NATIVE AMERICAN LANDSCAPES OF ST. CATHERINES ISLAND, GEORGIA
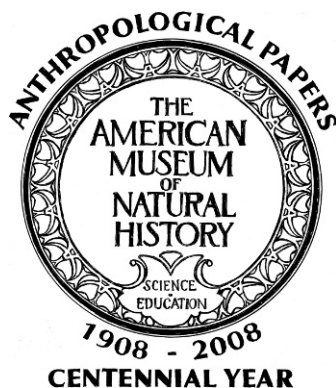
III. SYNTHESIS AND IMPLICATIONS

DAVID HURST THOMAS

Curator, Division of Anthropology
American Museum of Natural History

WITH CONTRIBUTIONS BY

C. Fred T. Andrus, Gale A. Bishop, Elliot Blair, Dennis B. Blanton, Douglas E. Crowe,
Chester B. DePratter, Joel Dukes, Peter Francis, Debra Guerrero, Royce H. Hayes, Maureen Kick,
Clark Spencer Larsen, Camille Licate, David Linsley, Jessica McNeil, J. Alan May,
Deborah Mayer O'Brien, Greg Paulk, Lorann S.A. Pendleton, Elizabeth J. Reitz, Harold B. Rollins,
Michael A. Russo, Matthew Sanger, Rebecca Saunders, and Anna Semon

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INTRODUCTION

This is the final part of a three-volume monograph addressing the aboriginal landscapes of St. Catherines Island, Georgia. The first part of this series developed the theoretical and pragmatic framework for addressing four specific questions about the aboriginal landscapes of St. Catherines Island: How and why did the human landscape (settlement patterns and land use) change through time? To what extent were subsistence and settlement patterns shaped by human population increase, intensification, and competition for resources? What factors account for the emergence of social inequality in Georgia's Sea Islands? Can systematically collected archaeological evidence resolve the conflicting ethnohistoric interpretations of the aboriginal Georgia coast (the so-called Guale problem)?

Part I presented new perspectives on the geomorphological and hydrological evolution of St. Catherines Island and addressed the theoretical landscape that informs our current research program. Working within the general paradigm of human behavioral ecology, we drew upon specific models developed from diet-breadth, patch-choice, and central place foraging theory. After discussing the assumptions involved with each approach, we summarized the results of the extensive optimal foraging experiments conducted across the diverse habitats of St. Catherines Island. The first part concluded with a series of specific, testable hypotheses regarding the subsistence and settlement practices of these aboriginal foragers and farmers and framed the research design employed to test these hypotheses.

Part II presented the chronological controls involved in this research, addressing the strengths and weakness of radiocarbon approaches and developing the island-specific reservoir correction factor necessary to integrate marine and terrestrial ^{14}C dates. We also developed a method of incremental growth sequencing in *Mercenaria mercenaria* and applied this technique to establish seasonality estimates for nearly 100 of the archaeological sites tested in the Island-wide survey.

We then addressed the specifics of the archaeological landscape, sampled across the diverse habitats of St. Catherines Island. We discussed site-by-site details for the Island-wide and shoreline archaeological surveys, presented the vertebrate zooarchaeological remains recovered, reanalyzed the mortuary evidence from St. Catherines Island, and summarized the more extensive excavations at the Meeting House Field and Fallen Tree sites. The final chapter presented results from newly available tree-ring research along the Georgia coastline.

In this concluding part of this series, we synthesize the diverse empirical and theoretical threads to reconstruct the changing configuration of St. Catherines Island during the past 5 millennia and examine the predictions derived from human behavioral ecology. Drawing upon central place theory and diet-breadth modeling, we evaluate the long-term trends in site positioning on the Pleistocene core and Holocene beach ridges of St. Catherines Island. Working from the diet-breadth model, we look at the issues of prey choice and resource depression through time. We synthesize and critically evaluate the changing aboriginal landscape of St. Catherines Island by dissecting the newly-available evidence on chronology, settlement pattern, subsistence, seasonality, bioarchaeology, and ritual activity from the Late Archaic through Spanish mission periods. We also evaluate the evidence for long-term trends in demography, occupational periodicity, resource intensification, and the emergence of social inequality along the aboriginal Georgia coast. The final chapter revisits the Guale problem, examining whether the new data available on economic intensification, residential mobility, and paleoclimatic fluctuations clarify our understanding of aboriginal people at the dawn of European contact on the Georgia coastline.

APPENDIX A
St. Catherines Island Survey Proveniences Studied

Site	Level	Test pit	Transect	Stratum
St. Simons				
9Li231	—	—	E1	West
9Li252	—	—	E6	East
Refuge-Deptford				
9Li49	—	—	L6	South
9Li173	—	—	B6	West
9Li180	—	—	F6	West
9Li197	20–30	TPI	H6	West
9Li197	30–40	TPII	H6	West
9Li197	10–30	TPI	I1	West
9Li197	0–40	TPII	I1	West
9Li197	0–40	TPIII	I1	West
9Li197	0–40	TPIV	I1	West
9Li223	—	—	H1	Center
9Li228	—	—	F1	West
9Li235	—	—	C1	East
9Li239	10–20	TPI	B1	Center
9Li239	10–20	TPIV	B1	Center
Wilmington				
9Li162	—	—	D1	East
9Li164	—	—	M1	South
9Li196	—	—	I6	Center
9Li198	—	—	H6	West
9Li201	—	—	H6	West
9Li209	—	—	I1	Center
9Li215	—	—	H1	East
9Li217	—	—	H1	East
9Li220	—	—	H1	Center
9Li221	—	—	H1	Center
9Li224	—	—	H1	Center
9Li233	—	—	D1	East
9Li237	—	—	B1	Center
9Li240	10–20	TPII	B1	Center
9Li240	10–20	TPIII	B1	Center
St. Catherines				
9Li22	—	—	B1	East
9Li165	—	—	M1	East
9Li178	—	—	F6	Center
9Li183	—	—	G6	East
9Li203	—	—	J1	West
9Li214	—	—	J6	South
Savannah				
9Li169	—	—	D6	East
9Li171	—	—	C6	Center
9Li189	—	—	H6	East
9Li227	—	—	F1	West
9Li230	—	—	E1	West
Irene				
9Li19	—	—	F6	East
9Li51	—	—	L6	South

APPENDIX A—(*Continued*)

Site	Level	Test pit	Transect	Stratum
9Li52	—	—	L6	South
9Li55	—	—	L6	South
9Li84	—	—	M1	South
9Li87	—	—	N6	South
9Li163	—	—	N1	South
9Li118	—	—	O1	South
9Li128	—	—	L6	South
9Li170	—	—	C6	West
9Li175	—	—	E6	West
9Li176	—	—	E6	West
9Li177	—	—	E6	West
9Li181	—	—	F6	West
9Li182	—	—	G6	East
9Li90/AMNH 436	—	—	I6	East
9Li90/AMNH 437	—	—	I6	East
9Li191	—	—	I6	East
9Li192	—	—	I6	Center
9Li197/AMNH 445	—	—	H6	West
9Li197/AMNH 446	—	—	H6	West
9Li197/AMNH 448	—	—	H6	West
9Li197/AMNH 450	—	—	H6	West
9Li197/AMNH 45	0–20	TPI	H6	West
9Li202	—	—	J1	West
9Li205	—	—	J1	East
9Li206	—	—	J1	East
9Li207	—	—	I1	East
9Li208	—	—	I1	East
9Li255/AMNH 474	—	—	G1	West
9Li212	—	—	K1	South
9Li213	—	—	L6	South
9Li216	—	—	H1	East
9Li218	—	—	H1	East
9Li222	—	—	H1	Center
9Li255/AMNH 495	—	—	G1	West
9Li226	—	—	F1	East
9Li229	—	—	E1	West
9Li234	—	—	D1	West
9Li239	10–30	TPIII	B1	Center
9Li240/AMNH 515	10–20	TPI	B1	Center
9Li240/AMNH 515	20–30	TPI	B1	Center
9Li241	—	—	B1	West
9Li242	—	—	B1	West
9Li243	—	—	B1	West
9Li244	—	—	E6	West
9Li251	0–10	TPIX	G6	West
Altamaha				
9Li13/AMNH 208	—	—	I6	West
9Li13/AMNH 208 A	—	—	I6	West
9Li13/AMNH 208 B	—	—	I6	West
9Li13/AMNH 208 D	—	—	I6	West
9Li8	—	—	I6	West

APPENDIX B
St. Catherines Island Survey: Deer Measurements[a]

Element	Dimension	Measurement (mm)
St. Simons		
Astragalus	Bd	26.2, 28.0
Astragalus	Dl	22.8, 24.4
Astragalus	Dm	22.9, 25.9
Astragalus	GLl	46.2
Astragalus	GLm	36.8, 40.9
Femur	Bd	47.5
Humerus	Bd	33.1, 44.5
Os malleolare	GD	18.5
Radius	Bd	33.6, 44.5
Radius	Bp	36.6
Tibia	Bd	33.3
Tibia	Dd	25.2
Refuge-Deptford		
Astragalus	Bd	22.5
Astragalus	Dl	18.4
Astragalus	Dm	18.8
Astragalus	GLl	32.7
Astragalus	GLm	35.6
Atlas	BFcr	56.5
Atlas	GB	91.3
Atlas	GL	81.3
Atlas	H	43.5
Calcaneus	GB	24.1
Calcaneus	GL	78.5
Humerus	Bd	33.8, 36.7, 36.9
Metacarpus	Bd	26.7
Os malleolare	GD	15.5
Radius	Bp	39.5
Scapula	GLP	37.5
Scapula	SLC	22.1
Tibia	Bd	36.5
Tibia	Dd	27.5
Wilmington		
Astragalus	Bd	23.4, 23.6, 23.8, 25.4
Astragalus	Dl	20.7, 21.2, 21.3, 21.7
Astragalus	Dm	21.3, 21.6, 22.2, 22.3
Astragalus	GLl	35.9, 37.4, 38.5
Astragalus	GLm	35.1, 35.1, 37.1, 48.5
Calcaneus	GL	79.5
Humerus	Bd	40.7
Metacarpus	Bp	28.2
Os malleolare	GD	17.9, 20.0
Radius	Bp	33.3
Scapula	SLC	27.2
Tibia	Bd	33.9, 34.2
Tibia	Bp	52.3
Tibia	Dd	25.0, 25.1
Ulna	DPA	31.4, 38.2
Ulna	SDO	29.4, 34.7

APPENDIX B
(Continued)

Element	Dimension	Measurement (mm)
St. Catherines		
Astragalus	Bd	24.4
Astragalus	Dl	21.9
Astragalus	Dm	20.8
Astragalus	GLl	36.6
Astragalus	GLm	38.9
Cubonavicular	GB	28.8
Humerus	Bd	35.4
Metacarpus	Bd	30.7
Metacarpus	Bp	28.6
Os malleolare	GD	16.8
Tibia	Bd	29.3, 33.4
Tibia	Dd	22.8, 24.0
Savannah		
Astragalus	Bd	21.6, 24.0
Astragalus	Dl	19.0, 21.4
Astragalus	Dm	19.6, 21.6
Astragalus	GL1	36.1
Astragalus	GLm	32.6, 36.3
Calcaneus	GB	23.6
Calcaneus	GL	85.5, 88.6
Scapula	GLP	31.8
Scapula	SLC	17.0
Ulna	BPC	29.5
Ulna	DPA	36.9
Ulna	SDO	32.0
Irene		
Astragalus	Bd	20.2, 22.9, 23.3, 24.3, 24.5, 24.5
Astragalus	Dl	18.4, 19.3, 19.9, 20.2, 20.5, 21.4
Astragalus	Dm	18.7, 20.0, 20.0, 20.8, 21.5
Astragalus	GLl	31.3, 36.3, 37.3, 37.4, 38.5
Astragalus	GLm	25.6, 34.7, 35.3, 35.9, 36.9, 39.6
Calcaneus	GB	25.0
Calcaneus	GL	75.6, 78.4
Cubonavicular	GB	25.7, 27.4
Femur	Bd	43.1
Humerus	Bd	34.2, 35.1
Metacarpus	Bd	25.9, 26.1
Metacarpus	Bp	23.0, 26.6, 28.2
Metacarpus	GL	108.2
Metacarpus	SD	14.2
Metatarsus	Bd	25.0
Metatarsus	Bp	21.0
Radius	Bd	29.85, 34.0
Radius	BFd	25.5
Radius	Bp	30.6, 32.9, 35.6
Scapula	SLC	19.9, 21.8

APPENDIX B (*Continued*)

Element	Dimension	Measurement (mm)
Irene (*continued*)		
Tibia	Bd	29.8, 30.8, 33.0
Tibia	Dd	24.1, 25.8, 26.1
Altamaha		
Astragalus	Bd	20.5, 20.5, 20.9, 21.0, 21.0, 21.0, 21.1, 21.55, 21.7, 21.8, 22.0, 22.2, 22.4, 22.9, 23.05, 23.05, 23.1, 23.2, 23.55, 23.6, 24.1, 24.19, 24.3, 25.5, 29.0
Astragalus	Dl	19.2, 20.5, 22.2, 22.5
Astragalus	Dm	18.8, 21.2, 21.7, 22.6
Astragalus	GLl	32.0, 32.5, 32.6, 33.3, 33.4 33.45, 33.9, 34.0, 34.3, 34.45, 34.7, 35.5, 36.0, 36.1, 36.2, 36.3, 36.95, 37.0, 37.3, 37.4, 38.5, 39.2, 40.5
Astragalus	GLm	30.5, 30.75, 31.2, 31.3, 31.6, 31.8, 32.3, 33.0, 33.2, 33.3, 33.4, 33.5, 34.3, 34.35, 34.4, 34.5, 35.1, 35.3, 36.6, 36.9
Atlas	GB	87.5
Atlas	GLF	72.3
Atlas	H	40.6
Axis	BFed	18.9
Axis	BPtr	41.25
Calcaneus	GB	24.0, 24.0, 24.5
Calcaneus	GL	75.5, 79.0, 82.95, 83.2, 83.7, 97.8
Cubonavicular	GB	25.4, 26.1, 26.8, 27.5, 28.0, 28.0, 29.1, 29.2, 29.30, 29.7, 29.9, 30.5, 34.0
Femur	Bd	41.7
Femur	Bp	53.0, 61.7
Humerus	Bd	32.1, 33.1, 33.7, 33.9, 35.8, 36.8, 39.0, 40.9
Metacarpus	Bd	25.6, 26.5, 27.1, 29.0, 30.8
Metacarpus	Bp	22.3, 22.5, 23.1, 23.3, 23.9, 24.5, 25.5, 25.7, 26.4, 26.9, 27.1, 27.1, 27.2, 27.20, 27.5, 27.6, 27.6, 28.6
Metacarpus	SD	15.5, 16.7
Metatarsus	Bd	27.6, 27.9
Metatarsus	Bp	20.85, 21.6, 22.2, 22.9, 23.8, 24.0, 24.1, 25.1, 25.5, 25.6, 26.46, 29.5
Metatarsus	SD	12.0
Os malleolare	GD	15.2, 17.1

APPENDIX B (*Continued*)

Element	Dimension	Measurement (mm)
Patella	GB	26.7
Radius	Bd	27.0, 32.30, 34.5
Radius	BFp	33.0
Radius	Bp	29.4, 30.9, 32.1, 32.3, 33.8, 33.8, 34.0, 34.6, 34.9, 35.4, 37.4, 39.2, 41.5, 41.9
Radius	SD	21.8
Scapula	GLP	34.5, 35.0, 36.7, 49.8
Scapula	LP	26.4
Scapula	SLC	18.4, 20.4, 29.5
Tibia	Bd	20.7, 28.4, 28.6, 29.0, 29.5, 29.6, 29.7, 30.6, 31.1, 31.5, 32.0, 32.2, 32.3, 33.3, 33.5, 33.6
Tibia	Bp	46.1
Tibia	Dd	21.6, 22.1, 23.0, 24.6
Tibia	SD	17.4, 18.7, 19.2, 19.5, 20.1, 20.3, 20.4, 21.0, 22.1
Ulna	BPC	16.1
Ulna	DPA	33.7
Ulna	LO	53.9
Ulna	SDO	30.7

[a] Measurement dimensions follow von den Driesch (1976).

APPENDIX C
Meeting House Field and Fallen Tree: Deer Measurements[a]

Element	Dimension	Measurement (mm)
Meeting House Field		
Astragalus	GLl	34.3
Humerus	SD	11.9
Humerus	Bd	19.1
Innominate	LA	36.1
Metacarpus	Bp	22.6, 25.4
Phalanx, 1st	SD	9.2
Phalanx, 1st	GL	34.9
Phalanx, 1st	Bd	10.5
Radius	Bp	20.8, 30.3, 32.9
Fallen Tree		
Astragalus	Dm	18.4
Astragalus	GLl	32.2
Astragalus	GLm	29.6, 30.7
Astragalus	Bd	20.0
Astragalus	Dl	17.7
Calcaneus	GB	22.0, 23.2, 27.0, 29.1
Calcaneus	GL	83.2, 84.2
Femur	DC	19.5, 22.8, 24.4
Femur	Bd	48.4
Femur	SD	18.5
Femur	Bp	52.9
Humerus	Bt	29.4, 33.0
Humerus	Bd	39.9
Humerus	SD	18.1
Innominate	LA	34.7, 38.2
Innominate	LFo	42.3
Metacarpus	Bp	19.7, 23.9, 27.9, 28.1, 28.4
Metacarpus	Bd	26.4, 27.1, 28.7
Metacarpus	SD	17.6
Metatarsus	Bp	24.9
Phalanx, 1st	GL	41.3, 44.0, 46.1
Phalanx, 1st	Bp	13.0, 13.6, 15.0, 15.0
Phalanx, 1st	SD	8.6, 9.9, 10.2, 10.6, 11.2
Phalanx, 1st	Bd	9.9, 10.8, 12.2, 12.4
Phalanx, 2nd	SD	9.4, 9.8
Phalanx, 2nd	Bd	9.0, 9.8
Phalanx, 2nd	GL	32.3, 33.7
Phalanx, 2nd	Bp	12.1
Radius	Bp	29.2, 31.1
Radius	Bd	30.3, 30.8, 31.0, 33.0
Radius	SD	19.1, 22.0
Scapula	SLC	20.8, 21.4, 23.2
Scapula	GLP	32.6
Tibia	Bd	26.6, 28.5, 28.6, 29.8, 30.1, 32.8, 34.5
Tibia	Bp	52.3
Tibia	SD	17.5
Ulna	BPC	19.9, 22.4

[a] Measurement dimensions follow von den Driesch (1976).

APPENDIX D

THE HAYES ISLAND SITE (9Li1620)

BY ELLIOT BLAIR

The Hayes Island site (AMNH-694, 9Li1620) is located in the upper salt marsh along the western margin of St. Catherines Island (and immediately north of Persimmon Point; see fig. 20.10). This discrete shell mound is roughly 15 m east/west by 8 m north/south. The entire midden is elevated about 50 cm to 1 m above the surrounding marsh—remaining above water even during high tide. Royce Hayes initially identified the site and reports that the shrub/tree forestiera (*Forestiera acuminate*) was present during the recent past—likely indicating the presence of a freshwater seep nearby (also indicated by the presence of a large outcrop of beach rock). The extinction of *Forestiera* from Hayes Island likely corresponds with the recent drop in the water table.

Four circular shell ''pit'' features are present along the eastern margin of 9Li1620. The top of each shell circle is flush with the surrounding marsh. Probing of these features, however, indicated that there was little or no depth to the shell. A grit-and-sand tempered sherd (28.4/5883) was found on the surface of one of these features. Three additional small sherds were also collected from the surface, as was a lithic fragment (28.4/5880) (made of Coastal Plain chert, and likely heat treated).

We excavated two 1 × 1 m squares at Hayes Island, saving bulk and flotation samples and wet screening the remaining fill through 1/8-in. mesh. Additionally, three samples of marine shell, all *Mercenaria mercenaria*, were submitted for radiocarbon dating (see table 13.4).

Test Pit I was located on the south side of Hayes Island, at the edge of the midden deposit. It was excavated in arbitrary 10 cm levels from the southeastern corner. Situated as it was on the southern slope of the mound, the northern half of the unit was significantly higher in elevation than the southern half—necessitating deeper excavation in the northern region of the unit in order to level the floor. The top level of the unit (0–10 cm) consisted of a gray sand/dense shell matrix with a transition to a wet gray-brown sand. At the bottom of the level the shell density significantly decreased and a very heavy concentration of sand rock began to appear—primarily in the northeast corner (excavated to 27 cm below surface—in order to reach 10 cm below the southeast corner). In this level nine ceramic fragments, all smaller than 3 cm in maximum diameter, were collected (see table D.1). Clam shell was also collected from this level and subjected to radiocarbon dating (Beta-215816).

Level 2 of TP I, 10–20 cm, was the final level excavated from the unit. Shell was almost completely absent from the level, and no other faunal material was observed. The level matrix was predominantly composed of a very wet, orange, black, and gray mottled sand with numerous large pieces of sand rock. One small, 6.06 mm, flake of Coastal Plain chert (28.4/5870) was the only cultural material recovered from the level.

Test Pit II was located northeast of TP I, slightly east of the center of Hayes Island, and directly above the high point of the mound. This unit was excavated in arbitrary 10-cm levels while following the contours of the mound. The terminal depth of the unit was 40 centimeters below surface. The unit matrix was comprised of a humic layer, above a dark brown-gray sand and shell layer, above a sticky/greasy darker gray-black sand. The terminal, sterile, level was a very dark brown sand with numerous sand rock inclusions.

Level 1 of the unit contained four small bone fragments. This level contained both the humic layer and the upper portion of the shell matrix. Level 2 (10–20 cm) was comprised of both the lighter and the darker/greasier shell matrix. Shell included numerous oysters, with few mussels, clams, crabs, and periwinkles. A clam shell collected from this level (Beta-215817) was sub-

TABLE D.1
Ceramics Recovered from Hayes Island (9Li1620)

	Surface	Test Pit I	Test Pit II		
		0–10 cm	0–10 cm	10–20 cm	20–30 cm
Grit and sand tempered	2	—	1	—	—
Grit tempered	—	—	—	—	2
Grit tempered, eroded	—	2	—	—	—
Sand tempered	—	1	—	1	1
Deptford Check Stamped	—	1	—	—	—
Small sherds	2	5	—	1	1

jected to radiocarbon dating. Level 3, 20–30 cm, was primarily composed of the greasy, black shell matrix—oyster with some mussel, clam, and periwinkle. Several small sherds appeared in this level (table D.1). Level 4, 30–40 cm, was the final level excavated in this unit. No artifacts were located. By the bottom of the level all shell from the midden deposit had disappeared, and sand rock was beginning to dominate the matrix. A clam shell sample (Beta-215818) was collected and radiocarbon dated.

The three clam shells selected for radiocarbon dating were selected in the hopes of representing both the vertical and horizontal extents of the midden. The two samples from TP II—located in the thickest, and centermost, portion of the midden—were selected from the top and bottom of the deposit. The sample from TP I came from the edge of the midden—at its southern, horizontal extent.

Because we had no realistic estimate of the age represented in the Hayes Island shell midden, we submitted three *Mercenaria* for radiocarbon dating (table 13.4). We hoped, in effect, that lack of knowledge about the associated ceramics might assist in addressing the chronology-based biases already introduced into the overall distribution of ^{14}C data from St. Catherines Island.

Test Pit I (0–10 cm):
(Beta-215816, *Mercenaria*) 1470 ± 80 B.P.,
    cal A.D. 650–990
Test Pit II (10–20 cm):
(Beta-215817, *Mercenaria*) 1190 ± 50 B.P.,
    cal A.D. 970–1220
Test Pit II (30–40 cm):
(Beta-215818, *Mercenaria*) 2410 ± 60 B.P.,
    cal 400–80 B.C.

As discussed in chapters 4 and 16 (this volume, Part I), date Beta-215818 from Hayes Island is important because it denotes a reappearance of Deptford Period marshside settlements along the western margin of St. Catherines Island (see also chap. 32).

CHAPTER 29. THE CHANGING SHAPE OF ST. CATHERINES ISLAND

DAVID HURST THOMAS, HAROLD B. ROLLINS, AND CHESTER B. DEPRATTER

This chapter combines the available stratigraphic and geomorphologic evidence from St. Catherines Island with the known distribution of archaeological ceramics recovered from the more than 200 sites discussed in this volume. We first reconstruct the shape of St. Catherines Island at key points in time and, in the next chapter, we use these geomorphic models to frame the archaeological evidence in more human terms.

Discussion of the interrelationships between St. Catherines Island's archaeological sites and environmental history depends upon accurate reconstruction of the geomorphic configuration of the Island during the past several millennia. Whereas the major evidence dealing with the geological evolution of St. Catherines Island has been summarized previously (chap. 3), the following discussion develops more fine-grained geomorphic models that facilitate understanding of the distribution of archaeological remains. Table 29.1 presents the 41 "noncultural" [14]C dates that have been processed to help investigators interpret the geomorphic evolution of St. Catherines Island. These dates were calibrated according to the protocols established in chapter 19.

At the end of this chapter, we supplement the archaeological and geomorphological evidence with a consideration of the various historical maps available. Beginning with the important 18th-century maps of William Gerard DeBrahm, it is possible to further document the evolution of modern St. Catherines Island by superimposing a succession of topographical and hydrographical maps.

RECONSTRUCTING MID- AND LATE HOLOCENE ENVIRONMENTS ON ST. CATHERINES ISLAND

St. Catherines Island lies at the apex of the so-called Georgia Bight, a shallow, sloping embayment that extends from the Georgia/Florida boundary northward into southern South Carolina. The Georgia Bight is a regional depositional basin that receives sediments eroding from the coastal plain. It is fringed by a discontinuous series of barrier islands, which are separated from one another by relatively evenly spaced tidal estuaries. The Georgia Sea Islands are unique because they experience "the lowest wave energy, the greatest tidal range, and the broadest forebarrier shelf and backbarrier marsh expanse of all barred segments of the U.S. Atlantic coast" (Frey and Howard, 1988: 622). In addition, the Georgia Sea Islands are complex combinations of Holocene and Pleistocene components and tend to be wider and shorter than the barrier islands along the North Carolina coast, which are separated from the mainland by wider and deeper back barrier bays.

Oertel (1979) distinguished two kinds of barrier islands along the Georgia coast: (1) those intimately associated with major river deltas, such as Tybee, Little Tybee, Wassaw, Ossabaw, Little St. Simons, and St. Simons islands and (2) islands not directly influenced by major rivers, including St. Catherines, Blackbeard, Sapelo, Jekyll, and Cumberland islands. The islands with recent fluvial input (Savannah, Ogeechee, and Altamaha rivers) have a broadly triangular outline and consist of Holocene sediments separated some distance from the Pleistocene strand by expanses of salt marsh, tidal creeks, and marsh islands (hammocks). Those islands more isolated from riverine influence have thin central Holocene beaches with prominently exposed Pleistocene cores, bordered to the north and south by recurved dune ridge sets (DePratter and Howard, 1977; Oertel, 1979; Frey and Howard, 1988). Accretionary terrains, in the form of late Holocene beach ridge sets, which tend to be developed on the southern portions of the islands, are

produced by the southward longshore drift (Frey and Howard, 1988; Booth et al., 1999a).

Of all the Georgia barrier islands, St. Catherines is currently farthest from a major river: Neither Sapelo Sound to the south nor St. Catherines Sound to the north communicates directly with a major freshwater source. Rather, the Medway, South Newport, and Sapelo rivers are salt marsh estuaries situated north of St. Catherines, Sapelo, and Little St. Simons islands, respectively, and are dominated by ebb tides, with very little freshwater inflow (Howard and Frey, 1975). Griffin and Henry (1984: 43) suggest that this isolation from major deltaic systems may account for the extreme rates of erosion observed on St. Catherines Island during the historic period. The Ogeechee and Altamaha rivers, on the other hand, have headwaters that extend far into the coastal plain and distributary systems that aggrade north of Ossabaw and Little St. Simons islands, respectively. Chowns (2002), however, suggests that the "Altamaha River may have originally emptied through St. Simons Sound and the Ogeechee via St. Catherines Sound".[1]

Sea level along the Georgia coast rose to present levels about 4000–5000 years ago, following the Wisconsinan lowstand (DePratter and Howard, 1977; Oertel, 1979; Colquhoun et al., 1980; Howard and Frey, 1980; Booth et al., 1999a, 1999b; chaps. 3 and 4, this volume). The barrier islands and marsh lagoons came to reoccupy positions of former Pleistocene lagoons and shorelines, and have been characterized as "drumstick-shaped" as a result of predominantly northeasterly winds and southward drift of sediment acting through time to prograde the islands in a southward direction (Hayes, 1979). During the late Holocene transgression, barriers "welded" onto the Silver Bluff (Pleistocene) remnants and the sea flooded relict embayments (evident as beach ridge sets on the northern and southern tips of most barrier islands in the Georgia Bight). This Holocene stabilization may have been accompanied by the growth of barrier islands seaward, still very evident where modern coastal rivers create deltaic

prisms (Oertel, 1979: 274; Linsley, 1993: 57), causing the characteristic butterfly, "double island" configuration conspicuous at Wassaw, Ossabaw, and St. Simons Islands.

The presence of such an offshore beach ridge island (herein named Guale Island) would have permitted the formation of a salt marsh and tidal creek system to the east of the St. Catherines Island core. If, as suggested by Chowns (2002), the Ogeechee River emptied at that time into St. Catherines Sound, there would have been an ample sediment supply to form such a "double island" companion to St. Catherines Island. Guale Island would likely be relatively short-lived following subsequent displacement of the Ogeechee River northward, victimized, in the absence of deltaic progradation, by intense overwash activity and rapid erosional flushing of sediment from the sound. As noted by Linsley (1993: 126), the sounds serviced by major rivers tend to be shallower and wider than those that are not. Today, only a disjunct ephemeral expanse of marsh remains along the eastern margin of St. Catherines Island, but a wide expanse of eroded relic marsh mud attests to an earlier and much larger marsh to the east (Morris and Rollins, 1977; West et al., 1990; Linsley, 1993).

Numerous vibracore samples have been taken from across St. Catherines Island (see chap. 3; table 29.1). The basal portions of the vibracore sections are dominated by Late Pleistocene estuarine facies that contain mixed marine and marsh fossils. These sediments are overlain by an eolian facies, evidence of a prograding beach ridge complex over the nearshore marine deposits (Linsley, 1993: 69) followed unconformably by a sequence of Holocene salt marsh sediments. Along its eastern margin, the Pleistocene core of St. Catherines Island was generally separated from the Atlantic Ocean by dune/beach ridges and *Spartina* marshes, which were connected to open water by two large tidal inlets, Seaside and McQueens. The radiocarbon age of cal 3270–2630 B.C. (table 29.1: Pitt-734) closely corresponds to age estimates of the Holocene transgressive maximum—suggesting

that a *Spartina* marsh was established as early as cal 2500 B.C. [4000 B.P.], very shortly after the peak of post-Wisconsinan transgression. This ancient marsh, located along the northeastern margin of St. Catherines Island, is presently represented by exposures of relic (fossil) marsh sediments with no protective dune ridge/barrier beach complex remaining on the seaward margin (Morris and Rollins, 1977; Groce, 1980; Fierstien and Rollins, 1987; Linsley, 1993). As the marsh aggraded, it was covered by higher elevation vegetation. A sandy palmetto root layer (paleosol) dated at cal A.D. 1310–1630 (laboratory number unknown) can be observed at the top of core 2, while the lower part of the rooted zone is visible in core 3.

Booth et al. (1999a) also report results from vibracore sampling on St. Catherines Island (at Cracker Tom Hammock, Cracker Tom Bridge, and Cracker Tom Rosette—all on the east-central portion of the Island, south of McQueens Inlet). They found a basal freshwater peat in one core, radiocarbon dated at greater than 40,000 years B.P. (USGS #WW1197; see table 29.1). Above the peat is a vast depositional hiatus followed by a disconformable shell layer containing a marine cockle shell (*Dinocardium robustum*?) radiocarbon dated to cal 3000–2670 B.C. (USGS #WW-1262), and charcoal that was dated to cal 5040–4780 B.C. (USGS #WW-1198). This shell layer is overlain by marine sediments, followed by deposits of marine sand with increasing terrestrial influence (denoting southerly beach ridge progradation and accretion to the island core).

Booth et al. (1999a) suggest that these data indicate that St. Catherines Island must have been separated from the mainland due to eustatic sea level rise immediately after cal 2980–2670 B.C., after which a pronounced beach ridge and swale landscape accreted on both ends of the island.[2] At the north end, this landscape was constructed from sands associated with marginal shoals, particularly during storm events (Oertel, 1975, 1979). If St. Catherines Sound was inherited from the displaced Ogeechee River (per Chowns, 2002), there

may have been at this time a broad but moderately deep channel immediately adjacent to the Pleistocene core at the northern end of the island. Tidal flushing and longshore current distribution of the abandoned deltaic sediments may have rather quickly led to construction and accretion of beach ridge sets along the island's northeastern margin. Channel lag deposits at the base of Holocene sequences in vibracores taken along one transect across North Beach suggest either a wider former tidal inlet or substantial lateral movement of the inlet mouth (Linsley, 1993). The entire Holocene sequence at the northern end of St. Catherines Island is only about 5 m, but the maximum depth of St. Catherines Sound is 14 m. Linsley (1993: 126) suggests that this either means ''a) that the sounds have not moved through time or b) when they were first formed after the Holocene transgression they were not as deep and that the dynamics of the marsh/island/sound system have changed through the Holocene.'' Adoption of the Chowns (2002) model would suggest acceptance of the second interpretation, that is, an early presence of the Ogeechee River emptying into St. Catherines Sound with abundant sediment supply. At that time the sound would have been wide and shallow, perhaps tight against the Pleistocene core of the island.

To the south, the beach ridge complexes are progradational bodies formed adjacent to tidal estuaries or on the oceanward side of the Island, ultimately extending as far as 2.2 km east and 5.8 km south of the island core. These low, essentially continuous deposits of beach sediment formed recurved spits and bars parallel to the shoreline, separated by low-lying sloughs commonly occupied by salt marsh or freshwater swamp. Such longshore bars and spits were aggraded by marine overwash during spring tides and major storms, and later were stabilized as beach ridges by vegetation as additional longshore bars accreted. Aeolian processes aided ridge aggradation as the vegetation baffled the wind blown sand. The dunes eventually were covered by trees as the shoreline extended southward and

TABLE 29.1
Noncultural Radiocarbon Dates from St. Catherines Island[a]

Lab no.	Location	Material	Contexts	^{14}C age B.P. (± 1σ)	^{13}C/^{12}C	^{13}C adjusted age B.P.	Radiocarbon age (± 2σ)	Refs[b]
Pitt–831	Core 3 (783–799 cm)	Shell	Subtidal marine	22,600 ± 310	*	—	—	1
Pitt–685	Core 5 (15–35 cm)	Organics	Marsh peat	Modern	—	—	—	1
Pitt–686	Core 5 (68–83 cm)	Organics	Low marsh *Spartina*	1600 ± 40	—	—	cal A.D. 380–560	1
Pitt–687	Core 5 (489–508 cm)	Organics	*Spartina* in mud clast	2590 ± 40	—	—	cal 830–550 B.C.	1
Pitt–723	Core 6 (133–151 cm)	Organics	Marsh, point bar	1720 ± 50	—	—	cal A.D. 170–430	1
Pitt–734	Core 6 (480–516 cm)	Organics	*Spartina* in mud clast	4290 ± 80	—	—	cal 3270–2630 B.C.	1
Pitt–735	Core 6 (653–689 cm)	Shell	Subtidal marine	24,220 ± 500	*	—	—	1
Pitt–736	Core 8 (317–334 cm)	Organics	*Spartina* in mud clast	3100 ± 50	—	—	cal 1490–1220 B.C.	1
Unknown	Core 13 (494–500 cm)	Organics	Disseminated carbon	4370 ± 120	—	—	cal 3370–2670 B.C.	1
GX–16792	Core 14 (275–285 cm)	Organics	Disseminated in mud	14,090 ± 640	—	—	cal 16,720–13,260 B.C.	1
Pitt–926	Core 17 (494–508 cm)	Organics	Marine lag deposit	4450 ± 50	—	—	cal 3340–2930 B.C.	1
Pitt–926a	Core 17 (494–508 cm)	Shell	Mixed marine shell bed	7870 ± 90	****	8280 ± 90	cal 7340–6760 B.C.	1
Pitt–927	Core 20 (27 cm from bottom)	Shell	—	4370 ± 120	****	4780 ± 120	cal 3070–2930 B.C.	—
GX–16791	Core 20 (72–84 cm)	Organics	North side of McQueen	2450 ± 150	****	—	cal 900–200 B.C.	—
GX–16708	Core 20 (34–38 cm)	Shell	North side of McQueen	550 ± 120	****	340 ± 120	cal A.D. 1330–1952	—
GX–13966	Eroding tidal scar	Wood	2 in. below peat surface	730 ± 80	—	—	cal A.D. 1160–1400	1
UGA–6267	Core 9005051 (502–512 cm)	Organics	Freshwater peat	28,370 ± 340	*	—	—	1
Pitt–925	Core 9005051 (502–512 cm)	Organics	Freshwater peat	33,510 ± 530	*	—	—	1
Pitt–645	Station 26 (surface)	Organics	Relict *Spartina*	840 ± 40	–0.10	1080 ± 50	cal A.D. 820–1030	1
Pitt–645A	Station 26 (surface)	Shell	*Geukensia*	1570 ± 60	0.0	1980 ± 60	cal A.D. 100–420	1
Pitt–646	(surface)	Organics	Disseminated in mud	1060 ± 50	0.10	1300 ± 60	cal A.D. 640–880	1
GX–13966	(surface)	Wood	Palmetto in mud	730 ± 80	—	—	cal A.D. 1060–1410	1
UGA–6160	South of line 43 south	Wood	In relict mud	470 ± 90	–27.52	430 ± 100	cal A.D. 1300–1660	8
UGA–6161	South of line 43 south	*Ostrea*	In relict mud	100 ± 80	–0.63	500 ± 80	cal A.D. 1500–1950	8
UGA–6162	South of line 43 south	*Mercenaria*	In relict mud	290 ± 90	–1.90	670 ± 90	cal A.D. 1350–1690	8
UGA–6163	South of line 43 south	*Geukensia*	In relict mud	190 ± 90	–1.13	580 ± 90	cal A.D. 1440–1810	8
Unknown	(surface)	Organics	*Spartina* in relict mud	480 ± ***	—	—	cal A.D. 1310–1620	2
Unknown	(surface)	Organics	*Spartina* in relict mud	1830 ± ***	—	—	cal A.D. 60–340	2
Unknown	(surface)	*Crassostrea*	In relict mud	1040 ± ***	—	—	cal A.D. 1070–1330	3
UGA–6442	Cracker Tom's hammock	*Crassostrea*	Zone C	3200 ± 50	–1.51	3590 ± 50	cal 1870–1540 B.C.	4,7

TABLE 29.1—(Continued)

Lab no.	Location	Material	Contexts	^{14}C age B.P. (± 1σ)	^{13}C/^{12}C	^{13}C adjusted age B.P.	Radiocarbon age (± 2σ)	Refs[b]
USGS #WW-1197 **	Cracker Tom's bridge	Peat	Zone A	47,620 ± 2500	*	—	—	4,5
USGS #WW-1262	Cracker Tom's bridge	Shell	Zone B	4060 ± 50	****	4450 ± 50	cal 3000–2670 B.C.	4,7
USGS #WW-1198	Cracker Tom's bridge	Charcoal	Zone B	6020 ± 50	—	—	cal 5040–4790 B.C.	4,5
Beta-115910 **	Beach pond (214 cm)	Wood	Zone B	1210 ± 40	—	—	cal A.D. 690–940	4
Beta-217245	South Beach	Mercenaria	Relic marsh	780 ± 50	-1.4	1170 ± 50	cal A.D. 990–1230	9
Beta-217246	South Beach	Crassostrea	Relic marsh	620 ± 50	-1.7	1010 ± 50	cal A.D. 1120–1380	9
Beta-217823	St. Catherines Shell Ring	Composite shell	Vibracore #3,3.5 m below surface	—	-0.6	>44,800	—	9
Beta-217824	St. Catherines Shell Ring	Peat sample	Vibracore #2,4.1 m below surface	39,130 ± 660	-26.2	39,110 ± 660	—	9,6
Beta-217825	St. Catherines Shell Ring	Peat sample	Vibracore #2,4.1 m below surface	29,440 ± 260	-26.2	29,410 ± 260	—	9,6
Beta-223509	St. Catherines Shell Ring	Composite shell	Vibracore	—	-2.0	>38,290	—	9,6
Beta-223511	St. Catherines Shell Ring	Composite shell	Vibracore	—	-2.0	>44,840	—	9,6

[a] All marine dates corrected for reservoir effect, per chapter 13.

[b] References: (1) Linsley (1993: appendix), (2) Pemberton and Frey (1985), (3) Fierstein and Rollins (1987), (4) Booth (1998), (5) Booth and Rich (1999), (6) Booth et al. (1999b), (7) Booth et al. (1999a), (8) Bishop and Rich (1990), (9) this volume.

* Beyond the currently available calibration curve.

** Denotes AMS date.

*** Estimate of variability unavailable; for calibration purposes will assume ± 60 radiocarbon years.

**** Fractionation estimate (^{13}C ratio) unavailable; for calibration purposes will add 390 years (per chap. 13).

eastward producing a distinct progradational sequence of accreted terrains.

These conspicuous Holocene beach ridges began to form after sea level stabilized, within 1 or 2 m of its present level—about cal 2500 B.C. ([4000 B.P.], DePratter and Howard, 1977, 1981). Those ridges closest to the island core reflect the earliest seaward progradation. The angle of shoreline development changed through time, as evidenced by different orientations of beach ridge sets. The earliest beaches extended in a southerly direction, roughly parallel to the modern coastline. Through time, the beach ridges shifted to a position parallel to that of modern Sapelo Sound, which separates St. Catherines Island from nearby Blackbeard Island. The sand source for such extensive beach ridge construction remains unclear. If St. Catherines Island lacked an adjacent fluvial source as it does today, then sand must have come from erosion of the island core and/or estuaries. On the other hand, if the Ogeechee River emptied into St. Catherines Sound, there would have been ample distributary sand available. As another variation on the latter scenario, Chowns (2002) suggests that Blackbeard Island may have formed from breaching and detachment of the spits originally attached to the south end of St. Catherines Island.

Linsley (1993) compiled available evidence to produce a four-part reconstruction of the geomorphic evolution of St. Catherines Island during the past 5000 years (reproduced here as fig. 29.1). He concluded that after the initial transgression, cal 3800–2500 B.C. [5000–4000 years B.P.], the sedimentary system was in a state of disequilibrium, with sea level rising at a rate of 5–7 m per millennium. The ca. 3000 B.C. [4400 B.P.] [14]C dates occur near the base of the Holocene sequence, which is represented in the cores by up to 5 m of salt marsh deposits disconformably overlying the Pleistocene sequence. These radiocarbon dates indicate a minimal time for initial stabilization of sea level at the northern end of St. Catherines Island. Over the next millennium, the marsh/tidal creek system developed, and by cal 2500–1250 B.C. [4000–3000 B.P.], the Island achieved a salt marsh system similar to

the one that exists today. With the achievement of equilibrium, a series of progradational beach dune ridge sequences accreted to the Island. The sounds deepened and assumed their modern aspect as the sand supply from the marsh was exhausted (Linsley, 1993: 128). This model implies that a large areal expanse of beach dune ridges and spits formed relatively early, prior to cal 1250 B.C. [3000 B.P.]. After this time, beach progradation continued, but at a slower pace due to the achievement of a depositional dynamic equilibrium. An alternative model, involving an early Holocene northward displacement of the mouth of the Ogeechee River, is also consistent with a pattern of early and rapid progradation, followed by diminished sediment supply and a lower rate of ridge and spit formation.

Throughout the remainder of this chapter, we will project Linsley's four-stage model against the available geomorphological and archaeological evidence. All the available archaeological survey data from St. Catherines Island are plotted here. These include the systematic transect survey, DePratter's 1977 shoreline survey, and intermittent, informal surveys conducted by archaeologists who have worked on the Island during the past century.

ST. SIMONS PERIOD
(CAL 3000 B.C.–1000 B.C.)

Figure 29.2 presents the Island-wide distribution of St. Simons period ceramics, which date cal 3000 B.C.–1000 B.C. on St. Catherines Island. The site distribution is overlain by our reconstruction of the shape of St. Catherines at cal 1500 B.C. [4000 B.P.].

GEOMORPHOLOGICAL EVIDENCE

The combined radiocarbon, palynological, and paleontological evidence suggests that modern St. Catherines Island formed after cal 3000–2670 B.C. (USGS #WW-1262), when sea level rose sufficiently to isolate the Pleistocene core from the mainland. Sea level probably stabilized to within a few meters of its modern position since that time.
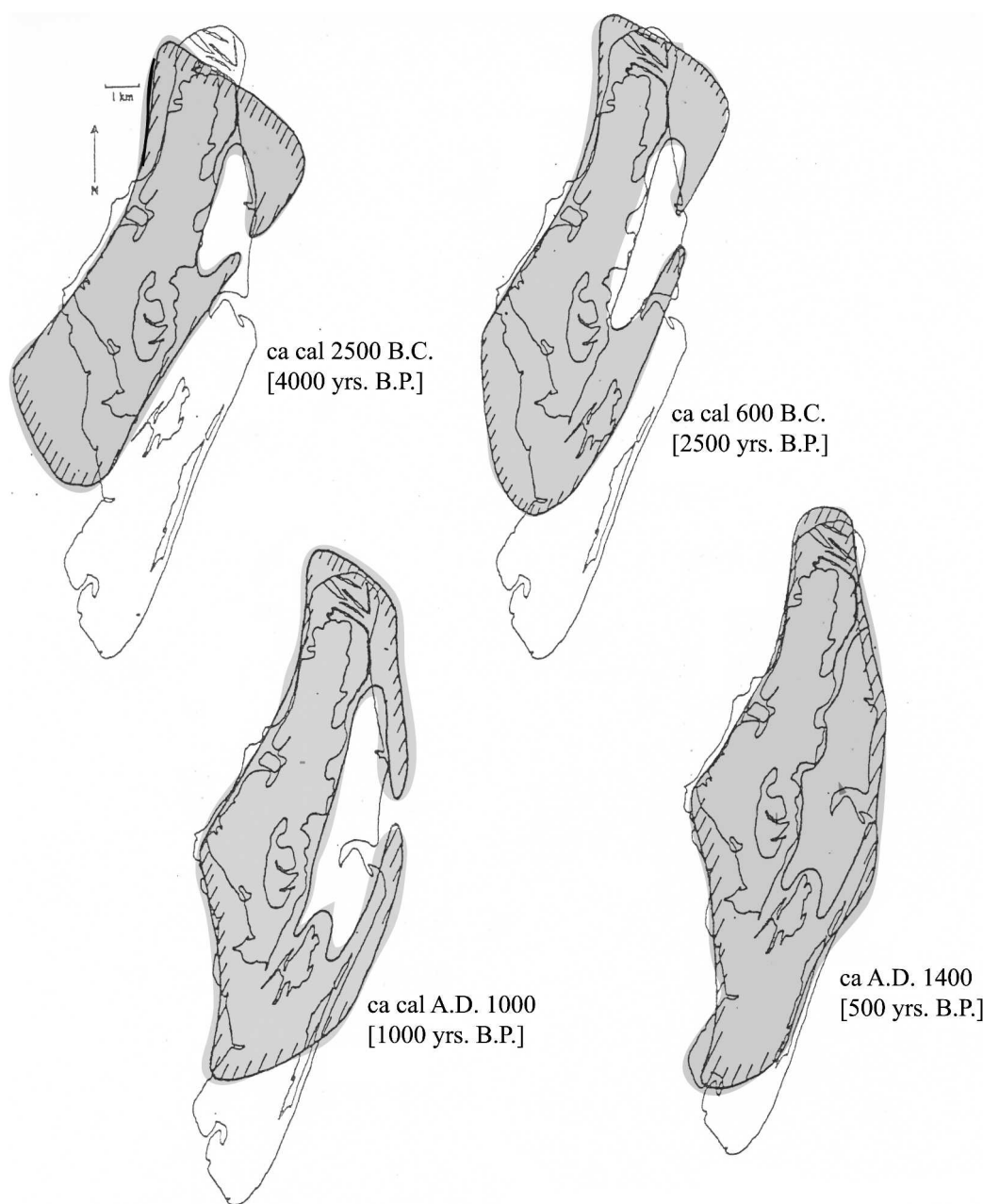
Fig. 29.1.　David Linsley's (1993) four-stage reconstruction of the changing shape of St. Catherines Island over the last four millennia.

Guale Island (shape
conjectural)

estimated shape at
cal 2500 B.C.

Guale Marsh

9Li215

Cracker Tom Hammock

9Li161

LEGEND
· archaeological site
✕ 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds

St. Simons Period
cal 3000 - 1000 B.C.

N

1 .5 0   1 km
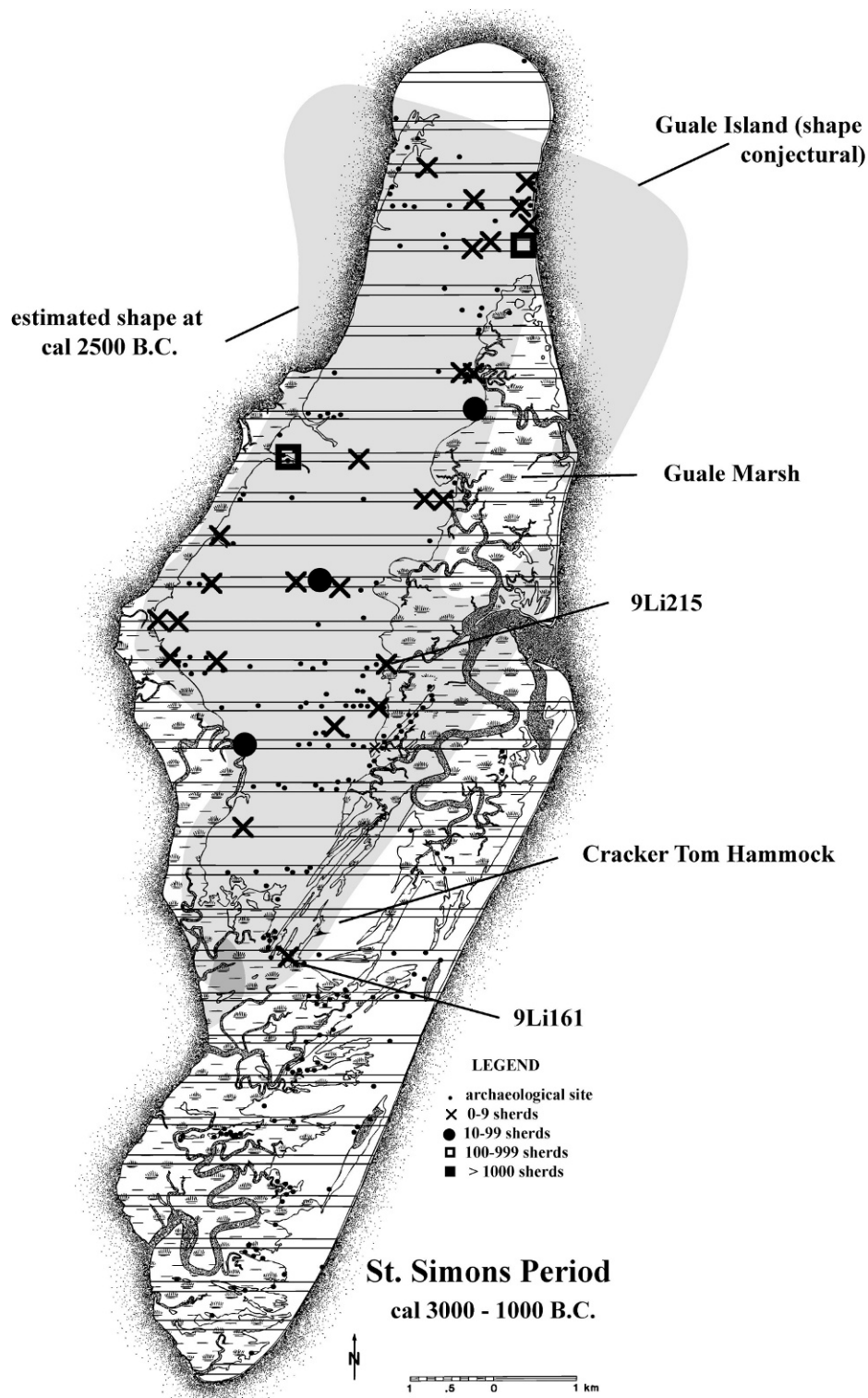
Fig. 29.2.   The distribution of known St. Simons period sites on St. Catherines Island.

Linsley (1993) suggests that by cal 2500 B.C. [4000 B.P.], St. Catherines Island retained a large portion of "Guale Island", the hooklike extension at the northeastern portion of the Island that effectively buffered the shoreline, protecting a large inter-island marshland extending from Picnic Bluff, past Seaside Inlet to the King New Ground dock area. Tidal creeks meandered through this vast inland marsh (termed here "Guale Marsh"), providing access to the rich resources of the local shellfishery and producing a mosaic of meander bends and levees along the creek beds. The thick sequence of relic marsh muds recorded in vibracore 5 (Transect B-B′, immediately off Seaside Road; see chap. 3) provides evidence of lateral migration of tidal creek channel(s) through the vibracore site at least five times over the last thousand years (Rollins et al., 1990; Linsley, 1993: 72). The southern extent of Guale Marsh reached as far as Middle Beach, indicated by exposures of relic marsh muds between Seaside and McQueens Inlets (West et al., 1990).

The surface of the relic Guale Marsh has been radiocarbon dated to cal A.D. 1310–1630 and cal A.D. 610–870 at a depth of 50 cm (Pemberton and Frey, 1985; laboratory numbers unknown and statistical variability estimated; see table 29.1). Radiocarbon dates on *Spartina* recovered at the base of the marsh facies (exposed in vibracores 5, 6, and 8 at North Beach) are cal 830–550 B.C. (Pitt-687; 489–508 cm), cal 3270–2630 B.C. (Pitt-734; 480–516 cm), and cal 1490–1220 B.C. (Pitt-736; 317–334 cm). These dates on organic material found in channel lag deposits near the base of the Holocene salt marsh sequence represent an early stage in the development of a salt marsh environment and Linsley (1993: 130) suggests that this salt marsh formation was "relatively instantaneous", probably within a few centuries. Taken together, these dates indicate that Guale Marsh likely formed around the time of sea level stabilization that followed the post-Wisconsinan transgression. As such, the maximum possible age of Guale Marsh, which stands at 0.75 m above MLT, is cal 1250 B.C.–cal 2500 B.C. [3000–4000 B.P.]

Booth and his colleagues recovered vibracore samples from Cracker Tom Hammock, further to the south (Booth, 1998: 90; Booth et al., 1999a, 1999b). At a depth of 225–194 cm below surface, the core penetrated an oyster bed dated at cal 1870–1540 B.C. (UGA-6442; see table 29.1). Overlying sediments indicate that while marine conditions existed for a while, they were followed by a progressively more terrestrial influence and the establishment of modern marsh and hammock communities. The palynological record indicates that, concurrently, the southern expansion of accretionary terrains had reached the Cracker Tom area and likely led to "relative hydrologic isolation" with a strong freshwater influence that even exceeds that of the present day (Booth et al., 1999b: 85).

Gayes et al. (1992) suggest that the Georgia Bight experienced a rather abrupt sea level drop of 2 m about cal 2300 B.C. ([3900 B.P.], chap. 4). Such a lowering (estimated at about 50 cm/century) would have most likely modified sedimentary dynamics of the Georgia Sea Islands, affecting the back island marshes most dramatically (including the western margin of St. Catherines Island) by draining expanses of low marsh and causing some degree of downward erosion of larger tidal creek channels (incisement). In addition, some amount of progradation of Guale Island and seaward expanse of Guale Marsh might have occurred.

ARCHAEOLOGICAL EVIDENCE

St. Simons period materials are distributed across the island core, with particular concentrations along the Picnic Area at North Beach bluff and along Seaside Inlet. According to Linsley's (1993) reconstruction for cal 2500 B.C. [4000 B.P.], the southeastern margin of St. Catherines Island lay immediately to the east of Back Creek Road. The most southerly occurrence of Late Archaic ceramics is beyond this point, at 9Li161, where St. Simons sherds were recovered from a buried shell scatter that extends along South Beach Road, skirting the southwestern margin of Cracker Tom Hammock. According to the St. Catherines

Island chronology (derived in chap. 15), St. Simons ceramics should date to the interval cal 1000 B.C.–3000 B.C. Thus, it is likely that 9Li161 was an extremely late St. Simons period site, occupied shortly after the modern hammock and plant communities were established on the newly formed Cracker Tom Hammock (i.e., after cal 1870–1540 B.C., per UGA-6442). The environmental reconstruction of Booth et al. (1999a, 1999b) suggests that an ample source of adjacent freshwater was also likely available.

Since the archaeological sites on St. Catherines Island are almost always associated with American oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*) shells, we assume that the native people established their habitation sites just above or very close to the shellfish source being exploited. By combining the geomorphological and archaeological evidence, it is possible to estimate the ages of ancient shorelines.

In figure 29.2, we estimate the maximum extent of progradation at about cal 2500 B.C. [4000 B.P.] near the end of the St. Simons period. This line passes along the western margin of Cracker Tom Hammock, meaning that the *precise* location of the former shoreline was probably somewhat to the south and/or east of the plotted archaeological site. As noted by DePratter and Howard (1977: 256), however, "It is unlikely that these lines can be drawn with any greater precision because the meandering by numerous tidal creeks has significantly eroded pre-existing barrier ridges."[3]

REFUGE-DEPTFORD PERIODS
(CAL 1000 B.C.–A.D. 350)

Figure 29.3 presents the Island-wide distribution of Refuge-Deptford period ceramics (known to date cal 1000 B.C. to cal A.D. 350), overlain by our reconstruction of the St. Catherines Island at cal 600 B.C. [2500 B.P.].

GEOMORPHOLOGICAL EVIDENCE

According to Linsley's (1993) reconstruction (fig. 29.1), St. Catherines Island during the early Woodland period retained the hook-shaped Guale Island, only slightly reduced along its southeastern margin from Late Archaic time (fig. 29.1). Additional beach ridges accumulated along the Island's southeastern shore, extending beyond the modern Cracker Tom Hammock and arching northward past the contemporary McQueens Inlet.

Guale Marsh, still buffered from the Atlantic Ocean by Guale Island, expanded markedly to the southwest, and extended into McQueens Inlet, perhaps as far south as Middle Settlement/Cemetery Road. Numerous beach ridges also formed along the Island's northern end, and, except for a remnant spur of island core to the northwest, the western shoreline approximated its modern configuration. By this time, it is possible that the Ogeechee River was displaced northward (according to the Chowns, 2002, scenario) and St. Catherines Sound was narrower and deeper.

ARCHAEOLOGICAL EVIDENCE

Figure 29.3 demonstrates that Refuge-Deptford period ceramics cover the Pleistocene island core, with particular concentrations along the northern Island area (banded between the Northwestern Marsh and Picnic Beach) and along the southwestern margin (the western marsh from Persimmon Point south past Wamassee Head, extending about a mile inland). No archaeological evidence was found on the northern Holocene beach ridges, but two sites document the progressive growth of the southern beach ridge complex.

Three Refuge-Deptford period components are known from the western margin of Cracker Tom Hammock, and two additional sites occurred on the southern beach margins. Six Refuge Punctated and Refuge Incised sherds were recovered from 9Li49, a series of shell scatters and concentrations exposed along the eroding bank of a Holocene dune ridge in transect L-6, where Long Marsh is flooded and drained by Camp Creek. The beach ridge site, 9Li73, covers the northwestern end of a peninsula that stretches along the upper reaches of Camp Creek, where it enters Long Marsh. This
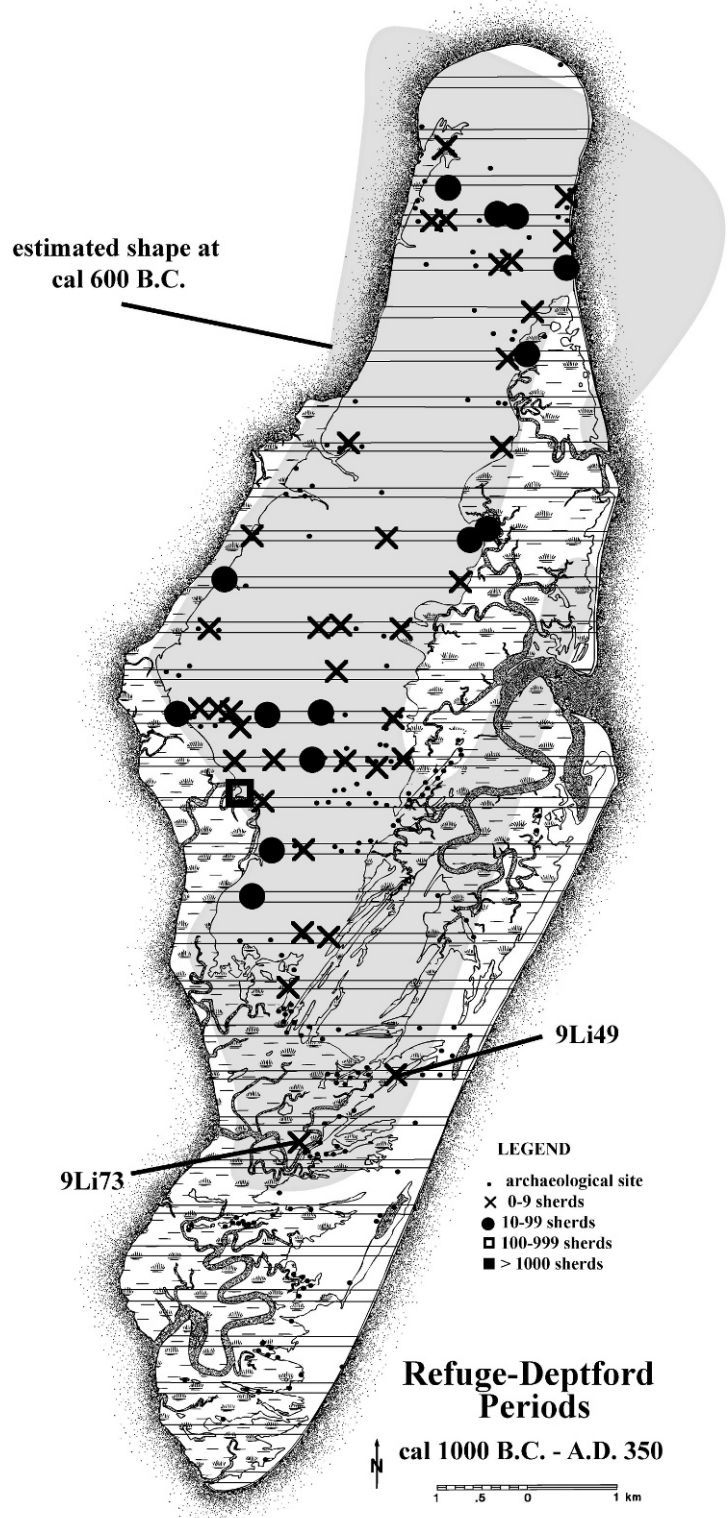
Fig. 29.3.   The distribution of known Refuge-Deptford period sites on St. Catherines Island.

discontinuous shell midden extends about 200 m along the northwest edge of the peninsula and possesses a ceramic assemblage that consists of several sand-and-clay sherds and eight Refuge sherds. Because 9Li73 fell to the north of transect M-6, it was not tested, and we must rely on surface collected materials.

The combined evidence suggests that the cal 500 B.C. [2500 B.P.] southern beachfront passed across Hickory Hills (just north of Beach Pond) and circled immediately to the south of Long Marsh and the upper reaches of Camp Creek.

WILMINGTON AND ST. CATHERINES PERIODS
(CAL A.D. 350–1300)

Figures 29.4 and 29.5 present the Island-wide distribution of Wilmington (cal A.D. 350–800) and St. Catherines (cal A.D. 800–1300) period ceramics, overlain by reconstructions of St. Catherines Island at cal A.D. 1000 and cal A.D. 1100.

GEOMORPHOLOGICAL EVIDENCE

By the end of the Wilmington period, about cal A.D. 800, Guale Island had significantly narrowed, but still protected the extensive Guale Marsh that reached southward past Hoke's Dock to the northern end of Cracker Tom Hammock. The tidal inlet to Guale Marsh was likely still north of the present-day McQueens Inlet. Linsley's (1993) reconstruction indicates that the southern beach ridge complex extended well beyond Hickory Hill and Long Marsh, terminating somewhere to the south of Beach Pond, a freshwater pond and marsh that covers about 30,000 m^2 about 50–100 m west of the beach scarp on the mid-southern portion of St. Catherines Island (Booth et al., 1999b).

Booth et al. (1999b) present the paleoenvironmental history of Beach Pond, based on the study of a single 4.5-m vibracore. Holocene marine sediments occur in the basal portion of this core and suggest nearshore marine deposition in a semi-restricted basin several meters deep and a few kilo-

meters south and east of the strand line. As sediment accumulated, the basin developed into a shallow lagoon, isolated by an offshore sand bar while retaining an inlet connection to a more open marine environment. This shallowing upward sequence was interrupted by an erosional event, followed by deepening of the lagoonal basin and probable eroding of portions of the accreted beach ridge sets. Then the basin continued to fill with lagoonal sediments accompanied by the formation of another accretionary terrain, and reisolation of the lagoon and deposition of a clay zone. Admixture of terrestrial pollen grains (*Pinus*) and marine fauna (microforams and dinoflagellates) indicates that an open connection to a marine environment was maintained (see Booth et al., 1999b: 573). A piece of wood recovered from the uppermost lagoonal clay has been radiocarbon dated (by AMS) to cal A.D. 690–940 (Beta-115910; see table 29.1).

The rapid change and cyclic nature of sediment sequences in the Beach Pond core indicate that the area of Beach Pond was very responsive to the minor autogenic effects of erosion and deposition that accompanied storm washover events and tidal processes as Holocene sea level continued to gradually rise. Palynological and sedimentological analysis indicates that, through time, the Beach Pond area experienced a nearshore lagoonal environment with incipient salt marsh and hammocks. This environment was followed by brackish marsh conditions and then abrupt formation of the modern freshwater pond, accompanied by calm conditions and peat formation. The construction of South Beach Road, sometime in the 19th century, catalyzed the development of modern Beach Pond, enhancing colonization by sedges, wax myrtle, and other plant communities characteristic of such swale communities. In short, more recent ^{14}C and palynological evidence confirms Linsley's (1993) suggestion that the Holocene beach ridge complex expanded southward, at least to the position of Beach Pond sometime after cal A.D. 800.

In 1990, Gale Bishop, Fred Rich, and Jack Reynolds sampled an exposed relic marsh deposit near the Island's southern
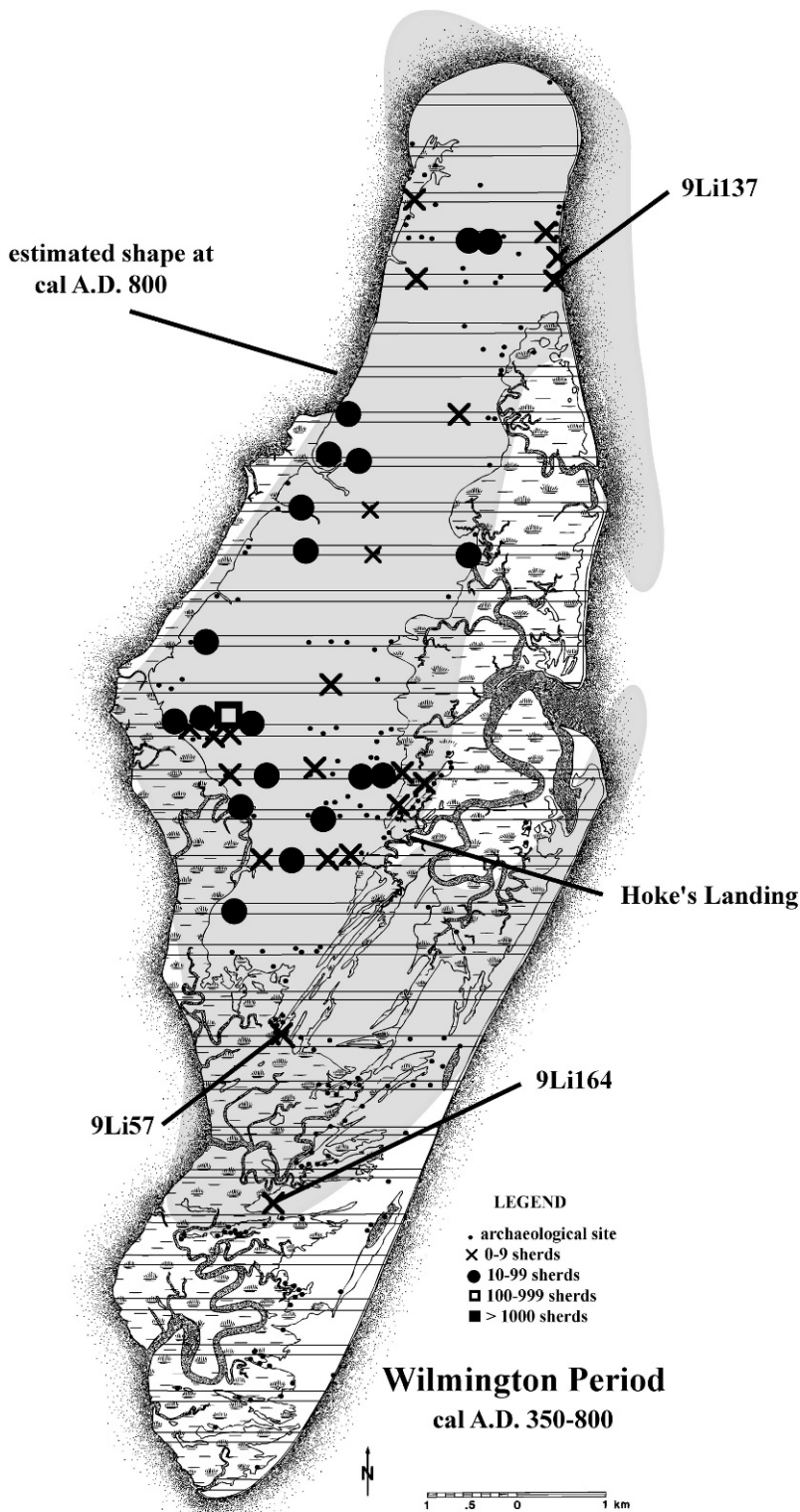
Fig. 29.4.   The distribution of known Wilmington period sites on St. Catherines Island. Estimated shape interpolated from Linsley (1993).

estimated shape at
cal A.D. 1000

Beach Pond
9Li128

9Li165

LEGEND
· archaeological site
× 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds

St. Catherines
Period
cal A.D. 800 - 1300

Line 43 relict marsh

.5   0   1 km
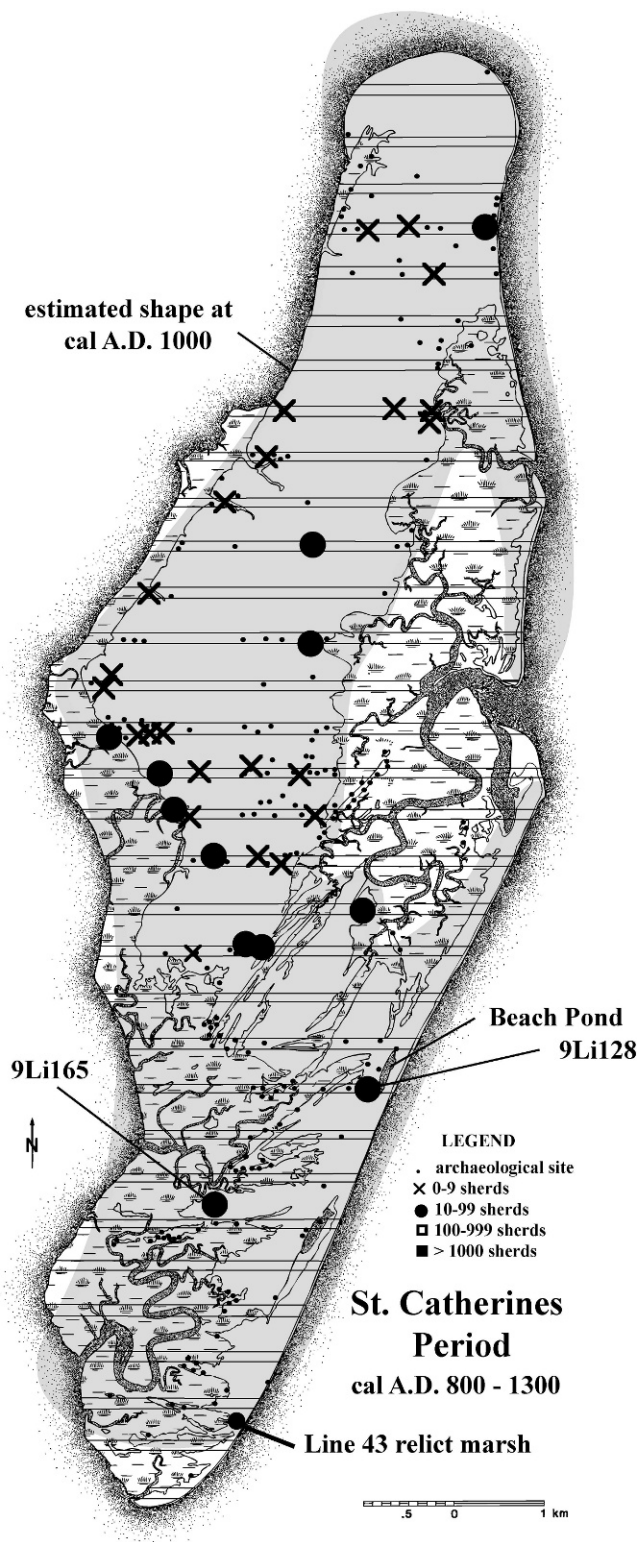
Fig. 29.5.   The distribution of known St. Catherines period sites on St. Catherines Island.

tip (near Bishop's "Line 43"), between AMNH transects O-1 and P-6 (see fig. 29.8, below). Four ^{14}C samples of charcoal and marine shell material establish that by about cal A.D. 1150 (table 29.1), a significant marsh had developed where the present beach is now located. The relationship of that marsh to sedimentary dynamics surrounding Sapelo Sound at the time is unclear.

<center>ARCHAEOLOGICAL EVIDENCE</center>

The available archaeological data also substantiate the geomorphological model. The distribution of Wilmington period (fig. 29.4) sites shifts notably southward from the previous Refuge-Deptford periods, with considerably fewer sites occupied on the northern end of the Island. There are more sites in the Rock Field, Meeting House Field areas, with the heaviest site concentration to the south, near the Rice Field, Wamassee Head, and South New Ground Field.

Two Wilmington-age sites occur on the southern ridge complex, at 9Li57 (on the southern margin of Cracker Tom Hammock) and 9Li164, where Wilmington Plain sherds were recovered from a small, thin subsurface shell lens located on a hammock at transect M-1, about 10 m north of the marsh edge.

The northern end of the Island preserves relatively sparse evidence of occupation during the St. Catherines period (fig. 29.5). The Rock Field/Meeting House Field sites show diminished occupation, with more material found near King New Ground and Greenseed Fields. Sites are still occupied in the Persimmon Point–Wamassee Head area, though not as densely as during the previous Wilmington period.

There is, however, an increase in southern beach ridge occupations during the St. Catherines period. Site Li165 (transect M-1) extends along the south bank to the end of the point that runs along the margin of Camp Creek. Covered by saw palmettos, this large site consists of scattered surface shell as well as a dense concentration of subsurface shell along the bank, reaching

inland about 15 m. Virtually all of the diagnostic sherds date to the St. Catherines period.

Site 9Li128 (transect L-6) is a medium-sized site along the west side of Jungle Road, on the southern margin of Beach Pond. Although two-thirds of the sherds date to the subsequent Irene period, a secondary St. Catherines period occupation accounts for 26 percent of the diagnostic ceramics.

As indicated in figure 29.4, the apparent shoreline at the end of the Wilmington period (cal A.D. 800) extended along the northern margin of transect M-1 (immediately to the south of 9Li164), just north of the upper reaches of Brunsen Creek. By the end of the St. Catherines period (cal A.D. 1000 [1000 B.P.]) the southern beachline prograded significantly southward, at least to the south of the "Line 43" relict marsh.

<center>IRENE PERIOD (CAL A.D. 1300–A.D. 1580 [UNCALIBRATED])</center>

Figures 29.6 presents the Island-wide distribution of Irene period ceramics (cal A.D. 1300–A.D. 1580 [uncalibrated]), accompanied by reconstructions of St. Catherines Island at about cal A.D. 1400 [500 B.P.].

<center>GEOMORPHOLOGICAL EVIDENCE</center>

In Linsley's (1993) reconstruction of the shape of St. Catherines Island, by cal A.D. 1400 [500 B.P.], all remnants of Guale Island had eroded away (leaving only subsurface relic marsh deposits) and the shoreline cliff at North Beach has retreated to near its historic-period configuration. Except for small isolated pockets of marsh behind barrier beach ridges, the northern portion of Guale marsh (the large inter-island marshland) was now directly exposed to strandline erosion and subsequently reduced to low-lying exposures of relict marsh mud. The southern beach ridges continued to prograde, extending southward to the margins of modern Flag Pond. As discussed in the next section, the St. Catherines Island of cal A.D. 1400 closely resembled the Island depicted on the 1760 map of Yonge and

LEGEND
. archaeological sites
× 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds

Flag Pond

9Li163

Irene Period
cal A.D. 1300 - 1580

9Li118

N

1 .5 0   1 km
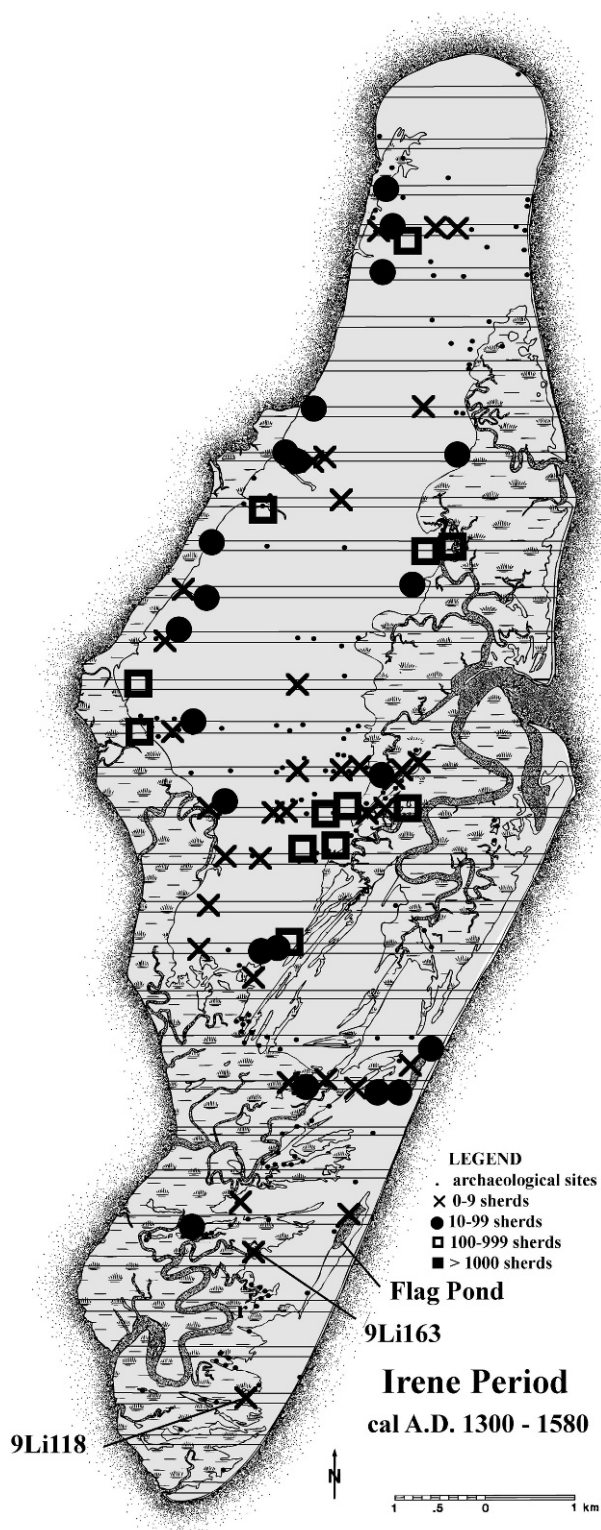
Fig. 29.6.   The distribution of known Irene period archaeological sites on St. Catherines Island.

DeBrahm, except for geomorphological details of the northern and southern tips and the meander positions of tidal creeks.

ARCHAEOLOGICAL EVIDENCE

Archaeological sites representative of the Irene period continue to reflect a trend of settlement in the west and the south of St. Catherines Island (fig. 29.6). The erosion of Guale Island meant that the large, highly productive Guale Marsh environment had greatly diminished, leading to a pronounced decrease in aboriginal occupation of this area. The once productive marsh, now reduced to primarily intertidal exposures of relic mud, was of little use to aboriginal inhabitants except as perhaps a material component in ceramic making. This southward shift is reflected in increased utilization of the marshes near Seaside, King New Ground, Hoke's Dock and Cracker Tom Hammock. Utilization of the southeastern marshlands (from King New Ground to Cracker Tom Hammock) intensified significantly, as did occupation along the western margin of the island core.

Increased occupation of the southern Holocene beaches also occurred during the Irene period, especially to the south and west of Beach Pond and, for the first time, along the margins of Flag Pond. Figure 29.6 plots the cal A.D. 1400 [500 B.P.] shoreline as passing south of Brunsen Creek, approximately 1 km south of Flag Pond.

ALTAMAHA PERIOD (A.D. 1580– 1700 [UNCALIBRATED])

Figure 29.7 shows the distribution of the Altamaha period ceramics, spanning the era of aboriginal–Hispanic contact on St. Catherines Island, from sometime in the late 1500s through about 1700, shortly after Mission Santa Catalina de Guale was abandoned. The geomorphic configuration of St. Catherines Island during the Spanish mission period can be extrapolated back in time from the Yonge and DeBrahm map of 1760, when the Island was longer and wider than it is today.

Figure 29.7 documents the dramatic consolidation and contraction of human settlements on St. Catherines Island during the Spanish period. Altamaha ceramics were found on only 13 of the 350 archaeological sites examined, with half of those occurrences located within 1 km of Wamassee Head, the location of Mission Santa Catalina de Guale. Two Altamaha period sherds were also recovered from 9Li250, a mostly Wilmington period occupation located 2 km north of the Mission.

On the northwestern tip of the Island, two Altamaha sherds were found at 9Li166, while 9Li242 (located 1 km to the south) contained a notable concentration of Altamaha period materials as well. Altamaha period sherds were found at sites located on the southern beach ridges, including 9Li163, a large palmetto-covered site about 300 m west of Jungle Road. The surface and buried shell scatter that extends across the full 100 m of transect N-1 contained Pine Harbor diagnostics, along with seven El Morro sherds.

SUMMARY OF AGE ESTIMATES FOR THE SOUTHERN BEACH RIDGE COMPLEX

Although it has long been intuitively obvious that the southern Holocene beach ridges on St. Catherines Island are progressively younger to the southeast, the temporal scale of their accretion remained elusive. Radiocarbon samples from vibracore transects provides a useful framework for dating the progradational shorelines, and the distribution of archaeological ceramics has enhanced the chronological details. Figure 29.8 plots the inferred extent and temporal pattern of beach ridge progradation across the southern end of St. Catherines Island (after Linsley, 1993, fig. 18).

EVIDENCE FROM HISTORIC ERA MAPS

At this point, we will augment the archaeological and geomorphological evidence by shifting our focus to the available documentary record from the historic era.
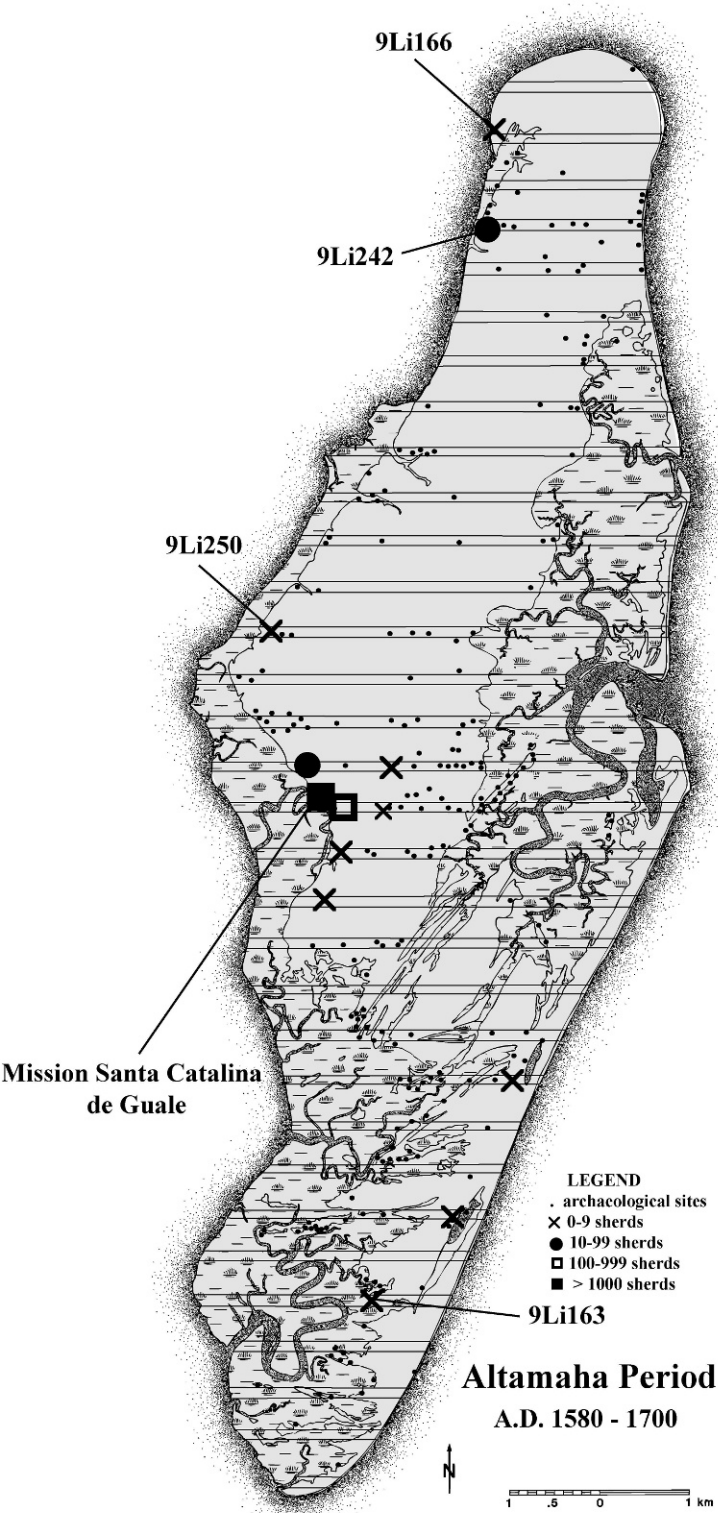
Fig. 29.7.   The distribution of known Altamaha period (Spanish period) sites on St. Catherines Island.

St. Catherines Sound
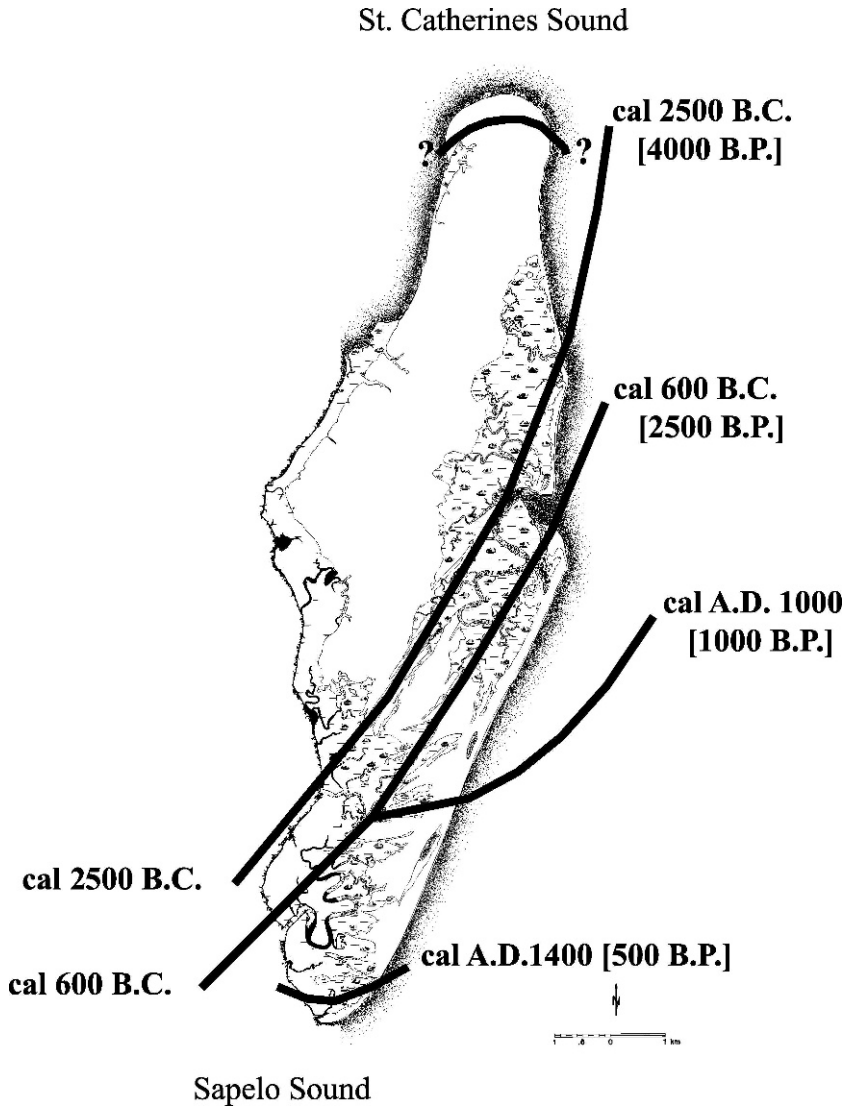
Fig. 29.8.   Estimated extent of the Holocene beach ridge complex on St. Catherines Island at cal 2500 B.C., cal 600 B.C., cal A.D. 1000 and cal A.D. 1400 (based on the distribution of dated archaeological deposits).

The earliest reliable map of St. Catherines Island was drawn by William Gerard De-Brahm, surveyor general of the British colonies in the Southeast during the 1760s and early 1770s (De Vorsey, 1971; Cumming, 1998: 29–30). The most prolific Southeastern mapmaker of his era, DeBrahm came to Georgia in 1751, and 3 years later, he was named as one of Georgia's four mapmakers by royal appointment. In 1757, DeBrahm published his landmark "Map of South Carolina and a Part of Georgia", providing for the first time in the southern colonies a degree of topographical accuracy based on scientific surveys (figs. 29.9 and 29.10). The Sea Islands were no longer rendered as "symbolic blobs" (Cumming 1998: 280); the size and shape of each island was depicted in some detail, as were the major rivers and coastline features.
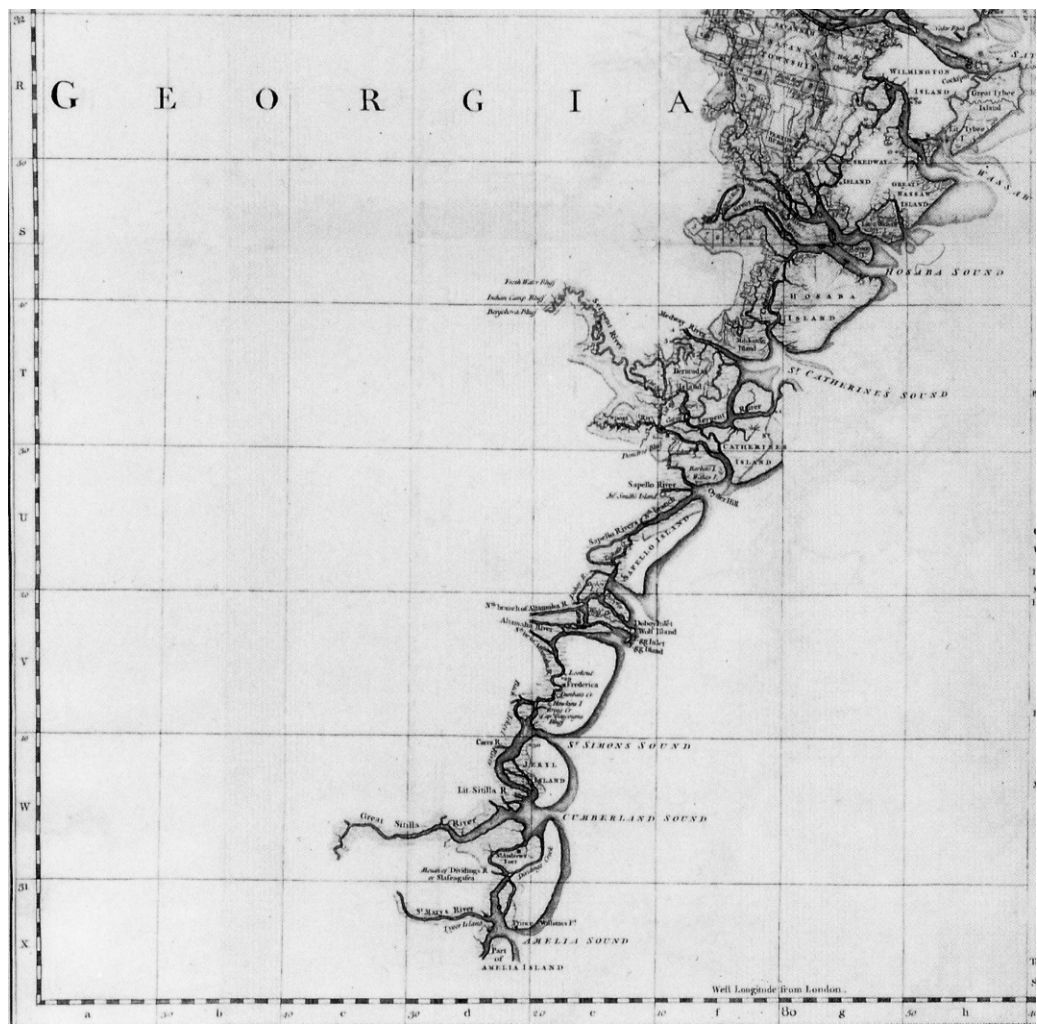
Fig. 29.9.   William De Brahm's 1757 "A Map of South Carolina and a Part of Georgia".

In 1759, as part of earlier dealings between James Edward Oglethorpe and Mary Musgrove (who had subsequently married Thomas Bosomworth), the Georgia Council ordered the surveyors DeBrahm and Henry Yonge to survey and map Ossabaw, St. Catherines, and Sapelo Islands. After prolonged discussions, the colony agreed to grant Mary Bosomworth title to St. Catherines Island and provide her with 2100 pounds of sterling from the sale of Ossabaw and Sapelo Islands. The resulting Yonge and DeBrahm map of 1760 provides the baseline from which all cartographic studies of St. Catherines Island must proceed

(fig. 29.9). This first accurate rendering of the configuration of St. Catherines Island looks quite familiar to the modern eye, with the island core, the salt marshes and the southern beach ridges all portrayed. Johnson, Brunsen, Cattle Pen, and Walburg (called "St. Catherines Creek") Creeks are carefully mapped and readily recognizable. Moreover, the Yonge and DeBrahm map leaves little doubt that the St. Catherines Island of 1760 was longer and wider than it is today.

