's occupation, than they are today, and favored the inshore encroachment of the above species.[5]

Dominance

Dominance (McNaughton 1968), construed culturally, can be assessed by looking at frequency of capture (percent MNI) and contribution to diet (percent EDBM).

Frequency of capture (percent MNI)

Table 8 summarizes dominance by MNI. Sea catfish were landed more frequently at Cerro Mangote (29 percent) than at Sitio Sierra (16 percent). The genera *"Arius"* and *Sciadeichthys* together represent more than 22 percent MNI, and the flap-nosed, Seemann's and Kessler's catfish more than 19 percent MNI. These three species, in addition to the widemouthed and thick-lipped catfish (*"Arius" "osculus"*), the five ETP *Cathorops* species, and the long-barbled catfish (*Bagre pinnimaculatus*) are permanent and ubiquitous residents in the middle estuaries of Parita Bay (Cooke 1993b; Cooke and Tapia 1994a, b). Seemann's catfish teem near river mouth human settlements where they feed voraciously on domestic refuse. Flap-nosed catfish—the largest ETP sea cats which often weigh more than 10 kg—are common in mangrove channels and in the oligohaline stretches of the Santa María River. We have taken widemouthed and Tuyra catfish (*Cathorops tuyra*) in the freshwater fluvial or upper estuary (Cooke 1992, 1993b; Cooke and Tapia 1994a).

At Sitio Sierra, MNI dominance exhibits a different pattern. Three species, none of which exceed 300 gm weight, comprise 50 percent marine fish MNI: Pacific threadfin herring (*Opisthonema* cf. *libertate*), Pacific moonfish, and brassy grunt (*Orthopristis chalceus*). Together they are more dominant than the first five ranked species at Cerro Mangote, where they are also present, but in noticeably smaller numbers.

Thesethree species appeared sporadically in Estero Palo Blanco fish trap, but in very small numbers. We did not capture them n the Santa María River (Cooke and Tapia 1994a, b). D'Croz et al. (1977), however, recorded large shoals of Pacific moonfish in stationary intertidal traps set close to Veracruz Beach, near Panama City. This locale lacks the extensive mudflats typical of central Parita Bay. We have observed large gillnet catches of thread-herrings about .5 km seaward of El Rompío in clearish water. El Rompío fisherfolk say that they net the brassy grunt and Pacific moonfish in currents of clear water on the incoming tide and also close to sandbanks within Parita Bay. Hence, it is likely that water-column clarity and substrate type are relevant paramerters to the intra-estuarine distribution of moonfish, thread-herrings, and brassy grunts. We not reject the inference that their dominance at Sitio Sierra is correlated with the use of gill-nets set some distance offshore

Table 8. Marine Families, Genera and Species Ranked 1-5 in the Archaeological Teleost Samples at Cerro Mangote and Sitio Sierra, Panama Expressed as Percent MNI (Includes Gobies and Sleepers).

Cerro Mangote		Percent MNI	**Sitio Sierra**		Percent MNI
Family					
1. Sea catfish	Ariidae	28.9	Herrings	Clupeidae	23.3
2. Sleepers etc.	Eleotrididae/Gobiidae	11.4	Grunts	Haemulidae	22.1
Corvinas etc.	Sciaenidae	11.4			
3.			Jacks etc.	Carangidae	17.7
4. Snook	Centropomidae	9.3	Sea catfish	Ariidae	16
5. Grunts	Haemulidae	6.1	Corvinas etc.	Sciaenidae	4.9
Toadfish	Batrachoididae	6.1			
Genus					
1. Sea catfish	*"Arius"*	12.6	Thread herring	*Opisthonema*	23
2. Sea catfish	*Sciadeichthys*	9.8	Grunt	*Orthopristis*	17
3. Snook	*Centropomus*	9.3	Moonfish etc.	*Selene*	10.8
4. Sleeper	*Dormitator*	8.1	Sea catfish	*"Arius"*	7.2
5. Toadfish	*Batrachoides*	6.1	Grunt	*Pomadasys*	3.9
Species					
1. Flap-nosed catfish	*Sciadeichthys dowii*	9.8	Thread herring	*Opisthonema libertate*	23
2. Spotted sleeper	*Dormitator latifrons*	8.1	Brassy grunt	*Orthopristis chalceus*	17
3. Seemann's catfish	*"Arius" seemanni*	6.1	Pac. moonfish	*Selene peruviana*	9.8
Toadfish	*Batrachoides* spp.	6.1	Flap-nosed catfish	*Sciadeichthys dowii*	3.5
5. Kessler's catfish	*"Arius" kessleri*	3.3	Spotted sleeper	*Dormitator latifrons*	3

(*contra* Cooke 1988, 1992). We must determine experimentally whether stationary traps set over sandbanks are appropriate for catching shoals of these taxa.

Contribution to diet (percent EDBM)

At Cerro Mangote, sea catfish account for 38 percent EDBM. One species alone—the flap-nosed catfish— represents 26 percent. Snook, the second-ranked teleost family, account for 11 percent EDBM. In spite of their small average size, the Pacific thread-herring, Pacific moonfish, and brassy grunt represent 16 percent marine fish EDBM at Sitio Sierra.

Fish with average adult body masses of more than 1 kg contribute a larger proportion of EDBM at Cerro Mangote. Thirty-seven individuals (15 percent) represent 61 percent EDBM, while at Sitio Sierra, 34 individuals (7 percent) provide 46 percent EDBM (Table 9).

Since we are dealing with samples which differ taphonomically and have some collection-induced biases, we should beware of exaggerating the significance of size-range discrepancies. Furthermore, bones smaller than .125 inches have yet to be considered in our calculations. However, it is possible that the larger number of sizeable fish captured at Cerro Mangote reflects a stronger emphasis on land-based capture techniques. For example, the high dominance levels of estuarine sea cats and snook would be consistent with damming up mangrove channel outlets with large-meshed nets or baskets and spearing from the channel and river edge. The two middle and upper estuary toadfish species, fifth-ranked by numbers at Cerro Mangote, but rare at Sitio Sierra, are ungainly, bulky and wholesome fish that hug muddy bottoms. They too would have been captured regularly if Preceramic fisherfolk had blocked off outlets with some kind of barrier that permitted the exit of smaller fish.

Table 9. Marine Teleosts in Archaeological Bone Samples from Cerro Mangote and Sitio Sierra, Panama, Whose Weight is Estimated to Exceed 1 kg.

	Cerro Mangote		Sitio Sierra	
	Inds. > 1kg	EDBM (kg)	Inds. > 1 kg	EDBM (kg)
"Arius" kessleri	1	1.30	3	4.00
"*A.*" species B	1	1.20	5	7.25
Bagre pinnimaculatus	1	1.50	2	5.25
Sciadeichthys dowii	12	40.50	9	29.75
Caranx caninus	1	2.00	3	16.75
Trachinotus kennedyi			1	3.00
Centropomus nig/vir	5	13.25	3	10.25
Pomadasys macracanthus	1	1.25	1	1.25
Lobotes surinamensis	2	6.80	3	7.25
Cynoscion albus	3	10.75	2	4.75
C. albus or *stolzmanni*			1	2.75
C. squamipinnis	1	3.50		
Micropogonias altipinnis	3	9.75	1	2.50
Lutjanus argentiventris	2	3.50		
Lutjanus novemfasciatus	2	3.50		
Epinephelus analogus	2	8.75		
Totals:	37	107.55	34	94.75

Concluding Remarks

Geomorphological Considerations

The fish bone samples collected using .125 inch mesh screens at Cerro Mangote and Sitio Sierra lend support to the principal events outlined in Barber's (1981) facies change model for the evolution of the Santa María delta. They also draw attention to details in local topography, which, though speculative, can be verified by geographical prospection at a later date.

No primary freshwater fish were identified in the Cerro Mangote sample. This suggests that this site's fisherfolk did not operate in the fluvial estuary and, probably, not in the oligohaline stretches of the river, either.

The hypothesis that Cerro Mangote was situated at some distance from the main river channel is challenged, albeit tenuously, by (1) the high rank of the widemouthed catfish which has not yet been recorded seaward of the main river mouth and (2) the use, apparently for food, of the Peruvian eelgoby. The abundance of small spotted sleepers (averaging less than 140 gm) alludes to fishing in shallow *alvina* pools or mangrove channels in the high and supra-tidal zones.

Other aspects of Cerro Mangote's fish bone proportionality infer fishing along intertidal mudflats and near the river mouth: the general dominance of sea catfish, particularly flap-nosed, Kessler's and Seemann's catfish, and the high rank of toadfish and snook.[6]

As befits its location in the upper, or fluvial, estuary, freshwater fish were captured regularly at Sitio Sierra. If this village had been near a smaller river than the Santa María, we believe that we would have recorded more bones of the ubiquitous blue-spotted cichlid. This species is most abundant in the stagnant shallows of streams and rivulets (Conkel 1993:181).

The archaeofaunal distribution of the marine mojarras (Gerreidae) may have implications for geomorphological reconstructions. These fish are abundant in Mexican coastal lagoons where they are present the year-round (Aguirre and Yáñez A. 1986; Warburton 1979). They are occasional within the Santa María River and along the mesohaline littoral, but generally as juveniles and young adults. Their bones dominate samples from the lagoonal Puerto Chacho site in northern Colombia (Legros

1992:191). Their fairly low archaeofaunal visibility in Parita Bay is not consistent with a fishing strategy that concentrates on shallow bar-formed lagoons (*sensu* Barnes 1980). Perhaps these ecologically special landforms did not exist near our two sites when their archaeo-ichthyofaunas were deposited.