Using a combination of coast and geodetic charts and aerial photos, Oertel and Chamberlain (1975) described rates of
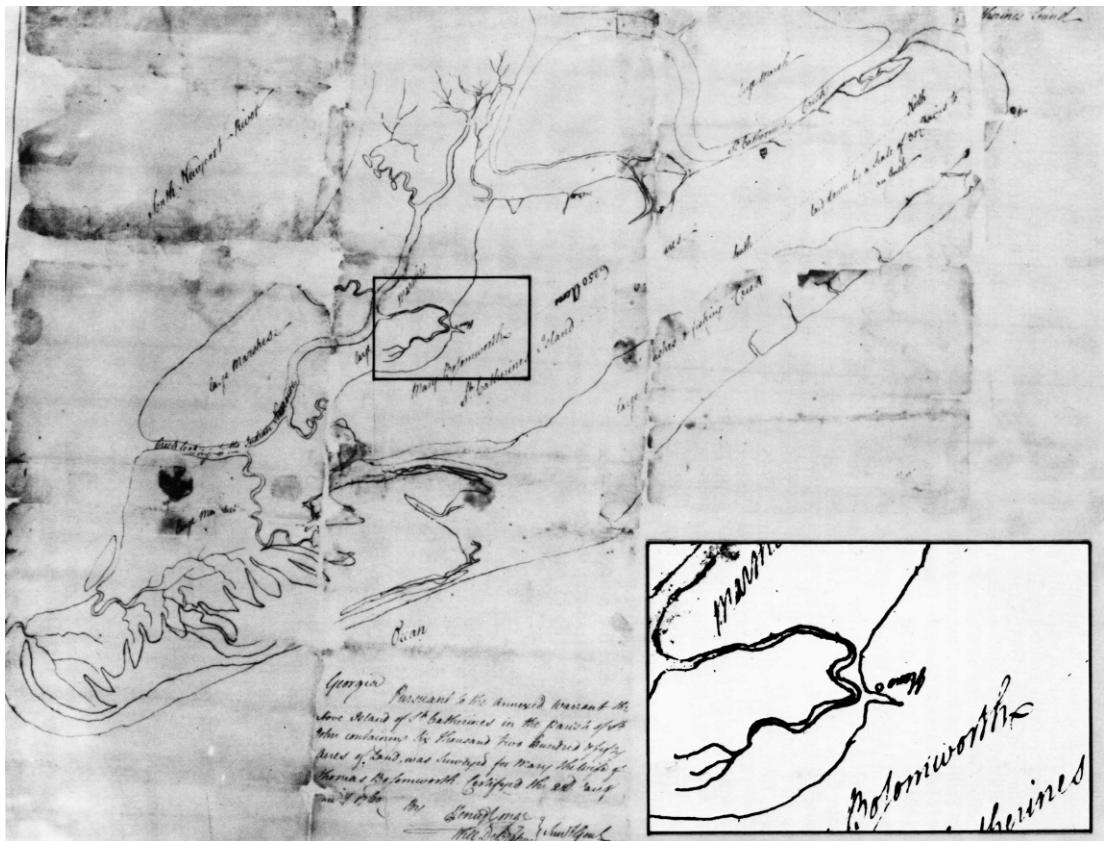
Fig. 29.10.   The 1760 DeBrahm map of St. Catherines Island; note the *hous* standing at the site of Santa Catalina de Guale.

shoreline change along the coastal islands of Chatham and Liberty Counties (Georgia) between 1897 and 1975. They concluded that, over this 78-year interval, St. Catherines Island experienced a ''net shoreline retreat of 4.0 m/yr'' and that this was the ''most ubiquitous erosion of those (islands) studied''. Only two areas of the Island did not experience erosion: the Island's northeastern corner ''advanced 385 m from 1897 to 1971'' and the ''south side of McQueens Inlet advanced 128 m'' (Oertel and Chamberlain, 1975: 387).

Griffin and Henry (1984) have also studied changes in the St. Catherines Island shoreline. Drawing upon the available hydrographic, topographic, and orthophotographic maps between 1858 and 1974, they superimposed the various shoreline positions on high altitude EROS photographs

taken in May 1982. The resulting composite maps (reproduced here as figs. 29.11 and 29.12) depict the historical changes in mean high water shorelines on St. Catherines Island during this 129-year interval. The Griffin and Henry study also highlighted the severe erosion of the Island's sandy beachfront between 1858 and 1982. The maximum erosion along North Beach was about 370 m, while a small area of accretion advanced about 450 m. Middle Beach experienced a maximum erosion rate of 4.3 m/year, with a second small area of accretion just south of McQueen Inlet (an advance of 480 m); but, just to the south, 310 m of beachfront was lost. On the south-central and extreme southern parts of St. Catherines Island, the shoreline retreats over the same time interval were about 300 m and 190 m, respectively, with the greatest ero-

St. Catherines Sound

ST. CATHERINES

McQueen Inlet

EXPLANATION
.... 1858 / 1867
–·····–·····– 1902 / 1904
–··–··–·· 1924
– – – – 1954
———— 1974
***** 1982

N

1 Mile

1 Kilometer

SAPELO SOUND

Fig. 29.11.   Composite map of shoreline changes on St. Catherines Island, 1858/1867–1982 (Griffin and Henry, 1984: fig. 18).

Subsequent research has confirmed this interpretation, and many studies have attempted to reconstruct the history of overwash events and barrier beach retreat on St. Catherines. Using a series of benchmark stakes to measure beach erosion between 1974 and 1979, McClain (1980) recorded the following rates of beach erosion on St. Catherines Island: a rate of 1.4 m/year on the North End, 5.3–12.7 m/year on the South End, and 7.0–11.0 m/year at Middle Beach. Linsley (1993: 62) estimated an erosion rate of 3.0–3.7 m/year in the area of transect B-B′. West and Rollins measured erosion rates on the northern end of Middle Beach (1987–1990) ranging between 5.5 and 7.5 m/year (cited in Linsley, 1993: 62; see also Pottinger, 1996). Goodfriend and Rollins (1998) used amino acid racemization to date the time of death of mollusk shells preserved in relict marsh deposits along St. Catherines Island's North and Middle Beaches. Using aerial photos from 1945, 1963, and 1990, standardized by detailed field measurement, they documented an average shoreline retreat of 3.8 m/year at a site on North Beach. They concluded that, over this time interval, the landward margin of the overwash sands remained nearly stationary while the barrier beach narrowed considerably (Goodfriend and Rollins, 1998: 968). The impact of overwash events along the Georgia coast has been emphasized by Deery and Howard (1977), who note that St. Catherines Island, situated at the apex of the Georgia Bight, received the brunt of overwash activity.

These studies demonstrate the dramatic erosion of tidal-dominated St. Catherines Island over the past few centuries (Pilkey and Theiler, 1992). Georgia's coastline is migrating landward as the seaward barrier dunes march into adjacent expanses of salt marsh. The process of ongoing retreat, however, is complicated by the existence of the relatively immobile relict Pleistocene (Silver Bluff) shoreline and by the distribution and variation of tidal inlets and estuaries. In contrast, erosion and migration of the narrow and elongate barrier islands of North Carolina's Outer Banks respond predictably to the impact of the longshore cur-

ST. CATHERINES

EXPLANATION

■ Erosion

▨ Accretion

N

1 Mile
1 Kilometer

Fig. 29.12. Composite map of net change in mean high water mark on St. Catherines Island, 1858/1867–1974 (Griffin and Henry, 1984: fig. 19).

sion evident on the entire Island occurring along Sapelo Sound, where the shoreline retreated about 950 m. Griffin and Henry (1984: 43) concluded that between 1858 and 1974, "St. Catherine Island's unique shoreline history is one of nearly unbroken retreat… resulting in a considerably narrowed and shortened barrier island. Recent field observations and aerial photographs fail to suggest any deceleration of this erosion trend."

rents of that wave-dominated coastline (Oertel, 1979: 274).

NOTES

1. The Chowns (2002) interpretation has major implications for the reservoir correction of radiocarbon dates from St. Catherines Island (chap. 13, this volume) because of the potential for shifting levels of ancient carbonates resulting from the changing catchments on the Piedmont.

2. This age corresponds exactly with the initial occupation of the St. Catherines Island Shell Ring (9Li231), as described in chapter 20.

3. We must emphasize here, however, how sparse our information is for 9Li161. This site was recorded by Chester DePratter in 1977 as part of his shoreline survey (as described in chap. 23.) But, because 9Li161 fell about 200 m to the south of transect K-1, the site was not tested and, as a result, the only available data derive from DePratter's surface collection. Given the apparent importance of 9Li161 in reconstructing the chronology of Holocene beach ridgelines on St. Catherines Island, this site should be comprehensively tested to see whether a St. Simons component is truly represented. The site should also be independently dated by radiometric methods. If we are incorrect about the dating of 9Li161—that is, if the site was not occupied about cal 1500 B.C.—then the southernmost Late Archaic site is 9Li216 (AMNH-485; transect H-1), a medium-sized, multiple component site, where six St. Simons sherds were recovered. This site is located east of Back Creek Road, on Pleistocene-age island core sediments, about 50 m west of the marsh. The difference in the cal 1500 B.C. line is less than 500 m, but the distinction seems important because if the evidence from 9Li161 is somehow invalid, then we would be forced to conclude that no Late Archaic sites were located on Holocene-age sediments. As such, the archaeological evidence used to support the stated scenario of geomorphic development of this portion of St. Catherines Island would be weakened.

CHAPTER 30. CENTRAL PLACE AND PATCH-CHOICE MODELING ON ST. CATHERINES ISLAND

DAVID HURST THOMAS

Central place foraging theory provides a powerful set of models for addressing fine-grained human foraging behavior in habitats where resources are not evenly distributed. The St. Catherines Island archaeological research employs central place theory in two ways, to estimate settlement positioning in the Sea Islands (the focus of this chapter) and to develop transport/butchering models (as summarized in the next chapter).

All else being equal, we expect that Sea Island foragers should situate their residential bases to maximize the net central place foraging returns with respect to the pursuit, handling, and transport costs from different patches. This chapter considers the implications of optimal settlement positioning with regard to the aboriginal landscape of St. Catherines Island.

THE SEA ISLAND SETTLEMENT MODEL

Georgia's Sea Islands tend to be relatively shorter and broader than most barrier island complexes. This fact of geomorphology means that the barrier islands protecting the Georgia coastline generally support broad expanses of maritime forest (particularly on the Pleistocene remnants), which in turn fosters a relatively high degree of terrestrial biodiversity. Simply put, the broader the island, the greater the potential patch diversity.

The prey-choice, patch-choice, and central-place foraging models suggest that—regardless of changes in diet breadth—the estuarine/inland salt marsh should be the highest ranking patch type available in the Sea Islands, followed closely by the maritime forest (both patches far outstripping the sandy beach and the ocean front patch types).

Following the theoretical arguments marshaled in chapter 11, we suggested that aboriginal residential bases should be positioned to maximize the average central place foraging returns (relative to the costs associated with pursuit, handling, and transport costs). Considering the potentially conflicting goals of male and female foragers, we hypothesized that foraging populations should select central places that maximizes the highest combined rate that both men and women can return to everyone living there (e.g., Zeanah, 2004: 20–21; Kennett, 2005).

The central place foraging settlement model for the Sea Islands (developed in chap. 11) projected that marshside settlements should be situated in optimal central places along the intersection of the two highest ranking patch types (positioned along the stabilized dune remnants that fringe the maritime forest, immediately adjacent to the salt marshes and the tidal streams that drain them). Marshside settlements offer ready access to the highest ranking marine and terrestrial patch types, each supporting multiple suites of high-ranking plant and animal food resources (see figs. 11.14 and 11.15).

Seaside settlements were projected as secondary (suboptimal) central places that maximize the spatial relationship between the next two highest ranking resource patches—in this case, the maritime forest (second highest ranking patch type) and the offshore (Atlantic Ocean) patch type, which ranks third. Because neither the sandy beach nor the dune ridge patch types can sustain prolonged human occupations, the seaward edge of the maritime forest provides the closest interface with offshore marine resources.

So defined, the optimally positioned marshside (primary) and seaside (secondary) settlements define parallel bands of probability that run along the edge between the highest ranking patch types, projecting the most probable location for each opti-

mally positioned central place. All else being equal, marshside settlements should produce the highest central place foraging rates because they maximize access to the highest ranking patch types. Seaside settlements, situated between the next lower ranking patch types, should generate relatively high (but somewhat lower) combined returns. Because the return rates for the maritime forest and offshore (Atlantic Ocean) patch types vary significantly by season, the relative rankings between these patch types could shift throughout the year, raising the issue of mobility (residential and/or logistic) between the two most optimal central places.

We also hypothesized that the variances associated with the marshside and seaside settlement distributions will be conditioned by the constraints of human lifespan, especially topographic and geomorphic variability, availablity of arable land (for cultivators), proximity to adequate docking facilities, access to saltwater creeks that dissect the salt marsh, and crowding by neighboring settlements desiring the same optimal positioning. We argued that the variances associated with marshside settlements should be asymmetrical—steeper toward the salt marsh/maritime patch margin, then trailing off within the terrestrial habitats. Because the scarps dividing the salt marsh and the maritime high ground have long been defined by the upper reach of the spring tides, this abrupt edge defines a one-way barrier prohibiting potential settlements situated closer to the marsh; the central places situated in more inland patches of maritime forest are not conditioned by such intertidal barriers.

SOME TOOLS FOR EVALUATING ARCHAEOLOGICAL SETTLEMENT PATTERNS ON ST. CATHERINES ISLAND

To evaluate the efficacy of central place foraging models relative to the archaeological record on St. Catherines Island, we must rely heavily on the principles and practices of contemporary probabilistic theory. We wish to be explicit about our use of inferential statistical theory as a practical decision-making apparatus, which involves:

- a concise statement of the hypothesis being tested;
- an adequate sampling strategy to generate empirical "observed" data (to ensure that the archaeological entities are counted or measured in a relatively objective manner);
- a probability density function appropriate for estimating theoretical expectations; and
- a probabilistic-based mechanism for assessing the goodness of fit between theoretical expectations and empirical observations.

Before turning to the specifics of St. Catherines Island archaeology, we must briefly consider the nature and efficacy of the various archaeological and statistical tools at our disposal.

SAMPLING CONSIDERATIONS

Although we relied on both gumshoe and shoreline survey strategies to generate a large sample of known archaeological sites on St. Catherines Island (see chap. 12), these strategies produce highly biased samples of the overall site distributions because of the obvious skewing toward large and highly visible sites (especially those marshside sites that can readily be spotted while walking the high water mark).

This is why, in addressing the aboriginal settlement patterning across St. Catherines Island, we felt it necessary to design an Island-wide systematic archaeological survey that would (1) generate a relatively unbiased sample of archaeological sites from all time periods across all parts of the island and (2) pinpoint the exact location of Mission Santa Catalina de Guale. The specifics of the various survey and testing strategies are set out in chapter 12, and we now draw upon those results to address the theoretical propositions derived from central place foraging theory. *Please remember that the following consideration of aboriginal settlement patterns draws exclusively from data generated in the Island-wide randomized transect survey of St. Catherines Island.*

We also think it worthwhile to reiterate the important distinction between archaeological *components* and archaeological *landscapes* (see chaps. 12 and 19). By "component", we mean the minimal culturally homogeneous unit recognizable within an archaeological site, a definition following the classic Willey and Phillips (1958: 21) formulation. Attempting to approach regional archaeology from a "nonsite" or "siteless" perspective (Thomas, 1973, 1975; Dunnell and Dancey, 1983), we also found it useful to employ the concept of archaeological "landscape", meaning the totality of all available archaeological evidence (termed a "presence"), partitioned according to specific temporal period and plotted across a well-defined and bounded geographical space. So defined, an archaeological "presence" could be one (or more) potsherds recovered in a solid archaeological context, one (or more) time-diagnostic lithic artifacts, or an apparently reliable radiocarbon date (in archaeological context, but not necessarily in the presence of ceramics or lithics).

ASSESSING FREQUENCY DISTRIBUTIONS

Since it is manifestly impossible to sample an entire archaeological universe, one can never compute parametric values directly from archaeological observations. Instead, we must select from a variety of plausible probabilistic models to generate adequate expectations against which to measure our empirical samples. In practical terms, this means fitting a theoretical frequency distribution to the archaeological specifics at hand.

Curve fitting is not an everyday practice in American archaeology, and to clarify the procedures employed here, we think it worthwhile to examine, briefly, how one such frequency distribution (the *Poisson* distribution) has proved useful in previous studies of landscape archaeology. Fitting a Poisson distribution helps to determine whether a number of relatively rare events have occurred independently of one another. The null hypothesis posits a random distribution of entities in time

or space (meaning that the variates follow a Poisson distribution). Rejection of the null hypothesis under the Poisson assumption can result if the distribution is *uniform* (that is, each temporal or spatial unit has the same number of entities) or the distribution is *clustered*, meaning that one event enhances the probability of a second such event; then the result is said to be clumped or "contagious" (Sokal and Rohlf, 1995: 83; Zar, 1999: 576). So here is my example.

Some years ago, I found applied Poisson distributions to explore the degree of dispersion of aboriginal artifacts recovered during randomized quadrat sampling at Reese River, Nevada (Thomas, 1971, 1973: 163–167). The Poisson distribution is a discrete frequency model designed to reflect the number of times a rare event occurs. The Poisson process, as typically employed in biostatistical research, can reflect either spatial or temporal variability (as, for example, the number of certain taxa in a sampling quadrat) or the number of parasites on a specific host (Sokal and Rohlf, 1995: 81–93). Because Poisson (random) distributions are generally characterized by means that are small relatively to the variance, the Coefficient of Dispersion is appropriate for comparing the ratio of the variance to the mean of datum points distributed across the sampling grid. In the Great Basin case, projectile points lost while pursuing deer, for instance, are expected to be distributed in Poisson (random) fashion; but projectile points discarded during repair in a winter village should be deposited in a clumped (non-Poisson) distribution (characterized by a Coefficient of Dispersion much greater than one). Fitting a Poisson distribution helped us determine the likely mechanism for artifact dispersal in the Reese River Valley (Thomas, 1971, 1973).

In a recent and innovative ethnoarchaeological investigation, Bird et al. (2004b: 188) drew upon the same Poisson processes to model intertidal prey choice among the Meriam Islanders in the Eastern Torres Strait. One of the key assumptions in the encounter contingent prey-choice model

(Stephens and Krebs, 1986: 17–23) is that encounters with prey are "sequential", meaning that encountering one prey type does not change the probability of encountering other items of that type. By assuming that prey are encountered in Poisson fashion (i.e., distributed in a fine-grained manner throughout the habitat), Bird et al. (2004b: 188, 190) assume that resources in the intertidal zone are not systematically clumped.[1]

Poisson processes involve a discrete theoretical model that is not directly relevant to the aboriginal landscape questions on St. Catherines Island (as presently phrased). While we do not advocate applying Poisson distributions to our present inquiry, it seems worthwhile to emphasize the importance of analyzing similar frequency distributions to compare theoretical expectations with empirical observations. The central place foraging projections (developed in chap. 11) involve continuous variables and require some different models for evaluating the expectations and the available empirical observations.

NORMAL/LOGNORMAL PROBABILITY DISTRIBUTIONS

We have already reviewed the relevance of *normal* (or "Gaussian") distributions to the issue of optimal settlement patterning on St. Catherines Island (chap. 11). Because normal distributions conform to a bell-shaped curve with a disproportionate number of variates clustering toward the midpoint, every normal curve can be precisely defined by two basic parameters—the arithmetic mean and the standard deviation. Despite the fact that the underlying causes of normality are generally unknown, the Central Limit Theorem predicts that normal distributions will commonly show up when numerous small effects act *additively and independently* (as in test scores and many natural and/or cultural variables than can be repeatedly observed; Thomas, 1986: 193–196; Zar, 1999: 76, 320). This is why the assumption of "normality" often provides a convenient model for quantitative analysis.

But when the effects are *multiplicative* (rather than additive), an assumption of normality is unwarranted because it is the *logarithm* of the variable in question— rather than the value of the variable itself—that is normally distributed. *Lognormal distributions* are "positively skewed", meaning that a large proportion of the variates are concentrated toward the left end (closest to zero). We have noted that the "distance to marsh" statistic employed in modeling St. Catherines Island foraging behaviors likely follows a lognormal distribution because variates can potentially increase without limit, but cannot fall below zero.

Central place foraging considerations likewise project that the site distribution should be "skewed to the right", meaning that "distance to marsh" should trail off into the maritime forest. The Sea Island model also projects that western marshside settlements should be distributed in statistically normal fashion, a mathematical curve (as noted above) that can be described by two simple parameters (mean and standard deviation).

The rest of this chapter will analyze the archaeological landscape of St. Catherines Island by applying both normal and lognormal models to the central place foraging models derived in chapter 11. But we must first examine the tools involved in that analysis.

GRAPHIC METHODS: Figure 30.1a shows an idealized normal curve for an undefined variable, displayed as a conventional probability distribution (peaked at the mean and trailing off symmetrically to the left and to the right along the *x*-axis). Figure 30.1b shows the same idealized dataset, this time expressed as a *probability plot*, an alternative (and less familiar) graphic technique that plots the value of variable *z* against the corresponding expectations from a theoretical normal distribution; in this case, the variates are expressed as *z-scores,* with a mean of zero and a standard deviation of unity (Sokal and Rohlf, 1995: 116–123). Any set of variates distributed in perfectly normal
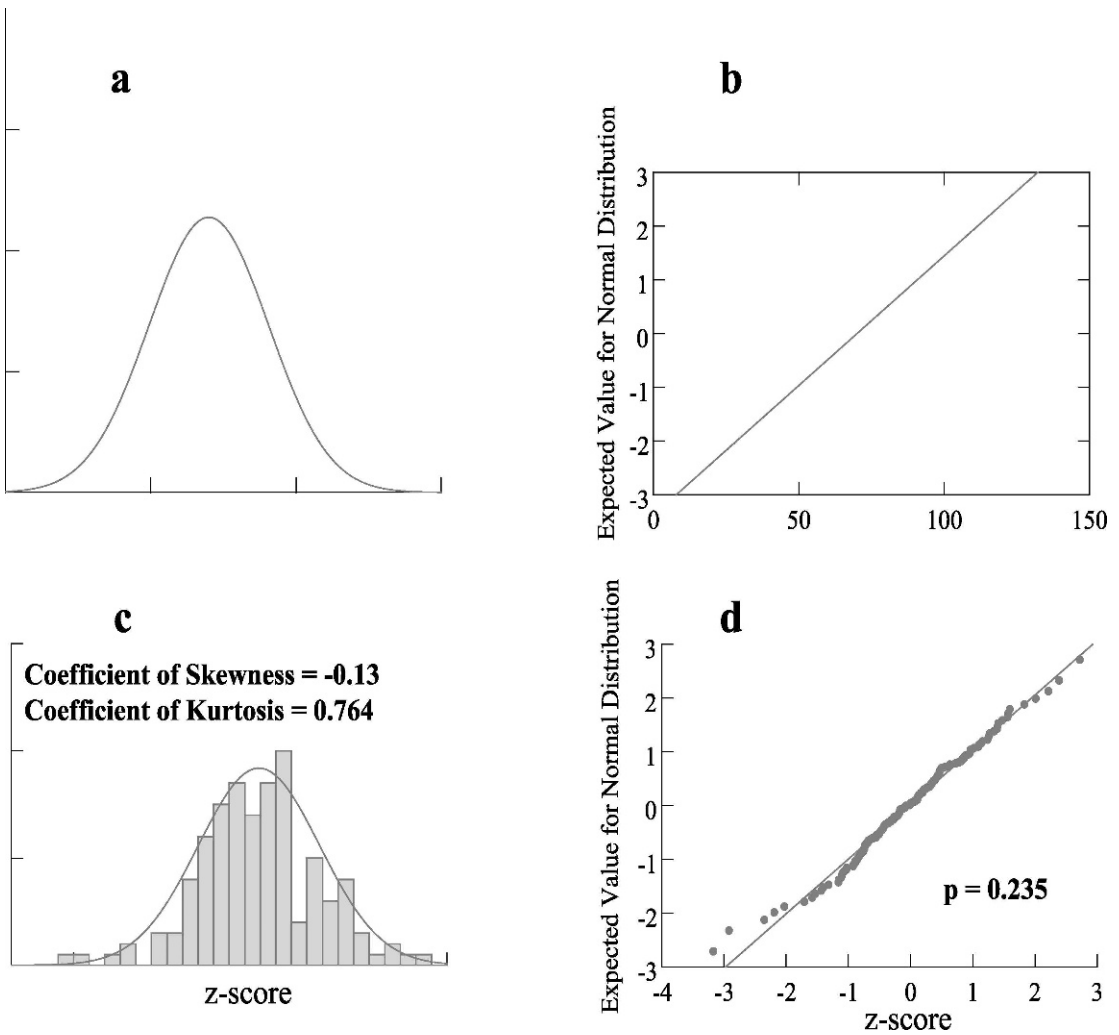
Fig. 30.1.   The idealized normal frequency distribution.

fashion will define a perfectly straight line (see fig. 30.1b).

The bottom two graphs (c and d) in figure 30.1 show how these two idealized distributions can be compared to a set of $n = 150$ randomly generated variates (plotted as z-scores with a sample mean of -0.022 and standard deviation of 0.976). At the bottom left is a probability histogram compared against the theoretical normal distribution (with a mean of zero and standard deviation of one). Figure 30.1d arrays the same randomly generated variates arrayed in a probability plot, compared to the idealized straight-line expectation.

ASSESSING GOODNESS OF FIT TO NORMAL EXPECTATIONS: Figure 30.1 shows how a set of observed variates can be compared to expectations derived from the hypothetical normal curve. At the bottom of figure 30.1, these $n = 150$ randomly generated z-scores generally follow the expected values predicted by a normal frequency distribution (and expressed as a straight line in fig. 30.1d). *But the question is whether these deviations between expected and observed values represent (1) random variability or (2) significant deviations from the ideal normal distribution.*

Statistical probability theory provides a means of evaluating the various goodness-of-fit measures between expected and observed frequencies with respect to normality. To do this, we entertain a null hypothesis that expected and observed variate sets are similar. In all such goodness-of-fit normality testing, a sufficiently small p-value indicates nonnormal data (that is, a departure from expectation under a normal/lognormal distribution).

The most common method for analyzing an empirically observed distribution of variables against normal expectations is the Kolmogorov–Smirnov one-sample test, which compares the cumulative frequency distribution against theoretical expectations under the null hypothesis (Thomas, 1986: 336–337; Sokal and Rohlf, 1995: 708–714). The K-S one-sample test is also commonly used to test goodness of fit against the expected uniform distribution (involving a rather different version of the null hypothesis). But in practice, the Kolomogorov–Smirnov test is nearly useless for the present purposes because the null hypothesis must be completely specified beforehand (prior to testing), with all parameters known—a circumstance that almost never pertains in actual practice. Chi-square can also be used to test the hypothesis of normality, but it generally performs rather poorly because it possesses very low power (Zar, 1999: 86–87).[2]

The *Lilliefors test* improves somewhat on the KS one-sample test (Sokal and Rohlf, 1995: 711) because it does not require that the specific parameters be spelled out before when framing the null hypothesis. Instead, the Lilliefors test begins with the hypothesis that a particular variable has a normal distribution with unspecified mean and variance when tested against the alternative (of which the distribution is not normal). In other words, this approach compares the empirical distribution of the variable under examination against a normal distribution having the same mean and variance. Although similar to the Kolmogorov–Smirnov test, the Lilliefors test adjusts for the fact that the parameters of the normal distribution are estimated from the observed sample rather than specified in advance.

The Lilliefors tests on the hypothetical z-scores in figure 30.1 results in $p = 0.235$, considerably greater than the critical alpha level of $p = 0.05$ employed throughout this volume (see Thomas, 1986: chap. 9). This means that one cannot reject the null hypothesis of no difference. In substantive terms, we conclude that there is no statistically significant difference between the distribution of z-score variates in figure 30.1d and expectations under normality, meaning that the observed frequencies are entirely consistent with a normal distribution.

Figure 30.2 introduces another hypothetical dataset that more precisely addresses the objectives at hand. The previous discussion of Central Place Theory (in chap. 11) set out some very specific expectations about the relationship of barrier island habitats to the archaeological record, specifically suggesting that residential bases should be positioned along the intersection of the two highest-ranking patch types (that is, along the stabilized dune ridges that fringe the maritime forest, with immediate access to the salt marshes and the tidal streams that drain them).

To establish the operational relevance of the archaeological data to this issue, the predictions from Central Place Theory are expressed as "distance to nearest salt marsh". At the top of figure 30.2 is a hypothetical distribution of 33 archaeological components relative to "distance to marsh" (a measure employed extensively throughout the remainder of this chapter). Table 30.1 presents several summary statistics derived from this hypothetical dataset.

At the top of figure 30.2 is the *probability histogram* for the same $n = 33$ observed variates compared against the theoretical normal curve (with a mean of 258 m and a standard deviation of ±193.8 m; table 30.1). This histogram (which arbitrarily employs a bar width of 125 m) shows some similarities to the overall frequency distribution expected under normality, but the variates are heavily clustered toward the lowest values, then trail off as distance to marsh increases. Once again, the question
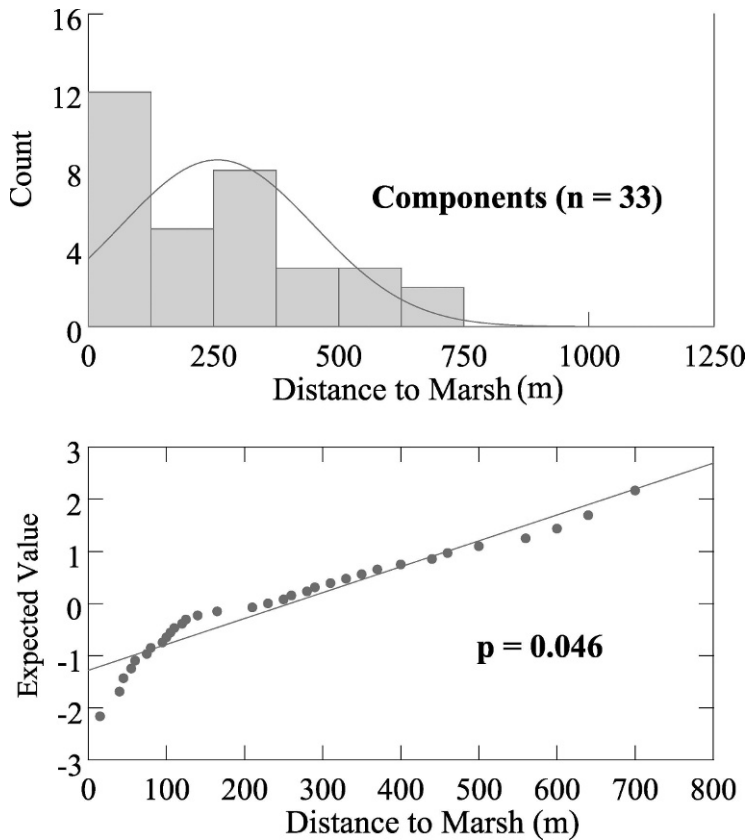
Fig. 30.2. Distribution of a hypothetical dataset of n = 33 archaeological components relative to the marsh edge.

becomes whether these deviations from normality are statistically significant.

At the bottom of figure 30.2, a *probability plot* arrays these same 33 variates against the theoretical normal distribution (expressed against the straight-line projections under the normal assumption). This graphic method clearly shows the overrepresentation of variates in the lower range of "distance to marsh", a slightly elevated frequency distribution in the 100–400 m range (with a major peak between 100 and 200 m), then an overrepresentation of variates >500 m.

A Lilliefors test was run on the hypothetical "distance to marsh" dataset in figure 30.2. The observed probability of p = 0.046 is less than the critical alpha level of p = 0.05, leading to a rejection of the null hypothesis of no difference. Because these

statistically significant differences exist between the observed distribution of "distance to marsh" variates in figure 30.2 and expectations under a normal distribution, we conclude that the sample variates were not drawn from a normally distributed population.[3]

ASSESSING GOODNESS OF FIT TO LOGNORMAL EXPECTATIONS: The central place foraging model also raises the possibility that residential bases on St. Catherines Island could well occur in *lognormal distribution* relative to the interface of the maritime forest and salt marsh patches. Logarithmic transformations work best when (1) effects are multiplicative rather than additive; (2) the variable in question can increase without limits but cannot fall below zero; (3) the variable is positively

skewed, with most of the values near the lower limit; and (4) the logarithm under study yields a normal distribution. Considering the relationship between normal and lognormal distributions, one must remember that there is nothing "natural" about the decimal system, since all scales of measurements are entirely arbitrary (Sokal and Rohlf, 1995: 412). The idea is to employ the measurement scale most appropriate to the data at hand.[4]

Figure 30.3 shows two methods for examining goodness of fit to the lognormal model. The upper graph converts the same hypothetical $n = 33$ observations on "distance to marsh" evaluated above (fig. 30.2 and table 30.1). Because this frequency distribution is clearly skewed toward the right (see fig. 30.2, upper), a log transformation creates a more symmetrical curve (Thomas, 1986: 427; Sokal and Rohlf, 1995: 413–415; Zar, 1999: 41–42, 354–356). The top of figure 30.3 plots the common logarithms (to the base 10) of the $n = 33$ "distance to marsh" variates against the straight-line expected values from a normal distribution. The Lilliefors modification of the K-S one-sample test (discussed above) produces a probability value of $p = 0.294$, meaning that one cannot reject the null hypothesis. The observed distribution of variates is entirely consistent with a lognormal distribution.[5]

Figure 30.3 shows an alternative approach, in which raw values of the "distance to marsh" are plotted against expectations under a lognormal distribution (which appears as a probability curve, contrasting with the straight-line expectations for a normal distribution). Except for the obvious departures >600 m, the goodness of fit to lognormality is obviously closer than that under the normal expectation. Although the resulting graph is quite different in appearance from the log plot (at the top), the data remain exactly the same and the Lilliefors test produces an identical probability value of $p = 0.294$. As before, we cannot reject the null hypothesis and hence conclude that the variates are consistent with a lognormal distribution. Because of its inherent simplicity, we will employ this

method to analyze the archaeological evidence discussed below (plotting the lognormal probability curve against untransformed variates).

ASSESSING SKEWNESS and KURTOSIS: The *Coefficient of Skewness* provides an independent statistical measure of symmetry around the mean (table 30.1 and fig. 30.4). A significant positive value in the Coefficient of Skewness denotes a long tail to the right; negative values indicate a long left tail. The distribution of the $n = 150$ randomly generated z-scores (at the bottom of fig. 30.1), for instance, has a Coefficient of Skewness = -0.103, indicating a slight skewness to the left. But in figure 30.2, the Skewness of Coefficient = 0.748 reflects the truncation at zero and long right-hand tail.

"Skewness" is considered to be significantly different from zero (that is, to be "asymmetric") if the absolute value of the Skewness Coefficient/Standard Error of Skewness is greater than two (Wilkinson and Engleman, 2002: 211–213). For the randomized z-scores, this value is 0.103/0.198 = 0.520, indicating that the degree of skewness is not significant. Similarly, in the "distance to marsh" example, this ratio is 0.739/0.409 = 1.80, indicating that the degree of skewness is not statistically significant.

The degree of *kurtosis* within the spatial distribution of marshside settlement can be evaluated in a similar way. A normal distribution has a kurtosis coefficient equal to zero. But a dataset with a nonnormal peak in the distribution of variates around the mean is said to exhibit a high degree of kurtosis; in other words, positive kurtosis occurs when distributions are bunched up near the mean (with relatively "thin" or "light" tails compared with a normal distribution). Variates showing a low degree of kurtosis define a flattish distribution around the mean; negative kurtosis occurs when a larger proportion of the values tend toward the extremes (with relatively "fat" or "heavy" tails compared with a normal distribution).

The degree of kurtosis is considered to be statistically different from zero if the abso-
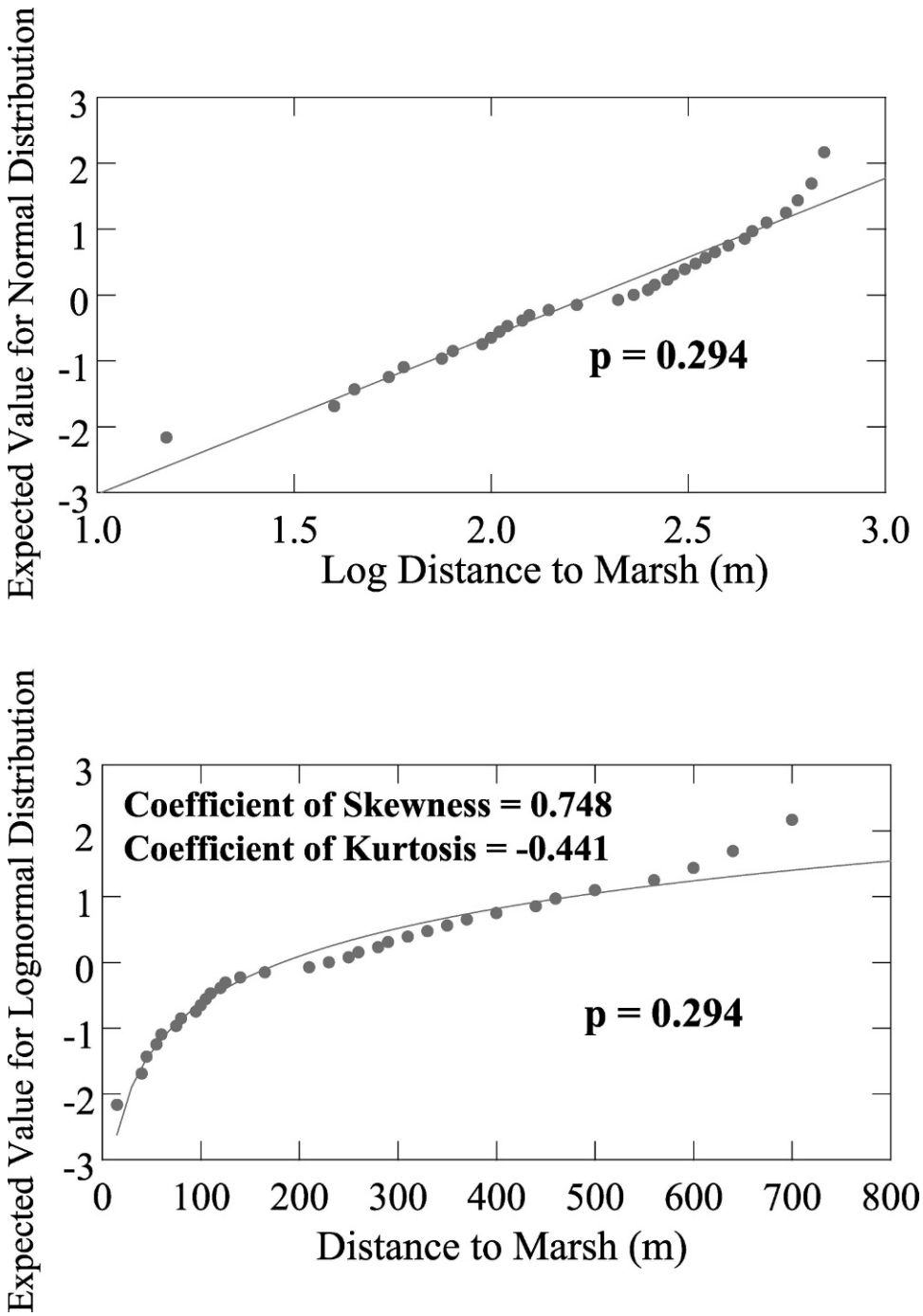
Fig. 30.3.   Two methods for testing goodness-of-fit to the idealized lognormal distribution.

TABLE 30.1
**Hypothetical Distribution of Archaeological Components Relative to the Salt Marsh Margin on
St. Catherines Island**

	n	Mean (m)	Standard deviation	Coefficient of Skewness	Standard Error of Skewness	Coefficient of Kurtosis	Standard Error of Kurtosis
z-scores	150	−0.022	0.976	−0.103	0.198	0.764	0.394
Distance to marsh	33	257.9	192.8	0.739	0.409	−0.441	0.798

lute value of the Coefficient of Kurtosis/ Standard Error of Kurtosis is greater than 2.[6] If a particular Coefficient of Kurtosis is determined to be significantly greater than zero, then the distribution in question has longer tails (that is, is "flatter") than expected in a normal distribution. If the Coefficient of Kurtosis is significantly less than zero, the distribution will be judged to be flatter than a normal distribution.

Figure 30.1 shows that for the $n = 150$ z-scores, the Coefficient of Kurtosis is 0.764, denoting a somewhat "peaked" clustering of variates. But this distribution does not differ significantly from normal expectations because the ratio of Coefficient of Kurtosis/Standard Error of Kurtosis (table 30.1) is 1.939, a value not significantly different from zero. The "distance to marsh" variates (fig. 30.2) appear to be somewhat flatter than the projected normal distribution, and this difference is reflected in the Coefficient of Kurtosis = −0.441 (a value not statistically significant at the 0.05 level).

DEALING WITH OUTLIERS: An "outlier" is an atypical, infrequent observation of extreme value (either unusually large or unusually smaller relative to the other observations in the dataset). Outliers also occur when a relative frequency distribution is extremely skewed (because by their nature, skewed distributions include extremely large or small observations. The presence of outliers can cause a sample to violate the assumptions of normality and can also dramatically change the central tendency and variability in a frequency distribution. Even a single outlier can exert a profound influence on the slope of

a regression line and consequently on the value of the correlation coefficient.[7]

Ideally, one would hope that all outliers result from simple random errors—perhaps an error of measurement or observation. But there is always the possibility that an outlier is correctly measured, but represents a legitimately extreme value of the phenomenon under study (a "rare" but perhaps important result). Or maybe the outlier is a measurement of a variate belonging to a different statistical population. An outlier may even result from a flaw in the assumed theory, alerting the researcher about the need for further investigation.

There is no generally accepted method for removing outliers in a systematic way. In some research frameworks, investigators routinely use established quantitative procedures to purge outliers before statistical analysis. In the case of normally distributed datasets, for instance, only about 1 in 150 observations can be expected to be a "mild" outlier, and only about 1 in 425,000 is an "extreme" outlier. Some investigators control for this effect by excluding observations that are outside the range of ±2 standard deviations (or even ±1.5 σ) around the group or design cell mean. When dealing with z-scores, for instance, any variates with z-value greater than 3 are conventionally considered to be outliers (following the Chebyshev theorem).

"Cleaning" the data of outliers may be absolutely necessary in some arenas of research, but in archaeological applications, we must agree with Zar (1999: 86) that it "is not appropriate to discard data simply because they appear (to someone) to be unreasonably extreme." Outliers should not be removed routinely without justification,
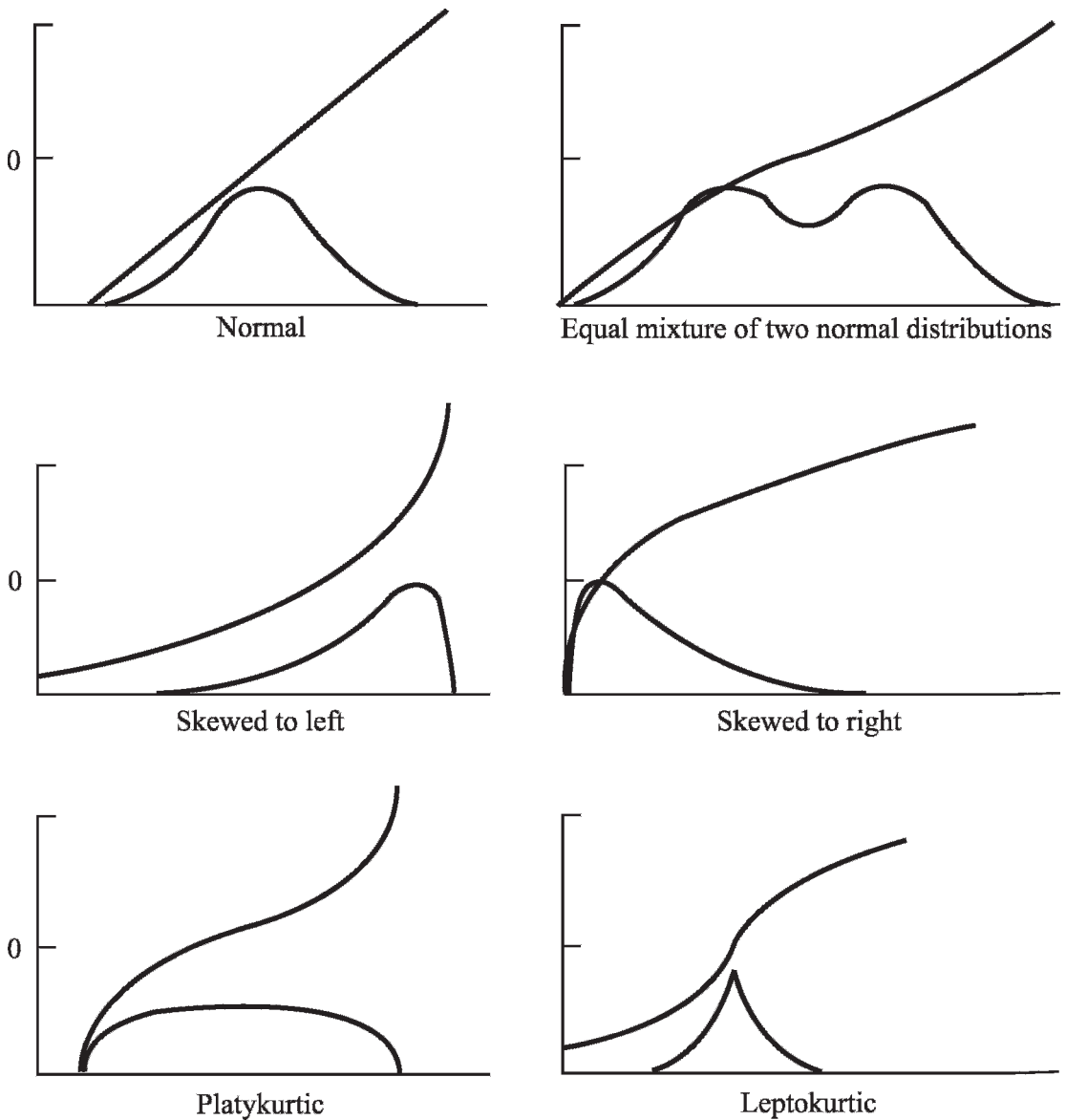
Fig. 30.4. Several continuous probability density distributions arrayed against comparable quartile probability plots (modified from Sokal and Rohlf, 1995: fig. 66).

and for this reason, we have refrained from removing any ''outliers'' from the computations developed in this chapter. But the significance of notable outliers is discussed in some detail because the ''exceptions'' can tell us a great deal about the uniformities we seek to understand.

UNIFORM PROBABILITY DISTRIBUTIONS

The diet-breadth model provides an alternative hypothesis that warrants consideration. As noted previously, the diet-breadth model requires the assumption that resources are relatively continuous, undif-
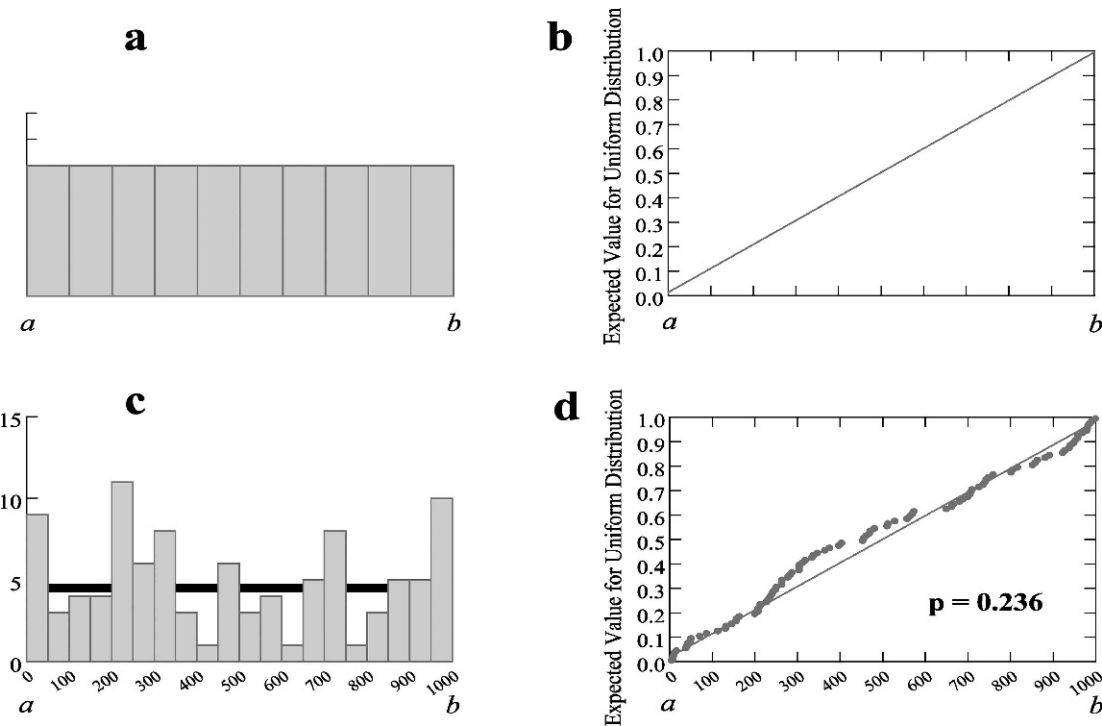
Fig. 30.5.   The idealized uniform frequency distribution expressed as histogram and as a probability plot, with comparisons of $n = 100$ randomly-generated variates against the idealized uniform histogram and the uniform probability plot.

ferentiated, and evenly distributed across space (see references and discussion in chap. 6). If the fine-grained assumption of environmental homogeneity holds true for the habitats of St. Catherines Island, then one expects foragers to leave behind an archaeological record of aboriginal settlements that is similarly random in its distributed across space, lacking any significant degree of nonrandom modality or centrality.[8]

In statistical terms, such a homogenous, randomly distributed archaeological record should approximate the theoretical *uniform population distribution*, a generalized version of the mathematical "rectangle function" (Zar, 1999: 576). Within the acceptable limits of sampling error, each spatial unit should contain the same number of entities, where the uniform shape of the overall distribution is governed only by two boundary parameters, the smallest

and largest variate values (denoted here as a and b, respectively).

Figure 30.5a depicts such an idealized uniform distribution for an unspecified variable, rendered in a conventional histogram format. Figure 30.5b shows the same idealized dataset expressed as a *probability plot* that arrays the value of a continuous variable, with a minimum value of $a = 0$ and a maximum value of $b = 1000$. Any set of variates distributed in perfectly uniform fashion will describe a perfectly straight line when plotted as a cumulative distribution (see fig. 30.5b). Although this graph superficially resembles the probability plots for normal/lognormal frequency distributions (figs. 30.1b,c and 30.3), a major difference exists along the y-axis: Whereas the normal/lognormal distributions are scaled as z-scores ("expected value for normal/lognormal distribution"), the uniform frequency

distribution (as in fig. 30.5b,c) presents the *y*-axis is a simple arithmetic, cumulative scaling.

The two graphs at the bottom of figure 30.5 demonstrate how the idealized uniform distribution can be used to compare theoretical and empirically observed variates. Figure 30.5c arrays a set of $n = 100$ randomly generated variates in a continuous uniform distribution ranging between 0 and 1000 (with a bar width of 50 units). The dark horizontal line represents the "expected" frequency distribution (as derived from a uniform frequency distribution with $a = 0$, $b = 1000$, and $n = 100$). Clearly, the observed distribution follows uniform "expectation" to some degree, but considerable variability exists as well.[9]

The bottom right of figure 30.5 arrays the same set of random variates against the theoretical uniform frequency distribution (shown as a cumulative curve with the same minimum and maximum border parameters). As in the histogram rendering of this same dataset, the $n = 100$ randomly generated variates generally follow the expected values predicted by a uniform frequency distribution (the straight line in fig. 30.5d). But the question remains whether these deviations between expected and observed values represent simple random variation or significant deviations from the ideal uniform distribution.

As with the goodness-of-fit criteria for normal/lognormal distributions (above), the Kolmogorov–Smirnov one-sample test can assess these deviations for statistical significance. The resulting probability value of $p = 0.236$ is considerably greater than the critical alpha level of $p = 0.05$, meaning that the null hypothesis of no difference between observed frequencies and those expected from uniform distribution expectations cannot be rejected. In substantive terms, this means that the $n = 100$ random variates in figure 30.5d do not differ significantly from the expectations from a uniform probability distribution.

These quantitative devices permit the evaluation of the empirical distributions available for the archaeological components and landscapes of St. Catherines Island.

ENCOUNTERING THE ABORIGINAL SETTLEMENTS OF ST. CATHERINES ISLAND: PROJECTIONS FROM CENTRAL PLACE FORAGING THEORY

In the generalized central place foraging settlement model for the Sea Islands (chap. 11), the marshside settlement is projected as a series of optimal central places positioned along the intersection of the two highest-ranking patch types. So defined, marshside settlements should define parallel bands of probability that run along the edge between the highest ranking patch types, projecting the most probable location for each optimally positioned central place. The variances associated with the marshside settlement distributions should be asymmetrical—steeper toward the salt marsh/maritime patch margin, then trailing off within the terrestrial habitats. This idealized aboriginal settlement patterning was previously projected across the generic barrier island landscape.

But several constraints came into play when considering the specifics of St. Catherines Island, which is differentiated into the first-tier (Pleistocene-age) and second-tier (Late Holocene-age) habitats encountered by late prehistoric (Irene period) aboriginal foragers and farmers on St. Catherines Island. As discussed in the previous chapter, the modern configuration of St. Catherines Island is conditioned by a complex blend of noncultural factors, and the island has changed shape markedly over the period of aboriginal occupation. For the past three decades, a first-rate team of paleoenvironmental specialists has conducted a number of vibracore transects and related analyses to reconstruct the geomorphology of St. Catherines Island during the period of human occupation (esp. Morris and Rollins, 1977; Fierstien and Rollins, 1987; Groce, 1980; Booth et al., 1999a; Linsley, 1993; see also chaps. 3 and 29, this volume). This geomorphological background has been augmented by an analysis of maps from the historic era to establish a geographical baseline for reconstructing the shape and biogeography

of St. Catherines Island at key points in time.

EFFECTIVE FORAGING RADIUS

Contemporary St. Catherines Island has a maximum longitudinal (north–south) distance of 16.4 km and it has a maximum latitudinal (east–west) distance of 5.5 km (including the outer barrier beaches protecting McQueens Inlet). Figure 11.12 plots the estimated *effective foraging radius* extending around the westernmost high ground on St. Catherines Island (Persimmon Point). Based on the modern configuration of St. Catherines Island, we know that any place on the island could have been systematically searched and exploited by individual foragers who could easily return home daily. This biogeographic constraint suggests that St. Catherines Island foragers could have readily pursued a strategy of logistic procurement and low residential mobility—if they chose to do so.

Chapter 11 also suggested that because St. Catherines Island is less than 6 km across at its widest point (and much narrower in most places), the distance between the two highest ranking central places—the marshside and seaside settlements—never will exceed the lower limit of the effective foraging radius (*EFR*). Figure 11.14 projected that the marshside and seaside settlement types on St. Catherines Island should merge into a single, very highly ranked central place (positioned as a marshside settlement). In fact, the distances are so close that a discrete "seaside settlement" type should disappear entirely because optimally positioned marshside settlements would have ready access to the three highest ranking patch types (the salt marsh, the maritime forest, and the marine offshore, in that order).

McQUEEN SALT MARSH

Each of Georgia's Sea Islands deflects the shoreface, high-energy waves to protect an intricate system of estuarine channels, point bars, tidal flats, and extensive salt marshes along its leeward shore (Howard and Frey, 1980: 100). As noted earlier, in addition to the estuary along its western margin, St. Catherines Island hosts a second major salt marsh system along the seaward shoreline. The McQueen salt marsh, which today covers approximately 13.5 km^2, is protected from high-velocity tidal surges by a series of prograding sand spits, shoals, hammocks, washover fans, and aeolian dunes. One cannot overestimate the importance of the McQueen salt marsh (and its prehistoric precursor, Guale Marsh, to the north) to the aboriginal forager. On St. Catherines Island, more than 80 percent of the maritime forest edge abuts directly on the margin of a significant salt marsh—effectively doubling the number of optimally positioned central places (fig. 11.14).

DISTRIBUTION OF ARABLE SOILS AND HABITABLE LAND

Chapter 11 developed a model relating the distribution of arable soil types to aboriginal settlement potential, with specific reference to Irene (late prehistoric) period habitations on St. Catherines Island.

In broad geomorphological perspective, the Pleistocene island core consists of two distinct Pleistocene remnant ridges, separated by a low-lying central depression (fig. 3.1). The *western Pleistocene core*, which defines the estuarine marsh edge, is truncated by the Walburg Scarp that runs northward from Persimmon Point and the Wamassee Scarp that spans the island margin between Persimmon Point past South End Settlement (Bishop et al., 2007). This ancient dune ridge, 1.2 km wide at its maximum, defines the distribution of Echaw–Foxworth–Centenary soils.

The *eastern Pleistocene core* marks the seaward extent of the Pleistocene core of St. Catherines Island, bounded by the St Catherines, King New Ground, and Back Creek Scarps. Like its western counterpart, this is relatively high ground is characterized by the relatively well-drained Echaw–Foxworth–Centenary soils. The eastern dune ridge runs for about 11 km, from South End Settlement, past Cracker Tom

Hammock, along the western margin of McQueens and Seaside Inlets, through North Pasture, where it meets the late Holocene dune ridges that have accreted along the northern end of St. Catherines Island. The eastern margin of the Pleistocene core has shifted somewhat since the mid-Holocene transgression, especially with the submergence of Guale Island/Guale Marsh, the subsequent erosion of the North Beach bluff, the southward-shifting salt marshes, and expansion of late Holocene dune ridges accreting along the northern and southern margins of the Pleistocene core. This means that, relative to the aboriginal settlement pattern on the eastern Pleistocene core, the *eastern limit* of human settlement was rather fluid, depending on the marsh and island configurations at that particular time.

Human settlements along the eastern Pleistocene core were constrained to the west by the meadows and freshwater lagoons that once dominated the central corridor of St. Catherines Island. This *central Pleistocene depression* (or *swale*) is a discontinuous low-lying zone characterized by poorly drained Rutledge soils. It is difficult to appreciate the magnitude of the hydrological change over this past century. Before the deep drilling of the late 19th century, the central part of St. Catherines Island was dominated by a long, linear freshwater lagoon that can be readily defined on pre-1930 topographic maps, on early aerial photographs, on soil distribution maps, and in the surviving geomorphic clues that persist on the Pleistocene core (see chap. 5). The distribution of the "large Savanna" corresponds almost precisely with the extent of Mandarin–Rutledge fine sands, the very poorly drained remnant soil that developed in the shallow depressions and bays of the former central meadow that defined nearly continuous margins to the western and eastern dune ridge, clearly defining the limits of human occupation on St. Catherines Island.

This means that the marshside settlements along the western edge of St. Catherines Island—north, say, of Wamassee Head—were limited to a strip of high ground defined by (1) the Walburg and Wamassee Scarps (defining the western marsh edge) and (2) the central freshwater lagoon. At its widest point (at Persimmon Point), the maximum possible leeway for human settlements was only 1.2 km wide. To the north, parallel to Walburg Creek, this maximum settlement breadth narrowed to only about 300 m (although, as noted earlier, there are some breaks in the discontinuous distribution of freshwater lagoon deposits along the northern end of St. Catherines Island).

FIRST- AND SECOND-TIER TERRESTRIAL HABITATS

We distinguish between the "first-tier" habitats available on the Pleistocene island core and the "second-tier" habitats of the Holocene beach ridge complex (present on both the northern and southern ends of St. Catherines Island; see chaps. 3 and 11).

The Pleistocene island core is considered to be first-tier habitat for several reasons. The Manderin and Rutledge soils in the central portion of the Pleistocene remnant on St. Catherines Island today hosts mature, mixed deciduous–pine forest. Whereas the generally low natural fertility renders these extremely acidic soils poorly suited for modern agriculture, these low-lying areas provided excellent habitat for maize cultivation using aboriginal technologies. The periphery of the Pleistocene remnant is ringed by the relatively higher quality soils (the Echaw–Foxworth–Centenary complex); although poorly suited to modern row crops, these soils would have been suitable for slash-and-burn methods of aboriginal maize cultivation. These relatively fertile soils and moderately good drainage likewise support a vigorous and widespread maritime forest, providing excellent mast yields supporting both human and nonhuman foragers.

By contrast, the Holocene-age beach ridges were distinctly second-tier habitat for aboriginal foragers on St. Catherines Island. These Holocene beaches are generally accreted into hammocks, typically comprised of several individual ridges.

The rolling beach ridge topography provides difficult conditions for human habitation, with little flat ground and a dense, in places impenetrable ground cover. The overall patch size is quite small, and the associated Fripp–Duckston soils are unsuitable for agriculture in any form. The poorly drained Rutledge fine sands at Flag Pond (and probably Beach Pond) did provide limited patches that could be exploited by aboriginal gardener employing a ''plant and harvest'' strategy. Moreover, because the soils blanketing the Holocene beach ridges are relatively young and infertile, they support mostly dense, nearly impenetrable scrub vegetation. Oaks and hickories do grow on these beach ridges, but the trees are smaller and the mast production inferior when compared to the forests of the Pleistocene core. Due to small patch size, the beach ridges support relatively few mast-producing trees, meaning that little redundancy exists in mast production. The dense vegetative cover, particularly the palmetto understory, made harvesting mast considerably more difficult (and hence, more expensive).

Holocene-age beach ridges also diminished the necessary requisites of human lifespace. Extensive edge exposure and the low-lying elevation offer little protection from storms, especially during the wintertime. Resource transport costs are high and whereas burning could reduce the understory on a temporary basis, nothing could fix the inherent problems with topography, soils, water, and exposure. In other words, relative to the expansive Pleistocene island core, the small and patchy Holocene beach ridges were expensive, less productive habitats, generally lacking in the basic conditions necessary for an effective central place.

Central Place Foraging Expectations for St. Catherines Island

Taking into account the effective foraging radius, the significance of the McQueen salt marsh (and its precursor, the Guale Marsh), the first-tier status of Pleistocene island core habitats, and the decidedly second-tier status of habitats on the Holocene accretionary beach ridges, we projected the most probable locations for residential bases on St. Catherines Island as follows (chap. 11):

- Potential locations for marshside settlements (providing direct access to the three highest ranking patch types, the salt marsh, the maritime forest, and the offshore) are widespread, spanning more than three-quarters of the Pleistocene core perimeter on St. Catherines Island (see figs. 11.14 and 11.15).
- On St. Catherines Island, the potential for seaside settlements is nil (see fig. 11.15). Whatever the potential of this suboptimal settlement might be on other barrier islands, it is entirely swamped by the widespread oceanside marsh available throughout the human occupation of St. Catherines Island.
- The accretionary Holocene-age beach ridges, along the extreme northern and southern margins of St. Catherines are decidedly second-tier habitats, with relatively lower potential as residential central places.

These central place foraging projections can now be tested against the empirical evidence of aboriginal settlement on St. Catherines Island, beginning with the Irene period occupations of the late prehistoric period.

ENCOUNTERING THE ABORIGINAL SETTLEMENTS OF ST. CATHERINES ISLAND: THE EMPIRICAL DATA

Given the theoretical framework of this project (articulated in chaps. 4–7), it was clear that the fieldwork relevant to this framework must derive from a regional (or ''landscape'') orientation rather than the single-site mentality typical of most archaeological investigations. By focusing on relationships between people and the land, so-called *landscape archaeology* attempts to define overarching relationships within the complex cultural geographies defined by human societies. By recognizing the fallacy of the single site (Thomas, 1998: 104–105; Thomas and Kelly, 2006: 81–83), emphasis shifts toward seeking out variability between contemporary sites within a regional settlement pattern.

Specifically, the regional research design of the Island-wide survey attempts to generate a relatively unbiased sample of archaeological sites from all time periods across all parts of St. Catherines Island. Chapter 12 details the specifics of this probabilistic survey program, which aims to provide meaningful negative evidence—not only documenting what sites occur in specific settings, but also generating data pinpointing those places that do not contain archaeological sites.

Chapters 11 and 19 discussed the research design and survey procedures employed in the 20 percent randomized transect survey of St. Catherines Island, and chapter 20 presented the site-by-site specifics for the 122 archaeological sites encountered during the Island-wide survey. Several other chapters in Part II discussed the macro- and microchronological controls employed here and the artifacts recovered from the transect survey. In chapter 22, Elizabeth Reitz presented and analyzed the vertebrate faunal remains from the transect survey sites.

To bridge between expected and observed results, it is necessary to review briefly the analytical protocols employed in the Island-wide survey and to summarize the various proxy measures employed.

ARCHAEOLOGICAL SITE

For the purposes of the Island-wide survey, we defined "aboriginal site" as basically anyplace where material evidence exists about the Native American past (chaps. 12 and 19, this volume; see also Sassaman et al., 1990: 218). Tables 20.1 and 20.2 present the key distributional characteristics of the archaeological sites recorded in the systematic regional sample of St. Catherines Island.

ARCHAEOLOGICAL COMPONENT

A "component" is a culturally homogeneous unit within a single archaeological site (per Willey and Phillips, 1958: 21; see chap. 12). So defined, *archaeological com-*

ponents are critical to this inquiry because they provide the most effective way to assess intrasite contexts by helping to clarify the interrelationship between the various evidence streams (including ceramic chronology, radiocarbon dates, zooarchaeological assemblages, and seasonality estimates).

Sometimes, archaeological "components" have been defined on the basis of compelling radiocarbon evidence, but most of the archaeological components in the Island-wide transect survey were defined by ceramic evidence. In a "single-component" site—defined as having greater than 75 percent of the diagnostic sherds deriving from a single temporal period—all the available radiocarbon, zooarchaeological, and seasonality evidence can be consisted relevant to the single "period" in question (and hence germane to the entire site context). In the case of "multicomponent" sites, the "major" component has greater than 50 percent of the diagnostic sherds deriving from a single temporal period; a "minor" component has greater than 20 percent of the diagnostic sherds deriving from a single temporal period; multiple minor components are sometimes evident. In evaluating the Island-wide transect results we generally assigned a "confidence level" to each component definition, a somewhat subjective assessment based largely on the number of diagnostic sherds recovered.

Tables 30.1 and 30.2 present the distribution of archaeological components defined from the systematic regional sample of St. Catherines Island. Table 30.2 further synthesizes the distributional data according to temporal period.

ARCHAEOLOGICAL LANDSCAPE

We also felt it necessary to generate a "nonsite" (Thomas, 1973, 1975)—or, as some would prefer it, a "siteless" (Dunnell and Dancey, 1983)—perspective to the large-scale, regional evidence generated in the Island-wide survey. For the probabilistic transect survey of St. Catherines Island, "archaeological landscapes" were defined by the available time-sensitive, geographically specific archaeological evidence re-

TABLE 30.2
Distribution of Archaeological Sites Recorded in the Systematic Transect Survey of St. Catherines Island

Period	Duration (centuries)	Western Pleistocene Core	Eastern Pleistocene Core	Southern Beach Ridges	Total
Altamaha period (A.D. 1580–1700)	2				
Components, Island-wide survey only		6	0	0	6
Components/century		3.0	0	0	3.0
% components/century		100%	0%	0%	100%
Occupations, Island-wide survey only		11	0	3	14
Occupations/century		5.5	0	0	5.5
% occupations/century		100%	0%	0%	100%
Irene period (cal A.D. 1300–1580)	3				
Components, Island-wide survey only		23	16	13	52
Components/century		7.67	5.33	4.33	17.33
% components/century		44.3%	30.8%	25.0%	100%
Occupations, Island-wide survey only		33	20	14	67
Occupations/century		11	6.67	4.67	22.33
% occupations/century		49.26	29.85	20.89	100%
St. Catherines period (cal A.D. 800–1300)	5				
Components, Island-wide survey only		9	7	4	20
Components/century		1.80	1.40	0.80	4.00
% components/century		45.0%	35.0%	20.0%	100%
Occupations, Island-wide survey only		22	14	5	41
Occupations/century		4.40	2.80	1.00	8.20
% occupations/century		53.7%	34.1%	12.1%	100%
Wilmington period (cal A.D. 350–800)	9.5				
Components, Island-wide survey only		14	11	1	26
Components/century		1.47	1.16	0.11	2.74
% components/century		53.8%	42.3%	3.8%	100%
Occupations, Island-wide survey only		27	16	4	47
Occupations/century		2.84	1.68	0.42	4.95
% occupations/century		57.4%	34.0%	8.5%	100%
Refuge-Deptford period (cal 100 B.C.–A.D. 350)	13.5				
Components, Island-wide survey only		7	7	1	15
Components/century		0.52	0.52	0.07	1.11
% components/century		46.6%	46.6%	6.7%	100%
Occupations, Island-wide survey only		23	18	1	42
Occupations/century		1.70	1.33	0.07	3.11
% occupations/century		54.8%	42.9%	2.4%	100%
St. Simons period (cal 300 B.C.–A.D. 350)	20				
Components, Island-wide survey only		1	9	0	10
Components/century		0.05	0.45	0.0	0.50
% components/century		10.0%	90.0%	0.0%	100%
Occupations, Island-wide survey only		10	13	0	23
Occupations/century		0.50	0.65	0.0	1.15
% occupations/century		43.5%	56.5%	0.0%	100%

gardless of abundance or stratigraphic context (see chap. 19).

An "archaeological landscape" thus incorporates the totality of all available archaeological indicators (termed a "presence" or "occupation"), partitioned according to specific temporal period and plotted across a well-defined and bounded

TABLE 30.3
Site Size for Known Archaeological Components on St. Catherines Island (Island-wide Survey Only)

Period	Western Pleistocene Core	Central Pleistocene Core	Eastern Pleistocene Core	Southern Holocene Beach Ridges	Total
Altamaha period (A.D. 1580–1700)					
Larger than 500 m^2	4	—	—	—	4
Between 50 m^2 and 500 m^2	—	1	—	—	1
Smaller than 50 m^2	—	—	—	—	—
Irene period (cal A.D. 1300–1580)					
Larger than 500 m^2	10	—	8	—	18
Between 50 m^2 and 500 m^2	—	—	5	6	11
Smaller than 50 m^2	8	3	4	4	19
St. Catherines period (cal A.D. 800–A.D.1300)					
Larger than 500 m^2	1	1	2	2	6
Between 50 m^2 and 500 m^2	2	2	2	2	8
Smaller than 50 m^2	2	1	1	—	4
Wilmington period (cal A.D. 350–A.D.1300)					
Larger than 500 m^2	2	3	—	—	5
Between 50 m^2 and 500 m^2	1	4	—	—	5
Smaller than 50 m^2	3	4	7	2	16
Refuge-Deptford period (cal 100 B.C.–A.D. 350)					
Larger than 500 m^2	3	1	—	1	5
Between 50 m^2 and 500 m^2	—	3	—	1	4
Smaller than 50 m^2	2	3	3	—	8
St. Simons period (cal 300 B.C.–A.D. 350)					
Larger than 500 m^2	—	—	—	—	—
Between 50 m^2 and 500 m^2	1	—	2	—	3
Smaller than 50 m^2	—	2	—	—	2

geographical space. So defined, an archaeological "presence" could be one or more potsherds recovered in a solid archaeological context, one or more time-diagnostic lithic artifacts, or even an apparently reliable "cultural" radiocarbon date (in context, but not necessarily in the presence of ceramics). Table 30.2 synthesizes the "landscape" evidence from the Island-wide survey by archaeological period.

SITE SIZE

During the transect survey, the use of probes, shovel tests, and test-pit excavations estimated the subsurface extent of all aboriginal sites encountered. "Small" sites have an inferred subsurface extent less than 50 m^2, "medium" sites extend between 50 m^2 and 500 m^2, and

"large" sites have an inferred subsurface extent greater than 500 m^2. Table 30.3 synthesizes the site size evidence from the Island-wide survey according to temporal period.

SEASONALITY

Evidence for seasonal resource procurement on St. Catherines Island comes from the analysis of vertebrate faunal elements recovered from the sites recognized in the Island-wide survey. Seasonal interpretations rely particularly on the presence of unshed white-tailed deer antlers, juvenile deer bones, the remains of sharks and sea catfish, and incremental growth bands preserved on hard clams (*Mercenaria mercenaria*). Table 30.4 synthesizes the evidence for seasonality for the archaeological components re-

TABLE 30.4
Summary of Seasonal Indicators for Sites in the Island-wide Survey of St. Catherines Island

	Season of occupation				
Period	Winter	Spring	Summer	Fall	Total seasons detected
Altamaha					
Number	4	4	3	3	14
Percent	28.6%	28.5%	21.4%	21.4%	100%
Irene					
Number	37	34	31	22	124
Percent	29.8%	27.4%	25.0%	17.7%	100%
St. Catherines					
Number	13	11	8	4	36
Percent	36.1%	30.6%	22.2%	11.1%	100%
Wilmington					
Number	16	13	11	8	48
Percent	33.3%	27.1%	22.9%	16.7%	100%
Refuge-Deptford					
Number	8	8	7	5	28
Percent	28.6%	28.6%	25.0%	17.9%	100%
St. Simons					
Number	2	2	1	1	6
Percent	33.3%	33.3%	16.7%	16.7%	100%

corded in the Island-wide survey; chapters 17, 19, 20, and 22 provide the empirical data and specific protocols employed.[10]

IRENE PERIOD SETTLEMENTS
(CAL A.D. 1300–A.D. 1580)

Based on a suite of 24 radiocarbon dates, we estimate that Irene period ceramics initially appeared on St. Catherines about cal A.D. 1300; these same dates also support De-Pratter's (1979a, 1991) estimate that the Irene period terminated shortly after Spanish contact, an uncorrected estimate of A.D. 1580.

Stable isotope evidence (reviewed in chaps. 24 and 32) demonstrates that the Irene populace ate maize, perhaps "in appreciable amounts" (Larsen, 2002: 64), but almost all of the available evidence comes from the Irene Mound rather than St. Catherines Island. Additional bioarchaeological and biomechanical studies support this finding, with an increase in periosteal lesions and dental caries, evidence consistent with a relatively sedentary village life, with poor sanitation, and an increase in the spread of infectious disease. Irene people

were shorter than their nonagricultural predecessors (a difference likely caused by poor nutrition).

Table 30.2 details a total of 52 archaeological components dating to the Irene period. The archaeological landscape during the Irene period consists of 67 known occupations (fig. 30.6) documented and tested during the Island-wide survey. Evidence of seasonality is available from 42 of these components. The site-by-site evidence was presented in chapter 20; the next section summarizes the overall trends and patterns during the Irene period.

IRENE PERIOD SETTLEMENT PATTERN

We feel confident in reconstructing the general configuration of St. Catherines Island during the Irene period. Geomorphological studies (discussed in chaps. 3 and 29) and the Yonge and DeBrahm map (figs. 29.9 and 29.10) confirm that the configuration of the Pleistocene core is nearly identical to maps from the historical period; during the Irene period, the southern beach ridge complex extended just southward of the margins of Flag Pond.

Probable Seasonality

December

September   March

June

Meeting House Field

Mound near South-end Settlement (9Li3)

LEGEND
. Archaeological site
✕ 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds
✪ Burial mound

Irene Period
cal A.D. 1300 - 1580

N

1 .5 0   1 km
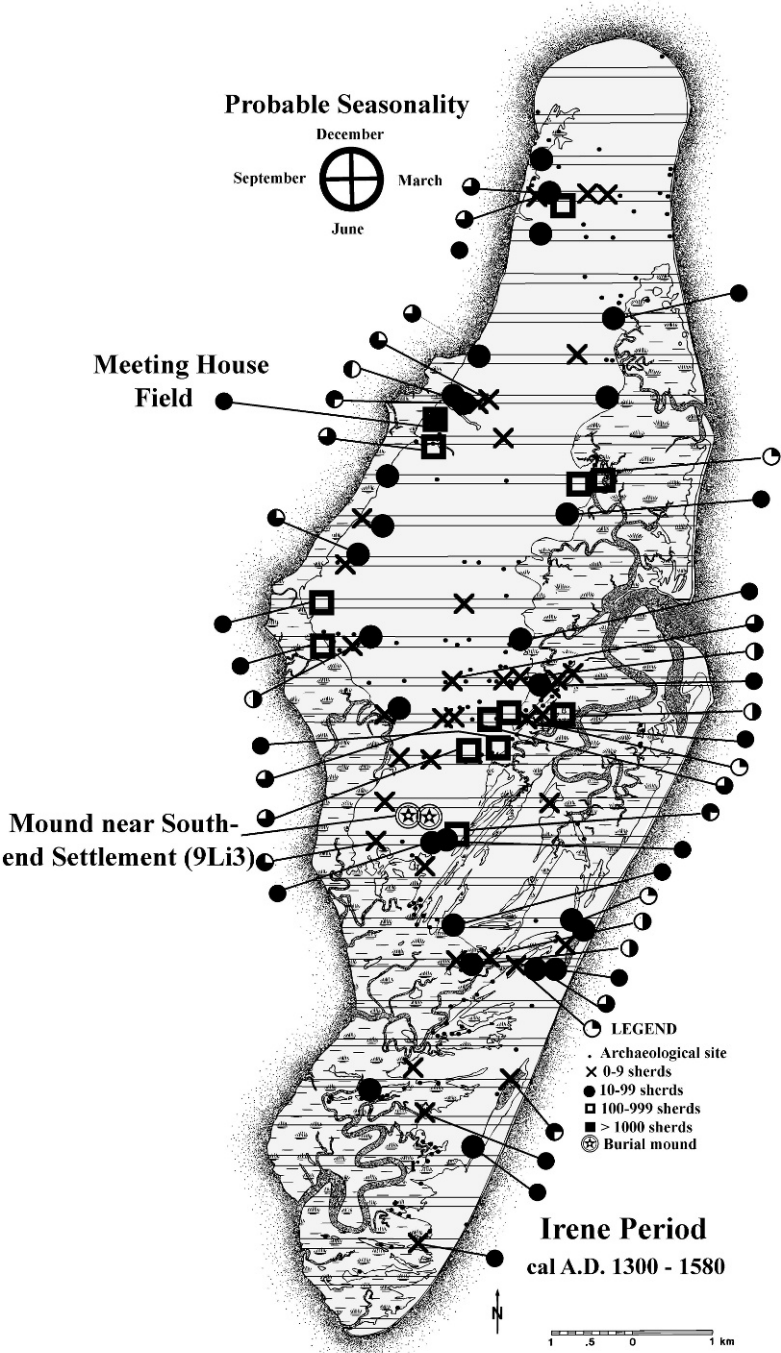
Fig. 30.6.   Seasonal distribution of archaeological components from the Irene period on St. Catherines Island.

We documented a tight cluster of six Irene period occupations on the northern end of the island, each site located within 1 km of the Northwestern Marsh (fig. 30.6). One of these sites (9Li170), near Little Sams Field, produced evidence of four-season occupation, while two sites have three-season (December–September) occupations from the Irene period. Site 9Li243 was occupied during every season except fall.

Despite the intensity of pre-Irene period occupations in the northeastern sector, this part of St. Catherines Island was completely abandoned after cal A.D. 1300. This once productive marshland, reduced to concentrations of relict mud, provided little for aboriginal people of the Irene period except, perhaps, as source material for ceramic manufacture.

We know of 19 Irene period occupations on the central part of the island core, with all but one encountered during the Island-wide systematic survey. Roughly two-thirds of these sites are clustered within 100–200 m from the western margin of St. Catherines Island.[11] The remaining Irene period sites on the central island core cluster around McQueens Inlet. Sites 9Li226 and 9Li169 were occupied during four seasons and 9Li19 produced evidence of only springtime utilization. With a single exception (9Li232), the inland portion of the central island core appears to have been virtually abandoned throughout the Irene period.

The south end of the island core was densely occupied during the Irene period, with 29 Irene occupations documented during the Island-wide survey. Roughly one-third of these occur along the western coastline, extending from Persimmon Point to Wamassee Head. The two largest sites (9Li255 and 9Li197) were occupied during four seasons, while the other sites represent various seasonal patterns.

The eastern margin of the island core, fronting the south end of McQueens Inlet, contained a particularly dense Irene period occupation, and roughly half of these sites produced evidence of four-season occupation. A few small sites were encountered in the inland portions of the southern island core, with evidence of all seasons present.

The fall is somewhat underrepresented in all these sites.

South End Mound I (9Li3) is located in the central part of the southern island core. This was the richest mortuary site that Moore encountered on St. Catherines Island (Moore, 1897; see also Larsen and Thomas, 1986; Larsen, 2002). Moore's report strongly suggests that this site was used almost entirely during the Irene period. Five Irene period sites were clustered within 500 m of the South End Mounds. 9Li204 and 9Li206 were occupied during four seasons and two other sites showed evidence of three-season occupation.

Utilization of the southeastern marshlands (from King New Ground to Cracker Tom Hammock) intensified significantly during the Irene period, as did occupation along the western margin of the island core. Roughly 20 percent (14 of 68) of the Irene period occupations occur on the southern beach ridge complex—by far the highest proportion of any aboriginal time period. Several of these sites are clustered around the Beach Pond area; five of these produced seasonal evidence. 9Li126 was occupied during four seasons and all the others were occupied at least during the winter months, and sometimes longer. At the extreme southern end of St. Catherines Island, four sites produced seasonal evidence, all but one of them exhibiting four-season occupational evidence.

Are Irene Settlements Distributed in Normal/Lognormal Fashion Relative to the Marsh Edge of St. Catherines Island?

Figure 30.7 compares the observed distributions of Irene phase components against the expected distribution based on the central place foraging model (developed in chap. 11). In each of the three distributions, two measures of ''distance to marsh'' are arrayed along the x-axis. The extreme left-hand side of the distributions in figure 30.6 represents the western (estuarine) marsh margin, with distance to marsh increasing toward the right portion of the x-axis. Concurrently, the distribution of marshside settlements is projected along

Central Place Foraging Model
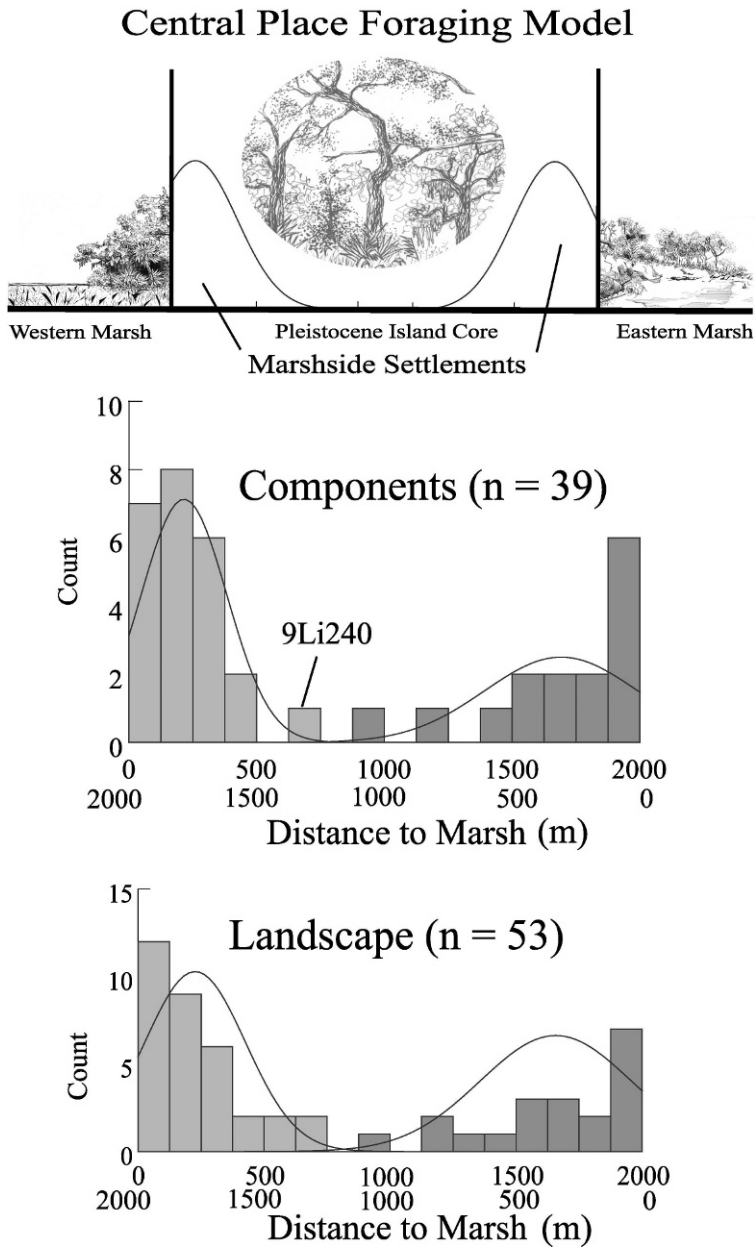
Fig. 30.7. Archaeological evidence from the Irene period compared to the Central Place Foraging model for marshside settlement on the Pleistocene core of St. Catherines Island.

the eastern (seaward) margins of the Pleistocene core; the extreme right-hand margin of figure 30.7 represents the eastern marsh edge, and the distance to marsh increases as one moves along the *x*-axis (toward the left).

The upper curve in figure 30.7 arrays the theoretical distribution of marshside settlements on the Pleistocene Core of St. Catherines Island. If energy efficiency were the sole concern of aboriginal foragers, one expects the central places to be arrayed along

TABLE 30.5
Distance of Archaeological Components from the Salt Marsh Margin of the Pleistocene Core on St. Catherines Island[a]

Period	Location	n	Mean (m)	Standard deviation	Coefficient of Skewness	Standard Error of Skewness	Coefficient of Kurtosis	Standard Error of Kurtosis
Pleistocene Island Core								
Altamaha	West	6	138.7	226.5	2.204	0.845	5.006	1.741
Altamaha	East	—	—	—	—	—	—	—
Irene	West	23	212.2	170.9	1.309	0.481	2.734	0.935
Irene	East	16	291.6	296.7	1.383	0.564	1.482	1.091
St. Catherines	West	9	250.4	225.4	0.372	0.717	−1.693	0.400
St. Catherines	East	7	196.4	395.7	2.601	0.794	6.812	1.587
Wilmington	West	14	370.0	264.4	0.298	0.597	−1.085	1.154
Wilmington	East	11	374.1	350.9	0.962	0.661	0.171	1.279
Refuge-Deptford	West	7	203.2	307.1	1.682	0.794	2.109	1.587
Refuge-Deptford	East	7	513.6	384.1	−0.056	0.794	−0.625	1.587
St. Simons	West	1	30.0	—	—	—	—	—
St. Simons	East	9	292.2	303.4	0.623	0.717	−1.637	1.400
Holocene Beach Ridges								
Irene	—	13	114.5	142.5	1.369	0.616	0.798	1.191
St. Catherines	—	4	62.5	98.5	1.986	1.014	3.953	2.619
Wilmington	—	1	10.0	—	—	—	—	—
Refuge-Deptford	—	1	10.0	—	—	—	—	—

[a] Significantly nonzero skewness and kurtosis are underlined.

a narrow linear band bordering the margin between the salt marsh and maritime forest (the two highest ranking resources patches); in this idealized case, the distance to marsh is DTM = 0. But a number of lifespace considerations—including soil distribution, drainage, freshwater access, foul weather protection, and landing places for canoes and dugouts—suggest that the actual positioning of central places is subject to a certain degree of variability. This is why the distribution of marshside central places is modeled according to normal/lognormal approximations (depending on whether these small effects are additive or multiplicative) with an unknown mean and variance. The various techniques for assessing goodness of fit between expected and observed distributions permit an analysis of the empirical evidence from the Island-wide survey of St. Catherines Island.

IRENE PERIOD COMPONENTS: The middle curve of figure 30.7 arrays the empirically observed distribution of the $n = 39$ Irene period components recorded, scaled with distance to marsh along the *x*-axis. The *western marshside settlements* are shown to the left, and the *eastern marshside settlements* on the right (see also table 30.5). Because the Pleistocene core of St. Catherines Island averages about 2 km wide, and to facilitate comparison between estuarine and marine settlements, figure 30.7 arrays all components according to a standardized island width of 2 km.

The 23 Irene components discovered along the western margin of St. Catherines Island average 212 ± 171 m from the Walburg and Wamassee scarps. Several Irene period sites are situated almost precisely at the projected mean distance to marsh developed through application of central place foraging theory. In transect B-1, for instance, 9Li243, a large two-season (winter and springtime) site, is almost entirely lacking in surface shell, yet it extends approximately 200 m[2] in projected subsurface extent; 9Li243 lies 230 m from the closest marsh margin. Almost identical spacing rel-
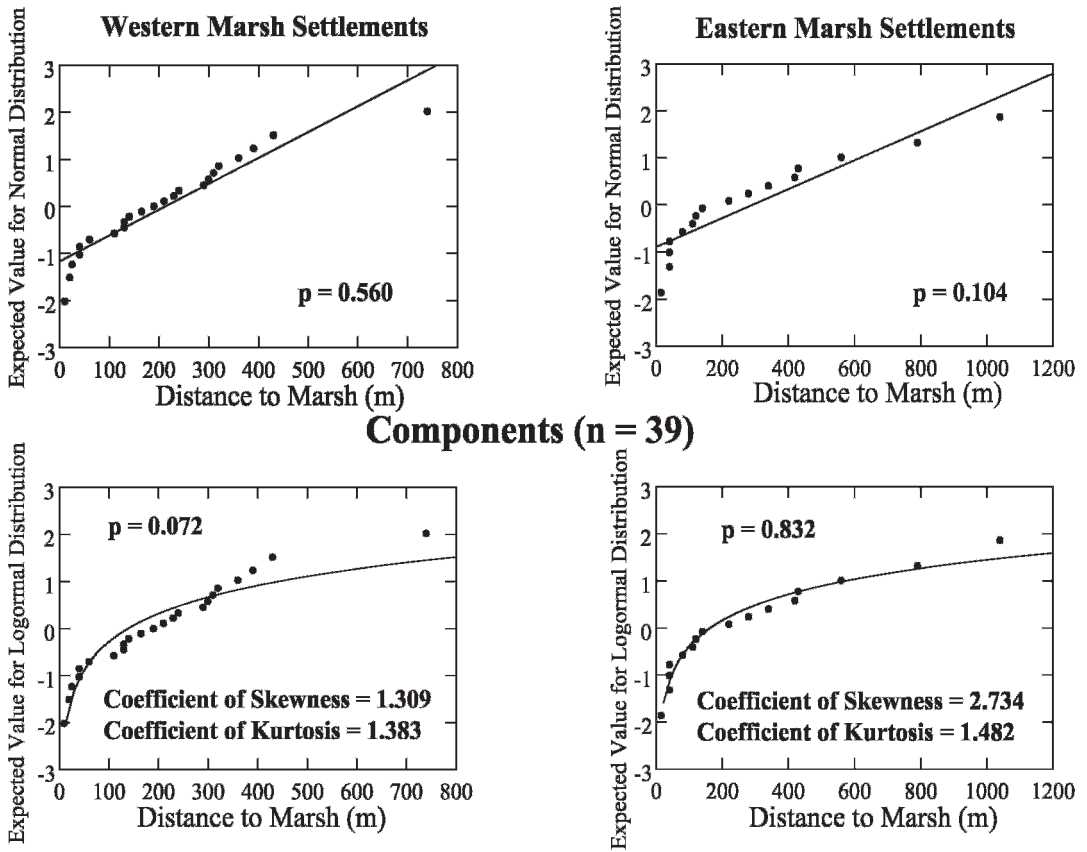
Fig. 30.8.   Comparison of normal and lognormal theoretical models to the distribution of Irene period archaeological components on the Pleistocene core of St. Catherines Island.

ative to the western marsh margin is evident at 9Li277, a small single-season (springtime) shell mound site located in Long Field. Two similarly positioned Irene period sites occur in Rock Field: 9Li176 is a large, three-season (summer through winter) site located 290 m from the marsh margin; 9Li177, located nearby, is a small, two-season (summer and fall) Irene period occupation. Yet despite their obvious differences in size and seasonality, each of these sites falls within 75 m of their projected locations based on Central Place Theory.

A very similar pattern holds for the eastern marshside settlement ($n = 16$), with the Irene components averaging 292 ± 297 m from the scarps defining the interface between the salt marsh and maritime forest edge. Although the western marshside set-

tlements average about 80 m closer to the marsh margin than their counterparts on the eastern side of St. Catherines Island, this observed difference in distance to marsh is not statistically significant.

Figure 30.8 arrays the same data in a different graphic format. To the left is the probability plot for components distributed along the western marsh margin of St. Catherines Island. As in figure 30.3, the empirically observed variates are shown on the x-axis (as distance to marsh) and the expectations under the normal/lognormal assumption are shown along the y-axis. On the upper left appear expectations based on a normal distribution; at the lower left are expectations from a lognormal frequency distribution. As noted previously (fig. 30.7), 9Li240 is an outlier. The good-
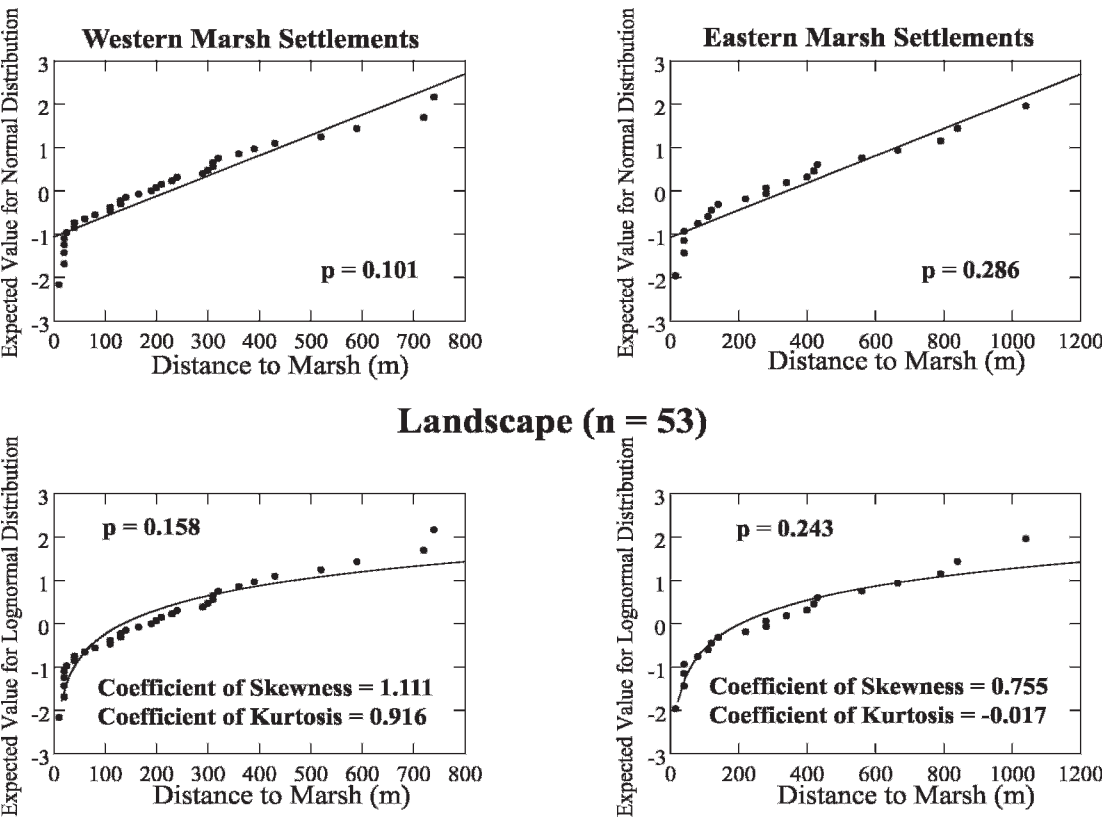
Fig. 30.9.   Comparison of normal and lognormal theoretical models to the Irene period landscape on the Pleistocene core of St. Catherines Island.

ness of fit has been assessed using the Lillie-fors test, with the associated probability values of $p = 0.560$ for the lognormal model and $p = 0.072$ for the lognormal distribution. This means that, whereas the empirical fit more closely corresponds to the lognormal model (especially for distance to marsh > 50 m), the distribution of Irene period components along the western marshland of St. Catherines Island is consistent with expectations from *both the normal and lognormal distributions* (because in neither case do the associated probability values fall into the critical region of $p < 0.05$ necessary to reject the null hypothesis).

Figure 30.9 also presents the appropriate Coefficients of Skewness and Kurtosis. By the criteria established above, three of the four coefficients differ significantly from zero (table 30.5). This means that the distri-

bution of Irene period archaeological components along the western marshline is significantly peaked and skewed to the right (relative to expectations under the normal/lognormal frequency distributions). A somewhat similar pattern holds for the Irene period settlements along the eastern marsh margin of St. Catherines Island, with the distribution of the $n = 16$ settlements along the ocean side being consistent with both normal and lognormal expectations (the small sample sizes involved does not allow us to distinguish between the two models). The eastern marsh settlements are also significantly skewed to the right, but the degree of kurtosis does not differ significantly from the normal/lognormal expectations. At noted in table 30.5, the distance to marsh statistic is likewise similar, the western components averaging

Western Pleistocene Core

Eastern Pleistocene Core

p = 0.001

p = 0.006

Components (n = 39)

p = 0.000

p = 0.012

Landscape (n = 53)
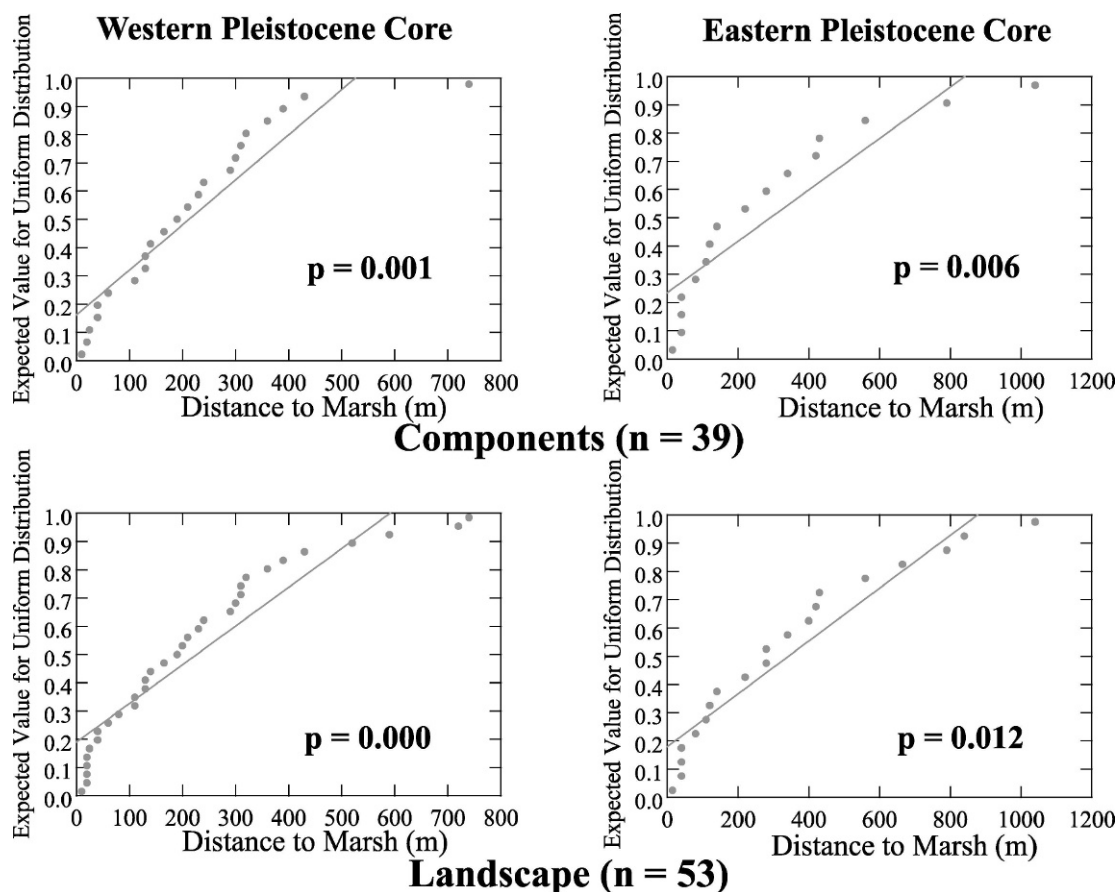
Fig. 30.10. Archaeological evidence from the Irene period compared to the Diet-Breadth Foraging (uniform) expectations on the Pleistocene core of St. Catherines Island.

212.2 m from the marsh edge and the eastern settlements averaging 291.6 m (a difference that does not approach statistical significance).

IRENE PERIOD LANDSCAPES: Extremely similar results emerge when Irene period settlements are viewed from a landscape perspective (fig. 30.10 and table 30.6). The landscape evidence is slightly more spread out from the marsh margins, with a slightly greater mean distance to marsh and associated standard deviation. The $n = 53$ landscape indicators are distributed in normal/lognormal fashion, and the only significant deviation from expectation occurs with western landscapes, which are significantly skewed to the right (table 30.6; fig. 30.6, bottom; fig. 30.9).

As with the components discussed above, the distribution of Irene period landscapes along the eastern and western marshsides is statistically compatible with both normal and lognormal expectations (meaning that all associated probability values for goodness of fit are >0.05). The landscape data are also less distorted (more precisely normal/lognormal) than the Irene components. Only the Coefficient of Skewness for the western marsh landscape is significantly different from zero (table 30.3); the remaining coefficients of skewness and kurtosis indicate statistical compatibility with the normal/lognormal models.

These comparisons answer a very simple, but important question: *Are the Irene settlements of St. Catherines Island distributed in normal/lognormal fashion relative to the*

TABLE 30.6
Distance of Archaeological Landscape Measures from the Salt Marsh Margin of the Pleistocene Core on St. Catherines Island[a]

Period	Location	n	Mean (m)	Standard deviation	Coefficient of Skewness	Standard Error of Skewness	Coefficient of Kurtosis	Standard Error of Kurtosis
Pleistocene Island Core								
Altamaha	West	11	194.3	261.5	1.859	0.661	2.591	1.279
Altamaha	East	—	—	—	—	—	—	—
Irene	West	33	226.4	200.0	1.111	0.409	0.755	0.798
Irene	East	20	342.5	300.9	0.916	0.512	−0.017	0.992
St. Catherines	West	22	261.8	241.7	0.892	0.491	−0.083	0.953
St. Catherines	East	14	283.6	339.2	1.403	0.597	1.109	1.154
Wilmington	West	27	294.9	259.6	0.685	0.448	−0.619	0.872
Wilmington	East	16	317.8	304.7	1.404	0.564	1.669	1.091
Refuge-Deptford	West	23	227.3	220.2	1.024	0.481	0.564	0.935
Refuge-Deptford	East	18	324.2	321.2	0.907	0.536	−0.032	1.038
St. Simons	West	10	133.7	144.0	1.163	0.667	0.457	1.334
St. Simons	East	13	236.2	266.9	1.132	0.616	−0.273	1.191
Southern Holocene Beach Ridges								
Altamaha	—	3	206.7	112.6	—	—	—	—
Irene	—	14	107.1	139.8	1.473	0.597	1.136	1.154
St. Catherines	—	5	70.0	39.0	1.380	0.913	1.117	2.000
Wilmington	—	4	16.3	3.8	0.370	1.014	−3.901	2.619
Refuge-Deptford	—	1	5.0	—	—	—	—	—

[a] Significantly nonzero skewness and kurtosis are underlined.

marsh edge? The conclusion is clearly ''yes'', meaning that the central place foraging model projects the Irene period settlement pattern on the Pleistocene core of St. Catherines Island to an extraordinarily accurate degree.

DOES DISTANCE TO THE MARSH VARY BY SEASON FOR IRENE SETTLEMENTS?

The estimates of Irene period seasonality (from 42 archaeological sites representing 124 seasonally specific occupations) are distributed as follows: winter, 30 percent; spring, 27 percent; summer, 25 percent; and fall, 18 percent. Figure 30.11 partitions this overall distribution into the 107 seasonally specific components known for the Irene period on the Pleistocene core of St. Catherines Island.

The indicators for fall occupations are slightly diminished when compared to other seasons (likely because indicators of mast harvest are not included in these estimates).

But nothing in the empirical histograms suggests a nonrandom relationship between the distance to marsh and site seasonality. Table 30.7 confirms this suspicion. No significant differences exist with respect to the distance to marsh statistics.

ARE IRENE SETTLEMENTS UNIFORMLY DISTRIBUTED ACROSS THE PLEISTOCENE CORE OF ST. CATHERINES ISLAND?

The contrasting diet-breadth model generates rather different expectations for Irene period settlement patterning, namely a relatively homogeneous distribution of archaeological evidence across the Pleistocene core of St. Catherines Island. Figure 30.11 sets out this possibility in graphic fashion, comparing the observed distributions of Irene period archaeological components and landscapes against the expected uniform distribution of variates. As with the normal/lognormal models, each of the three distributions depicted in figure 30.11 em-

Irene Period Seasonality
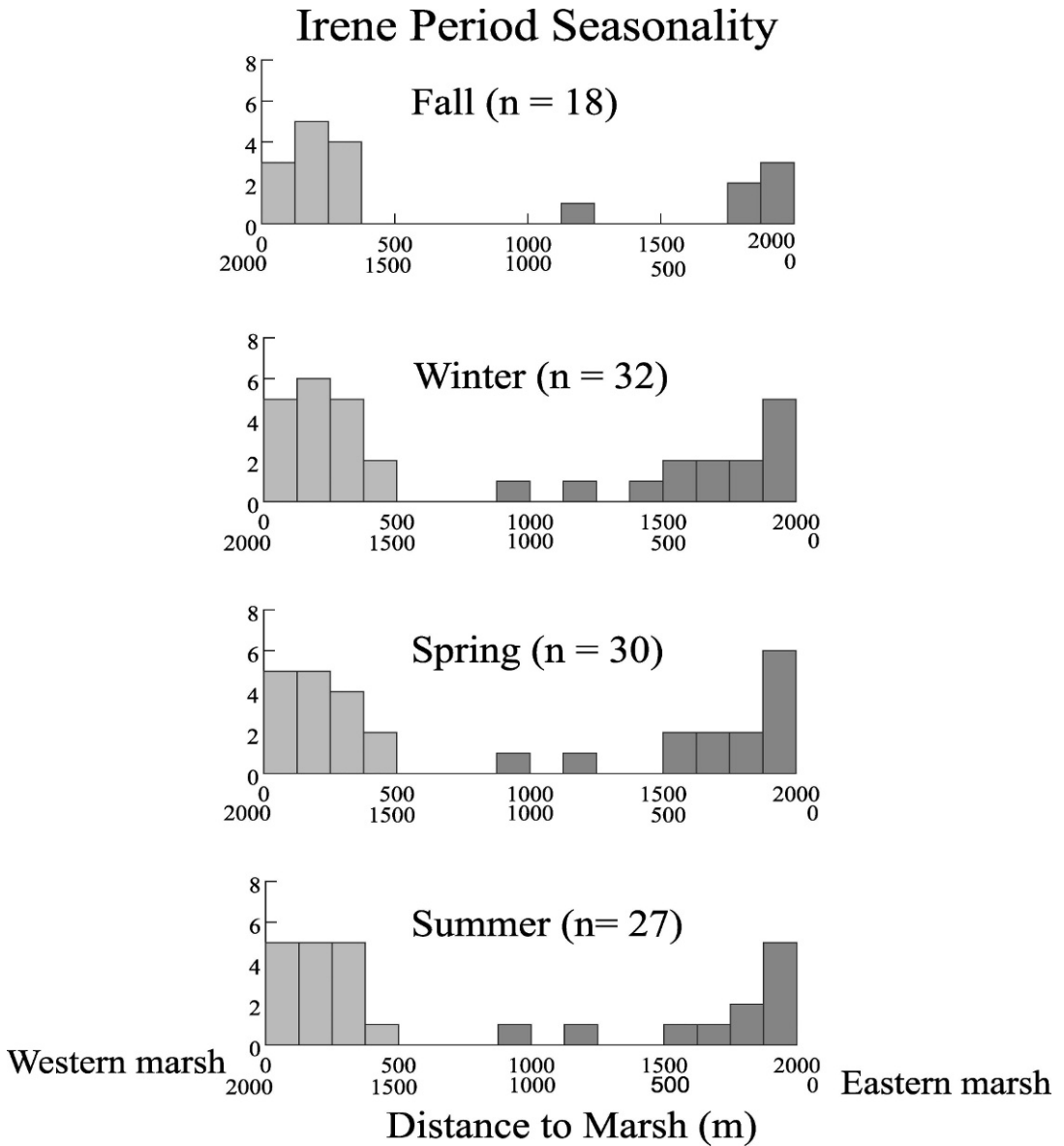
Fig. 30.11.   The seasonal distribution of Irene period components relative to Distance to Marsh on the Pleistocene core of St. Catherines Island.

ploys two measures of distance to marsh arrayed along the *x*-axis. The extreme left-hand side of figure 30.11 represents the western Pleistocene core, which borders the (estuarine) marsh margin; distance to marsh increases toward the right portion of the *x*-axis. The distribution of settlements is likewise projected along the eastern

(seaward) Pleistocene core; the extreme right-hand margin in figure 30.12 represents the eastern marsh edge, and the distance to marsh increases as one moves along the *x*-axis (toward the left). The gap between the western and eastern marshes represents the central swale, the discontinuous low-lying zone of uninhabitable fresh-

TABLE 30.7
Distance to Marsh Statistics for Irene Period Components, Sorted by Seasonal Indicators

Distance to Marsh	n	Mean (m)	Standard deviation	Minimum	Maximum
Irene Period					
Western marsh					
Fall components	12	184.2	105.6	20	320
Winter components	18	196.1	138.4	10	430
Spring components	16	197.5	140.4	10	430
Summer components	16	188.2	128.3	10	390
Eastern marsh					
Fall components	6	218.3	117.7	40	320
Winter components	14	305.7	81.7	15	1040
Spring components	14	301.9	80.7	15	1040
Summer components	11	337.5	101.7	15	1040
St. Catherines Period					
Western marsh					
Fall components	4	206.0	221.5	2	520
Winter components	8	209.3	138.4	2	430
Spring components	7	173.4	188.2	2	520
Summer components	4	206.0	221.5	2	520
Eastern marsh					
Fall components	0	—	—	—	—
Winter components	4	291.3	523.8	10	1090
Spring components	5	257.0	467.8	10	1090
Summer components	2	32.5	24.8	15	50
Wilmington Period					
Western marsh					
Fall components	5	325.0	300.5	10	720
Winter components	10	407.5	275.5	10	790
Spring components	9	418.3	289.9	10	790
Summer components	6	319.2	269.2	10	720
Eastern marsh					
Fall components	4	732.5	298.6	400	1090
Winter components	9	428.3	365.6	10	1090
Spring components	7	428.6	421.8	10	1090
Summer components	6	536.7	390.9	10	1090

water lagoon, today recognizable by the distribution of poorly drained Rutledge soils.

The upper curve in figure 30.12 sets out the *theoretical uniform distribution* of Irene settlements across the Pleistocene core of St. Catherines Island. If the Pleistocene core consisted of an entirely homogeneous terrestrial patch, then we would expect the archaeological evidence to be uniformly distributed across the maritime forest growing on the high ground between the eastern and western salt marshes and the central swale. The parameters of this idealized, uniform distribution are established by the smallest and largest values of distance to marsh (represented as a and b in fig. 30.12); unlike the normal/lognormal distributions implied by central place foraging theory, the diet-breath/uniform frequency distribution model excludes all lifespace considerations (including freshwater access, foul weather protection, and landing places for canoes and dugouts).

IRENE PERIOD COMPONENTS: The middle curve of figure 30.12 arrays the same empirically observed distribution of the n = 39 Irene period components as shown in figure 30.7, scaled with distance to

Diet-Breadth Foraging Model

Western Pleistocene Core   Central Swale   Eastern Pleistocene Core
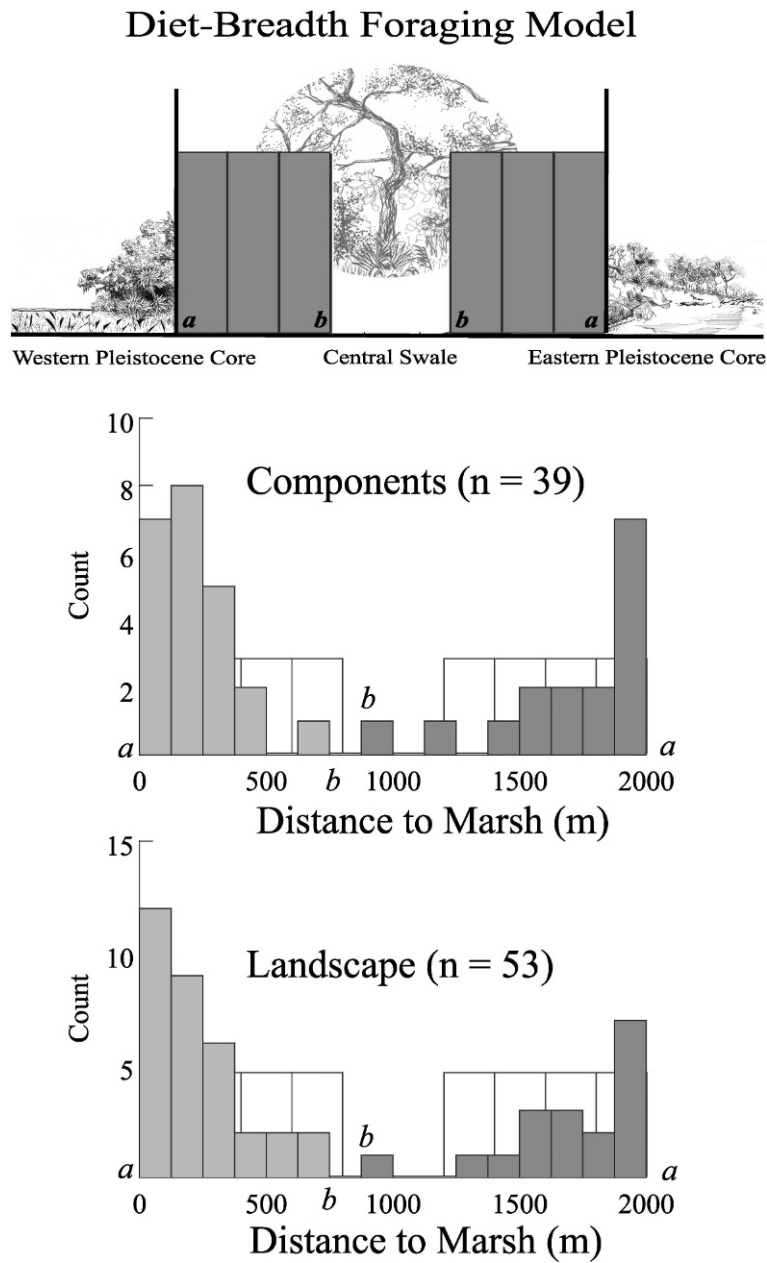
Fig. 30.12.   Comparison of uniform theoretical model to the distribution of Irene period archaeological evidence on the Pleistocene core of St. Catherines Island.

marsh along the *x*-axis, with the *western Pleistocene core* shown to the left, and the *eastern Pleistocene core* on the right. To facilitate comparison between estuarine and marine settlements, figure 30.12 arrays all components according to a standardized island width of 2 km and all empirical evidence is displayed in histogram fashion, with a bar width of 125 m.
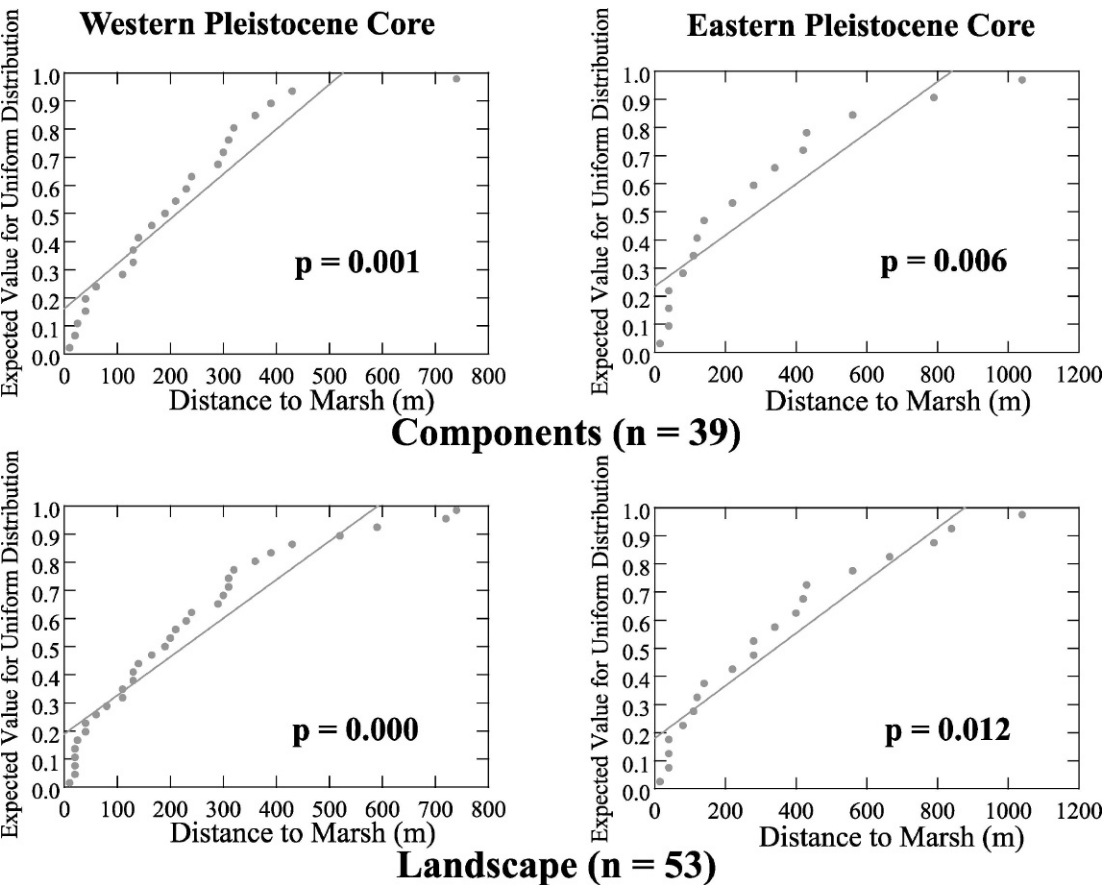
Fig. 30.13.   Distance to Marsh estimates for Irene period components and landscapes compared to the cumulative frequency expectations for a uniform diet-breadth model.

The theoretical uniform distribution is stylized in figure 30.12, with the western and eastern Pleistocene cores represented by blocks of histogram bars of equal length, separated by a gap representing the uninhabitable central swale. In the statistical analysis (below), the actual goodness of fit is computing using the K-S one-sample test for a uniform frequency distribution, defined by the specific boundary parameters a and b (defined by the empirical limits of the archaeological dataset).

Figure 30.13 arrays these same data in terms of the cumulative frequency expected from a uniform distribution (with limits of a and b, as defined above). On the left side are probability plots for the Irene period settlements along the western and eastern Pleistocene cores. As in figure 30.3, the empirically observed variates appear on the x-axis (as distance to marsh); the uniform frequency expectations are shown schematically shown along the y-axis. In the upper left, we plot the expectations for Irene components along the western Pleistocene core. Goodness of fit has been assessed using the K-S one-sample test, with the associated probability value of $p = 0.001$. This means that the empirical distribution differs significantly from expectations from the theoretical uniform distribution, with boundary parameters matched to the empirically observed minimum and maximum (a and b). The top-right of figure 30.12 arrays similar comparisons for Irene period components along the eastern Pleistocene core. The val-
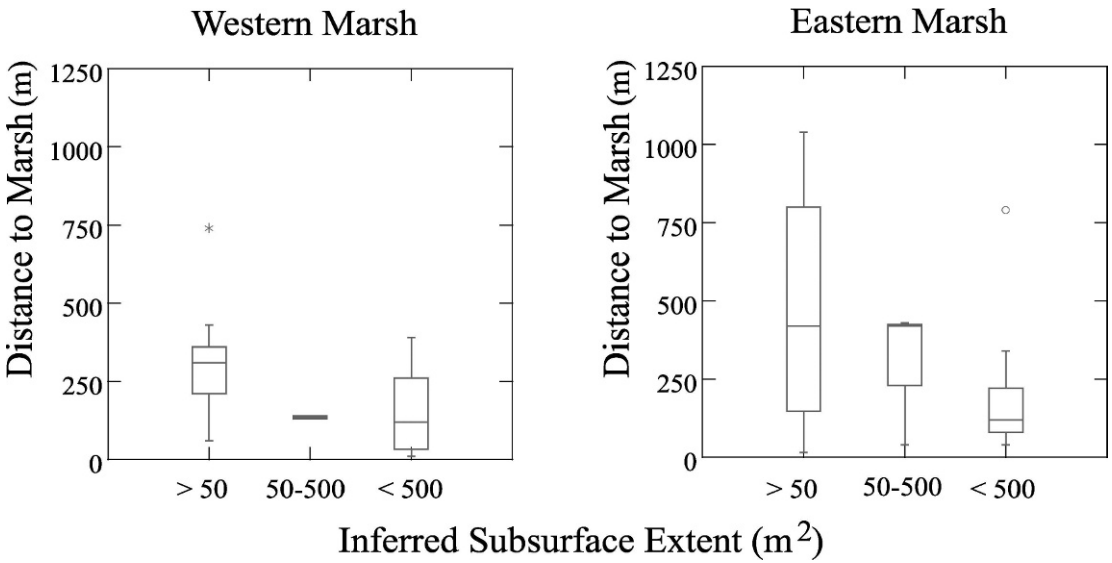
Fig. 30.14. The relationship of size (measured as inferred subsurface extent) of Irene period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

ue of $p = 0.006$ (computed by a K-S one-sample test) indicates a statistically significant disparity between uniform expectations and the empirical distribution. Similar results obtain for all additional comparisons between Irene period archaeological landscapes and uniform expectations, on both the Pleistocene and Holocene dune ridge habitats (see table 30.6).

These results answer another important question: *Are the Irene settlements uniformly distributed across the Pleistocene core of St. Catherines Island?* The answer is clearly "no", meaning that the diet-breadth model fails to explain the observed Irene period settlement pattern on the Pleistocene part of St. Catherines Island.

DOES IRENE SITE SIZE VARY WITH DISTANCE TO THE MARSH?

As discussed in subsequent chapters, Irene period assemblages tend to be larger and more frequent than those from any other aboriginal time period. Specifically, large sites (those with estimated subsurface extent >500 m²) account for nearly 20 percent (12 of 72) of the Irene period sites recorded in the transect survey and, con-versely, the proportion of smaller sites (estimated subsurface extent <50 m²) is only 47 percent (34 of 72), the lowest percentage for any aboriginal time period on St. Catherines Island (table 30.3). Furthermore, looking strictly at the Island-wide transect survey results, we estimate that Irene period settlements accumulated at a rate of 34 components/century—more than three times the rate for any other aboriginal period (table 30.2; see also chap. 34).

Figure 30.14 illustrates the tendency for the largest Irene period components (i.e., those larger than 500 m²) to be closer to the marsh margin, with the smaller size components (those smaller than 50 m²) tending to be further inland (see also table 20.2). Viewed in terms of nonparametric correlation, this tendency can be expressed as $r_S = -0.497$ for the western marshside settlement and $r_S = -0.268$ for the eastern marshside settlements.

Because these relationships are not statistically significant, one must conclude that the size of a central place has no relationship to the distance to marsh for the Irene period components on the Pleistocene core of St. Catherines Island.

Fig. 30.15.   The relationship of occupational intensity (measured as sherd density) of Irene period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

Does Intensity of Occupation of Irene Components Vary with Distance to Marsh?

As discussed in chapter 34, one can employ the "number of sherds/m^3" as a proxy for density of occupation, and figure 30.15 plots this index against distance to marsh for both the eastern and western marsh margins of St. Catherines Island. Both parametric and nonparametric correlation coefficients demonstrate a lack of relationship between density of potsherds and the distance to marsh for the Irene components of the Pleistocene core.

Marshside Settlements on the Holocene-Age Beach Ridges

Figure 30.16 plots the distance to marsh for the Irene period archaeological components and landscape located on the southern Holocene beaches of St. Catherines Island. Table 30.8 tallies the results for the K-S one-sample/Lilliefors test for the archaeological components on the southern beach ridges. Whereas Irene period components are consistent with normal/lognormal expectations, the distribution of Irene landscapes follow only a lognormal distribution (with a significant difference of $p = 0.036$ indicated for normal comparisons).[12]

Relative to comparable Irene-age settlements on the Pleistocene core, the archaeological components and landscape elements are considerably closer to the Holocene beach ridge margins. The mean distance to marsh for the Pleistocene core components are 212 ± 171 m and are 292 ± 297 m for western and eastern marshland settlements, respectively. But on the southern Holocene beach ridges, the distance to marsh decreases to 115 ± 143 m. While this difference lacks statistical significance, it is clear that the reduced patch sizes available in the Holocene beach terrain effectively miniaturizes the central place relationships.

In light of such "miniaturization", one might ask whether larger Irene components tend to be found on the largest hammocks that make up the southern Holocene beach ridges. Figure 30.17 charts this relationship, plotting "hammock size" (expressed in km^2) for the $n = 31$ discrete hammocks evident on the southern end of St. Catherines Island The nonparametric correlation ($r_S = 0.209$) does not significantly differ from zero, demonstrating a lack of relationship between the size of a southern beach hammock and the Irene period components found there.

Table 30.5 summarizes the various goodness-of-fit statistics for Irene period settle-

Southern Holocene Beach Ridge Settlements

Components (n = 12)
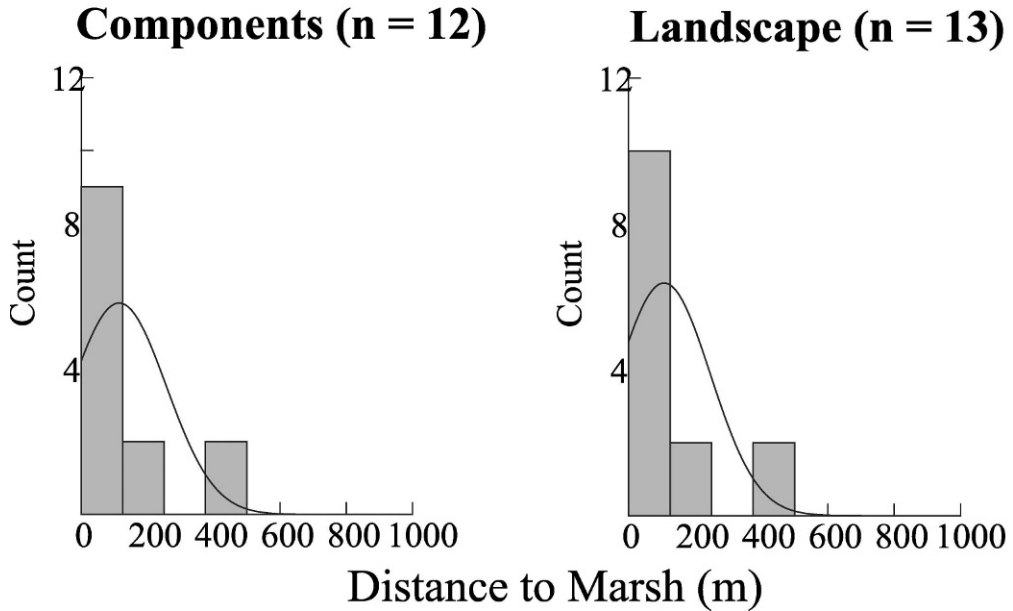
Landscape (n = 13)

Fig. 30.16.   Irene period components and landscapes on the southern Holocene beach ridges of St. Catherines Island.

ments and landscapes. The concluding section of this chapter explores the relevance of central place foraging theory to St. Catherines Island archaeology.

IRENE PERIOD OUTLIERS

Outliers can, beyond question, skew the sample results, but (as noted above) researchers must be cautious in removing extreme values (to avoid "cooking" the data toward favorable results). All empirical comparison presented in this chapter will retain all observed variates (extreme or not) when computing sample statistics, to avoid biasing the outcome. The most extreme outliers will be discussed here because of their potential to explicate the meaning of unexpected archaeological results.

With respect to the marshside settlements on the Pleistocene island core, the most extreme Irene period components are well beyond 0.5 km from the marsh margin, and the question becomes: Can such sites, located so far from the marsh, still be properly

considered as "marshside" instead of "inland"?

The most extreme Irene period deviation along the western marsh is 9Li240, located 740 m inland (figs. 30.6 and 30.13). This small shell scatter contains both Irene and Wilmington and Irene period components. The idealized normal distribution in figure 30.8 predicts that 9Li240 should be only 560 m from southern edge of Northwestern Marsh. But examining this prediction against the topography and soil distributions of St. Catherines Island, we find that the central place foraging projection lands in a small patch of Rutledge fine sand (indicating the presence of a freshwater pond at this location during Irene times). Because 9Li240 was sited immediately to the east of this small lagoon, it deviates from the "ideal" normal distribution.

South New Ground Field 6 (9Li193) is another outlier in figure 30.8. This small, buried shell lens, perhaps a lone pit feature, contained winter/spring-harvested clams. It

TABLE 30.8
Summary of Distance to Marsh Relationships

Location	n	Normal distribution	Lognormal distribution	Significant skewness?	Significant kurtosis?	Uniform distribution
Altamaha Period						
Western marsh: components	6	No ($p = 0.022$)	Yes ($p = 1.00$)	Yes: skewed to right	Yes: peaked distribution	No ($p = 0.010$)
Western marsh: landscape	11	No ($p = 0.002$)	Yes ($p = 0.275$)	Yes: skewed to right	Yes: peaked distribution	No ($p = 0.001$)
Eastern marsh: components	—	—	—	—	—	—
Southern beach: components	—	—	—	—	—	—
Southern beach: landscape	3	Yes ($p = 1.000$)	Yes ($p = 0.396$)	No	No	Yes ($p = 0.778$)
Irene Period						
Western marsh: components	23	Yes ($p = 0.560$)	Yes ($p = 0.072$)	Yes: skewed to right	Yes: peaked distribution	No ($p = 0.001$)
Western marsh: landscape	33	Yes ($p = 0.101$)	Yes ($p = 158$)	Yes: skewed to right	No	No ($p = 0.000$)
Eastern marsh: components	16	Yes ($p = 0.104$)	Yes ($p = 0.832$)	Yes: skewed to right	No	No ($p = 0.006$)
Eastern marsh: landscape	20	Yes ($p = 0.286$)	Yes ($p = 0.243$)	No	No	No ($p = 0.012$)
Southern beach: components	13	Yes ($p = 0.052$)	Yes ($p = 0.249$)	Yes: skewed to right	No	No ($p = 0.007$)
Southern beach: landscape	15	No ($p = 0.036$)	Yes ($p = 0.241$)	No	No	No ($p = 0.002$)
St. Catherines Period						
Western marsh: components	9	Yes ($p = 0.510$)	Yes ($p = 0.288$)	No	Yes: flattened distribution	No ($p = 0.000$)
Western marsh: landscape	22	Yes ($p = 0.076$)	No ($p = 0.031$)	No	No	No ($p = 0.011$)
Eastern marsh: components	7	No ($p<0.000$)	Yes ($p = 0.243$)	Yes: skewed to right	No	No ($p = 0.000$)
Eastern marsh: landscape	14	No ($p = 0.34$)	Yes ($p = 0.508$)	Yes: skewed to right	No	No ($p = 0.004$)
Southern beach: components	4	No ($p = 0.015$)	Yes ($p = 0.222$)	Yes: skewed to right	Yes: peaked distribution	No ($p = 0.017$)
Southern beach: landscape	5	Yes ($p = 0.185$)	Yes ($p = 1.00$)	No	No	Yes ($p = 0.109$)
Wilmington Period						
Western marsh: components	14	Yes ($p = 0.084$)	No ($p = 0.002$)	No	No	Yes ($p = 0.314$)
Western marsh: landscape	27	Yes ($p = 0.057$)	No ($p = 0.002$)	No	No	No ($p = 0.009$)
Eastern marsh: components	11	Yes ($p = 0.817$)	Yes ($p = 0.539$)	No	No	Yes ($p = 0.180$)
Eastern marsh: landscape	16	Yes ($p = 0.220$)	Yes ($p = 0.539$)	No	No	No ($p = 0.008$)
Southern beach: components	1	—	—	—	—	—
Southern beach: landscape	4	Yes ($p = 0.331$)	Yes ($p = 0.301$)	No	No	Yes ($p = 0.187$)

TABLE 30.8—(Continued)

Location	n	Normal distribution	Lognormal distribution	Significant skewness?	Significant kurtosis?	Uniform distribution
Refuge-Deptford Period						
Western marsh: components	7	No ($p = 0.018$)	Yes ($p = 0.573$)	Yes: skewed to right	No	No ($p = 0.009$)
Western marsh: landscape	23	Yes ($p = 0.173$)	Yes ($p = 0.283$)	Yes: skewed to right	No	No ($p = 0.004$)
Eastern marsh: components	7	Yes ($p = 1.00$)	No ($p = 0.014$)	No	No	Yes ($p = 0.674$)
Eastern marsh: landscape	18	No ($p = 0.008$)	Yes ($p = 0.220$)	No	No	No ($p = 0.004$)
Southern beach: components	1	—	—	—	—	—
Southern beach: landscape	1	—	—	—	—	—
St. Simons Period						
Western marsh: components	1	—	—	—	—	—
Western marsh: landscape	10	No ($p = 0.046$)	Yes ($p = 0.070$)	No	No	No ($p = 0.000$)
Eastern marsh: components	9	Yes ($p = 0.057$)	Yes ($p = 0.400$)	No	No	Yes ($p = 0.107$)
Eastern marsh: landscape	13	No ($p = 0.005$)	Yes ($p = 0.128$)	No	No	No ($p = 0.000$)
Southern beach: components	—	—	—	—	—	—
Southern beach: landscape	—	—	—	—	—	—
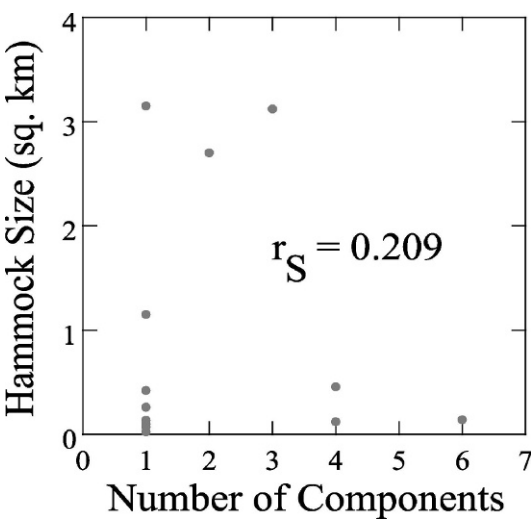
Fig. 30.17. Comparison of hammock size to number of Irene period archaeological components on the southern Holocene beach ridge complex on St. Catherines Island.

lies 560 m from the eastern marsh edge, on a broad band of Foxworth soil that extends across the entire breadth of St. Catherines Island (because the central freshwater swale does not extend this far south). Nearby is South New Ground Field 3 (9Li222), a small, four-season site, located on a narrow band of Echaw/Centenary fine sand. Both sites were constructed on high ground (at an elevation of 6.1 m), perhaps denoting a relatively ''hickory ridge'' habitat.

ST. CATHERINES PERIOD SETTLEMENTS (CAL A.D. 800–A.D. 1300)

At the beginning of the St. Catherines period (about cal A.D. 800), the remnants of Guale Island protected the extensive Guale Marsh that reached southward past Hoke's Dock to the northern end of Cracker Tom Hammock, with the tidal inlet likely north of the present-day McQueens Inlet. The southern Holocene beach ridge complex terminated somewhere immediately to the south of Beach Pond.

Figure 30.18 shows the distribution and seasonality of the 19 archaeological components (and 39 landscape indicators) attributable to the St. Catherines period (table 30.2).

The northern end of St. Catherines Island contains a relatively sparse occupational record during the St. Catherines period, with no evidence that the Northwestern Marsh was exploited during this interval. Seasonal estimates are available from only two sites on the northern end of the island: 9Li171 was occupied during all four seasons and 9Li22 had evidence of three-season (December–September) occupation. All five of the St. Catherines period sites (on the northern end of the island) stand within 700 m of Marys Mound (9Li20), which was erected during the St. Catherines period.

The central island core contains evidence of 11 St. Catherines era occupations (accounting for 26.8% of the known assemblages from this period). Four of these sites are arrayed along the western margin of the island, ranging from Rock Field, Meeting House Field, and Long Field; 9Li230 shows evidence of a two-season (December–June) occupation. Three additional sites cluster near the Seaside marshland; one of these, 9Li233, also shows a two-season occupation (December–June).

Two midden sites at King New Ground Field date to the St. Catherines period; one of these, 9Li19, shows evidence of a four-season occupation. One kilometer to the south, 9Li183 has a three-season occupation (December–September).

Nearly half of the known St. Catherines period occupations occur on the southern island core. The primary site cluster runs along the Wamassee Scarp (from Persimmon Point southward to Wamassee Head) and extends eastward through South New Ground and Cunningham Fields. Seasonal estimates are available from five of these sites: one site (9Li15) was occupied during four seasons; 9Li198 was occupied during three seasons (December–September); 9Li200 and 9Li203 were occupied from December to June (two seasons); and 9Li185 was a winter-only site.

As indicated in figure 29.5, the apparent shoreline at cal A.D. 1000 extends along the northern margin of transect M-1 (immediately to the south of 9Li164), just north of the upper reaches of Brunsen Creek. By the end of the St. Catherines period, the southern beachline prograded significantly southward, at least to the south of the "Line 43" relict marsh, and four St. Catherines era sites were recorded here. 9Li165, a summer through spring occupation, extends along the south bank to the end of the point that runs along the margin of Camp Creek. Two additional sites, 9Li203 and 9Li214, show evidence of winter and spring occupation; with 9Li214 occupied during the summer as well.

ARE ST. CATHERINES PERIOD SETTLEMENTS DISTRIBUTED IN NORMAL/LOGNORMAL FASHION RELATIVE TO THE MARSH EDGE OF THE PLEISTOCENE CORE?

Figure 30.19 compares the observed distributions of these archaeological components against the expected distribution based on the central place foraging model. As before, the extreme left-hand side of the frequency distribution represents the western (estuarine) marsh margin, with distance to marsh increasing toward the right portion of the x-axis. The distribution of marshside settlements along the eastern (seaward) margins appears along the extreme right-hand margin in figure 30.19, with the distance to marsh increasing along the x-axis (toward the left).

The middle curve of figure 30.19 arrays the empirically observed distribution of the 16 St. Catherines period components in the Island-wide sample. The nine western marshside settlements average 250 ± 225 m from the marsh margin. The eastern marshside settlements average much closer to the marsh edge (196 ± 196 m), but the distribution is clearly bimodal, with all but one of the sites clustering within 125 m of the marsh edge.

Figure 30.20 arrays these same data in a different graphic format. The probability plot at the left shows the St. Catherines period components as distributed along the western marsh margin. The upper left of figure 30.20 plots the expectations based on a normal distribution; at the lower left are expectations from a lognormal frequency distribution. The Lilliefors test generates
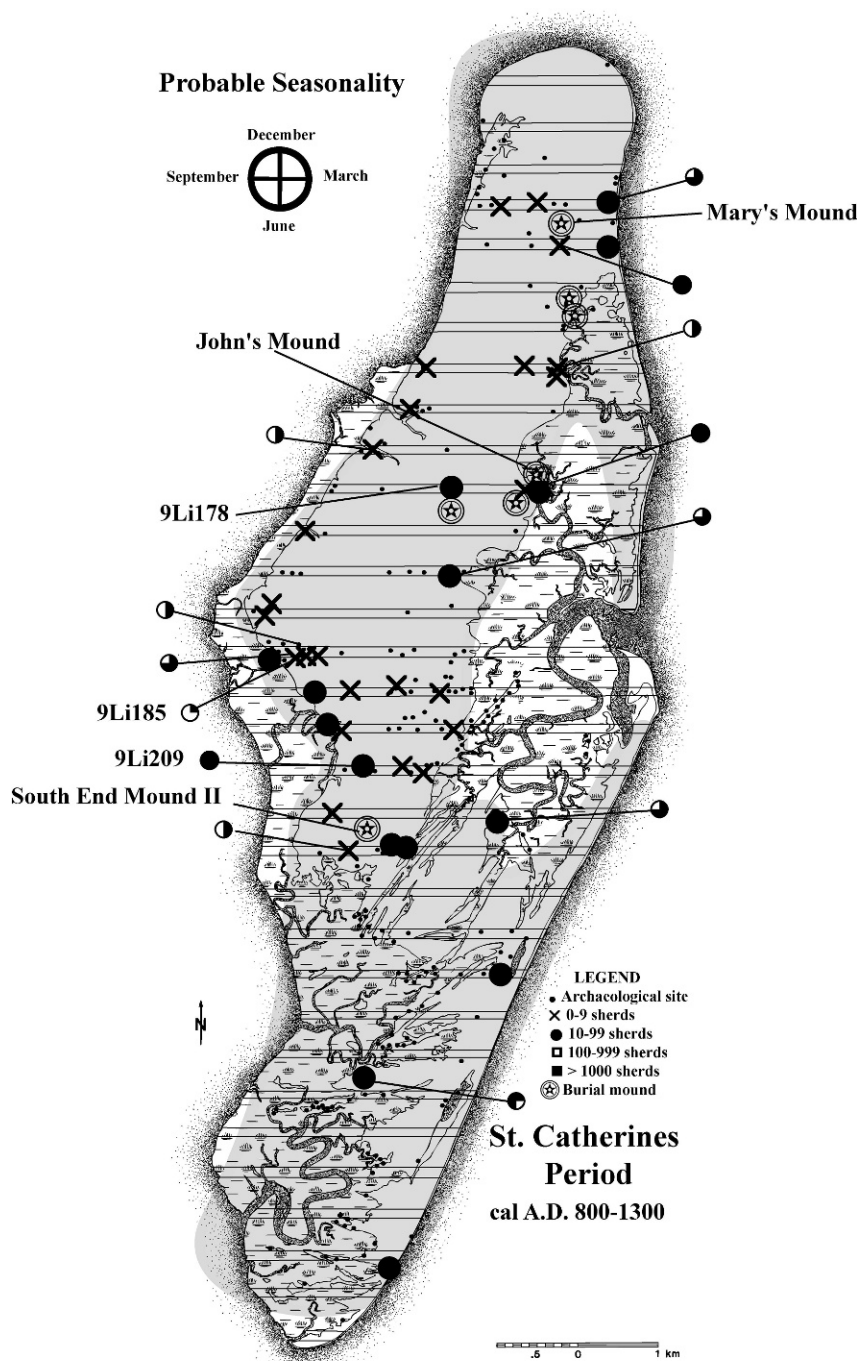
Fig. 30.18.   Seasonal distribution of archaeological components from the St. Catherines period on St. Catherines Island.

Central Place Foraging Model

Fig. 30.19.   Archaeological evidence from the St. Catherines period compared to the Central Place Foraging model for marshside settlements on the Pleistocene core of St. Catherines Island.

Fig. 30.20.   Comparison of normal and lognormal theoretical models to the distribution of St. Catherines period archaeological components on the Pleistocene core of St. Catherines Island.

associated probability values of $p = 0.510$ for the lognormal model and $p = 0.288$ for the lognormal distribution. Whereas the lognormal model more closely corresponds to the empirical observations, the distribution of St. Catherines period components along the western marshland is consistent with expectations from *both the normal and lognormal distributions* (because in neither case do the associated probability values fall into the critical region of $p < 0.05$ necessary to reject the null hypothesis).

A different situation pertains to the distribution of St. Catherines components along the eastern marsh edge. Although the components are consistent with a lognormal distribution ($p = 0.243$), they differ from normal expectations ($p < 0.000$). The outlier here is 9Li178, a medium-sized, two-season (winter and springtime) site located inside Greenseed Field.

Table 30.5 sets out the associated Coefficients of Skewness and Kurtosis. As with the Irene period components, three of the

Western Marsh Settlements

p = 0.076

Expected Value for Normal Distribution

Distance to Marsh (m)

Eastern Marsh Settlements

p = 0.034

Expected Value for Normal Distribution

Distance to Marsh (m)

Landscape (n = 36)

p = 0.031

Expected Value for Lognormal Distribution

Distance to Marsh (m)

p = 0.508

Expected Value for Lognormal Distribution

Distance to Marsh (m)

Fig. 30.21.   Comparison of normal and lognormal theoretical models to the St. Catherines period landscape on the Pleistocene core of St. Catherines Island.

four coefficients differ significantly from zero. This means that the distribution of St. Catherines period archaeological components along the western marshline is significantly peaked (relative to expectations under the normal/lognormal frequency distributions). The lone outlier significantly skews distribution of St. Catherines period settlements along the eastern island marsh margin.

The configuration of the *archaeological landscape* for the St. Catherines period appears at the bottom of figure 30.21. The 36

landscape indicators are distributed in normal fashion along the western marsh and in lognormal distribution along the eastern marsh (which has a significant degree of skewness, meaning that the distribution is skewed toward the right).

This analysis answers the initial question posed by the central place foraging model: *Are the St. Catherines settlements found in normal/lognormal distribution relative to the marsh edge on the Pleistocene core?* Although the fit is not quite as precise as that for the Irene period, table 30.8 clearly de-

monstrates that no matter how the St. Catherines period landscape and components are partitioned, each observed distribution is clearly consistent with either the normal or the lognormal theoretical frequency distributions; two-thirds of the St. Catherines period distributions are consistent with *both* the normal and lognormal expectations.

The contrasting diet-breadth model assumes a homogeneous resource distribution, which if true, would create a distinctive, uniform frequency distribution of archaeological components and landscapes. The contrasting observed and expected uniform distribution of variates for the western and eastern sides of the Pleistocene core and the southern beach ridge complex are summarized in table 30.8. None of the observed–expected comparisons for St. Catherines period components and landscapes on the Pleistocene core are consistent with the uniform theoretical distribution.

DOES DISTANCE TO THE MARSH VARY BY SEASON FOR ST. CATHERINES PERIOD SETTLEMENTS?

Seasonal estimates are available from 13 archaeological components dating to the St. Catherines period, representing three dozen seasonally-specific components, distributed as follows: winter, 36 percent; spring, 31 percent; summer, 22 percent; and fall, 11 percent.

Figure 30.22 plots the distribution of the seasonally specific St. Catherines period components across the Pleistocene core of St. Catherines Island. Throughout the archaeological sequence, such fall occupations are underrepresented (likely due to the importance of mast harvest, but the lack of paleobotanical evidence masks this activity). The small sample size makes pattern recognition difficult, but we see nothing in the empirical histograms to suggest a relationship between the distance to marsh and site seasonality. Table 30.7 confirms this suspicion. While it is true that summer components are extremely close to the edge of the eastern marsh (average 30.5 ± 24.8 m), the small sample size ($n = 2$) undermines

any meaningful comparison. We see no significant seasonal differences with respect to the distance to marsh statistics during the St. Catherines period.

DOES ST. CATHERINES PERIOD SITE SIZE VARY WITH DISTANCE TO THE MARSH?

St. Catherines period assemblages tend to be smaller and less frequent than occupations during the later Irene period. Looking strictly at the Island-wide transect survey results, we estimate that St. Catherines period settlements accumulated at a rate of only 4.0 components/century (compared with a rate of 17.3 components/century for the Irene period; see table 30.2 and chap. 34).

Figure 30.23 shows no particular relationship between the size of a St. Catherines period settlement and its distance to the marsh margin. Along the eastern marsh edge, virtually all St. Catherines period sites are "medium" in size (i.e., ranging between 50 and 500 m^2) and they range broadly in distance to the marsh ($r_S = 0.524$). Along the western marsh margin, St. Catherines period site size varies widely, but there is no particular trend toward size sorting ($r_S = -0.310$). Neither of these relationships is statistically significant.

We conclude that the size of a central place has no relationship to the distance to marsh for the St. Catherines period components on the Pleistocene core of St. Catherines Island.
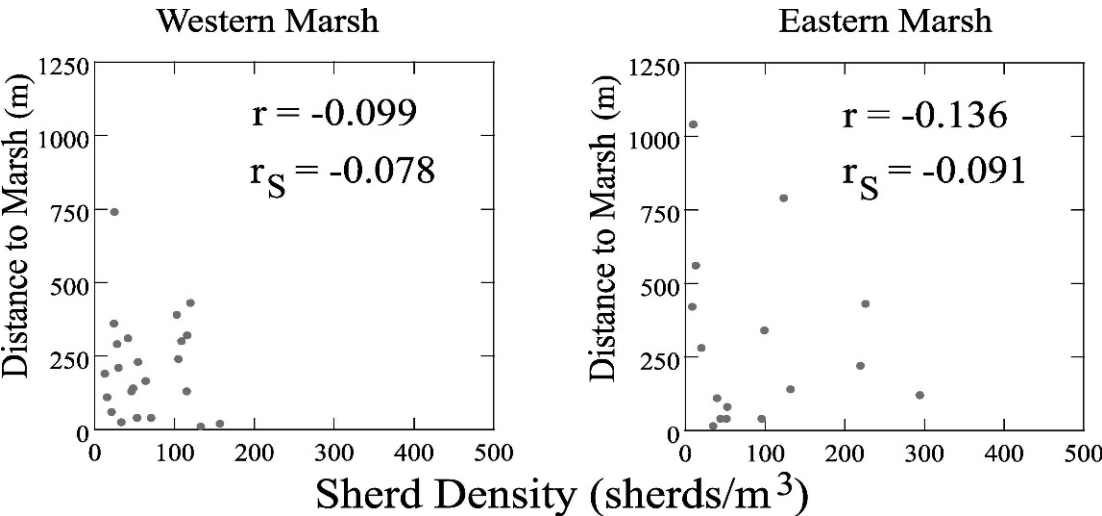
DOES INTENSITY OF OCCUPATION OF ST. CATHERINES PERIOD COMPONENTS VARY WITH DISTANCE TO MARSH?

Figure 30.24 plots the density of occupation (operationally defined as the number of sherds/m^3 of excavated deposit) against distance to marsh for both the eastern and western marsh margins of St. Catherines Island. As indicated by the nonparametric correlation coefficients, there is no demonstrable relationship between the intensity of occupation and the distance to marsh for the St Catherines period components of the Pleistocene core.
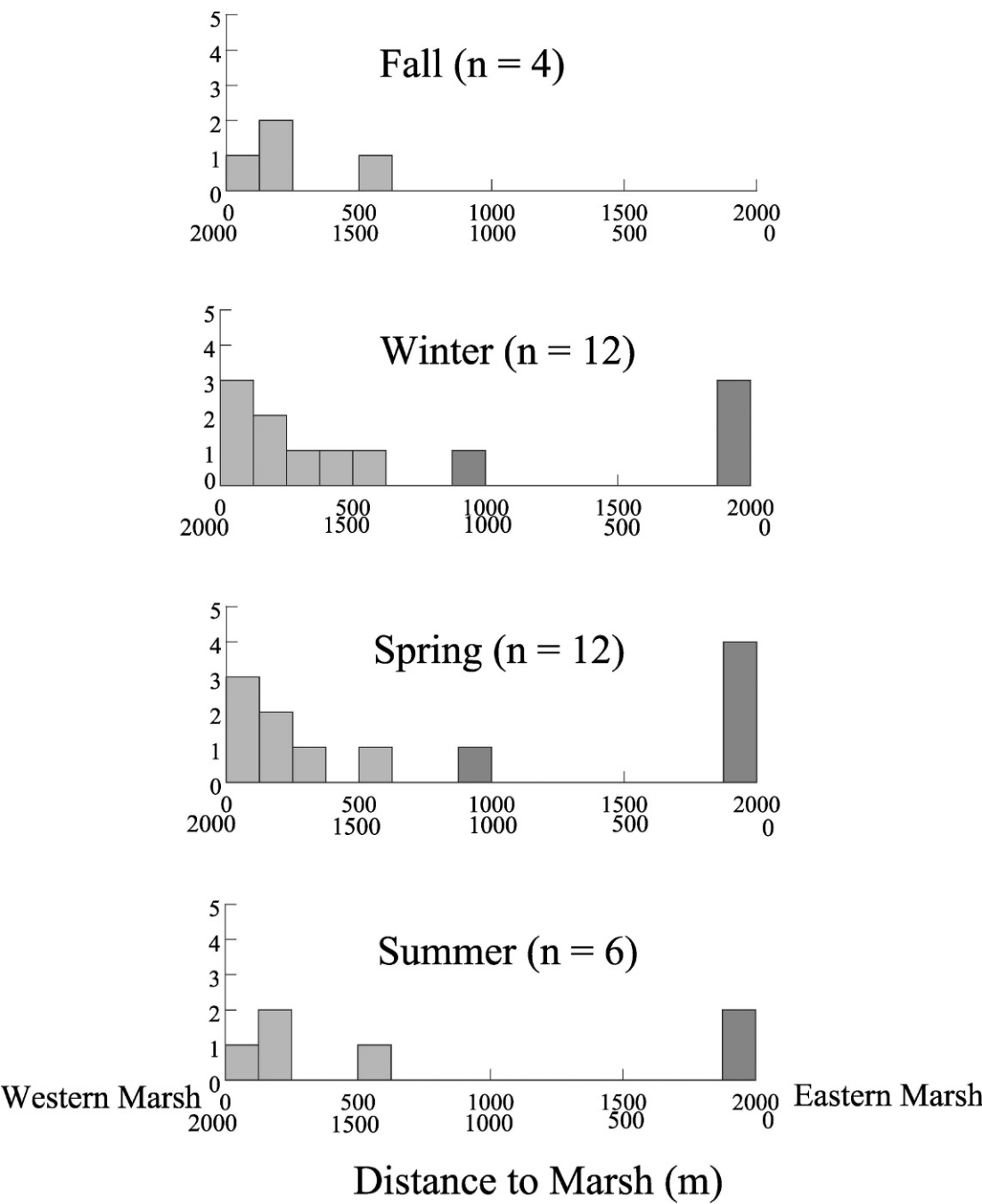
Fig. 30.22. The seasonal distribution of St. Catherines period components relative to Distance to Marsh on the Pleistocene core of St. Catherines Island.

Western Marsh

Eastern Marsh

Inferred Subsurface Extent (m^2)
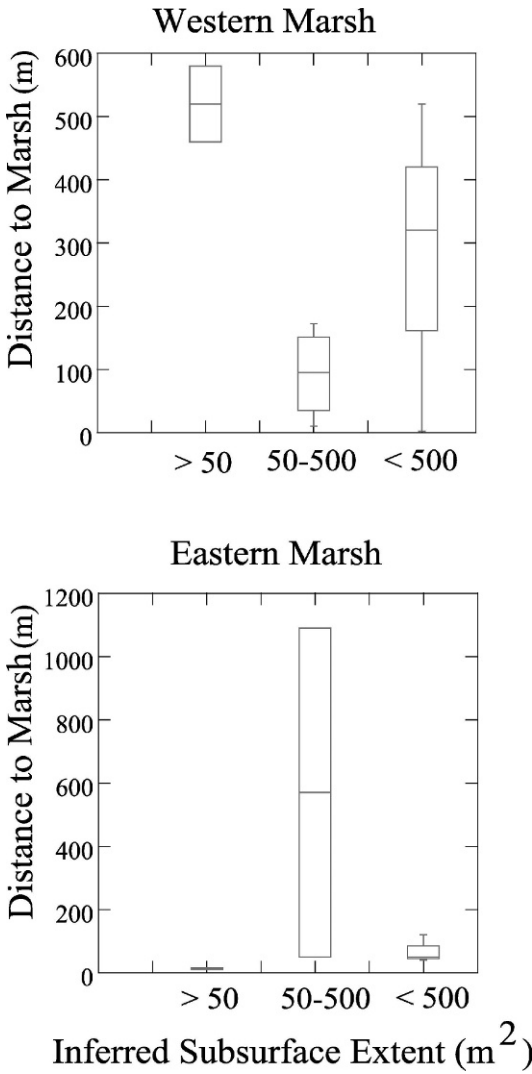
Fig. 30.23.   The relationship of size (measured as inferred subsurface extent) of St. Catherines period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

MARSHSIDE SETTLEMENTS ON THE
HOLOCENE-AGE BEACH RIDGES

Figure 30.25 plots the distance to marsh for the archaeological components and landscape of the St. Catherines period settlements on the southern Holocene beaches of St. Catherines Island (see also tables 30.2 and 30.3).

When viewed against comparable St. Catherines-age settlements of the Pleistocene core, the archaeological components and landscapes of the Holocene beach ridge margins are miniaturized. The mean distances to marsh for the Pleistocene core components are 250 ± 225 m and 196 ± 396 m for western and eastern marshland settlements, respectively. But on the south-

Western Marsh

Eastern Marsh

Sherd Density (sherds/m³)
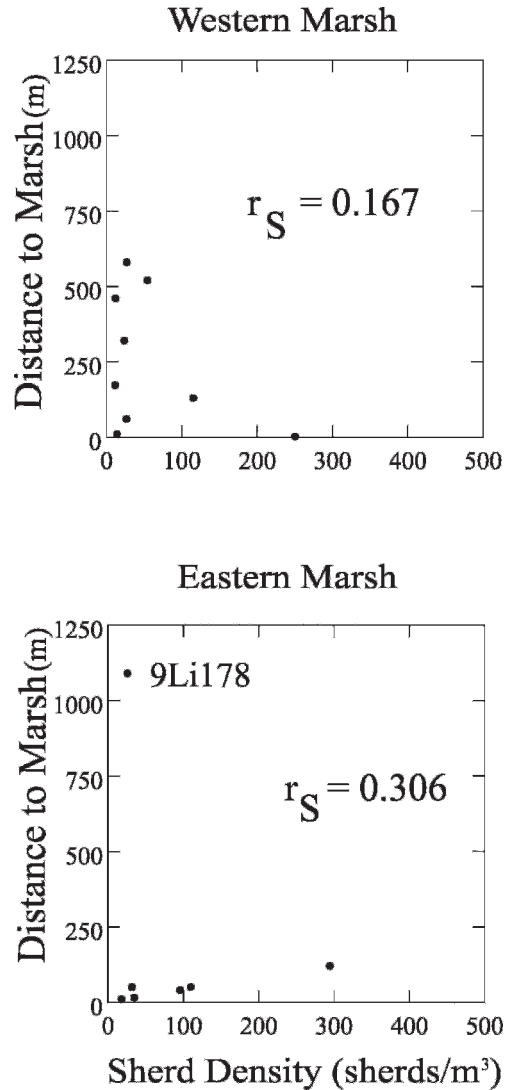
Fig. 30.24.   The relationship of occupational intensity (measured as sherd density) of St. Catherines period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.
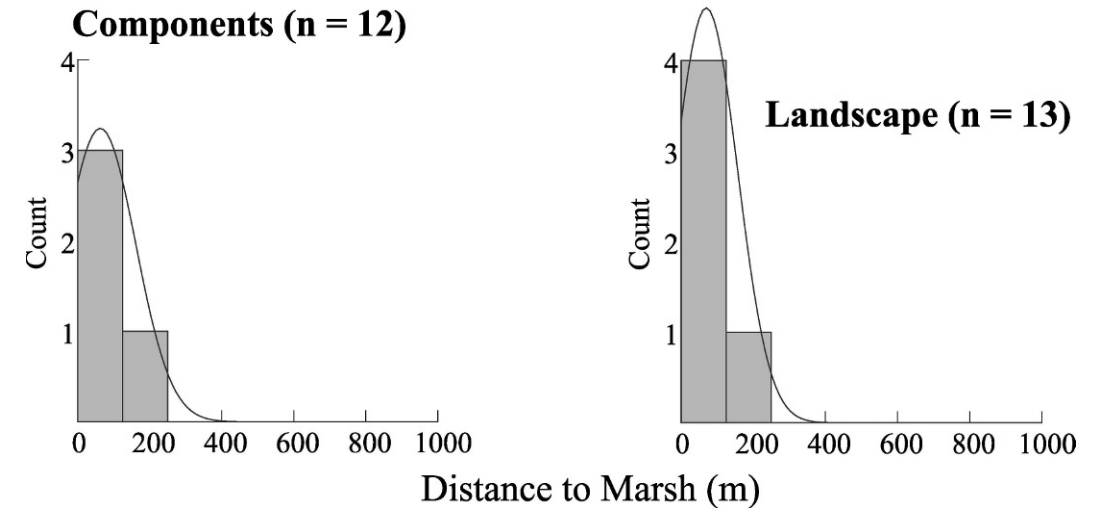
Fig. 30.25. St. Catherines period components and landscapes on the southern Holocene beach ridges of St. Catherines Island.

ern Holocene beach ridges, the distance to marsh for St. Catherines period components is only 63 ± 99 m, reflecting the dramatically fragmented patches of the Holocene beach terrain. Similar relationships hold for the St. Catherines period landscape (table 30.2), but due to the variability and small sample size involved, the results lack statistical significance.

Table 30.8 presents the results from goodness-of-fit testing between expected and observed frequencies for the southern Holocene beach ridges. The distribution of St. Catherines period components ($n = 4$) is consistent with the theoretical lognormal model ($p = 0.222$), with a significant degree of skewness (to the right) and positive kurtosis (meaning the distribution is peaked, with smaller than expected tails). The landscape distribution is consistent with both normal and uniform expectations, but the small sample size does not allow adequate discrimination between theoretical and observed values. But the small sample sizes involved inspire little confidence in these results.

ST. CATHERINES PERIOD OUTLIERS

Although central place foraging expectations appear to account for a considerable amount of variability in the St. Catherines settlement pattern, several outliers are themselves quite informative (see figs. 30.19 and 30.21).

Three St. Catherines period sites are located in an inland, lacustrine setting, bordering the once expansive freshwater meadow that once dominated the central swale of St. Catherines Island. Rice Field 2 (9Li185) is located on the Echaw/Centenary soil, immediately adjacent to a patch of Rutledge series soils. This small site, located 460 m east of the marsh, consists of a dense, buried shell deposit. The extraordinarily consistent incremental pattern on *Mercenaria* from this site strongly suggests a single wintertime harvest.

Near Wamassee Pond, 9Li224 is located 580 m inland from the western marsh. This is the only site known to exist on Ellebelle loamy sand, a very poorly drained soil common to depressions, bays, and large drainage ways, immediately to the east of a freshwater meadow/lagoon. This site was initially occupied during the Wilmington period, with a secondary St. Catherines period component.

Greenseed Field 1 (9Li178) is located 1090 m inland, where a long, narrow band

of Echaw/Centenary fine sand defines the inland margin of the eastern swale, with its characteristic long, linear freshwater swamp.

The final outlier, at Cunningham Field (9Li209), is different. Located 520 m from the western marsh margin, 9Li209 occurs on a broad expanse of Foxworth fine sand, without any apparent freshwater connections. This four-season site consists of several deposits of subsurface shell and low mounds, located to the south of the Cunningham burial mound complex (which had apparently been abandoned, at least for mortuary purposes, during the St. Catherines period). The Cunningham Field site was initially used during the Wilmington period, with settlement carried forward into St. Catherines times.

WILMINGTON PERIOD
SETTLEMENTS (CAL A.D. 350–A.D. 800)

During the Wilmington period, remnants of Guale Island remained along the northeastern margin of the Pleistocene core of St. Catherines Island (fig. 30.26). At that time, Guale Island still protected the extensive inter-island Guale Marsh that reached southward past Hoke's Dock to the northern end of Cracker Tom Hammock. The primary tidal inlet to this marsh was probably still north of the present location of McQueens Inlet. The southern beach ridge complex extended well beyond Hickory Hill and Long Marsh and terminated somewhere to the south of Beach Pond.

Table 30.8 details distribution for a total of 26 archaeological components dating to the Wilmington period, with an average of 2.74 components/century (considerably less than recorded for the succeeding St. Catherines period). From a landscape perspective, a total of 47 Wilmington period occupations were located in the Island-wide systematic transect survey (see fig. 30.26), for an overall accumulation of 4.95 occupations/century (roughly half of the St. Catherines phase total).

The overall density and distribution of Wilmington period occupations are positioned further than during the succeeding St. Catherines period. Site 9Li137 is a winter/spring site that overlooks Northwestern Marsh, and three sites (of unknown seasonal utilization) overlook North Beach; the latter three sites were presumably positioned near the northern extent of the great inland marsh. Two inland sites (9Li238 and 9Li240) were utilized during the wintertime (as was nearby 9Li139 during the preceding Refuge-Deptford periods). Immediately to the south of these sites stands Marys Mound (9Li20), where ceremonial activities may have begun during late Wilmington times.

Wilmington-era occupations on northern St. Catherines Island largely echo the patterns established during the preceding Refuge-Deptford periods (see below), except that (1) the Wilmington foragers began new mortuary activities on the northern end of the island and (2) habitation sites became increasingly sparse on the northern end of the island, undoubtedly reflecting the simultaneous southward migration of Guale Marsh.

Twelve Wilmington period occupations are known from the central island core, in a site cluster extending from Rock and Seaside fields southward into Long Field and King New Ground. Seasonal evidence is available from 9Li162, 9Li232, and 9Li178, each of them two- or three-seasonal occupations (with all four seasons represented).

More than half (25 of 47) of the known Wilmington age occupations were discovered on the southern island core, a dramatic increase in density from the preceding Refuge-Deptford periods. The Wilmington landscape runs from the Jesamin Finger/Persimmon Point area, eastward to South New Ground and Davy Fields, and southward to about Wamassee Head. Several Wilmington period occupations cluster along the present western margin of St. Catherines Island; but when occupied, these sites were probably situated some distance inland because the island core likely extended several hundred meters to the west between cal A.D. 350 and 800.

One small site (9Li187) is of particular interest. The lone test pit excavated here

Probable Seasonality

December
September ⊕ March
June

LEGEND
. Archaeological site
✕ 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds
⊛ Burial mound

Wilmington Phase
cal A.D. 350-800

N

1   .5   0   1 km
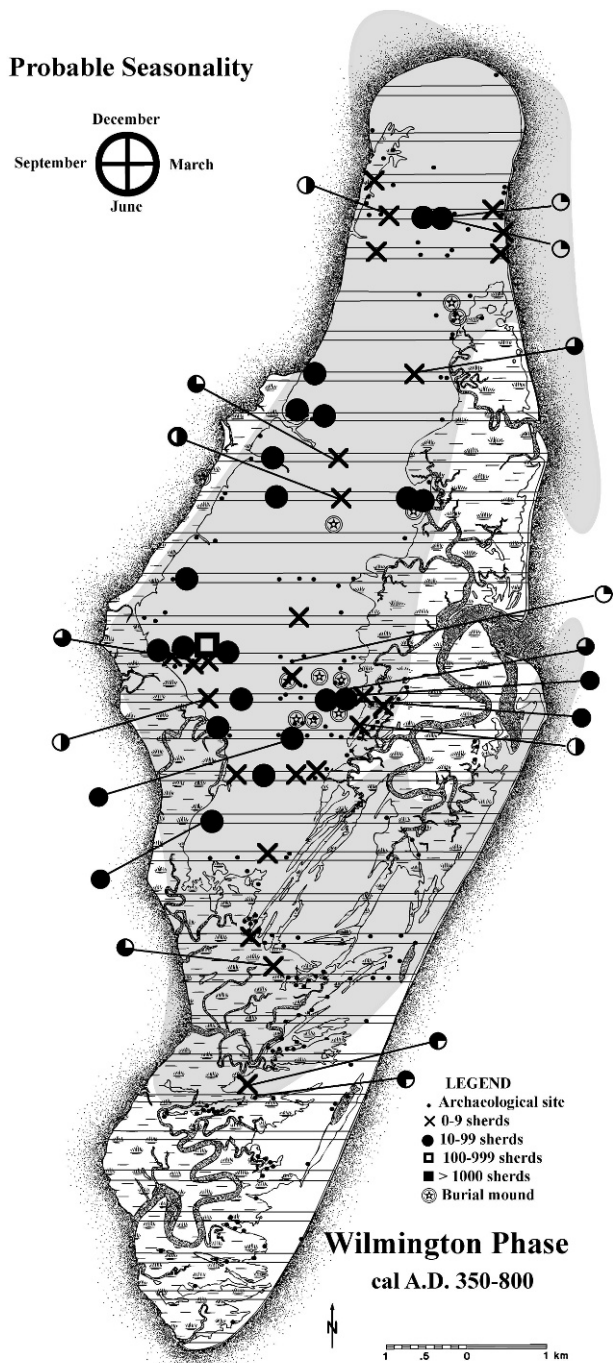
Fig. 30.26.   Seasonal distribution of Wilmington period archaeological components recorded in the Island-wide survey of St. Catherines Island.

revealed a shell-filled pit that contained no ceramics at all. The unusually clear-cut pattern of growth increments (evident in the 23 available hard clams) shows that the *Mercenaria* were harvested exclusively during the winter. A ^{14}C date processed on one of these clams yielded a date of cal A.D. 560–770, placing this aceramic site into the mid-Wilmington period.

Seasonal information is available from eight additional sites on the southern island core: Four of the Wilmington occupations contained four season occupations, two sites represented three seasons, and another site was occupied during at least two seasons. All seasons are well represented during the Wilmington occupation of the central island core.

The Cunningham Mound group was located within 1 km of the vast marshland surrounding McQueens Inlet and during the Wilmington period, this marshland extended southward nearly to Cracker Tom Hammock. Although well established during the preceeding Refuge-Deptford periods, the Cunningham Mound group was significantly expanded during Wilmington times.

Four Wilmington-age sites are known from the southern ridge complex, three of them in the Island-wide survey sample. 9Li97 is a dense, three-part shell midden draped across a long peninsula. All available hard clams were analyzed for seasonality, disclosing a three-season occupation from summertime through the winter. No ceramics were recovered, but a single radiocarbon date (Beta-183637) indicates that the midden accumulated during the late Wilmington period (cal A.D. 670–890).

The two additional Wilmington era sites on the southern beach ridge complex sites likewise indicated a three-season occupation. Site 9Li164 is located only a few dozen meters from 9Li97 (the aceramic site mentioned above), and both sites were occupied from summer through winter. *Mercenaria* from 9Li57, located 1500 m to the north, documented a March through December occupation.

To summarize, the incremental data from *Mercenaria*, seasonal estimates are available from 18 Wilmington period components on St. Catherines Island. The Island-wide archaeological survey documented a total of 48 seasonally specific components, distributed as follows: winter, 33 percent; spring, 27 percent; summer, 23 percent; and fall, 17 percent. Within the limits and biases of the techniques involved, it is clear that during the Wilmington period, St. Catherines Island was utilized during all seasons of the year.

ARE WILMINGTON SETTLEMENTS DISTRIBUTED IN NORMAL/LOGNORMAL FASHION RELATIVE TO THE PLEISTOCENE-AGE MARSH EDGE OF ST. CATHERINES ISLAND?

Figure 30.27 compares the observed distributions of these archaeological components and landscape manifestations from the Wilmington period against the expected distribution based on the central place foraging model.

In the distributions represented in figure 30.27, the extreme left-hand side of the diagram represents the western (estuarine) marsh margin, with distance to marsh increasing toward the right portion of the *x*-axis. The distribution of marshside settlements along the eastern (seaward) margins appear along the extreme right-hand margin, with the distance to marsh increasing along the *x*-axis (toward the left). The middle curve of figure 30.27 sets out the empirically observed distribution of the 25 Wilmington period components recorded in the Island-wide sample. The 14 *western marshside settlements* average 370 ± 264 m from the marsh margin. The *eastern marshside settlements* are similarly distributed relative to the marsh edge (374 ± 351 m).

Figure 30.28 arrays these same data as probability plots with the western and eastern marshside Wilmington period components arrayed against the theoretical normal/lognormal frequency distributions for identical means and variances. K-S/Lilliefors tests show that the distribution of Wilmington period components is generally consistent with normal/lognormal expectations (except for the western marshland

Central Place Foraging Model
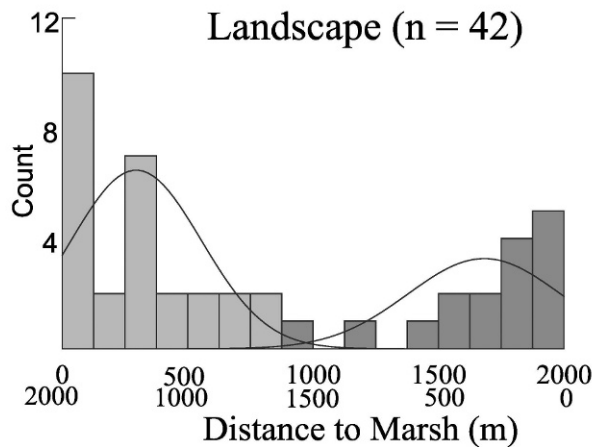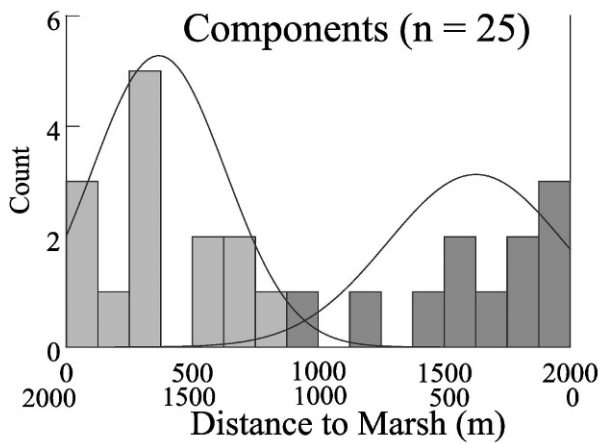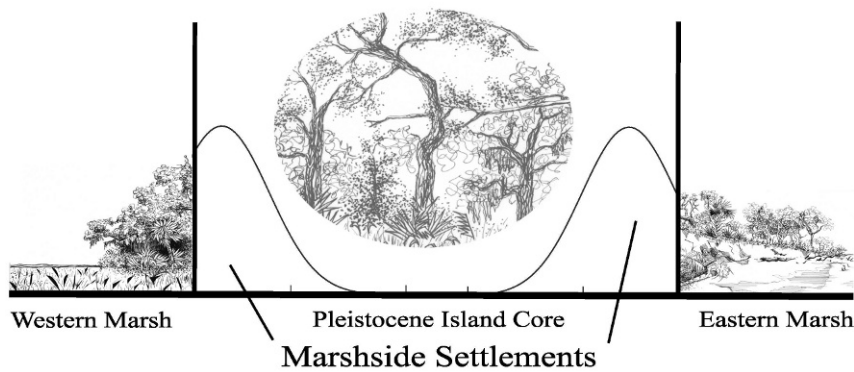
Fig. 30.27.   Archaeological evidence from the Wilmington period compared to the Central Place Foraging model for marshside settlements on the Pleistocene core of St. Catherines Island.
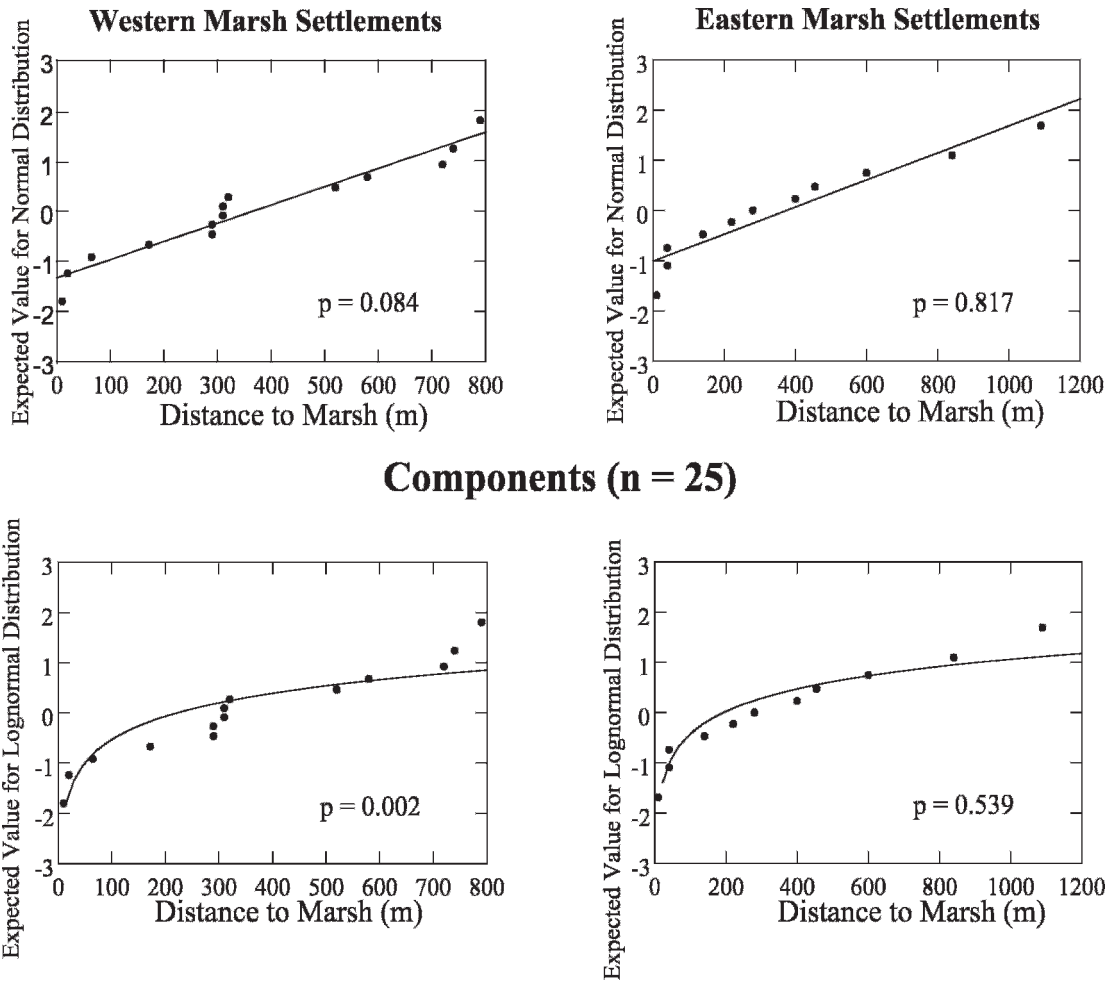
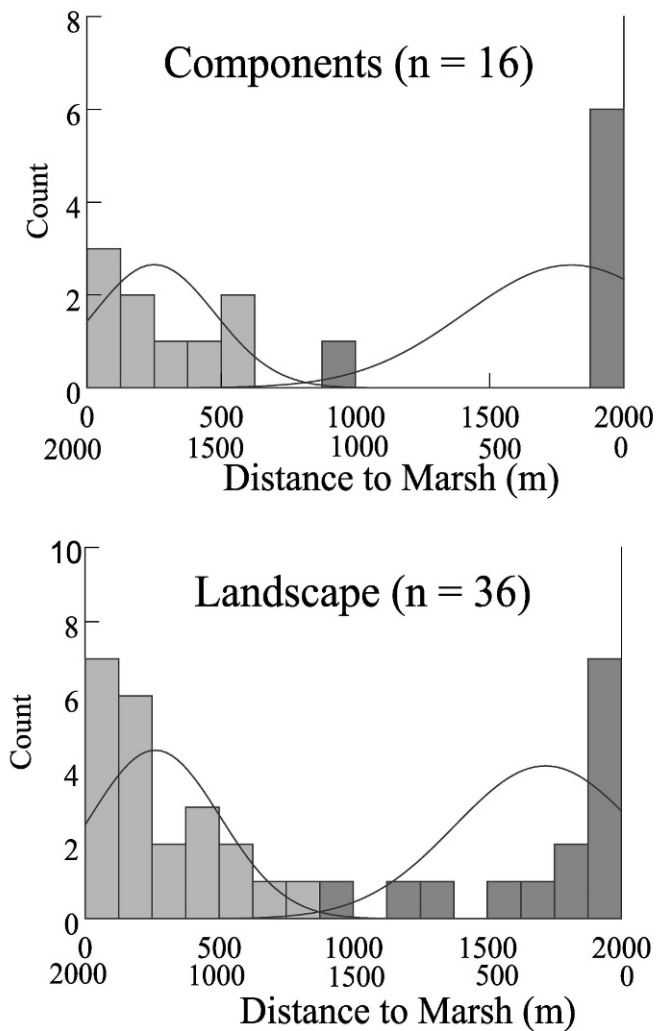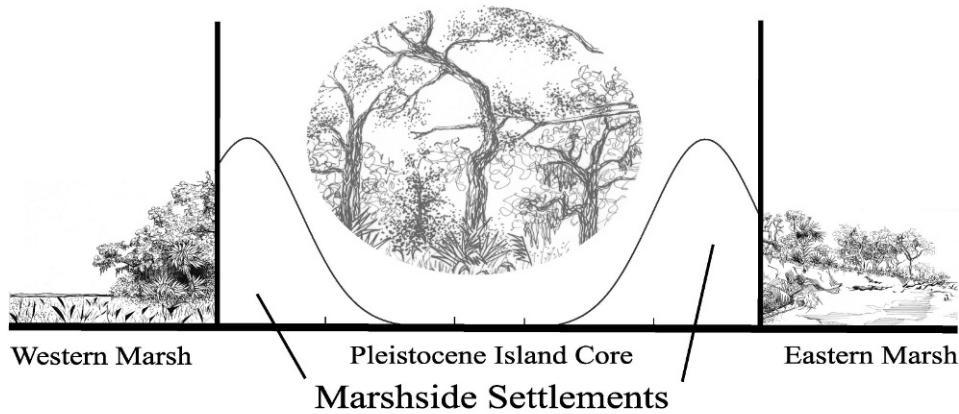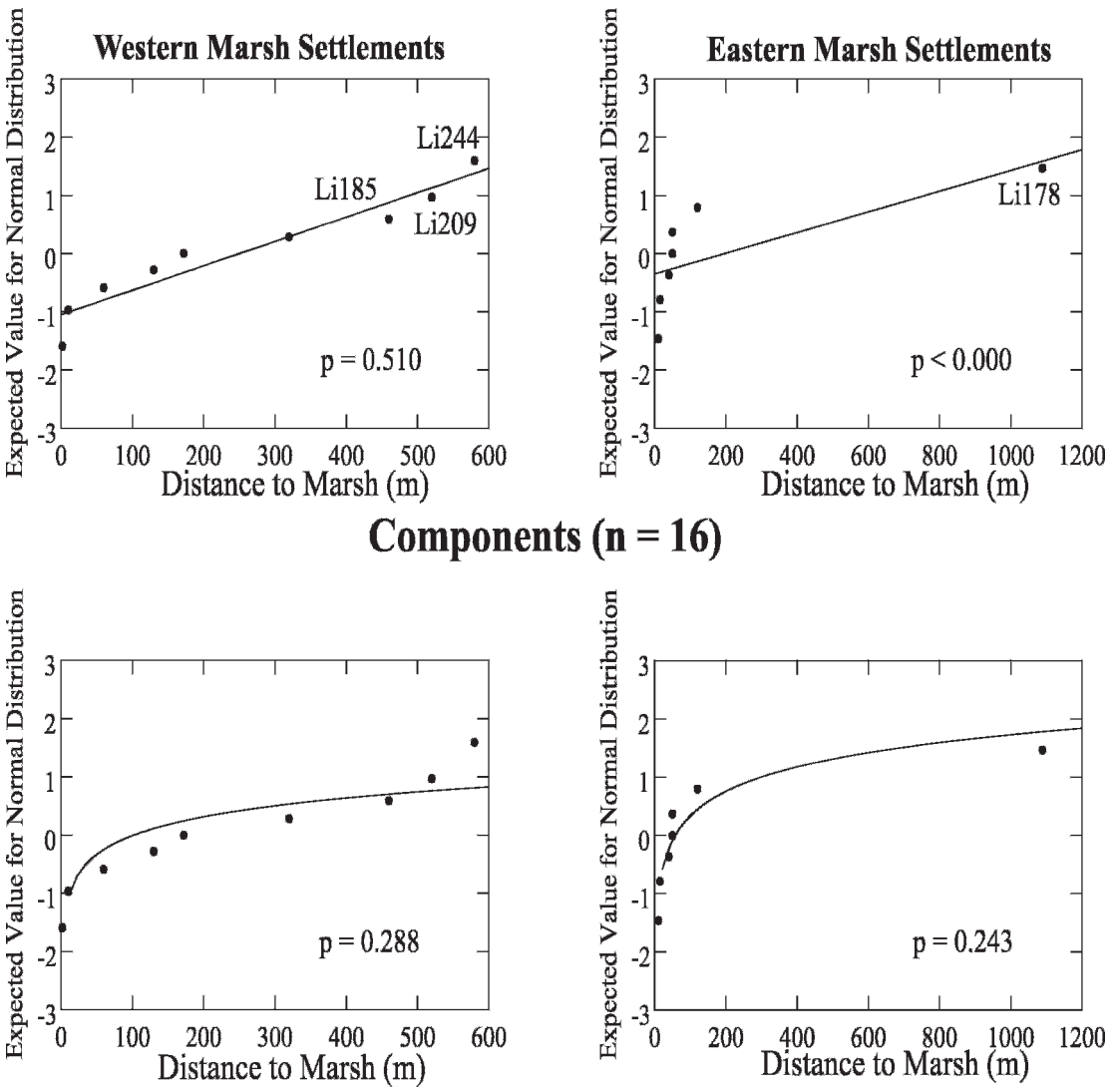Fig. 30.28.   Comparison of normal and lognormal theoretical models to the distribution of Wilmington period archaeological components on the Pleistocene core of St. Catherines Island.

central places, which differ significantly from expected lognormal frequencies). Identical relationships are evident for the distribution of landscape elements (fig. 30.27, bottom; fig. 30.29).

Tables 30.5 and 30.6 include the Coefficients of Skewness and Kurtosis for the Wilmington period components and landscapes. None of these coefficients are significantly different from zero, indicating that the archaeological distributions are neither skewed nor peaked/flattened with regard to expectations under the normal/lognormal model.

ARE WILMINGTON SETTLEMENTS UNIFORMLY DISTRIBUTED ACROSS THE PLEISTOCENE CORE OF ST. CATHERINES ISLAND?

The contrasting diet-breadth model assumes a homogeneous distribution of resources and raises the possibility of a similarly homogeneous distribution of archaeological evidence across the Pleistocene core of St. Catherines Island. Figure 30.30 frames this possibility in graphic fashion, comparing the observed distributions of Wilmington period archaeological components and landscapes against
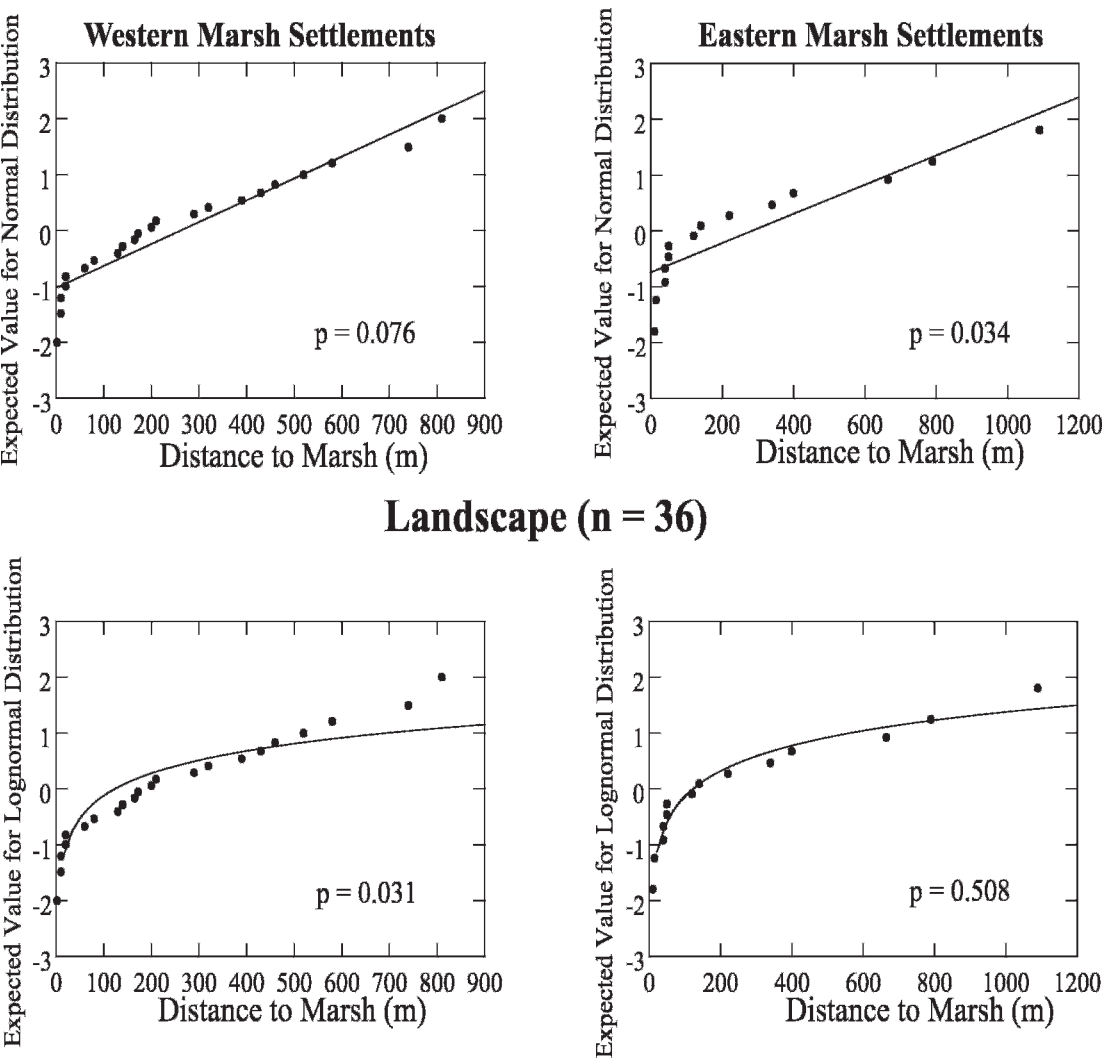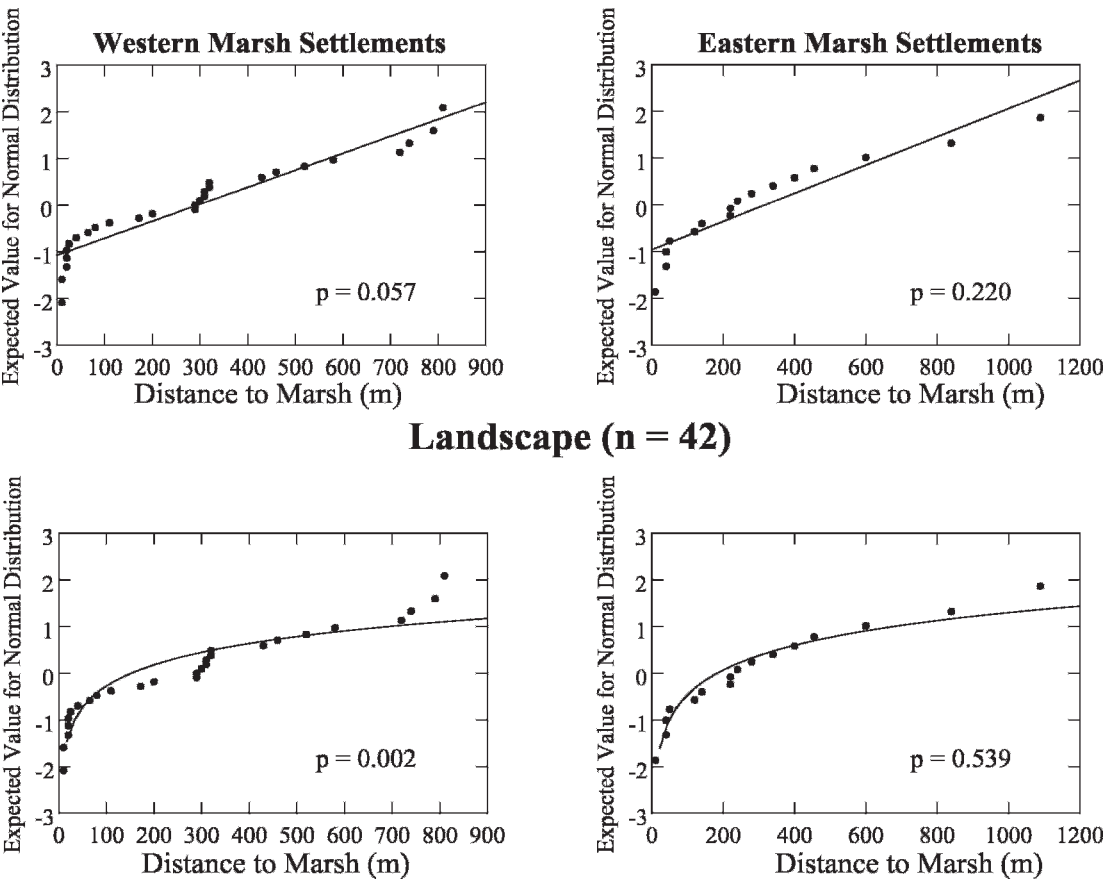
Fig. 30.29.   Comparison of normal and lognormal theoretical models to the Wilmington period landscape on the Pleistocene core of St. Catherines Island.

the expected uniform distribution of variates.