Fishing Practices and Cultural History

It is hardly surprising that the purveyors of marine foods for Cerro Mangote (5000-3600 cal B.C.) and at Sitio Sierra (cal A.D. 1-400) did not make forays into deep clear water to search out shoals of epipelagic piscivores and their prey, and that they did not fish around coral reefs or rocky substrates, given the intrinsic taxonomic richness and productivity of this and other ETP estuaries. Even so, Cerro Mangote's age and Sitio Sierra's inland position vis-à-vis the delta, confirm the longevity and geographical amplitude of Precolumbian fishing in turbid littoral waters (Cooke 1988).

With regard to Cerro Mangote's "brown zone" sample, the lack of primary freshwater fish, the dominance of sea catfish, snook, toadfish, and spotted sleepers, and the distribution of sea catfish and croaker species, point strongly towards fishing in intertidal mudflats, *Rhizophora* mangroves, *alvinas*, and the lowest (mesohaline and mixing) sections of the Santa María River. The presence of a few species that normally stay away from shallow soft-bottom waters, particularly the chihuil catfish and high-fin corvina, may be suggestive of fishing in deeper water. However, since these species occasionally wander towards the littoral, their generally low numbers cannot be considered proof of nets and hooks and lines. All told, even if Cerro Mangote was approximately 5 km from the active shore, its fisherfolk probably never had to travel more than 7 km to keep their families and kin well supplied with fish.

The considerably greater abundance of thread herrings, brassy grunts, and Pacific moonfish at Sitio Sierra may indicate the growing importance of watercraft and gillnets. The thread herring is a filter-feeder and will not take a hook. We have taken care, however, not to overstate relationships between fishing methods and fish distribution within the estuary, in the expectation that continuing study of present-day fish distributions will provide better analogies than those we have at hand.

At "inland" Sitio Sierra freshwater fish were important dietary items notwithstanding the small adult size of some species such as the bluntnose cat. In spite of their having lived about 12 km from the coast, as the crow flies, and much further taking into consideration the river's meanders, villagers could have obtained some marine species nearby. For example, in the upper fluvial estuary and at the inward edge of the oligohaline zone, they could have caught white corvina; widemouthed, flap-nosed and Tuyra catfish; dog snapper; freshwater grunt; and white and black snook. Many of the marine species they used, however, have not been recorded in the main channel of the Santa María River. This suggests either that villagers had to undertake the quite arduous and probably dangerous canoe trip down the river and into the delta or that they obtained some fish from other communities. Bearing in mind that occupational and settlement specialization is apparent at this stage in the development of central Panamanian society (Cooke and Ranere 1992b; Hansell 1988; Linares 1977) exchange in foodstuffs should have existed among related sectors of the regional population. The Spanish lieutenant Gaspar de Espinosa (1913:166) saw coastal peoples at Natá, whose geographical location is similar to that of Sitio Sierra, exchanging crabs for maize. The occasional consumption of a few "outer estuarine" species, such as green jack and sierra mackerel, is, perhaps, the best indication that Sitio Sierra was in contact with distant or technologically sophisticated fisherfolk. Since these oily fish spoil quickly, salting and drying would have been the most practical way to preserve them.

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Notes

1. All estimates for site occupation spans are presented in calibrated years using Stuiver and Reimer (1993). For marine calibrations, ∂R was estimated as 5.0 ± 50.0.

2. "Dietary" means that we assume the fish were eaten rather than used for something else. "Biomass" is the aggregate of estimated "body masses," i.e., "live" weights.

3. Our species-level identifications were made by reference only to species known unequivocally to occur in Panamanian waters. They were accepted as valid only if all species for a particular genus were present in the comparative collection. Since this text was written, however, we have become aware of *Orthopristis cantharinus*, which according to the 1995 FAO guide is sympatric with *O. chalceus*. Hence it behooves us to test whether these species can be distinguished osteologically. We have also become skeptical whether *Centropomus viridis* and *C. nigrescens*

can be differentiated safely on the basis of their osteology, and believe they may belong to a single polymorphic species.

4. Contra Cooke (1992), we have eliminated the black-blotch pompano from this group because it frequently enters the Estero Palo Blanco fish trap.

5. We know nothing about the habits and distribution of the Panamanian catfish and worm-lined croaker, recorded only at Cerro Mangote. They seem to be rare in nature.

6. We identified all six ETP snook species in the "brown zone" sample, but we have not captured longspine and humpback snook (*Centropomus unionensis*) more than 7 km up the Santa María River. We believe that these two species are the least anadromous ETP snook.

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