The upper curve in figure 30.30 sets out the *theoretical uniform distribution* of Wilmington settlements. The parameters of this idealized, uniform distribution are established by the smallest and largest values of distance to marsh (represented as *a* and *b*). The middle curve of figure 30.30 arrays the same empirically observed distribution of the 25 Wilmington period components as shown in figure 30.31, scaled with distance to marsh along the *x*-axis, with the *western Pleistocene core* shown to the left, and the *eastern Pleistocene core* on the right. The theoretical uniform distribution is stylized in figure 30.30, with the western and eastern dune ridges represented by blocks of histogram bars of equal length, separated

by a gap representing the uninhabitable central swale.

Figure 30.31 arrays these same data in terms of the cumulative frequency expected from a uniform distribution (with limits of *a* and *b*, as explained above). The lower two plots compare the expectations for the Wilmington period landscapes along the western and eastern Pleistocene cores; both patterns are inconsistent with uniform expectations (table 30.5). The upper two plots compare similar plots for the Wilmington period components. Goodness-of-fit tests demonstrate that both empirical distributions are consistent with uniform expectations. Wilmington landscapes on the southern Holocene beach ridges are likewise consistent with a theoretical uniform distribution.

Diet-Breadth Foraging Model
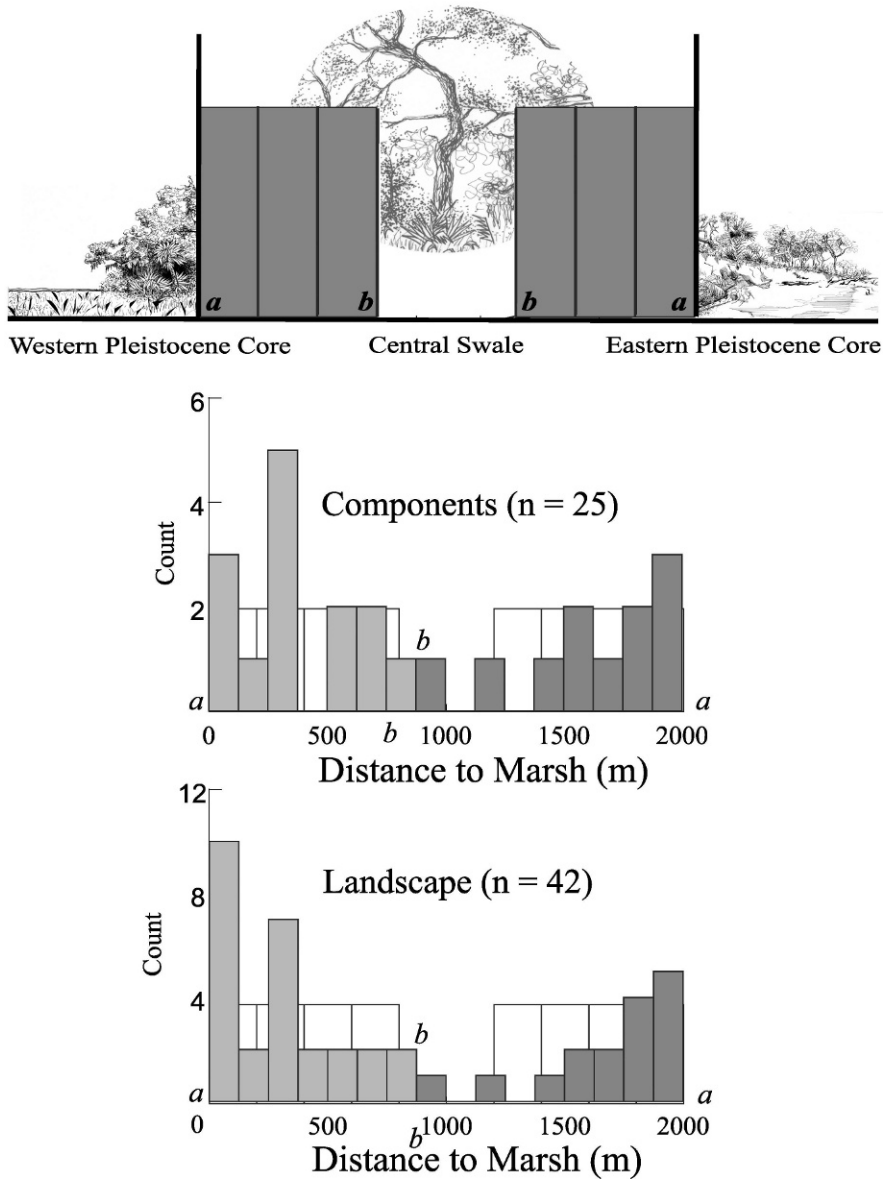
Fig. 30.30. Archaeological evidence from the Wilmington period compared to the Diet-Breadth Foraging (uniform) expectations on the Pleistocene core of St. Catherines Island.

Unlike the distribution patterns noted for the subsequent Irene and St. Catherines periods, a significant number of Wilmington settlements are consistent with diet-breadth (uniform) expectations.

DOES DISTANCE TO THE MARSH VARY BY SEASON FOR WILMINGTON SETTLEMENTS?

The Island-wide archaeological survey documented 48 seasonally specific compo-
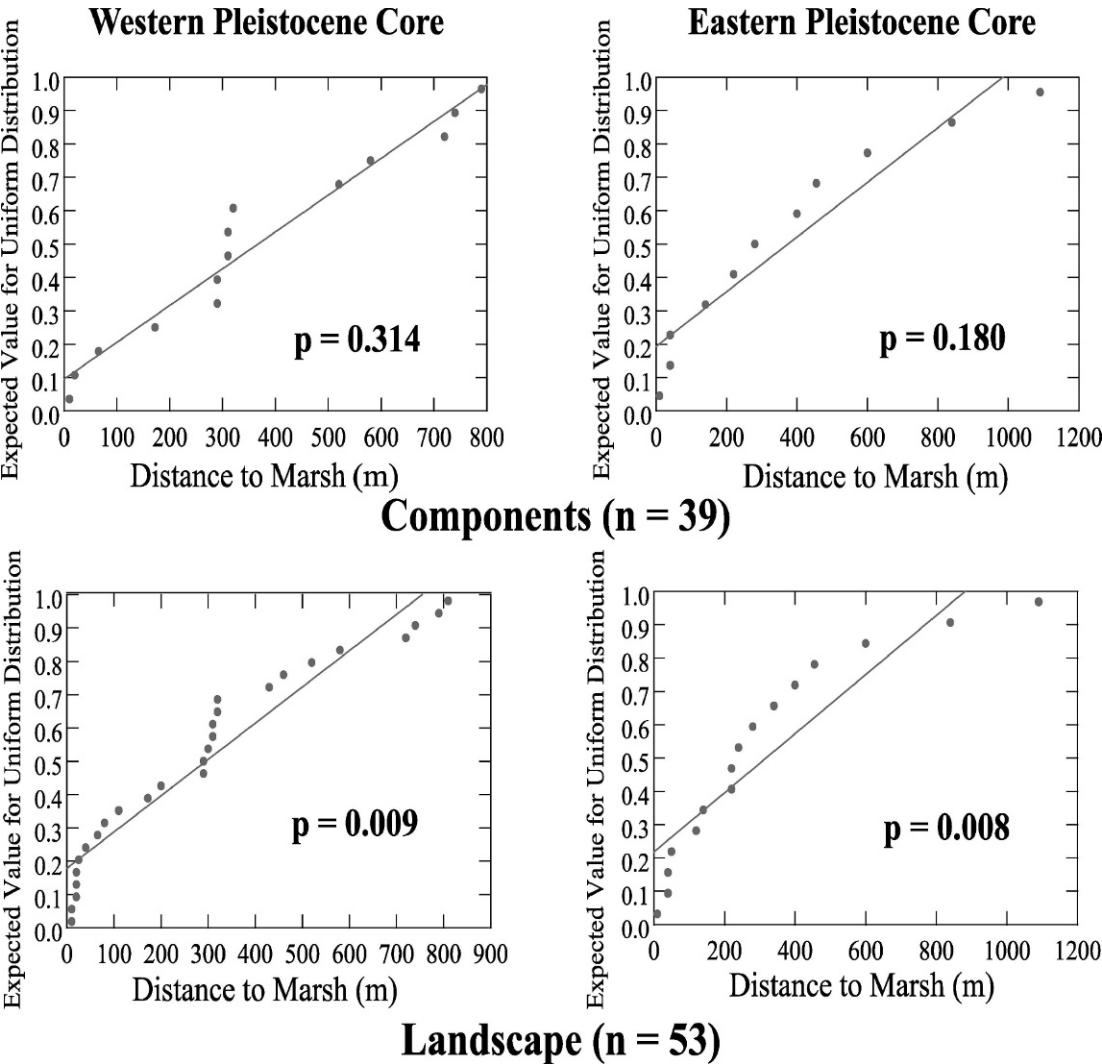
Fig. 30.31.   Comparison of uniform theoretical model to the distribution of Wilmington period archaeological evidence on the Pleistocene core of St. Catherines Island.

nents for the Wilmington period, distributed as follows: winter, 33 percent; spring, 27 percent; summer, 23 percent; and fall, 17 percent. Figure 30.32 plots the distribution of these components across the Pleistocene core of St. Catherines Island. For all seasons, this is a virtually "flat" distribution, with nothing in the empirical histograms to suggest a relationship between the distance to marsh and site seasonality.

DOES WILMINGTON SITE SIZE VARY WITH
DISTANCE TO THE MARSH?

Figure 30.33 shows no particular relationship between the size of Wilmington period sites and their distance to the marsh margin. Along the western marsh edge, the medium-size sites (ranging between 50 and 500 m^2) are relatively close to the marsh edge, but smaller and larger sites
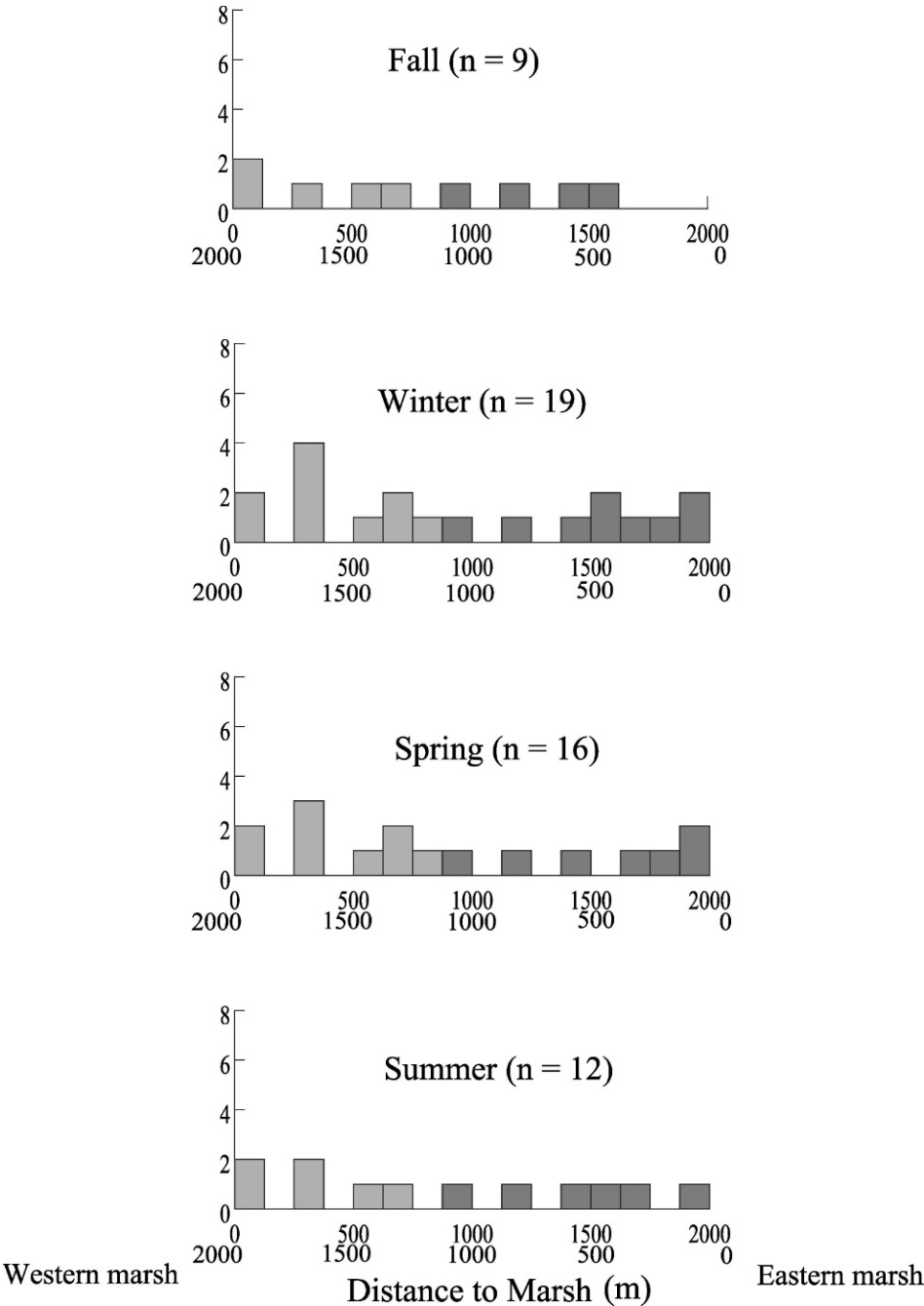
Fig. 30.32.   The seasonal distribution of Wilmington period components relative to Distance to Marsh on the Pleistocene core of St. Catherines Island.
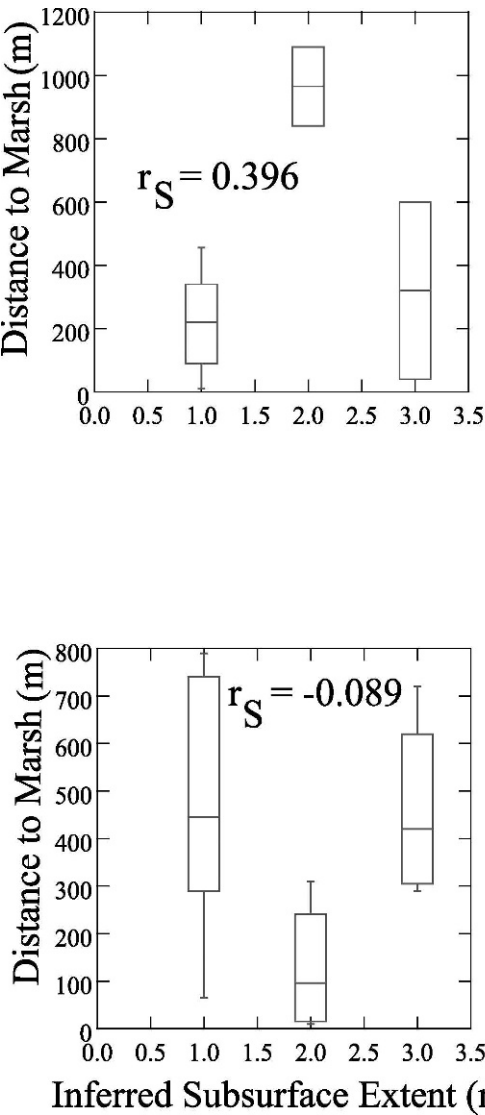
Fig. 30.33.   The relationship of size (measured as inferred subsurface extent) of Wilmington period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

Does Intensity of Occupation of Wilmington Components Vary with Distance to the Marsh?

Figure 30.34 plots the density of occupation against distance to marsh for both the eastern and western marsh margins of St. Catherines Island. Although there is a slight

Fig. 30.34.   The relationship of occupational intensity (measured as sherd density) of Wilmington period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

tend to be further away from the marsh margin. On the eastern margin, this trend is reversed, with the medium-size components the furthest away from the marsh edge. Neither relationship is statistically significant.

Southern Beach Beach Ridge Settlements

Components (n = 1)

Landscape (n= 4)
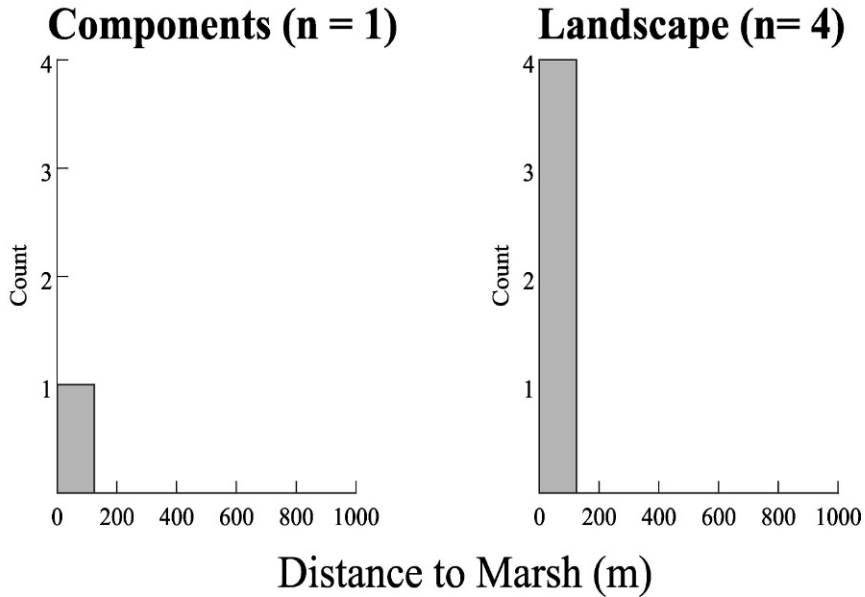
Distance to Marsh (m)

Fig. 30.35.   Wilmington period components and landscapes on the southern Holocene beach ridges of St. Catherines Island.

trend for sherd density to increase with distance to marsh, the nonparametric correlation coefficients do not differ statistically from zero.

MARSHSIDE SETTLEMENTS ON THE HOLOCENE-AGE BEACH RIDGES

Figure 30.35, as well as tables 30.5, 30.6, and 30.8, present the distance to marsh statistics for the Wilmington period landscapes on the southern Holocene beaches of St. Catherines Island. When viewed against comparable Wilmington period settlements of the Pleistocene core, archaeological components and landscapes of the Holocene beach ridge margins appear to be miniaturized.

The lone Wilmington period component on the southern Holocene beach ridges is only 10 m away from the marsh margin, as compared with the a mean distance to marsh of 370 ± 264 m and 374 ± 351 m, respectively, for Wilmington components found on the western and eastern marsh-

lands of the Pleistocene core. Similarly, the four Wilmington landscape indicators on the southern beach ridges average only 16.3 ± 3.8 m from the marsh edge, compared with an average distance to marsh of 295 ± 242 m for the western marshland of the Pleistocene core and 318 ± 305 m for the oceanside marsh. Probably due to the small sample sizes involved ($n = 4$), the empirically observed distribution is consistent with all three theoretical models (normal, lognormal, and uniform).

WILMINGTON PERIOD OUTLIERS

Three of the Wilmington period outliers (9Li178, 9Li209, and 9Li224) were already discussed as St. Catherines period outliers, underscoring the settlement pattern continuities from Wilmington through St. Catherines periods.

Sites 9Li178 and 9Li224, discussed above, are inland, lacustrine settlements, and so is 9Li240, a small, disturbed surface scatter of shell, and a buried midden about

7 m in diameter. Located 740 m from the western marsh margin, this inland, winter-only occupation is situated by the nearby freshwater swamp.

The three additional Wilmington period outliers lack lacustrine associations. 9Li220 is a large irregular distribution of surface and buried shell midden, located about 600 m inland from the eastern marsh. This is a four-season deposit within the Cunningham Mound group, on a broad expanse of Foxworth fine sands. Located nearby South New Ground Field II (9Li221) is a single-component Wilmington period occupation, located 840 m from the eastern marsh margin. Site 9Li196 is associated with the Cunningham Field mound group (although no mortuary activities in these mounds appear to date from the Wilmington period). Located atop a small ridge (at an elevation of 6.1 m) within a broad exposure of Foxworth fine sand, this is a four-season occupation.

REFUGE-DEPTFORD PERIOD SETTLEMENTS (CAL 1000 B.C.–A.D. 350)

Table 30.2 details a total of 15 archaeological components dating to the Refuge-Deptford periods, and the Island-wide transect survey documented a Refuge-Deptford presence in 42 places (fig. 30.36; see also table 20.3). These data indicate an average of 1.11 Refuge-Deptford components/century, less than half of the subsequent Wilmington period. From a landscape perspective, the Refuge-Deptford presence accumulates at an average of 3.11 occupations/century, considerably less than during the Wilmington period.

LANDSCAPES OF THE REFUGE-DEPTFORD PERIODS

The hook-shaped Guale Island was well developed during the Refuge-Deptford periods, protecting the extensive Guale Marsh, located slightly to the northeast from the succeeding Wilmington period. Numerous beach ridges had accumulated during this period along the island's southeastern shore, ranging beyond the modern Cracker Tom Hammock.

Eleven known Refuge-Deptford occupations occur on the northern island core, comprising more than one-quarter (26.2%) of the occupations encountered during the systematic survey. Many of the Refuge-Deptford occupations likely eroded away with the remnants of Guale Island. The surviving archaeological evidence defines a 1-km-wide band running from the Northwestern Marsh to the northern margin of Guale Marsh.

Seasonal evidence is available from four Refuge-Deptford sites on the northern island core: 9Li173 and 9Li172 were occupied during four seasons; 9Li137 showed procurement evidence for three seasons; data from 9Li239 confirmed only a winter occupation. One of the inland occupations (at 9Li172) produced a ^{14}C date of cal 560–1000 B.C. (the only nonmortuary date for the Refuge period) and cal A.D. 60–410 (toward the end of the Deptford period). Somewhere in this vicinity is Moore's "Low Mounds at the North-end," which may date to the Refuge-Deptford periods.

Overlooking the extensive salt marsh, today fringed by Black Hammock, is a cluster of three habitation sites associated with the Seaside I and II mounds, on the eastern margin of Seaside Field. If Lewis Larson's (1998: 38) placement of Moore's "Mounds near the North-end" is correct, then these mounds probably also belonged to the Seaside group. Geomorphological evidence indicates that during this time period, Guale Marsh extended along the entire eastern margin of the central island core (thus fronting the Seaside mound group). One of these Deptford-age midden sites (9Li235) was occupied during the winter and springtime.[13]

A rather similar site cluster occurs 2 km to the south, where three habitation sites occurred within 300 m of Moore's "Mound in King's New Ground Field" (9Li5). Although the cultural affiliation remains unknown, we agree with Larson's (1998: 72) suggestion that this mound was probably constructed and utilized during the Woodland period.

Probable seasonality

December

September ⊕ March

June

Seaside Mounds

King New Ground Field Mound

Greenseed Field Mound
(location approximate)

Cunningham Mounds

LEGEND
• Archaeological site
✕ 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds
⊛ Burial mound

Refuge-Deptford Periods

cal 350 B.C. - A.D. 350

N

1   .5   0   1 km
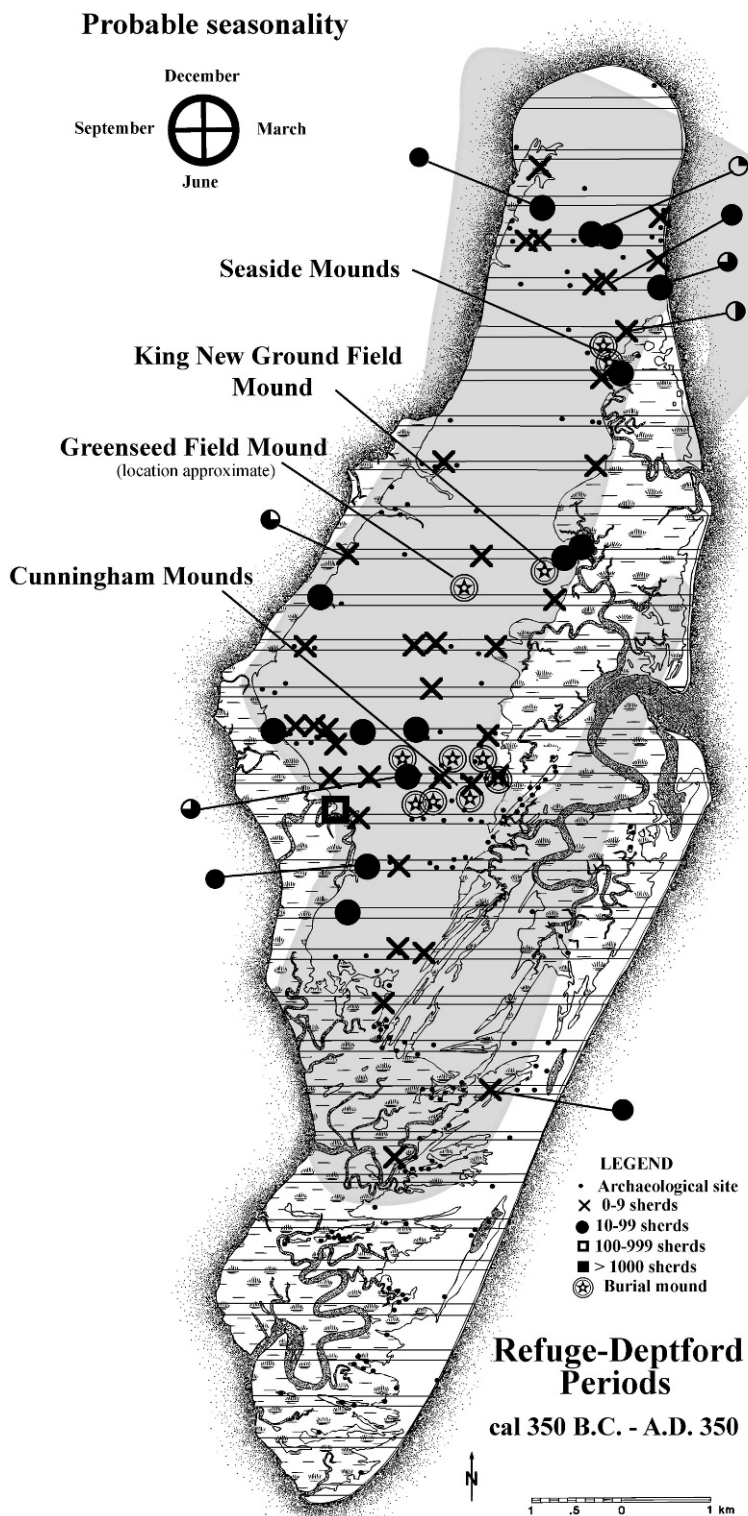
Fig. 30.36.   Seasonal distribution of archaeological components during the Refuge-Deptford interval on St. Catherines Island.

The remaining Refuge-Deptford sites in the central island core are scattered across the well-drained soils of the Echaw–Foxworth–Centenary complex. Somewhere in this area is Moore's (1897: 86–89) "Mound in Greenseed Field" (9Li6), which likely dates to the Woodland period (Larson, 1998: 72).

The Island-wide survey documented 16 Refuge-Deptford occupations on the southern island core. This is an extremely dense occupational cluster (table 30.2), accounting for 38 percent of the known Refuge-Deptford landscape encountered during the Island-wide survey. At the southern reach of these inland occupations, the Refuge-Deptford presence spans the entire island core from McQueens Inlet to the westward extent of St. Catherines Island. The associated Cunningham Mound group was constructed on the south-central island core (fig. 30.36).

Nearly a dozen Refuge-Deptford occupations cluster between Persimmon Point and Wamassee Head, an area that has been eroding eastward after these sites were abandoned. This means that most of these sites were likely located some distance inland from the estuarine marsh that defined the western edge of the Island at the time. One of these sites (9Li15) was occupied during all four seasons.

The combined ceramic and ^{14}C evidence suggests that at about cal 500 B.C., the southern beachfront passed across the Hickory Hills (just north of Beach Pond) and circled immediately to the south of Long Marsh and the upper reaches of Camp Creek. During the Refuge-Deptford periods, the initial occupation of the southern Holocene beach ridge complex is evident in the three sites that cluster on the island core/beach ridge margin, in the vicinity of Cracker Tom Hammock.

Four Refuge-Deptford occupations have been documented on the Southern Beach Ridge complex. Although two of these sites are adjacent to the Pleistocene island core, the other two were located on newly formed beach ridges to the southeast; one of these (9Li49), located immediately to the west of Beach Pond, was utilized in cal A.D. 440–680, with evidence of a four-season occupation.

We recovered sufficient evidence to assess seasonality in nine Refuge-Deptford occupations. Indicators of seasonality are approximately evenly distributed across all four seasons, with fall slightly underrepresented at 17.9 percent (table 30.4). Four of these components (at 9Li172, 9Li173, 9Li15, and 9Li49) are four-season occupations. From an Island-wide perspective, it is clear that four-season Refuge-Deptford occupations were not atypical.

ARE REFUGE-DEPTFORD SETTLEMENTS DISTRIBUTED IN NORMAL/LOGNORMAL FASHION RELATIVE TO THE MARSH EDGE OF ST. CATHERINES ISLAND?

Figure 30.37 compares the observed distributions of these archaeological components and landscape manifestations from the Refuge-Deptford period against the expected distribution based on the central place foraging model.

The middle curve of figure 30.37 sets out the empirically observed distribution of the Refuge-Deptford period components recorded in the Island-wide sample. The western marshside settlements average 203 ± 307 m from the marsh margin. Eastern marshside settlements occur much further inland, averaging 514 ± 384 m from the marsh edge; this is the longest distance to marsh average noted in the Island-wide survey data, and the most extreme disparity in spacing between the eastern and western marshes of the Pleistocene core (although this difference lacks statistical significance because of the high variances and small sample sizes involved).

Figure 30.38 casts these same data into probability plots, with the western and eastern marshside Refuge-Deptford period components arrayed against the theoretical normal/lognormal frequency distributions for identical means and variances. The Lilliefors tests show that the western marsh distribution is consistent with expectations from the lognormal distribution ($p = 0.573$), with significant skewness to the right. The empirical distribution of eastern

Central Place Foraging Model
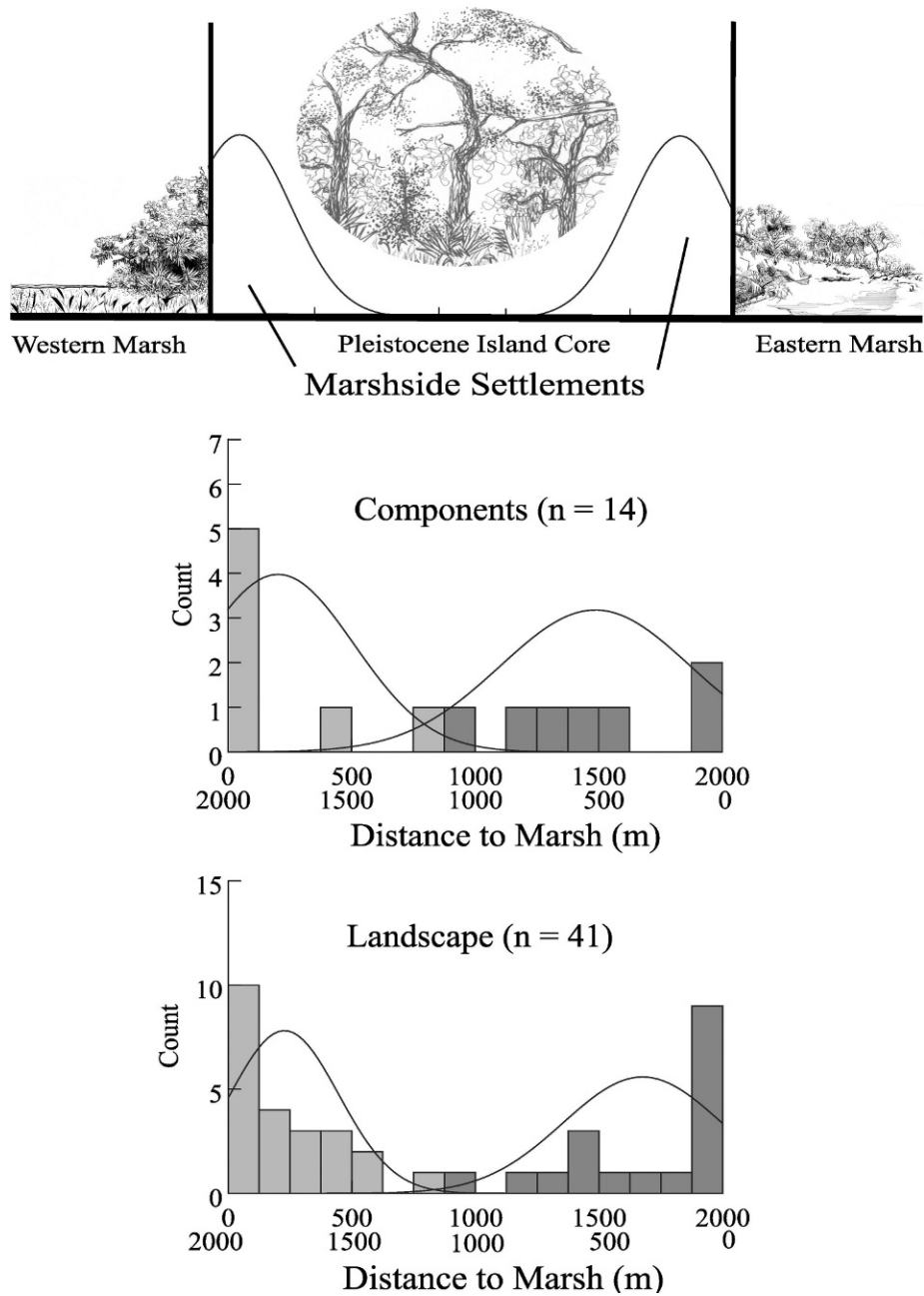
Fig. 30.37.　Archaeological evidence from the Refuge-Deptford period compared to the Central Place Foraging model for marshside settlements on the Pleistocene core of St. Catherines Island.
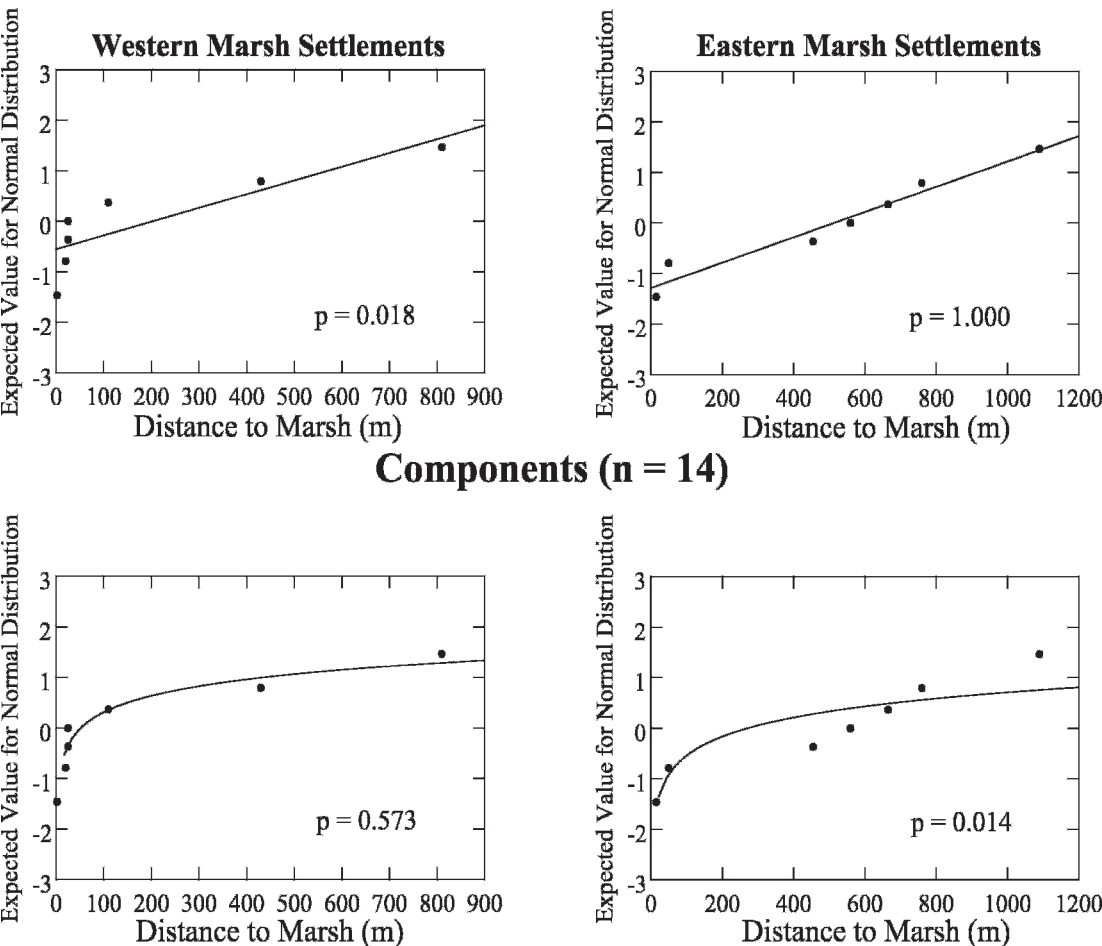
Fig. 30.38.   Comparison of normal and lognormal theoretical models to the distribution of Refuge-Deptford period archaeological components on the Pleistocene core of St. Catherines Island.

marsh settlements follows a normal distribution almost perfectly ($p = 1.000$), but deviates significantly from lognormal expectations.

The lower curve of figure 30.37 sets out the empirically observed distribution of the Refuge-Deptford period landscape diagnostics. The 23 western marshside settlements average 227 ± 220 m from the marsh margin. The eastern marshside settlements occur slightly further inland, averaging 324 ± 321 m from the marsh edge. In figure 30.39, the western marsh distribution is consistent with both normal and lognormal expectations ($p = 0.173$ and 0.283, respectively). The eastern marsh settlements are likewise consistent with lognormal expectations ($p = 0.220$), but differ significantly from the theoretical normal distribution ($p = 0.008$).

DOES REFUGE-DEPTFORD SITE SIZE VARY WITH DISTANCE TO THE MARSH?

The Island-wide survey documented 14 archaeological components dating to the Refuge-Deptford periods (table 30.2); a landscape perspective on these same data produced 41 Refuge-Deptford period occupations (table 30.3).[14]

Figure 30.40 plots site size for the Refuge-Deptford period occupations against
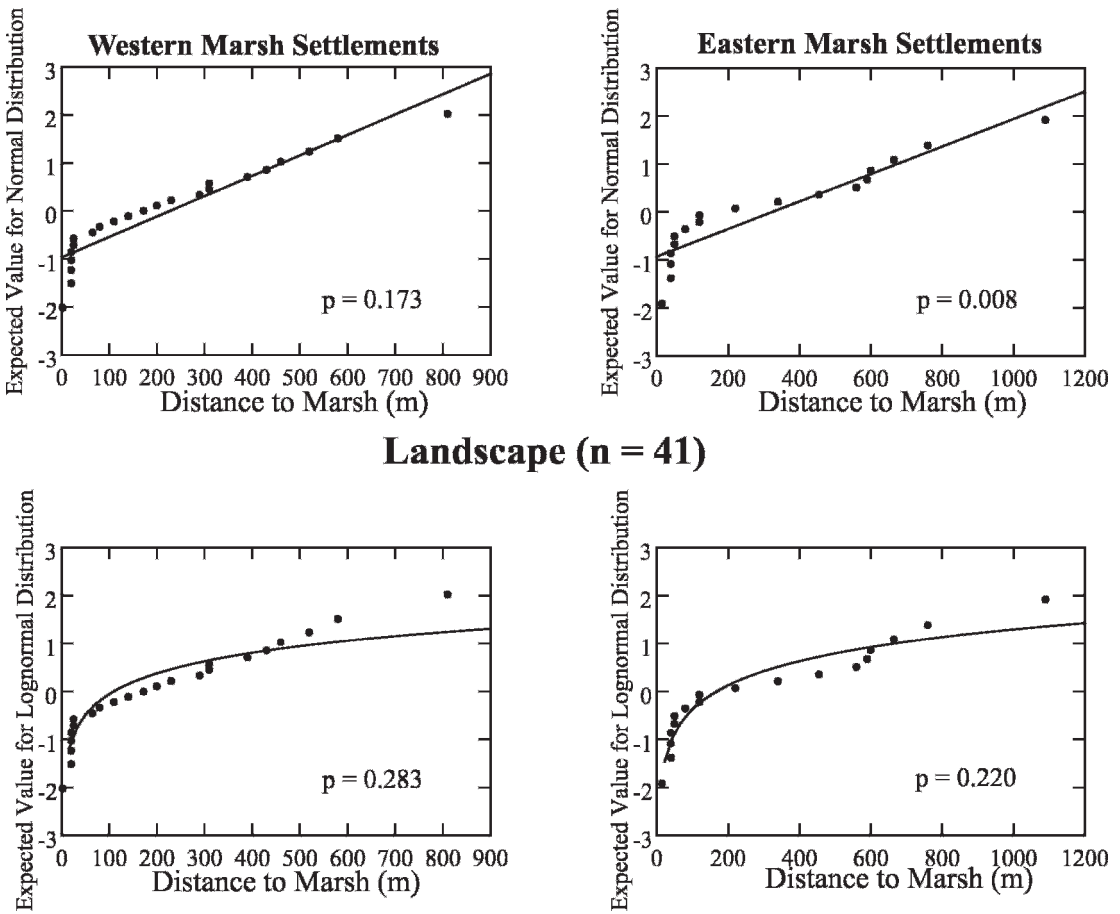
Fig. 30.39.   Comparison of normal and lognormal theoretical models to the Refuge-Deptford period landscape on the Pleistocene core of St. Catherines Island.

their distance to the marsh margin. Along the western marsh edge, the smallest sites (those <50 m^2 in inferred subsurface extent) occur relatively close to the marsh edge, and relative few larger sites were found. On the eastern margin, this trend is exaggerated, with both small- and medium-size components averaging nearly 600 m from the marsh edge. None of these relationships is statistically significant.

DOES INTENSITY OF OCCUPATION OF REFUGE-DEPTFORD COMPONENTS VARY WITH DISTANCE TO MARSH?

Figure 30.41 plots the density of occupation proxy against distance to marsh for both the eastern and western marsh margins of St. Catherines Island. The nonparametric correlation coefficients demonstrate no statistically significant relationship between these two variables.

MARSHSIDE SETTLEMENTS ON THE HOLOCENE-AGE BEACH RIDGES

Only a single Refuge-Deptford period component (at 9Li49) was found on the southern beach ridges. This large site consists of several shell scatters and concentrations exposed for about 60 m along the eroding blank of a Holocene dune ridge; the maximum distance to marsh is about 10 m. All diagnostic sherds date to the Ref-
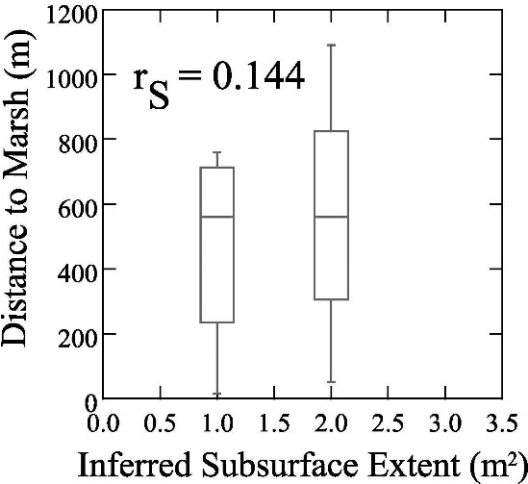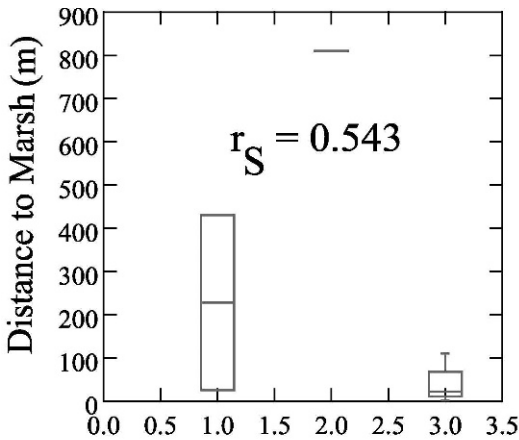
Fig. 30.40. The relationship of size (measured as inferred subsurface extent) of Refuge-Deptford period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

uge period, but the lone radiocarbon date (Beta-20829) falls into the early Wilmington period.

REFUGE-DEPTFORD PERIOD OUTLIERS

The Island-wide archaeological recorded only 14 Refuge-Deptford period compo-

nents. Using the standards developed for the subsequent cultural periods, almost half of these distance to marsh variates could qualify as legitimate outliers.

On the western marshside, 9Li186 would seem to be an extreme variate (at a distance to marsh = 430 m) and 9Li223 is undoubtedly an outlier (distance to marsh = 810 m).

The uppermost component of 9Li186, an Irene period winter and/or early springtime occupation (previously discussed), would appear to fall within the range of Irene marshside settlements. But in the contexts of the Refuge-Deptford period (fig. 30.41), it is indeed an outlier. This small site consists of two mounds of densely packed shell, situated about 5 m apart; seasonal estimates were not possible for the Refuge-Deptford component. This lacustrine site, located on Echaw/Centenary fine sand, is immediately adjacent to the central freshwater marsh.

South New Ground Field 4 (9Li223) is a medium-sized, discontinuous scatter of surface and buried shell midden. Analysis of incremental growth in *Mercenaria* indicates that clams were harvested in almost equal proportions during the winter and early spring. This site is located on a ridge of Echaw/Centenary soil, in the middle of the Refuge-Deptford ceremonial complex, without a lacustrine association.

The seven Refuge-Deptford sites on the eastern half of the Pleistocene core pose a different problem. This configuration is consistent with both normal and uniform frequency distributions (likely due to the small sample size). But using the standards applied to later periods, at least four (and perhaps five) of these sites would be considered to be outliers relative to distance to marsh:

- 9Li238 (distance to marsh = 455 m): North Pasture 1 is located on Echaw/Centenary soils and occupied primarily during the Refuge-Deptford period, with a minor Wilmington period component. All *Mercenaria* analyzed were harvested during the winter.
- 9Li253 (distance to marsh = 560 m): 9Li253 is a single-component Refuge period site, located 650 m from the eastern marsh margin, on a narrow ridge of Echaw/Centenary soils (elevation = 6.1 m), immediately to the east of
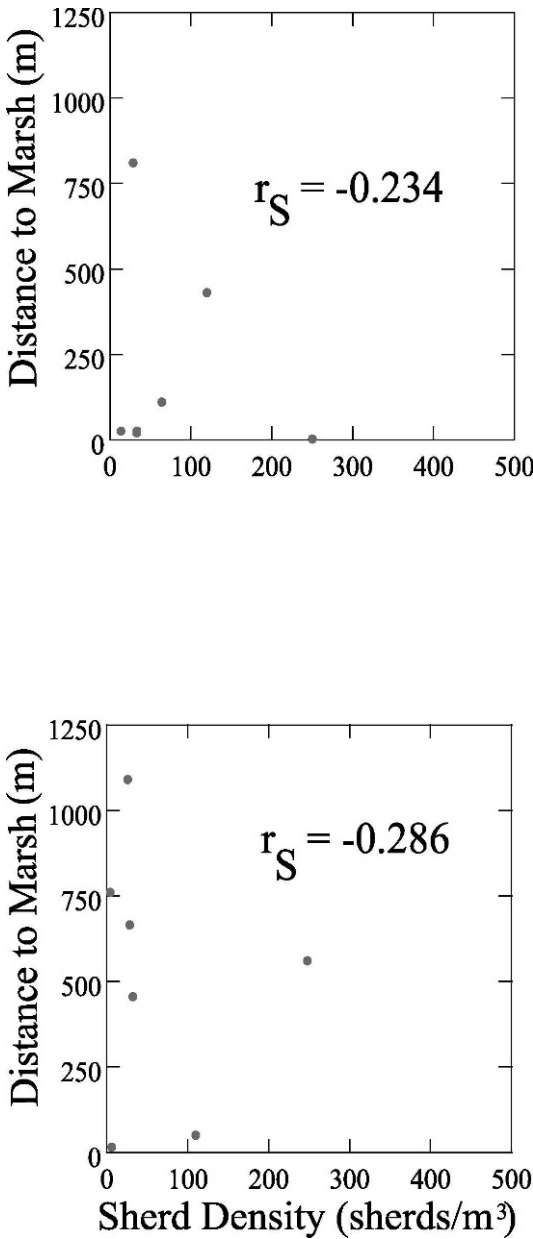
Fig. 30.41.   The relationship of occupational intensity (measured as sherd density) of Refuge-Deptford period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

the long, central freshwater slough. This medium-sized site was undetected in the randomized transect survey, and found only through systematic shovel testing in transect H-6. Shell was almost completely absent and no estimate of seasonality is possible.

- 9Li239 (distance to marsh = 665 m): North Pasture 2 (9Li239) is a small buried shell midden, about 20 m in diameter. Situated on a narrow ridge of Echaw/Centenary soils (6.1 m elevation), this site is immediately to the east of the central freshwater marsh (Rutledge soil). All the *Mercenaria* studied from the Refuge-Deptford component were harvested during the winter.
- 9Li249 (distance to marsh = 760 m): This small site is unusual because it is located on the poorly drained Rutledge soil (at an elevation of 4.6 m). Shell is entirely absent and 9Li249 was detected only during systematic shovel testing of this transect. The ceramic assemblage recovered from the five test pits (5.00 m^3) consists of 22 sherds, 16 diagnostic of the Refuge and St. Simons periods. No seasonality information is available.
- 9Li178 (distance to marsh = 1090 m): Greenseed Field 1 (already discussed as a St. Catherines period outlier) is a lacustrine site located along the inland margin of the eastern swale, adjacent to the long, linear freshwater swamp.

ST. SIMONS PERIOD SETTLEMENTS
(CAL 3000 B.C.–1000 B.C.)

The Island-wide probabilistic transect survey identified 10 archaeological components dating to the St. Simons period, all but one located near the Yellow Bank Scarp that constrains the eastern Pleistocene core (see table 30.2). From a landscape perspective, a Late Archaic presence is evident at 23 localities in the probabilistic survey of St. Catherines Island (fig. 30.42; see also tables 20.1 and 20.2).[15]

The combined radiocarbon, palynological, and paleontological evidence suggests that modern St. Catherines Island formed after cal 2980–2670 B.C., when sea level rose sufficiently to isolate the Pleistocene core from the mainland (although, as discussed in chaps. 4 and 32, significant lower amplitude fluctuations in sea level have transpired since then).

At cal 2500 B.C., the hook-like Guale Island abutted the northeastern portion of the Island, buffering the shoreline and protecting a large inter-island marshland extending from Picnic Bluff, past Seaside In-
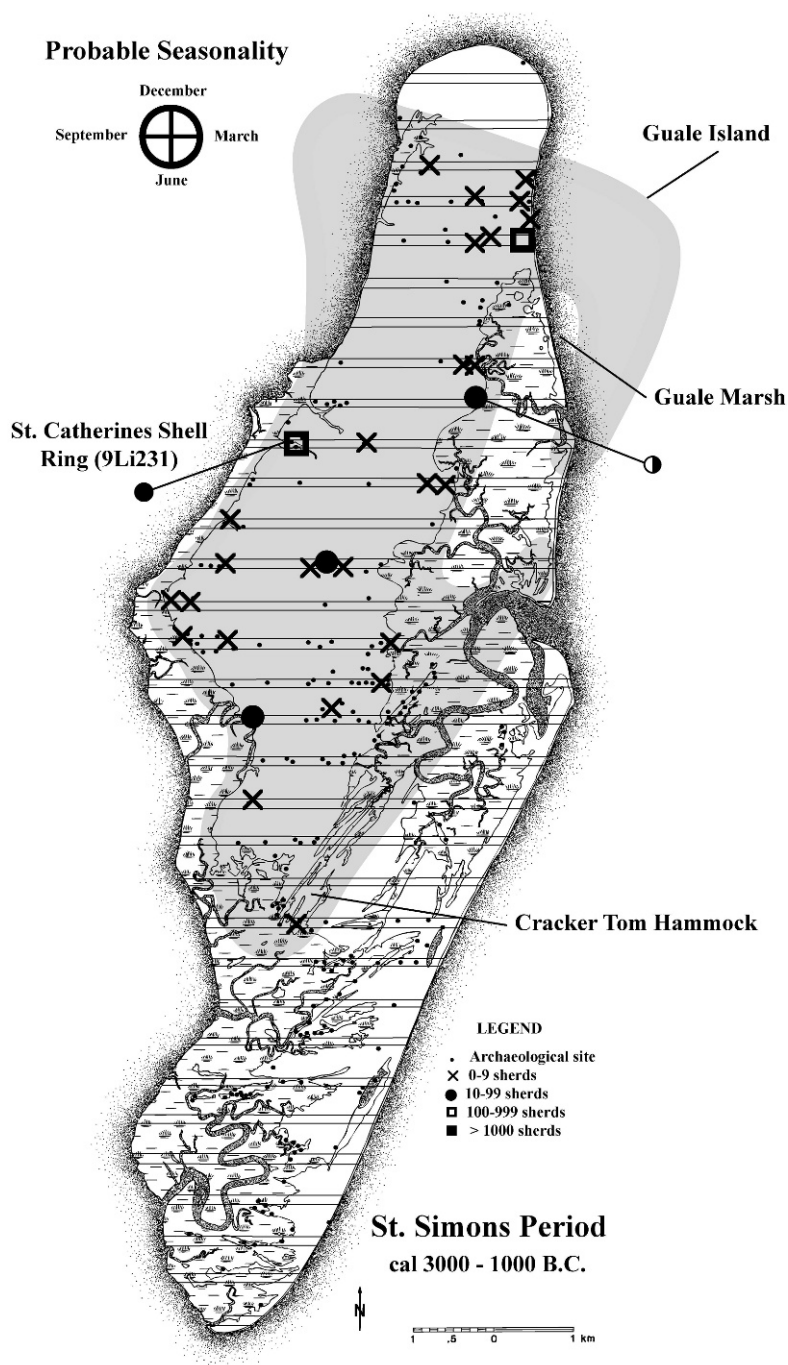
Fig. 30.42.   Seasonal distribution of archaeological evidence during the St. Simons period on St. Catherines Island.

let, to the King New Ground dock area. Tidal creeks meandered through this vast inland Guale Marsh, providing access to the rich resources of the local shellfishery and producing a mosaic of meander bends and levees along the creek beds. The thick sequence of relict marsh muds recorded in vibracore 5 (chap. 3) shows evidence of lateral migration of tidal creek channel(s) through the core area at least five times over the last thousand years. The available radiocarbon dates indicate that the maximum possible age of Guale Marsh, which stands at 0.75 m above MLT, is cal 1250 B.C.–cal 2500 B.C.

The earliest extensive human exploitation of St. Catherines Island was centered on the high ground surrounding Guale Marsh. Because Guale Island and Guale Marsh have subsequently disappeared, we cannot precisely plot the relationships between many of the surviving archaeological sites and the now extinct saltwater marshland. But the Island-wide survey documents a St. Simons presence in eight places clustered along the northern end of the island core. Today, nearly all of these northern St. Simons occupations are situated at an elevation of roughly 6 m above sea level, located on well-drained Echaw–Foxworth–Centenary soils. These were almost certainly inland sites during the St. Simons interval, located on the relatively high ground, yet less than 1 km from the Guale Marsh.

The St. Catherines Shell Ring (9Li231) was perched along the westernmost (estuarine) margin of the island; this is the oldest recorded human presence on St. Catherines Island. Nearly half (11 of 24) of the St. Simons period occupations documented during the transect survey are located on the nearby central island core.

During St. Simons times, the southern island core may have been twice its present size, extending an unknown distance to the east. Nine St. Simons period occupations are known from the southern island core, seven of them located in the systematic transect survey. Guale Marsh was still situated well to the north (meaning that the present area of McQueens Inlet was probably covered by high ground of the Pleistocene core).

Vibracore evidence from Cracker Tom Hammock documents the southern expansion of accretionary terrestrial terrains, with active oyster beds (dating to cal 1530–1830 B.C.) that were eventually overlain by modern marsh and hammock communities. Likewise, palynological data (recovered from these same vibracores) documents that freshwater ponding exceeded modern levels. During the St. Simons period, the southeastern margin of St. Catherines Island probably lay immediately to the east of Back Creek Road, as documented by the presence of St. Simons ceramics at 9Li161, which must have been occupied shortly after the modern hammock and plant communities were established on the newly formed Cracker Tom Hammock.

Geomorphological evidence suggests that the additional St. Simons occupations on the southern core—today located on the modern marsh edge—were actually situated some distance inland when inhabited.

The southern beach ridge complex contained only one St. Simons component (9Li161), identified in DePratter's shoreline survey (chap. 23). This buried shell scatter skirts the southwestern margin of Cracker Tom Hammock, probably situated in the lee of the dune ridge that marked the maximum extent of beach progradation at the time.

Distance to marsh estimates for the surviving St. Simons sites are problematic. In some cases, the eastern margin of the Pleistocene core remains intact (see chap. 3), and we can measure a standard distance to marsh estimate. Although the area between the Picnic Area and the Party Bluff is actively eroding (and Late Archaic sites are still being lost), portions of a relic marsh (a remnant of Guale Marsh) survive along North Beach. These surviving remnants appear to represent the western-most oxbows of ancient salt creeks that drained Guale Marsh, and the associated radiocarbon dates pinpoint their age to the Late Archaic period. The surviving Late Archaic sites in this area appear to cluster around these relic marsh remnants. In many cases, we have been able to establish distance to marsh estimates by measuring between the archaeo-

Central Place Foraging Model

Western Marsh   Pleistocene Island Core   Eastern Marsh

Marshside Settlements

Components (n = 10)

Landscape (n = 23)
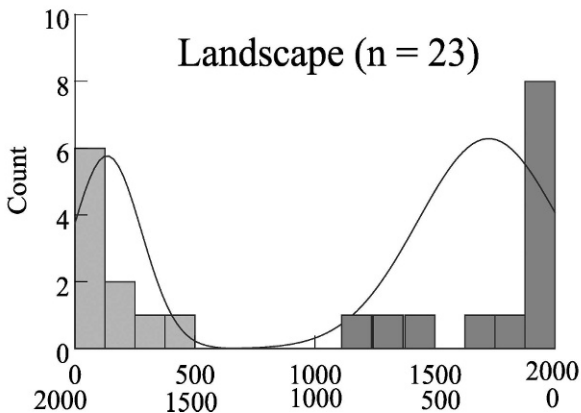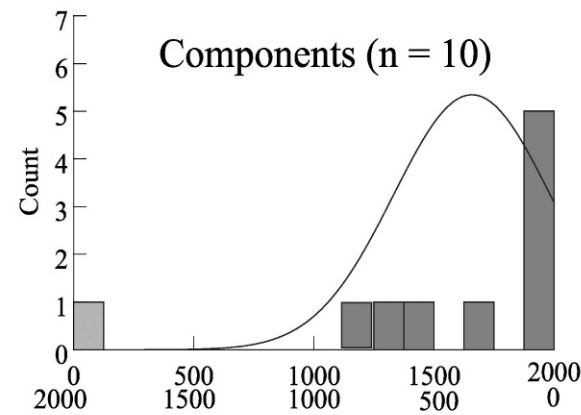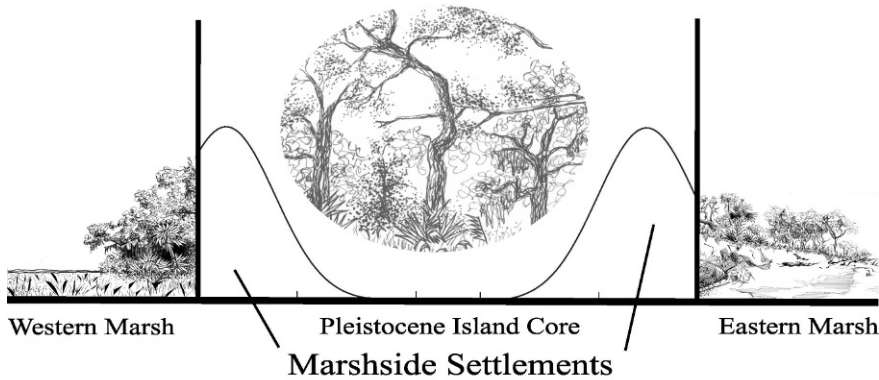
Fig. 30.43.   Archaeological evidence from the St. Simons period compared to the Central Place Foraging model for marshside settlements on the Pleistocene core of St. Catherines Island.

logical site and the associated relic marsh remnant evident on North Beach. But in such cases, exact estimates are impossible, and this is why table 20.2 includes estimates such as "340+ m," reflecting the uncertainty involved; these minimum estimates are excluded from the present discussion (and omitted from tables 30.2 and 30.3).

Eastern Marsh Settlements
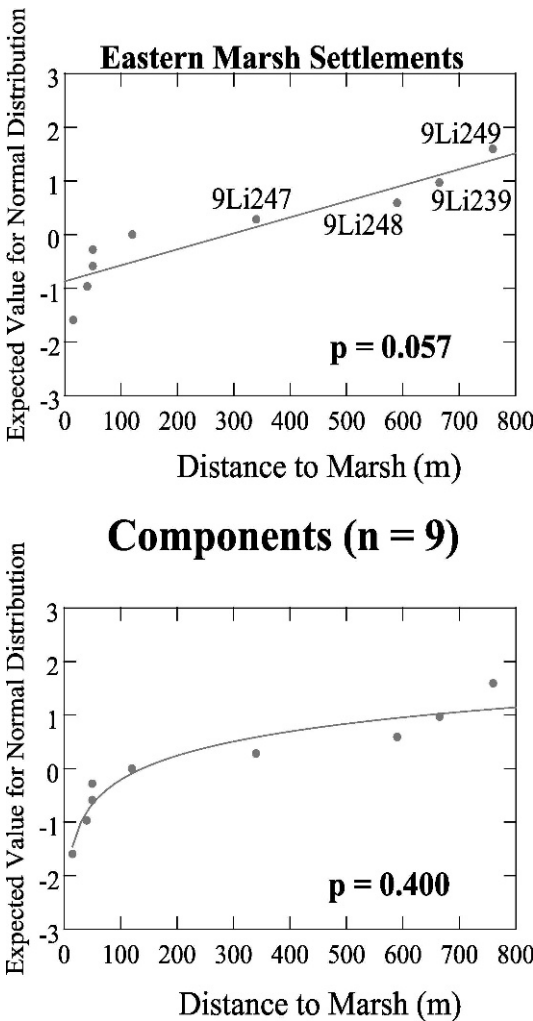
Components (n = 9)

Fig. 30.44. Comparison of normal and lognormal theoretical models to the distribution of St. Simons period archaeological components on the Pleistocene core of St. Catherines Island.

ARE ST. SIMONS SETTLEMENTS DISTRIBUTED IN NORMAL/LOGNORMAL FASHION RELATIVE TO THE MARSH EDGE OF ST. CATHERINES ISLAND?

In chapter 20, we defined a total of six St. Simons period components, all of them located on the Pleistocene island core (fig. 30.42; tables 20.1 and 20.2). Figure 30.43 compares the observed distributions of these archaeological components and landscape manifestations from the St. Simons period against the expected distribution based on the central place foraging model.

The middle curve of figure 30.43 sets out the empirically observed distribution of the $n = 10$ St. Simons period components recorded in the Island-wide sample. Only a single Late Archaic site, St. Catherines Shell Ring (9Li231), is known along the western marsh margin of St. Catherines Island. Although the full extent of this large shell midden is not known, this is clearly a major, four-season marshside settlement; its positioning (30 m from the western marsh edge) is entirely consistent with central place foraging projections.

The eastern marshside settlements occur much further inland, averaging 292 ± 303 m from the marsh edge. Figure 30.44 casts these same data into probability plots. The K-S/Lilliefors tests show that the eastern marsh distribution is consistent with expectations from both the normal ($p = 0.057$) and the lognormal distributions ($p = 0.072$ and 0.282, respectively). The eastern components are also consistent with the uniform distribution projected by the diet-breadth model (table 30.8). Table 30.5 also presents the relevant Coefficients of Skewness and Kurtosis, none of which differ significantly from zero.[16]

The configuration of the archaeological landscape for the St. Simons period appears in figure 30.45. The Late Archaic landscape ($n = 10$) averages 134 ± 144 m from the western marsh margin. The mean for the eastern marsh edge is considerably larger (236 ± 267 m), but the difference is not statistically significant. The $n = 23$ landscape indicators are distributed in lognormal fashion along both the western and eastern marsh edges, without significant skewness or kurtosis (table 30.5).

DOES DISTANCE TO THE MARSH VARY BY SEASON FOR ST. SIMONS SETTLEMENTS?

Seasonality estimates are available for only two St. Simons period sites (see chap. 20). The three test pits excavated at the St. Catherines Shell Ring (9Li231) indicates a four-season occupation (based on incremental pattern in *Mercenaria* and the pres-
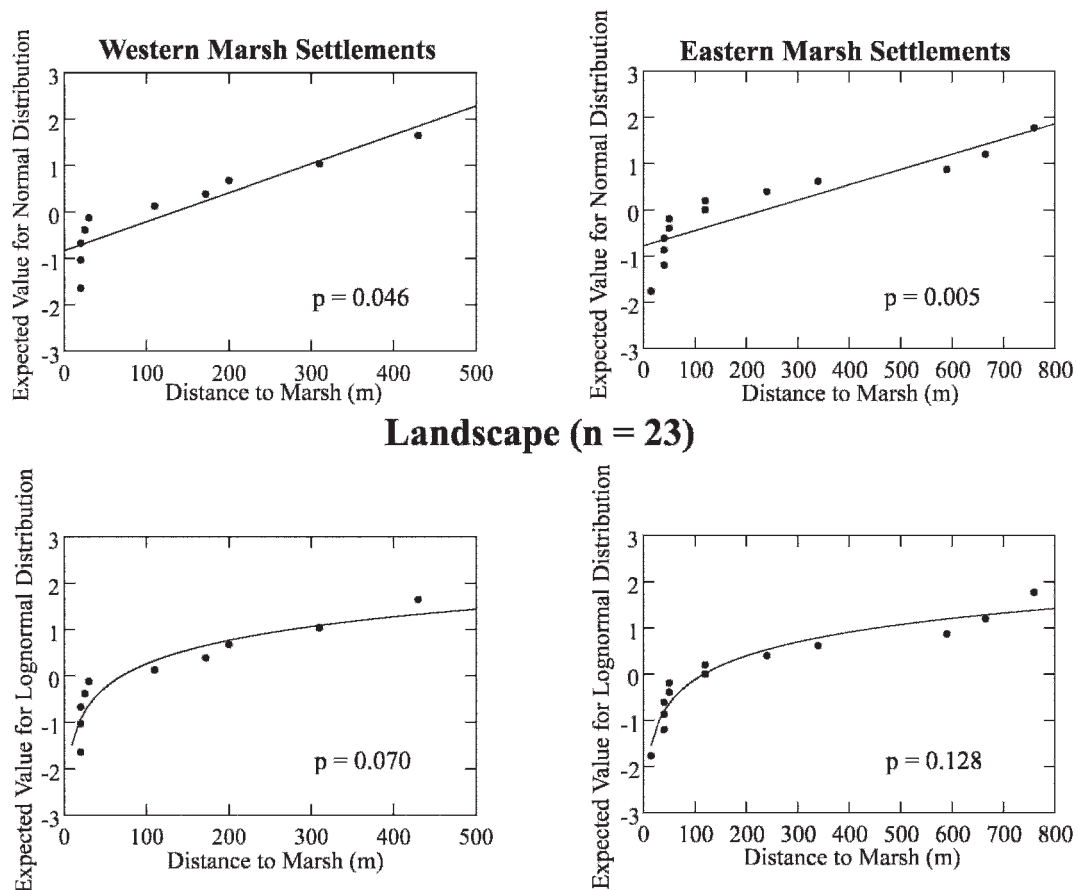
Fig. 30.45.   Comparison of normal and lognormal theoretical models to the St. Simons period landscape on the Pleistocene core of St. Catherines Island.

ence of shark and sea catfish, taxa indicative of occupation sometime between April and October). *Mercenaria* recovered at Seaside Field (9Li252) were collected in the winter, early spring, and summer/fall. These data are insufficient to investigate the relationship between seasonality and distance to marsh.

DOES ST. SIMONS SITE SIZE VARY WITH DISTANCE TO THE MARSH?

Figure 30.46 plots the relationship between site size and distance to marsh for the various St. Simons period components on the Pleistocene core of St. Catherines Island. The nonparametric correlation (r_S = −0.174) is not significantly different from zero.

DOES INTENSITY OF OCCUPATION OF ST. SIMONS COMPONENTS VARY WITH DISTANCE TO MARSH?

Figure 30.47 plots the relationship of sherd density to the distance to marsh estimates for the St. Simons components along the eastern Pleistocene core of St. Catherines Island. Clearly, the nonparametric correlation does not differ from zero.

MARSHSIDE SETTLEMENTS ON THE HOLOCENE-AGE BEACH RIDGES

The southern beach ridge complex contained only one St. Simons component (9Li161), identified during DePratter's shoreline survey (see chap. 23). This buried shell scatter skirts the southwestern margin
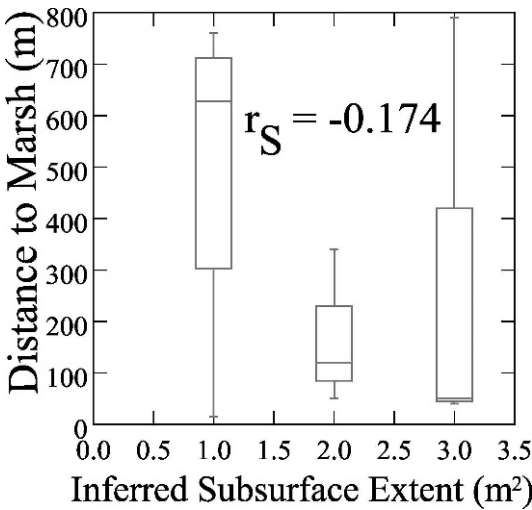
Fig. 30.46.   The relationship of size (measured as inferred subsurface extent) of St. Simons period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

of Cracker Tom Hammock, probably situated in the lee of the dune ridge that marked the maximum extent of beach progradation at the time; but because this site did not fall into the 20 percent randomized transect sample, we will not employ these data in
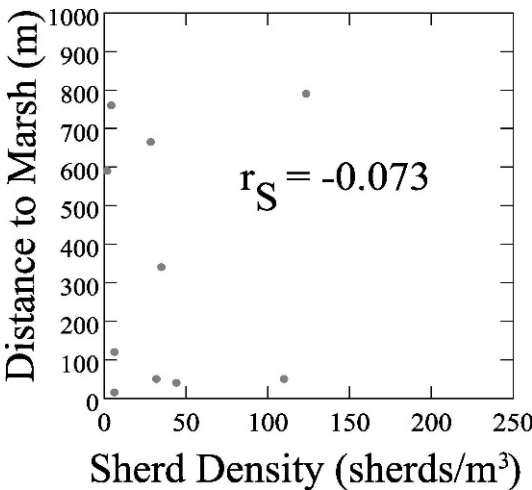
Fig. 30.47.   The relationship of occupational intensity (measured as sherd density) of St. Simons period components relative to Distance to Marsh for the Pleistocene core of St. Catherines Island.

this consideration of central place foraging theory.

ST. SIMONS PERIOD OUTLIERS

Five of the St. Simons components clearly qualify as marshside settlements, all of them fall within 150 m of the modern marsh margin. But four St. Simons components fall outside this range, and these exceptions are informative.

We have already noted the anomalous North Pasture site, a settlement occupied sporadically into Irene times. This would appear to be a wintertime inland hunting site.

The most notable exception to the central place foraging model is a cluster of three St. Simons components found near the middle of transect G-6. Sites 9Li247, 9Li248, and 9Li249 were located 340, 590, and 760 m (respectively) from the eastern marshside margin. Notably, all three of the sites lacked marine shell of any kind; in fact, they were detected only during systematic shovel-testing across transect G-6. We discuss the implications of these settlements below.

CENTRAL PLACE FORAGING AND LONG-TERM SETTLEMENT TRENDS ON ST. CATHERINES ISLAND

This chapter has presented a number of key findings about the archaeology of St. Catherines Island.

We projected that, all else being equal, aboriginal foragers on St. Catherines Island should situate their residential bases to maximize the net central place foraging returns with respect to the pursuit, handling, and transport costs from different patches. Specifically, this model projected that marshside settlements should be positioned in optimal central places along the margins of the maritime forest, immediately adjacent to the salt marshes and the tidal streams that drain them. Such placement, along the marshside margin, offers ready access to the two highest ranking resource patches (the estuarine/oceanside salt

marshes and the maritime forest), each supporting multiple suites of high-ranking plant and animal food resources.

We further hypothesized that the central tendencies and variability associated with the marshside settlements should be significantly conditioned by human lifespace considerations, especially topographic and geomorphic variability, availability of arable land (for cultivators), proximity to adequate docking facilities, access to saltwater creeks that dissect the salt marsh, and crowding by neighboring settlements desiring the same optimal positioning.

Because such lifespace considerations likely introduced considerable variability into the positioning of optimal central places, we concluded that the normal/lognormal probability distributions provided the most likely statistical models for projecting aboriginal settlement patterning on St. Catherines Island. Because the shape of normal/lognormal frequency distributions is governed by only two parameters (the mean and the standard deviation), we inferred that central places should be characterized by a relatively low, but somewhat variable distance to marsh statistic. The *mean distance to marsh* should be relatively constant (because it reflects placement along the intersection of the two highest ranking patches). Because the margin between the salt marsh and the maritime high ground is defined by the upper reach of spring tides, this abrupt edge becomes a one-way barrier, prohibiting potential settlements situated closer to the marsh; potential central places locations in more inland patches of maritime forest are not conditioned by such intertidal barriers. This means that the *variances* associated with marshside settlements should be asymmetrical—steeper toward the salt marsh/maritime patch margin, then trailing off within the terrestrial habitats.

As an alternative hypothesis, we set out contrasting settlement pattern projections based on the diet-breadth model, in which the resource base is assumed to be relatively continuous, undifferentiated, and evenly distributed across the terrestrial habitat. If such a fine-grained assumption of environ-mental homogeneity holds for the landscape of St. Catherines Island, then we anticipate an archaeological record comprised of aboriginal settlements that would be randomly distributed through space, entirely lacking in the nonrandom modality or centrality projected by the normal/lognormal model implied through Central Place Theory. The appropriate statistical model for testing the diet-breadth assumption of homogeneity is the uniform population distribution, in which each spatial unit is projected to contain the same number of entities.

First Conclusion: Central Place Foraging Theory Successfully Projects the Major Elements of Aboriginal Settlement Patterning on St. Catherines Island

We tested the alternative normal/lognormal and uniform frequency distribution models against the data generated in a 20 percent, Island-wide, probabilistic transect sampling of St. Catherines Island. These results were expressed in terms of roughly 130 archaeological components and 225 archaeological presences designed to reflect the broader nonsite archaeological landscape. Table 30.4 summarizes the various statistical measures that assess overall goodness of fit to the central place foraging and diet-breadth model developed in chapter 11 and summarized at the outset of this chapter.

The most striking finding is this: With very few exceptions, the archaeological record of St. Catherines is remarkably consistent with expectations from central place foraging theory. Of the roughly 130 archaeological components spanning the last 5 millennia, only two dozen of these can be viewed as even potential outliers from the normal/lognormal statistical models. In other words, more than 80 percent of the archaeological components encountered in the Island-wide survey are fully consistent with the marshside settlement model derived from central place foraging theory.

The uniform distribution model (derived from the diet-breadth assumption of homogeneity) did not fare so well. As indicated

on table 30.8, only rarely was the archaeological evidence consistent with uniform frequency projection (and in those few cases where expected and observed frequencies were consistent, we generally attribute the result to small sample sizes).

Throughout the rest of this chapter, we explore the behavioral implications and important trends evident when central place foraging theory is applied to the aboriginal settlements of St. Catherines Island

SECOND CONCLUSION: MARSHSIDE SETTLEMENTS MOVE PROGRESSIVELY SOUTHWARD THROUGH TIME

The earliest human settlements on St. Catherines are broadly spread across the Pleistocene core (fig. 30.42). The St. Catherines Shell Ring (9Li231) is, by far, the largest surviving site, a single-component St. Simons period occupation located almost directly on the western marsh margin. The Late Archaic landscape hugs the western marsh margin, conforming to Central Place expectations, with the lowest observed distance to marsh anywhere on the Pleistocene core. Along the oceanside margin, St. Simons period components and landscapes cluster along the high ground overlooking Guale Marsh, on the northeastern margin of the Pleistocene core, with a sporadic distribution further south. But through time—by the end, say, of the St. Catherines period (cal A.D. 1300)—only a handful of components and landscape elements linger on the northern end of St. Catherines Island because the center of gravity has shifted dramatically southward.

The primary impetus for this southward shift is geomorphological. Given the importance of salt marsh exploitation in the prey-choice/patch-choice models, the exact placement of nearshore marshland is critical in positioning central places for maritime foragers. As Guale Island eroded away, and Guale Marsh moved correspondingly southward (eventually coming to occupy its present location in the Seaside and McQueens Inlets area), the placement of marshside settlements shifted accordingly. Although the Northwestern Marsh survives through the last 5 millennia, the northeastern corner of the Pleistocene core has changed dramatically, and so did the human response to it.

THIRD CONCLUSION: INTRODUCTION OF MAIZE CULTIVATION DID NOT TRIGGER A SIGNIFICANT SHIFT IN THE SETTLEMENT PATTERN

As the marshside settlements moved progressively southward—shifting location in response to the changing shape of St. Catherines Island—the vast majority of the Irene period settlements (i.e., post-cal A.D. 1300 landscapes) were concentrated on the southern two-thirds of the Pleistocene core (with a sprinkling of archaeological remains around the Northwestern Marsh and along the less productive southern Holocene beach ridges).

Figure 30.48 shows the convergence between (1) soil types, (2) the distribution of Irene period settlements on St. Catherines Island, and (3) the placement of antebellum fields constructed in the 18th and 19th centuries. As discussed in chapter 5, we believe that the distribution of plantation-era cotton fields provides an excellent proxy measure of the distribution of arable soils. According to the Soil Conservation Service (Looper, 1982), the most desirable agricultural soil is the Foxworth fine sand, followed closely by Echaw and Centenary fine sands. As demonstrated in table 5.2, the vast majority (18 of 21) of the antebellum fields on St. Catherines Island were constructed on Foxworth soils. The other three antebellum clearings (Long Field, Billy Field, and Jesamin Finger) were constructed on Echaw and Centenary fine sands. As plotted in figure 30.48 (right), the southern half of the Island core was blanketed with plantation-era fields, but to the north of Persimmon Point (the western-most extent of St. Catherines Island), the antebellum fields are along the marshside margins of the stabilized relict dunes that define the Pleistocene core of the island—clearly avoiding the central swale (the low-lying, poorly drained freshwater lagoons that once dominated the north-
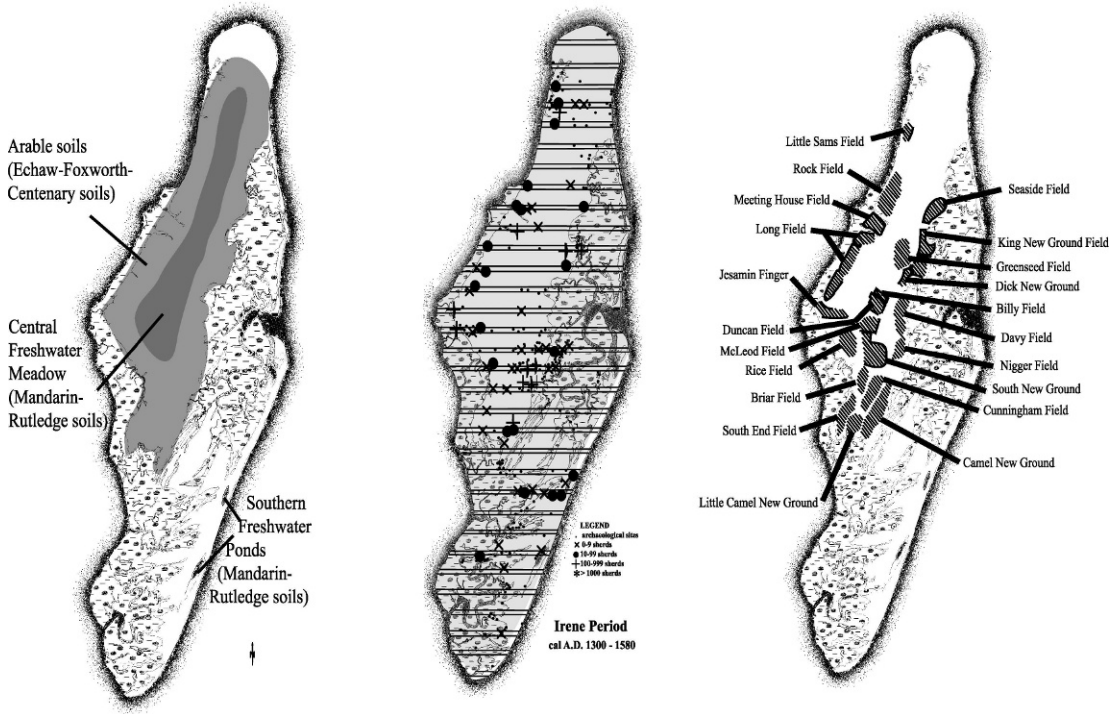
Fig. 30.48.   Comparison of the generalized soil types of St. Catherines Island (left) with the distribution of Irene period landscapes (center) and plantation era cotton and rice fields.

central portion of the Island core). Antebellum fields were never constructed on the low-lying Mandarin-Rutledge soils that define the extent of the central swale (see chap. 5) and, with the sole exception of Little Sams Field, not a plantation field was constructed north of the Seaside–Rock Field boundary.

Why are antebellum fields completely lacking along the northern quarter of St. Catherines Island? Despite the large, continuous band of Echaw–Foxworth–Centenary soils (the soils favored for agriculture elsewhere on the island), the northern part of St. Catherines Island is ill suited for agriculture because of the relatively high elevations encountered there (often in excess of 6 m above MHW). That is, despite the prevalence of relatively desirable, well-drained soils in this area, cotton will not grow in such relatively high elevations because access to the water table is difficult. This is why plantation-era planters avoided the northern end of St. Catherines Island.

We must also take note of the near complete lack of plantation fields on the southern Holocene beach ridges. The Fripp–Beaches–Duckson soils that dominate this area have extraordinarily low agricultural potential (Looper, 1982). As discussed in chapter 5, an early 19th century newspaper described "good crops of corn" for three consecutive years during which 40 (of the 70) acres were placed under cultivation at Flag Pond, on the extreme southern end of St. Catherines Island. The two patches of Rutledge fine sands (at Flag Pond and Beach Pond) provided the only agricultural potential on the entire Holocene beach ridge complex, and the distribution of Irene period sites (particularly in the vicinity of Beach Pond) would seem to corroborate this plantation-era pattern as well.

Figure 30.48 shows the remarkable correlation between soil types, Irene period

landscapes, and plantation-era fields on St. Catherines Island. But—to repeat the conventional disclaimer that dominates quantitative approaches to natural science—correlation is not causality, and we think it worthwhile to explore this relationship in a bit more detail.

We noted earlier how the changing shape of St. Catherines Island conditioned a progressively southward shift in the aboriginal landscape. From the perspective of human behavioral ecology, we believe that the optimal placement of central places responded to the changing geography and geomorphology of St. Catherines Island (between cal 3000 B.C. and cal A.D. 1300). This means that, by the time that maize cultivation became an option to aboriginal foragers of the Sea Islands (sometime shortly after cal A.D. 1300), the Irene period settlement was already positioned near the most arable soil available on the island. That is, by positioning their central places at the intersection of the two most highly ranked resource patches (the saltwater marsh and the maritime forest) and because virtually all maize cultivation takes place within the maritime forest, the aboriginal foragers of St. Catherines Island were in a sense prepositioned, preadapted to pursue the possibilities raised by maize cultivation *without changing their settlement pattern.*

To conclude: despite the neat convergence between soil type, plantation-era agricultural fields, and Irene period forager/farmer landscapes, we do not believe that Irene period settlements were deliberately sited to be close to arable land. Instead, the Irene settlement pattern was primarily driven by central place foraging considerations—to place primary settlements along the intersection of the saltwater marsh and the maritime forest (the two highest ranking patches available on St. Catherines Island). Over a 5-millennium period, similar cost–benefit considerations dominated the settlement patterning decision making of St. Catherines Island foragers. That is, it was the evolving geomorphic configuration of this island—not the introduction of maize-based cultivation—that determined the distribution of archaeological sites across St. Catherines Island.[17]

FOURTH CONCLUSION: OUR CENTRAL PLACE FORAGING FRAMEWORK DID NOT ANTICIPATE THE PRESENCE OF INLAND, LACUSTRINE SETTLEMENTS

We have already noted the high degree to which the empirically observed aboriginal settlement pattern corresponds to theoretical expectations from central place foraging theory. But the fit is not perfect.

The cluster of three St. Simons period components found near the middle of transect G-6 (9Li247, 9Li248, and 9Li249) is important because each of these sites lacked marine shell of any kind and were detected only through the systematic shovel-testing program conducted as part of the Island-wide transect survey. All three St. Simons components lie along the margin of the Rutledge soil type that dominates the central north–south swale of the Pleistocene core. This poorly drained area of lowered elevation was doubtless flooded by freshwater ponds before the artesian water table was lowered a century ago. Apparently, these Late Archaic components accumulated as a lacustrine adaptation flanking the central freshwater ponds, likely exploiting freshwater resources such as turtles, migratory waterfowl, bulrush and cattails, and perhaps even freshwater fish.

Comparable lacustrine settlements (9Li186, 9Li253, 9Li329, 9Li249, and 9Li178) are also evident during the subsequent Refuge-Deptford period. Each of these small sites is situated along the margins of the central freshwater marsh. Shell was entirely absent at 9Li249 and 9Li253, and these sites were located only by systematic shovel testing. Where *Mercenaria* shell was recovered, incremental analysis suggests that the sites were occupied mostly during the wintertime.

Wilmington period sites 9Li178, 9Li224, and 9Li240 continue this pattern—relatively small and mostly wintertime occupations situated near the central freshwater swamp. Three similar St. Catherines period components were also mapped at Rice Field 2 (9Li185), Wamassee Pond (9Li224), and Greenseed Field 1 (9Li178). Interestingly, this pattern virtually disappears during the

late prehistoric period, with only a single Irene period site (9Li240) found in a lacustrine setting (along the margin of a small freshwater pond, far inland from the southern edge of Northwestern Marsh).

These lacustrine settlements are the most notable deviation from central place foraging expectations, which posited that the major settlements should occur at the interface of saltwater marsh and the maritime forest. This is so because we defined four terrestrial hunt types (chap. 4): hunting, harvesting mast (fall), harvesting wild plants (late summer through early fall), and cultivating maize (post-A.D. 1000)—each of which played out across a relatively undifferentiated maritime forest habitat. But given the apparent significant clustering of lacustrine sites along central lowlands of St. Catherines Island, future investigations might wish to subdivide the overall "maritime forest" patch type into the following:

Pleistocene cores, stabilized relic dunes that run parallel and define the western and eastern margins of St. Catherines Island. These long, linear expanses of high ground are generally characterized by the relatively well-drained Echaw–Foxworth–Centenary soils.

Pleistocene swale (the "central depression"), a discontinuous, but linear, low-lying zone characterized by poorly drained Rutledge soils that developed in the shallow depressions and bays of the former central freshwater meadow.

The Pleistocene cores provide appropriate habitat for terrestrial hunting, harvesting mast, and cultivating maize. But the Pleistocene swale might well host newly defined hunt types such as lacustrine hunting (including ducks, freshwater turtles, and perhaps freshwater fish taxa), harvesting lacustrine wild plants (including cattail and bulrush), and plant-and-harvest maize cultivation (a strategy for utilizing the low-lying slough areas characterized by Rutledge soils; previously lumped with swidden maize cultivation, which is better suited for the Pleistocene dune habitats).

Archaeological samples generated during the Island-wide transect survey are inadequate for assessing the efficacy of such a Pleistocene swale habitat to host a distinctive lacustrine settlement type. This opens an important new possibility for archaeological research on St. Catherines Island, namely an inland shoreline survey—basically walking the interface among the Rutledge/Echaw–Foxworth–Centenary soil types, much the way we walked out the marsh margins of the late Holocene beach ridges. Such a survey should rely on systematic shovel testing (because marine shell is sometimes absent at such sites, particularly those utilized during Late Archaic and Refuge time periods). This archaeological survey strategy should determine whether the site cluster of 9Li247, 9Li248, and 9Li249, for instance, is anomalous or represents a previously undetected lacustrine settlement type. One potential problem is that such "nonshell" sites, lacking in the calcium carbonates contributed by marine shells, will tend to have soil with acidic pH and correlatively poor preservation. The test excavation strategy should also seek out concentrations of charred plant and/or animal remains (perhaps through remote sensing techniques such as proton magnetometry).

CONCLUDING THOUGHTS

We agree with Kennett (2005: 238) that coastal habitats are particularly well suited for the application of central place foraging theory (see also Yesner, 1980; Ames, 2002; Fitzhugh, 2002). Not only is the resource base distributed in a patchy and discontinuous fashion, but the logistics of boat transport and residential patterning render central place foraging models particularly appropriate for archaeological studies of maritime foragers. This chapter describes a first and fairly sketchy approximation of the possibilities for St. Catherines Island. But combined with increasingly sensitive, problem-oriented archaeological survey techniques with newer approaches to seasonality, bioarchaeology, and paleoethnobotany, the overarching perspectives presently available from human behavioral

ecology offer great promise for deeper understanding of the human adaptations in such coastal habitats.

NOTES

1. While this assumption generally holds for reef flat collecting in the mid-sublittoral, the assumption does not hold for the intertidal zone as a whole (Bird et al., 2004b: 192).

2. The statistical concept of *power* refers to the ability of a statistical test to correctly reject a null hypothesis when it is, in fact, false (Thomas, 1986: 216). Because the power of a statistical procedure is determined both by the alpha-level and the sample size, the small sample sizes involved in the present discussion seriously reduce the power of the Lilliefors test to reject the (null hypothesis) association with the theoretical normal/lognormal distributions (see also Zar, 1999: 83–85).

3. This procedure works best for samples of $n > 20$ (Zar, 1999: 86–87); unfortunately a rare occurrence in the archaeological datasets being discussed here.

4. Once a transformation is performed, the goodness of fit can be assessed statistically. But generally, the estimates of central tendency are still expressed in untranformed terms (Sokal and Rohlf, 1995: 412–413); but the confidence limits and standard errors become asymmetrical—that is, by looking up antilogs of the transformed means.

5. Following the conventions generally applied in biometric analysis, we have used common logarithms (to the base 10). Several other log transformations are available, and any base would produce satisfactory results (Zar, 1999: 275). We also note that when many values are extremely low (or equal to zero), many investigators prefer to use a transformation of $\log(1 + X)$ instead of $\log X$ (Zar, 1999: 275), but because this is not an issue with our central place foraging data, we have not taken this additional step.

6. The Standard Error of Kurtosis is defined as $SEK = (SQR\ 24/n)$.

7. In general, outliers have little or no impact on nonparametric tests (since the largest data will be treated the same, as will the smallest variates, regardless of whether they are accurate or exaggerated).

8. This is, of course, a deliberate oversimplification. As with many coastal habitats, the resources of St. Catherines Island are actually quite patchy and discontinuous, but we think that the relative simplicity of the diet-breadth model (and the associate uniform frequency distribution) provides a useful contrast set to the central place foraging arguments developed above.

9. The mean of the randomized, "empirical" distribution of observed variates is 483, with a standard deviation of 316. Note how irrelevant (and even meaningless) are such conventional estimators of central tendency and distribution when applied to a uniform frequency distribution.

10. Keep in mind that all seasonal estimates employed here rely on vertebrate and invertebrate animal remains only. We have excluded all paleoethnobotanical data from the present discussion.

11. We should also mention that Meeting House Field, which fell outside the Island-wide transect survey, likewise had evidence of a four-season occupation (chap. 25).

12. We must note that the value of $p = 0.052$ is borderline, nearly denoting a significant departure from normality with respect to Irene components on the southern beach ridges.

13. At some unknown location, not far from the Seaside Mound group, stood Moore's "Mound near the Light-house" (9Li7), which probably dates to the Deptford period.

14. We recovered too few seasonal indicators to plot against distance to marsh statistics.

15. As explained in chapters 12 and 19, we have followed the classic Willey and Phillips (1958: 21) definition of an *archaeological component* as a culturally homogeneous unit within an single archaeological site; in chapter 19, we set out the protocols employed in defining the archaeological components identified in the Island-wide survey. Defining "components" is critical in this study because it provides an effective means of assessing intrasite contexts, particularly helping to establish the interrelationship between the various evidence streams (including ceramic chronology, radiocarbon dates, zooarchaeological assemblages, and seasonality estimates). But we have also employed a "nonsite" archaeological perspective by introducing the concept of *archaeological landscape*, defined as the totality of all available archaeological evidence (termed a "presence"), partitioned according to specific temporal period and plotted across a well-defined and bounded geographical space (see chap. 19). So defined, an archaeological "presence" can be one or more potsherds recovered in a solid archaeological context, one or more time-diagnostic lithic artifacts, or an apparently reliable radiocarbon date (in context, but not necessarily in the presence of ceramics).

16. The small sample sizes involved here ($n = 10$) require caution in attributing substantive significance to these statistical decisions.

17. This said, we must recognize how this fortuitous convergence of foraging potential and arable soil patches must have played into the day-to-day, month-by-month decisions to forage or to farm. In the final chapter of this monograph, we explore the implications of these foraging/farming decisions in some detail.

CHAPTER 31. DIET BREADTH ON ST. CATHERINES ISLAND

DAVID HURST THOMAS

When developing the theoretical framework for this inquiry (chaps. 6–9), we drew upon the diet-breadth (or prey-choice) model to pose a deceptively simple question: *Which foods should an efficient forager harvest from all those available on St. Catherines Island?* This chapter will attempt to answer that question.

The diet-breadth model employs two key assumptions: (1) that all resources are randomly distributed (without patches) and (2) that ''capture/handling'' and ''search'' times represent the sum total of all time spent foraging (Winterhalder, 1981; O'Connell and Hawkes, 1981, 1984; Smith, 1991), and requires estimates of post-encounter return rates for potential food resources (which are generated through our own experimental and ethnohistorical research; presented in chaps. 7 and 8). Chapter 9 expanded diet-breadth considerations by addressing a number of horticultural technologies that may have been introduced to St. Catherines Island within the last millennium.

Because resources are clearly *not* distributed homogeneously across the various habitats on St. Catherines Island (assumption 1, above), it was necessary to define a series of terrestrial, littoral, and marine ''hunt types'' to categorize and analyze the differential diet breadths likely employed among aboriginal Sea Islanders. The changing month-to-month availability of key prey taxa on St. Catherines Island, especially the summer nesting of sea turtles and the late summer/fall harvest (of mast, small seeds, and maize during late prehistoric times) imposed a distinctive, seasonal pattern on the subsistence forager, who likely exploited resources simultaneously (often on the same day) in both terrestrial and marine ecosystems. Use of the various hunt types insured that the assumption of fine-grained foraging was satisfied within each prey set.

The diet-breadth model specifically predicts that (within each hunt type) an energy-efficient forager will always harvest the highest ranked resources encountered. Inclusion of lower ranked prey into the optimal set depends only on the encounter rate of the higher ranked prey; a counterintuitive projection is that the abundance of a lower ranked item does not condition its inclusion in the optimal diet. This model also predicts that should forager population densities increase, a disproportionate number of higher ranked prey will be harvested, resulting in decreased encounter rates with these most desirable taxa. As the search time increases, the overall harvesting efficiency would likewise decrease (with the diet breadth expanding accordingly).

The diet-breadth model allows us to make the following testable predictions about the archaeological record of St. Catherines Island (see also Broughton, 1994a, 1994b, 2002; Cannon, 2000a; Kennett, 2005: 18):

- If the abundance of higher ranked prey species increases, the diet breadth will decrease (resulting in decreased diversity among exploited resources).
- If the abundance of higher ranking resources decreases (inflating search costs), then diet breadth will increase; this is why potential prey types enter the diet based on the abundance of higher ranked resources (not just because of immediate value).
- As human population densities increase, the availability of higher ranked prey species is expected to decrease, although external constraints, including shifting climatic conditions, can sometimes mask this outcome.

In this chapter, these assumptions are considered in light of the available archaeological evidence from St. Catherines Island.

Elizabeth Reitz has analyzed the zooarchaeological evidence from the nonhuman vertebrate remains recovered in our St. Catherines Island research (chaps. 22 and 27, this volume). Table 31.1 pools the

TABLE 31.1
Distribution of the Vertebrate Fauna Recovered in the St. Catherines Island Excavations Discussed in This Volume (extracted from chaps. 22 and 27)

Taxa	Estimated return rate	St. Simons Period		Refuge-Deptford Period		Wilmington Period		St. Catherines Period[a]		Irene Period		Altamaha Period		Σ NISP	Σ MNI
		n	MNI	n	MNI	n	MNI	n	MNI	n	MNI	n	MNI		
Terrestrial vertebrates															
Alligator	25,600	—	—	2	1	—	—	—	—	3	1	—	—	5	2
White-tailed deer	12,096–19,895	182	6	181	10	153	15	63	6	646	56	1022	21	2247	114
Softshell turtle	12,805–16,181	1	1	—	—	—	—	—	—	—	—	—	—	1	1
Snapping turtle	12,805–16,181	—	—	—	—	4	1	—	—	4	1	1	1	9	3
Raccoon	10,595–15,281	12	2	43	6	39	9	7	3	154	31	128	13	383	64
Turkey	9707–14,000	7	1	1	1	—	—	—	—	—	—	1	1	9	3
Opossum	6540–12,113	41	2	—	—	—	—	—	—	—	—	1	1	42	3
Canada goose	5410–10,404	—	—	3	1	—	—	—	—	—	—	4	2	7	3
Rabbit	2302–7093	6	1	1	1	—	—	1	1	28	11	1	1	37	15
Pond turtle family[b]	3842–4855	31	1	122	1	27	—	61	—	141	1	37	2	419	5
Mud turtle family	3842–4855	13	1	—	—	7	1	2	1	29	8	3	1	54	12
Mink	—	—	—	—	—	—	—	—	—	1	1	1	1	2	2
Skunk	—	1	1	—	—	—	—	—	—	—	—	—	—	1	1
Duck	1526–2824	—	—	—	—	—	—	—	—	2	2	1	1	3	3
Diamondback terrapin	1600–2410	59	5	247	8	102	8	89	5	1519	76	181	8	2197	110
Squirrel	870–1613	—	—	—	—	—	—	1	1	2	1	4	2	7	4
Mole	—	—	—	—	—	—	—	—	—	4	3	—	—	4	3
Cotton rat	—	1	1	—	—	—	—	—	—	1	1	—	—	2	2
Subtotal	—	354	22	600	29	332	34	224	17	2534	193	1385	45	5429	340

TABLE 31.1—(*Continued*)

Marine vertebrates[c]

Taxa	Estimated return rate	Size	St. Simons Period n	MNI	Refuge-Deptford Period n	MNI	Wilmington Period n	MNI	St. Catherines Period[a] n	MNI	Irene Period n	MNI	Altamaha Period n	MNI	Σ NISP	Σ MNI
Rays	>45	very large	8	1	—	—	—	—	—	—	—	—	—	—	8	1
Sharks	>10	very large	2	1	—	—	—	—	—	—	—	—	1	1	3	2
Red drum	1.8–3.6	large	—	—	—	—	—	—	—	—	4	3	3	1	7	4
Gar	>2.0	large	72	1	15	2	7	1	—	—	8	3	30	2	132	9
Gafftopsail catfish	0.34–0.68	large/medium	47	2	26	3	34	5	16	2	174	18	2	2	299	32
Black drum	0.45–1.36	large/medium	22	2	11	2	82	6	—	—	8	5	6	3	129	18
Star drum	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	1
Drum family	—	—	—	—	—	—	—	—	—	—	1	1	2	1	3	2
Flounder	0.45–1.36	large/medium	3	1	—	—	4	2	—	—	2	2	—	—	9	5
Sheepshead	0.45–1.36	large/medium	—	—	—	—	2	2	3	1	10	3	—	—	15	6
Seatrout	0.34–0.57	medium/small	48	2	5	2	19	4	—	—	6	4	5	2	83	14
Hardhead catfish	0.15–0.30	small	666	82	12	2	11	7	40	4	358	56	54	8	1141	159
Mullet	0.115–0.40	small	—	—	—	—	1	1	—	—	66	11	49	2	116	14
Atlantic croaker	0.11–0.45	small	—	—	—	—	—	—	—	—	—	—	1	1	1	1
Silver perch	0.11–0.45	small	—	—	—	—	—	—	—	—	—	—	1	1	1	1
Toadfish	0.04–0.09	small	—	—	—	—	1	1	—	—	—	—	—	—	1	1
Mummichog	0.0015	very small	—	—	—	—	—	—	—	—	67	13	—	—	67	13
Subtotal	—	—	868	92	69	11	161	29	59	7	705	120	154	24	2016	283
Totals	—	—	1222	114	669	40	493	63	283	24	3439	313	1539	69	7445	623

[a] The bone counts for the Savannah phase (NISP = 126) have not been employed in this analysis (see chap. 15).
[b] For present purposes, the NISP for chicken turtles has been combined into the category "Pond Turtle Family" and introduced European taxa are not included.
[c] Average size for marine vertebrates is 1.0 kg.
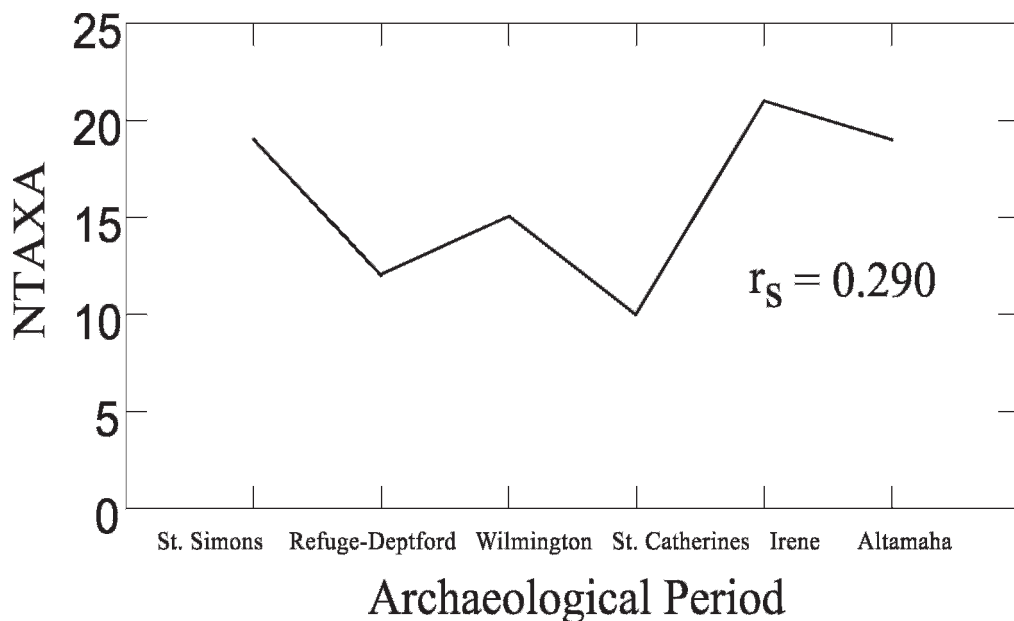
Fig. 31.1.   The distribution of NTAXA (number of identified vertebrate taxa) across the cultural periods of St. Catherines Island.

relevant bone counts (number of identified specimens [NISP] = 7445; minimum number of individuals [MNI] = 623) for all vertebrate remains recovered from a total of 85 archaeological components (71 individual sites on St. Catherines Island). To facilitate analysis according to the previously defined hunt types, table 31.1 is subdivided into terrestrial and marine vertebrate taxa.

TERRESTRIAL HUNTING

The terrestrial vertebrate assemblage is dominated by white-tailed deer and diamondback terrapins, which together account for more than 80 percent of all nonhuman, terrestrial vertebrate bones recovered (NISP = 4444 of 5429). Raccoons, rabbits, mud and other pond turtles are also well represented in deposits that span the precontact and postcontact periods. In general, the zooarchaeological frequencies in table 31.1 suggest that the overall energetic return rates for the terrestrial hunt type typically exceeded 1600–2410 kcal/hr.[1] Terrestrial animals with return rates lower than diamondback terrapins (includ-

ing squirrels and rats) are only minimally represented in the Island-wide survey samples.

Figure 31.1 plots the changes in the number of vertebrate taxa (NTAXA) represented in these various period-specific assemblages. This relationship is clearly nonlinear, with a nonparametric correlation coefficient not significantly different from zero (r_S = 0.290). The zooarchaeological sample of vertebrates dating to the initial human occupation of St. Catherines Island (the St. Simons period) suggests that many terrestrial taxa (NTAXA = 19) were exploited. Over the next 2 millennia (i.e., during the Refuge-Deptford, Wilmington, and St. Catherines periods), NTAXA declines notably. Only during the late prehistoric (Irene) period does the number of vertebrate taxa increase, to NTAXA = 21 (the highest value recorded in the St. Catherines Island data). The number of vertebrate taxa declines during the mission period, to NTAXA = 19 (the same number as the initial St. Simons period occupation, excluding domestic species).

When the vertebrate fauna is divided into terrestrial and marine components (fig.
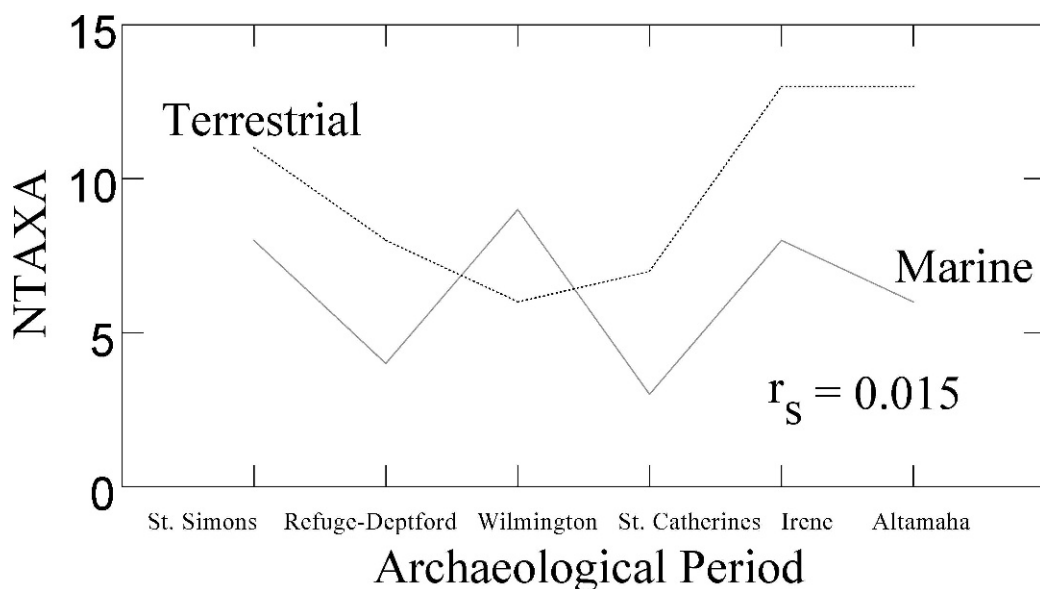
Fig. 31.2.   Comparison of NTAXA$_{Terrestrial}$ and NTAXA$_{Marine}$ recovered from the excavations on St. Catherines Island.

31.2), the assemblage patterns are generally similar, except for an increase in fish exploitation during the Wilmington period (when NTAXA$_{Marine}$ spikes to nine taxa). The correlation coefficient for this nonlinear relationship is not significantly different from zero ($r_S = -.015$).

It is tempting to view NTAXA as a proxy for the ethnographic (or behavioral) view of diet breadth, meaning the "total number of resources in the diet" (Kaplan and Hill, 1992: 171). But NTAXA is not a straightforward measure of past diet breadth, and multiple difficulties attend any effort attempting to translate NTAXA into behavioral diet breadth. These difficulties include the effects of time-averaging, differential time-sampling, mechanical effects (such as differential fragmentation), and differential bone transport (e.g., Broughton and Grayson, 1993; Grayson and Delpech, 1998; Cannon, 2003).

Problems also exist with differential sample sizes. Figure 31.3 plots the relationship between the NISP against the number of marine and terrestrial vertebrate taxa (NTAXA) across the six archaeological periods on St. Catherines Island (employing a logarithmic transformation for both variables). The NISP–NTAXA relationship is clearly linear (with $r_S = 0.928$, $p < 0.05$). In other words, for the marine and terrestrial vertebrates recovered from St. Catherines Island, the taxonomic diversity during each cultural period is heavily and significantly dependent on the raw number of zooarchaeological specimens recovered. This means that a larger sample of available bones will tend to product a greater apparent taxonomic diversity. That is, excavating a couple of test pits might produce a small sample of bones, suggesting a low value of NTAXA. But increasing the number of excavation units can expand the apparent taxonomic diversity significantly (because diversity is directly proportional to the increasing size of the zooarchaeological sample). This is another reason to avoid equating NTAXA with behavioral diet breadth.

For these reasons, the quantitative trends evident in figures 31.1 and 32.2 cannot be taken as proxy measures of diet-breadth changes over the past 5000 years on St. Catherines Island. But it is possible to address some correlative changes at the species level.
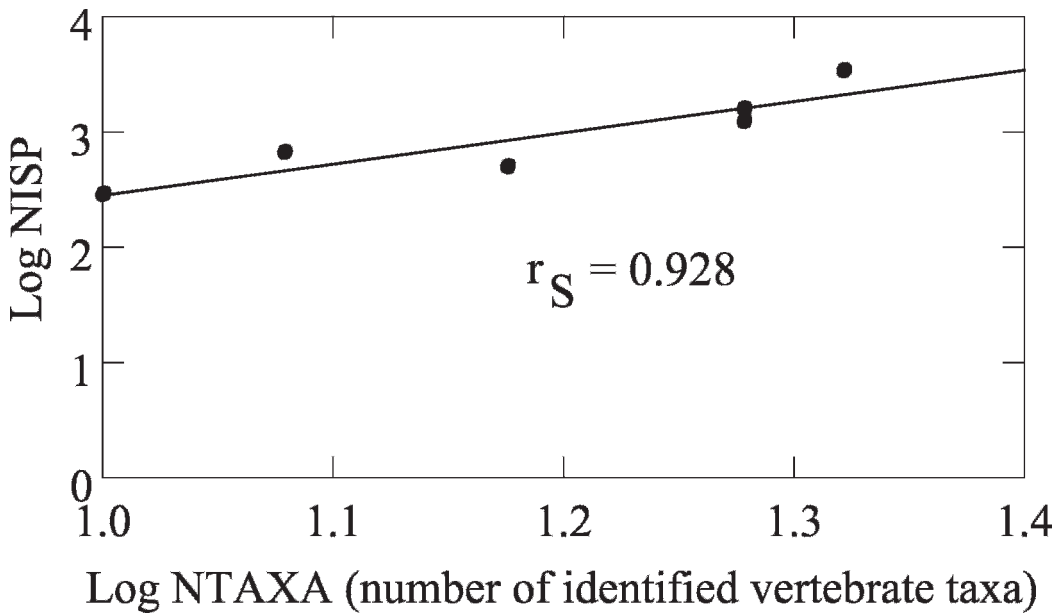
Fig. 31.3.   Relationship between NTAXA (number of identified vertebrate taxa) and NISP (the total number of identified vertebrate specimens).

THE VERY HIGHEST RANKING TAXA

Black bear (*Ursus americanus*) is the highest ranking terrestrial taxon available to aboriginal foragers on St. Catherines Island (table 8.27). No black bear remains were recovered during the St. Catherines Island excavations reported in this volume. But black bear bones are occasionally recovered at archaeological sites in coastal Georgia, including Bourbon Field (on Sapelo Island; Reitz, 1982b: table 3), and Red Bird Creek (Pearson, 1984a: table 3). Brown and/or black bear bones were recovered at the Irene site (Caldwell and McCann, 1941: appendix III).

American alligator (*Alligator mississippiensis*), the second-highest ranking terrestrial taxon, was rarely recovered on St. Catherines Island excavations. The vertebra from a very small individual was found at 9Li173 (transect B-6) fronting the Northwestern Marsh. An alligator rib, likewise from a very small individual, was found at 9Li169, located near Seaside Marsh (at the extreme eastern end of transect D-6). Elsewhere on the Georgia coast, alligator remains have been found in several archaeological deposits, including Sapelo Island (Kenan Field and the North End site; Crook, 1978a; Reitz, 1982a: table 1), Red Bird Creek (Pearson, 1984: table 3), a shell ring on St. Simons Island (Marrinan, 1975: table 10), and the Irene site (Caldwell and McCann, 1941: appendix III).

WHITE-TAILED DEER

White-tailed deer, the third-highest ranking terrestrial vertebrate, is the most abundant vertebrate taxon represented in the zooarchaeological assemblages from St. Catherines Island (accounting for more than 30 percent of all bones recovered; see table 31.1). Table 31.2 tabulates the relative biomass estimates for white-tailed deer, arrayed as a proportion of the total vertebrate remains (including fish, rays, and sharks) and partitioned by archaeological period (per Reitz, chaps. 22 and 27, this volume). The total biomass contribution of white-tailed deer (among terrestrial and marine vertebrates) ranges from roughly 60 percent (during the Irene period) to nearly 90 percent during the Altamaha (mission) period.

TABLE 31.2

Relative Biomass Estimates for the Various Excavations Reported in This Volume, Summarized as Proportion of the Total Vertebrate Remains Partitioned by Archaeological Phase (synthesized from chaps. 22 and 27)[a]

Period	Number of archaeological components	Assemblages Biomass (kg)	White-tailed deer		Diamondback terrapin		Big Fish Index			Marine/Terrestrial Index	
			Biomass	Percent	Biomass	Percent	Biomass Total Fish	Biomass Big Fish	Percent	Biomass	Percent
Altamaha											
Santa Catalina de Guale	—	28.01	24.20	86.4%	0.437	1.5%	0.2521	0.042	16.7%	0.025	0.09%
Fallen Tree Survey[b]	—	1.54	1.07%	69.8%	0.139	21.4%	0.139	0.0	0.0%	0.108	7.0%
Fallen Tree Survey[c]	—	58.48	54.68	93.5%	0.20	0.34%	0.994	0.78	78.5%	0.099	0.2%
Fallen Tree Excavations[d]	—	38.65	32.56	84.2%	2.037	5.2%	0.4976	0.2179	43.8%	0.498	1.29%
Weighted average	3	126.68	112.51	88.8%	2.813	0.82%	1.8515	1.039	56.1%	0.729	0.58%
Irene											
Island-wide Survey	—	33.582	25.334	75.4%	1.887	5.6%	2.85	0.6242	21.9%	2.854	8.5%
Meeting House Field (DHT)	—	12.31	6.360	51.7%	4.50	36.7%	0.259	0.04	15.4%	0.256	2.1%
Meeting House Field (Saunders)	—	0.556	0.219	39.4%	0.184	33.1%	0.066	0.013	19.70%	0.066	11.87%
South End Mound I	—	30.966	14.661	47.3%	0.436	1.41%	0.56	0.2179	38.9%	0.436	1.41%
Weighted average	49	77.414	46.574	60.2%	7.007	9.65%	3.735	0.8862	23.7%	3.612	4.67%
St. Catherines	6	6.523	4.815	73.8%	1.057	16.2%	0.215	0.15	69.7%	0.215	3.3%
Wilmington	14	15.093	11.846	78.5%	0.917	6.1%	1.61	1.419	88.1%	1.373	9.1%
Refuge-Deptford	9	16.114	12.805	79.5%	1.073	6.7%	0.886	0.709	80.0%	0.886	5.5%
St. Simons	2	15.431	10.312	67.8%	0.47	0.3%	2.963	1.93	65.1%	2.962	19.2%
Total	—	257.255	18.862	77.30%	13.337	5.18%	11.261	6.63	34.0%	9.777	3.80%

[a] As explained in chapters 15 and 22, the "Savannah period" counts are excluded from this table.
[b] DHT, chapter 22.
[c] Caldwell, chapter 22.
[d] Chapter 27.

PREY CHOICE AND RESOURCE DEPRESSION
ON ST. CATHERINES ISLAND: The prey choice
model is frequently employed to derive
expectations about resource selection and
subsistence change due to increased
foraging pressure (e.g., Broughton, 1999;
Cannon, 2000a; Butler and Campbell,
2004). The model projects that a forager's
most efficient strategy is to take the highest
ranked prey upon encounter. As foraging
pressures increase, the abundance of
higher-ranking prey should decline and
lower ranked resources should be included
only when the density of high-ranking prey
is significantly reduced. Several studies in
the American West have produced evi-
dence suggesting human-initiated resource
depression (including Broughton, 1994a,
1999; Hildebrandt and Jones, 1992; Jones
and Hildebrandt, 1995; see also Lyman,
1995; Janetski, 1997; Grayson, 2001; Byers
and Broughton, 2004).

Several investigators have employed an
index of relative abundance to explore the
issue of prey choice and resource depression
(e.g., Bayham, 1979; Szuter and Bayham,
1989; Broughton, 1994a; Ugan and Bright,
2001: 1309; Butler and Campbell, 2004:
338; Wolverton, 2005). So-called *AI* (*abun-
dance index*) measures assume that the rel-
ative abundance of large prey in archaeo-
logical assemblages provide an accurate
reflection of their abundance in the sur-
rounding environment. Such abundance in-
dices commonly take the form of ''frequen-
cy of a high-ranking taxon/frequency of all
taxa'' and the resulting index (which ranges
between zero and one) reflects the relative
portion of certain high-ranked prey in
a zooarchaeological assemblages. When
scaled across a stratigraphic sequence with-
in a single site, such abundance indices have
been employed as proxy estimates reflecting
changing diet breadth. As with NTAXA,
however, numerous analytical problems ac-
company the applications of the various
abundance indices. While the indices of rel-
ative abundance provide useful tools for
first-approximation comparisons, it is im-
portant to avoid overinterpreting these
these results (especially given the problems
of small sample sizes, differential bone

transport, and the unknown age structures
of the vertebrate populations involved).[2]

To explore the nature of vertebrate exploi-
tation and resource depression on St. Cather-
ines Island, we will define a *White-tailed
Deer Index,* measured as NISP, MNI, and
Biomass (per Reitz and Wing, 1999; chap.
7; see also Reitz, chap. 22, this volume).

$$White-tailed\ Deer\ Index_{NISP}$$
$$= \Sigma(Deer_{NISP})/$$
$$\Sigma(All\ vertebrate\ taxa_{NISP})$$

$$White-tailed\ Deer\ Index_{MNI}$$
$$= \Sigma(Deer_{MNI})/$$
$$\Sigma(All\ vertebrate\ taxa_{MNI})$$

$$White-tailed\ Deer\ Index_{Biomass}$$
$$= \Sigma(Deer_{Biomass})/$$
$$\Sigma(All\ vertebrate\ taxa_{Biomass})$$

The value of each White-tailed Deer Index
varies between 0 and 1.0, with larger values
indicating higher relative frequency of white-
tailed deer bones in the overall assemblage.[3]
Table 31.3 charts the values of the three
White-tailed Deer Indices for the archaeolog-
ical sites discussed in this volume. Note that
the values represent the abundance of deer
bones relative to *all vertebrate taxa recovered*
(meaning that the denominator includes all
the fish, shark, amphibian, and reptile re-
mains recovered—regardless of hunt type).

Figure 31.4 charts the variability of the
White-tailed Deer Indices across the six tem-
poral periods on St. Catherines Island.[4] It is
clear that the three abundance measures—
NISP, MNI, and Biomass—are highly inter-
correlated and reflect the same fundamental,
nonlinear trends for white-tail deer remains in
the middens of St. Catherines Island. The
nonparametric correlation between three in-
dices is statistically significant.[5]

The diet-breadth model predicts that as
human population increases through time
(as it demonstrably does on St. Catherines
Island), a disproportionate number of high-
ranking prey taxa (such as white-tailed
deer) should be harvested. Over time, the
total encounter rates for the most desirable

TABLE 31.3
Abundance Indices for the Vertebrate Zooarchaeological Assemblages Reported in This Volume

Index	St. Simons	Refuge-Deptford	Wilmington	St. Catherines[a]	Irene	Altamaha	Pooled sample
White-Tailed Deer (NISP)	0.1489	0.2706	0.3103	0.2226	0.1878	0.6641	0.7292
White-Tailed Deer (MNI)	0.526	0.2500	0.2381	0.2500	0.1789	0.3043	0.5457
White-Tailed Deer (Biomass)	0.678	0.795	0.785	0.738	0.602	0.888	0.7730
Diamondback Terrapin (NISP)	0.0483	0.3692	0.2069	0.3145	0.4417	0.1176	0.2951
Diamondback Terrapin (MNI)	0.0439	0.200	0.1270	0.2083	0.2428	0.1159	0.1766
Diamondback Terrapin (Biomass)	0.003	0.067	0.0061	0.0162	0.005	0.0222	0.0518
Big Fish (NISP)	0.1774	0.750	0.801	0.322	0.2950	0.2857	0.3006
Big Fish (MNI)	0.087	0.636	0.5517	0.4286	0.300	0.4167	0.2827
Big Fish (Biomass)	0.651	0.800	0.881	0.697	0.227	0.561	0.3400
Percent marine vertebrates (NISP)	0.7103	0.1031	0.3266	0.2085	0.2050	0.1001	0.2708
Percent marine vertebrates (MNI)	0.8070	0.275	0.4603	0.2917	0.3834	0.3478	0.454
Percent marine vertebrates (Biomass)	0.1920	0.055	0.910	0.033	0.047	0.0058	0.038

[a]The bone count for the Savannah phase (NISP = 126) has not been employed in this analysis (see chap. 22).

prey items should decrease and the diet breadth should increase as lower ranking taxa are included to compensate for the overall decrease in net energy intake.

This is not what happens on St. Catherines Island. With respect to the MNI, figure 31.4 and table 31.1 indicate that white-tailed deer comprise only five percent of the individual vertebrates recovered from St. Simons period deposits. As Reitz (chap. 22, this volume) cautions, these data derive exclusively from the St. Catherines Shell Ring (9Li231), and one must question the degree to which this limited sample reflects deer acquisition practices during the late Archaic time period; nevertheless, white-tailed deer contributed two-thirds of the biomass represented in the Late Archaic sample (see table 31.3).

Except for the sharp increase in deer utilization during the mission period (discussed below), the importance of white-tailed deer hovers between approximately 20–30 percent of the MNI and NISP from the overall vertebrate faunal sample throughout the rest of the precontact sequence on St. Catherines Island (from Refuge-Deptford through Irene times; see table 31.2). That is, during this 200-year-long interval, venison contributes 60–80 percent of the biomass available from terrestrial and marine vertebrate sources.

We can explore the issue of resource depression in white-tailed deer populations by focusing strictly on the Refuge-Deptford through Irene period deposits (spanning the interval cal 1000 B.C. through A.D. 1580). Figure 31.5 compares the linear regressions for various abundance indices available to characterize white-tailed deer exploitation on St. Catherines Island. The plot for White-tailed Deer Index$_{Biomass}$ during the Refuge–Irene period interval has a negative slope (decreasing slightly through time) and this linear relationship is statistically significant ($r_S = -1.0$, $p < 0.05$). The corresponding abundance indices for NISP and MNI also show a very slight decrease through time, but these relationships are not statistically significant (with $r_S = -0.80$ and -0.632, respectively).

The live weight of white-tailed deer is known to have decreased through time in
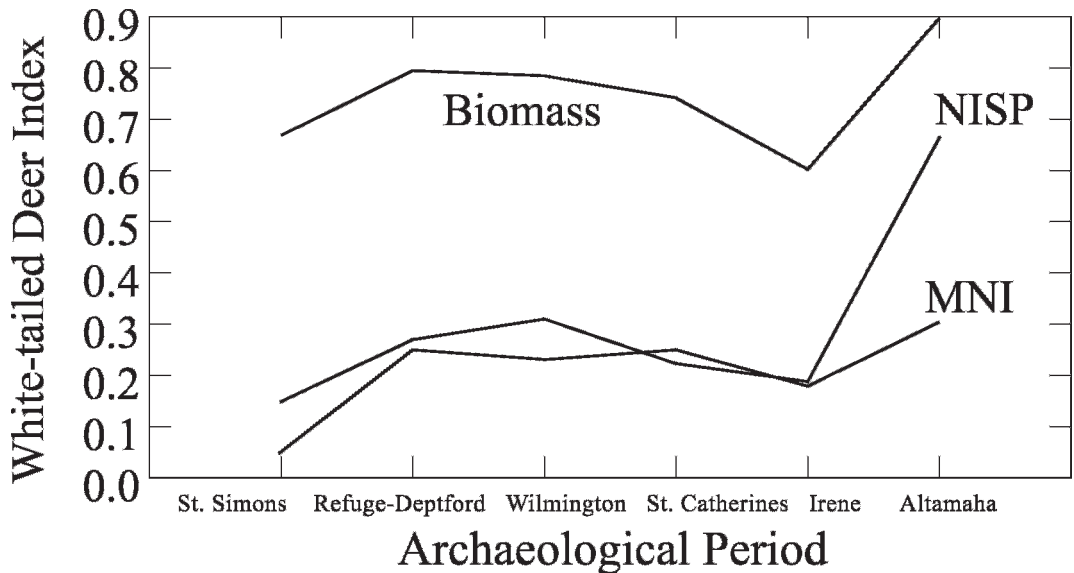
Fig. 31.4.   White-tailed Deer Indices for St. Catherines Island, scaled as NISP, MNI, and Biomass for all vertebrate remains.

barrier island populations (Purdue and Reitz, 1993; see also chap. 8, this volume). Table 8.4 documents the changing body size for mainland and barrier island white-tailed deer populations over the last 3000–4000 years. At about 1600 B.C. (during the late St. Simons period), mean adult body weight was about 72.5 kg. Thereafter, and until today, the body size of island deer populations decreased markedly. White-tailed deer on the contemporary Sea Islands are only about half the size of their ancestors 3600 years ago.

As Reitz (chap. 22) explains, the biomass estimates derive from the allometric relationship between live weight and skeletal weight (table 22.1). Because a single allometric equation was applied to all mammal remains (regardless of body size or taxon), the biomass estimates represented in figure 31.5 are independent of the decreasing live weight among island white-tailed deer populations. This means that body mass does not account for the decreasing relative importance of white-tailed deer in the overall biomass contributed by vertebrates.

Reitz (chap. 22) also considers the possibility that the decline in body size of white-tailed deer resulted from human hunting pressure, particularly after A.D. 1000. She notes that although the relationships between hunting pressure and body size in white-tailed deer is complex, 42 percent of the deer MNI from the Island-wide survey sites are juveniles or subadults. Since it appears that the number of deer hunted actually increases during the mission period, "the assumption must be made that deer were able to support this hunting pressure," perhaps through reduced adult body size and altered reproductive habits that could survive the culling of large numbers of young animals. Reitz (chap. 22) concludes, "it remains to be seen why St. Catherines Island was an exception."

In other words, deer remain the most important vertebrate captured during the interval from cal 1000 B.C. to A.D. 1580 (with biomass contribution ranging between 60 and 80 percent of all vertebrates). But figure 31.5 does indicate a *relative* decline in deer importance through time; while this finding is generally consistent with the diet-breadth prediction of resource depletion, the decline is not dramatic. The results from St. Catherines Island thus conflict with the numerous studies (cited above) from the American West, which document radical
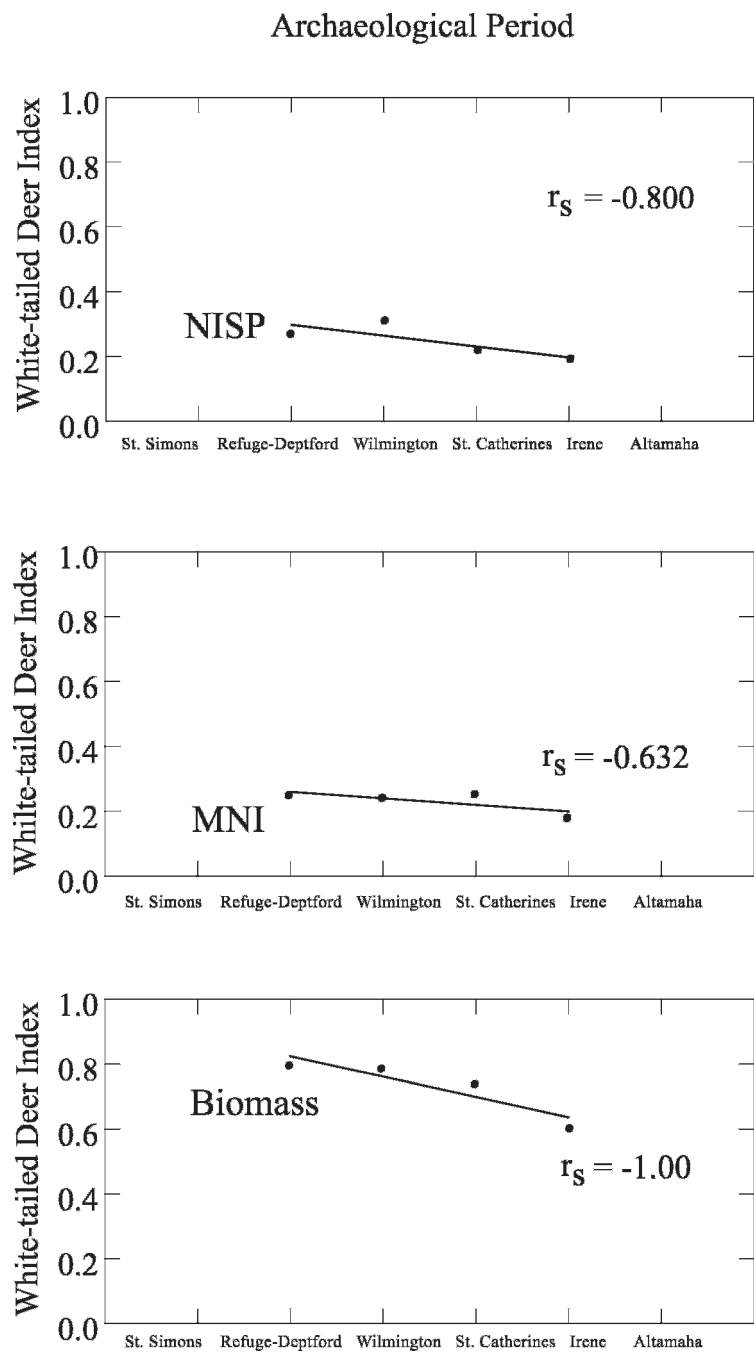
Fig. 31.5.   Regression equations comparing the distribution of the three White-tailed Deer Indices on St. Catherines Island (Refuge-Deptford through Irene periods).

declines in high-ranking prey populations due to human hunting pressure (Grayson, 2001: 16). Butler and Campbell (2004: 398) argue that such anthropogenic declines are not inevitable. Noting the continued and intensive utilization throughout the Northwest Coast and Plateau areas, the same two high-ranking terrestrial and marine prey (cervids and salmon) remained critical resources, used in increasing proportions through time; they conclude that ''in spite of thousands of years of hunting, fishing, and gathering the same animals, our data show no evidence for resource depression in either the Northwest Coast or Plateau study areas.''

In truth, abundance indices cannot distinguish the *declining importance* of a higher-ranking resource (such as white-tailed deer) from the *increasing importance* of other lower ranking resources (such as diamondback terrapins) that belong to the same hunt type. Thus, while one cannot resolve the issue of anthropogenic influence based on the data presently available, it is clear that white-tailed deer remained a key resource for foragers during the entire aboriginal period on St. Catherines Island.

WHITE-TAILED DEER EXPLOITATION DURING THE MISSION PERIOD: Figure 31.4 likewise charts the remarkable abundance of deer bones recovered from mission period deposits on St. Catherines Island (see also table 31.2). The proportion of white-tailed deer bones (NISP) increases to 66.4 percent. Measured as MNI, the mission period relative abundance of deer is 31.4 percent. Overall, venison accounts for 88.8 percent of the biomass derived from vertebrates during the mission period. Each of these three measures is the highest of any computed for the precontact period.[6]

Figure 31.4 suggests that the Guale people had shifted away from the relatively broad diet characteristic of the precontact period (that included turtles, fish, and venison) to a surprisingly narrow dietary focus on white-tailed deer during the mission period. As Reitz observes in chapter 22, the huge quantity of venison consumed at Mission Santa Catalina also stands in marked contrast to Spanish diets reconstructed for coastal Spanish Florida, the Caribbean, or Spain.

We suspect that the dramatic increase in deer bones can be attributed, in part, to the brisk trade in deerskins during the mission period (see also Reitz and Duke, chap. 27). The ethnohistoric literature makes it clear that the Guale and other coastal tribes used deerskins as currency for tribute and other expenses: ''The Indians, 'even to the poorest,' brought the Spanish leaders 'free-will gifts'' of 'deerskins, mantels of *gato* [panther or wildcat], pearls, or maize'' (Bushnell, 1994: 60, 74). The Guale commonly bartered deerskins in exchange for religious items, such as wax and burial expenses (Matter, 1972: 135; see also Waselkov, 1989). The increased availability of firearms doubtless changed the energetics of deer hunting during the mission period, and the extensive clearing for mission fields likely favored browse for deer. In this context, then, it seems likely that the remarkable increase in deer bone could reflect a response to demands for meat and/or hides by the Spanish at Mission Santa Catalina de Guale. Reitz (1990: 551, 1991: 302) estimates that Spaniards stationed on St. Catherines Island ate twice as much pork and more than 10 times as much venison as their counterparts living in St. Augustine.[7]

The diet-breadth model clearly anticipates this outcome. With estimated post-encounter return rates ranging from 12,096–19,895 kcal/hr, white tailed deer are among the very highest ranking taxa available to terrestrial foragers and farmers on St. Catherines Island (exceeded only by alligator, sea turtle, black bear, and some very large fish, all of which were likely much more scarce than deer). The diet-breadth model predicts that energy-efficient forager/farmers should always harvest such high-ranking resources upon encounter.

But in the larger context of coastal Georgia archaeology, the abundance of white-tailed deer remains on St. Catherines Island is surprising, even extraordinary. As Elizabeth Reitz observes, ''this is the most unexpected result of the transect study and one that is difficult to explain based on present knowledge'' (chap. 22, this volume,

see also Reitz, 1982b). The next section explores the question of why deer were so important to St. Catherines Islanders and so apparently irrelevant to many inhabitants of neighboring islands.

WHITE-TAILED DEER EXPLOITATION ON GEORGIA'S BARRIER ISLANDS: To understand the apparent disparities of white-tailed deer hunting, we must situate the St. Catherines Island results within a broader context. Table 31.4 marshals the range of White-tailed Deer Indices (employing NISP, MNI, and Biomass estimates) available from archaeological investigations on the barrier islands and mainland along the Georgia coast.

The Spanish colonial site of Santa Elena is located on Parris Island, a marsh island in Port Royal Sound (South Carolina) and occupied during 1566–1587 (South 1980, 1982). Deer remains are present, but not common at Santa Elena, with the zooarchaeological evidence indicating an MNI of only 18 individual white-tailed deer (in a sample of 429 NISP), with a biomass contribution of 23.1 percent (Reitz and Scarry, 1985: table 11; Reitz, 1985).

Grove's Creek (9Ch71) is an Irene period site located on Skidaway Island (about 25 km to the north of St. Catherines Island). Keene (2002) reports that deer bones were rare in the Structure 5 proveniences (2 of 47 NISP), an expected result since house floors were typically swept and kept free of large food debris such as deer bones. But she also notes that the "2001 Midden Unit" contained only three deer bones (out of 5619 mammal, bird, fish, and turtle bones recovered). By contrast, the more extensive "Elderhostel excavations" (conducted in 1985–1991) produced 92 white-tailed deer bones. Overall, Keene (2002) estimates that white-tailed deer contributed a total of 47.3 percent of the vertebrate biomass.

The zooarchaeological evidence from Ossabaw Island (immediately to the north of St. Catherines Island) indicates that white-tailed deer was the most heavily exploited species, providing 78 percent of the estimated biomass in Savannah-age middens and 85 percent during the Irene

period (Pearson, 1979a: 138, table 12). Pearson (1979a) estimated biomass in a slightly different manner from that employed by Reitz (this volume; see also Reitz and Wing, 1999, 2008), but that methodological difference cannot account for the overwhelming importance of white-tailed on Ossabaw Island.[8] Significant quantities of deer bone were recovered in every site tested on Ossabaw Island, and Pearson (2001: 91, 1979a: 144) concludes that "deer bones consistently appear in the middens examined on Ossabaw and they certainly provide an important proportion of the non-shellfish meat to the diet of the island's prehistoric residents."

St. Catherines Island is the next barrier island to the south, and the zooarchaeological evidence indicates that white-tailed deer account for 60–90 percent of the biomass from vertebrates throughout the aboriginal period.

On Sapelo Island, Moore (1897: 73) reports encountering "shattered deer bones" during his explorations in the Late Archaic shell ring. Working at the same site, Waring and Larson (1968: 265–266, table 25) report that white-tailed deer bones comprised "about 85 percent of the total" number of bones recovered. These same authors comment that whereas "today Sapelo abounds with white-tailed deer, from 15 to 30 deer per square mile" (Waring and Larson, 1968: 266), the precontact deer densities were likely lower due to the restricted browse available in the climax forest that once dominated the Sapelo landscape.

Victor Thompson's recent research on the Sapelo Island Shell Ring complex (Thompson, 2006) included a partial reanalysis of the faunal remains recovered by Waring and Larsen: "Based on the number of NISP, whitetail deer are (*Odocoileus virginianus*) the most frequently identified specimen. … [M]ammals, especially whitetail deer, dominate the assemblage" (Thompson, 2006: 248). Only a limited sample of the 2003 zooarchaeological assemblage has been analyzed and white-tailed deer bones were apparently absent in the two column samples examined: "This is to be expected, as the sample was very small"

TABLE 31.4
Abundance Indices for Deer Exploitation along the Georgia–Northern Florida Coastline

Site	Location	Northing	Time period	Deer			Recovery technique	Source
				NISP	MNI	Biomass		
Barrier Island Assemblages								
Santa Elena	Paris Island, SC	—	1566–1587	—	18 of 429 (4.2%)	21.69 of 93.8 (23.1%)	1/4″ & fine-screening	Reitz and Scarry (1985: table 11); Reitz (1985: table 2)
Grove's Creek	Skidaway Island	3535	Irene	63 of 2506 (2.5%)	6 of 115 (5.2%)	5.70 of 12.04 (47.3%)	—	Keene (2002: tables D-1, D-6, D-9, D-11)
Miscellaneous Sites	Ossabaw Island	3518	Savannah	50 of 260 (19.2%)	11 of 47 (23.4%)	78%	—	Pearson (1979a: table 12) fn 1[a]
Miscellaneous Sites	Ossabaw Island	3518	Irene	102 of 199 (54.8%)	12 of 37 (32.4%)	85%	—	Pearson (1979a:138, table 12) fn 1
3 components	St. Catherines Island	3500	Mission	1022 of 1539 (66.4%)	21 of 69 (40.4%)	79.0 of 88.1 (89.7%)	1/4″& 11/32″ screen, some fine-screening	Reitz (chaps. 22 and 27, this vol.)
49 components	St. Catherines Island	3500	Irene	646 of 3439 (18.7%)	56 of 343 (17.9%)	46.6 of 77.7 (60.2%)	1/4″& 11/32″ screen, some fine-screening	Reitz (chaps. 22 and 27, this vol.)
6 components	St. Catherines Island	3500	St. Catherines	63 of 283 (22.3%)	6 of 24 (25.0%)	4.9 of 6.5 (73.8%)	mostly 1/4″	Reitz (chap. 22, this vol.)
14 components	St. Catherines Island	3500	Wilmington	153 of 493 (31.0%)	15 of 63 (23.8%)	11.8 of 15.090 (78.5%)	mostly 1/4″	Reitz (chap. 22, this vol.)
9 components	St. Catherines Island	3500	Refuge-Deptford	181 of 669 (27.0%)	10 of 40 (25.0%)	12.8 of 16.1 (79.5%)	mostly 1/4″	Reitz (chap. 22, this vol.)
2 components	St. Catherines Island	3500	St. Simons	182 of 1222 (14.9%)	6 of 114 (5.3%)	10.3 of 15.4 (66.8%)	1/4″ screen	Reitz (chap. 22, this vol.)
North of Shell Ring Drain	Sapelo Island	3487	Irene	51 of 1127 (4.5%)	2 of 107 (1.9%)	4.06 of 10.27 (39.5%)	—	Reitz (1982a)
Shell Ring	Sapelo Island	—	St. Simons	Deer bones "about 85% of the total" sample bones recovered			—	Waring and Larson (1968: 265–266, table 25)
Bourbon Field	Sapelo Island	3484	Savannah/ Irene	492 of 3567 (13.7%)	63 of 563 (11.2%)	19.06 of 29.36 (64.9%)	1/4″ 1/16″	Crook (1978b,1984); Reitz (1982a, 1985); Pavao-Zuckerman (2000: table 2)
Kenan Field	Sapelo Island	3483	Savannah/Irene	—	38 of 398 (9.5%)	—	1/4″ 1/16″	Crook (1978b); Reitz (1982a, chap. 22, this vol.)
St. Simons Shell Ring	St. Simons Island	3460	Late Archaic	—	10 of 1384 (0.7%)	—	Flotation	Marrinan (1975: appendix 5); Reitz (chap. 22, this vol.)

TABLE 31.4—(Continued)

Site	Location	Northing	Time period	Deer			Recovery technique	Source
				NISP	MNI	Biomass		
North End Site (9GN107)	Little St. Simons Island	3457	—	17 of 3021 (0.6%)	—	—	—	Weinand et al. (2000: table 1)
Stafford North	Cumberland Island	—	—	Numerous deer bones encountered			—	Milanich (1971: 35–39, 43)
Table Point	Cumberland Island	3430	—	—	11 of 60 (18.3%)	—	None	Milanich (1971: table 6)
Cumberland Island	Cumberland Island (overall)	3430	—	—	39 of 140 (27.8%)	—	None	Milanich (1971: table 7)
Colonel's Island	Railroad site	—	Protohistoric	5 of 645 (0.775%)	2 of 45 (4.44%)	—	1/4″	Steinen (1984: table 2)
Colonel's Island	Jointer Creek	—	Deptford	4 of 45 (8.89%)	1 of 6 (16.7%)	—	1/4″	Steinen (1984: table 2)
Amelia Island, Florida	Harrison Homestead Village (8Na41)	—	Mission	—	2 of 12 (16.7%)	—	1/4″	Hemmings and Deagan (1973: table 3)
Amelia Island, Florida	Walker Point Mound and Village (8Na28)	—	St. Johns I & II	—	2 of 58 (3.4%)	—	1/4″	Hemmings and Deagan (1973: table 9)
Anastasia Island, Florida	Summer Haven	—	Fiber-tempered (Orange)	730 of 4487 (16.3%)	—	Est. >60%	None	Bullen and Bullen (1961: 12–13)
Mainland Assemblages								
Red Bird Creek (9BN9)	Ogeechee River (mainland)	3528	Irene	153 of 418 (36.69%)	5 of 49 (10.2%)	59.0%	—	Pearson (1984a: table 3, 4)[b]
Harris neck (9Mc141)	Mainland	3498	Irene	29 of 1,071 (2.7%)	3 of 56 (5.4%)	1.4509 of 3.3041 (43.9%)	—	Braley et al. (1986: 120, tables 14–19)
Cathead Creek (9Mc360)	Darien	3470	—	11 of 1611 (0.68%)	3 of 74 (4.0%)	145.4 of 1973.3 (7.4%)	—	Modified from Reitz and Quitmyer (1988: table 3)[c]

TABLE 31.4—(*Continued*)

Site	Location	Northing	Time period	Deer			Recovery technique	Source
				NISP	MNI	Biomass		
Kings Bay (9CAM171)	St. Marys River	3410	Savannah	20 of 1699 (1.2%)	3 of 257 (1.1%)	2.03 of 6.27 (32.4%)	1/18"	Smith et al. (1981: 508–511); Reitz (1982a: chap. 22, this vol.)
Kings Bay (9CAM171)	St. Marys River	3410	Swift Creek	4 of 12490 (0.03%)	3 of 1697 (0.18%)	418.1 g of 5493.6 (7.6%)	1/18"	Reitz and Quitmyer (1988: table 4)
Kings Bay	—	—	Mission	—	1 of 50 (2.0%)	—	1/18"	Reitz (chap. 22, this vol.)
Devil's Walikingstick (9CAM177)	—	—	Protohistoric	—	9.1%	71.0%	—	Pavao-Zuckerman (2000: table 6); Smith et al (1981)
Devil's Walikingstick (9CAM177)	—	—	Prehistoric	—	7.9%	44.0%	—	Pavao-Zuckerman (2002: table 6; Smith et al. (1981)
Fountain of Youth (8SJ31)	1 km off St. Augustine	3297	Aboriginal	11 of 4851 (0.2%)	6 of 322 (1.9%)	0.76 of 27.55 (2.8%)	—	Reitz (1985: table 5; 1993: table 14.4)
Nombre de Dios	St. Augustine	—	Precontact	Deer "minor component"			—	Reitz (chap. 22, this vol.)
St. Augustine	—	—	16th & early 17th centuries	—	30 of 1094 (2.7%)	—	1/4"	Reitz (1985: table 2)
St. Augustine	—	—	17th century	—	2 of 166 (1.2%)	—	—	Reitz (1993: table 14.4)
St. Augustine	—	3297	16th century	—	31 of 1126 (2.8%)	16.13 of 125.86 (12.8%)	1/4" screen	Reitz (chap. 22, this vol.); Reitz and Scarry (1985: table 10)

[a] This method employed for computing biomass differs slightly from that followed by Reitz and Wing (1999); Reitz (1982b: 68) excluded the Ossabaw Island samples because MNI was not computed on the basis of right/left element comparisons.

[b] Screened through 1/4" mesh; results likely skewed toward larger taxa.

[c] By assuming all mammalia bones are white-tailed deer.

(Thompson, 2006: 258; see also tables 6.7 and 6.8).

In excavations at Kenan Field, a Savannah/Irene period site on Sapelo Island, Crook (1978b: table 14) recovered relatively few deer bones, representing only 9.5 percent of the individuals recovered (Reitz, 1982a). Similar results were obtained at the "North of the Shell Ring Drain" site, another Irene period occupation on Sapelo Island, excavated by Lewis Larson, and the zooarchaeological remains are reported by Reitz (1985). Relatively few terrestrial animal bones were encountered and, based on MNI, raccoons and rabbits were more heavily exploited than deer at this particular site. Nevertheless, white-tailed deer did account for nearly 40 percent of the total biomass from vertebrates.

Nearby Bourbon Field is a multicomponent occupation located behind Blackbeard Island along the east side of Sapelo Island. Crook (1984: 252–261) suggests that from Deptford times through the Irene and Spanish periods, Bourbon Field reflects a "remarkably constant" subsistence pattern centered on the exploitation of white-tailed deer, followed by fish (especially catfish) and turtles. A total of 492 deer bones were recovered (out of NISP of 3601), representing 11.2 percent of the MNI and 64.9 percent of the biomass (Reitz, 1982a, 1985; Crook, 1978b, 1984).

On St. Simons Island, Marrinan (1975) excavated two Late Archaic shell ring sites at Cannon's Point. At the Marsh Ring (9GN57), she found that whereas fish remains were numerous, "Appendix 5 clearly shows that faunal elements present in the marsh cultural level were higher in numbers of deer and small mammals" (Marrinan, 1975: 33–34). The West Ring (9GN76) contains much thinner (and apparently somewhat later) midden deposits, with the lower levels containing evidence that fish had far greater importance (both in terms of number of species and number of individuals). Periwinkles were also common at the West Ring site (Marrinan, 1975: table 4). In chapter 22 (this volume), Reitz reports that Marrinan's excavations produced only 10 individuals of white-tailed deer, in a context containing an MNI of 1384 (Marrinan, 1975, appendix 5; Reitz, chap. 22, this volume). In his column sampling of Couper Field (a late prehistoric/protohistoric site also located on St. Simons Island) Wallace (1975: table 12) reports the recovery of numerous deer bones in column sampling (but the samples are too small for inclusion in table 31.4).

Little St. Simons Island is a small, Holocene-age island located immediately to the northeast of the Pleistocene-age St. Simons Island. Adjacent to Altamaha Sound is the North End site (9GN107; Weinand et al., 2000, table 1; Crook, 2004), a Savannah period shell midden. Here, an unusual vertebrate assemblage is dominated by estuarine fish, turtles, and reptiles, with few very mammals recovered; only 17 deer bones were present in a zooarchaeological assemblage with NISP numbering nearly 8500. Particularly abundant were the bones of cownose ray (*Rhinoptera bonasus*). Crook (2004) argues that the North End site was occupied primarily in the late fall and early winter months, with intermittent use in July and August and occasional visitation in February–April (for a different perspective, see Weinand et al., 2000).

Milanich (1971) tested two Deptford period sites on Cumberland Island. At Stafford North, white-tailed deer bones were recovered in Tests I, III, and IV (1971: 35–39, 43). At Table Point, he tested several shell middens and an aboriginal shell and dirt ring, with a large oval midden in the center (1971: 46). The fill contained bones of deer, raccoon, pocket gopher, and fish. In the associated Deptford period house and work area, Milanich (1971: table 6) recovered 11 deer individuals (out of a total of 60 vertebrate individuals encountered). Overall, white-tailed deer account for 27.8 percent of the MNI (39 of 140) and Milanich concludes that subsistence evidence from Cumberland Island is "quite similar to the species reported by Waring and Larson (1968: 265, 275) for their excavations at the Sapelo island shell ring. … [D]eer is the largest source of meat relative to other species" (Milanich, 1971: 73, 77).

On Colonels Island, a marsh island located between the Brunswick and the Little
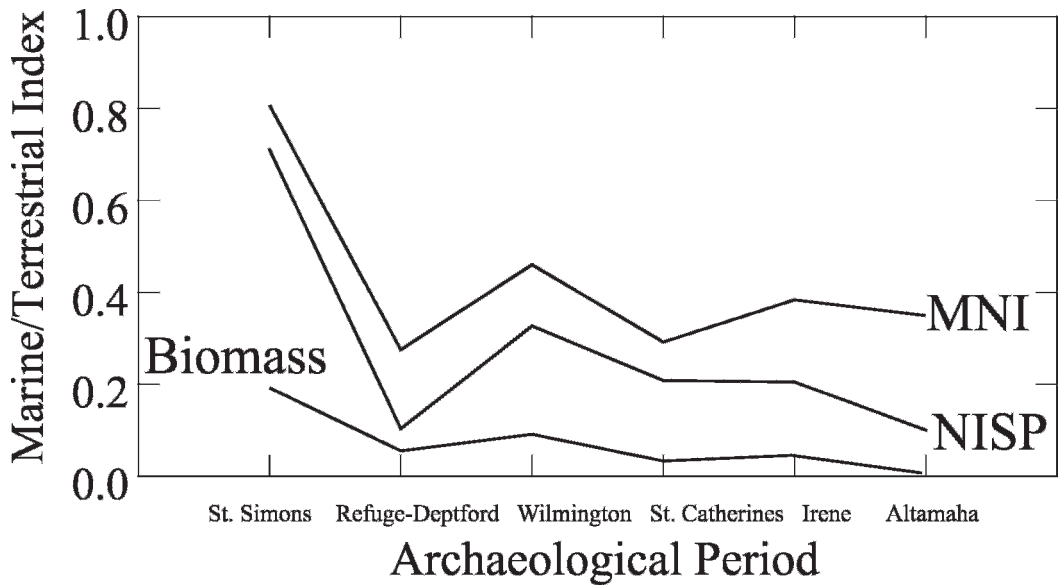
Fig. 31.6.   Temporal distribution of the three White-tailed Deer Indices for the barrier islands of the Georgia coastline.

Satilla Rivers in Glynn Country, Steinen (1984) conducted small-scale testing in six disturbed middens. All deposits were screened through 1/4-in. mesh. The largest of these, the protohistoric Railroad site, contained only five deer bones (two individuals) in an assemblage with total NISP = 645 and total MNI = 45. Jointer Creek, the second most productive site on Colonels Island, contained mostly Deptford period sherds and four deer bones (with total NISP = 45 and total MNI = 6).

Hemmings and Deagan (1973) investigated two sites on Amelia Island (northeastern Florida). Although the Harrison Homestead Village site (8Na41) is a multicomponent site, the bulk of materials are associated with the Spanish mission at Santa María, dating to the late 16th- and 17th-century aboriginal occupation (Hemmings and Deagan, 1973: 29). Two white-tailed deer individuals were represented in the zooarchaeological assemblage from Harrison Homestead (in a total vertebrate assemblage with MNI = 12 individuals).

At the Walker Point Mound and Village (8Na28), also on Amelia Island, Hemmings and Deagan (1973: 31–53) tested shell middens dating to late St. Johns I and St. Johns II times (about A.D. 700 to 1200). The associated burial mound was likely used between A.D. 1100–1200. The shell midden at Walker Point, especially the submound midden, produced a vertebrate zooarchaeological assemblage of MNI = 58 individuals, only two of which were white-tailed deer (Hemmings and Deagan, 1973: table 9).[9]

The southern-most locality in the present sample is Summer Haven, a fiber-tempered site located on Anastasia Island (Florida), immediately to the south of Matanzas Inlet (Bullen and Bullen, 1961). Although the deposits were apparently not screened, numerous food bones were recovered. Bullen and Bullen (1961: 12–13) report that "deer … bones were quite plentiful … [including] both young, i.e., immature, and old individuals." Of the NISP = 4487 vertebrate bones recovered, 730 are white-tailed deer. The faunal remains "indicate the orientation of the economy of Indians living at the Summer Haven site to water—either salt or fresh—with deer as the major nonaquatic food" (Bullen and Bullen, 1961: 12).

Figure 31.6 shows the distribution of these various White-tailed Deer Indices through time in the barrier island sample.
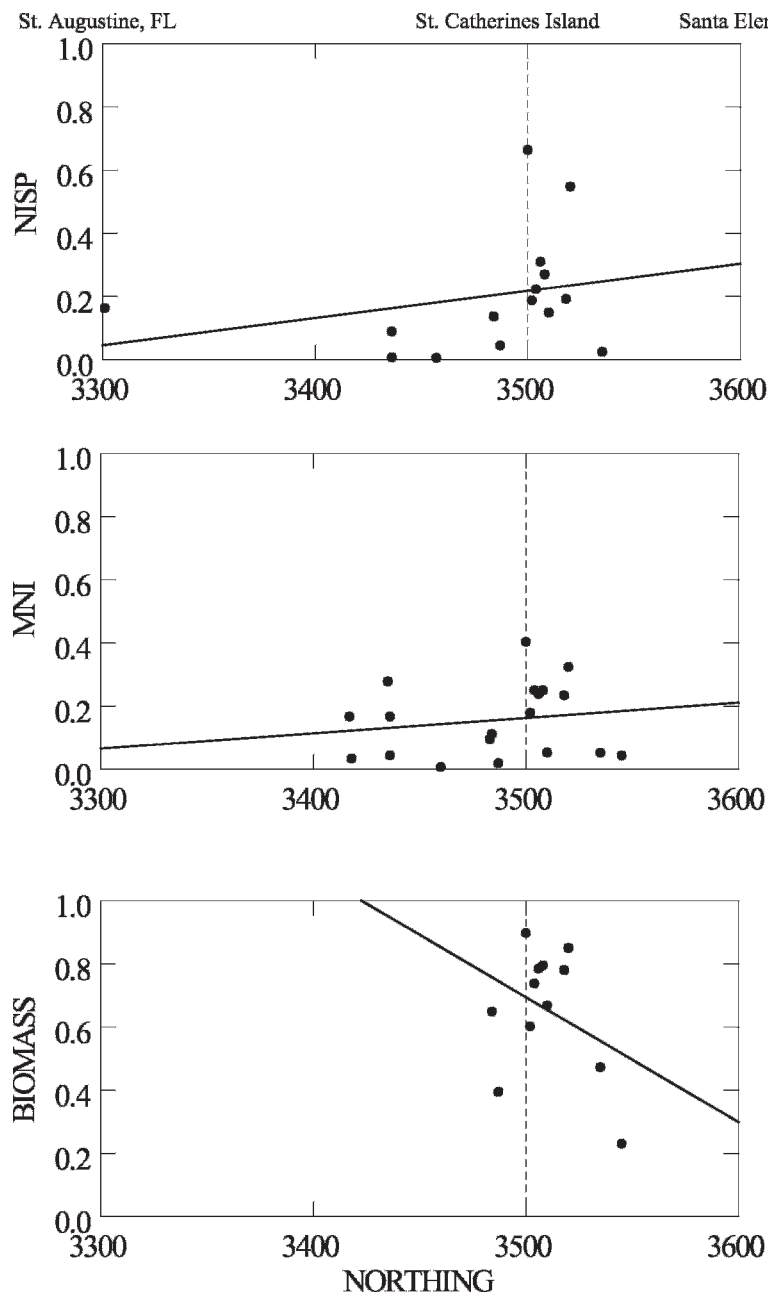
Fig. 31.7. The distribution of the three White-tailed Deer Indices scaled along a "northing".

As expected, the three indices are significantly intercorrelated.[10] The central tendencies and variability in the indices for biomass, NISP, and MNI are presented on table 31.4. There are no significant changes in any index through time.

Figure 31.7 plots the three White-tailed Deer Indices scaled along a "northing" from St. Elena (South Carolina) at the far right of the x-axis through St. Augustine (Florida), with Georgia's barrier island assemblages arranged in between; the vertical

dashed line shows the position of St. Catherines Island. Figure 31.7 clearly demonstrates that white-tailed deer exploitation (whether measured as NISP, MNI, or Biomass) is the highest in the neighborhood of St. Catherines and Ossabaw Islands, trailing downward both to the north and the south.[11]

WHITE-TAILED DEER EXPLOITATION ON GEORGIA'S COASTAL MAINLAND: This section compares the barrier island pattern of deer exploitation with evidence from archaeological sites located on the mainland of the Georgia Bight.

White-tailed deer exploitation was important at the Bilbo site, a St. Simons period occupation immediately to the east of Savannah. Waring (1968a: 165; 191: table 11) reports an extensive antler and bone industry, mostly deer. He also notes the extensive utilization of mussel, oyster, clam, snail, gar, and sturgeon, with "animal bone [presumably deer] pounded to small fragments."[12] Waring concludes that the Bilbo occupants were a "pre-maize, hunting-fishing-gathering group" (1968a: 197).

Although Caldwell and McCann (1941: appendix III) report the presence of deer remains at the late prehistoric Irene Mound, which fronts the Savannah River in Chatham County, one cannot obtain quantitative estimates of dietary importance.

Red Bird Creek (9BN9) is an Irene period site located on the mainland salt marsh about 5 km south of the Ogeechee River (and about 15 km northwest of St. Catherines Island). "White-tailed deer form the bulk of the mammal collection" (Pearson, 1984a: 29). Deer bones are abundant in the four shell middens tested, and account for 20.9 percent of the identifiable vertebrate remains (NISP = 733). As with the Island-wide survey results from St. Catherines Island, the Red Bird Creek results are likely somewhat skewed toward larger vertebrates because of the use of 1/4-in. screens (Pearson, 1984a: 24).

At Harris Neck (9Mc141), a mostly Irene period occupation on the mainland across from St. Catherines Island, Braley et al. (1986: 120, tables 14–19) report finding only 29 deer bones (in an assemblage with NISP = 1071) within features that were exposed with a motor grader; the feature fill was screened with 0.64- and 0.32-cm mesh (Braley at al., 1986: 35, 37). White-tailed deer at Harris Neck contributed about 43.9 percent of the biomass (1.4509 of 3.3041 kg).

At the Pine Harbor site, another late prehistoric site located further down the Georgia coast, Larson (1980a: 224–226) tested six shell middens, five of which he believes represent the accumulation of a single winter season each; Larson suggests that the sixth midden was occupied during two winter seasons. One of these middens contained no deer bones, while all of the others contained various quantities; Larson believes that a single deer carcass was distributed among several middens (families)[13] and computes that five individual white-tailed deer are represented in a vertebrate assemblage that also includes raccoons, bobcats, opossums, and rabbits. Larson compares the meat available from shellfish, concluding that the Guale living at Pine Harbor obtained "the bulk of their winter protein from oysters. Deer were hunted, but along with other mammals, fish, and mollusk species they provided only the needed supplement of animal food" (1980a: 226).

Cathead Creek (9Mc360) is a Swift Creek site located on a bluff overlooking the upper reaches of the Altamaha Sound, at the junction of Cathead Creek and the Darien River (about 30 km southwest of St. Catherines Island; see Reitz and Quitmyer 1988: 95). The sample was sieved through graded screens, the smallest of which had a mesh size of 0.5 mm. Mammal bones of any kind were extremely rare (NISP = 11, accounting for less than 1 percent of the total biomass from vertebrates and invertebrates (Reitz and Quitmyer, 1988: table 3). One can obtain a maximum estimate of white-tailed deer importance by assuming that all 11 "Mammalia" bones are white-tailed deer (likely an overestimate); if so, then (at a maximum) deer could have accounted for only 0.68 percent of the vertebrate NISP (11 of 1611), 4.0 percent of vertebrate MNI (3 of 75) and 7.4 percent of the biomass

from vertebrate sources (145.40 g of 1973.28 g).

Kings Bay (9CAM171) is located on the St. Marys River, behind Cumberland Island (Smith et al., 1981; Reitz, 1982a, 1985: table 3; Reitz and Quitmyer, 1988). In their fine-grained analysis of three Swift Creek trash pit features, Reitz and Quitmyer (1988: table 4) determine that white-tailed deer contributed less than 0.3 percent of the individuals recovered, representing only 7.6 percent of the biomass from vertebrates, a result almost identical to the Cathead Creek findings reported above.

The Savannah period occupation at Kings Bay contained very few deer remains, accounting for only 10.1 percent of the vertebrate biomass. The small sample from late prehistoric/protohistoric contexts at Kings Bay contained only a single individual deer, representing only 2 percent of the MNI (Reitz, chap. 22, this volume).

Devil's Walkingstick (9CAM117), another site at the Kings Bay locality, produced rather different results, with white-tailed deer representing 44 percent of the biomass in the prehistoric component and 71 percent in the protohistoric deposits (Pavao-Zuckerman, 2000: table 6; Smith et al., 1981).

Several important excavations provide comparable data from the St. Augustine area. The Fountain of Youth Park site (8SJ31), located 0.8 km north of the Castillo de San Marcos, is a horizontally stratified deposit dating to the late prehistoric/early historic period (Deagan, 1983; Merritt, 1983). Despite the use of 1/4-in. screens, Reitz (1985: table 5, 1993: table 14.4) reports that only 11 deer bones were recovered in a large zooarchaeological assemblage (NISP = 4851), with white-tailed deer representing just 2.8 percent of the vertebrate biomass. Rabbits and deer were more heavily exploited than deer.

At St. Augustine, the Spanish colonial town founded in 1565, Deagan (1979, 1981) excavated numerous 16th- or early 17th-century domestic contexts, and Reitz (1985: 47) reports that white-tailed deer account for only 2.7 percent of the biomass represented. Similar results from St. Augustine are reported by Reitz and Scarry (1985: table 10; see also Reitz, chap. 22, this volume) for additional 16th century contexts (where deer accounted for 12.8% of biomass) and Reitz (1993: table 14.4) for 17th-century proveniences, where deer accounted for only 1.2 percent of biomass.

Figure 31.8 plots the distribution of the three White-tailed Deer Indices for mainland sites along a north–south continuum running from St. Elena (South Carolina) at the far right of the x-axis through St. Augustine (Florida); the vertical dashed line shows the position of St. Catherines Island.

The plots for White-tailed Deer$_{MNI}$ and especially White-tailed Deer$_{Biomass}$ show a statistically significant and linear dropoff in deer exploitation moving southward along the South Carolina–Georgia–northeastern Florida coast. Figure 31.9 demonstrates similar relationships for White-tailed Deer$_{NISP}$, though the indices are geographically scattered and the trend is not statistically significant. As figure 31.8 shows, insufficient high quality zooarchaeological samples exist from the mainland of the Georgia Bight to adequately explore change in deer exploitation over time.

COMPARING BARRIER ISLAND AND MAINLAND DEER EXPLOITATION: To reiterate the cautions articulated above:

- Numerous pragmatic problems plague applications of abundance indices to issues of diet breadth, and
- significant archaeological issues (including sample size, biased sampling strategies, and differential recovery technique) hamper our understanding of archaeology along the Georgia Bight.

That said, the currently available archaeological record and our understanding of it will never improve if we merely bemoan the shortcomings. We think it worthwhile to meld the available theoretical, methodological, and empirical perspectives into a set of testable hypotheses regarding aboriginal exploitation of white-tailed deer along the Georgia coastline.

Several important trends and distinctions emerge in this comparison between the archaeological record of white-tailed deer ex-
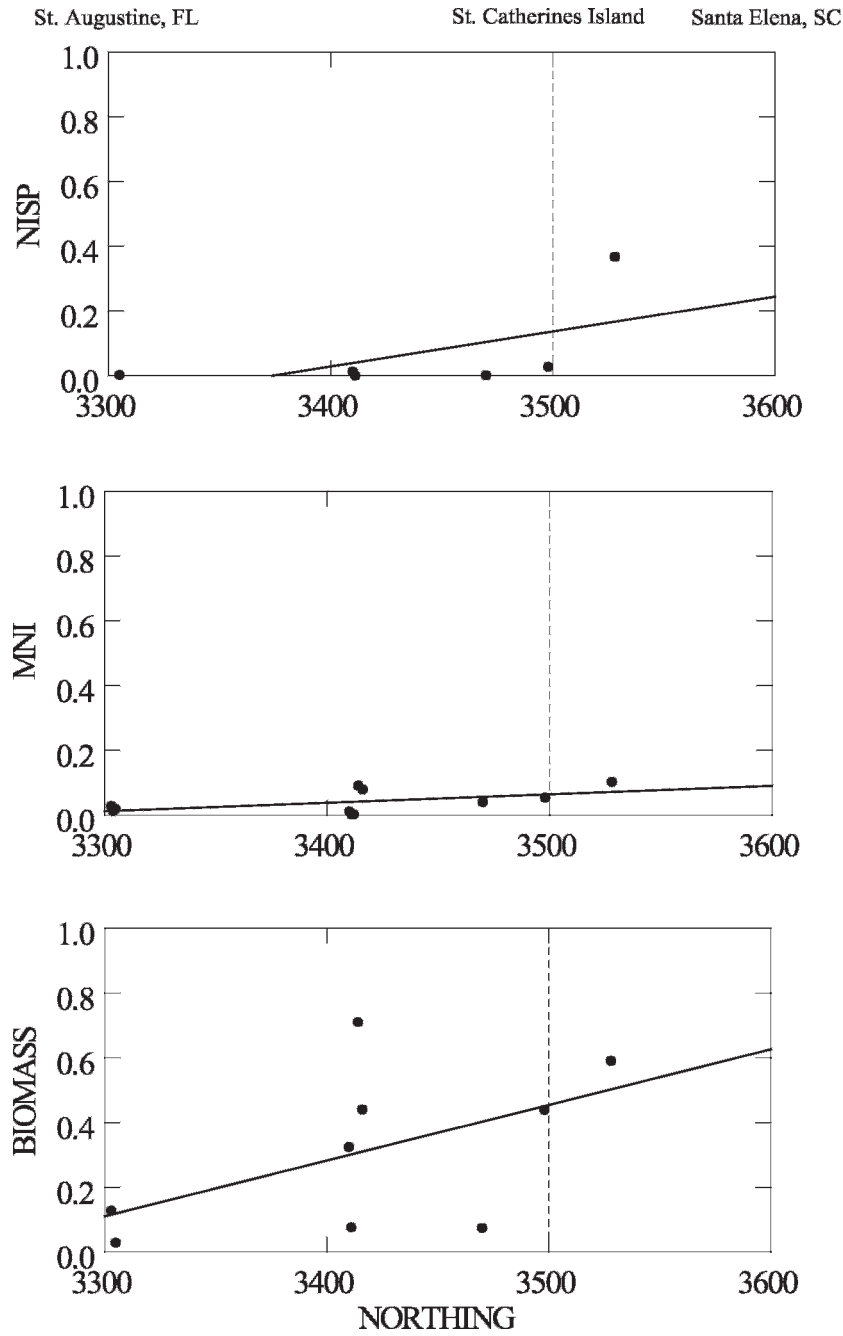
Fig. 31.8.   The distribution of three White-tailed Deer Indices for mainland sites along a north-south continuum.
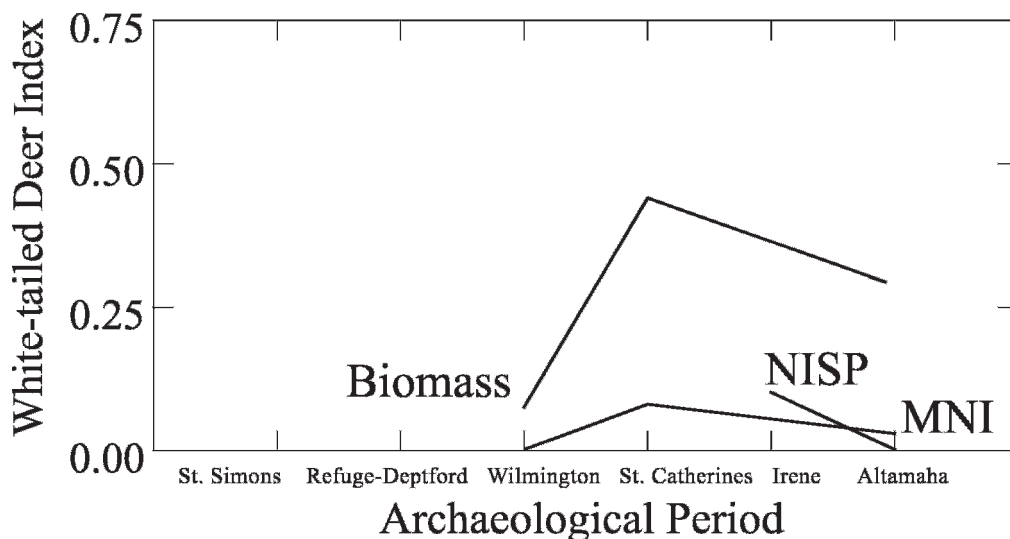
Fig. 31.9.   Temporal distribution of the three White-tailed Deer Indices for archaeological sites on the Georgia mainland.

ploitation on the barrier islands and mainland along the Georgia Bight—from Santa Elena (South Carolina), through the barrier island and mainland sites along the Georgia coast, southward to St. Augustine (long-term capital of La Florida).

The most important finding is this: *For all time periods, and regardless of recovery methods or indices (NISP, MNI, or Biomass) employed, white-tailed deer exploitation was much more intensive on the Georgia Sea Islands than in nearby mainland sites.*

Figure 31.10 compares the values of the three White-tailed Deer Indices between archaeological sites on the barrier islands and those on the mainland (as summarized in table 31.5). The differences in White-tailed Deer Index$_{MNI}$ and White-tailed Deer Index$_{Biomass}$ are striking. Both indices demonstrate (at a level of high statistical significance) that deer exploitation was three to four times more intensive on the barrier islands than evidenced at the mainland sites (see table 31.4). With respect to NISP, barrier islands sites show an even greater disparity, with White-tailed Deer Index$_{NISP}$ of 0.230 ± 0.201 as opposed to the index of mainland sites (0.034 ± 0.160). Given the small sample size for mainland sites ($n = 6$), this value is not statistically significant ($p =$

0.112). That is, regardless of whether monitored by NISP, MNI, or Biomass, it is clear that white-tailed deer were hunted far more intensively in the Georgia Sea Islands than at mainland localities.

The three White-tailed Deer Indices have also been scaled along a north–south continuum, with the y-axis reflecting geographical placement of each assemblage (expressed as a "northing") along the Georgia Bight; Santa Elena (South Carolina) lies at the top of the graph and St. Augustine (Florida) at the bottom.

The trend along this north–south geographical gradient is simultaneously complex and striking. *For all time periods, and regardless of recovery methods or indices (NISP, MNI, or Biomass) employed, exploitation of white-tailed deer is most intensive on St. Catherines and Ossabaw Islands, but less important on barrier islands to the north and especially to the south. To a lesser degree, a parallel exists in archaeological sites on the adjacent mainland, although white-tailed deer exploitation was always more important on the barrier islands.*

Specifically with respect to the White-tailed Deer Index$_{NISP}$, the 11 archaeological assemblages from the northern Georgia coast (St. Catherines Island northward) av-

erage 0.269 ± 0.198, while the 10 zooarchaeological assemblages from the southern Georgia/Florida coast (Sapelo Island southward) average only 0.034 ± 0.053; this difference is highly significant ($p = 0.004$). Similar and equally compelling trends are evident with respect to White-tailed Deer Index$_{MNI}$ and White-tailed Deer Index$_{Biomass}$ (see table 31.4). Why are white-tailed deer exploited more intensively along the northern Georgia coastline?
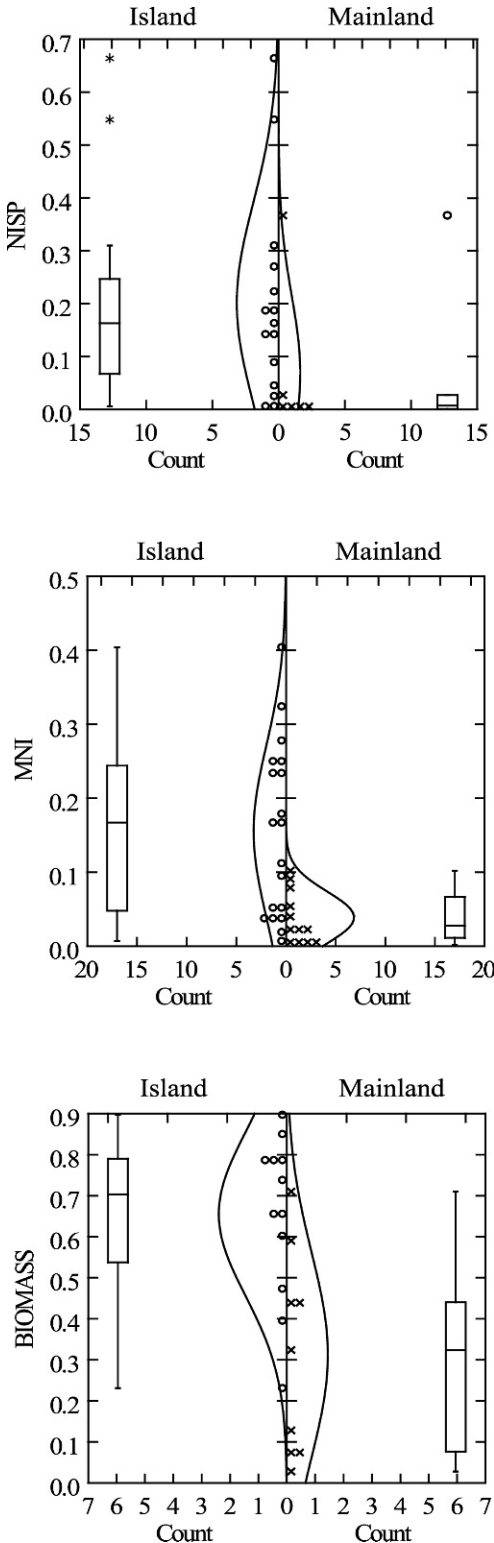
Both findings are intriguing and seem to suggest a paradox: The diet-breadth model predicts that white-tailed deer, one of the highest ranking resources available to aboriginal foragers in Georgia's Sea Islands, should have always been taken upon encounter. The archaeological record of the northern Georgia Sea Islands (especially from St. Catherines Island northward) appears to be fully consistent with this projection: white-tailed deer are present and they are intensively exploited through time. But the available zooarchaeological evidence (mostly from St. Catherines Island) fails to demonstrate a significant depression in white-tailed deer exploitation (as also projected by the diet-breadth model).

On the other hand, a number of the mainland sites and many of the barrier island localities show that evidence of white-tailed deer exploitation was relatively sparse and sometimes entirely absent, especially during the late prehistoric and early historic periods. Perhaps these results reflect overhunting of local white-tailed deer populations (as projected by diet-breadth considerations). If this is true, then we might expect that more complete zooarchaeological evidence would show a greater reliance on white-tailed deer hunting during the earliest periods of human occupancy, trailing off as this high-ranking resource becomes overexploited.

Each of these possibilities begs further investigation.

←

Fig. 31.10. Graphic comparison of three White-tailed Deer Indices between barrier island and mainland archaeological sites.

TABLE 31.5
White-tailed Deer Indices, Sorted by Geographical and Geomorphological Criteria

Variable	Mean ± SD	n	Mean ± SD	n	p
	North Georgia Coast[a]		South Georgia Coast[b]		
NISP	0.269 ± 0.198	11	0.046 ± 0.062	10	0.004
MNI	0.182 ± 0.121	12	0.065 ± 0.073	19	0.008
Biomass	0.654 ± 0.196	12	0.314 ± 0.255	9	0.005
	Barrier Islands		Mainland		
NISP	0.201 ± 0.190	15	0.068 ± 0.147	6	0.112
MNI	0.155 ± 0.116	19	0.039 ± 0.035	12	0.000
Biomass	0.655 ± 0.200	12	0.312 ± 0.249	9	0.004

[a] Defined as St. Catherines Island and Harris Neck northward to Santa Elena, SC.

[b] Defined as Sapelo Island southward to St. Augustine, FL.

ISLAND BIOGEOGRAPHY, PREY CHOICE, AND WHITE-TAILED DEER EXPLOITATION: The diet-breadth/prey-choice model provides one approach for investigating the differential exploitation of white-tailed deer populations along the ancient Georgia Coast.

It is now possible to couple the prey-choice model with an appreciation of changing island biogeography along the Georgia coastline to project the foraging behaviors and long-term consequences of human foraging on the Sea Island landscape. This discussion will focus on St. Catherines Island because our knowledge is most complete for that landscape, but the model developed below shold apply to the entire Sea Island chain along the Georgia Bight.

The geomorphic precursor of St. Catherines Island was formed more than 40,000 years ago during the latest Pleistocene lowstand. Sea level began to rise ca. 10,000–8000 years B.C.; thereafter, the Holocene transgression marched rapidly westward from a maximum lowstand at least 60 m below present mean sea level, reworking the sediments of the modern continental shelf. The vegetation cover during this period was basically an inland plant community, dominated by *Pinus*, *Quercus*, *Carya*, and Poaceae. Early and middle Holocene foragers may well have exploited the late Pleistocene strandlines that would eventually become St. Catherines Island. If so, these sites have remained invisible using the archaeological survey and excavations methods described in this volume.

After the initial transgression of the Atlantic Ocean, cal 3800–2500 B.C., the sedimentary system of the Georgia coast was in a state of disequilibrium, with sea levels rising at a rate of 5–7 m per millennium (Linsley, 1993), with some significant sea level fluctuations still taking place (chap. 4). This rapid westward transgression would eventually create the modern sequence of Sea Islands, with active Holocene dune ridges welded against the relic late Pleistocene strandlines (DePratter and Howard, 1977; Oertel, 1979; Colquhoun et al., 1980; Howard and Frey, 1980; Booth et al., 1999a). Rising eustatic sea level subsequently isolated the inland dune ridges that would become St. Catherines Island (Booth et al., 1999a, 1999b); not long thereafter, a pronounced beach ridge and swale landscape began accreting on both ends of the island. As sea levels stabilized, salt marsh lagoons came to reoccupy positions of former Pleistocene sloughs, thereby defining the landward edges of barrier islands. Marsh islands (hammocks) formed between the barrier islands and the mainland margins, where the increasingly brackish waters fostered the development of back-barrier *Spartina* marshes. Meandering tidal creeks, sounds, and salt marshes slowly separated the barrier islands from one another and from the marsh islands. Sometime after about cal 3000 B.C., St. Catherines Island developed a salt marsh system similar to

that which exists today. As the system approached equilibrium, Holocene beach dune ridges and sand spits accreted southward, creating the hammock and marsh communities that remain today. Low, sandy beaches fringed the seaward edges, with steeper beaches adjoining the sound margins, which had deepened and assumed their modern aspect as the sand supply from the marsh was exhausted.

During the middle and late Holocene, barrier island vegetation shifted from an inland plant assemblage to a nearshore maritime forest, salt marsh, and tidal flat environment (Booth et al., 1999a, 1999b). The plant communities of St. Catherines and similar composite barrier islands doubtless responded to the fluctuating hydrology as eustatic sea level rise isolated the Pleistocene core from the mainland. Local plant composition was directly related to local hydrological conditions (particularly salinity) in the mosaic of swales and ridges that hosted the new marsh and hammock plant communities. The lowest marshes were colonized by cordgrass (*Spartina*) in places of strong tidal influence, but in more hydrologically isolated marsh, freshwater plants (such as cattail and sedges) took hold. The high ground was typically dominated by oaks, wax myrtle, and saw palmetto (*Serenoa*) with various ecotonal plants such as composite shrubs (including marsh elder) and chenopods (including glasswort). Palynological studies on St. Catherines Island attest to the stability of southeastern floral elements, such as *Pinus, Quercus, Taxodium, Nyssa*, and *Liquidambar*, throughout the Late Pleistocene and Holocene in coastal Georgia (Booth et al., 1999a, 1999b). In other words, despite the sea-level fluctuations, from a time when the island landscape remained attached to the mainland through its subsequent isolation as St. Catherines Island, the familiar southeastern flora persisted, with local variations.

The same is true for barrier island animal communities. As the Sea Islands isolated from mainland habitats, terrestrial vertebrate populations found themselves stranded on the major islands and to some extent, the marsh islands and hammocks as well.[14]

The theory of island biogeography (MacArthur and Wilson, 1967) has long focused on species numbers and diversity in such contexts, with less attention focused on the changes within populations following isolation (Adler and Levins, 1994: 474). Faced with significant habitat fragmentation, as certainly happened when the barrier islands separated from mainland Georgia, terrestrial species either became extinct or adapted to the habitats. Specifically, terrestrial vertebrate populations living on barrier islands have restricted mobility and limited immigration, with open water barriers limiting opportunities for genetic exchange (Johnson et al., 1974: 55).

This is why long-term directional selection may produce locally adapted island populations that differ from mainland populations (Adler and Levins, 1994: 482). On Georgia's Sea Islands, four vertebrate taxa are known to have been phenotypically distinguishable from their mainland relatives: the Cumberland Island pocket gopher (*Geomys cumberlandius*; Bangs, 1898), the St. Simons Island raccoon (*Procyon lotor litoreus*), the Anastasia Island cotton mouse (*Peromyscus gossypinus anastasae*), and the Blackbeard Island deer (*Odocoileus virginianus nigribarbis*; see also chap. 8). Unfortunately, understanding of such speciation is hampered by a lack of specimens and the rapid rate of change during the historic period (e.g., Bangs, 1898; Elliot, 1901; Johnson et al., 1974: 55; Neuhauser and Baker, 1974).[15]

We have already noted the remarkable size change in Sea Island deer populations during the late Holocene. At approximately cal 1600 B.C. (toward the end of the St. Simons period)—only a millennium after St. Catherines Island had separated from the mainland landscape—the mean adult body weight of island deer is estimated to have been 72.5 kg, slightly larger than their mainland counterparts. Thereafter, the biomass of island deer populations shrinks markedly to an adult body size of about 37 kg for contemporary white-tailed deer populations in the Sea Islands. Quite literally, the aboriginal hunters from Mission Santa Catalina de Guale stalked white-

tailed deer that were half the size of those hunted by their Late Archaic ancestors.

What caused the Sea Island deer to shrink? Is the decreased body size due to a genetic adaptations, to habitat deficiencies, to behavioral change, or a combination of all these factors?

Given the relatively poor soils that characterize many barrier islands (particularly those comprised solely of Holocene-age dune deposits), one can readily frame a scenario of deficient food resources directly leading to small body mass. Comparisons to modern deer populations show that average body weights were lower on Blackbeard Island (Georgia) than on Kiawah Island (South Carolina), and the comparison is instructive (Osborne et al., 1992). The lower body weights on Blackbeard been attributed to the result of lower quality nutrition and habitat conditions because Blackbeard Island remains an undeveloped Holocene-age accretional terrain (a decidedly second-tier habitat). By contrast, the well-fertilized and irrigated landscape of Kiawah Island apparently enhances the nutritional quality of deer forage. This is particularly true of the ryegrass planted along roadsides and around the many golf courses, a species which offers little cover, but considerable fertilized and irrigated forage. In another study, white-tailed deer captured from Blackbeard Island were placed in a fence enclosure near Albany, Georgia. After being fed a high-nutrition diet, they experienced significant increases in body size (Osborne et al., 1992: 36), suggesting that poor nutrition might be a key factor in conditioning the small size of deer on Blackbeard Island.

Selective factors likewise play a critical role in determining body mass among barrier island deer populations. Faced with significant habitat fragmentation, mammalian species commonly either become extinct or experience selective changes that enable adaptation to modified living conditions. Island biogeography theory (MacArthur and Wilson, 1967) holds that when subjected to increasingly fragmented landscapes—whether actual islands or disparate terrestrial "islands"—medium-size mammalian species seem to gain certain reproductive advantages over both smaller and larger taxa (Cox and Moore, 1973; Lomolino, 1985; Brown et al., 1993). This so-called "island syndrome" (Adler and Levins, 1994)—what Van Valen (1973) has termed the "island rule"—holds that in a significantly fragmented habitat, smaller mammals tend to become larger, medium-sized mammals stay the same size, and larger mammals generally decrease in size (Schmidt and Jensen, 2003). Foster (1964), for instance, has noted the tendency for gigantism in insular rodent (and perhaps marsupial) populations, but dwarfism is characteristic of insular carnivores, lagomorphs, and artiodactyls. This is because the reproductive capacity in mammalian species is heavily conditioned by body mass (Brown et al., 1993), with medium-size species gaining certain reproductive advantages over both smaller and larger taxa (MacArthur and Wilson, 1967; Cox and Moore, 1973; Lomolino, 1985; Brown et al., 1993). In other words, a larger population of medium-size animals is more readily supported by a limited and/or fragmented resource base, thereby increasing survivability in times of stress (as during hurricanes, droughts, hunting pressure, and other environmental perturbations).

Regardless of the respective roles of habitat deficiencies and genetic adaptation, we know that aboriginal people who first colonized St. Catherines Island (probably just shortly after the Pleistocene core became isolated as an island) hunted full-size white-tailed deer that were identical to deer on the mainland. The longer the island deer population was isolated from the mainland population, the smaller the individual deer became. Post-Pleistocene climatic change may be a factor here, since mainland deer were becoming somewhat smaller during this interval (Purdue, 1980; Purdue and Reitz, 1993). By the time of Spanish contact, the deer of St. Catherines Island had become much smaller and quite distinct from their mainland counterparts.

The prey-choice model predicts that (1) St. Simons period hunters should have pursued white-tailed deer whenever encoun-

tered and (2) through time, this high-ranking resource should have been differentially depleted. Significantly, the newly arrived Late Archaic peoples on St. Catherines Island encountered a white-tailed deer population at risk. With an average adult size >70 kg, these white-tailed deer were adapted to the expansive southern forests that covered the coastal plain, from the Fall Line, to the frequently flooded bottomlands, to the Atlantic shoreline. The late Holocene marine transgression, however, fragmented the coastal landscape into the small-scale patchy habitats that characterize the contemporary Sea Islands.

Beyond the overriding issues of habitat fragmentation, the newly isolated Sea Island deer populations likewise faced a significant change in dietary composition. Whereas browse is today adequate on Blackbeard Island and other barrier islands, much of this browse is low quality (particularly that growing in second-tier habitats, such as Blackbeard Island and the south end of St. Catherines Island). Although white-tailed deer likely foraged across all available island habitats—including the maritime forest, the dune fields, and even the island-edge into the salt marsh—this was clearly a population under stress, experiencing the accelerated habitat fragmentation characteristic of the mid- to late Holocene landscapes of the Georgia Bight. As we suggested in chapter 8, barrier island deer populations came to depend almost exclusively on mast production, which in turn supported artificially high population densities, created an intensified grazing pressure, and likely eliminated many of the desirable woody browse species in the barrier islands. Osborne et al. (1992: 36) argue that ''a dense deer population fueled by mast may insure that the few good woody browse species present never became abundant, thus when mast is unavailable, deer have few good quality buffer foods to which they may turn.''

The shift from a browse-dominated to a mast-dominated diet was critical because (as noted in chap. 8) it signaled a change in the mechanisms governing deer population dynamics between barrier island and main-land landscapes. For mainland habitats, game managers conventionally assume (1) a simple and direct relationship between deer numbers and the quantity of woody browse available and (2) that small size of deer reflects the poor quantity of available browse. Arguing from the evidence on Blackbeard Island, however, Osborne et al. (1992: ix) warn that such density-dependent models fail to account for the population dynamics of barrier island habitats, where deer population density depends almost exclusively on a high-energy mast diet. The white-tailed deer population on Blackbeard Island is regulated by density-*independent* mechanisms, specifically the availability of acorns and the pressure of the human harvest (Osborne et al., 1992: 65–67). This should mean that physical density of the deer population will not greatly influence the overall carrying capacity of the barrier island landscape.

The Late Archaic human presence likely posed considerable threat to local island deer populations, which were already under stress due to extreme habitat fragmentation. In addition, the shift from density-dependent to density-independent population regulators likely took place shortly after the Sea Islands became isolated from the mainland landscape—at precisely the time that human foragers first populated the barrier islands.

The timing and mechanisms of island isolation are ill defined at present. As discussed in chapter 4, we now appreciate that significant changes in sea level took place during the Late Holocene period along the Georgia coast (DePratter and Howard, 1980, 1981; Brooks et al., 1989; Colquhoun et al. 1980; and esp. Gayes et al., 1992). Between cal 3300 B.C. and cal 2300 B.C., sea level rose about 2 m (at a rate of about 50 cm/century), with a correlative growth of the estuarine and inter-island marshlands. St. Catherines Island was occupied by Late Archaic foragers shortly after the island core separated from the mainland, circa cal 3000 B.C. This Late Holocene transgression probably topped out at cal 2300 B.C., when the sea level stood approximately 1.25 m below contemporary Mean High Water.

Then, during a regressive interval (cal 2300 B.C.–cal 1600 B.C.), sea level dropped about 3 m, at a rapid rate of about 50 cm/ century (Gayes et al., 1992). During this 7-century span, the saltwater marshes along the western scarps of St. Catherines Island must have been dramatically reduced, if not eliminated altogether. Since cal 1600 B.C., sea levels have risen slowly and steadily (at a rate of 10 cm/century) from a low-water mark of roughly 3 m below MHW to present levels. Marshland resources along the eastern margin of St. Catherines Island deteriorated due to the overtopping of Guale Island and disappearance of Guale Marsh, and the estuarine marshlands reappeared along the entire western margin of the island.

The degree to which St. Catherines and the other barrier islands were reconnected to the mainland during this regressive interval is unclear; but if a Late Holocene "reconnection" actually occurred, this would have had marked implications for terrestrial fauna living on the nascent Sea Islands— especially white-tailed deer. Regardless of the sea level changes involved, the newly isolated deer populations of the barrier islands likely faced the dual pressures of habitat fragmentation and intensified human predation *before* a genetic response had moved away from long-standing mainland patterns of reproductivity toward island dwarfism.

The threat to barrier island deer populations was further magnified by the nature of Late Archaic subsistence and settlement patterns along the Georgia coastline. Milanich (1994: 87, 89) points out that large, densely clustered Late Archaic sites, "certainly … associated with sedentary populations [are found] almost everywhere archaeologists look in east Florida, especially in coastal settings." Russo (1996: 197) adds that "all coastal preceramic Archaic Florida sites for which seasonality analyses have been undertaken reflect multiseasonal and year-round settlement. This is a settlement pattern markedly distinct from that typically associated with most contemporary interior Archaic people," where seasonal dependence on upland deer and nuts drew coastal populations to the interior uplands.

This pattern is consistent with the limited evidence from St. Catherines Island, although we have seasonality estimates for only two St. Simons period components (chap. 20). Throughout this volume, we have taken a relatively conservative approach to the issue of "seasonality" and "sedentism," noting that our seasonality estimates were drawn from limited evidence provided by vertebrate faunal remains and incremental growth evidence in *Mercenaria* (neither of which can justify an inference that any given site was "continuously occupied" during any particular interval). That said, the available evidence from St. Catherines Shell Ring denotes a four-season occupation (and at least two seasons are represented at Seaside Field). The most conservative reading of the available evidence is this: During the St. Simons period, St. Catherines Island seems to have provided a sufficiently rich resource base to support year-round habitation, should the Late Archaic people have wished to do so.[16] Specifically, while a four-season occupation was demonstrated, this evidence does not necessarily require a full-time, permanent, sedentary occupation of any particular site (although, frankly, this is exactly what we suspect). This is why we think that Late Archaic populations (particularly during the first half of the St. Simons period) could have had a sizable impact on the newly isolated deer population of St. Catherines Island.

Figure 31.11 plots the distribution of known Late Archaic shell rings sites along the Georgia Bight; including the St. Catherines Shell Ring (9Li231; see chap. 20, this volume). These distinctive circular or semicircular deposits typically contain large quantities of oyster shell, food bone, artifacts, and soil (Russo and Heide, 2002; fig. 31.11). "Shell rings have yielded evidence of the earliest permanent year-round occupations, the earliest development of pottery and the earliest examples of large-scale monumental architecture … [but] the function of shell rings remain an open question" (Russo and Heide, 2001: 491; see also DePratter, 1979a; Trinkley, 1980; Russo, 1996: 188).
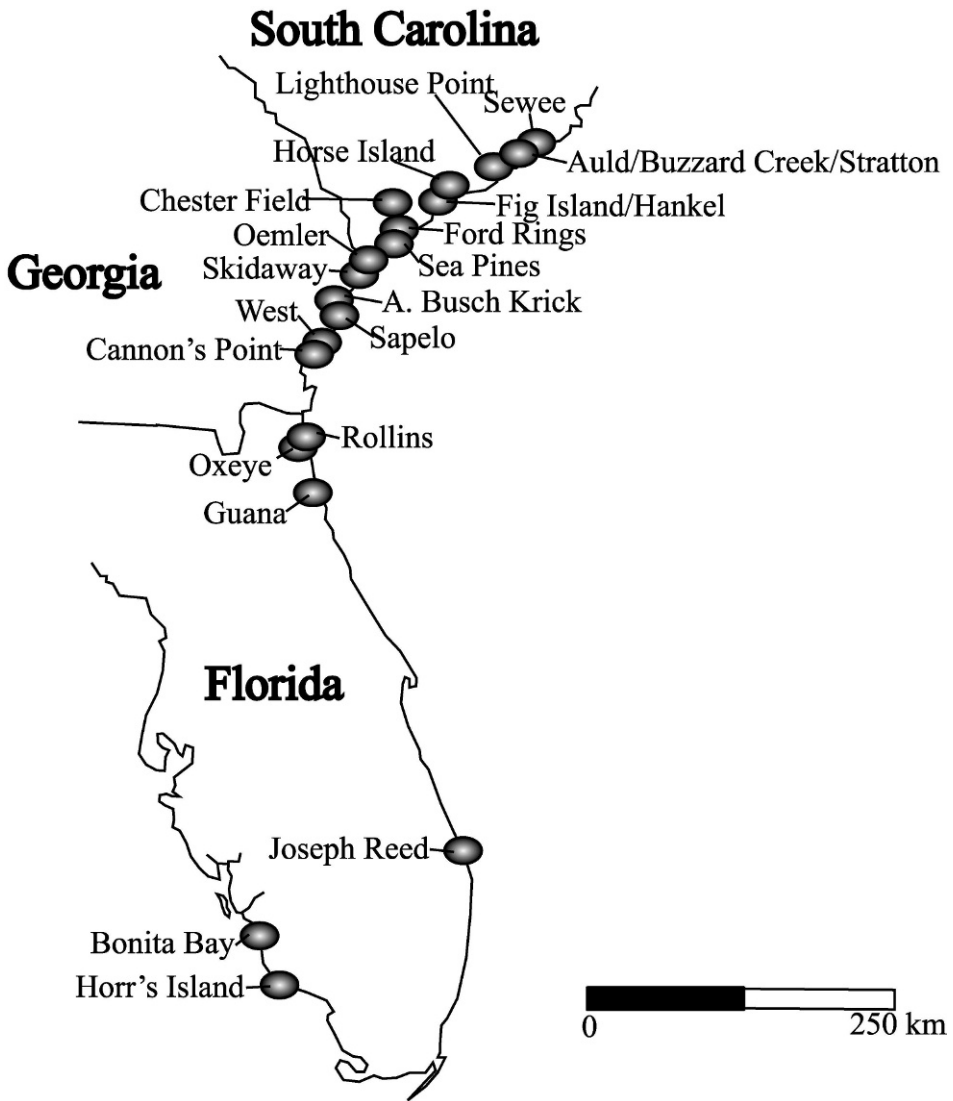
Fig. 31.11.   Distribution of known shell-ring sites along the Georgia Bight (after Russo and Heide, 2001: fig.1).

Perhaps the presence of these distinctive shell rings can be taken as a proxy of intensive Late Archaic occupations. Russo (2004b) has noted that the shell rings of South Carolina and Georgia (vis-à-vis those of Florida) "are smaller, more densely packed, and more numerous suggesting a greater population, and likely, greater demographic stress."

But the randomized transect sampling of St. Catherines Island identified only 10 ar-

chaeological components dating to the St. Simons period; by far the lowest density recorded for any time period during the aboriginal occupation of St. Catherines Island.[17] These data suggest that St. Simons period occupations (as measured by the components/century ratio) are relatively sparse on the island. Specifically, from the perspective of the 5000-year-long aboriginal sequence, one might take the relatively low site density as suggesting a relatively modest aboriginal

occupation of St. Catherines Island during the St. Simons period (see also chap. 33).[18]

White-tailed deer were the most important vertebrate captured on St. Catherines Island during the interval from cal 1000 B.C. to A.D. 1580 (with biomass contribution ranging between 60 and 80 percent of all vertebrates). But, as noted above (esp. fig. 31.5), there is a *relative* decline in venison during the aroriginal period. Although these results are generally consistent with the diet-breadth prediction of resource depletion, the decline is far from dramatic. We also noted that because abundance indices cannot distinguish between *declining importance* of a higher ranking resource from the *increasing importance* of lower ranking resources, it is impossible to resolve the issue of anthropogenic influence based on the data presently available. Further, despite the overall downward trend prior to European contact (reflecting the relative decrease in deer bones relative to the other vertebrate taxa), the White-tailed Deer Index (for biomass and MNI) for the Wilmington period actually increases slightly from the preceding Refuge-Deptford period, when lower ranking diamondback terrapin remains and turtle remains far outnumbered deer bones. To be sure, the sample sizes of the Island-wide survey are quite small, and perhaps the relative increase in deer bone is merely a random fluctuation.

Expanding the discussion of Late Archaic occupations elsewhere along the northern Georgia coast, we note that on nearby Ossabaw Island, Pearson (2001) recently synthesized his own research (1977a, 1979a, 2001) with DePratter's (1974) survey, reporting on evidence from 222 sites on Ossabaw Island. Pearson (2001: 12) concludes that ''only a small number of St. Simons period sites are known on Ossabaw, most confined to the western edge of the Pleistocene segment of the Island.'' The largest of these is the Cane Patch Site (OSS 28), located on a detached hammock just west of the main body of Ossabaw at its northern end (see also Crusoe and DePratter, 1976). Cane Patch is the largest single shell midden on the island, measuring 60 m across and up to 3 m thick. The second largest quantity of St. Simons

period pottery came from Arrowhead Beach (OSS 8), located on the northern shore of the island, facing Ossabaw Sound (Pearson, 2001: 13). Only a handful of additional occurrences of St. Simons ceramics are known from elsewhere on Ossabaw.

The aboriginal population density of Ossabaw Island appears to trail off after Late Archaic times. No Refuge period sites have been identified on Ossabaw Island, and only 10 sites have produced Deptford pottery (Pearson, 2001: 15–16); but, as noted in chapter 4, sites from this time period could have been drowned by rising sea levels. Wilmington/St. Catherines ceramics are associated with 16 known sites on Ossabaw. During the Savannah period, archaeological sites become widely distributed on Ossabaw Island, and Irene sites ''are scattered over the entire island'' (Pearson, 2001: 22). Altamaha period ceramics have been recovered from a single site on Ossabaw Island.

Limited settlement data are also available from Skidaway Island, where DePratter (1975) surveyed the P. H. Lewis property. Ten St. Simons period sites were located in this survey, mostly situated along the eastern marsh, with only small campsites located on the shoreline near the marsh (DePratter, 1975: 116). A small shell crescent (9CH60) was recorded on Skidaway Island, and contained both fiber-tempered and Wilmington period ceramics (Crusoe and DePratter, 1976: 9). Relatively little Refuge period material was recorded in the Skidaway Island survey. More sites were occupied during the Wilmington period on Skidaway Island than any other time period, with the island interior occupied for the first time. Site densities drop off during the St. Catherines and Savannah periods, but increase during the Irene period.

Despite the uneven and incomplete nature of the available archaeological evidence, we can posit a generalized settlement pattern for the northern Georgia barrier islands. The archaeological records of St. Catherines and Ossabaw Islands have been sampled in disparate ways and exhibit distinct differences, but they share some similarities. Both islands have a well-defined, limited occupation during the St. Simons period. Both

islands have a distinct signature site from the Late Archaic (the St. Catherines Shell Ring and Cane Patch sites), each located along the extreme western margin of the Pleistocene remnant. The remaining St. Simons sites are considerably smaller and widespread across the larger island landscape. Whereas the aboriginal occupation of Ossabaw Island dwindles after the Late Archaic, St. Catherines Island contains a substantial, if sporadic, occupation during the subsequent Refuge, Deptford, and Wilmington periods. On Skidaway Island, DePratter's (1975) survey suggests a pattern similar to that on Ossabaw, with a post-St. Simons population decline followed by a buildup during the Wilmington period.

The presently-available data are insufficient to support a meaningful estimate of Late Archaic population levels along coastal Georgia; in fact, a simple tabulation of available site records for the area could provide very misleading results without systematic investigations of the sites in question. There is also an issue of conflating the Refuge period ceramics of the northern Georgia coast with the sand-tempered Thoms Creek ceramics common to the shell rings of coastal South Carolina (Michael Russo, personal commun.).

But we must express a suspicion that the Late Archaic presence seems relatively low along the northern Georgia coastline, that is, in the vicinity of St. Catherines, Ossabaw, and Skidaway Islands, precisely those areas where white-tailed deer exploitation appears to be important during the subsequent aboriginal occupation (table 31.4). We hypothesize that deer populations survived a relatively sparse and perhaps discontinuous St. Simons period occupation of these composite barrier islands along the northern Georgia coastline. The newly isolated white-tailed deer populations were ill adapted to barrier island life due to habitat fragmentation caused by marine transgression. If white-tailed deer populations were subjected to less intensive hunting pressure (as along the southern Georgia and southeastern Florida coastline; see below), then perhaps these deer populations adapted and survived for millennia by downsizing, both in terms of nu-

trition and also genetics. There is some evidence, in fact, that some degree of selective hunting pressure actually increased the long-term survivability of white-tailed deer herds. In recent times, deer densities in the Sea Islands may have far surpassed those in mainland habitats; this suggests that, given a chance to adapt to the newly fragmented barrier island habitats, the surviving deer populations could withstand a significant and sustained harvest.

We further hypothesize that a different scenario may have played out along the southern Georgia/northern Florida coastline. Waring and Larson (1968) commented on the abundance of deer bones (about 85% of the total) in the large shell ring on Sapelo Island, obviously reflecting an abundant white-tailed deer population during at least part of the Late Archaic period (see also Thompson et al., 2004; Thompson, 2006). Excavation of later sites on Sapelo reflect a complex biogeographic record: At Kenan Field, Crook (1978b: table 14; see also Reitz, 1982a) reports that deer represent only 9.5 percent of the individuals recovered (Crook, 1978b: table 14; Reitz, 1982a); similarly, at the North of Shell Ring Drain site, deer bones account for only 1.9 percent of MNI (but 39.5% of the biomass). At Bourbon Field, deer account for 64.9 percent of the vertebrate biomass.

The diet-breadth model predicts that white-tailed deer should be hunted whenever available, and seasonal variability between the Sapelo Island sites could perhaps account for the (apparently) broad disparity in white-tailed deer exploitation. If so, then perhaps the Sapelo Island deer population was drastically reduced after Late Archaic times and fluctuated markedly during subsequent occupation periods. Or perhaps the population was eradicated entirely, and the deer at Kenan and Bourbon Field were hunted on nearby Blackbeard Island and transported to Sapelo. Additional evidence is needed regarding relative abundance, seasonality, and especially butchering and transport practices before this issue may be resolved.

A rather different pattern prevailed on St. Simons Island, where Marrinan's (1975)

excavation at the Late Archaic shell ring turned up few deer bones, while late prehistoric/protohistoric column samples from Couper Field contained numerous deer bones (Wallace, 1975: table 12).[19] As with Sapelo Island, existing evidence does not allow us to distinguish the dynamics of local deer population and the long-distance transport of deer carcasses from another location.

Native white-tailed deer do not live today on Little St. Simons Island, and recent excavations at the prehistoric North Point site (9GN107; Weinand et al., 2000: table 1) produced few deer bones in a huge zooarchaeological assemblage. Have white-tailed deer always been rare (or absent) on Little St. Simons Island? Or did an early aboriginal occupation extirpate the deer herd?

When it comes to island deer populations, local extinction can be forever. Although some immigration from neighboring islands and the mainland can never be totally ruled out—white-tailed deer have been occasionally spotted swimming the estuarine waters—the odds of deer reestablishing a breeding population on an isolated barrier island seems remote (barring, of course, human intervention, which has happened numerous times in the Sea Islands over the last century).

It seems more likely that local, island-level variability in herd dynamics, boom and bust cycles, episodes of human overpopulation, times of island abandonment, natural disasters (including droughts and hurricanes), local extinctions, and, on occasion, recolonization of white-tailed deer populations from neighboring islands or the mainland are involved.

This scenario reflects the sentiment, expressed at least back to Larson's (1958a) synthesis, that the long-term history of the Georgia Sea Islands involves an extraordinary complexity and island-specific variability. In discussing his own research on St. Catherines Island, Caldwell (1971) posited that "no single cultural sequence will hold for the entire Georgia coast, and I suspect that we already need a separate sequence for the regions adjacent to each major estuary."

We agree completely. Each Sea Island has a unique geomorphic and biogeographic history. Of all the Georgia barrier islands, St. Catherines is currently farthest from a major river: Neither Sapelo Sound to the south nor St. Catherines Sound to the north communicate directly with a major freshwater source. Griffin and Henry (1984: 43) suggest that this isolation from major deltaic systems may account for the extreme rates of erosion observed on St. Catherines Island during the historic period (and perhaps also the disappearance of Guale Island and Guale Marsh within the last 2000 years; see chaps. 9 and 24). We have already discussed the need for a highly-specific and localized resolution to ceramic chronology (chaps. 14 and 15), the reservoir correction in ^{14}C dating (chap. 13), and stable isotope analysis of mortuary remains (chaps. 24 and 33). To this growing list of focused, island-specific studies, one should also add the question of white-tailed deer population levels in the Sea Islands.[20]

Specifically with respect to terrestrial hunting, we hypothesize that white-tailed deer populations on each barrier island have distinctive and (perhaps) unique trajectories, reflecting the quality and distribution of local habitats and the intensity of human hunting pressure through time. We emphasize the importance of human predation during the St. Simons period, shortly after the island white-tailed deer populations became isolated from the mainland, but before selective pressures could produce the smaller, more adaptive phenotypes necessary to survive in the narrow and restrictive barrier island habitats. We are hypothesizing, in effect, that the hunting pressure exerted on early island deer populations is directly proportional to the duration and intensity of Late Archaic occupations on each island.[21]

DIAMONDBACK TERRAPIN

Chapter 8 discussed several dissections of gravid females that permitted estimation of the post-encounter return rate of diamondback terrapins to be 1260 kcal/hr (Kick, Semon, and Thomas, chap. 8, this volume). Although this energetic return makes diamondback terrapins among the lowest ranking terrestrial vertebrates, Table 31.1
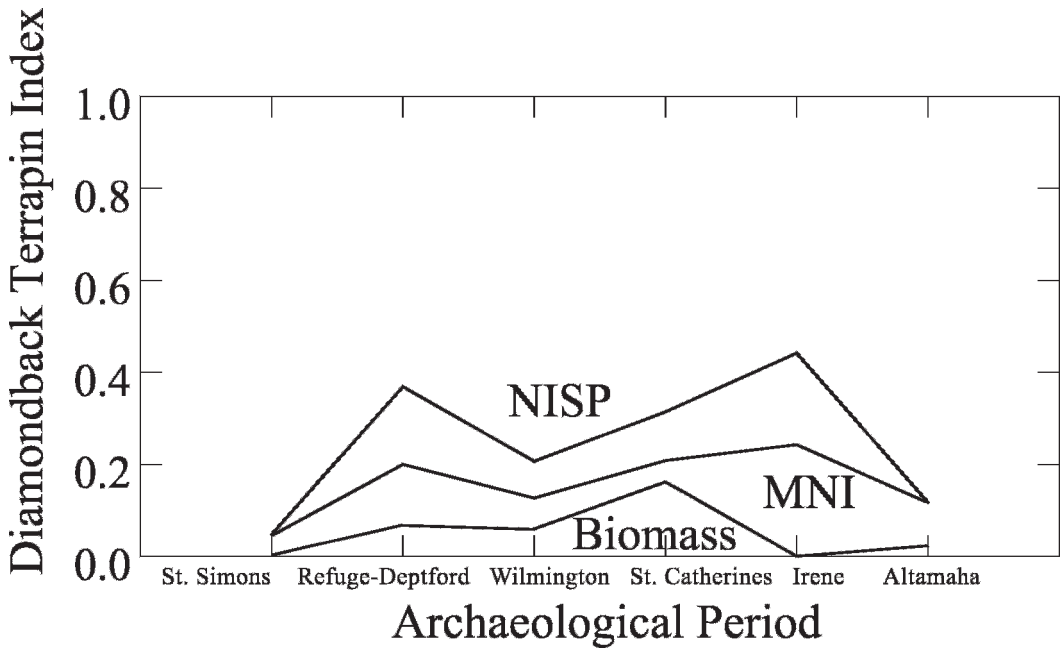
Fig. 31.12.   Diamondback Terrapin Indices for all aboriginal occupations on St. Catherines Island.

shows diamondback terrapins to be the second-most abundant terrestrial vertebrate recovered in the Island-wide survey, accounting for nearly 30 percent (NISP = 2197 of 7445) of all the vertebrate food bone recovered.[22]

The following *Diamondback Terrapin Indices* inform this discussion of turtle exploitation on St. Catherines Island:

$Diamondback\ Terrapin\ Index_{NISP}$

$= \Sigma(DBT_{NISP})/$

$\Sigma(All\ vertebrate\ taxa_{NISP})$

$Diamondback\ Terrapin\ Index_{MNI}$

$= \Sigma(DBT_{MNI})/$

$\Sigma(All\ vertebrate\ taxa_{MNI})$

$Diamondback\ Terrapin\ Index_{Biomass}$

$= \Sigma(DBT_{Biomass})/$

$\Sigma(All\ vertebrate\ taxa_{Biomass})$

As with the White-tailed Deer Index, this simple measure ranges between 0 and 1.0, with larger values corresponding to higher relative frequencies of diamondback turtle remains in the overall (terrestrial and marine) vertebrate assemblage.

Figure 31.12 plots the three diamondback terrapin abundance indices across the six aboriginal temporal periods on St. Catherines Island. Although very few terrapin remains (NISP < 5%) were recovered in the earliest (St. Simons period) middens, this result might be biased because, as noted above, only two St. Simons sites produced vertebrate faunal remains. The mission period (Altamaha) sample likewise contains relatively few diamondback terrapins (NISP = 11.7 %), reflecting the overall trend toward a narrower diet breadth and an intensive exploitation of white-tailed deer.

Diamondback terrapin remains are quite common in the refuse middens throughout the rest of the precontact period (from the Refuge-Deptford through Irene periods), accounting for roughly 20–45 percent of the NISP and 12–25 percent of all vertebrate individuals recovered (MNI). Figure 31.13 shows the regression plots for various abundance indices available to characterize diamondback terrapin exploitation during the precontact period on St. Catherines Island. The indices for both NISP and MNI show
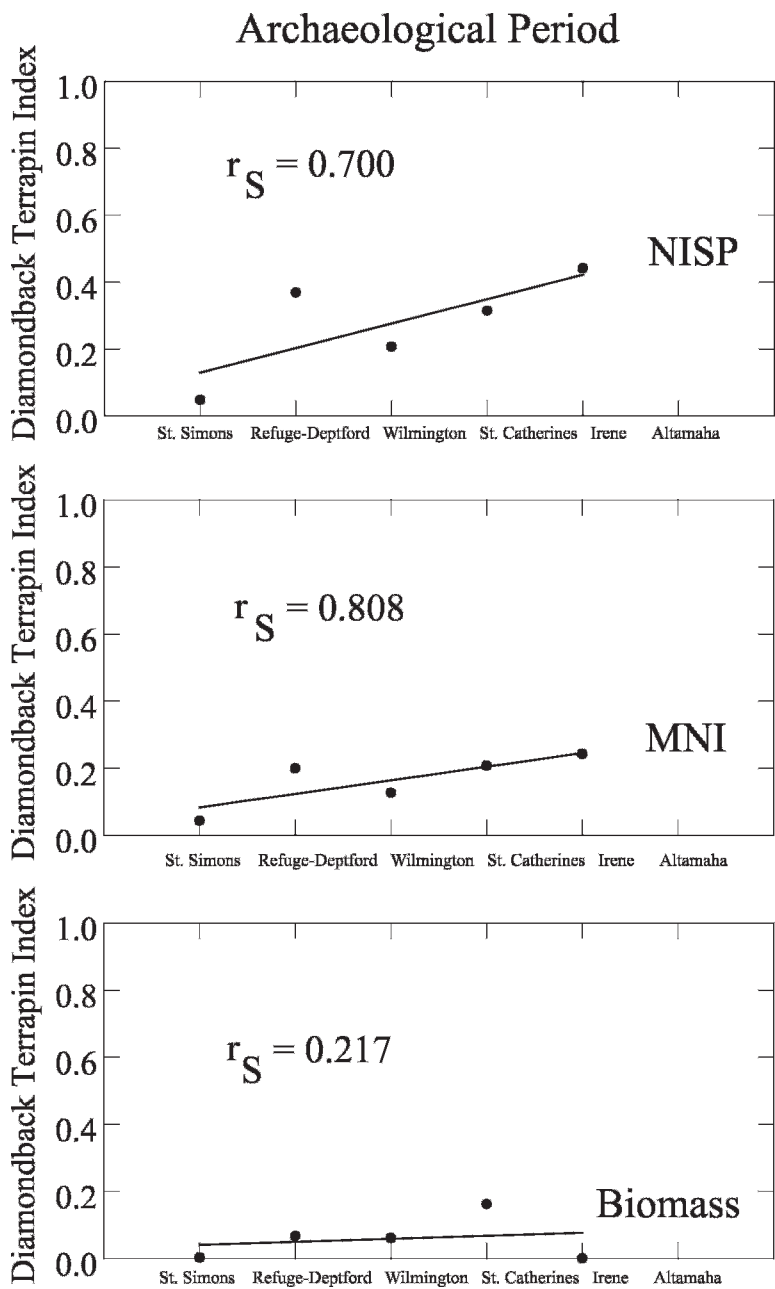
Fig. 31.13.   Simple linear regression models fitted to the Diamondback Terrapin Indices for all precontact periods on St. Catherines Island.

distinct linear increases through time (with r_S = 0.70 and 0.808, respectively—values not significantly different from 0). Due to the small body size (adult female diamondbacks average 0.9–1.1 kg, while adult males are much smaller, averaging only 0.3 kg), the contribution to overall biomass is relatively low, ranging between 6 and 16 percent of all vertebrates (there is no linear trend through time, with r_S = 0.217).

ESTIMATING DIET BREADTH FOR THE TERRESTRIAL HUNT TYPE

Table 31.1 raises an important issue regarding diet breadth for the terrestrial hunt type on St. Catherines Island. Although black bear and alligator have the highest post-encounter return rates for any taxa within the terrestrial hunt type, their virtual absence in the archaeological record suggests that they were rarely harvested. When humans first arrived on St. Catherines Island, 5000 years ago, the white-tailed deer living on the island were much larger than today and an extraordinarily high post-encounter return rate, in the neighborhood of 12,000–20,000 kcal/hr (see chap. 8). The archaeological evidence demonstrates that white-tailed deer were commonly hunted during the St. Simons period, as were raccoons, opossum, and pond and mud turtles. The lowest return rate recorded in the archaeological evidence for the terrestrial hunt type is 1260 kcal/hr for gravid female diamondback terrapins.

Over the next 3000 years, the relative abundance of white-tailed deer bones fluctuated in the archaeological middens. Although venison clearly remained the staple for the aboriginal foragers of St. Catherines Island (accounting for 60–80% of the biomass contributed by marine and terrestrial vertebrates), post-encounter return rates decreased in proportion to the shrinking body size (see fig. 8.1 and table 8.4). The same suite of lower ranking taxa was also hunted throughout, but the remains of diamondback terrapin remains increased significantly with respect to deer bones. Because of the nature of the archaeological indices employed, we cannot determine whether deer hunting actually decreased, diamondback terrapin collecting increased, or both.

This scenario suggests that the overall diet breadth for the terrestrial hunting type on St. Catherines Island remained relatively broad—likely at a level of 1300 kcal/hr or so—for nearly 4000 years. But making this inference requires the tenuous assumption that diamondback terrapins were procured *only* by terrestrial hunters. We think it likely that diamondback terrapin procurement (and that of other brackish and freshwater turtles as well) was embedded in other hunt types, including saltwater fishing, shellfish collection, and even the exploitation of terrestrial plant resources (such as mast and maize horticulture; see chap. 8). Turtles and terrapins were probably also collected upon encounter by children and elders (which would certainly modify the post-encounter return rates, involving different parameters of encounter and search time; see Bird and Bliege Bird, 2000, 2002; Bird et al., 2004b).[23]

In other words, because diamondback terrapin procurement does not exclusively belong to the terrestrial hunt type, the relatively low-ranking return rates associated with diamondback terrapins is not necessarily an accurate estimate of diet breadth.

SALTWATER FISHING

The Island-wide testing program on St. Catherines Island recovered thousands of fish bones, and table 31.1 summarizes these frequencies (using data extracted from chaps. 22 and 27). A broad range of taxa are represented, although a half-dozen species dominate the number of identified specimens (NISP), especially gar, gafftopsail, and hardhead catfish, black drum, sea trout, and mullet. Mummichog (*Fundulus heteroclitus*), a very small fish, was recovered only at Meeting House Field (almost certainly due to the fine-grained recovery methods employed there; see chap. 23).[24]

DIET BREADTH AND MARINE VERTEBRATE ZOOARCHAEOLOGY

Given the overarching theoretical background regarding prey size and prey ranking (articulated in chaps. 7–9), the question of aboriginal fish procurement on the Georgia coast requires a different approach from that employed for terrestrial hunting. This section will itemize the individual taxa available to aboriginal fishermen working the waters surrounding St. Catherines Island, but the post-encounter return rates are generalized across the various fish species, pooled into five discrete size categories. This

was done to avoid the obvious allometric problems that attend gross-weight estimates of the fish species involved (Reitz and Wing, 1999: 70–72). Because live-weight estimates overlap considerably and because interspecific caloric differences are unclear, these size categories are employed to estimate the variability in fish procurement strategies.[25]

Fish were likely captured in several different ways during the aboriginal period, including seines and weirs, "mullet jumping," fish traps, nets, trotlines and handlines, spearing, and harpooning (see chap. 7). These various technologies have a major effect on the post-encounter return rates, meaning that live weight can only provide a coarse-grained measure of energetics in fish procurement; the energy return from spearing a dozen hardhead catfish is vastly different from that expended to capture the same dozen catfish in a weir. Return rates likewise differ between catching a spotted sea trout on a trotline and taking a spotted sea trout with a handline. As noted in chapter 7, the mass collection of invertebrates (such as grasshoppers or oysters) and fish (either taken while spawning or in facilities) can provide returns up to 23 times greater than individually acquired big game (e.g., Lindström, 1996; Ugan, 2005a: 79).

Alas, when working from the actual fish bones recovered from an archaeological site, one cannot tell how the fish were captured. Although mass capture technology clearly plays an important role here, body size will always be germane to this discussion—rays will always have higher return rates than toadfish, regardless of how they are captured. Table 31.1 scales the various marine vertebrate taxa by the live weights derived in chapter 7. The diet-breadth framework permits an exploration of relationships between (1) prey choice to resource depression and (2) the importance of marine fishing relative to terrestrial hunting.

THE VERY HIGHEST RANKING TAXA

Rays and sharks (Chondrichthyes) are the highest ranking marine vertebrates, based on relative mean size (chap. 7). Single ray and shark individuals (NISP = 8 and 3,

respectively) were recovered during test excavations at St. Catherines Shell Ring (9Li231), and one additional shark bone turned up in mission period deposits; rays were entirely absent in later deposits.

PREY CHOICE AND RESOURCE DEPRESSION

The diet-breadth model predicts that as human population densities increase, the abundance of the highest ranking prey species should decrease through time. What mix of potential marine vertebrates was actually harvested by the aboriginal foragers of St. Catherines Island? And did this mix of high-ranking and low-ranking marine vertebrates change through time?

Table 31.1 lists the NISP and MNI for all marine vertebrates recovered in the St. Catherines Island excavations, rank-ordered according to estimated live weight (as derived in chap. 8). Given the difficulties posed by mass capture technologies, it seems useful to derive a simple proxy measure to distinguish between "higher ranking" marine vertebrates (those taxa with an average live weight greater than 1.0 kg) and "lower ranking" taxa (which weigh less than 1.0 kg). Accordingly we present the Big Fish Index as

$Big\ Fish\ Index_{NISP}$

$= \Sigma(Big\ Fish_{NISP} > 1.0\ kg)/$

$\Sigma(All\ marine\ vertebrates_{NISP})$

$Big\ Fish\ Index_{MNI}$

$= \Sigma(Big\ Fish_{MNI} > 1.0\ kg)/$

$\Sigma(All\ marine\ vertebrates_{MNI})$

$Big\ Fish\ Index_{Biomass}$

$= \Sigma(Big\ Fish_{Biomass} > 1.0\ kg)/$

$\Sigma(All\ marine\ vertebrates_{Biomass})$

As with the White-tailed Deer Index, the values of this measure vary between 0 and 1.0—the larger the index, the higher frequencies of larger fish. An assemblage containing exclusively gar and gafftopsail catfish, for instance, will have a Big Fish Index
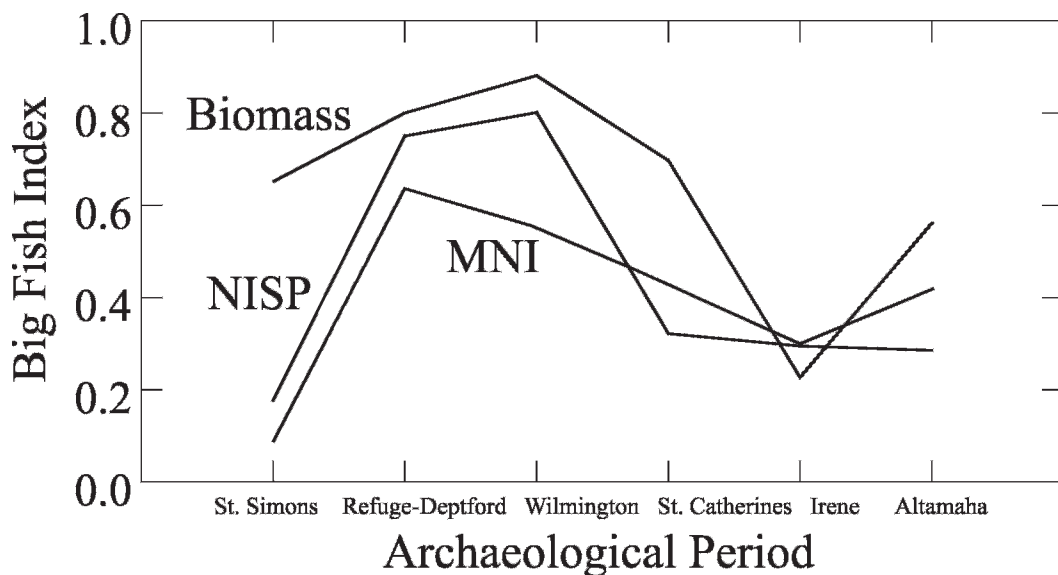
Fig. 31.14.   Big Fish Indices for all aboriginal occupations on St. Catherines Island.

of 1.0, but a collection comprised of sea trout and hardhead catfish bones will produce a Big Fish Index of 0.

Figure 31.14 shows the variability evident in the abundance indices for saltwater fishing on St. Catherines Island. During the St. Simons period, the marine vertebrate assemblage is dominated by hardhead catfish bones (NISP = 666 of 868 fish and shark bones recovered), a "small" fish (averaging only 0.15 to 0.30 kg). Accordingly, the Big Fish Indices for NISP and MNI are just 0.1774 and 0.087, respectively. The presence of numerous bones from several "large" (average weight > 1.0 kg) taxa (including rays, sharks, gar, gafftopsail catfish, and black drum) raise the Big Fish Index$_{Biomass}$ to 0.651, the largest value observed for any period in this study. As with other indices, the St. Simons period zooarchaeological assemblage is unique within the aboriginal occupation of St. Catherines Island.

During the next five cultural periods, Big Fish Indices follow a fairly consistent pattern, tending to peak during the Refuge-Deptford and Wilmington periods and decline thereafter (fig. 31.14). Figure 31.15 plots regression curves for the Big Fish Indices (excluding the atypical St. Simons period counts). The top of figure 31.15 demonstrates the precipitous decline in Big Fish Index$_{NISP}$, from a peak of roughly 75 percent during the Refuge/Deptford/Wilmington periods to a low of about 30 percent during and after the St. Catherines period ($r_S = -.900$; $p < 0.05$). Similar but somewhat less dramatic declines characterize the distribution of the Big Fish Index$_{MNI}$ ($r_S = -9.00$; $p < 0.05$) and the Big Fish Index$_{Biomass}$ ($r_S = -.800$; a value not statistically different from zero).

These data support the diet-breadth projection that high-ranking taxa should decline in importance as human population increases and foraging pressures intensify. Unlike white-tailed deer, the relative frequency of "big fish"—that is, those taxa with an average weight greater than 1.0 kg—decreases significantly through time, especially after cal A.D. 1200, the beginning of the St. Catherines period.

To summarize: The diet-breadth model projects that through time, the highest ranked taxa should be harvested disproportionately, stimulating an expansion in diet breadth as foragers turned to lower ranking taxa. Within the saltwater fishing hunt type, this is precisely what happened on St. Catherines Island. But the precise mechanism accounting for this shift remains unclear.

Archaeological Period
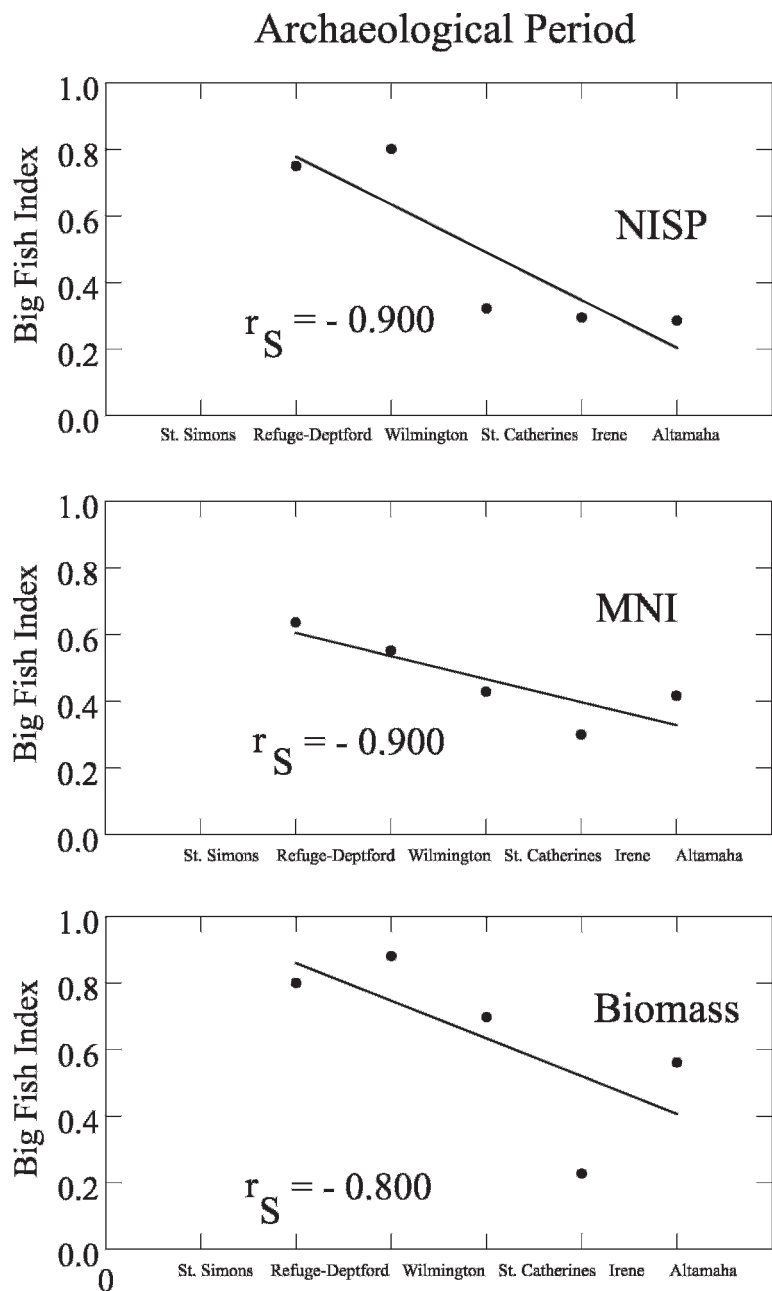
Fig. 31.15.   Simple linear regression models fitted to the Big Fish Indices for St. Catherines Island.

COMPARING MARINE AND TERRESTRIAL VERTEBRATE EXPLOITATION

Chapter 7 of this volume established that saltwater fishing provides the highest *poten-tial* return rates of any "hunt type" available to St. Catherines Island foragers (tables 8.21 and 8.22). Without doubt, the sharks, rays, sea turtles, red drum, and sheepshead have always been among the very largest "meat packages" available any-

where on the Georgia coast, but the availability of these taxa (and the mass fish capture technology appropriate for catching them) likely varied considerably through time. Gill nets, trotlines, and fish weirs generate vastly superior returns compared to spear and harpoon fishing techniques, and their overall efficiency greatly exceeds that of encounter hunting strategies commonly employed to procure terrestrial vertebrates. Ethnohistoric sources report that tidal traps were so effective that fish were not only extraordinarily abundant and easy to capture, but in some cases, they were kept alive in the weir, to be harvested at the pleasure of the cacique. It is not surprising that Rostlund believed that the aboriginal people of the Georgia–Carolina littoral ''probably had a better chance than most of the others in North America of keeping themselves supplied with fresh fish at all times'' (1952: 138).

The vertebrate faunal data from St. Catherines Island provide one way to gauge the relative importance of terrestrial and marine vertebrates to aboriginal foragers, as expressed in a series of *Marine/Terrestrial Indices*:

$$Marine/Terrestrial\ Index_{NISP}$$

$$= \Sigma(Marine_{NISP})/$$

$$\Sigma(All\ vertebrate\ taxa_{NISP})$$

$$Marine/Terrestrial\ Index_{MNI}$$

$$= \Sigma(Marine_{MNI})/$$

$$\Sigma(All\ vertebrate\ taxa_{MNI})$$

$$Marine/Terrestrial\ Index_{Biomass}$$

$$= \Sigma(Marine_{Biomass})/$$

$$\Sigma(All\ vertebrate\ taxa_{Biomass})$$

The intent is to track the relative dependence on marine and terrestrial vertebrate taxa through time. As before, the values of the Marine/Terrestrial Index vary between 0 and 1.0—the larger the index, the greater the proportion of marine vertebrate in the zooarchaeological assemblage being monitored. While an archaeological assemblage containing exclusively gar and gafftopsail

catsfish bones would have a Marine/Terrestrial Index of 1.0, a collection containing only white-tailed deer and raccoon remains would produce a Marine/Terrestrial Index of 0.

Figure 31.16 plots the distribution of Marine/Terrestrial Indices through time. Characteristically, the earliest (St. Simons period) assemblage differs markedly from subsequent zooarchaeological samples. Part of this difference might be attributed to sampling issues (because only two sites are represented) and also because hardhead catfish (*Ariopsis felis*) remains dominate the assemblage (NISP = 666 of 1222 elements recovered). Although a few sea catfishes remain in the inshore area year-round, most leave during cold weather (Dahlberg, 1972) and the presence of sea catfish remains almost certainly indicates summer seasonality. As noted elsewhere, this suggests that the zooarchaeological assemblage from St. Catherines Shell Ring may not be representative of overarching subsistence patterns during the St. Simons period on St. Catherines Island, potentially illustrating the ''fallacy of the typical site'' (Thomas, 1998: 104–105; Thomas and Kelly, 2006: 81–83).

Further, because the zooarchaeological sample for the St. Simons period is dominated by a single site (St. Catherines Shell Ring), the MNI would have been considerably higher had this same sample been generated from several St. Simons period (or had Reitz computed MNI based on stratum, rather than pooling the collection by site). There is every reason to believe that a more diverse sample of zooarchaeological remains from St. Simons period sites, comparable to the Island-wide samples available for the subsequent periods, would paint a different picture of species diversity. For this reason, we will not treat the St. Simons zooarchaeological sample as ''typical'' of Island-wide trends during the Late Archaic period.

All of that said, the available St. Simons assemblage is clearly dominated by marine vertebrates, with the Marine/Terrestrial Index$_{NISP}$ = 0.7103 and Marine/Terrestrial Index$_{MNI}$ = 0.8070 (Table 31.3). The Marine/

Archaeological Period
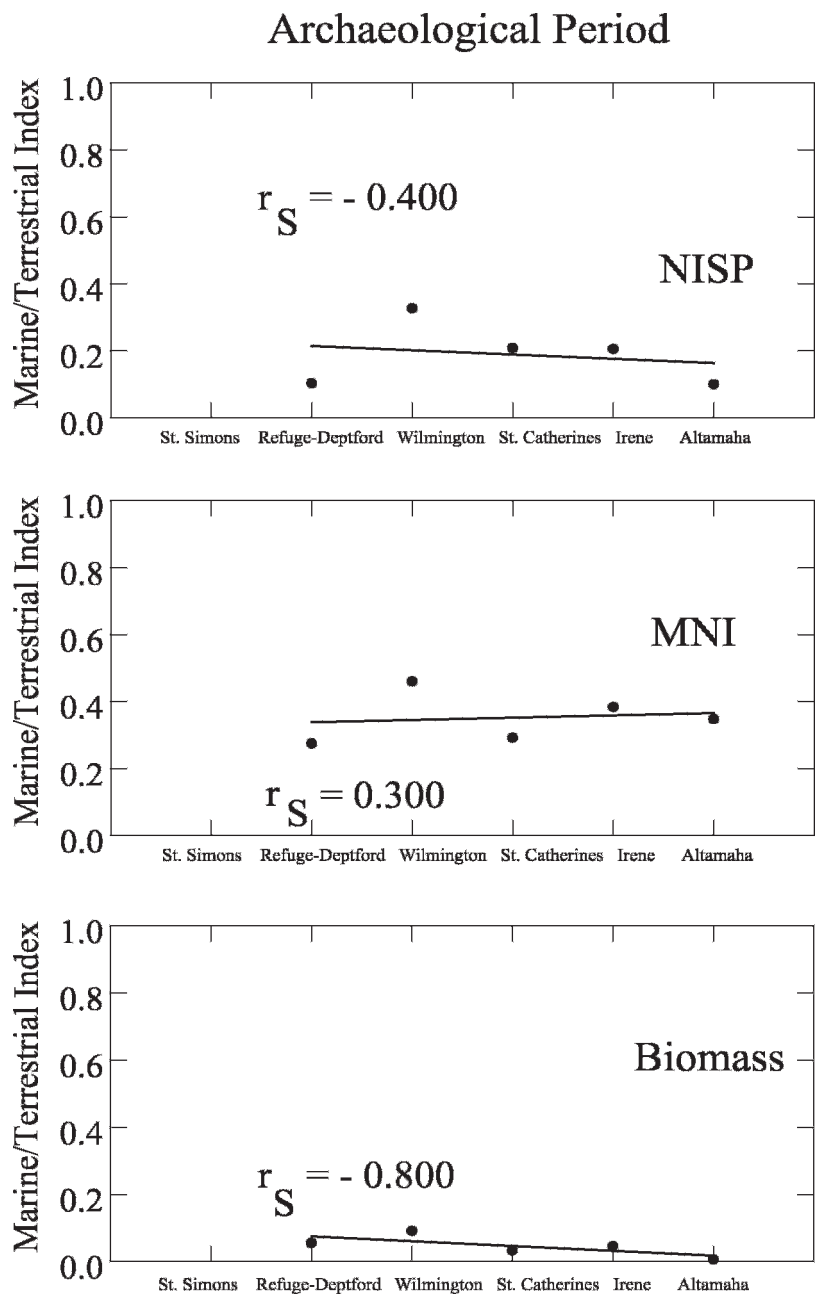
Fig. 31.16.   Marine/Terrestrial Indices for all aboriginal occupations on St. Catherines Island.

Terrestrial Index$_{Biomass}$ = 0.1920, meaning that marine resources account for slightly less than 20 percent of the total biomass from all vertebrates and represents the highest proportion for all time periods on St. Catherines Island.

Figure 31.16 plots the various abundance indices for the post-St. Simons occupations on St. Catherines Island. The most notable trend is a steady decline in the Marine/Terrestrial Index$_{Biomass}$ (with r_S = −0.8), meaning that from the Refuge-Dept-

ford through the mission (Altamaha) occupations, marine vertebrates become less important to aboriginal foragers (relative to terrestrial vertebrate taxa). The Marine/Terrestrial Indices for NISP and MNI fluctuate during this interval, increasing slightly during the Wilmington period, with no linear trend apparent (with $r_S = -0.4$ and $r_S = 0.3$, respectively; neither value is significantly different from 0).

Moving away from the specifics to focus on the trends evident across the entire 5000-year sequence, table 31.3 shows that marine taxa contribute about NISP = 30 percent of the total vertebrate elements recovered, roughly MNI = 18 percent of the vertebrate individuals, and only about 5 percent of the overall biomass from vertebrate sources. These results are somewhat biased because 1/4-in. screens were used for most of the excavations described here, and this relatively large screen mesh favors the recovery of bone from larger taxa (such as white-tailed deer) and hampers recovery of the smaller fish bones (Reitz and Quitmyer, 1988). Reitz (chap. 22) estimates that the bias against the relative recovery of fish bones might reach 25 percent. Even taking such a notable recovery bias into account, it is clears that despite the high projected values for post-encounter return rates, marine vertebrates never contributed more than about one-quarter of the total biomass from vertebrate sources.

To summarize: The zooarchaeological samples obtained from 85 archaeological components (distributed across 71 individual sites) indicate that terrestrial vertebrates always contributed *at least 3 times* the number of individuals harvested as marine vertebrate sources, and during most of the aboriginal occupation of St. Catherines Island, terrestrial taxa contributed *more than 10 times* the biomass as marine vertebrates.

These findings recall Lewis Larson's earlier assessment about the relative importance of saltwater fishing along the Georgia coastline:

the archaeological and ethnohistorical information that we have at hand now indicates that, at best, *fishing … was only a secondary and seasonal subsistence activity.* … As such it did not approach the productive importance of gathering wild plant foods. … This is not to minimize the importance of fishing; to the contrary, it was certainly a critical supplement to other productive endeavors. (Larson, 1980a: 126)

The zooarchaeological evidence from St. Catherines Island reinforces Larson's previous interpretation, and stands in contrast to the extremely high post-encounter return rates marshaled on tables 7.21 and 7.22. It may be true that the energetic *potential* from saltwater fishing is vastly superior to all other subsistence activities, including shellfishing, wild plant gathering, and agriculture. But as cautioned throughout this monograph, diet-breadth modeling does not address dietary importance; instead, the prey-choice model projects only whether a given resource will be selected upon encounter.

SEA TURTLE HARVESTING

Despite projected high return rates, sea turtle remains are virtually absent from the sites discussed in this volume. Only five sea turtle bones were recovered in the Island-wide survey on St. Catherines Island. All of these came from Little Camel New Ground Field, site number 5 (9Li206; AMNH-466), a medium-sized Irene period site (with a secondary St. Catherines period component) located 10 m east of South Beach Road (in transect J-1). Test Pit I (0–10 cm) contained one costal, one carapace (upper shell) fragment, and two "peripherals," fragments from the edge of the carapace (Elizabeth Reitz, personal commun.). Test Pit IV (10–20 cm) contained an additional sea turtle peripheral. A random sample of $n = 25$ *Mercenaria* from the Irene component demonstrates that clams were harvested equally in the winter and in summer/fall (late fall was also represented). The presence of sea catfish remains suggests an occupation sometime between April and October, when sea turtles would have been available.

HARVESTING MAST AND OTHER WILD PLANTS

A major shortcoming in the present research design has been the lack of system-

atic recovery and analysis of paleobotanical materials. To date, systematic paleoethnobotanical recovery and analysis have been conducted only at the Fallen Tree site (reported in chap. 22) and at Mission Santa Catalina de Guale (Ruhl, 1990, 1993, 2003). Hickory nut shells and acorn shells were recovered at both sites, as were chenopod seeds (*Chenopodium berlandieri*). Table 31.6 enumerates the present state of knowledge regarding the paleobotany at Mission Santa Catalina de Guale (see also chap. 23). Until appropriate ethnobotanical studies are conducted across the range of archaeological sites discussed in this volume, our knowledge of aboriginal diet breadth on St. Catherines Island will remain preliminary and incomplete.

MAIZE CULTIVATION

Because the research design employed did not adequately sample the paleobotanical record on St. Catherines Island, this serious flaw limits our understanding of all plant harvesting, including maize cultivation. That said, there is excellent evidence regarding the long-term bioarchaeology of St. Catherines Island, and these data provide considerable information about plant consumption over the past 3000 years (see chaps. 24 and 32).

There is no convincing bioarchaeological evidence of maize consumption on St. Catherines Island prior to cal A.D. 1300. Not only are the isotope data equivocal (Schoeninger et al., 1990), but skeletal and dental infections (commonly associated with the adoption of maize cultivation) are virtually absent during and prior to the St. Catherines period (Larsen and Thomas, 1982: 327–329). Although the skeletal sample is quite limited for the late prehistoric occupation of St. Catherines Island, the evidence from stable isotope analysis indicates that people of the Irene period "ate maize in appreciable amounts" (Larsen, 2002: 64; Reitz et al., 2002: 45); but we emphasize that most of this evidence is from Irene Mound samples, not those from St. Catherines Island. Additional bioarchaeological studies support this conclusion. The frequency of periosteal lesions and dental caries

TABLE 31.6
Plant Remains Recovered from Mission Santa Catalina de Guale, St. Catherines Island (after Ruhl, 1993: table 15-1)

Old World domesticates	
Watermelon	*Citrullus vulgaris*
Hazelnut	*Corylus avellana*
Melon	*Cucumis melo*
Fig	*Ficus carica*
Pea	*Pisum sativum*
Peach	*Prunus persica*[a]
Wheat	*Triticum* sp.
Indigenous New World domesticates	
Squash/pumpkin	*Curcurbita pepo*
Squash/pumpkin	*Curcubita* sp.
Curcurbit rind	—
Curcurbit peduncle	—
Sunflower	—
Bottle gourd	*Lagenaria sicervaria*
Bottle gourd rind	—
Common bean	*Phaseolus vulgaris*
Corn	Zea mays[a]
Exotic New World domesticates	
Moschata squash	*Curcurbita moshata*
Chili pepper	*Capsicum* sp.
Nuts	
Hickory	*Carya* sp.[a]
Acorn	*Quercus* sp.[a]
Fruits	
Palm family	Arecaeae
Creeping cucumber (?)	*Melothria pendula*
Wax myrtle	*Myrica* sp.
Maypop	*Passiflora incarnata*
Blackberry	*Rubus* sp.
Elderberry	*Sambucus* sp.
Grape	*Vitis* sp.
Tubers	
Greenbriar	*Smilax* sp.
Commensal/wetland plants	
Copperleaf	*Acalypha* sp.
Amaranth family	Amaranthaceae
Rape/mustard	*Brassica* sp.
Sedge	*Carex* sp.
Sandspur	*Cenchrus* sp.
Chenpod	*Chenopodium* sp.[b]
Euphorb family	Euphorbiaceae
Legume family	Fabaceae
Poke	*Phytolacca americana*
Pine	*Pinus* sp.
Grass family	Gramineae
Knotweed family	Polygonaceae
Knotweed	*Polygonum* sp.
Purslane	*Portalaca oleracea*
Wild bean	*Strophostyles umbellate*
Violet	*Viola* sp.

[a] Also recovered from mission-era deposits at Fallen Tree (see chap. 26).

[b] Chenopodium berlandieri was also recovered from mission-era deposits at Fallen Tree (chap. 26).

increases significantly during the Irene period, likely reflecting poor sanitation conditions and the spread of infectious disease prior to the arrival of Europeans (Reitz et al., 2002: 50, 53, 54). Biomechanical studies of Irene period remains further suggest decreased mobility and shorter stature than pre-Irene populations on St. Catherines Island (Larsen, 2002: 58, 61). The extensive stable isotope and additional bioarchaeological analyses of human remains from Mission Santa Catalina de Guale (chaps. 24 and 32, this volume; see also Larsen, 1990, 2002) indicate that maize was a dietary staple during the mission period.

SHELLFISHING

To date, a systematic, quantitative examination of the nonvertebrate faunal remains has not been attempted for the aboriginal shell middens of St. Catherines Island, highlighting another major shortcoming in our research design (and one which, at this writing, we are taking steps to rectify). Without detailed knowledge of midden constituents (especially the relative frequencies of shellfish taxa) across the temporal and functional range of sites discussed, little specific can be said regarding biomass or diet breadth within this important hunt type.

ENERGETICS OF ABORIGINAL SHELLFISHING

Assessments of aboriginal shellfishing have long been couched in stereotypes and hyperbole, but judicious combination of prey-choice modeling and fine-grained archaeological investigation can clarify the role of shellfishing to aboriginal foragers of the Georgia coast.

While it is true that marine habitats are generally less productive per unit of area than terrestrial habitats, this generalization applies only to open ocean waters; certain coastal habitats exhibit extraordinarily high productivity (Yesner, 1980; Erlandson, 1988, 1991; Raab, 1992). In fact, shellfish beds produce one of the highest rates of biomass production on earth (Jones and Richman, 1995; see also Yesner, 1980; Claassen, 1986a, 1986b; Stein, 1992).

To be sure, the energetic return rates for shellfish are considerably lower than those attending other marine resources (especially fish and reptiles) and most terrestrial vertebrates on St. Catherines Island (chaps. 7 and 8). Compared to other available food items, clams, oysters, whelks, and other shellfish taxa are relatively low ranking, with energetic return approximately the same as mast crops and small seeds.[26] The "meat packages" are quite small and the proportion of edible meat is generally low. For a duck or a squirrel (fairly small "meat packages" by terrestrial vertebrate standards), the proportion of usable meat is about 70 percent. For shellfish, such as oysters and clams, the proportion of usable meat is between 12 and 30 percent. Setting aside the issue of field processing to reduce the load (in chap. 10 we considered the relevance of central place/transport models), it is nevertheless clear that shellfish gatherers must be willing to invest considerable energy in (1) collecting and transporting heavy loads of shellfish, only a small part of which is edible, and (2) extracting the meat from each shell package.

THE SHELL MIDDEN PARADOX

Despite the low energetic rankings involved, it is manifestly obvious that shellfish were extensively exploited by the aboriginal foragers of St. Catherines Island. Even the most casual glimpse at the island archaeology shows that the Guale people and their ancestors carted hundreds of tons of mollusks and gastropods from the marsh to their settlements. Roughly 700 archaeological sites—most with multiple shell middens of varied size—survive today on the modern landscape of St. Catherines Island, and many more shell middens have eroded into the sea. In point of fact, the intensive archaeological surveys discussed in this monograph were designed specifically to inventory these ancient middens and to answer basic questions about their age, seasonal utilization, and contents.

This, then, is the shell midden paradox: *The diet-breadth model predicts that mollusks, gastropods, and crustaceans are low-*

ranking resources, generally found in small packages with relatively low utility, high transport costs, and even higher handling cost. Given this low level of net energetic potential, why is St. Catherines Island littered with thousands of aboriginal shell middens that span the last 5 millennia?

BIOARCHAEOLOGY

The bioarchaeological evidence from St. Catherines Island provides some insights. Although there are, as noted elsewhere, some attendant problems with using stable isotopes to distinguish between the consumption of marine resources and domesticated maize, use of nitrogen isotope ratios can help distinguish between the two.

Lacking any bioarchaeological data for the St. Simons period, the Island-wide archaeological survey documented a Late Archaic presence at 24 archaeological components (fig. 25.1). The shellfish remains found in many of these St. Simons period sites confirm that shellfish were extensively harvested prior to cal 1000 B.C. Bioarchaeological evidence is available from four late Deptford–Wilmington period burial mounds. Considerable variability is evident in the isotope ratios within the Deptford–Wilmington time span, especially among the five females interred within the Central Tomb at McLeod Mound (see also chaps. 24 and 32). Four new AMS dates span the interval cal A.D. 300–600. Whereas the nitrogen levels of all individuals are virtually identical, they have a surprisingly broad distribution of $\delta^{13}C$ ‰ values. Although bone chemistry is a lifelong average, growth during youth and adolescence is of particular importance to isotope analysis because bone collagen forms during this time. The Central Tomb contained the remains of three women who were raised on a diet consisting of approximately 50 percent marine resources (almost certainly from both vertebrate and invertebrate taxa). On the other hand, McLeod individuals 13 (buried as a bundle) and 15 (who died immediately before interment), had the most extreme carbon isotopic values observed among the St. Catherines Island samples. These two

women were clearly raised on diets dominated by terrestrial C_3-based resources (likely including acorn, hickory, deer, rabbit, etc.). In other words, the overall range of variability within these five females far exceeds that expected from a single dietary regimen—especially considering the likelihood that these women lived at the same time, knew one another (perhaps were related), and were buried together in a common grave.

Stable isotope data is available from a dozen burials recovered in St. Catherines period contexts and the isotope are entirely consistent with data from the Deptford and Wilmington periods (see chap. 32). But the respective standard deviations and ranges clearly indicate decreasing variability from Deptford through St. Catherines times. The overall trend toward decreasing nitrogen and carbon isotope levels suggests a varied diet based on continued use of marine foods.[27]

Schoeninger et al. (1990) indicate that ingesting increased amounts of marine food from a lower trophic level (such as seaweed or mollusks) might also produce the same isotopic distributions as maize consumption. Reitz (1985) believes that oysters were more heavily exploited during the St. Catherines period, and if these mollusks were harvested during the winter (as were *Mercenaria* on St. Catherines), they would have had disproportionately high carbohydrate values relative to protein. Schoeninger et al. (1990: 90) note that to account for the high carbohydrate intake for the observed $\delta^{13}C$ values to result from oysters, they would have had to account for nearly 100 percent of the total diet. Clearly, additional isotope sampling coupled with paleobotanical evidence and an assessment of the seasonality of oyster harvesting is needed to fully resolve this issue.[28]

The isotope evidence, reiterated above, leaves little doubt that maize was a dietary staple during the mission period, roughly comparable to $\delta^{15}N$ values for pueblo agriculturalists of the American Southwest (Schoeninger et al., 1983; 1990: 90). Continued use of marine resources on St. Catherines Island depresses the overall distribution of $\delta^{15}N$ values, suggesting a lower de-

pendence on maize consumption as island residents explored a broader range of subsistence alternatives than those available to their pueblo counterparts.

Despite the low post-encounter return rates, shellfish have doubtless been an important resource throughout the aboriginal occupation of St. Catherines Island (subject, of course, to variable sea level, which clearly impacts the availability of marsh resources). In addressing the disparity between the energetic projections and archaeological evidence, three intriguing possibilities emerge:[29]

- Do differential fitness objectives of male and female foragers account for the apparent popularity of a "suboptimal" resource such as shellfish?
- Is "net energy intake" the appropriate currency for assessing the evolutionary significance of aboriginal shellfishing?
- Could it be that the widely utilized/employed diet-breadth (prey-choice) model might not apply in this case?

DIFFERENTIAL DIET BREADTH

The prey-choice model predicts that if overall energetic efficiency is being maximized, then (1) the highest ranked prey type is always handled on encounter, (2) lower ranked prey are handled if, and only if, their individual return rates exceed the marginal foraging efficiency, and (3) the inclusion of lower ranked taxa is independent of their abundance. It is clear that the foragers of St. Catherines Island did not pass over these lower ranked resources—indeed, they harvested shellfish in huge quantities over millennia; it is legitimate to inquire about the diet breadth of those foragers responsible for accumulating the extensive shell middens.

Chapter 6 made the point that simple, one-to-one comparisons of post-encounter return rates across all available prey items on St. Catherines Island would seriously violate the assumption of fine-grained foraging. Further, the combined effects of seasonality and the overlap between marine and terrestrial ecosystems created a decidedly nonhomogeneous distribution of prey items. This is why energetic returns from,

for example, hunting wild turkeys cannot be directly compared to return rates for harvesting hardshell clams. Because there is absolutely no overlap within the spatial distribution of these two prey items, there is zero probability of locating these two taxa in random sequence. Following Smith (1991), the overall resource base was partitioned into seven distinct "hunt types" (or, perhaps more appropriately, "foraging types").

This approach allows us to explicitly recognize the degree to which men and women might share a common diet breadth. As noted elsewhere, prey typically exploited by men tends to be mobile and rare, commonly involving considerable search costs, while resources typically exploited by women tend to be stationary and more abundant. "Given an evolutionary perspective of sexual division of labor, it seems likely that men bypassed plant resources that were in their optimal prey set because they received greater reproductive benefits by sharing large packages of meat. In contrast, women harvested plants that fell out of their optimal prey set, because doing so ensured provisioning their offspring, particularly during episodic food shortages" (Zeanah, 2004: 17). From a fitness perspective, one might expect that females could generally earn overall higher foraging returns than males across all seasons, despite the fact that males pursue higher ranked prey. These St. Catherines Island foraging types likewise reflect the possibility that male and female foraging may reflect variability in anticipated returns. Since women must nourish their children on a *daily* basis, the high-risk uncertainty involved in hunting larger game becomes unacceptable in female foraging strategies.

The possibility of differential diet breadths leads one to miminize the fact that shellfish are a low-ranked resource relative to the entire range of available prey items (and this generalization violates the baseline assumptions of the diet-breadth model). *Emphasis is placed instead on the fact that oysters and clams are among the very highest ranking resources available to female foragers on St. Catherines Island, with only*

two seasonally restricted resources—cattail pollen and oil made from mast—ranking higher. So framed, shellfish becomes a prized resource for the female forager with parental investment. Oysters and clams are stationary and predictable food items, available year-round, and packaged in small containers that are easily collected by foragers of all ages and readily distributed among family members.

Among the Meriam of the Torres Strait, nerites and *Asaphis* clams are extremely low ranking, but they are collected in great numbers when females forage with small children or when the tide covers the mid-littoral (both conditions effectively decreasing the encounter rate with higher ranked prey on the reef flat). Bird et al. (2004b) argue that this is explains the prevalence of these low-ranking shellfish resources in Meriam shell middens. The same holds true the Anbarra, for whom shellfish is one of the most dependable food resources, even more reliable than fishing. After all, "shellfish are there for the taking, like the food on a supermarket shelf" (Meehan, 1982: 160).[30]

By casting the range of available food items in terms of gender-specific foraging types, diet-breadth considerations narrow to concrete foraging episodes. The prey-choice model assumes that individual foragers make self-interested decisions over a very short time, responding to situation-specific environmental and cultural contexts; the archaeological record is the long-term summation of these decisions. Virtually all of the shell middens on St. Catherines Island contain predominately oyster shells, sometimes with a significant number of clam shells (resources associated with return rates in the range of 1000–4000 kcal/hr). A number of these mostly-oyster shell middens also contain ribbed mussel and periwinkle shells (resources associated with far lower post-encounter return rates than clams and oysters). If the stratigraphic evidence suggests that such shell middens accumulated from a single foraging episode, then the diet-breadth model would project that these foragers were operating with a broader diet breadth and a decreased for-

aging efficiency (with a threshold of 25–1260 kcal/hr or less). One might further hypothesize that female foragers who operate "at the bottom of the chart"—collecting ribbed mussel and periwinkles—should also be expected to collect small seeds (chenopods, knotweed, and little barley if available) and to dig freshwater cattail and bulrush roots when they elected to harvest terrestrial wild plants. More intensive technologies involving maize horticulture fall into the energetic range of 220–370 kcal/hr, suggesting that a diet broad enough to include intensive maize cultivation might also include extremely low-ranked items in the female foraging set, such as ribbed mussels and periwinkles (although these are two distinct foraging types).

Differences in respective fitness goals could have created conflicts of interest between male and female foragers, reified in divisions of subsistence labor. Men and women within the same environment likely entertained different foraging objectives and focused on different resource sets, each with its own associated diet breadth. Thus, while oysters and clams are low-ranking relative to potential prey items in male hunt types, these same shellfish taxa might have been ranked extremely high when viewed in the context of female foraging.[31]

QUESTIONS OF CURRENCY

Applying the models of optimal foraging requires the investigator to select a currency, defining precisely what is being maximized (or minimized). Since one cannot measure "fitness" directly, conventional foraging models maximize the net rate of energy gain while foraging, assuming that more energy is better (Stephens and Krebs, 1986: 7–9). Anthropologists likewise stress the importance of energy efficiency which "provide[s] a useful, proximate measure of adaptive behavior with both empirical and theoretical importance, and broad applicability" (Winterhalder, 1981: 20).

Energy is not the only currency available to optimal foraging theorists; Stephens and Krebs (1986: 7–9) suggest that instead of maximizing energy capture, time spent for-

aging could be minimized. Winterhalder (1987) notes that nutritional qualities have provided useful currencies in several ethnographic and archaeological studies (including Meehan, 1977b; Keene, 1985).

Similarly, Erlandson suggests that the economics of shell exploitation should be evaluated in non-energetic alternatives, "including factors such as the nutritional role played by various resources, the technological investment in resource acquisition, nonfood payoffs, the availability of various foods to different age and gender groups within a society, seasonal limitations on the availability of different resources, and differential storability" (1989: 15; see also Erlandson and Moss, 2001; Moss, 1993). Shellfish provide a high-quality, predictable protein source that contains all essential amino acids and compares favorably with other animal species (table 7.1, figs. 7.8–7.10; see also Perlman, 1980: 280). Claassen (1986a) further hypothesizes that shellfish collectors along the middle Atlantic may have timed oyster harvesting to maximize carbohydrate content (see also Erlandson, 1988: 103).[32]

This suggestion is supported by the now classic research conducted among the Gidjingali (Anbarra) foragers of Australia. Meehan (1977b, 1982) determined that the caloric contribution of shellfish varied between 6 percent and 17 percent annually, depending on the month. Sometimes, Anbarra women sought out beds where shellfish were smaller and less plentiful, specialized in a single species rather than taking all shellfish encountered, and preferred better tasting species. Clearly, shellfish remained a dietary supplement, but Meehan (1977b: 523) believes that "the Anbarra may well have suffered hardship during this month if shellfish had not been readily available." The Anbarra people clearly regarded shellfish as a "prime resource … and proximity to shell beds was a major consideration in the location of base and dinnertime camps."

In the nutrient-rich tidal estuaries, mollusks are concentrated in great abundance, providing compact resource clusters of high-quality animal protein that is easily and predictably procured and available throughout most, if not all, of the year.

Whereas the post-encounter return rates are low with respect to many terrestrial and marine resources, foragers working the oyster beds are virtually assured of meeting subsistence requirements, even in lean times. Labor can be flexibly adjusted; hunters may have to travel far away to hunt, but shellfish are available to women, children, and elders, which insures a stable level of protein intake for offspring (Meehan, 1982: 197). Whereas shellfish are indeed susceptible to storm or red tide events, such problems can sometimes be predicted and ameliorated (Moss, 1993: 640–641) and, of course, agricultural crops and other terrestrial foodstuffs are likewise susceptible to flood, drought, frost, and disease (Quilter and Stocker, 1983).

Having considered differential diet breadth and switching currencies as potential avenues for addressing the shell midden paradox, it remains to entertain a third possibility, namely that the widely applied diet-breadth model may not be applied here.

REVISITING POST-ENCOUNTER RETURN RATES

Clams and oysters have traditionally been viewed as coming up short because they are small and expensive to process. But the extensive shell middens of St. Catherines Island are paradoxical only when the post-encounter return rates shellfish are compared with the gaudy energetic returns projected from larger, highly mobile game animals.

Since post-encounter return rates are informative only in a *relative* sense, we might consider another possibility, and focus on the options available to the shellfishing forager. For example, what if some of the larger, more mobile resources actually have lower potential returns for the female forager faced with immediate day-to-day provisions to sustain herself and her dependents. There is evidence to suggest that the *average* post-encounter return rate might be a misleading parameter for measuring prey choice (e.g., Hill et al., 1987: 17–19; Sih and Christensen, 2001; Bliege Bird and Smith, 2005). Hunters pursuing large and/or highly mobile game commonly experience a high

failure rate, meaning that extremely high variances are often associated with high-risk hunting. Recent ethnoarchaeological research among male and female Martu (Mardu) hunters of Australia's Western Desert supports this point (Bliege Bird and Bird, 2005; D. W. Bird, personal commun.). Bustards (*Ardeotis australis*) and kangaroo (*Macropus rufa* and *M. robustus*) are the largest game taken by the Martu, and when only pursuit and processing costs from successful hunts are considered, the average return rates are extraordinarily high (>40,000 kcal/hr, with an extremely low variance). But hunting bustards and kangaroos is extremely risky business, with failure rates of 61 percent and 68 percent, respectively. Each failed hunt greatly lowers the mean return rates and significantly inflates the associated variance. In fact, when failed hunts are considered, the effective return rates for hunting bustards and kangaroos drop below that of much smaller animals, such as sand goanna (*Veranus goudii*) and skinks, which return approximately 5000 and 15,000 kcal/hr, respectively. Because the smaller taxa are easier to hunt, the pursuit success rate is quite high, and the variance is low.

Differential pursuit success can dramatically impact the realized return rates (and hence the rankings and predictions derived from the prey-choice model). Hunting white-tailed deer, alligators, and loggerheads are failure-prone enterprises. But the failure rate for pursuing a stationary shellfish taxon (especially oysters) approaches zero, recalling Meehan's (1982: 160) observation that collecting shellfish was like taking "the food on a supermarket shelf." In archaeological applications of the diet-breadth model, it is impossible to compute rates of "pursuit failure" with any degree of accuracy, though these differential pursuit rates can make a huge difference in prey ranking.

BACK TO LARGE GAME HUNTING

The potential problem for the prey-choice model runs even deeper. Hildebrandt and McGuire (2002: 232) raise some intriguing questions regarding the relationship between optimal foraging and gender roles. If "efficient provisioning" is always the primary goal of human foraging, then

- Why do Meriam men (of the Torres Straits of Melanesia) engage in high-risk spearfishing on the reef instead of doubling their return rate by collecting shellfish in the same location, as do the women (Bliege Bird, 1999)?
- Why do Aché men (of the Paraguay rainforest) hunt large game when they could realize higher energetic returns by collecting palm starch and small animals, as do the women (Hawkes, 1990, 1991; Hill et al., 1987)?
- Why do Hiwi men (of Venezuela) insist on hunting when they could realize higher returns by digging roots, as do the women (Hurtado and Hill, 1989)?

In other words, what if "the provisioning assumption, so key to … optimal foraging constructs, was not the only motivation driving men to hunt large game?" (Hildebrandt and McGuire, 2002: 232).

What other motivations might exist? Several investigators (Smith and Bliege Bird, 2000; Bliege Bird et al., 2001; Bliege Bird and Smith, 2005) argue for the importance of "social capital" or "signal value" as a means of conveying information about successful hunters. Hawkes (1990, 1991, 1992, 1993) hypothesizes that by returning with a large game kill, the successful hunter is visibly demonstrating his fitness to potential mates, allies, and competitors. Those receiving the "signal" benefit immediately, not only because they receive a meat share, but also because of the information conveyed about underlying qualities of the hunter. In addition, the hunter's prestige is enhanced with each successful hunt, which could result in more mating partners, in his children being well treated, and in marrying a hard-working woman.

Moreover, large game is almost universally associated with widespread sharing beyond the household, though the hunters often have little control over the distribution mechanism. In more than 80 percent (59 of 71) cases, successful Mardu hunters completely relinquish control of the large game carcasses—usually from a young hunter to an elder (Douglas Bird, personal com-

mun.). In the case of kangaroo distributions, the hunter and his family might only receive the head and the tail. Among many hunters, such postacquisition sharing of the largest game animals translates into very low return rates for the hunter who made the kill (Hawkes and Bliege Bird, 2002).

Meriam sea turtle hunting is another illustrative case in point (Bliege Bird and Bird, 1997; Bliege Bird et al., 2001, Bliege Bird and Smith, 2005: 229–230), and this example is directly relevant to foraging behavior on St. Catherines Island. Although hunting *Cheloinia mydas* is a competitive pursuit and a costly enterprise, successful hunters and their families get little of the turtle meat acquired because it is widely distributed to more than 30 households in elaborate public feasts (Bliege Bird and Bird, 1997: 58–60).

When Bliege Bird et al. (2001: 17) measured the cost of Meriam turtle hunting (using direct material currencies including time, energy, and money), they discovered that successful turtle hunters actually operated at a very low (sometimes even negative) return rate. In fact, despite the high average post-encounter return rates, the hunting of singly pursued large animals is a poor provisioning strategy; there is too much time between successful hunts, too little return when game is taken, and a danger of freeloaders ceasing to hunt altogether and instead relying on the efforts of their more successful colleagues. So if efficient provisioning were the only foraging goal, why do Meriam men bother to hunt sea turtles at all?

One possibility is that reciprocal sharing is a way to reduce (or at least buffer) the high variances typically associated with large game hunting. In this way, large game might still retain its high ranking—despite the high incidence of pursuit failure—if the hunter understands that, sometime in the future, he gets back what he has willingly given.

Such meat-on-the-waters reciprocity can only lower the variance significantly when the shares are channeled toward those most likely to share back; and, ideally, the shares will be reciprocated with interest (or maybe provided in a time of special need). Some disagreement exists among human behavioral ecologists with respect to reciprocal sharing. Some investigators (Bliege Bird and Bird, 1997; Hawkes et al., 2001; Bliege Bird et al., 2002) documented a one-way flow of meat from high producers to those who produce little (and share nothing), and suggest that sharing of large-game is not contingent upon returns. But Gurven et al. (2000a, 2000b, 2001) believe that food sharing among Aché and the Hiwi foragers is at times contingent. Nevertheless, Douglas Bird (personal commun.) argues that most of the relevant information about big game suggests a pattern quite at variance with a risk-reduction pattern of reciprocity. Sharing game on a large scale provides ample opportunity for freeloaders to benefit from the efforts of successful hunters, a real problem when hunters give away so much that they actually operate at a negative return rate (as among the Meriam turtle hunters). So viewed, large game hunting would seem to be a rather poor method of provision for one's family and offspring. Given the typically long intervals between successful hunts and the low rates of energy return to successful hunters, one might simply decide to simply quit hunting and freeload off the efforts of others.

Could it be that such social considerations might actually outweigh net energetic returns? Bliege Bird and Smith (2005: 230) argue that because successful hunting is impossible to fake, the public display of hunting success coveys critical and reliable information in a valid way to potential allies, competitors, and mates. Those receiving the signal benefit immediately from the information (and in the case of hunting, from the meat being shared). The community learns something about the underlying qualities of the hunter, and the hunter benefits in terms of prestige or renown. As community elders, the feast hosts enhance their own status by ensuring that guests have plenty of turtle meat. In addition, assuming that successful hunting is a reliable signal of the hunter's ability, the turtle hunters benefit because their harvesting success is publicly signaled to their community. Be-

cause hunters of lesser ability can be expected to fail more frequently on turtle hunts, in the long run, they will contribute less meat per capita to the communal feast. Failure to deliver a turtle for feasting is evident to all participants; because high-quality hunters have a lower probability of failure, their likelihood of social benefit is enhanced.

Bliege Bird et al. (2001: 18) amplified this hypothesis by suggesting that fitness benefits may also come to hunters *even in the absence of distributing material goods to observers.* Simply displaying the catch is perhaps sufficient to signal hunting success to all interested parties. Whereas Meriam turtle hunters supply meat that is widely shared at communal feasts, spearfishers typically target prey that is too small for widespread sharing, but that can still be publicly displayed (Hawkes and Bliege Bird, 2002). ''Men may hunt to show off, not to share per se. Men may seek large game not because they can trade the meat for prestige and other benefits, but because it requires a particular skill that is a reliable indicator of other characteristics. By hunting, they can broadcast that skill to the large audience that is attracted to the kill. The fact that big game is shared is incidental'' (Bliege Bird, 1999: 71–72).

This suggests that signaling behavior may contravene the conventional notion that sexual division of labor tends to maximize the productivity of a cooperative male–female pair. Bliege Bird et al. (2001) propose that the positive signaling benefits attached to certain foraging strategies can overshadow the attempt for energetic return rates. For example, when Meriam men forage on the reef they commonly bypass shellfish collecting (which has little signaling value) in favor of spearfishing. This returns less net energy capture, but provides the spearfisherman with high signaling value (the speared fish). It is for this same reason that men elect to hunt turtles for feasting, despite the little provision afforded to their own households.

These results suggest that gender differences in foraging behavior arise (1) not because men prefer meat and women prefer plants and shellfish, (2) not because women prefer small resource packages and men prefer larger prey, and (3) not because shellfish are easier to harvest with children present. Instead, Bliege Bird et al. (2002: 17) propose that gender-based foraging preferences reflect differential benefits from signaling behaviors, noting that ''where there is a choice in foraging method, men seem to prefer to acquire meat through more risky methods that more easily differentiate the skill of individual foragers, while women seem to prefer less risky methods carrying little potential for discriminating forager quality.'' This suggests that many of the differences noted between male and female foragers could result from disparities in signals rather than from social competition (Bliege Bird et al., 2001; Smith et al., 2003); ''Women may compete to gain notoriety as consistent provisioners, men to demonstrate intrinsic, hidden qualities relating to gaining social benefits. Women may not compete as men do because the costs of doing so are high relative to their provisioning goals; men do not compete as women do because provisioning competes with their goal of demonstrating hidden qualities'' (Bliege Bird and Bird, 2005: 478).

CONCLUDING THOUGHTS

The goal of this concluding discussion is simply to acknowledge and explore the diversity of human foraging strategies currently being debated in human behavioral ecology. In subsequent chapters, some of these specific issues will be further addressed; for now it is seems sufficient to recognize the debate (Elston and Zeanah, 2002; Hildebrandt and McGuire, 2002; Broughton and Bayham, 2003; Byers and Broughton, 2004; Zeanah, 2004). Beginning with the work of Beaton (1973), human behavioral ecology within archaeology focused largely on the application of the basic prey choice model. Today, however, the range of explanatory potential is huge, from evolution of hominine social behavior during the Plio-Pleistocene (O'Connell et al., 2002) to the collapse of monumental Ma-

yan architecture (Neiman, 1997). Numerous investigators (e.g., Bliege Bird et al., 2001, 2002; Hawkes and Bliege Bird, 2002; Smith et al., 2003; Bliege Bird and Smith, 2005) have argued that "symbolic" behavior can confer significant fitness-related advantages, meaning that certain foraging activities should be understood in terms of their social and competitive value, rather than merely their nutritional contribution. Douglas Bird (personal commun.) suggests that "in our Meriam work (and now with the Martu) we were quite wrong to assume, as does the [prey-choice model], that the goal of all foraging is to maximize the efficiency of foraging for food." As archaeologists grapple with the implications of these various theoretical constructs, it must be recognized that all aboriginal foraging pursuits exist within "both a gastronomic and social context, each with potential evolutionary consequences" (Hildebrandt and McGuire, 2002: 232). Although both approaches can be subsumed under the rubric of human behavior ecology, models that assume efficient energy maximization differ significantly from those that assume social costs (such as costly signaling). Ideally, archaeologists will frame competitive and testable hypotheses against which to array the archaeological results.

NOTES

1. As we will discuss later in this chapter, this generalization must be tempered by the likelihood that diamondback terrapins were also collected by shellfishers and fishing parties working the salt marsh. We also suspect that children and the aged collected brackish and freshwater turtles on occasion; if so, then apparent diet breadth of the terrestrial hunt type would appear to be broader than it actually was.

2. The effects of recovery techniques on relative abundance indices have been well studied (e.g., Cannon, 1999; Reitz, chap. 22, this volume). As Grayson and Cannon (1999: 148–149) point out, while a decreasing index of large mammals might reflect resource depression, an increased use of smaller prey would also decrease the abundance index (without any change in the density of large animals). As a result, the abundance index, taken in isolation, is not an accurate estimate of resource depression. This is why independently derived evidence—such as changing age structure of the larger prey taxa—should be brought to bear on issues of resource depression and diet breadth (e.g., Broughton, 1997; Grayson and Cannon, 1999). Several other fac-

tors (independent of human predication) can likewise reduce prey abundance, including environmental change (e.g., Byers and Broughton, 2004; Wolverton, 2005) and technological innovation (as in mass capture techniques increasing efficiency of smaller-size prey). Abundance indices can also be influenced by human population increase, meaning only a per capita decline in density of large prey, but not an absolute decline (Broughton, 1994b). Furthermore, unlike fish, the relative abundance of mammal bones can readily reflect hunting distance from the site locality, meaning that the relative abundances of high- and low-ranking prey might not be a straightforward index of efficient in mammal foraging (Broughton, 1994a and 1994b).

3. As noted above with respect to fish remains, we find that MNI has certain problems when applied to our Island-wide sample. Because the St. Simons period zooarchaeological sample derives strictly from the St. Catherines Shell Ring site, the MNI = 6 was computed on a single site (with all test pits, levels, and zones combined analytically). Had this same sample of 182 deer bones been recovered from any subsequent time period, where multiple sites are involved, then the MNI for deer would be inflated (perhaps considerably). But, given the available sample, the MNI method appears to significantly understate the importance of deer in the St. Simons period sample. This is why, whenever possible, we will scale the various abundance indices across NISP, MNI, and Biomass.

4. Note that table 31.1 also provides a similar index computed on MNI rather than NISP. Reitz (chap. 22) has already discussed the difficulties in computing MNI for this Island-wide sample due to the numerous, but generally small samples involved. Increasing the number of analytical units generally increases the number of individuals estimated. In estimating MNI for the St. Catherines materials, remains from each test site were considered discrete analytical units, but test pits, levels, and zones within each site were combined analytically. This means that MNI computed for larger collections (such as those from Meeting House Field and Fallen Tree) will be consistently underrepresented relative to the smaller, more numerous survey site samples. For these reasons, we will rely on NISP for comparisons in this chapter.

5. The Spearman correlation coefficient between NISP–MNI and MNI–Biomass is $r_S = 0.943$ ($p < 0.01$). The correlation between NISP and Biomass is likewise significant ($r_S = 0.886$, $p < 0.05$).

6. These results largely reflect the zooarchaeological assemblage from Fallen Tree, where the mission period Guale Indians lived immediately to the south of Mission Santa Catalina de Guale.

7. The likely involvement in the deerskin trade raises certain problem with applying the diet-breadth model to mission period archaeology on St. Catherines Island. E. A. Smith encountered somewhat similar problems when analyzing Injjuamiut foraging patterns because they harvested foxes primarily for the pelt, with food consumption only incidental; "For this reason, I am loath to try and analyze trapping effort in the context of an energy-return currency" (Smith, 1991: 221) and he excluded fox hunting from his diet-breadth anal-

ysis. Although we recognize this problem, we doubt that much venison went to waste.

8. Specifically, Reitz (1982b: 68) has excluded the Ossabaw Island samples because MNI were not computed on the basis of right/left element comparisons.

9. Hemmings and Deagan (1973: 6) report that 1/4-in. mesh screens were employed throughout their Amelia Island excavations.

10. The value of r_S for White-tailed Index$_{NISP-MNI}$ = 0.908, n = 15, p < 0.01; r_S for White-tailed Index$_{NISP-Biomass}$ = 0.835, n = 12, p < 0.01; r_S for White-tailed Index$_{MNI-Biomass}$ = 0.900, n = 12, p < 0.01.

11. Figure 31.4 also points up the paucity of biomass estimates for archaeological sites south of Sapelo Island.

12. "All bones had been cracked and pounded to small bits. This suggested the custom of bone-boiling to make sort of a broth, a custom which persisted into historic times among some Plains groups. It represents an effort to extract the last edible molecule form the carcass" (Waring, 1968a: 191).

13. Apparently, the Pine Harbor zooarchaeological assemblages were recovered without the benefit of screens, perhaps accounting for the absence of reported fish bones (Larson, 1980a: 226).

14. The modern distribution of terrestrial vertebrates is somewhat uneven across the Sea Islands. Opossum, for instance, were reported on Cumberland Island by White (1849), but apparently went extinct during the Civil War; today, opossums occur only on Sapelo and Little St. Simons Islands (see Neuhauser and Baker, 1974).

15. Georgia's barrier islands once hosted several species of carnivores (including gray fox, bobcat, black bear), but only raccoon, mink, and otter survive today (Neuhauser and Baker, 1974).

16. We also note that Reitz (chap. 22) hypothesizes, strictly on the basis of vertebrate faunal remains recovered in the Island-wide survey, that year-round occupation of St. Catherines Island began during the St. Simons period.

17. From a landscape perspective, we can document a Late Archaic presence at 23 localities in the probabilistic survey of St. Catherines Island (fig. 30.1; see also tables 20.1 and 20.2).

18. As noted in chapters 29 and 32, this impression may be misleading. Except for the St. Catherines Shell Ring, all the known St. Simons components lie along the eastern Pleistocene core (table 30.1), indicating that the Late Archaic settlement pattern was clearly focused on the Guale Island/Guale Marsh area. But because of the extensive erosion along the northeastern island margin, we have doubtless lost a disproportionate number of Late Archaic sites on St. Catherines Island.

19. Crusoe and DePratter (1976) report on excavations at the A. Busch Krick site (9Mc187), a 60-foot-long midden with ample fiber-tempered ceramics, located on Creighton Island (inside St. Simons Island), about 7 miles east of Darien.

20. Resolving such issues requires a commitment to a strategy of regional archaeology capable of generating systematic, diachronic samples that monitor the entire range of aboriginal subsistence activities and provide workable estimates of changing population densities for both human predators and high-ranking prey taxa.

21. We must also reiterate the possibility of a reconnection with the mainland when sea level apparently lowered during the middle St. Simons period, continuing during the Refuge and early Deptford periods. If St. Catherines Island did indeed hook up with the mainland during this period of depressed sea level, then the effects on local white-tailed deer population could be dramatic.

22. These numbers would be somewhat higher if we included the counts entered as "pond turtle family," which doubtless include a number of diamondback terrapin remains.

23. With respect to reef flat collecting by the Meriam, Bird et al. (2004b: 188–194, table 2; see also Bird and Bliege Bird, 2000, 2002) distinguish between overall return rates for adults and children. The adult rate is commonly twice to three times that for children harvesting the same resources. Whereas the prey-choice model predicts that certain low-ranking prey types should be passed over by adult foragers, children face different constraints and they typically select prey differentially and transport in bulk. Meriam children search the reef much slower than do adults, their encounter rates are lower, and they almost always harvest lower ranked resources that adults will generally bypass because choosing such "less profitable" taxa would reduce the mean reef flat collecting energetic return rates. But for children, who forager slower (and hence have lower encounter rates with higher ranking taxa), selecting a broader range of taxa will increase their foraging efficiency. Children's prey selection is hence broader because they encounter higher ranked resources at a rate lower than adults (Bird et al., 2004b: 194).

24. Clearly, our use of 1/4-in. screens in the Island-wide testing has missed many of the smallest fish taxa (and the virtual absence of small fish bones likely reflects the coarse-grained recovery methods employed); higher NISP values clearly reflect the finer grained recovery techniques that were employed at Fallen Tree and Meeting House Field. We would expect that recovery by fine-grained screening and flotation would markedly increase the recovery of fish remains on St. Catherines Island (Reitz and Quitmyer, 1988).

25. We must explicitly recognize the degree to which archaeological recovery technique has an important and potentially biasing impact on the White-tailed Deer Index. These larger screen meshes are biased in favor of larger bone fragments (such as those of white-tailed deer) and against recovery of the smaller fishes commonly found in zooarchaeological assemblages from the Georgia Bight. Recovery by flotation further enhances the recovery rate of the smallest taxa (Reitz and Quitmyer, 1988; Quitmyer and Reitz, 2006). Reitz (chap. 22) believes that screening with 1/4-in. mesh increases the apparent relative frequency of deer bones by a factor of about 10 percent over 1/8-in. screens; the larger screen mesh decreases the relative recovery of fish bones, perhaps by a factor of 25 percent. Specifically with respect to the recovery issues involved in the St. Catherines Island samples reported here, concluding that "it is unlikely that a 1/4-inch screen alone is responsible for the prominence of deer in the survey samples (tables 22.70 and 22.71)." Wherever possible,

table 31.4 summarizes the recovery methods employed by the excavators.

26.   As we have seen in chapter 9, shellfish are superior to most forms of maize horticulture as practiced in the habitats of St. Catherines Island.

27.   As Schoeninger et al. (1990: 88–89) point out, some of the Deptford period individuals—and everyone included in the St. Catherines period sample—were ingesting food items rich in ^{13}C, though with a nitrogen value similar to the rest of the group. Consumption of maize (or some other C_4 plant) could certainly account for this result. But if the observed δ^{13}C and δ^{15}N values during the St. Catherines period are due to increased maize consumption, then the same should be true for at least four of the Deptford–Wilmington period individuals (samples with the same isotope distributions). It is very difficult to believe that people during the Deptford–Wilmington period (cal 350 B.C.–A.D. 800) ingested significant quantities of maize. The skeletal and dental data (Larsen and Thomas, 1982: 327–329) for the St. Catherines period individuals are likewise consistent with a diet dependent on nondomesticated sources.

28.   The sample of stable isotope samples from the Irene period on St. Catherines Island is quite small, and additional samples are being processed as this is being written.

29.   In addressing the shell midden paradox, we acknowledge that post-encounter return rate estimates in table 8.27 are imperfect. But we believe that our return rate estimates are internally consistent, reasonably accurate, and, as documented above, correspond with better grounded estimates from other sources.

30.   Erlandson (1988) emphasizes the high protein value of shellfish, as a predictable and readily available meat source, and as a source that could be gathered by women, children, and the aged (Meehan, 1977b; Erlandson, 1989: 175; Moss, 1993: 632).

31.   Lupo and Schmitt (2005: 336) note that whereas the prey-choice model generally predicts overall patterns of resource selection for pooled samples of adult foragers (e.g., Hawkes and O'Connell, 1982; Hill and Hawkes, 1983; Hill et al., 1987), daily and seasonal variability likewise reflect fine-grained individual variability with regard to some resources (Hill et al., 1984; Smith, 1991; Sosis, 2002). Forager efficiency is also impacted by macronutritional concerns (Hill, 1988).

32.   The average protein and carbohydrate content varies markedly in southern oysters (Galtsoff, 1964: 382; see also Blair and Thomas, chap. 7, this volume). Although our data remain incomplete, on-going experiments with St. Catherines Island oyster populations seem to conflict somewhat with the results from Lee and Pepper (1956) and Lee et al. (1960). While we have not presented these results in this monograph, we believe that future research on the changing seasonal nutrients of oyster populations will soon provide additional insights into the dynamics of shellfish procurement.

CHAPTER 32. SYNTHESIS: THE ABORIGINAL LANDSCAPE OF ST. CATHERINES ISLAND

David Hurst Thomas

This chapter integrates the various evidentiary threads presented earlier in this monograph. Working period by period through the cultural sequence of St. Catherines Island, this chapter addresses the chronology, the aboriginal landscape (specifically relating the changing geomorphology to the distribution of known sites), subsistence, evidence for site seasonality, bioarchaeological data, and ritual activity.

THE ST. SIMONS PERIOD
(CAL 3000 B.C.–1000 B.C.)

The Island-wide survey identified 10 archaeological components dating to the St. Simons period, all but 1 of them along the eastern Pleistocene core (see table 30.2). From a landscape perspective, the probabilistic survey of St. Catherines Island documented a Late Archaic presence (fig. 30.2; see also tables 20.1 and 20.2).[1]

THE CERAMIC CHRONOLOGY

Chapter 14 already described the St. Simons and St. Simons Punctated ceramics that characterize the Late Archaic occupation of St. Catherines Island. The type descriptions are based on Waring (1968b), as modified by DePratter (1979a: 114, 1991). Fiber-tempered pottery is the oldest ceramic complex known in North America (see Sassaman, 2006; Sassaman et al., 2006 for a review of the evidence).

The various excavations on St. Catherines Island generated 10 ^{14}C determinations in direct association with St. Simons ceramics (table 15.1; figs. 15.1 and 15.8). Six of these dates came from the St. Catherines Shell Ring (9Li231), recorded as part of the Island-wide systematic survey (chap. 20).

The pooled ^{14}C evidence from St. Catherines Island indicates that the St. Simons period began about cal 3000 B.C. (or shortly thereafter) and ended about cal 1000 B.C. These parameters differ only slightly from DePratter's (1979a, 1991) estimate that St. Simons ceramics on the northern Georgia coast date from about 2200 B.C. to 1100 B.C. When calibrated, these dates convert to cal 2850 B.C./2725 B.C. through cal 1360 B.C./1310 B.C., estimates that are quite close to the St. Catherines Island chronology derived here.

We conclude that the St. Simons period (cal 3000 B.C.–1000 B.C.) begins about 200 years earlier than DePratter's (1979a, 1991) estimate for the Northern Georgia coast and lasts 360 years later. In the St. Catherines Island chronology, the St. Simons period expands from 14 to 20 centuries in duration.

GEOCHRONOLOGY

The available geomorphological evidence suggests that modern St. Catherines Island formed shortly after cal 3000–2650 B.C., when sea level rose sufficiently to isolate the Pleistocene core from the mainland (chap. 29). By cal 2500 B.C., Guale Island protected the northeastern portion of St. Catherines Island, effectively buffering that shoreline and protecting a large interisland marshland extending along the Yellow Bank Scarp. The tidal creeks that meandered through Guale Marsh provided immediate access to this rich shellfishery and produced a mosaic of meander bends and levees along the creek beds (Rollins et al., 1990; Linsley, 1993: 72; see also chap. 3, this volume). During the St. Simons period, Guale Marsh extended southward to Middle Beach, as indicated by exposures of relic marsh muds between Seaside and McQueens Inlets (West et al., 1990).

Vibracore samples recovered from Cracker Tom Hammock disclosed an oyster bed dating cal 1870–1540 B.C. (UGA-6442); these marine conditions were soon followed
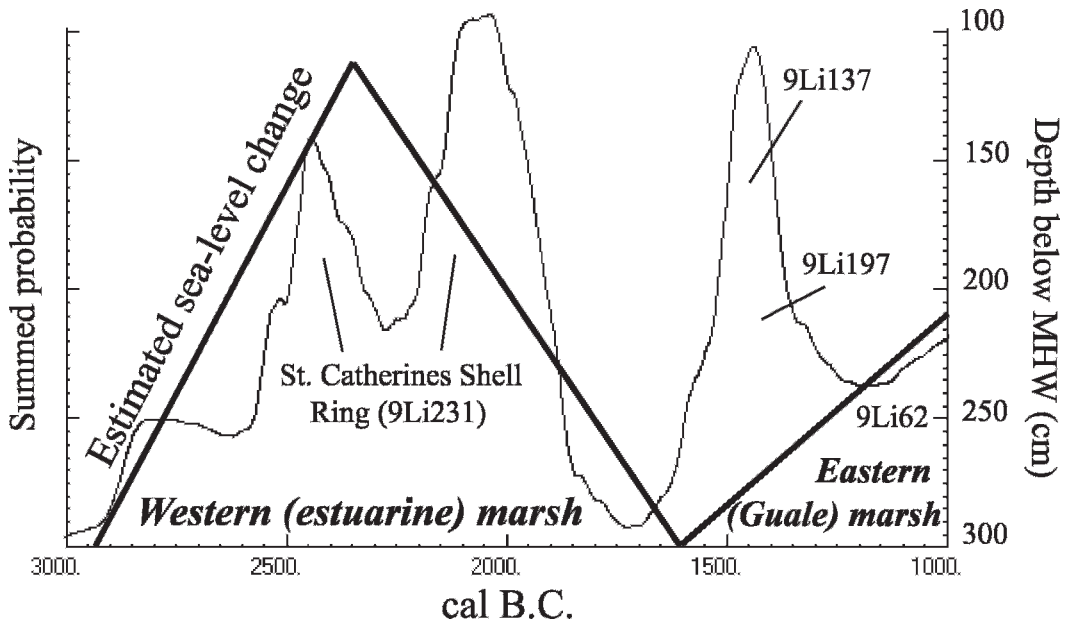
Fig. 32.1. The cumulative probability profile for marine radiocarbon samples ($n = 10$) available from the St. Simons period on St. Catherines Island, compared with estimate sea level changes for the same time period.

by the establishment of modern marsh and hammock communities and an increasing terrestrial environment (Booth, 1998: 90; Booth et al., 1999a, 1999b). The palynological record documents the progressive southward expansion of accretionary terrains "with a strong freshwater influence that even exceeds that of the present day" (Booth et al., 1999a: 85). We estimate the maximum extent of progradation reached the western margin of Cracker Tom Hammock by cal 2500 B.C., near the end of the St. Simons period (figs. 29.2 and 29.8).

Sea level peaked out, then dropped throughout the first half of the St. Simons period (DePratter, 1975, 1977b; DePratter and Howard, 1977, 1980, 1981; Brooks et al., 1986; Gayes et al., 1992; see also chap. 4 and fig. 32.1). From a localized highstand at about cal 2300 B.C. (roughly 130 cm below MHW), sea level dropped about 2 m (at a rate of 50 cm/century). Such a lowering of sea level likely modified the sedimentary dynamics of the Georgia Sea Islands, affecting the back island marshes most dramatically (including the western margin of St. Catherines Island) by draining expanses of

low marsh and causing some degree of downward erosion (incisement) of larger tidal creek channels. Some degree of progradation of Guale Island and seaward expanse of Guale Marsh might have occurred.

THE RADIOCARBON CHRONOLOGY

A quarter-century of archaeological investigations on St. Catherines Island generated a database of 116 "cultural" radiocarbon dates (dubbed the "2005 Database" in chap. 16). The cumulative probabilities of these ^{14}C samples demonstrated a decidedly nonrandom distribution of the radiocarbon record across the 5000 years of aboriginal occupation. Whereas some time periods had distinctive peaks of multiple radiocarbon dates, other "gaps" denoted time spans for which ^{14}C dates were rare (or even absent, fig. 16.11). Because several of these gaps seemed to correspond with transitions between major cultural periods, we questioned the degree to which this cumulative radiocarbon record could provide a proxy of long-term aboriginal dynamics (chap.

16). Specifically, "Gap A" denoted the obvious lack of St. Simons period radiocarbon dates (significantly below the one-sigma level of the overall probabilistic distribution), with dates especially underrepresented at cal 2500 B.C. and cal 1500 B.C. Radiocarbon dates were also quite rare from the succeeding Refuge period (immediately post-cal 1000 B.C.).

Despite the relatively large sample size, we were concerned about the sampling biases involved in the 2005 radiocarbon database. After deconstructing our motivations for processing ^{14}C dates (in chap. 16), we isolated two major research strategies that had previously guided our selection of radiocarbon samples: (1) defining chronostratigraphy during mortuary and midden excavations and (2) providing absolute chronological controls of the northern Georgia ceramic chronology. These two research strategies heavily conditioned our selection of samples for dating, meaning that all potential radiocarbon samples did not share an equal probability of selection (a hallmark of unbiased, randomized sampling). Beyond the clear-cut sampling biases, we were also concerned about the stochastic distortions involved in the marine and terrestrial calibration curves because the very process of "calibrating" radiocarbon dates introduces its own peak-and-valley configuration (even within a continuous, uniformly sampled series of dates).

This is why we processed nearly five dozen additional radiocarbon determinations in 2006, samples individually targeted to "fill the gaps" evident in the radiocarbon record of St. Catherines Island (chap. 16). Specifically, because of concerns over the scarcity of ^{14}C determinations dating to the St. Simons interval (cal 3000–1000 B.C.), this redating exercise processed an additional 15 samples (from six archaeological sites), each sample in apparent association with St. Simons period ceramics (table 16.1). The results produced some assurances and some surprises:

St. Catherines Shell Ring (9Li231): Each of the four samples submitted in the 2006 reanalysis generated ^{14}C ages within the expected early and middle St. Simons period (ranging between about cal 2500 B.C. and cal 1800 B.C.). These new dates are fully consistent with the two radiocarbon dates processed previously in conjunction with the systematic transect survey (chap. 20).

9Li137: The ceramic assemblage suggested a St. Simons–Refuge association, and all three dates processed in 2006 fell into the mid- to late St. Simons period (roughly cal 2200 B.C.–1500 B.C.).

9Li252: The two additional radiocarbon samples processed in 2006 were clearly associated with St. Simons ceramics. But both ^{14}C ages estimates fell into the St. Catherines period, a surprising result because clay tempered was entirely absent in the ceramic assemblage recovered at 9Li252. The conclusion: At 9Li252, Late Archaic sherds were recovered in the context of marine shells harvested 2000 years later.

9Li197: Based on the associated ceramics, we predicted a St. Simons age for Beta-218098, but the results dated to the Wilmington period. A second radiocarbon sample (Beta-218097), clearly associated with St. Simons and Irene period ceramics, dated to the Deptford/Wilmington transition. In both cases, the ^{14}C dates on *Mercenaria* significantly postdated the apparently associated ceramics.

Overall, the 2006 redating exercise generated 15 additional ^{14}C samples, each apparently associated with fiber-tempered ceramics. Only 40 percent of these determinations fell into the expected age range. Significantly, more than half of the marine shell samples produced significantly later ages than the St. Simons period. Further, as documented in chapter 16, this is a unidirectional bias because *none* of the additional 34 samples associated with later ceramic types produced St. Simons-age dates. Clearly, there is a tendency for St. Simons sherds to be commingled with marine shell from later time periods.

To summarize, the cumulative radiocarbon record for the St. Simons period shows several distinct trends:

- Significant quantities of shell midden accumulated on St. Catherines Island during the millennium following cal 2500 B.C.
- Very few marine shell radiocarbon dates (only 8 of 123) from St. Catherines fall between cal 1350 B.C.–120 B.C. Of these, only two marine dates (Beta-20822 and Beta-21406) derive from primary midden contexts; the remaining six marine shell dates come from mortuary features, which are apparently secondary deposits and perhaps reflect long-distance transport.
- With respect to both the late St. Simons and early Refuge periods, roughly two-thirds of the ^{14}C in the 2006 Dataset produce age estimates significantly later than the apparently associated Late Archaic ceramic assemblages.
- Conversely, none of the radiocarbon dates associated with later ceramic periods produced ^{14}C dates from the late St. Simons/early Refuge-Deptford periods.

Thus, despite concerted efforts to fill the Late Archaic gap in ^{14}C dates, we could only consistently generate radiocarbon determinations that spanned the first two-thirds of the St. Simons interval (circa cal 2500 B.C.–1350 B.C.), and part of this distribution is quite spotty and uneven (esp. cal 1900 B.C.–1530 B.C.). During the 1000-year-long interval beginning about cal 1350 B.C., marine radiocarbon dates are conspicuously lacking in the pooled sample (fig. 6.13).

Moreover, many of the marine shell samples apparently associated with St. Simons and early Refuge-Deptford period ceramics actually produce much later ^{14}C age estimates. This systematic error seems to reflect the general lack of shell deposits dating to the time span 1350 B.C.–cal 200 B.C. (despite the presence of fiber-tempered and Refuge-Deptford period ceramics).

This hiatus in shell midden deposition (an amalgam of Gaps A and B) is perhaps the major archaeological anomaly identified during our 3 decades of archaeological fieldwork on St. Catherines Island, and it is important to explore the reasons for this patterning. Figure 32.1 plots the pooled probability distribution for all of the marine ^{14}C dates available for the St. Simons period on St. Catherines Island against the contemporary sea level changes (per projections in chap. 4). The distinctive dating cluster during the early St. Simons period (circa cal 3000 B.C.–2000 B.C.) defines a period of rising sea level, peaking at about cal 2300 B.C., then dropping at a rate of 50 cm/century. This early St. Simons dating cluster consists almost entirely of ^{14}C dates from the western marshside, six from the St. Catherine Shell Ring (9Li231) and the other from 9Li137 (cal 2400 B.C.–1020 B.C.).

Between cal 2000 B.C. and cal 1500 B.C., sea-level change reverses and so does the frequency distribution of radiocarbon dates on marine shell. We think that the estuarine marsh significantly retreats (and perhaps disappears entirely) during this period and this is why Late Archaic sites dating to this interval are absent along the western margin of St. Catherines. Significantly, each of the remaining six ^{14}C dates (fig. 32.1) from the Late Archaic period dating post-cal 1500 B.C. derived from archaeological sites along the eastern margin of St. Catherines Island. This important paleoenvironmental shift has clear-cut consequences for the human settlement of the St. Simons period.[2]

THE ST. SIMONS LANDSCAPE

We employed central place foraging theory to estimate settlement positioning on St. Catherines Island. All else being equal, one expects that St. Catherines Island foragers should have situated their residential bases to maximize the net central place foraging returns with respect to the pursuit, handling, and transport costs from different patches.

Combined with prey-choice and patch-choice models, central place foraging theory suggests that—regardless of changes in diet breadth—the estuarine and inland salt marshes should be the highest ranking patch type available on St. Catherines Island, followed closely by the maritime forest (both patches far outstripping the sandy beach and the ocean front patch types). As argued in chapter 11, aboriginal residential bases should be positioned to maximize the average central place foraging returns (relative to the costs associated with pursuit, handling, and transport costs). Despite potentially conflicting goals between male and

female foragers, we hypothesized that foraging populations should select central place locations that maximize the highest combined rate that both men and women can return to everyone living there (Zeanah, 2004: 20–21; Kennett, 2005).

Central place foraging theory projects that *marshside settlements* should be sited in optimal places along the intersection of the two highest ranking patch types—specifically positioned along the stabilized dune remnants that fringe the maritime forest, immediately adjacent to the salt marshes and the tidal streams that drain them. So situated, marshside settlements offer ready access to the highest ranking marine and terrestrial patch types, each of which support multiple suites of high-ranking plant and animal food resources (figs. 11.14 and 11.15).

In addition to the estuary along its western margin, which characterizes all the barrier islands of the Georgia shoreline, St. Catherines Island is a composite that hosts a second major salt marsh system along the seaward shoreline. McQueen salt marsh, which today covers approximately 13.5 km^2, is protected from high-velocity tidal surges by a series of prograding sand spits, shoals, hammocks, washover fans and aeolian dunes. One cannot overestimate the importance of the McQueen salt marsh (and its prehistoric precursor, Guale Marsh, further north) to the aboriginal forager. More than 80 percent of the maritime forest edge on St. Catherines Island fronts directly on the margin of a significant salt marsh—effectively doubling the number of optimally positioned central places (fig. 11.14).

These optimally positioned marshside settlements define parallel bands of probability that run along the edge between the highest ranking patch types, projecting most probable locations for each optimally positioned central place. All else being equal, marshside settlements should produce the highest central place foraging rates because they maximize access to the two highest ranking patch types. Further, the variances associated with marshside settlements should be asymmetrical—steeper toward the scarp defining the salt marsh/maritime patch margin, then trailing off within the terrestrial habitats. The scarp between the salt marsh and the maritime high ground is defined by the upper reach of the spring tides, effectively creating an abrupt, one-way barrier that prohibits potential settlements situated closer to the marsh; central places located in more inland patches of maritime forest are not conditioned by such intertidal barriers.

The diet-breadth model provided an alternative hypothesis for aboriginal settlement patterning on St. Catherines Island. If the resource base was assumed to be continuous, undifferentiated, and evenly distributed across space, such environmental homogeneity should foster an archaeological record that is randomly distributed across space, without any significant degree of nonrandom modality or centrality.

The principles and practices of contemporary probability theory provide the tools necessary to evaluate the results of the Island-wide archaeological survey on St. Catherines Island (chap. 20). The following procedures were followed for each temporal period:

- define a concise statement of the hypotheses being tested
- evaluate the sampling strategy and operational protocols that generated the empirical observed archaeological data
- develop appropriate probability density functions to express the theoretical expectations
- and analyze the probabilistic mechanisms for assessing goodness of fit between theoretical expectations and empirical observations.

The next few sections evaluate the archaeological results and broader implications of the St. Simons occupation of St. Catherines Island.

WESTERN MARSHSIDE SETTLEMENTS: The St. Catherines Shell Ring (9Li231) is the oldest known human presence on St. Catherines Island, and the most important single site from the St. Simons period. 9Li231 was initially recorded during the probabilistic survey as a medium-sized, crescent-shaped shell midden. Subsequent test pits produced only undecorated fiber-tempered ceramics and two ^{14}C dates falling into the early St. Simons period. The

American Museum returned to the St. Catherines Shell Ring in 2006 to initiate long-term archaeological investigations; this follow-up mapping and excavation disclosed that 9Li231 is a complete (and perfectly circular) shell ring (fig. 20.5), the only such site known on St. Catherines Island.

The St. Catherines Shell Ring is similar to many other Late Archaic sites known along the Georgia Bight (esp. Marrinan, 1975; Waring and Larsen, 1968; DePratter, 1975; Russo, 1996; Sassaman and Ledbetter, 1996; Thompson et al., 2004; Thompson, 2006). DePratter and Howard (1980: fig. 15) suggest that whereas shell rings may have existed on both side of the barrier islands in coastal Georgia, the surviving shell rings tend to occur exclusively on the estuarine side of Pleistocene barrier islands. Those built on the seaward side have likely eroded away altogether (suggesting, perhaps that additional shell rings may once have existed on Guale Island).

The stratigraphy of the St. Catherines Shell Ring is complex and not fully understood at present. The oldest available radiocarbon date (Beta-21409) is cal 2920–2470 B.C.) and the basal stratum is well above the modern marsh surface.[3] A slightly later cluster of two dates has a pooled mean age of cal 2590–2240 B.C. The latest ^{14}C dates cluster at cal 2180–1890 B.C. (see fig. 32.2). Since 2006, we have been conducting additional vibracore sampling of the shell ring and surrounding marsh deposits to situate the archaeological site within its broader geomorphological context.

When the St. Catherines Shell ring was initially occupied, circa cal 2900–2500 B.C., sea level was apparently rising at a rate of roughly 50 cm/century (Gayes et al., 1992: 159, fig. 6; see also chap. 4 and fig. 32.2). The carbonate-rich Pleistocene core of St. Catherines Island had long fronted the open Atlantic Ocean, anchoring high foredunes that prevented overwashing and landward migration (Hayes, 1994). But the rising seas must have influenced the availability of certain aquatic resources near the estuary mouths because the corresponding estuarine expansion would have dispersed key resources, such as small intertidal oyster beds in the expanding tidal creek network. As the sea continued to rise, saltwater flooded previously freshwater lagoons as the intertidal zone shifted inland, creating new estuarine tidal flats, marshes, and back-barrier bays, reflecting the tidal range and the tide/wage energy balance of the Georgia Embayment (Crusoe and DePratter, 1976; Bahr and Lanier, 1981; Davis and Hayes, 1984; Davis, 1997: 158). The juxtaposition of the high-ranking resources of the Pleistocene core (especially the mast crop and newly isolated white-tailed deer herds) and the equally high-ranking saltwater marsh provided human foragers with an extraordinarily diverse and closely spaced set of marine and terrestrial patches.

Then as now, the St. Catherines Shell Ring was perched along the westernmost (estuarine) margin of the Walburg Scarp (fig. 32.2). The midden is comprised primarily of a dense, roundish kind of oysters (unusual in archaeological or modern oyster shells on St. Catherines Island), the occasional *Mercenaria*, and periwinkles in surprising abundance. Bone preservation is excellent, and vertebrate remains (especially fish bones) are common. The positioning of the St. Catherines Shell Ring, only 30 m from the modern marsh edge, is entirely consistent with central place foraging projections.

The Late Holocene transgression likely peaked roughly cal 2300 B.C., when sea level stood approximately 1.25 m below contemporary Mean High Water (fig. 32.1). Then the sea level began to drop rather rapidly, and the radiocarbon evidence shows that the St. Catherines Shell Ring was still being utilized during this time of transition. During a span of only 7 centuries, the sea level apparently dropped about 2 m. This was a dramatic turn of events for Late Archaic foragers of St. Catherines Island because the saltwater marshland along the estuarine (western) side of the Island must have been dramatically reduced, if not eliminated altogether. If marsh remnants did survive in the estuary, associated human settlements might be expected to pursue the lower

9Li173

Guale Island (shape conjectural)

estimated shape at cal 2500 B.C.

9Li215

9Li137

St. Catherines Shell Ring (9Li231)

Guale Marsh

9Li215

9Li247, 9Li248, & 9Li249

Cracker Tom Hammock

9Li161

LEGEND
- archaeological site
- ✕ 0-9 sherds
- ● 10-99 sherds
- ☐ 100-999 sherds
- ■ > 1000 sherds

St. Simons Period

cal 3000 - 1000 B.C.

N

1   .5   0   1 km
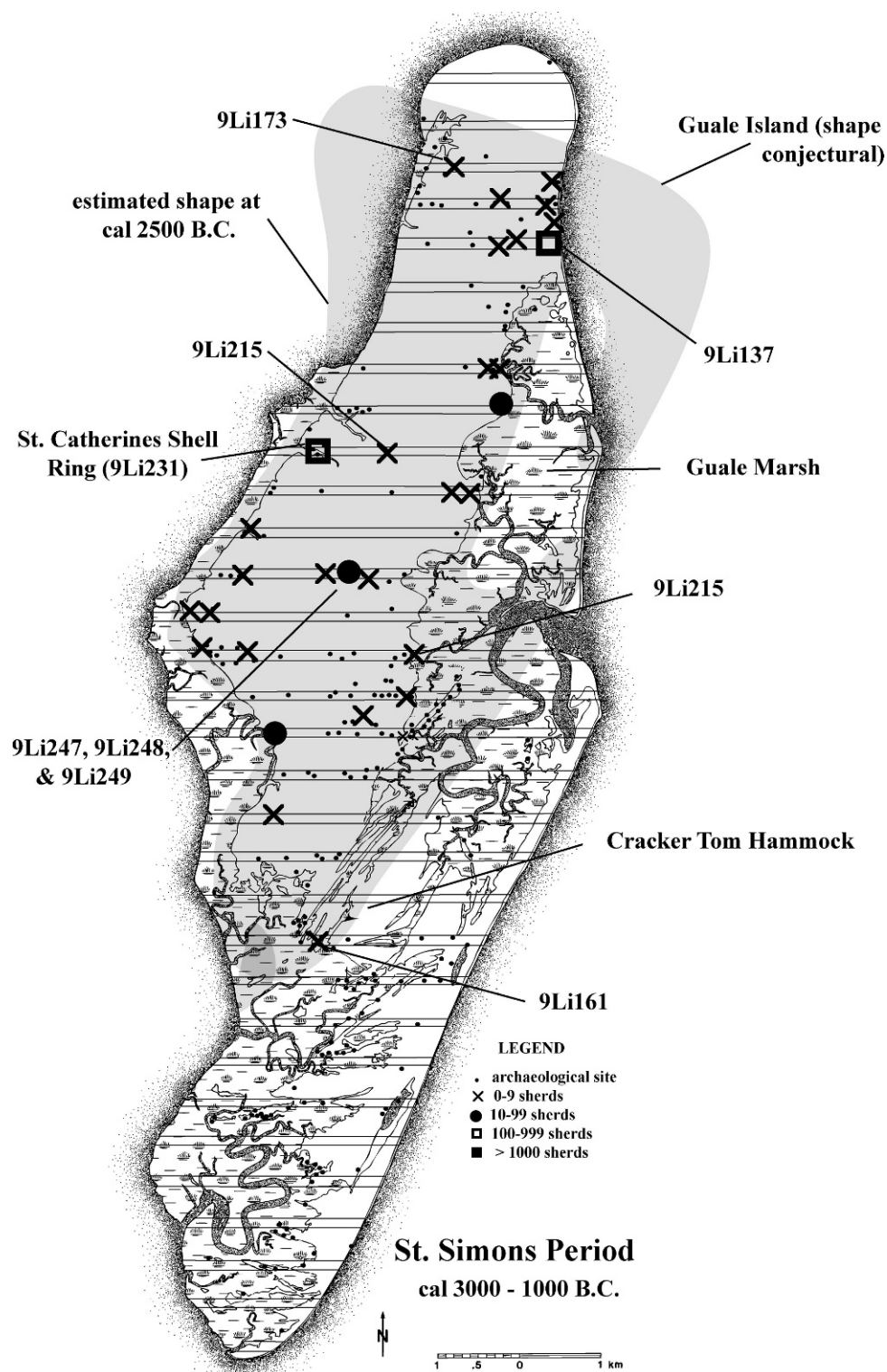
Fig. 32.2.   Distribution of archaeological sites dating to the St. Simons period on St. Catherines Island, with an estimated reconstruction of the island shape at cal 2500 B.C.

reaches of the dwindling saltmarsh resources.[4] If so, then most of the archaeological evidence for marshland exploitation along western margin of St. Catherines Island between cal 2300 B.C. and cal 1600 B.C. is likely submerged beneath a meter or more of marsh sediments that accumulated later (as the sea rose to approach modern levels).

Present evidence indicates that St. Catherines Shell Ring was abandoned circa cal 2180–1890 B.C., coincident with the disappearance of the western (estuarine) marshlands. Chapter 30 tested the distribution of St. Simons period components and landscape manifestations against the expected distribution based on the central place foraging model. The configuration of the archaeological landscape for the St. Simons period appears in figure 30.45. The Late Archaic landscape averages 134 ± 144 m from the western marsh margin, and this distribution is consisted with the log normal patterning projected from central place theory.

Site 9Li173 is another western marshside settlement, located along the margin of the Northwestern Marsh, where the majority of habitation debris encountered at this site dates to the Refuge-Deptford and Irene periods. Only a trace of St. Simons presence is evident here. Although lacking the necessary radiocarbon evidence, we hypothesize that the St. Simons occupation at 9Li173, as elsewhere along the Walburg and Wamassee scarps, is contemporary with the St. Catherines Shell Ring (i.e., between about cal 2900 B.C. and cal 1900 B.C.). During this interval, the estuarine marsh prospered, with sea level rising rapidly and peaking about cal 2300 B.C. But when sea level retreated over the next 7 centuries (fig. 32.1), the western margin of St. Catherines Island was likely abandoned until the sea level rose sufficiently to allow recovery of the estuarine saltwater marsh (during mid-/late Deptford times).[5]

EASTERN MARSHSIDE SETTLEMENTS: A rather different scenario played out along the seaside (eastern) margin of St. Catherines Island. The generally rising sea level during early Holocene triggered a rapid westward transgression of off-shore barrier islands, eventually docking these newly-formed beach ridges to the relic late Pleistocene landscape by cal 3000 B.C. or so, when the offshore Guale Island formed along the northeastern margin of St. Catherines Island. This new barrier effectively buffered the ocean front, and an extensive, inter-island marsh (Guale Marsh) evolved as the sea level rose. Guale Island would eventually be overtopped by still-rising Late Holocene sea levels, but during its short-lived existence, it must have provided a refuge salt marsh habitat along the eastern shoreline of St. Catherines to those foragers abandoning the dwindling estuarine salt marshes along the western island scarps.

Figure 32.2 plots the distribution of St. Simons-age settlements along the eastern scarps of St. Catherines Island. The St. Simons presence clusters along the northeastern end of the island core, centered on the high ground surrounding Guale Marsh. Today, nearly all of these northern St. Simons occupations are situated at an elevation of roughly 6 m above sea level, located on well-drained Echaw–Foxworth–Centenary soils. These were inland sites during the St. Simons period, located on relatively high ground, but still within 1 km of the Guale Marsh margin.

Site 9Li137 is the largest of the eastern marshside settlements, a bluff-top locality tested in the late 1970s; all evidence of 9Li137 has since eroded into the Atlantic Ocean. Little shell of any kind was observed in the deposit, and a number of fiber-tempered sherds turned up in what the fieldnotes recorded as "sterile sand." This might suggest that Guale Marsh had only recently formed when 9Li137 and the other St. Simons sites on the northern tip of the island were occupied.

But sufficient *Mercenaria* were recovered for estimating site seasonality (chap. 20), and we also recently ran several radiocarbon dates on hard clam samples from 9Li137, each unambiguously associated with St. Simons ceramics. The earliest of these (Beta-217217) is cal 1920 B.C.–2400 B.C., which overlaps statistically with the later dating cluster from the St. Catherines

Shell Ring (fig. 32.1). This is the earliest documented exploitation of Guale Marsh, but the scarcity of shell in the deposits of 9Li137 suggests that the intra-island marsh may have just been forming during this time of sea level retreat (pre-cal 1600 B.C.). The other two radiocarbon determinations from 9Li137, cal 1280 B.C.–1690 B.C. (Beta-217219) and cal 1340 B.C.–1590 B.C. (Beta-217218), date to a period of rising sea level. We hypothesize that by this time, the St. Simons settlement pattern had shifted eastward to exploit the catchment around Guale Marsh.

Although the ceramic assemblage from 9Li137 contained mostly undecorated fiber-tempered sherds, we did recover a few St. Simons Punctated, St. Simons Incised/Punctated, and St. Simons Simple Stamped sherds. The presence of these decorated sherds is consistent with radiocarbon evidence from the late St. Simons period.

The southern island core may have been twice its present size during the St. Simons period, extending an unknown distance to the east. Guale Marsh was still situated well to the north (meaning that the present area of McQueens Inlet was probably covered by high ground of the Pleistocene core). Figure 32.2 shows the St. Simons period occupations known from the southern island core, seven of them located in the systematic transect survey.

The southeastern margin of St. Catherines Island lay immediately to the east of Back Creek Road during the St. Simons period, as documented by the presence of St. Simons ceramics at 9Li161, which must have been occupied shortly after the modern hammock and plant communities were established on the newly formed Cracker Tom Hammock.

Site 9Li197 consists of numerous shell mounds, surface scatters, and buried deposits, all circumscribed within a 100-m diameter. Clearly, a flourishing saltwater marsh was close at hand, with ample shellfish being returned to the residential base. One of these *Mercenaria* valves was dated to cal 1050–1470 B.C. (Beta-20822), in association with exclusively St. Simons Plain ceramics.

Geomorphological evidence suggests that the additional St. Simons occupations on the southern core—today located on the modern marsh edge—were actually situated some distance inland when inhabited. The same is true of the three sites (9Li249, 9Li251, and 9Li254) clustered near Hoke's Dock, on the edge of McQueens Inlet. During the St. Simons period, the Guale Marsh was likely located at least 1 km to the northeast.

The southern beach ridge complex contained only one St. Simons component (9Li161), identified in DePratter's shoreline survey (chap. 23). This buried shell scatter skirts the southwestern margin of Cracker Tom Hammock, probably situated in the lee of the dune ridge that marked the maximum extent of beach progradation at the time.

To summarize, these findings are consistent with the available geomorphological evidence suggesting that about cal 1600 B.C., sea level began to rise slowly and steadily (at a rate of 10 cm/century) from a low-water mark of roughly 3 m below MHW to present levels. On St. Catherines Island, this meant that foragers of the late St. Simons and early Refuge-Deptford periods probably likely witnessed (1) a progressive deterioration (and southward migration) of saltwater marsh resources along the eastern margin of St. Catherines Island (due to the overtopping of Guale Island and disappearance of Guale Marsh), and (2) a resurgence of estuarine marshlands along the entire western margin of the island.

The nine eastern marshside components average 292 ± 303 m from the marsh edge, placement consistent with (1) the normal and lognormal projections from central place theory (figs. 30.43 and 30.44), and also (2) the uniform distribution projected by the diet-breadth model (table 30.8).[6]

With few exceptions, then, the archaeological record of the St. Simons phase on St. Catherines Island is fully consistent with the marshside settlement model derived from central place foraging theory. The eastern marshside settlements are also consistent with the uniform distribution model (derived from the diet-breadth assumption

of homogeneity). This alternative hypothesis requires an assumption that the environment is relatively homogeneous (''fine-grained''), meaning that they are relatively continuous, undifferentiated, and evenly distributed across space.[7]

LACUSTRINE SETTLEMENTS: Despite the excellent fit between the empirically observed aboriginal settlement pattern and expectations from human behavioral ecology, the deviations are notable and significant.

Figure 32.2 plots that three St. Simons period components (9Li247, 9Li248, and 9Li249) were positioned along the midline of St. Catherines Island and distinctly separated from the marshside settlements of the eastern and western shorelines. Each buried component went undetected during the initial part of the systematic transect survey due to the absence of marine shell. Situated along the margin of the Rutledge soil type that dominates the central depression of the Pleistocene core, these archaeological sites were discovered only during the follow-up systematic shovel-testing program that completed the Island-wide survey (see chap. 20). The ceramic assemblage from each component is almost exclusively fiber-tempered pottery.

These lacustrine settlements comprise the most significant deviation from central place foraging expectations, which posited that the major settlements should occur at the interface of saltwater marsh and the maritime forest, the two highest ranking resource patches. During St. Simons times, the poorly drained central depression hosted numerous freshwater ponds, which survived into the antebellum period (prior to the lowering of the artesian water table a century ago; see chap. 5). These Late Archaic components apparently reflect a lacustrine adaptation that flanked the central freshwater ponds, perhaps exploiting freshwater resources such as turtles, migratory waterfowl, bulrush and cattails, and perhaps even freshwater fish. Given the relatively coarse-grained sampling fraction employed during the 1977–1979 shovel-testing program, we think it likely that numerous buried, nonshell St. Simons era sites remain to be discovered in this inland setting.[8]

Given the apparent significant clustering of ''lacustrine'' sites along central lowlands of St. Catherines Island, in subsequent research one might wish to subdivide the overall ''maritime forest'' patch type into the following two zones.

The Pleistocene core(s): These long, linear, stabilized relic dunes run parallel and define the western and eastern island scarps, are characterized by the relatively well-drained Echaw–Foxworth–Centenary soils and provide appropriate habitat for terrestrial hunting, harvesting mast, and cultivating maize.

The Pleistocene swale (the ''central depression''): This discontinuous, but largely linear, low-lying zone is characterized by poorly drained Rutledge soils that developed in the shallow depressions and bays of the former central freshwater meadow. The Pleistocene swale could host newly defined hunt types such as ''lacustrine hunting,'' ''harvesting lacustrine wild plants,'' and (post-A.D. 1000) ''plant-and-harvest maize cultivation'' (a strategy for utilizing the low-lying slough areas characterized by Rutledge soils; previously lumped with swidden maize cultivation, which is better suited for the Pleistocene dune habitats).

Although we lack adequate post-encounter rate estimates, diet-breadth modeling indicates that after the (temporary) disappearance of estuarine marshland resources (during a time of lowered sea levels), the lacustrine hunt type might have become the second highest ranking patch (after the maritime forest). This scenario suggests that the interface running along the margins of the Rutledge soils could potentially become the highest ranking central place.

Archaeological samples generated during the Island-wide transect survey are inadequate for assessing the efficacy of Pleistocene swale habitats and the potentially host a distinctive lacustrine settlement type. But this possibility suggests an important new horizon for archaeological research on St.

Catherines Island, involving an inland shoreline survey (basically walking the interface between the various Rutledge/Echaw–Foxworth–Centenary soil types—similar to the way we surveyed the marsh margins along the late Holocene beach ridges). This survey should rely heavily on systematic shovel testing (because marine shell is sometimes absent at such sites, particularly those utilized during Late Archaic and Refuge time periods). Such a survey strategy could, for instance, determine whether the site clusters of 9Li247, 9Li248, and 9Li249 are anomalous or represent a previously undetected lacustrine settlement type.[9]

SUBSISTENCE

During the St. Simons period, St. Catherines Islanders established a generalized subsistence pattern that persisted for millennia, relying on a broad range of resources from the nearby estuarine and marine waters, including vertebrates (such as fish) and invertebrates including clams, oysters, crabs, and shrimp (Reitz, chap. 22, this volume; see also Reitz, 1988a). Aboriginal foragers also hunted deer and likely collected a range of terrestrial food sources including hickory nuts and acorns, berries, edible roots, and tubers. These conclusions are based strictly on ethnobiological remains recovered during previous test excavations. To date, we have not conducted any flotation or fine screening at any of these sites, nor have we recovered any human remains that date to the St. Simons period (precluding any bioarchaeological analysis to confirm these patterns).

Vertebrate faunal remains were recovered from two St. Simons period sites, 9Li231 and 9Li252 (Reitz, chap. 22, this volume). The 9Li252 assemblage contained only one mammal specimen and will not be further considered (table 22.5). The three test pits excavated in the 1970s at the St. Catherines Shell Ring (9Li231) yielded the single largest collection in the entire Island-wide survey (table 22.6), consisting of 2559 specimens and the remains of an estimated 120 individuals. More than

three-quarters of these individuals were fishes, two-thirds of which were identified as hardhead catfish (*Ariopsis felis*). Deer (*Odocoileus virginianus*) provided the prominent source of meat (in terms of biomass), although this result may be inflated by the 1/4-in. screens employed during the transect survey.

Looking more closely at these results, the diet-breadth model predicts that—*within each hunt type*—the highest ranked prey should always be taken upon encounter. Inclusion of lower ranked prey in the optimal set depends only on the encounter rate of the higher ranked prey, meaning that the abundance of lower ranked items does not condition its inclusion in the optimal diet (Stephens and Krebs, 1986: 23; see also chap. 6). For the resource base of St. Catherines Island, this means that items of sufficiently high rank should be included in the "optimal set" of resources to be pursued whenever encountered. The highest ranking island resources have estimated post-encounter return rates higher than 20,000 kcal/hr (suggesting that lower ranked food items should be ignored whenever alligators, white-tailed deer, and nesting female loggerheads are encountered). The prey-choice model also predicts that the highest ranking resources should have been differentially depleted through time.

Modern white-tailed deer living on the Sea Islands are considerably smaller than the mainland counterparts, and their biomass varied significantly through time (Purdue and Reitz, 1993; chap. 8, this volume). Figure 8.1 compared the changing body size over the last 3000–4000 years for mainland and barrier island white-tailed deer populations in the coast area (see also tables 8.4 and 8.5), with body size changing most dramatically in the Georgia Sea Island samples. At approximately cal 1600 B.C.—perhaps a millennium after St. Catherines Island had separated from the mainland landscape—the mean adult body weight of Sea Island deer is estimated at 72.5 kg (slightly larger than their mainland counterparts). But thereafter, the biomass of island deer populations shrank markedly, reaching an adult body size of only 37 kg for

contemporary white-tailed deer populations in the Sea Islands. Quite literally, then, St. Simons period hunters were stalking deer twice the size of those hunted at Mission Santa Catalina de Guale.

The longer the St. Catherines Island deer population was isolated from the mainland population, the smaller the individual deer became. Why did the white-tailed deer population of the Sea Islands shrink so rapidly? Post-Pleistocene climatic change may be a factor here, since mainland deer were becoming somewhat smaller during this interval (Purdue, 1980; Purdue and Reitz, 1993), and the newly isolated Sea Island deer populations faced a significant change in dietary composition. Although white-tailed deer probably foraged across all available island habitats (including the maritime forest, the dune fields, and even the island edge into the salt marsh), this was clearly a population under stress. Late Holocene marine transgressions had fragmented the coastal landscape into the small-scale patchy habitats that characterize the contemporary Sea Islands, and Late Archaic foragers likely imposed significant hunting pressure on the local, newly isolated island deer populations.

Figure 31.14 demonstrates the variability evident in the abundance indices for saltwater fishing on St. Catherines Island. The marine vertebrate assemblage from the St. Simons period is dominated by hardhead catfish, a "small" fish (averaging only 0.15 to 0.30 kg). But the presence of numerous bones from several large taxa (including rays, sharks, gar, gafftopsail catfish, and black drum) raise the Big Fish Index$_{Biomass}$ to 0.651, the largest value observed for any period in this study.

Marine/Terrestrial Indices also vary through time (fig. 31.16). The earliest (St. Simons period) assemblage differs markedly from subsequent zooarchaeological samples, and some difference might be attributed to sampling issues (because only a single site is actually represented). Hardhead catfish (*Ariopsis felis*) remains dominate this assemblage (NISP = 666 of 1222 elements recovered) and whereas some sea catfishes remain in the inshore area year-round, most

leave during cold weather (Dahlberg, 1972); this is why we consider the presence of sea catfish remains as indicative of summer seasonality. The zooarchaeological assemblage from St. Catherines Shell Ring may not be representative of overarching subsistence patterns during the St. Simons period on St. Catherines Island.

Further, because the zooarchaeological sample for the St. Simons period derives strictly from the St. Catherines Shell Ring, MNI is considerably lower than if this same sample had been generated from several St. Simons period sites (or had Reitz computed MNI based on stratum, rather than pooling the collection by site). There is every reason to believe that a more comprehensive sample of zooarchaeological remains from several St. Simons period sites might paint a different picture of species diversity. This is why we cannot treat the St. Simons zooarchaeological sample as somehow "typical" of island-wide trends during the Late Archaic period.

Despite these potential biases, the St. Simons assemblage is obviously dominated by marine vertebrates, with the Marine/Terrestrial Index$_{NISP}$ = 0.7103 and Marine/Terrestrial Index$_{MNI}$ = 0.8070 (table 31.3). The Marine/Terrestrial Index$_{Biomass}$ is 0.1920, meaning that marine resources account for slightly less than 20 percent of the total biomass from all vertebrates. This is the highest proportion of marine vertebrates observed for all time periods on St. Catherines Island.

SEASONALITY

The evidence for seasonality during the St. Simons period on St. Catherines Island is decidedly limited when compared to data available for later time periods. Seasonality estimates are available for only two St. Simons period sites (see chap. 20, fig. 30.2, and table 30.4). The extraordinarily large vertebrate faunal sample contained shark and sea catfish, taxa indicative of occupation sometime between April and October; Reitz hypothesizes (chap. 22)—strictly on the basis of vertebrate faunal remains recovered in the Island-wide

survey—that year-round occupation of St. Catherines Island began during the St. Simons period.

Incremental analysis of a random sample of *Mercenaria* recovered from the St. Catherines Shell Ring demonstrates that clams were collected during the winter and early spring, in roughly equal proportions. All of available *Mercenaria* at Seaside Field (9Li252) were collected in the winter, early spring, and summer/fall.

Both vertebrate and invertebrate assemblages thus suggest a four-season presence at the St. Catherines Shell Ring, but we caution that this evidence does not necessarily require a full-time, permanent, sedentary occupation of any particular site (although we suspect this to be the case). The most conservative reading of the available evidence suggests that during the St. Simons period, St. Catherines Island seems to have provided a sufficiently rich resource base to support year-round presence, should the Late Archaic people have elected to do so.

BIOARCHAEOLOGY

No human remains from St. Catherines Island date to the St. Simons period.

RITUAL ACTIVITY

The St. Catherines Shell Ring (9Li231) is a unique feature on the St. Catherines Island landscape. Considerable speculation exists about the construction and use of shell rings in the American Southeast, and several investigators have discussed their implications regarding social inequality (DePratter, 1979b; Trinkley, 1985; Russo, 1994, 1996, 2004a, 2004b, 2006; Anderson, 2002; Sassaman, 2004; Saunders, 2004). Whereas some investigators suggest that the rings resulted from deposition of refuse shell adjacent to habitation structures (e.g., Waring and Larson, 1968; Trinkley, 1980; Thompson et al., 2004; Thompson, 2006), others have suggested that the shell rings accumulate as the result of periodic feasting (e.g., Russo, 1991, 2004a, 2004b). As noted earlier, we are presently conducting large-scale excavations at the St. Catherines Shell Ring, attempting geomorphic reconstruction through vibracoring and applying remote sensing technology; we think it prudent to withhold judgment on such issues until our own investigations have produced tangible results.

The Shell Ring aside, we can document no additional ritual activities that took place during the St. Simons period (that is, prior to cal 1000 B.C.) on St. Catherines Island. But evaluating the totality of evidence, it is possible to identify the complex beginnings of ritual activity and sacred spaces that pervaded the subsequent aboriginal occupation on the Island.

Johns Mound, for instance, is one of the most important mortuary sites on St. Cath?show=[fo]?>erines Island, eventually holding the remains of more than 70 individuals. The most obvious ritual activities at Johns Mound took place between cal A.D. 990–1160 (during the St. Catherines period). But a careful reading of the archaeological evidence shows that human activities at Johns Mound actually began during St. Simons times, when several pits were excavated into the premound surface and filled with fiber-tempered ceramics. Johns Mound was used as a mortuary facility well into the Spanish period (as evidenced by the intrusive burials accompanied by Altamaha period ceramic vessels and partial remains of a domestic pig). While we cannot conclusively demonstrate that these early features were mortuary (or even ritual in nature), it is likely that (at a minimum), the physical space occupied by Johns Mound enjoyed a very long history of aboriginal involvement.

The same is true for Cunningham Mound C, where a burial mound (probably constructed during the Wilmington period) containing a premound pit (Feature 2) with fiber-tempered ceramics. An associated ^{14}C date (UGA-1686) indicates that the pit was utilized about cal 1410–1060 B.C.

Three more pieces of "mortuary?" evidence are available from pre-cal 1000 B.C. contexts on St. Catherines Island. Radiocarbon date UCLA-1997E was processed on charcoal recovered from the primary humus level at McLeod Mound, and UGA-

1562, from nearby Cunningham Mound A, dates charcoal found in Feature 3, a large burnt upright log. The two dates are statistically indistinguishable (at the .95 level), with an average age of cal 1460–1730 B.C. One cannot determine whether the charcoal resulted from a deliberate burning of the immediate areas upon which McLeod and Cunningham Mound were subsequently built or whether the contemporary dates result from more widespread forest fire (which could, of course, have been deliberate or accidental). In addition, the premound surface at Seaside Mound II contained a number of small pits and oyster shell middens, and shell from Feature 1 (a shell-filled pit) was ^{14}C dated to the late St. Simons period (UGA-1553, cal 1240–830 B.C.).

In other words, seven radiocarbon dates (from six different sites) define the *St. Simons cluster* (*pre-cal 1000 B.C.*) of mortuary(?)-associated ^{14}C dates from the earliest known occupation on St. Catherines Island.

REFUGE-DEPTFORD PERIOD
(CAL 1000 B.C.–A.D. 350)

Fifteen archaeological components are known from the Refuge-Deptford period on St. Catherines Island, all but one of them along the eastern Pleistocene core (see table 30.2). From a landscape perspective, the probabilistic transect survey documented a Refuge-Deptford presence at 42 localities (fig. 29.3; see also tables 20.1 and 20.2).[10]

THE CERAMIC CHRONOLOGY

DePratter (1979a, 1991) previously estimated that along the northern Georgia coast, the Refuge period ranged from about 1100 B.C. to 400 B.C. (cal 1350 B.C. through cal 400 B.C.), and the Deptford period lasted from 400 B.C. to A.D. 500 (cal 400 B.C. through A.D. 630). As explained in chapter 15, these two temporally contiguous periods have been combined because of the difficulties in distinguishing between them in the relatively small ceramic assemblages generated during the Island-wide survey.

The St. Catherines Island research produced 16 radiocarbon determinations directly associated with Refuge-Deptford ceramics (table 15.1, fig. 15.2). Their probability distribution is distinctly bimodal (figs. 15.2 and 15.8), and the break between these two clusters (cal 370–260 B.C.) corresponds almost precisely to the boundary between the Refuge and Deptford periods. Although the sample sizes of the ceramic assemblages from St. Catherines Island are insufficient to define the Refuge-Deptford boundary, we certainly believe this to be the case.

We conclude that the Refuge-Deptford period (cal 1000 B.C.–A.D. 350) begins 350 years later than previous estimates and lasts almost 300 years later (DePratter, 1979a, 1991). In the St. Catherines Island chronology, the Refuge-Deptford period lasts between 20 and 13.5 centuries. The break between Refuge and Deptford periods probably occurs at cal 350 B.C.

GEOCHRONOLOGY

Linsley (1993) reconstructed St. Catherines Island during the Refuge-Deptford period (figs. 29.1 and 32.3). Guale Island survived along the northeastern margin of the island and additional beach ridges had accumulated along the southeastern shoreline, extending beyond the modern Cracker Tom Hammock and arching northward past the contemporary McQueens Inlet.

Guale Marsh, still buffered from the Atlantic Ocean by Guale Island, expanded markedly to the southwest, extending into McQueens Inlet and perhaps as far south as the Middle Settlement/Cemetery Road area. Numerous beach ridges also formed along the Island's northern end, and, except for a remnant spur of island core to the northwest, the western shoreline approximated its modern configuration.

Beginning about cal 1600 B.C. and continuing throughout Refuge-Deptford times, sea level began rising slowly (at a rate of 10 cm/century), from a low-water mark of roughly 3 m below MHW. Marshland resources along the eastern margin of St. Catherines Island diminished (due to the eventual overtopping of Guale Island and disappearance of Guale Marsh), and estuarine marsh-

estimated shape at
cal 600 B.C.

9Li228

9Li186

9Li223

**Seaside Mound
group**

**Cunningham
Mound group**

LEGEND
. archaeological site
× 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds

**Refuge-Deptford
Periods**

cal 1000 B.C. - A.D. 350

1 .5 0   1 km
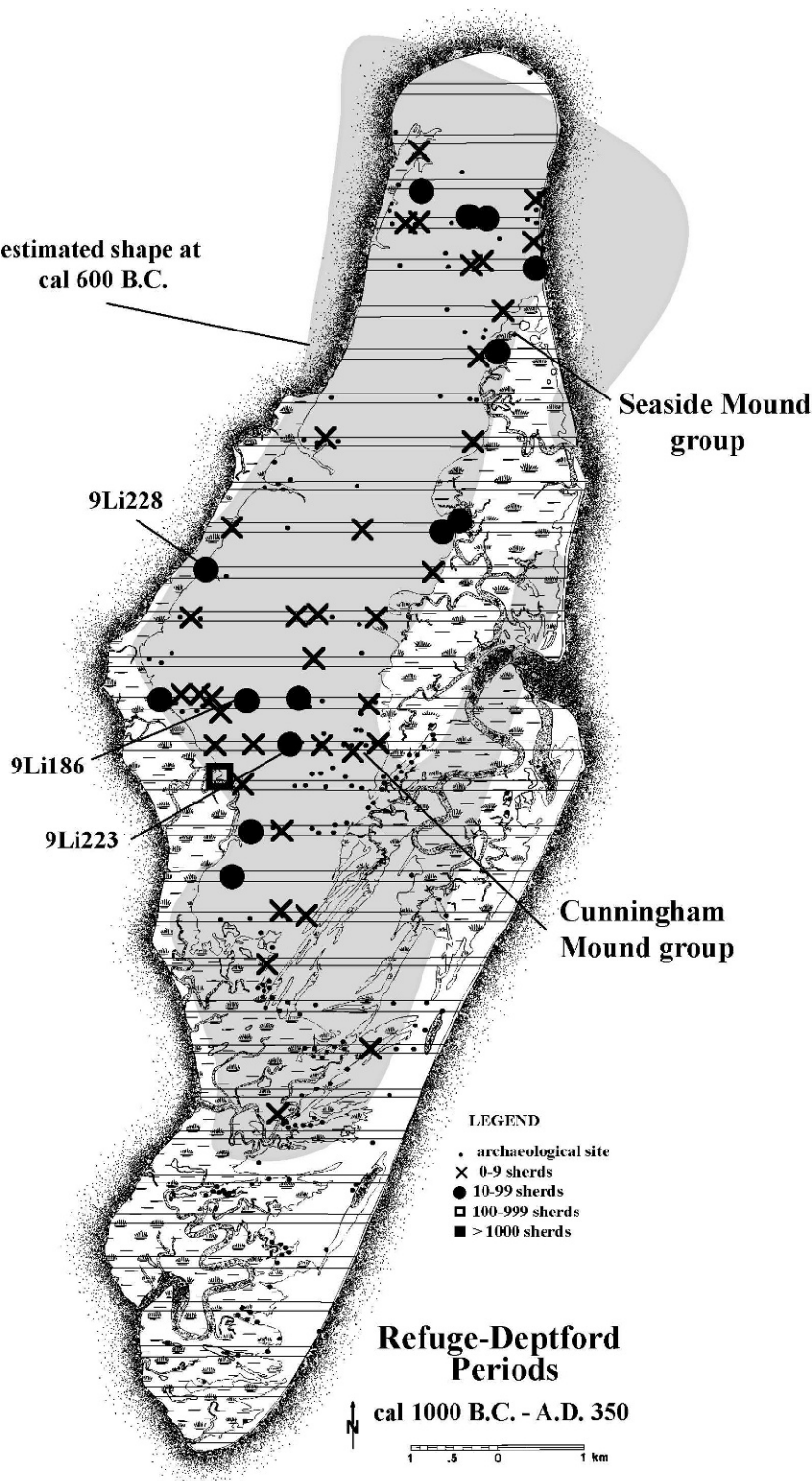
Fig. 32.3.   Distribution of archaeological sites dating to the Refuge-Deptford periods on St. Cath-
erines Island, with an estimated reconstruction of the island shape at cal 600 B.C.

lands reappeared along the entire western margin of the island.[11]

THE RADIOCARBON CHRONOLOGY

The probability distribution of the 116 radiocarbon dates in the 2005 Dataset contained a distinctive valley (Gap B) evident during the Refuge-Early Deptford period (cal 1000 B.C.–200 B.C.; see chap. 16). Although the Cunningham and Seaside mound groups are spatially separated and constructed in rather different habitats, the 2005 Dataset showed a surprising statistical contemporaneity between the two mortuary complexes. Specifically, whereas the Refuge period spans about 6.5 centuries, virtually all of the demonstrable cultural activities transpired during a brief interval (cal 600–750 B.C.), as defined by a cluster of eight ''mortuary'' radiocarbon dates from six different burial mounds. But a disproportionate number of samples were processed on charcoal samples, meaning such ''contemporaneity'' could perhaps reflect widespread forest fires instead of deliberate mortuary activities.

Because the 2005 Dataset lacked shell midden dates during the Refuge and early Deptford periods, we submitted ten additional ^{14}C samples to explore the nature of this gap (chap. 16), with the following results:

9LI228: The ceramic assemblage at this large site is dominated by Refuge-Deptford period diagnostics, with a few Irene sherds also present. To derive chronometric age estimates from late Refuge/early Deptford contexts, three additional *Mercenaria* were submitted for radiocarbon analysis (Beta-217232, Beta-217233, and Beta-217234), all from the same excavation unit. The results fell in perfect stratigraphic order, each dating mid/late Deptford period (roughly cal 100 B.C.–cal A.D. 300).

Duncan Field (9LI225): This buried shell lens produced a ceramic assemblage ranging from the Refuge through Irene periods. Previously, we processed a radiocarbon date (Beta-21405, cal A.D. 480–780) on *Mercenaria* associated with Wilmington Cord Marked ceramics. In the gap-hunting exercise, we submitted two additional *Mercenaria* valves for radiocarbon dating (Beta-217230 and Beta-217231), each clearly associated with Refuge period ceramics. The results indicate that both clams date to the Wilmington period (roughly cal A.D. 500–700), which is well represented in other parts of the site.

9LI235: In May 2006, we dated two hard clams recovered in apparent association with Refuge period ceramics (Beta-217237 and Beta-217238). Both *Mercenaria* date to the much later St. Catherines period (roughly cal A.D. 1000–1200), confirming the previous results (namely, that the ceramic associations are poor predictors of ^{14}C dates at 9Li235).

9LI49: The relatively sparse ceramic assemblage consisted of six Refuge period diagnostics, but a previous ^{14}C determination from this site (Beta-20829, *Mercenaria*) yielded a date of cal A.D. 440–680 (much too late for the Refuge Punctated and Refuge Incised sherds recovered here). Attempting to date the Refuge occupation at 9Li49, we submitted another *Mercenaria* valve (Beta-218101), which is clearly associated with Refuge Punctated and Refuge Incised sherds); but the resulting age dates to the Irene period (cal A.D. 1430–1620).

Long Field 3 (9LI180): This small shell concentration produced only a single diagnostic sherd (Refuge Plain). We processed two AMS determinations on associated *Mercenaria* (Beta-217220 and Beta-217221) to date the age of the midden. Clearly, this midden accumulated during the St. Catherines period (roughly cal A.D. 900–1200).

To summarize: In attempting to fill Gap B (cal 1000 B.C.–200 B.C.), the 2006 redating exercise processed 10 additional ^{14}C samples. Three of these samples did indeed fall within the expected middle and late Deptford period (cal 100 B.C.–cal A.D. 300) and one radiocarbon date (Beta-215818), unas-
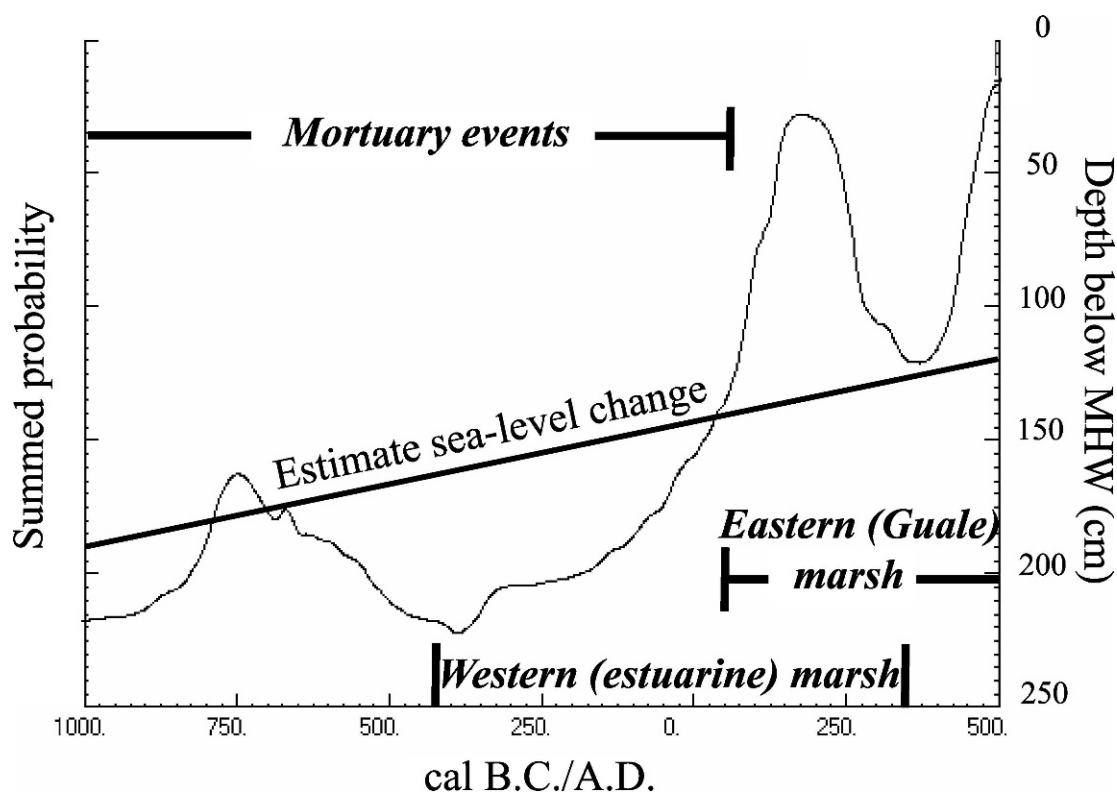
Fig. 32.4. The cumulative probability profile of marine radiocarbon samples ($n = 29$) available for the Refuge-Deptford period on St. Catherines Island, compared with estimate sea-level change and the duration of contemporary mortuary events.

sociated with diagnostic ceramics, dated to cal 400–80 B.C. But the remaining radiocarbon samples processed in 2006 derive from significantly later time periods.

Despite concerted efforts to close Gap B, the Refuge-Early Deptford period (cal 1000 B.C.–200 B.C.) remains a significant hiatus in the cultural radiocarbon record of St. Catherines Island. Except for the samples from 9Li228, all of the dated marine shells that were apparently associated with Refuge-Early Deptford period sherds actually accumulated much later. This systematic bias reflects the scarcity of Refuge- and early Deptford-age shell deposits (even in the presence of Refuge-Deptford period ceramics) and reinforces the impact of changing sea level on the marine resources surrounding St. Catherines Island.

This important trend is illustrated in figure 32.4, which explores the probability dis-

tribution of the 29 available ^{14}C determinations on marine shell from the Refuge-Deptford period (cal 1000 B.C.–A.D. 350).[12] As discussed above, changing sea level shifted the position of marshlands surrounding St. Catherines Island during the preceding St. Simons phase (fig. 32.1). The initial human settlement began along the western (estuarine) Walburg Scarp, but after sea level dropped more than 3 m, the estuarine marshland disappeared and the St. Simons settlement pattern shifted eastward to the margins of Guale Marsh.

This trend continues into the Refuge and subsequent Deptford period (fig. 32.4). During the Refuge period (cal 1000 B.C.– 350 B.C.), sea level gradually rises, but ^{14}C dates are entirely absent during this interval (apparently reflecting the scarcity of Refuge-age marshlands, at least along the estu-

arine margin of St. Catherines Island). The only radiocarbon dates from the Refuge period on St. Catherines Island derive from *mortuary contexts*, which define a date cluster at cal 1240 B.C.–420 B.C. and includes radiocarbon dates from McLeod Mound (UGA-1554) and Seaside Mounds I and II (UGA-SC3, UGA-1552, and UGA-104); presumably these marine shells were collected from Guale Marsh and transported to the Seaside and Cunningham Mound groups; as noted above, no corresponding Refuge-age shell middens have been found.

With the onset of the Deptford period (at cal 350 B.C.), marshside settlements reappear along the western (estuarine) margin of St. Catherines Island. Beginning with the occupation of Hayes Island (at cal 400 B.C.–80 B.C.), a low-lying (and partially flooded) shell midden along the southern extent of the Walburg Scarp, a cluster of eight ^{14}C dates (from five sites) documents the resurgence of marshside settlements along the western margin of St. Catherine Island. Although these settlements overlap temporally with the mortuary activities at the McLeod and Seaside Mounds, no eastern (Guale) marshside settlements can be documented between cal 1050 B.C. and cal A.D. 50—such deposits are now submerged or, more likely, eroded away entirely with the disappearance of Guale Island.

This temporal pattern reverses during the mid-Deptford period. Beginning with the occupation of 9Li171 (a buried midden site in North Pasture) at cal A.D. 50–400 (Beta-21407), the marshside settlement pattern on St. Catherines Island shifts abruptly eastward, and western marshside settlements disappear once again.[13] A cluster of one dozen radiocarbon dates (from eight different archaeological sites) defines this reoccupation of the eastern marshside settlements, after an apparent hiatus of a millennium. Perhaps the Guale/McQueen marshland disappeared (or was not exploited), or perhaps the Refuge–early Deptford age marshside sites were entirely flooded or eroded away with the overtopping and eventual destruction of Guale Island (and whatever archaeological sites existed there).

LANDSCAPES OF THE REFUGE-DEPTFORD PERIOD

Chapter 30 compared expectations from prey-choice, patch-choice, and central place foraging models against the empirical distribution of archaeological components and landscape indicators for the Refuge-Deptford period. Specifically, the central place model projected that *marshside settlements* should be situated in optimal central places along the intersection of the two highest ranking patch types, along the stabilized dune remnants that fringe the maritime forest, immediately adjacent to the salt marshes and the tidal streams that drain them.

The diet-breadth model provides an alternative hypothesis. If the resource base is assumed to be relatively undifferentiated and evenly distributed across space, then such environmental homogeneity should condition an archaeological record of aboriginal settlements that are randomly distributed through space, without any significant degree of nonrandom modality or centrality (fig. 30.37). The next several sections evaluate the results and broader implications for the Refuge-Deptford occupation of St. Catherines Island.

WESTERN MARSHSIDE SETTLEMENTS: Figure 32.3 shows the observed distributions of these archaeological components and landscape manifestations from the Refuge-Deptford period. The seven western marshside settlements average 203 ± 307 m from the marsh margin and this distribution is consistent with expectations from the lognormal distribution, with significant skewness to the right (fig. 30.38). With respect to landscape diagnostics, the 23 western marshside settlements average 227 ± 220 m from the marsh margin, and this empirical distribution is consistent with both normal and lognormal expectations from central place theory (fig. 30.39).

The ^{14}C evidence strongly suggests that the western marshside settlements—located along the Walburg and Wamassee scarps, including Hayes Island (9Li1620), Shell Field 2 (9Li15), Li228, and Wamassee Head (9Li13)—date to the Deptford period (from

roughly cal 400 B.C. through about cal A.D. 300). Whereas these western marshside settlements overlap temporally with the McLeod and Seaside mounds, no eastern marshside settlements can be documented for the interval cal 1050 B.C. through cal A.D. 50.

EASTERN MARSHSIDE SETTLEMENTS: This pattern reversed about cal A.D. 50–400, when the western marshside settlements are virtually abandoned and numerous eastern marshside localities are established, after an apparent hiatus of a millennium. Eleven of the known Refuge-Deptford occupations occur on the northern island core, comprising more than one-quarter (26.2%) of the known occupations encountered during the systematic survey.

Guale Island protected the extensive Guale Marsh, which had moved slightly to the south after the previous St. Simons period. Numerous beach ridges had already accumulated along the island's southeastern shore, ranging beyond the modern Cracker Tom Hammock, and several Refuge-Deptford phase occupations cluster along the eastern island margin. The combined ceramic and ^{14}C evidence suggests that at about cal 500 B.C., the southern beachfront passed across the Hickory Hills (just north of Beach Pond) and circled immediately to the south of Long Marsh and the upper reaches of Camp Creek. The initial occupation of the southern Holocene beach ridge complex took place during the Refuge-Deptford periods. Three sites cluster on the island core/beach ridge margin, in the vicinity of Cracker Tom Hammock.

Four Refuge-Deptford occupations are known from the southern beach ridge complex. Although two of these sites are adjacent to Pleistocene island core, the other two were located on newly formed beach ridges to the southeast; one of these (9Li49), located immediately to the west of Beach Pond, was utilized during cal A.D. 440–680, with evidence of a four-season occupation.

Overall, these eastern settlements are much further inland during the Refuge-Deptford period, averaging 514 ± 384 m from the marsh edge.[14] This is the largest average distance-to-marsh statistic observed in the Island-wide survey data (and the greatest disparity in spacing between the eastern and western marshes of the Pleistocene core). The empirical distribution of eastern marsh settlements follows a normal distribution almost perfectly, but deviates significantly from lognormal expectations. The eastern marshside landscape indicators average 325 ± 321 m from the marsh edge, results consistent with lognormal expectations, but significantly different from theoretical normal distribution projected from central place theory (fig. 30.37).

LACUSTRINE SETTLEMENTS: As noted with respect to the St. Simons landscapes, *lacustrine settlements* deviate significantly from Central Place Foraging expectations and contrast markedly with marshside settlement patterning in which central places cluster along the interface of saltwater marsh and the maritime forest (the two highest ranking resource patches). The five Refuge-Deptford lacustrine settlements cluster instead along the margins of the poorly-drained central depression, characterized by the Rutledge soil type:[15]

9Li186 (distance to western marsh = 340 m): This lacustrine site, located on the Echaw/Centenary fine sandy soil, lies immediately adjacent to the central freshwater marsh.

9Li253 (distance to eastern marsh = 560 m): 9Li253 is a single component Refuge period site, located 650 m from the eastern marsh margin, on a narrow ridge of Echaw/Centenary soils (elevation = 6.1 m), immediately to the east of the long, central freshwater slough. This medium-sized site was found only through the systematic shovel-testing of transect H-6. Shell was virtually absent and no estimate of seasonality is possible.

9Li239 (distance to eastern marsh = 665 m): North Pasture 2 (9Li239) is a small buried shell midden, about 20 m in diameter. Situated on a narrow ridge of Echaw/Centenary soils (6.1 m elevation), this site is immediately east of the central freshwater marsh (Rut-

ledge soil). All the *Mercenaria* studied from the Refuge-Deptford component were harvested during the winter.

9Li249 (distance to eastern marsh = 760 m): This small site is unusual because it is located on the poorly drained Rutledge series soil (at an elevation of 4.6 m). Shell is entirely absent at 9Li249 and the site was detected only through the systematic shovel testing. The ceramic assemblage is diagnostic of the St. Simons–Refuge periods. No seasonality information is available.

Greenseed Field 1 (9Li178; distance to eastern marsh = 1090 m): This site occurs on a long, narrow band of Echaw/Centenary fine sand along the inland margin of the eastern swale, with its characteristic long, linear freshwater swamp.

Each Refuge-Deptford outlier flanks the central freshwater pond complex, perhaps to exploit turtles, migratory waterfowl, bulrush, cattails, and freshwater fish. Marine shell is virtually absent at 9Li249, and many such Refuge-Deptford sites likely remain to be discovered in this inland, lacustrine setting.

Seasonality

Seasonality estimates are available from nine Refuge-Deptford occupations. Diagnostics are rather evenly distributed across all four seasons, with fall slightly underrepresented at 17.9 percent (table 30.4). Four components (at 9Li172, 9Li173, 9Li15, and 9Li49) are four-season occupations. From an island-wide perspective, it is clear that numerous Refuge-Deptford occupations were year-round.

Subsistence

Vertebrate faunal materials survived in nine Refuge-Deptford components, but the samples are uniformly small and the combined assemblage consists of only 1491 specimens (an estimated 42 individuals). 9Li228, along the western margin of the island core, produced the largest zooarchaeological assemblage, which is dominated by a variety of fishes. Deer and diamondback terrapin contribute the bulk

of the biomass, and some of the deer bones show signs of reworking.

Faunal remains recovered from these sites clearly indicate the degree to which deer and estuarine animals were exploited during the Refuge-Deptford periods. This pattern continues, almost without exception, throughout the succeeding Wilmington, St. Catherines, Savannah, and Irene periods. As Reitz has noted (in chap. 22), "continuity rather than change" characterizes the exploitation of vertebrates throughout the aboriginal history of St. Catherines Island.

While the percentages of other wild mammals, turtles, and fishes appear to covary, deer constituted between 22 percent and 26 percent of the individuals in the combined prehistoric samples (table 22.70). The biomass contributed by deer is also quite stable, fluctuating between 74 percent and 80 percent (table 22.71). This degree of homogeneity is remarkable, considering the wide range in sample sizes and the large number of sites involved in this summary.

These zooarchaeological assemblages are fairly consistent through time and, except for the relative abundance of deer bones in St. Catherines Island samples, they compare favourably to those recovered from Woodland and Mississippian period sites elsewhere along the Georgia coast (Reitz, 1982a, 1988a; Reitz and Quitmyer, 1988). This suggests that the observed variability in the faunal record on St. Catherines Island more likely reflects functional variability in site use rather than broader trends in temporal or spatial change. As Reitz put it (in chap. 22), "Greater individual variation should be expected among sites within the same time periods than between time periods."

[14]C Periodicity in the Refuge-Deptford Mortuary Complex

Decades ago, we commented on the remarkable contemporaneity in ritual activities in the Refuge-Deptford burial mounds of St. Catherines Island (Thomas and Larsen, 1979: 135–144); at the time, we were unable to distinguish between results from marine and terrestrial dates, and our age estimates were somewhat skewed. Having
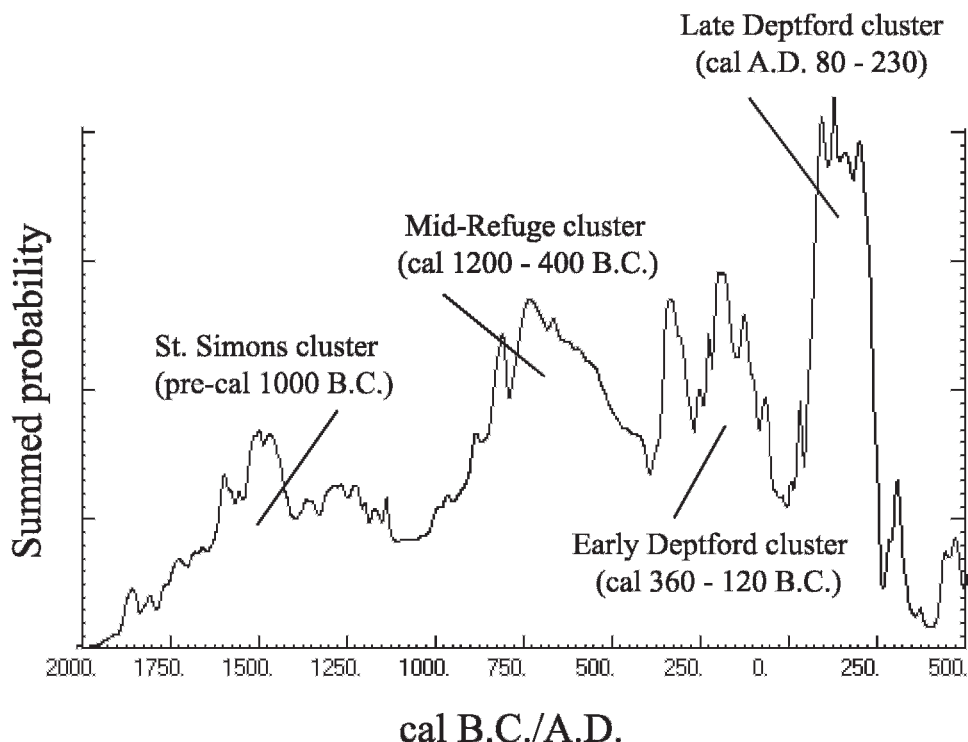
Fig. 32.5. The cumulative probability profile for mound construction based upon ^{14}C dates ($n = 23$) available for the interval cal 2000 B.C.–A.D. 500 on St. Catherines Island.

recalibrated all ^{14}C determinations (per the conventions discussed in chaps. 13 and 16), we must discard the six clusters of dates defined in Thomas and Larsen (1979).

Clearly, these various mortuary facilities were utilized over lengthy time spans. More than half of the individuals were interred before actual mound construction, which typically occurred relatively late in the ritual sequence. In other words, mortuary rituals during the Refuge-Deptford periods began with the construction of cemeteries and later evolved into small sand mounds, confirming Joseph Caldwell's (1971) initial suspicion that such mortuary sites "may start with a dimple and end with a pimple."

Establishing contemporaneity (or lack thereof) between the various corrected ^{14}C determinations helps explicate the timing of various subsistence and mortuary ceremonial activities during each period. Chapter 16 sorted the available radiocarbon dates by contexts, separating mortuary from mid-

den dates; the shell midden dates were discussed above and we now return to the patterning in mortuary dating.

Figure 32.5 plots the distribution of 23 radiocarbon dates derived from mortuary contexts spanning cal 2000 B.C.–A.D. 500. Three distinct clusters emerge from these during the Refuge-Deptford periods, each reflecting a flurry of mortuary activity that took place simultaneously across St. Catherines Island.

MID-REFUGE CLUSTER (cal 1200–400 B.C.): A cluster of 12 radiocarbon dates (from seven mortuary sites) defines the Refuge cluster.

Two nonoverlapping dates, both from Seaside Mound I (UGA-SC3: cal 1240 B.C.–130 B.C. and UGA-104: cal 780 B.C.–260 B.C.), derive from oyster shells recovered from Feature 2, a pit excavated into the primary humus. Another date, from nearby Seaside Mound II (UGA-1552: cal 810 B.C.–A.D. 420), was processed on marine shell contained within Feature 1, a similar pre-

mound pit. UGA-1557 (cal 980 B.C.–600 B.C.) dated charcoal from the premound primary humus at McLeod Mound; sometime later, several pits were excavated and covered with a ring of potsherds and oyster and clam shells, which date cal 880 B.C.–470 B.C. (UGA-1554) and cal 980 B.C.–600 B.C. (UGA-1557; chap. 24). Although the mound fill contains numerous Refuge-Deptford potsherds, four newly available AMS dates demonstrate that mound construction must have taken place during the Wilmington period (sometime after cal A.D. 430–580).

The date from Cunningham Mound B (UCLA-1978: cal 790–420 B.C.) came from charcoal in Feature 1, which was excavated into the premound primary humus (a second charcoal date from this feature, UGA-1008: cal 380 B.C.–50 B.C., falls into the early Deptford period cluster). The final determinations in this cluster (UGA-1253: cal 770 B.C.–230 B.C. from Cunningham Mound B and UGA-1255: cal 1130 B.C.–830 B.C.) from Cunningham Mound D) date charcoal contained in the primary humus.

Although the Cunningham and Seaside mound groups are nearly 5 km apart, the ^{14}C evidence demonstrates a remarkable contemporaneity in construction stages. Roughly half (6 of 11) of the Refuge period ^{14}C determinations date marine shells, and the rest were processed on charcoal samples in burned primary humus (an important factor in eliminating "natural" causes such as wildfires).

The shell dates are statistically the same (at 95%), with a pooled age of cal 600–750 B.C. This means that a batch of oysters were harvested simultaneously (statistically speaking) and their shells deposited in pits dug into the surface that would eventually underlie Seaside Mounds I and II. Five kilometers away, at exactly the same time (within statistically defined limits), the ground surface at the future site of McLeod Mound was burned and clams were harvested, transported about 1 km inland, and eventually incorporated into the Central Tomb feature.

The charcoal dates likewise disclose the virtually simultaneous burning of the primary humus at four future mound locations in the Cunningham mound group. While the archaeological evidence does not permit discrimination between deliberate, localized firing and accidental forest fires, it seems significant that the burning took place at the same time that marine shells were being harvested (and ultimately incorporated into the premound features).

Several conclusions emerge regarding the Refuge Period Cluster (fig. 32.5):

- Although the Refuge period spans about 650 years, virtually all of the demonstrable mortuary activities transpired during a very brief interval (cal 600–750 B.C.).
- Occupational middens are virtually absent during the Refuge period, and none are contemporary with the mortuary activity. Due to depressed sea level, only two midden dates are known from this interval, one from 9Li173 (Beta-21406: cal 1020 B.C.–560 B.C.) and the other from Hayes Island (9Li1620, Beta-215818: cal 400 B.C.–80 B.C.).
- Deliberate mortuary activity (to date)can be demonstrated only at Cunningham Mound C, where a human cremation was buried in a premound pit during the preceding St. Simons period. All remaining activities recorded at the "mortuary" sites during this interval involve features that might (or might not) be directly related to mortuary ritual.
- No mound building can be documented on St. Catherines Island prior to cal 350 B.C.

EARLY DEPTFORD CLUSTER (cal 360 B.C.–120 B.C.): After a notable gap in the existing radiocarbon record (toward the end of the Refuge period), the earliest Deptford period is marked by a slightly bimodal distribution of five statistically identical ^{14}C dates from five different mounds, clustering between cal 120–360 B.C. (fig. 32.5).

UCLA-1997C dates Feature 3, a premound pit at Cunningham Mound A (also dated by UGA-1254, which belongs to the Refuge period cluster, discussed above). UGA-1008 was processed on charcoal from Feature 1, a premound pit at Cunningham Mound B (also dated by UGA-1007, discussed above). UGA-1555 was processed on clams associated with the Central Tomb at McLeod Mound (another shell from this feature, dated by UGA-1554, fell into the earlier cluster). UGA-1689 derives from

premound charcoal at South New Ground. UGA-3460 comes from charcoal contained the upper mound fill at South End Mound II, suggesting that this area was burned (perhaps deliberately) during this time period.

The early Deptford period ^{14}C cluster suggests the following:

- Statistically simultaneous burning and marine shell harvesting took place throughout the various mortuary contexts within the Cunningham Mound group.
- Numerous contemporary midden dates are available from sites along the western margin of St. Catherines Island, reflecting the rising sea level during the early Deptford period.
- Nothing in the available radiocarbon evidence suggests that actual mound building had commenced anywhere on St. Catherines Island by cal 360–120 B.C. (early Deptford period). During this interval, marine shells that would eventually be incorporated into the Central Pit at McLeod Mound were being harvested (probably in December or January). The premound surface was burned (and sometimes nonmortuary features excavated) at four additional places where mounds would eventually stand.

LATE DEPTFORD CLUSTER (cal A.D. 80–230): Following a hiatus of perhaps 2 or 3 centuries is a cluster of five ^{14}C dates derived from four mounds in the Cunningham group (fig. 32.5 and 32.7, below). These dates are statistically the same (at 95%) and yield a pooled age of cal A.D. 80–230.

Date UGA-1256 from McLeod Mound derives from charcoal contained within the mound fill, but new data from AMS dating of the Central Tomb burials indicates that the mound was built considerably later (see chap. 24 and below). The date from Cunningham Mound A (UGA-1560) was processed on charcoal contained in Feature 4, a large, flat-lying log situated on the premound surface. Both dates from Cunningham Mound B (UGA-16834 and UGA-1007) come from charcoal contained in the premound primary humus. The date from South New Ground Mound (UGA-1688) also derives from charcoal contained on the premound surface.

The only demonstrable mortuary activity during the late Deptford period (cal A.D. 80–230) is the log-lined Central Pit that was excavated at Cunningham Mound A (no bones were found inside this feature). We are unable to establish conclusively (1) whether the additional premound activities during this interval involved mortuary rituals, or (2) the sand mounds were erected over these premound surfaces (although this possibility seems likely in several cases, including Seaside Mounds I and II, South New Ground Mound, and Cunningham Mounds A, B, and C).

Numerous radiocarbon determinations from several shell middens are available from the late Deptford period, several of which are located in the general vicinity of the Cunningham Mound Group.

SUMMARY OF REFUGE-DEPTFORD CONTEMPORANEITY: A total of 22 radiocarbon dates are available from mortuary contexts during the Refuge-Deptford interval on St. Catherines Island. Although this temporal period spans more than 13 centuries, the radiocarbon evidence defines three tightly circumscribed clusters: cal 600–750 B.C., cal 120–360 B.C., and cal A.D. 100–300.

MORTUARY ACTIVITIES

Of the five dozen Deptford period burials excavated on St. Catherines Island, only 12 can be assigned a specific burial treatment (see table 32.1).[16] Five Deptford period burials were interred in a supine-extended position, indicating that these individuals were buried shortly after death because decomposition and disarticulation would have occurred within a matter of weeks (Ubelaker, 1974: 66). These individuals almost certainly died on (or near) St. Catherines Island and were buried shortly thereafter.

Nearly one-half (5 of 12) of the Deptford individuals were interred as bone bundles, perhaps the result of deliberate "bone cleaning" or from natural decay in a charnel house, where a large number of deceased were processed and buried (suggested by the Irene site by Caldwell and McCann, 1941: 30; see also Anderson and Mainfort, 2002: 7). These individuals were likely buried a considerable time after death.

TABLE 32.1

Summary of Known Aboriginal Burials from St. Catherines Island

Site	Number of burials	Sex			Age			Treatment				Context			Reference
		Female	Male	Indeterminate	Adult	Indeterminate	Sub-adult	Bundle	Cremation	Flexed	Supine/Extended	Unknown	Primary	Intrusive	
Deptford Period															
Cunningham Mound A	1	0	0	1	1	0	0	0	0	0	0	0	0	0	3
Cunningham Mound C	4	1	0	3	4	0	0	0	1	0	1	2	4	0	3
South New Ground Mound	1	1	0	0	1	0	0	0	0	0	0	1	1	0	1,3
Seaside Mound I	16	2	5	9	11	1	4	2	0	0	2	8	9	3	2,3
Seaside Mound II	16	4	3	9	10	5	1	3	1	0	2	7	3	9	3
Subtotal	58	16	11	29	47	6	5	8	2	0	16	24	22	27	—
Deptford Period (?)															
Greenseed Field Mound	25	5	7	0	4	0	0	0	0	0	24	—	0	0	1
Light-House Mound	>11	0	0	0	11	0	1	0	1	1	0	—	0	0	1
North-End Mounds	1+	0	0	0	0	0	0	0	0	0	0	—	0	0	1
Subtotal	26+	5	7	0	15	0	1	0	1	1	24	—	0	0	—
Wilmington Period															
McLeod Mound	20	10	3	7	20	0	0	3	0	0	11	6	5	15	3
Seaside I, Burial 5	1	—	0	1	1	0	0	0	0	0	0	1	0	1	3
Cunningham C, Burial 1	1	1	0	0	1	0	0	0	0	0	1	0	0	1	3
Cunningham Mound D	8[a]	1	1	3	5	1	1	1	1	1	1	1	1	5	3
Cunningham Mound E	1	1	0	0	1	0	0	0	0	0	0	1	0	1	3
Subtotal	11	3	1	4	8	1	1	1	1	1	1	3	1	8	—
St. Catherines Period															
South End Mound II	17+	3+	1+	0	11	0	2	15+[b]	2	0	0	0	0	17+	5
Johns Mound[c]	70	18	21	41	61	3	16	11	1	2	37	12	62	2	2,4
Marys Mound	6	2	0	4	2	1	30	2	0	2	0	0	6	0	2,4
Subtotal	93+	23+	22+	45	74	4	46	28+	3	4	37	12	68	19+	—

TABLE 32.1—(Continued)

Site	Number of burials	Sex			Age			Treatment				Context			Reference
		Female	Male	Indeterminate	Adult	Indeterminate	Sub-adult	Bundle	Cremation	Flexed	Supine/Extended	Un-known	Pri-mary	Intru-sive	
Late Woodland(?)															
King New Ground Field	38	17	12	0	29	0	5	0	1	9	21	—	0	0	1
Irene Period															
South End Mound I	50	12	9	0	22	0	20	6-8 ?[d]	1	26	0	—	—	—	1,5,6

References: 1: Moore (1897); 2: Caldwell (1971); 3: Thomas and Larsen (1979); 4: Larsen (1982); 5: Larsen and Thomas (1982); 5: Larsen and Thomas (1986); 6: Larsen (2002).
[a] Does not include the plantation period Burials 3 and 5 (described in Thomas et al., 1977).
[b] The "bundle" burial at South End Mound II consists of a mass grave containing at least 15 individuals (Larsen and Thomas, 1986).
[c] Johns Mound also contained two "skull only" burials and four cases of isolated postcranial elements (Larsen and Thomas, 1982: table 9).
[d] Includes urn burials (Moore, 1897: 161–167).

Two Deptford interments were cremations. Burial 2 at Cunningham C contained the cremated remains of two adults in a premound pit; bundle burial 8 at Seaside Mound II contained the remains of three individuals (one of whom had been cremated).

We have previously suggested that Moore's "Mound in Greenseed Field", "Mound near the light-house", and "Low Mounds at the North-end" were most likely constructed during the Deptford period (see chap. 24). Of the burials that Moore exposed in the Greenseed Field mound, all appear to be supine-extended. One burial at the Light-house mound was flexed, and another was cremated.

Sex could be reliably determined in only 31 of the burials attributed to the Refuge-Deptford period on St. Catherines Island (table 32.1). Females account for slightly over 60 percent (19 of 31) of the adults buried in the Refuge-Deptford interments.

Larsen could estimate age at death for slightly more than 80 percent of the known Refuge-Deptford burials (33 of 38), identifying 27 adults and only 5 subadults;[17] as noted previously, extrapolation from actuarial tables indicates that preadults were significantly underrepresented in the Refuge-Deptford mounds. Approximately 35–40 percent of the population might be expected to die before the age of 10; these estimates suggest that only one-third to perhaps one-quarter of the available preadults were actually buried in the Refuge-Deptford mounds (Thomas and Larsen, 1979: 150).

Moore's "Mound in the Greenseed Field" was probably constructed in Deptford times. Of the 25 skeletons encountered, 7 were males and 6 were females (the remainder was uncertain); except for two children and two adolescents, all individuals were adults (Moore, 1897: 88). The "Mound near the light-house" contained 11 adults and a single subadult.[18]

THE WILMINGTON PERIOD
(CAL A.D. 350–800)

Table 30.2 characterizes the 26 archaeological components dating to the Wilmington period, for an average of 2.74 compo-

nents/century (more than twice that for the previous Refuge-Deptford period). From a landscape perspective, the Island-wide survey documented 47 Wilmington period occupations (see fig. 30.26).

THE CERAMIC CHRONOLOGY

DePratter (1979a, 1991) projected the temporal limits of the Wilmington period to be A.D. 500 through A.D. 1000, which calibrate to cal A.D. 630–A.D. 1050/1150 (table 15.3). The various archaeological investigations on St. Catherines Island produced 13 radiocarbon determinations that we believe are firmly associated with Wilmington ceramics. The individual probability distributions of these dates are shown in figure 15.3 and the pooled probability profile appears at the bottom of this diagram. The one-sigma limits of this unimodal distribution are cal A.D. 480–A.D. 690 and the two-sigma limits are cal A.D. 310–A.D. 780.

The St. Catherines Island chronology dates the Wilmington period (cal A.D. 350–A.D. 800) about 3 centuries earlier than DePratter's (1979a, 1991) previous estimate. Both chronologies estimate that the Wilmington period lasted about 4 centuries.

GEOCHRONOLOGY

Guale Island had narrowed significantly by the end of the Wilmington period, but it still protected the extensive Guale Marsh that reached southward past Hoke's Dock to the northern end of Cracker Tom Hammock, with a tidal inlet probably still to the north of present-day McQueens Inlet (fig. 32.6). Linsley's (1993) reconstruction indicates that the southern beach ridge complex extended well beyond Hickory Hill and Long Marsh, terminating somewhere to the south of Beach Pond (Booth et al., 1999a, 1999b). Vibracore evidence demonstrates the rapid change and cyclic nature of sediment sequences, suggesting that Beach Pond was very responsive to the effects of erosion and deposition that accompanied storm washover events and tidal processes as Holocene sea level continued to gradually rise.

THE RADIOCARBON CHRONOLOGY

The probability distribution of the 2005 Dataset (i.e., the 116 cultural radiocarbon dates available at that time) showed two significant gaps that bracketed the Wilmington period (fig. 16.17):

- Gap C. The Deptford–Wilmington Boundary (cal A.D. 400): This hiatus in the ^{14}C probability distribution separates the boundary between the Deptford and Wilmington periods, a break that is statistically significant at the two-sigma level.
- Gap D. The Wilmington–St. Catherines Boundary (cal A.D. 800): A gap in the distribution of radiocarbon evidence spans transition between the Wilmington and St. Catherines periods; this hiatus is statistically significant at the two-sigma level.

With these distributions in mind, we deliberately selected shell samples directed at closing the Deptford–Wilmington interval (Gap C) and an additional eight ^{14}C samples designed to provide age estimates to date the Wilmington–St. Catherines transition (Gap D). These samples were processed in 2006, with the following results (see table 15.2):

North Pasture 1 (9LI238): This small shell midden, located just north of Marys Mound, contains mostly Refuge-Deptford period sherds, with some Wilmington ceramics present as well. Although we processed radiocarbon dates on four *Mercenaria* valves in an attempt to fill the Deptford–Wilmington period gap, none of the samples fell into the target temporal range (although three did fall into the later Wilmington period). This is yet another case of older potsherds deposited in the contexts of a considerably younger shell midden.

9LI196: The ceramic assemblage of this large site (located just north of Cunningham Mound A) is dominated by Wilmington sherds. We selected three samples from the top, middle, and bottom of Test Pit II (Beta-217225, Beta-217226, and Beta-217227), attempting to define a stratigraphic sequence and explore the internal variability of an

Marys Mound

9Li237

estimated shape at cal A.D. 800

Seaside Mound Group

Cunningham Mound Group

Hoke's Landing

9Li164

9Li57

LEGEND

- . archaeological site
- X 0–9 sherds
- ● 10–99 sherds
- ▢ 100–999 sherds
- ▪ > 1000 sherds

Wilmington Period
cal A.D. 350–800

N

1 .5 0 1 km
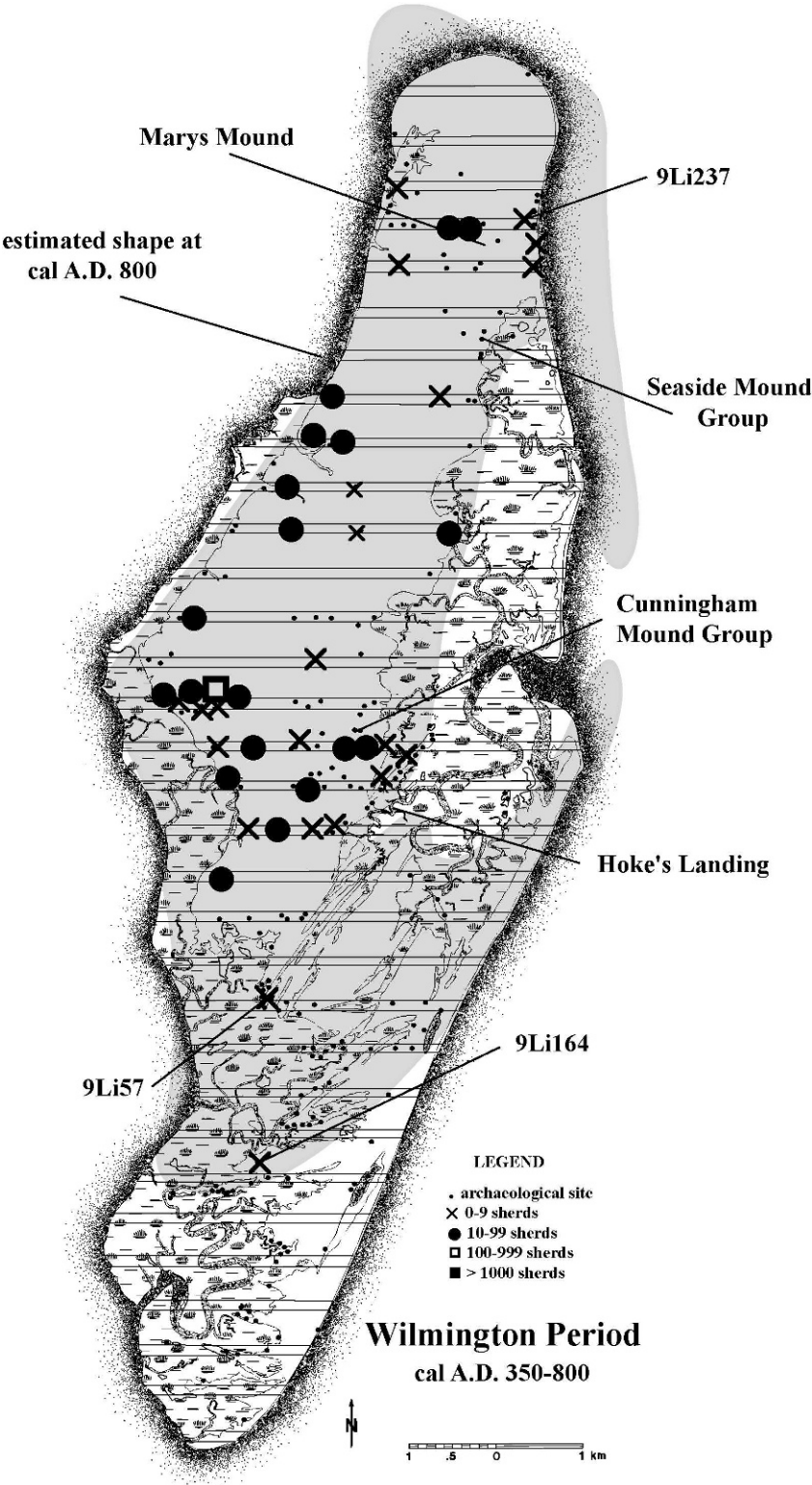
Fig. 32.6. Distribution of archaeological sites dating to the Wilmington period on St. Catherines Island, with an estimated reconstruction of the island shape at cal A.D. 800.

apparently "pure" Wilmington-age midden. As anticipated, the results define a tight chronostratigraphic sequence and fall within the target range of cal A.D. 300–650.

South End Field (9Li194): This site has a ceramic assemblage dating mostly to the Wilmington period, with a minority Deptford component also present. In 2006, we submitted two *Mercenaria* valves for AMS dating (Beta-217223 and Beta-217224). Although each clam shell was found in apparent association with Deptford and Wilmington age ceramics, both *Mercenaria* from 9Li194 date from the late Wilmington period (cal A.D. 700–900). South End Field also contained St. Catherines sherds, and two additional *Mercenaria* valves (Beta-218095 and Beta-218096) were processed to define the Wilmington–St. Catherines transition, which they did.

Rice Field 1 (9Li184): This small site produced Wilmington and Deptford period diagnostics. We submitted a single *Mercenaria* for radiocarbon analysis (Beta-21722), attempting to date the Deptford–Wilmington transition; but the resulting age determination, cal A.D. 660–900, is consistent with the late Wilmington period.

9Li233: This site produced primarily Wilmington ceramics, five additional sherds date to the St. Catherines period. We processed one *Mercenaria* sample (Beta-217235) in association with St. Catherines ceramics and another (Beta-217236), apparently associated with Walthour Complicated Stamped (early Wilmington) ceramics, and both samples fell within the target range.

9Li230: In March 2006, we collected two additional ^{14}C samples from 9Li230 (Beta-215819 and Beta-21520) and, as predicted, both radiocarbon dates span the Wilmington–St. Catherines period transition.

9Li198: This small shell mound contained mostly Wilmington ceramics, with some St. Catherines sherds present as well. We processed two additional *Mercenaria* valves, both associated with Wilmington/St. Catherines ceramics. Beta-218099 provides an acceptable radiocarbon estimate from the Wilmington–St. Catherines period transition and Beta-218100 was harvested during the St. Catherines period.

To summarize: Of the 10 additional ^{14}C samples selected to bridge the gap between the Deptford and Wilmington periods (Gap C, roughly cal A.D. 400; see chap. 16), only two (both from 9Li196) fell within the target interval. With only a single exception, these additional dates consistently dated to the later Wilmington period.[19] Date Beta-218098 (previously discussed as associated with St. Simons ceramics) produced a marine shell date falling on the extreme margin of Gap C (cal A.D. 400–700).

Clearly, then, Gap C (the Deptford–Wilmington Boundary, circa cal A.D. 400) persists despite the rigorous redating reflected in the 2006 Dataset. Figure 32.4 clearly shows this gap in the radiocarbon probability distribution, not only separating the Deptford from the subsequent Wilmington period, but also demarcating the shift from exploitation of western (estuarine) marsh resources to marshside settlements clustering along the eastern (Guale) saltwater marsh (see also fig. 16.12 and 16.17).

A different outcome resulted from retesting the Wilmington–St. Catherines transition (Gap D). All eight of the newly submitted ^{14}C dates provide age estimates falling reasonable close to the Wilmington-St. Catherines transition. In addition, five other *Mercenaria* samples (Beta-217239, Beta-217238, Beta-217221, Beta-217243, and Beta-217244), each found in association with older ceramic associations (primarily from the St. Simons and Refuge periods), fall within the range of Gap D, as did one of the Hayes Island dates (without adequate ceramic associations). From an island-wide perspective, then, Gap D (the Wilmington–St. Catherines Boundary, circa cal A.D. 800) is effectively closed (figs. 16.12 and 16.17; but note that Gap D does persist in the mortuary record of St. Catherines Island; fig. 32.7).
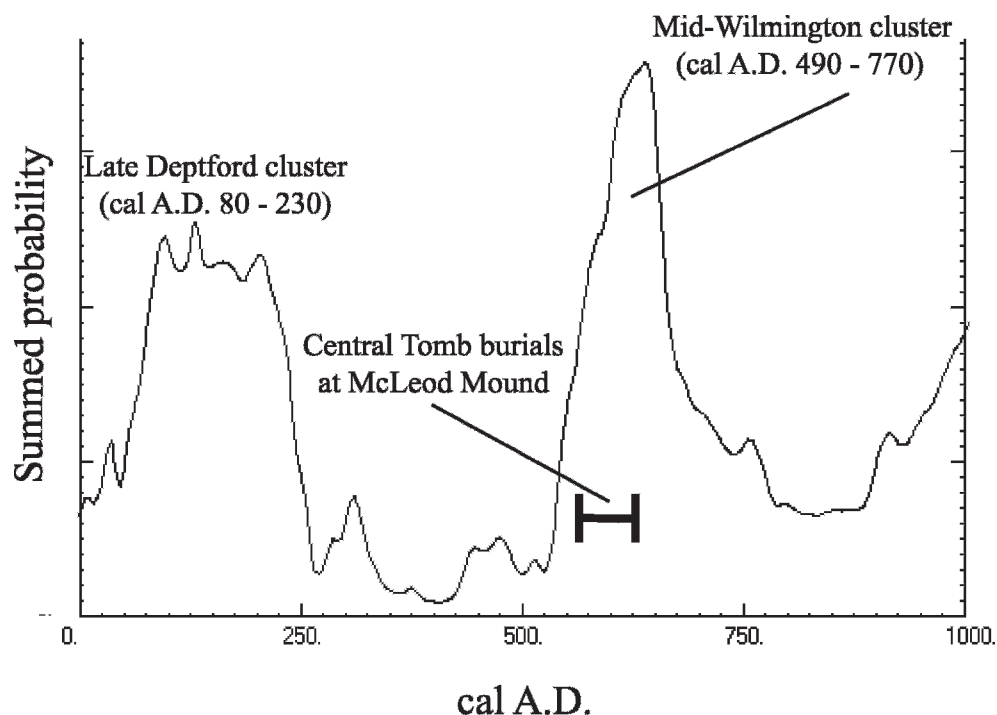
Fig. 32.7.   The cumulative probability profile for mound construction ^{14}C dates (n = 10) available for the interval cal A.D. 1–A.D. 1000 on St. Catherines Island.

The Wilmington Period Landscape

Expectations from prey-choice, patch-choice and central place foraging models have already been compared with the observed distributions of archaeological components and landscape indicators for the Wilmington period (chap. 30).

Figure 32.6 shows the distribution of Wilmington period archaeological components and landscape indicators. The 14 *western marshside components* average a distance of 370 ± 264 m from the marsh margin, consistent with the normal (but not lognormal) distributions projected from central place foraging theory. Identical relationships characterize the distribution of landscape elements (fig. 30.27, bottom, and 30.29).

The Wilmington-age components are also consistent with the contrasting diet-breadth model, which assumes a homogeneous distribution of resources and archaeological evidence across the Pleistocene core of St. Catherines Island. The observed distributions of Wilmington period archaeological components are consistent with the expected uniform distribution of variates, but the landscape distribution is not (fig. 30.30).

The 11 *eastern marshside components* are similarly distributed relative to the marsh edge (374 ± 351 m), and this distribution is consistent with the normal and lognormal expectations from central place foraging theory. Identical relationships are evident for the distribution of landscape elements (fig. 30.27, bottom, and 30.29). The Wilmington-age components are also consistent with the contrasting diet-breadth model, which assumes a homogeneous distribution of resources, but the landscape indicators are not.

Wilmington-era occupations on northern St. Catherines Island thus follow the pattern already established during the previous Refuge-Deptford periods—except that during the Wilmington period (1) the apparent beginnings of mortuary activities appear on

the northern end of the island (at Marys Mound), and (2) habitation sites become relatively more sparse (representing only about 15% of the island-wide total). This settlement pattern shift doubtless reflects the simultaneous southward migration of Guale Marsh because, except for the Northwestern Marsh, the northern end of St. Catherines Island apparently no longer provided access to a productive marshland (figs. 32.3 and 32.6).

One dozen Wilmington period occupations are known from the central island core, in a site cluster extending from Rock and Seaside fields southward into Long Field and King New Ground. Seasonal evidence is available from 9Li162, 9Li232, and 9Li178, each of them two- or three-seasonal occupations (with all four seasons represented). During the late Wilmington period (cal A.D. 400–880), a large intrusive pit was excavated into the Seaside Mound I fill and Burial 5 was placed inside and then covered with several logs. Along the southern margin of Seaside I, a large, postmound midden accumulated with Wilmington ceramics and an adult burial. Oyster shells from this feature dated to cal A.D. 510–770.

The Cunningham Mound group, located within 1 km of the vast marshland surrounding McQueens Inlet was significantly expanded during Wilmington times. At McLeod Mound (9Li47), five female burials were incorporated into the Central Tomb, and the new AMS radiocarbon dates indicate that these individuals died over a temporal span of A.D. 430–580 (1540 ± 25 B.P.). Burial 16, the most recently deceased of these individuals interred in the Central Tomb burials (Beta-223517, cal A.D. 540–670), provides a *terminus post quem* for the construction of McLeod Mound, meaning that mound construction must have taken place during the mid-Wilmington period or later.

The premound primary humus at Cunningham Mound D (9Li46) was burned about cal A.D. 440–710, and the mound was constructed sometime thereafter. The remains of five individuals were recovered here. We think that all mortuary activity at Cunningham Mound D dates to the Wilmington period.

The premound humus at nearby Cunningham Mound E was torched about cal A.D. 540–670. A single (intrusive) burial was encountered here, and the available evidence suggests that Cunningham E was likely constructed and utilized entirely during Wilmington times.

Although Cunningham Mound C was constructed during the Refuge-Deptford periods, an intrusive pit was excavated into the mound fill about cal A.D. 530–770 during the Wilmington period, probably in preparation for interring Burial 1 (an adult female). There is no evidence of subsequent usage.

Four Wilmington-age sites are known from the southern ridge complex, three of them in the Island-wide survey sample. 9Li97 is a dense, three part shell midden draped across a long peninsula. All available hard clams were analyzed for seasonality, disclosing a three-season occupation from summertime through the winter. Although no ceramics were recovered, a single radiocarbon date (Beta-183637) indicates that the midden accumulated during the late Wilmington period (cal A.D. 670–890).

The two additional Wilmington era sites on the southern beach ridge complex sites likewise indicated a three-season occupation. Site 9Li164 is located only a few dozen meters from 9Li97 (the aceramic site mentioned above), and both sites were occupied from summer through winter. *Mercenaria* from 9Li57, located 1500 m to the north, documented an occupation from March to December.

To summarize the incremental data from *Mercenaria*, seasonal estimates exist from 18 Wilmington period components on St. Catherines Island. The total of 48 seasonally specific components is distributed as follows: winter, 33 percent; spring, 27 percent; summer, 23 percent; and fall, 17 percent. Within the limits and biases of the techniques involved, it is clear that during the Wilmington period, St. Catherines Island was utilized during all seasons of the year.

SUBSISTENCE

Wilmington era vertebrate remains are available from 14 sites, none of which pro-

duced large amounts of material. The combined Wilmington assemblage contains 1442 bone fragments, representing only an estimated 65 individuals (table 22.23); deer contributed most of the biomass. Although the largest proportion of these bones came from the central island core, more than 40 percent of these individuals are fishes, with the hardhead catfish (*Ariopsis felis*) more abundant than the others. Reitz (chap. 22) notes that the Wilmington period faunal assemblage differs somewhat from the other post-Archaic periods due to the larger proportion of fishes and the relative scarcity of turtle remains.

Limited stable isotope data are available for the Wilmington period (tables 32.2 and 32.3). The $\delta^{13}C$ ‰ value for two intrusive Wilmington-era burials falls in the exact middle of the probability range for available Deptford period samples. Although one of the $\delta^{13}N$ ‰ values is elevated—the highest recorded in the 50 samples from St. Catherines Island—the difference between the Deptford and Wilmington values is not statistically significant. On the basis of the available samples, we can detect no meaningful dietary differences present between the Deptford and Wilmington periods.

Periodicity of ^{14}C Evidence

Chapter 16 partitioned the Pooled Dataset into mortuary and midden subsamples. The upper half of figure 16.20 plots the probability distribution of the radiocarbon dates recovered from midden contents for the cal A.D. 1–A.D. 1000.[20] The probability distribution of marine dates increases gradually during this interval, with no gaps evident at the two-sigma level.[21] Strictly with respect to midden deposition, the previously apparent gaps in the radiocarbon record (Gaps C and D) were filled with the new dates in the 2006 Dataset.

A very different story pertains to the timing of mortuary events during the Wilmington period. Figure 32.7 presents the probability distribution of the roughly 17 radiocarbon dates reflecting the two distinct flurries of mound construction activities between cal A.D.1 and cal A.D. 1000 on St. Catherines Island.

We have already discussed the cluster of mortuary activities during the late Deptford period (cal A.D. 80–230). Figure 32.7 shows the second spike in mortuary ^{14}C evidence activity during the mid-Wilmington period (circa cal A.D. 490–A.D. 770), separated by a slight gap (formerly called Gap D) prior to resumption of burial mound building during the St. Catherines phase. Although this cal A.D. 770–A.D. 900 gap is swamped by the prevalence of radiocarbon dates from midden contexts in the pooled distribution (fig. 16.20), the Wilmington–St. Catherines period transition in mortuary behavior indeed seems to have cultural significance.

The mid-Wilmington cluster derives from four archaeological sites. Two of these dates come from Seaside Mound I: UGA-112 was processed on charcoal from a log associated with an intrusive ovoid burial pit and UGA-1826 dates marine shell recovered from Feature 15 (a postmound midden). The Cunningham Mound C date (UCLA-1997A) was processed on charcoal contained within Feature 1 (a hearth associated with intrusive Burial 1). The Cunningham Mound D date (UCLA-1997D) and the two dates from Cunningham Mound E (UGA-1559 and UGA-1561) come from charcoal contained in the primary humus.

In addition to the six mound-construction dates are the four new AMS dates (Beta-223515, Beta-223516, Beta-223517, and Beta-223518) on human bone recovered from the Central Tomb at McLeod Mound. Burial 16, the most recently deceased of these individuals interred in the Central Tomb burials (Beta-223517, cal A.D. 540–670), provides a *terminus post quem* for the construction of McLeod Mound.

This cluster of 10 mid-Wilmington mortuary dates suggests the following:

- By cal A.D. 540–660, additional burial mounds stood at Seaside I and Cunningham C.
- McLeod Mound was erected sometime after cal A.D. 540–670.
- Whereas the premound surface was burned at Cunningham Mounds D and E, one cannot conclusively demonstrate any specific mortuary behavior or mound building at either site.

TABLE 32.2
Stable Isotope Values for Bone Samples from St. Catherines Island (after Larsen et al., 2001: table 3.2)

Lab no.	Site	Burial no.	Sex	$\delta^{13}C$‰	$\delta^{15}N$‰	Period	Context	Estimated birthdate	Reference
UCT386	Seaside Mound II	11	♂	−13.8	10.6	Deptford	Premound burial	Deptford period	2,3
UCT387	Seaside Mound II	13	♀	−15.7	—	Deptford	Premound burial	Deptford period	2,3
UCT385	Seaside Mound I	14	♂	−15.0	—	Deptford	Premound burial	Pre-cal A.D. 540–640	2,3
UCT395	Cunningham Mound C	3	♀	−14.8	—	Deptford	Premound burial	Pre-cal A.D. 540–640	3
UCT389	McLeod Mound	13	♀	−17.1	13.1	Wilmington	Premound tomb	Est. cal A.D. 500–600	3
UCT391	McLeod Mound	15	♀	−18.6	12.9	Wilmington	Premound tomb	cal A.D. 490–600 (Beta-223516)[a]	3
UCT392	McLeod Mound	16	♀	−13.8	12.6	Wilmington	Premound tomb	cal A.D. 540–670 (Beta-223517)[a]	3
UCT393	McLeod Mound	17	♀	−13.6	12.4	Wilmington	Premound tomb	cal A.D. 260–540 (Beta-223518)[a]	3
UCT388	Seaside Mound II	14	♀	−13.4	13.2	Deptford ?	Intrusive burial	Unknown	2,3
UCT394	Cunningham Mound C	1	♂	−16.0	14.4	Wilmington	Intrusive (Feature 1)	cal A.D. 540–640	3
UCT396	Cunningham Mound D	2	♂	−13.9	12.9	Wilmington	Intrusive burial	Unknown	3
UCT372	Johns Mound	1	♂	−14.2	11.6	St. Catherines	Shell core burial	cal A.D. 960–1230	2,4
UCT379	Johns Mound	14	♂	−13.4	13.1	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT377	Johns Mound	16	♀	−14.6	13.3	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT376	Johns Mound	18	♀	−13.9	13.6	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT374	Johns Mound	26	I[b]	−13.6	12.3	St. Catherines	Intrusive into Stage I	cal A.D. 960–1230	2,4
UCT370	Johns Mound	36	I[b]	−14.1	13.0	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT375	Johns Mound	37	♀	−14.4	12.7	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT378	Johns Mound	47	♂	−14.3	13.5	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT373	Johns Mound	B	♂	−14.2	12.9	St. Catherines ?	Association unknown	—	2,4
UCT371	Johns Mound	11A	♂	−14.2	13.3	St. Catherines	Stage I burial	cal A.D. 1020–1250	2,4
UCT380	Marys Mound	1	♀	−14.3	11.8	St. Catherines	Premound pit	Pre-cal A.D. 1160–1402	2,4
UCT381	Marys Mound	5	♀	−14.7	12.9	St. Catherines	Intrusive burial	Post-cal A.D. 1160–1402	2,4
MS4843	South End Mound I	5	♂	−13.3	13.1	Irene	Moore's burial 32	—	1,5,7
MS4844	South End Mound I	6	♀	—	12.5	Irene	Moore's burial 39	—	1,5,7
MS4847	South End Mound I	16	♀	—	10.4	Irene	Moore's burial 46	—	1,5,7
MS4850	South End Mound I	24	♀	−13.2	12.8	Irene	Moore's burial 34	—	1,5,7
MS4851	South End Mound I	27	♀	−12.4	11.7	Irene	Moore's burial 24	—	1,5,7
MS2835	Santa Catalina de Guale	9	♀	−9.6	7.4	Mission	Cemetery	A.D. 1580–1680	6
MS2836	Santa Catalina de Guale	18	♂	−11.7	9.6	Mission	Cemetery	A.D. 1580–1680	6
MS2838	Santa Catalina de Guale	22	♀	−12.4	9.6	Mission	Cemetery	A.D. 1580–1680	6
MS2839	Santa Catalina de Guale	39	♂	−11.6	10.4	Mission	Cemetery	A.D. 1580–1680	6

TABLE 32.2—(*Continued*)

Lab no.	Site	Burial no.	Sex	$\delta^{13}C‰$	$\delta^{15}N‰$	Period	Context	Estimated birthdate	Reference
MS2840	Santa Catalina de Guale	41	♂	−11.0	9.8	Mission	Cemetery	A.D. 1580–1680	6
MS2841	Santa Catalina de Guale	46	♂	−10.4	8.5	Mission	Cemetery	A.D. 1580–1680	6
MS2844	Santa Catalina de Guale	58	♀	−12.0	9.5	Mission	Cemetery	A.D. 1580–1680	6
MS2832	Santa Catalina de Guale	60	♀	−14.3	9.5	Mission	Cemetery	A.D. 1580–1680	6
MS2848	Santa Catalina de Guale	64	♀	−11.8	9.9	Mission	Cemetery	A.D. 1580–1680	6
MS2849	Santa Catalina de Guale	74	♂	−9.69	7.5	Mission	Cemetery	A.D. 1580–1680	6
MS2850	Santa Catalina de Guale	88	♀	−11.0	9.7	Mission	Cemetery	A.D. 1580–1680	6
MS2851	Santa Catalina de Guale	98	♀	−11.2	8.9	Mission	Cemetery	A.D. 1580–1680	6
MS2857	Santa Catalina de Guale	99	♀	−12.1	9.0	Mission	Cemetery	A.D. 1580–1680	6
MS2861	Santa Catalina de Guale	107	♂	−10.8	10.8	Mission	Cemetery	A.D. 1580–1680	6
MS2865	Santa Catalina de Guale	123	♀	−11.2	10.2	Mission	Cemetery	A.D. 1580–1680	6
MS2862	Santa Catalina de Guale	160	I[b]	−12.9	9.9	Mission	Cemetery	A.D. 1580–1680	6
MS2869	Santa Catalina de Guale	169	♂	−11.6	9.3	Mission	Cemetery	A.D. 1580–1680	6
MS2871	Santa Catalina de Guale	219	I[b]	−11.0	8.9	Mission	Cemetery	A.D. 1580–1680	6
MS2876	Santa Catalina de Guale	235	I[b]	−10.6	10.0	Mission	Cemetery	A.D. 1580–1680	6
MS2879	Santa Catalina de Guale	276	♀	−11.3	9.4	Mission	Cemetery	A.D. 1580–1680	6
MS2877	Santa Catalina de Guale	294	♂	−11.4	9.8	Mission	Cemetery	A.D. 1580–1680	6
MS2859	Santa Catalina de Guale	111	I[b]	−12.6	9.6	Mission	Cemetery	A.D. 1580–1680	6

References: 1: Moore (1897); 2: Caldwell (1971); 3: Thomas and Larsen (1979); 4: Larsen and Thomas (1982); 5: Larsen and Thomas (1986); 6: Larsen (2001); 7: Larsen (2002).

[a] The AMS radiocarbon dates actually estimate time of death (rather than birthdate) but given the errors of estimate, this difference is negligible.
[b] Sex indeterminate.

TABLE 32.3
Summary Statistics from Stable Isotope Analysis of Human Bone Recovered on St. Catherines Island

Period	n	Mean	SD	Range
Carbon isotopes				
Deptford–Wilmington	11	−15.06	1.657	−13.4 to −1.86
St. Catherines	12	−14.158	0.375	−13.4 to −14.7
Irene	3	−12.967	0.493	−12.4 to −13.3
Mission	22	−11.464	1.044	−9.6 to −14.3
Nitrogen isotopes				
Deptford–Wilmington	8	12.760	1.060	10.6 to 14.4
St. Catherines	12	12.833	0.637	11.6 to 13.6
Irene	5	12.100	1.084	10.4 to 13.1
Mission	22	9.418	0.819	7.4 to 10.8

MORTUARY ACTIVITIES

Of the 31 burials assigned to the Wilmington period, specific burial treatment could only be assessed in 18 individuals (table 32.1). One dozen of the Wilmington period burials were buried in a supine-extended position, which indicates that these individuals were interred shortly after death. Four of the Wilmington individuals were interred as bone bundles, and these individuals were likely buried a considerable time after death. One cremation was recovered at Cunningham Mound D, as was a single flexed burial. Larsen estimated estimate age at death for most of the Wilmington period burials (29 of 31), identifying 28 adults and only 1 subadult (Thomas and Larsen, 1979: 150).

Particularly noteworthy is the Central Tomb at McLeod Mound, which contained five adult female burials. As noted in chapter 24, the Central Pit at McLeod began as a 6-m-long excavation through the primary humus; this pit was subsequently refilled; no artifacts or burials survived within this pit. Sometime well before cal A.D. 1, the filled-in pit was covered with a ring of marine shell and potsherds. Two clam shells (UGA-1554 and UGA-1555) from this feature were radiocarbon dated (to cal 850–460 B.C. and cal 340 B.C.–A.D. 80, respectively); seasonal analysis indicates that the clams were collected during the winter. A second pit was excavated on the northern end of this feature, and five female skeletons (burials 13–17) were laid out in the northern pit and then covered with clean yellow sand.

Returning to the four AMS radiocarbon dates on burials found within the Central Tomb of McLeod Mound (see table 13.4), figure 32.8 plots the individual radiocarbon dates and the summed probability:

(Beta-223515 [AMS], burial 14) 1500 ± 50 B.P. cal A.D. 430–650

(Beta-223516 [AMS], burial 15) 1580 ± 50 B.P. cal A.D. 490–600

(Beta-223517 [AMS], burial 16) 1430 ± 50 B.P. cal A.D. 540–670

(Beta-223518 [AMS], burial 17) 1640 ± 50 B.P. cal A.D. 260–540

As noted earlier, the age of death for Burial 16 (Beta-223517, cal A.D. 540–670) provides a *terminus post quem* for the construction of McLeod Mound, demonstrating that the mound fill at McLeod must have been added during the mid-Wilmington period or later.

Note the range of variability within these four dates. Writing about the burials within the Central Tomb at McLeod Mound, we had previously suggested that "the individuals buried as bundles perhaps died on the mainland, and were then transported for burial on St. Catherines; the articulated individuals might well have died shortly before the mound itself was constructed" (Thomas and Larsen, 1979: 147). Using standard forensic conventions, Larsen further suggested a hypothetical burial sequence within the Central Tomb at McLeod Mound:

Beta-223517   Burial 16

Beta-223515   Burial 14

Beta-223516   Burial 15

Beta-223518   Burial 17
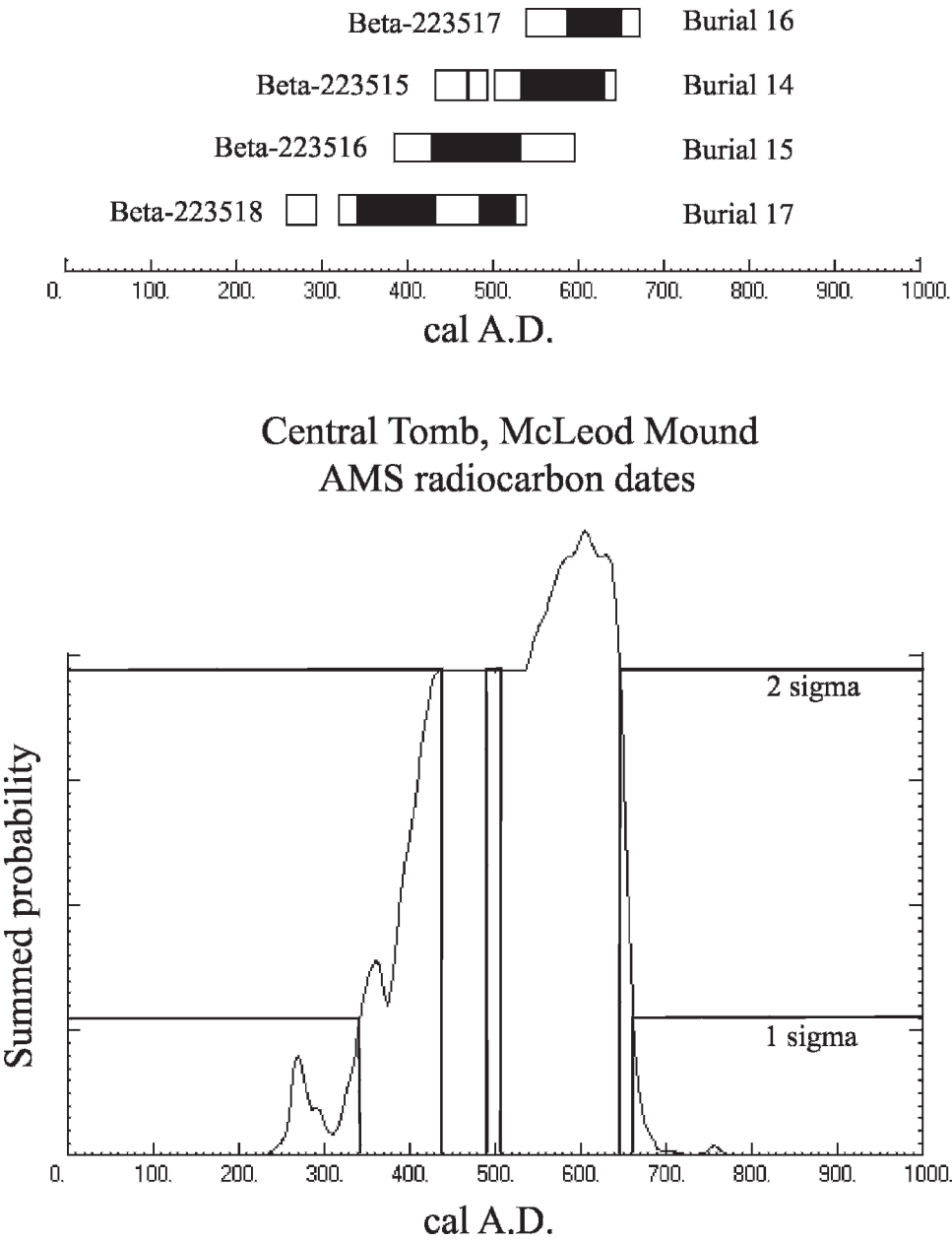
cal A.D.

Central Tomb, McLeod Mound
AMS radiocarbon dates

2 sigma

1 sigma

Summed probability

cal A.D.

Fig. 32.8. Cumulative probability distribution for four AMS-dates on human bone from the Central Tomb at McLeod Mound, St. Catherines Island.

- Individuals 13 and 17, both adult females, were buried as bone bundles. Based on the absence of any articulated bones in the burial bundles, Larsen estimated that these two individual had died *at least* 6 months before interment.
- The partially articulated left hand and thoracic vertebrae of individual 14 (an adult female) suggest a death less than 6 months before interment (and hence, considerably later than individuals 13 and 17).
- Two females, individuals 15 and 16 were fully articulated when interred, indicating that each person must have died shortly before her burial in the Central Tomb.

These are, of course, minimal estimates, especially with regard to burials 13 and 17 (since bundle burials could be buried/reburied centuries after the individuals' demise).

The AMS radiocarbon evidence can now be projected against Larsen's hypothetical burial sequence, as formalized into three hypotheses:

- *Hypothesis One: Forensic evidence suggests that individuals 13 and 17 died well before the other females buried in the Central Tomb*. The AMS radiocarbon evidence partially confirms this proposition, because individual 17 (Beta-223518) is significantly older than the age at death for individuals 14 and 15.[22]
- *Hypothesis Two: Individual 14 died after individuals 13 and 17, but before individuals 15 and 16*. The AMS evidence suggests that individual 14 did indeed die later than individual 17, but the difference in age between individuals 14, 15, and 16 is not statistically significant.[23]
- *Hypothesis Three: Individuals 15 and 16 are the most recently deceased in the Central Tomb:* The mean estimated age at death for individual 16 is indeed later than that for individual 17 (and this difference is statistically significant), but the other temporal differences are not significantly different.[24]

The ^{14}C evidence is generally consistent with the suggestions based on Larsen's forensic analysis of burials inside the Central Tomb at McLeod Mound. But, clearly, the temporal scale of AMS radiocarbon dating is too coarse-grained for satisfying results.

BIOARCHAEOLOGY

Tables 32.2 and 32.3 present the results of stable isotope analysis from 11 samples of human bone dating to the Deptford–Wilmington periods on St. Catherines Island (from McLeod Mound, Seaside Mounds I and II, and Cunningham Mounds C and D). Except for the two (undated) intrusive burials and the burials in Seaside Mound II, the birthdates of these individuals can be bracketed between cal A.D. 1 and cal A.D. 540–640 (the late Deptford through mid-Wilmington periods).

Figure 32.9 plots the relevant isotope ratios, and considerable variability characterizes the Deptford–Wilmington time span

(cal 350 B.C.–A.D. 800). Of particular interest are the results from the four (of five) female burials interred within the Central Tomb at McLeod Mound, which (as discussed above) have a mean pooled ^{14}C age of cal A.D. 430–580. Nitrogen levels are virtually identical in all four individuals, ranging between 12.4‰ and 13.1‰ and falling toward the center of the overall distribution for the Deptford–Wilmington period on St. Catherines Island.

The considerably broader distribution of $\delta^{13}C$ values is both striking and informative. McLeod individuals 13 and 15 have carbon isotopic values of –17.1‰ and –22.6‰ respectively, the most negative $\delta^{13}C$ values observed for any of the 50 samples available from St. Catherines Island. With respect to these two individuals, Schoeninger et al. (1990: 88) conclude that the strongly negative carbon values resulted from a diet heavily dependent on terrestrial foods: "An individual eating only terrestrial C_3-based food (acorn, hickory, deer, rabbit, etc.) should have a bone collagen $\delta^{13}C$ value of around –21‰. Thus, within the sample from the Deptford-Wilmington period, there are individuals who had different lifelong dietary adaptations." The remaining samples are comparable to the four McLeod Mound samples with respect to nitrogen isotope levels, but they contain notably higher (less negative) $\delta^{13}C$ values. Schoeninger et al. (1990: 92) conclude that the individuals represented in the Deptford–Wilmington samples "probably enjoyed diets that ranged from less than 30 percent of calories from marine foods to over 50 percent from marine sources."

Bone chemistry is a lifelong average of an individual's diet, but growth during youth and adolescence is particularly critical because this is when bone collagen forms. The Central Tomb contained the remains of two individuals who had been raised on a predominantly marine-based diet (similar to that found on St. Catherines Island, or perhaps a nearby coastal environment). Individuals 13 (buried as a bundle) and 15 (who died immediately before interment), however, were raised on more terrestrial diet, ingesting significantly fewer marine re-
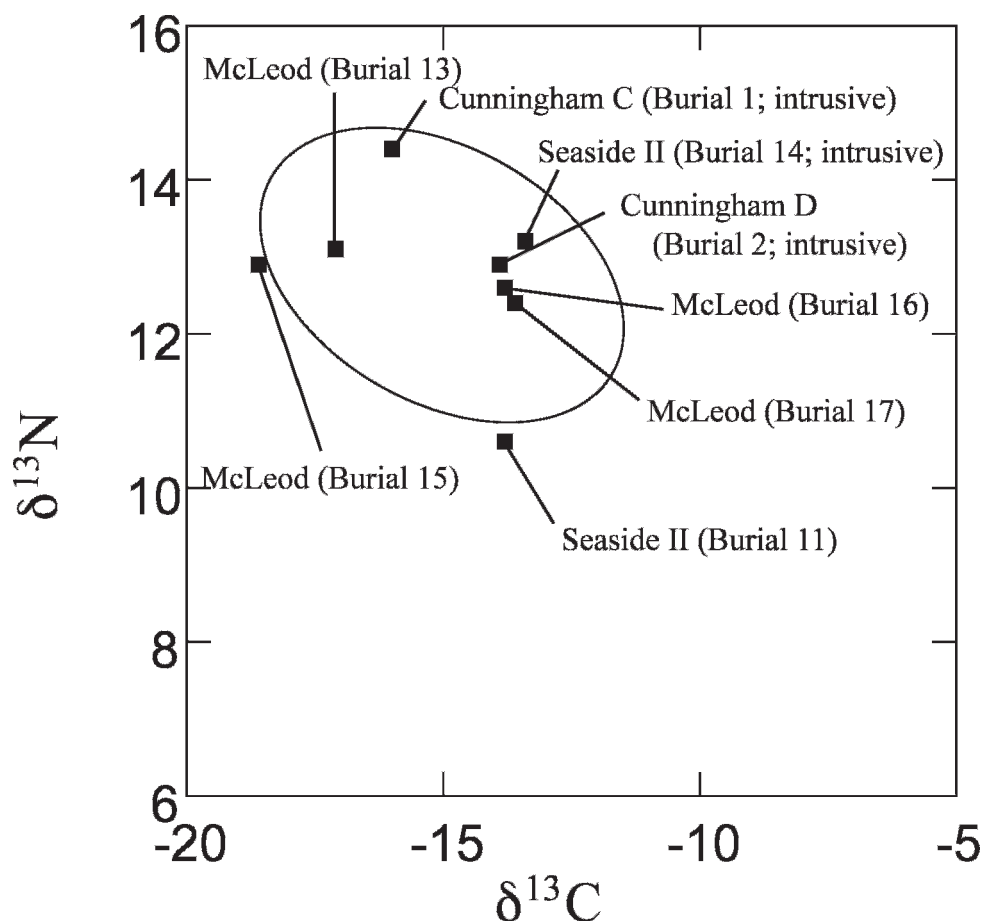
Fig. 32.9.   Results of stable isotope analysis on Deptford-Wilmington period burials from St. Catherines Island.

sources. Simply put, the overall range of variability within these five females is greater than that expected from a single dietary regimen—particularly given the fact that these women lived at the same time, likely knew one another (perhaps were related), and were buried together in a common grave.

Biomechanical analysis of Deptford–Wilmington period burials shows that the femora and humeri from McLeod Mound (and contemporary sites on the Georgia Coast) tend to be quite robust, with a marked degree of sexual dimorphism, likely reflecting differential gender roles, especially long-distance travel by males (Ruff and Larsen, 2001; see also Ruff et al., 1984; Ruff and Larsen, 1990; Larsen and Ruff, 1994; Larsen et al., 1996). Deptford–Wil-

mington males also had an increased overall mechanical loading of the lower and upper limbs. Compared with the aboriginal populations that lived subsequently on St. Catherines Island, people of the Deptford–Wilmington periods seem to have had relatively few infectious diseases (as reflected by the lack of periosteal reactions), and they also enjoyed superior dental health (as indicated in the low rate [2.3 %] of dental caries and carious lesions; per Reitz et al., 2002: 52–53). These findings are generally consistent with trends noted among hunter–gatherer populations elsewhere in North America.

Limited stable isotope data are available for the additional burials of the Deptford–Wilmington period. The $\delta^{13}C$ ‰ value for

two intrusive Wilmington-era burials falls in the exact middle of the probability range for available Deptford–Wilmington period samples (Schoeninger et al., 1990; see tables 3 and 4). Although one $\delta^{13}N$ value is elevated—the highest recorded in the sample of 50 samples from St. Catherines Island—the difference between Wilmington and Deptford values is not statistically significant. On the basis of the available samples, we can detect no meaningful dietary differences present between the Deptford and Wilmington periods.

Data relevant to mortuary behavior are likewise quite limited for the Wilmington period. As noted above, intrusive burials were added to existing mounds in the Seaside and Cunningham Mound groups, and two additional mounds were constructed in the Cunningham Mound group. The available evidence suggests a continuation of the pattern already well established for the Deptford period: the interment of mostly adults, a preponderance of female burials, the absence of specific grave furniture, and continued usage of well-defined cemeteries and mounds.

THE ST. CATHERINES PERIOD
(CAL A.D. 800–1300)

Table 30.2 details 20 archaeological components dating to the St. Catherines period. Figure 30.7 plots the St. Catherines period landscape, which consists of 41 occupations documented during the Island-wide systematic transect survey (fig. 32.10). The various St. Catherines assemblages tend to be much smaller than those of previous and subsequent periods (table 30.2); despite extensive testing in several of these components, the complete absence of large St. Catherines period assemblages seems noteworthy.

THE CERAMIC CHRONOLOGY

DePratter (1979a, 1991) previously suggested that the St. Catherines period spanned the A.D. 1000–1200 interval (which translates to cal 1050/1150–A.D. 1280). Sixteen ^{14}C dates from St. Catherines Island can be positively associated with St. Catherines ceramics (figs. 15.4 and 15.11) and

figure 15.5 demonstrates a unimodal probability ranging between one-sigma limits of cal A.D. 890–A.D. 1170; the two-sigma limits are cal A.D. 780–A.D. 1270.

These data confirm the conclusion, discussed above, that the Wilmington–St. Catherines period boundary is about cal A.D. 800. Defining the terminal boundary of the St. Catherines period is relatively straightforward. The one-sigma limit of the pooled probability distribution is cal A.D. 1170, and the two-sigma limit is cal A.D. 1270 (figs. 15.4 and 15.11). Looking strictly at the St. Catherines period data, we have rounded off this terminal date to cal A.D. 1300 (which corresponds almost precisely to DePratter's, 1979a, 1991, previous estimate).[25]

The St. Catherines Island chronology dates the St. Catherines period to cal A.D. 800–A.D. 1300, which begins about 300 years earlier than the previous estimate and ends about the same time. In the transition from the Northern Georgia coast chronology to the St. Catherines Island chronology, the St. Catherines period expands from <200 years to 5 centuries in duration.

GEOCHRONOLOGY

Guale Island had significantly narrowed by the end of the Wilmington period, but it still protected the extensive Guale Marsh that reached southward past Hoke's Dock to the northern end of Cracker Tom Hammock. Linsley's (1993) reconstruction indicates that the southern beach ridge complex extended well beyond Hickory Hill and Long Marsh, terminating somewhere to the south of Beach Pond (Booth et al., 1999a, 1999b).

THE RADIOCARBON AND TREE-RING CHRONOLOGIES

We already discussed the radiocarbon retesting of the Wilmington–St. Catherines transition (Gap D: cal A.D. 1200–1300) previously evident in the 2005 Database. All eight of the ^{14}C dates submitted in 2006 provided age estimates falling reasonably close to the Wilmington–St. Catherines transition and an additional five *Merce-*
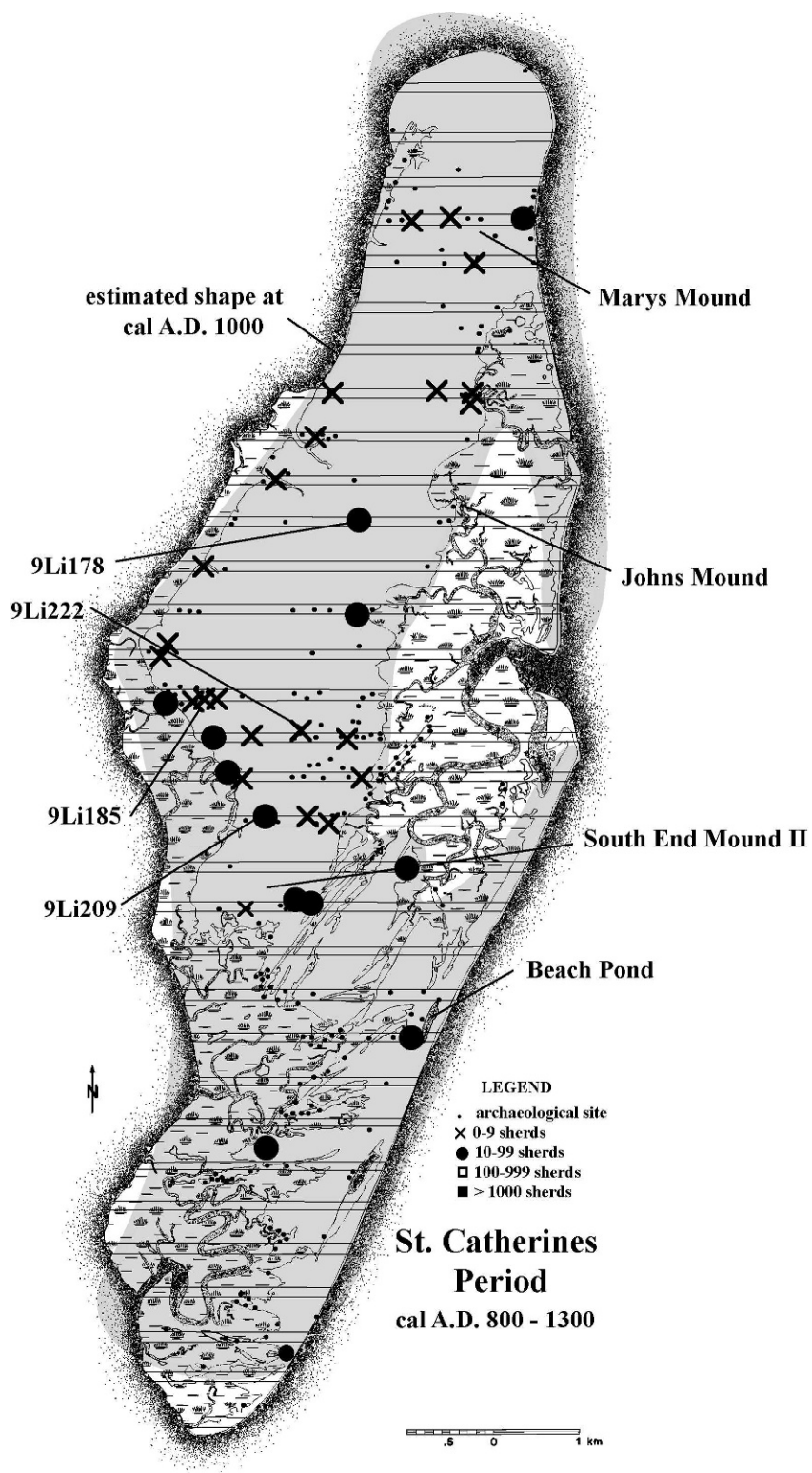
Fig. 32.10. Distribution of archaeological sites dating to the St. Catherines period on St. Catherines Island, with an estimated reconstruction of the island shape at cal A.D. 1000.

naria samples, each found in apparent association with sherds (primarily from the St. Simons and Refuge periods), also fell into the range of Gap D, as did one of the Hayes Island dates, without adequate ceramic associations. As a result, we concluded that Gap D (the Wilmington–St. Catherines Boundary, circa cal A.D. 800) was effectively closed (figs. 16.12 and 16.17).

Chapter 16 discussed the so-called Gap E that defined the St. Catherines–Irene period boundary (cal A.D. 1200–1300) in the 2005 Database. In 2006, we processed several additional *Mercenaria* samples, each associated with St. Catherines, Savannah, and/or Irene period ceramics.

9Li169: This large site is adjacent to Seaside Mound II. In 2006, we processed two additional ^{14}C samples (Beta-215812 and Beta-215813) to clarify further the age of St. Catherines–Savannah period ceramics. Both ^{14}C samples, found with Savannah ceramics, produced dates spanning the St. Catherines–Irene period transition.

Davy Field 1 (9Li189): To examine the relationship of late St. Catherines, Savannah, and Irene ceramic complexes, we processed two *Mercenaria* values for ^{14}C analysis (Beta-215814 and Beta-215815), which date to the St. Catherines–Irene period transition (although Beta-215814 is slightly later).

Hayes Island (9Li1620): Without adequate ceramic associations, we could not anticipate the age of Hayes Island radiocarbon dates. Beta-215817 spans the St. Catherines–Irene transition.

Each of the targeted ^{14}C samples produced radiocarbon dates spanning the transition between the St. Catherines and Irene periods. Gap E, The St. Catherines–Irene Boundary (cal A.D. 1200–1300) remains, but it is much narrower, with one-sigma limits of cal A.D. 1180–1280 (near the common boundaries of the St. Catherines, Savannah, and Irene periods).

Specifically, the radiocarbon record for the St. Catherines period shows an influx of ^{14}C dates from midden contexts, peaking about cal A.D. 1050, then trailing off to define a notable gap between cal A.D. 1150 and A.D. 1300 (figs. 16.20 and 16.24). Figure 16.24 plots the probability distribution of all post-cal A.D. 1000 radiocarbon dates recovered from midden contents (roughly 67 individual ^{14}C dates). Although calibration distortion effects could condition the overall configuration of marine shell dates during the post-A.D. 1000 interval, such effects did not create the one-sigma trough centered at cal A.D. 1180–1280 (near the boundary between the St. Catherines and Irene periods; see also fig. 16.24). This gap in the shell midden chronology not only coincides almost exactly with the St. Catherines Period Drought of 1176–1220, as defined by the baldcypress tree-ring sequence (see chap. 28, this volume), but the trough immediately predates the projected interval for the Savannah period in the northern Georgia chronology, which DePratter (1979a, 1991) estimates to have ranged between A.D. 1200 and A.D. 1325 (in uncalibrated ^{14}C years), which converts to cal A.D. 1280–1310/1390.

Chapter 16 considered the difficulties in recognizing a Savannah period presence on St. Catherines Island, despite the impressive presence of Savannah period constructions near the mouth of the Savannah River (see also Caldwell and McCann, 1941; Waring, 1968d). Looking at the linkages among tree-ring data, radiocarbon evidence, mound construction sequences, and ceramic frequencies, it is clear that a period of prolonged drought from A.D. 1176 through A.D. 1220 must have had a serious and negative impact on St. Catherines Islanders.

THE ST. CATHERINES PERIOD LANDSCAPE

Figure 32.10 arrays the distribution of the 16 St. Catherines period components in the Island-wide sample (see also fig. 30.29). The nine western marshside settlements average 250 ± 225 m from the marsh margin. The eastern marshside settlements average much closer to the marsh edge (197 ± 197 m), but this distribution is clearly bimodal, with all (but one) of the sites clustering within 125 m of the marsh

edge. Figure 30.20 shows that the distribution of St. Catherines period components along the western marshland is consistent with expectations from both the normal and lognormal distributions. Along the eastern marsh margin, the St. Catherines components are consistent with a lognormal distribution, but differ from normal expectations under the central place foraging model. The 36 landscape indicators for the St. Catherines period are distributed in normal fashion along the western marsh and in lognormal distribution along the eastern marsh (fig. 30.21).

Simply put, no matter how the St. Catherines period landscape and components are partitioned, the observed distributions are fully consistent with normal/lognormal expectations. This is a better degree of fit to the central place foraging model than any previous temporal period on St. Catherines Island.

MARSHSIDE SETTLEMENTS ON THE HOLOCENE-AGE BEACH RIDGES: Figure 30.25 plots the distance to marsh for the archaeological components and landscape of the St. Catherines period settlements on the southern Holocene beaches of St. Catherines Island (tables 30.2 and 30.3). When viewed against comparable St. Catherines-age settlements of the Pleistocene core, the archaeological components and landscapes of the Holocene beach ridge margins appear to be miniaturized. The mean distance to marsh for the Pleistocene core components are 250 ± 225 m and 196 ± 396 m for western and eastern marshland settlement, respectively. On the southern Holocene beach ridges, the distance to marsh for St. Catherines period components is only 62.5 ± 99 m, reflecting the dramatically fragmented patch sizes of the Holocene beach terrain. Similar relationships hold for the St. Catherines period landscape (table 30.2), but, due to the variability and small sample sizes involved, the results lack statistical significance.

Table 30.8 presents the results from goodness-of-fit testing between expected and observed frequencies for the southern Holocene beach ridges. The distribution of St. Catherines period components is consistent with the theoretical lognormal model.

The landscape distribution is also consistent with both normal and uniform expectations, but the small sample size does not allow adequate discrimination between theoretical and observed values.

The contrasting diet-breadth model does not fare so well (table 30.8), with none of the observed–expected comparisons for St. Catherines period components and landscapes being consistent with the uniform theoretical distribution.

Looking at comparable settlements of the Pleistocene core, the St. Catherines period components and landscapes are miniaturized across the Holocene beach ridge margins (fig. 30.25, tables 30.2 and 30.3). As noted above, the mean distance to marsh for the Pleistocene core components is 250 m and 196 m for western and eastern marshland settlements, respectively, but on the southern Holocene beach ridges, the distance to marsh for the St. Catherines Island components is only 63 ± 99 m, reflecting the diminished patch sizes of the Holocene beach terrain. Similar relationships hold for the St. Catherines period landscape (table 30.2), but due to the variability and small sample sized involved, the results lack statistical significance.

The distribution of St. Catherines period components on the southern Holocene beach ridges is consistent with the theoretical lognormal model (table 30.8), and the landscape distributions are consistent with normal and uniform expectations. But the small sample sizes do not allow adequate discrimination between theoretical and observed values.

ST. CATHERINES PERIOD OUTLIERS: Central place foraging theory predicts the St. Catherines period settlement pattern to a remarkable degree, but the outliers remain noteworthy.

Cunningham Field (9Li209) is an anomalous site, without freshwater or marshaside connections. Located 520 m from the western marsh margin on a broad expanse of Foxworth fine sand, this four-season site is just to the south of the Cunningham burial mound complex (which was apparently not used for mortuary purposes during the St. Catherines period).

Three additional St. Catherines period sites are located in an inland, lacustrine setting, bordering the expansive freshwater meadow that once dominated the central swale of St. Catherines Island.

Rice Field 2 (9Li185) stands on Echaw/Centenary soils, but is immediately adjacent to a patch of Rutledge soil; the unusually consistent incremental pattern on *Mercenaria* strongly suggests a single wintertime harvest.

9Li224 is located at Wamassee Pond, 580 m inland from the western marsh, and is the only site recorded on Ellebelle loamy sand (a very poorly drained soil common to depressions, bays, and large drainage ways). Situated immediately to the east of a freshwater lagoon, 9Li224 was occupied primarily during the Wilmington period, with a secondary St. Catherines period occupation.

Greenseed Field 1 (9Li178) is located 1090 m inland, where a long, narrow band of Echaw/Centenary fine sand defines the inland margin of the eastern swale, with its characteristic long, linear freshwater swamp.

SUBSISTENCE

We recovered a rather small sample of St. Catherines period vertebrate remains from six sites, only 641 specimens (representing a minimum of 27 individuals).[26] Although St. Catherines period sites are more numerous on the Pleistocene island core, the most of these faunal materials came from sites on the southern beach ridge complex. The St. Catherines period bones are mostly those of deer, diamondback terrapins, hardhead catfishes, and raccoons, with deer contributing most of the biomass.

SEASONALITY

Seasonal estimates are available from 13 St. Catherines period sites representing three dozen seasonally specific components and distributed as follows: winter, 36 percent; spring, 31 percent; summer, 22 percent; and fall, 11 percent. These totals represent a slight decrease in documented fall occupations from previous and subsequent periods.

MORTUARY ACTIVITIES

The specifics of the St. Catherines period mortuary complex have been considered elsewhere (Larsen and Thomas, 1982, 1986: 40–41; Larsen, 2002; see also chap. 24, this volume); here, we concentrate on the overarching commonalities and differences.

The architecture of the three St. Catherines period mounds is remarkably similar. All three mounds commenced with a central pit feature containing multiple human burials (a large proportion of which are subadults). The central features at Johns and Marys mounds were log-line pentagonal pits (and that at South End Mound II, while conspicuous, was not sufficiently well preserved to define the mode of construction). Each central pit feature was then covered by an oyster shell core, and the ^{14}C dates of these features are statistically identical. The shell features at South End Mound II contained strictly St. Catherines period ceramics, as did the corresponding strata at Johns and Marys mounds. The ceramic complexes recovered at all three sites are likewise comparable, including some Savannah period ceramics, which are likely contemporaneous with St. Catherines period diagnostics (see chap. 15).

The mortuary demographics changed significantly during the St. Catherines period. Burial features dating to the previous Deptford–Wilmington periods contained mostly adults, with subadults comprising only about 10 percent of the total burials (for which age at death could be determined). But in the three St. Catherines period mortuary sites—Marys Mound, Johns Mound, and South End Mound II—subadults comprised 41.8 percent (46 of 120) the total individuals. Of these subadults, many were infants and children, with several placed in more elaborate burial contexts.

Specifically, the log-lined Central Pit at Johns Mound contained a partially articulated child burial (3–5 years of age), with
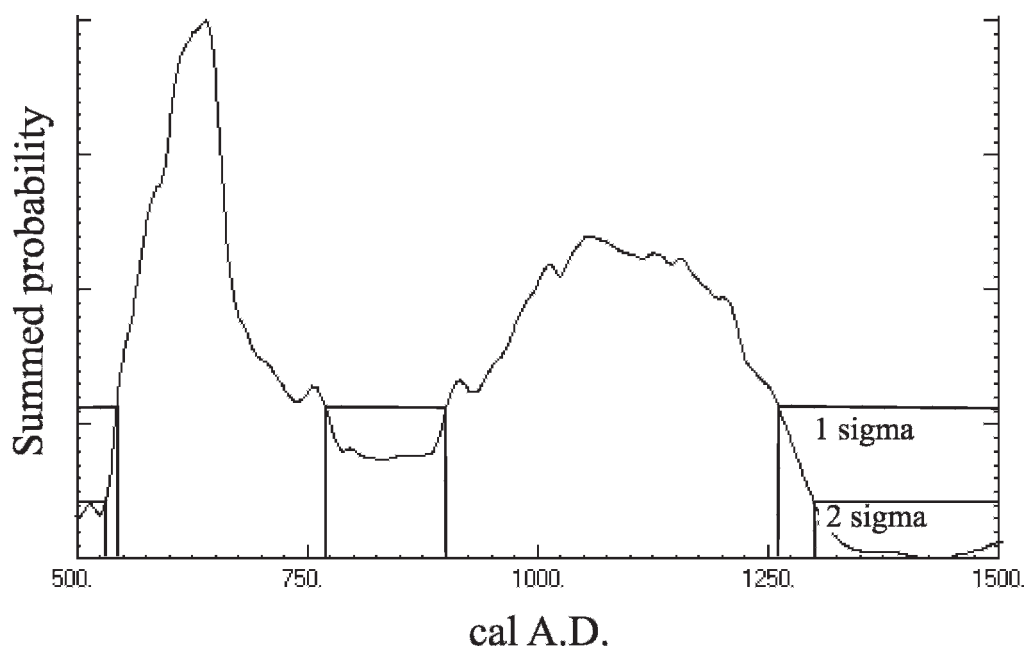
Fig. 32.11.   The cumulative probability profile for mound construction ^{14}C dates available for the interval cal A.D. 500–A.D. 1500 on St. Catherines Island.

additional adult bones scattered about. Numerous burials in the so-called Old Cemetery surrounded the Central Pit, including a fetus, a number of infants, several children, and numerous subadults (Larsen and Thomas, 1982: 313–322). This entire mortuary area was then covered with a St. Catherines period sand mound. The Central Pit at South End Mound II contained two cremations and a mass grave for 15+ individuals. Larsen estimates that at least two infants were included in this mass grave. Finally, although the Central Tomb at Marys Mound contained no human bones, four individuals (one of which was unavailable for study) were placed in an adjacent pit: one flexed female (35–39 years old at death), a preadult (about 13 years old) bundle, and a child bundle (age 4). Two individuals were placed atop the shell cap that covered the Central Pit: burial 5 is an adult female and burial 6 is an incomplete child (aged 2 years).

There are, however, a couple of notable differences among the St. Catherines period mounds. Stage I at Johns Mound contained a distinctive premound cemetery complex (Marys Mound and South End Mound II did not). Johns and Marys Mounds both contained a number of postmound and intrusive burials (and South End Mound II did not).

PERIODICITY IN ^{14}C DATING: THE ST. CATHERINES PERIOD CLUSTER (cal A.D. 1040–1230)

All detectable mortuary-related activities during the preceding Wilmington period transpired within a single century (with two-sigma limits of cal A.D. 540–650). Figure 32.11 also documents the probability distribution of radiocarbon dates available from mortuary contexts on St. Catherines Island, defining a significant gap separating the Wilmington–St. Catherines interval. The lone radiocarbon date from a mortuary context during this interval is UGA-1687 (a charcoal date of cal A.D. 660–950) processed on burned primary humus underlying Marys Mound (the mound itself was likely erected a few centuries later).

A single peak in mortuary activity (during the mid-St. Cathrines period) follows

this multicentury gap in the radiocarbon record, followed by a steep falloff of documented mortuary activity after cal A.D. 1300 (fig. 32.11).[27] This cluster of five ^{14}C dates derives from almost identical mortuary features at three contemporary burial mounds. All dates in this cluster are statistically the same (at the 95% level) and define a pooled age of cal A.D. 1040–1230 (the mid-St. Catherines period).

At South End Mound II, dates UGA-3458 and UGA-3459 derive from marine shell within Feature B, a thick lens of midden containing St. Catherines period ceramics and overlying the Central Pit. Two dates are available from Johns Mound: UGA-61 was processed on charcoal obtained from a log incorporated in the Central Pit, while UGA-64 comes from the Stage II marine shell lens that overlies the Central Pit and Old Cemetery. UGA-1685 was processed on oysters contained in Stage II shell feature at Mary Mound, which overlies the Central Pit and associated burials.

This suite of mid-St. Catherines period dates leads to two important conclusions:

- Setting aside the lone humus date from Marys Mound, the available radiocarbon record defines a 4-century hiatus in mortuary activities between the Wilmington (cal A.D. 540–640) and St. Catherines periods (cal A.D. 1040–1230).
- Johns Mound, Marys Mound, and South End Mound II were, statistically speaking, constructed at exactly the same time (cal A.D. 1040–1230, during the mid-St. Catherines period).

BIOARCHAEOLOGY

Stable isotope results are available from one dozen burials recovered in St. Catherines period contexts (Thomas and Larsen, 1982; see also table 32.2). The 95 percent confidence ellipse for the St. Catherines period is contained entirely within the much larger ellipse characterizing the earlier Deptford and Wilmington periods (see fig. 32.12). Whereas the mean values of δ^{13}C and δ^{15}N do not differ significantly between the Deptford–Wilmington and St. Catherines period samples, variability decreases notably during this interval.
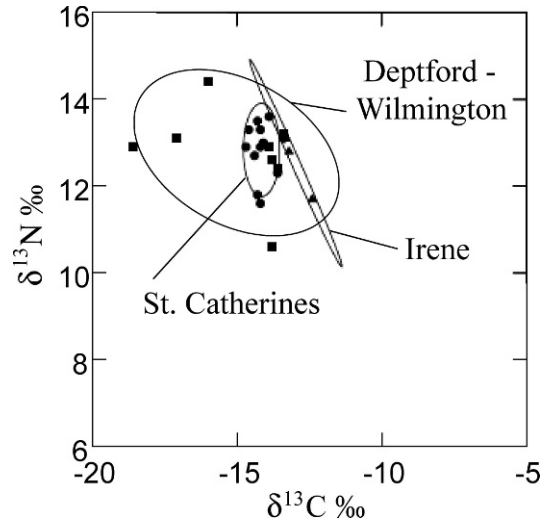
Fig. 32.12.   Results of stable isotope analysis on Deptford-Wilmington, St. Catherines, and Irene period burials from St. Catherines Island.

The overall trend toward decreasing nitrogen and carbon isotope levels would seem to suggest a varied dietary pattern based on continued use of marine foods, perhaps augmented by gradual adoption of maize-based agriculture. Despite the relatively small number of samples involved, these results strongly suggest that people buried at Johns and Mary Mounds (during the St. Catherines period) experienced a considerably narrower diet breadth than their immediate predecessors (likely reflecting to some degree, the changing sea levels during the Late Holocene).

With respect to these data, Schoeninger et al. (1990: 88–89) speculate that some of the Deptford–Wilmington period individuals—and everyone included in the St. Catherines period sample—ingested food items rich in ^{13}C, though with a nitrogen value similar to the rest of the group. Consumption of maize (or some other C_4 plant) could certainly account for this result. But if the observed δ^{13}C and δ^{15}N values for the St. Catherines period reflect some degree of maize consumption, then the same could be said for at least four individuals from the Deptford–Wilmington period. We have considerable difficulty believing that people during Deptford–Wilmington times (cal 350 B.C.–A.D. 800) were consuming very much maize.

One must also question the importance of maize consumption during the St. Catherines period. As Larsen has noted (in Larsen and Thomas, 1982: 327–329), dental pathologies "are noticeably rare in the Johns and Marys mounds skeletal series: specifically, pathologies resulting from skeletal or dental infections are apparently absent. … [O[f 453 teeth observed in this dental series, only six (1.3 %) showed any form of dental caries. … [T]he skeletal and dental data suggest that the economic regime associated with the human populations represented by skeletal remains from Johns and Marys mounds is one based primarily on nondomesticated dietary sources. … [T]his population probably enjoyed good skeletal and dental health in association with a physically active lifeway."

Schoeninger et al. (1990) suggests that similar isotopic distributions could result from eating an increased amount of marine food from a lower trophic level (such as seaweed or mollusks). The proportions of protein and carbohydrate varies seasonally in Southeastern oyster populations (Galtsoff, 1964: table 355), with the protein percentage peaking in August and decreasing throughout the winter months and reaching an annual low point in May; by contrast, carbohydrate levels are relatively high in oysters from autumn through spring, dropping notably during the summer months. Claassen (1986a) has argued that oysters harvested during the winter months (as we suspect they were on St. Catherines Island) would have disproportionately high carbohydrate values relative to protein. But Schoeninger et al. (1990: 90) note that for such a high carbohydrate intake to account for the observed $\delta^{13}C$ values, mollusks would have to account for nearly 100 percent of the ingested calories. Based strictly on the evidence from stable isotope analysis, we cannot distinguish between these alternatives.[28]

This analysis of stable isotopes in the St. Catherines Island burial population, discussed above, was conducted in 1990 (Schoeninger et al., 1990; Larson et al., 1992; Hutchinson et al., 1998; Larsen, 2001: 29, 72; see also chaps. 25 and 32, this volume). At this writing, we are conducting a follow-up study of stable isotopes in the human remains from St. Catherines. This new research is specifically designed to (1) process new samples that fill the gaps in the previous sampling scheme, and (2) obtain previously unavailable data on bone apatite carbon. Additionally, with the advent of AMS radiocarbon dating, we can now reach a level of chronological precision unavailable during the previous research (see chap. 24).

The focus of the bioarchaeological research has likewise shifted over the past 15 years. During the 1990 isotope study, Schoeninger and Larsen were primarily concerned with the variation in maize dependence through time; the nitrogen data were employed largely as a method for controlling for marine ingestion.[29] Schoeninger (personal commun.) was also heavily influenced by her postdoctoral research on samples from the Pacific coast, where the marine system overall is characterized by relatively high $\delta^{15}N$ values. Since then, Schoeninger and Larsen have discovered that a heavy dependence on marine foods along the Eastern Seaboard produces much lower values in consumers (when compared to West coast equivalents). In other words, looking at the St. Catherines Island data today, they appear to be much more "marine-like" than previously recognized.

Schoeninger (personal commun.) remains uncertain about the meaning of the carbon isotope values; perhaps they reflect heavy maize dependence (as apparently reflected in the newly available archaeological data). But to be certain of this, it is necessary to plot the carbon values from collagen against those from bone apatite. Her recent research indicates that diets with C_3, C_4, and marine protein each produce separate (largely parallel) lines in the bone apatite profiles, which may resolve the previous problems of using carbon isotope data to monitor consumption of marine resources.

The nitrogen isotope data likewise need revisiting. Nitrogen is the only way to reconstruct the trophic level of the ingested marine food (e.g., nearshore shellfish versus deeper water fish). During previous research, the best comparison for the Georgia coast was a study on Nantucket Island, in which Little

and Schoeninger (1995) analyzed marine samples representing multiple trophic levels. But Schoeninger (personal commun.) now believes these results reflect both the differences between west and east coast (unrecognized at the time) and also the influence of trophic level. Further, she thinks that for the St. Catherines Island samples with an obvious marine signal (greater than 10), more than one trophic level is likely represented. The archaeological evidence seems to suggest a more variable dietary in times of stress (as when the shellfish estuary collapses), and this seems to be reflected in the nitrogen (rather than the carbon) evidence.

THE IRENE PERIOD
(CAL A.D. 1300–A.D. 1580)

Table 30.2 details the 52 archaeological components dating to the Irene period. The St. Catherines Island landscape during this time frame contains 67 known Irene occupations (fig. 32.13). Evidence of seasonality exists in 42 of these components. The site-by-site evidence was already presented in chapter 20; the following sections summarize the overall trends and patterns during the Irene period.

Irene assemblages tend to be larger and more frequent than any other aboriginal time period. Looking strictly at the probabilistic, Island-wide survey results, Irene period occupations accumulated at a rate of 34 occupations/century (more than three times the rate for any other time period; see table 30.2). The site testing protocols produced the highest percentage of large sites and the proportion of "smaller" sites is quite low (34 of 72), the smallest proportion from any aboriginal time period (table 30.4).

THE CERAMIC CHRONOLOGY

DePratter (1979a, 1991) projected the temporal limits of the Irene period from A.D. 1325 (which calibrates to cal A.D. 1310–1390) through A.D. 1580, a historical-derived date (and thus not subject to calibration).

The St. Catherines Island research generated 24 radiocarbon dates directly associated with Irene ceramics (table 15.1 and fig. 15.6). This pooled probability distribution approximates a normal curve, spanning the interval cal A.D. 1310–1530 (at the one-sigma level); the two-sigma intervals are cal A.D. 1220–A.D. 1680 (99.2%), cal A.D. 1780–A.D. 1800 (0.76%), and modern (0.03%). Rounding these results, we estimate that Irene period ceramics first appeared on St. Catherines Island about cal A.D. 1300, a figure that closely corresponds to DePratter's (1979a, 1991) estimate. Moreover, as documented earlier, the pooled probability distributions of radiocarbon dates for the St. Catherines and Irene periods are mutually exclusive, intersecting at cal A.D. 1300.

We accept DePratter's (1979a, 1991) estimate that the Irene period ended at A.D. 1580.

GEOCHRONOLOGY

Linsley (1993) reconstructs of the shape of St. Catherines Island at cal A.D. 1400 [500 B.P.], with all remnants of Guale Island eroded away and the shoreline cliff at North Beach retreating to its historic-period configuration. The southern beach ridges continued to prograde, extending southward to the margins of modern Flag Pond. The St. Catherines Island of cal A.D. 1400 closely resembles the Island depicted on the 1760 map of Yonge and DeBrahm (De Vorsey, 1971; Cumming, 1998: 29–30), except for the geomorphological details of the northern and southern tips and the meander positions of tidal creeks.

THE IRENE PERIOD LANDSCAPE

The central place foraging theory model of Sea Island settlements was specifically designed to address the Irene period, and the fit to St. Catherines Island archaeology is excellent.

Figure 30.7 compares the observed distributions of Irene components against the expected distribution based on the central place foraging model. If energy efficiency were the sole concern of aboriginal foragers, one expects the central places to be arrayed along a narrow linear band bordering the margin between the salt marsh and maritime forest (the two highest ranking resources patches).

Meeting House Field

South End Mound

LEGEND
. archaeological sites
✕ 0-9 sherds
● 10-99 sherds
□ 100-999 sherds
■ > 1000 sherds

Flag Pond

Irene Period
cal A.D. 1300 - 1580

N

1 .5 0   1 km
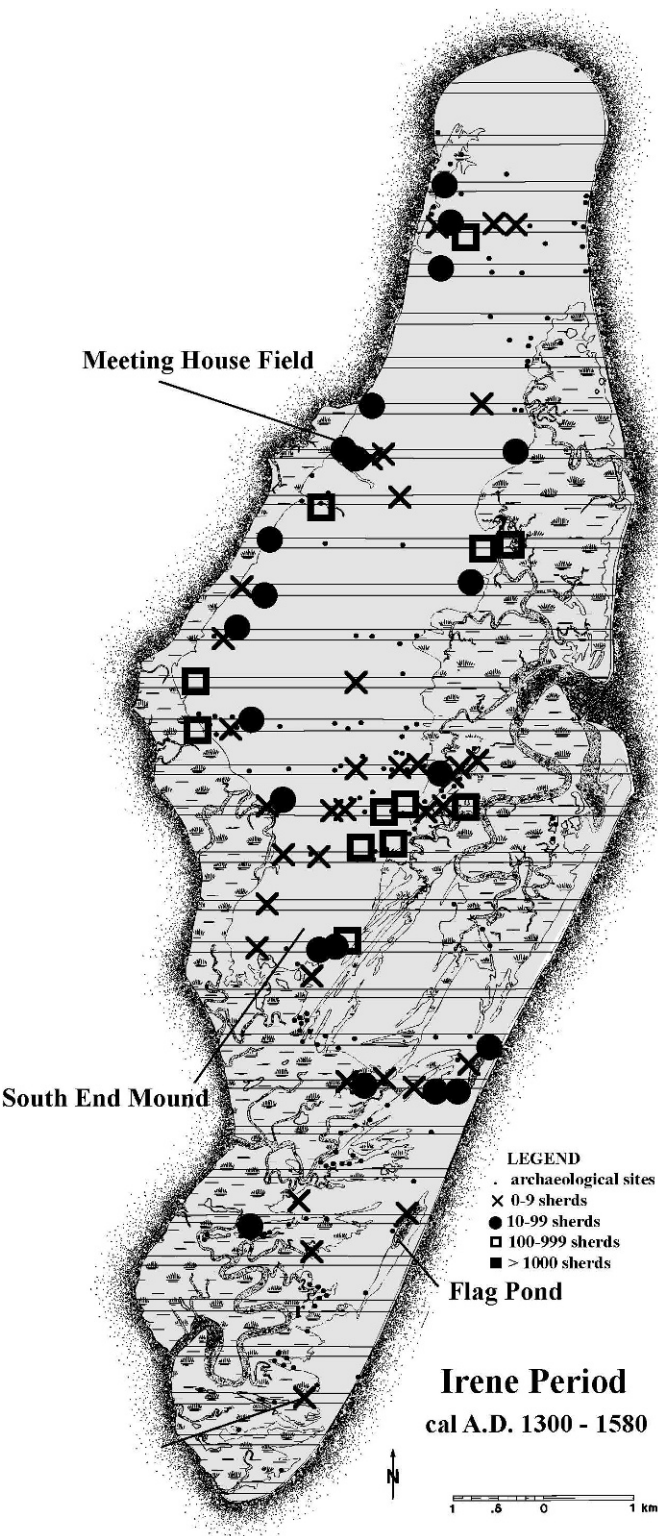
Fig. 32.13.   Distribution of archaeological sites dating to the Irene period on St. Catherines Island.

The 23 Irene components discovered along the western margin of St. Catherines Island average 212 ± 171 m from the modern marsh edge. A very similar pattern holds along the eastern marshline settlement ($n = 16$), with the Irene components averaging 292 ± 297 m from the interface between the salt marsh and maritime forest edge. Although the western marshside settlements average about 80 m closer to the marsh margin than their counterparts on the eastern side of St. Catherines Island, this difference is not statistically significant.

Whereas the empirical fit of the marshside settlements most closely corresponds to the lognormal model (especially for distance to marsh > 50 m), the distribution of Irene period components along the western marshland of St. Catherines Island is consistent with expectations from both the normal and lognormal distributions.

Nearly identical results emerge for Irene period landscapes (fig. 30.20 and table 30.6). Although landscape indicators are slightly more spread out from the marsh margins (with a slightly greater mean distance to marsh and associated standard deviation), the 53 landscape indicators are distributed in normal/lognormal fashion.

The contrasting diet-breadth model hypothesizes that Irene settlements should have accumulated in a relatively homogeneous distribution across the Pleistocene core of St. Catherines Island. Figure 30.22 sets out the theoretical uniform distribution of Irene settlements across the Pleistocene core of St. Catherines Island and, as demonstrated in chapter 30, the diet-breadth model fails to explain any of the observed Irene period settlement pattern on the Pleistocene part of St. Catherines Island.

MORTUARY ACTIVITIES

The primary mortuary evidence for the Irene period on St. Catherines Island comes from the "Mound Near South-End Settlement" (9Li3), excavated in 1896 by C.B. Moore, who exposed 50 human burials and a significant quantity of grave goods (including a soapstone pendant, numerous shell beads, some ceramic smoking pipes, and several decomposed rattles). Although lacking a central pit, the middle of the mound was comprised of an oyster shell layer 2 feet thick and 10–20 feet across. The majority of burials were flexed, with head toward the south; Moore also excavated four urn burials and the occasional cremation. South End Mound I was used almost entirely during the Irene period.

Under the direction of Clark Spencer Larsen, crews from the American Museum of Natural History and Purdue University discovered that the burials originally exposed by Moore remained (more or less) in place a century later. Larsen recovered 26 of the 50 individuals previously exposed by Moore and conducted a variety of bioarchaeological analyses on these remains (Larsen, 2002).

South End Mound I differs from the St. Catherines period burial mounds in several ways. The distinctive Central Pit feature—conspicuous at Johns Mound, Marys Mounds, and South End Mound II—was absent at South End Mound I. In addition, whereas most interments in the St. Catherines period mounds were bundle and extended burials, the majority of the South End Mound I burials were flexed, on the right side, with head toward the south. Finally, urn burials (which comprised 12% of the South End burials encountered) are entirely absent from all pre-Irene contexts on St. Catherines Island. Individual Irene period burials seem to have more associated grave goods (during the St. Catherines period, grave goods tend to be associated with multiple-interment features).

Site 9Li226 contained an Irene period midden burial, the only such occurrence from the Island-wide survey testing.

Only one ^{14}C date is available from mortuary contexts during the Irene period. At Seaside Mound II, UGA-1556 dates an intrusive, Irene period bundle burial (cal A.D. 1330–1650).

SUBSISTENCE

Vertebrate zooarchaeological remains were recovered from 47 Irene period components within the Island-wide survey, and

consisted of 4204 specimens (an estimated 212 individuals).[30] The largest faunal assemblages come from the eastern and western portions of the island core. Overall, fishes contribute 37 percent of the individuals, with the hardhead catfish (*Ariopsis felis*) more abundant than the others. Raccoons, deer, and diamondback terrapins are also common, with deer contributing most of the biomass.

Tables 32.2 and 32.3 present the stable isotope data for the Irene period. Although a much larger sample of human bones was available for other bioarchaeological studies, carbon and nitrogen measurements were processed on only three Irene period individuals from South End Mound I. Figure 32.12 shows that the probability ellipse for these samples forms a skewed, nearly linear distribution, with considerable variability in $\delta^{15}N$ values and a much tighter distribution of $\delta^{13}C$ measurements. The mean value for $\delta^{13}C$ for the Irene period is larger (less negative) than the mean for the St. Catherines and Deptford–Wilmington periods, and this difference is statistically significant (at the 0.05 level). While the mean $\delta^{15}N$ for the Irene period is slightly larger (less negative) than the earlier samples, this difference is not statistically significant.

Although we would certainly welcome additional isotope data for the late prehistoric period, the significant increase in delta carbon values indicates to Larsen (2002: 64) that the Irene population "ate maize in appreciate amounts", a diet likely accompanied by a reduced consumption of marine resources.[31] Reitz et al. (2002: 45) suggest that "the carbon isotope ratios for the South End Mound I individuals are lower than for the historic-era Guale from the Santa Catalina de Guale missions on St. Catherines and Amelia Islands. These findings are consistent with the trend for the regional as a whole—late prehistoric populations ate more maize than did early prehistoric populations, but less maize than did the mission-era groups, and late prehistoric populations ate somewhat less marine foods than did early prehistoric populations, but more marine foods than during the mission era."

Additional bioarchaeological studies support this finding. Periosteal lesions are "not an uncommon occurrence" on the bones of 26 individuals studied from the South End Mound I (Reitz et al., 2002: 46, 48) and these findings are "consistent with the population having lived in a relatively sedentary village community with poor sanitation and an environment conducive to the maintenance and spread of infectious disease." Dental caries are likewise well represented in the Irene period sample. Of the nearly 200 teeth available from excavations at South End Mound I, 9.8 percent contain caries in one form or another; this frequency is within the range of agricultural populations and well in excess of that (1.2%) known for coastal Georgia foragers: "The increase of infection reflects increased sedentism and concentration of population on St. Catherines, well preceding the arrival of Europeans" (Reitz et al., 2002: 50, 53, 54).

Biomechanical studies of the South End Mound I sample reinforce the suggestion of decreased mobility. People are shorter than their nonagricultural predecessors (and this difference is likely due to poor nutrition). With respect to bone strength, it would appear that adult males "are generally more physically active (more mobile) than females" who are "perhaps less mobile than the prehistoric and early historic Guale" (Larsen, 2002: 58, 61).

Ethnohistoric data amplify the findings from zooarchaeology and bioarchaeology. Chapters 2 and 11 have already reviewed the conflicting ethnohistoric record regarding Guale subsistence during the late prehistoric and early contact periods. New insights are now available from an important unpublished paper by John Worth (1999), who specifically revisited the available ethnohistorical evidence from the Port Royal Sound (South Carolina) to the mouth of the St. Johns River (Florida).

After several brief and sporadic episodes of contact, the decade of the 1560s brought the first significant sustained European contact to the area. Two French colonial forts were established in 1562 and 1564 (Charles Fort and Fort Carolina) and each

was occupied for about a year. The subsequent Spanish towns of St. Augustine and especially Santa Elena involved even more significant contact with Indian people after 1565. These early ethnohistoric accounts speak specifically of the Orista (and later Escamazu) chiefdom, the Guale chiefdom, and three important Mocamo chiefdoms (of Saturiwa, Tacatacuru, and Guadalquini). Jesuit missionization was restricted to the years 1569 and 1570, followed by Franciscan friars in 1574–1575. Comprehensive missionization did not occur in Mocamo until 1587 and in Guale between 1595 and 1605.

Worth (1999) argues that the surviving ethnohistoric documentation indicates "beyond any shadow of doubt that not only did the inhabitants of all coastal chiefdoms in the study area grow corn, and I would say they grew a lot of it." Even at the onset of initial European contact in the 1560s "all coastal chiefs maintained sufficient surplus corn to be able to give or trade substantial amounts to recently-arrived colonists, yet still maintain enough backup surplus for use in chiefly political negotiations and in planting their crops the following year. Documentary records also indicate that both French garrisons bartered for large quantities of maize and beans with the Guale in 1562 and 1563. They already possessed large storehouses of maize, under their chiefly control, and the stores were sufficiently large to barter away to French soldiers on multiple occasions."[32] French accounts from Fort Caroline make it clear that by the time of European arrival, the coastal Indians were completely aware of agricultural cycles, including the timing of planting and harvesting maize fields, the annual maturation cycles in different locations, and the importance of maintaining sufficient seed corn for planting future crops.[33]

Furthermore, the existing ethnohistoric documentation makes it clear that all aboriginal groups along the Georgia coast already possessed extensive cleared corn fields at contact; in fact, a consistent strategy in warfare (both European and Native American warriors alike) was to destroy the cornfields of the enemy. Worth also describes the retaliatory strategy of the Spanish in response to the coastal rebellions in Guale and Orista in 1576 and 1597, during which they burned the villages and cornfields of the rebels. "Since the strategy worked on both occasions, eventually bringing rebellious chiefs to the negotiating table in order to resettle their towns and fields, I can only conclude that annual corn crops and fields used to produce them were very important resources for coastal chiefs. Had the coastal chiefdoms been characterized by the dispersed settlement patterns implied by some researchers, with only limited recourse to corn agriculture in comparison to hunting, fishing, and gathering, the Spanish reprisals should not have produced such rapid results. The coastal Guale and Orista-Escamazu were behaving very much like sedentary agricultural chiefdoms."

Worth's (1999) conclusions confirm the bioarchaeological evidence summarized above. At least during the late Irene period on St. Catherines Island, maize cultivation was not only widespread among the Guale Indians and other chiefdoms of the Georgia coast, it was a "a fundamental component of both domestic subsistence and political power in coastal chiefdoms. This kind of behavior was no recent innovation among coastal groups, but rather reflected what I would argue was a centuries-old cultural adaptation for coastal chiefdoms within the broader Missisippian period world of the Southeast."

THE ALTAMAHA PERIOD
(CAL A.D. 1580–A.D. 1700)

Human settlement patterns on St. Catherines Island changed dramatically during the Spanish mission period (fig. 32.14). All six documented archaeological components of the Altamaha period occur along the western Pleistocene core, and only 14 archaeological sites located in the Island-wide survey of St. Catherines Island produced Altamaha period ceramics. Half of these occupations occur within 1 km of Wamassee Head, the location of Mission Santa Catalina de Guale.
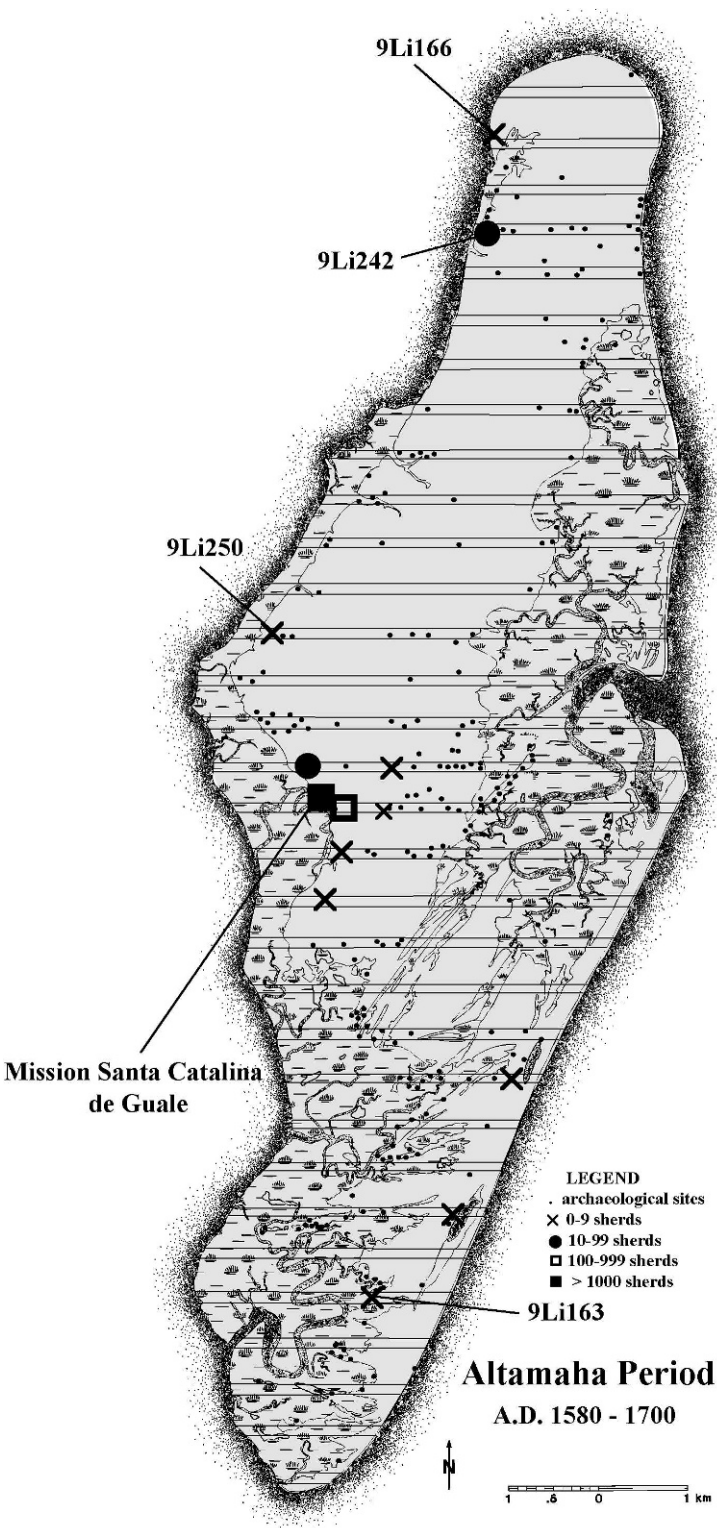
Fig. 32.14.   Distribution of archaeological sites dating to the Altamaha period on St. Catherines Island.

THE CERAMIC CHRONOLOGY

Relying on historical documentation, DePratter (1979a, 1991) began the Altamaha (Spanish Period) occupation at A.D. 1580 and ended the interval at A.D. 1700. Chapter 15 reviewed the five available ^{14}C radiocarbon dates from the Altamaha period on St. Catherines Island. Although deferring detailed discussion of Mission Santa Catalina de Guale for a future monograph, we arrayed the Altamaha period radiocarbon dates from St. Catherines Island as individual probabilities in figure 15.7, with the pooled probability profile along the bottom of this figure. The one-sigma limits are complex: cal A.D. 1320–1360 (13.7%), cal A.D. 1390–1530 (70.0%), and cal 1570–1630 (19.3%); two-sigma limits are cal A.D. 1300–1686. These limited data suggest that Altamaha period ceramics appeared at 9Li13 and 9Li274 (two mission-related sites at Wamassee Head on St. Catherines Island) sometime between about cal A.D. 1310 and 1450 (at least a century prior to Spanish contact). This is a surprising result, given that the Altamaha Line Block Stamped type ceramic is recognized as the hallmark of the Spanish mission period on the Georgia coast. That said, we retain DePratter's previous, historically derived estimate of A.D. 1580 for the beginning of the Altamaha period. Although noting the disparity in the available ^{14}C dating, additional research is required on this subject before the "early Altamaha" dates can be accepted as valid.

The terminal radiocarbon dates for Altamaha series ceramics fall between cal A.D. 1660 and cal A.D. 1800. Following DePratter's lead, the St. Catherines Island chronology employs the historically derived limit of A.D. 1700, which roughly corresponds to the abandonment of Mission Santa Catalina de Guale and signals the end of the Spanish period on St. Catherines Island.

GEOCHRONOLOGY

The geomorphic configuration of St. Catherines Island during the Spanish mission period can be extrapolated back in time from the Yonge and DeBrahm map of 1760, when the Island was longer and wider than it is today. Radiocarbon samples from vibracore transects have provided a useful framework for dating the progradational shorelines, and the distribution of archaeological ceramics has enhanced the chronological details. Figure 29.8 plots the inferred extent and temporal pattern of beach ridge progradation across the southern end of St. Catherines Island (after Linsley, 1993: fig. 18).

The available documentary record can augment the archaeological and geomorphological evidence. The earliest reliable map of St. Catherines Island was drawn by William Gerard DeBrahm, surveyor general of the British colonies in the Southeast during the 1760s and early 1770s (De Vorsey, 1971; Cumming, 1998: 29–30). This first accurate rendering of St. Catherines Island shows all the salient features—the island core, the salt marshes, the southern beach ridges, Johnson, Brunsen, Cattle Pen, and Walburg (called "St. Catherines Creek") Creeks. Using a combination of coast and geodetic charts and aerial photos, Oertel and Chamberlain (1975) described rates of shoreline change along the coastal islands of Chatham and Liberty Counties (Georgia) between 1897 and 1975, concluding that over this 78-year interval, St. Catherines Island experienced a "net shoreline retreat of 4.0 m/yr" and that this was the "most ubiquitous erosion of those (islands) studied."

MISSION PERIOD LANDSCAPES

Figure 32.14 documents the dramatic consolidation and contraction of aboriginal settlements on St. Catherines Island during the Spanish period. Altahama ceramics were found in only 13 of the 350 archaeological sites examined, with half of those occurrences located within 1 km of Wamassee Head, the location of Mission Santa Catalina de Guale. Two Altamaha period sherds were also recovered from 9Li250, a mostly Wilmington period occupation located 2 km north of the Mission.

On the northwestern tip of the island, two Altamaha sherds were found at 9Li166, and 9Li242 (located 1 km to the south) contained a notable concentration

of Altamaha period materials, as well. Altamaha sherds were found at sites located on the southern beach ridges, including 9Li163, a large palmetto-covered site about 300 m west of Jungle Road. The surface and buried shell scatter extends across the full 100 m of transect N-1 and contains Pine Harbor diagnostics, along with one annual and seven El Morro sherds.

Seasonality estimates are available from four of the Altamaha period sites. As expected, all three sites near Wamassee Head have a demonstrable four-season occupation. 9Li242, located at the southern end of Engineer's marsh, was occupied at least during the winter and spring.

The settlement pattern data documents a notable degree of nucleation during the Altamaha period, a site distribution that is entirely consistent with the well-known Spanish strategy of *reducción*. This refers to the practice in which Spanish officials gathered together aboriginal communities into fixed settlements (Bushnell, 1994: 22–23, 65, 126), thereby providing for more efficient administration, both religious and secular.

BIOARCHAEOLOGY AND ETHNOHISTORY

As discussed in chapter 12, one of the overarching objectives of the Island-wide survey of St. Catherines Island was to pinpoint the location of Mission Santa Catalina de Guale; elsewhere, we discussed that successful survey and the subsequent excavations (see Thomas, 1987; Larsen, 1990).[34]

The only known cemetery at Mission Santa Catalina occurs inside the mission church (the *iglesia*), where we encountered a minimum of 431 individuals buried beneath the floor of the nave and sanctuary (none were encountered beneath the sacristy). Thomas was responsible for locating the mission complex, exploring the architecture of Mission Santa Catalina de Guale and defining the mission cemetery; Larsen supervised the complete excavation of the cemetery. The human remains recovered from Mission Santa Catalina de Guale constitute one of the best-documented and most extensive series of human remains from an early contact period site in North America.

Roughly one-third of these interments occurred in primary context, buried in a supine position with feet toward the altar and hands across the chest or, less commonly, across the abdomen. The remaining individuals were found as scattered, disarticulated bone in the upper grave fill, a secondary zone of disturbance created as previous burials were disturbed by later interments.

The cemetery at Santa Catalina contained a remarkable array of associated grave goods (several of which are illustrated in Thomas, 1988a, 1988b). Detailed analysis of these materials will be presented in a subsequent monograph. A partial listing includes four complete majolica vessels, several projectile points, a chunky stone, a rattlesnake shell gorget in the "Tellico" style, two complete glass cruets, 12 crosses of metal and wood, 10 small glass and gold leaf cruciform ornaments, 10 bronze religious medals, one gold medallion, one silver medallion, two mirrors, 15 finger rings, two hawks bells, one rosary, eight shroud pins, two copper plaque fragments, one clay tablet (with depictions of saints on both sides), one large piece of shroud cloth, and approximately 70,000 glass beads.

The bioarchaeological analysis of the Mission Santa Catalina de Guale remains has been presented elsewhere (see especially Larsen, 1990, 2002), with the relevant findings summarized here. Twenty-two of the individuals buried inside the church/cemetery at Mission Santa Catalina de Guale were analyzed for stable carbon and nitrogen isotopes (tables 32.2 and 32.3). Figure 32.15 plots the individual datum points and extrapolates the 95 percent probability ellipse for this tightly clustered distribution. Figure 32.15 shows the mean value for $\delta^{13}C$ for the mission period is larger (less negative) than the means computed for all preceding periods, and this difference is statistically significant (at the 0.01 level) in all cases. The drop in the $\delta^{15}N$ values is even more notable, and the difference from earlier samples is likewise statistically significant.

The isotope concentrations leave little doubt that maize was a dietary staple dur-
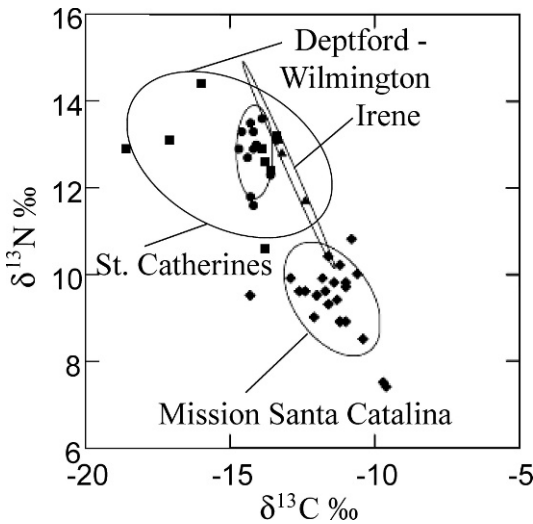
Fig. 32.15.   Results of stable isotope analysis on St. Catherines Island (all periods).

ing the mission period. The observed $\delta^{15}N$ values for the Mission Santa Catalina samples overlap those with pueblo agriculturalists of the American Southwest (Schoeninger et al., 1983, 1990: 90), although the continued use of marine resources depresses the overall distribution of $\delta^{15}N$ values. The $\delta^{13}C$ values for the contact period on St. Catherines Island are likewise somewhat less than that for Southwestern pueblo farmers (implying a lower dependence on maize for the island population); the relatively large range of variability suggests that Island residents explored a broader range of subsistence alternatives than their pueblo counterparts.

Hutchinson and Larsen (1990) found that enamel hypoplasias (a commonly employed indicator of biological stress) were more common among individuals from the Mission Santa Catalina than among those living during the precontact periods. In other words, the so-called preagricultural populations living during the Deptford, Wilmington, and St. Catherines periods seem to have experienced more single-stress events than did contact period populations, despite the fact that the mean width of the hypoplasias was narrower (Hutchinson and Larsen, 1990: 64). Although a smaller percentage of the mission period population was so af-

fected, the width of the growth interruptions increased after contact. This implies that some people living at Mission Santa Catalina most likely experienced an increased duration of stress, an increased intensity of stresses, or perhaps both.

To understand more clearly the nature of aboriginal subsistence during the Altamaha period, we return to the recent unpublished research of Worth (1999) on the mission-period ethnohistorical record of the South Carolina, Georgia, and Florida coastline:

> All coastal Indians are clearly documented to have produced substantial agricultural surpluses during the mission period, and available evidence provides clear links between agricultural crops and labor, and traditional notions of social rank and political organization at the time. … [T]he soils around these comparatively nucleated mission villages were in fact perfectly capable of producing substantial agricultural harvests each and every year. Quite clearly, the coastal zone … was actually well-suited for indigenous corn agriculture, although arable soils are known to have been patchy, and would presumably have required shifting cultivation and other specialized techniques. … [I]t becomes clear [from the surviving documents] that European-influenced agricultural intensification, which definitely did occur during the primary Franciscan mission period, probably did not even begin until the late 1590s, post-dating first contact by as much as three or more decades. … I believe that agricultural production prior to the mission period would have been almost wholly aboriginal in character, deriving principally from pre-existing agricultural practices with prehistoric roots.[35]

NOTES

1. As explained in chapters 12 and 19, we have followed the classic Willey and Phillips (1958: 21) definition of an *archaeological component* as a culturally homogeneous unit within a single archaeological site; in chapter 19, we set out the protocols employed in defining the archaeological components identified in the Island-wide survey. Defining ''components'' is critical in this study because it provides an effective means of assessing intrasite contexts, particularly helping to establish the interrelationship between the various evidence streams (including ceramic chronology, radiocarbon dates, zooarchaeological assemblages, and seasonality estimates). But we have also employed

a "nonsite" archaeological perspective by introducing the concept of *archaeological landscape*, defined as the totality of all available archaeological evidence (termed a "presence"), partitioned according to specific temporal period and plotted across a well-defined and bounded geographical space (see chap. 19). So defined, an archaeological presence can be one or more potsherds recovered in a solid archaeological context, one or more time-diagnostic lithic artifacts, or an apparently reliable radiocarbon date (in context, but not necessarily in the presence of ceramics).

2. In chapter 16, we also partitioned the radiocarbon record from the St. Simons period into "mortuary" and "midden" subsamples (fig. 16.16), defining major peaks (at the two-sigma level) in the distribution of midden marine shell dates between cal 2540 B.C. and cal 1900 B.C. After a gap of roughly 4 centuries is a second spike (cal 1530 B.C.–1350 B.C.), followed by a length hiatus in midden shell dates (cal 1350 B.C.–120 B.C.). Conversely, the probability distribution of radiocarbon dates processed from mortuary contexts (primarily terrestrial [charcoal] dates) stands in almost inverse relationship to the midden dates (fig. 16.16, bottom). At the two-sigma level, we see a peak in mortuary activity, ranging from cal 1740 B.C. to A.D. 260.

3. We note that some of the St. Simons period shell rings are buried underwater up to a depth of 1 m (Waring, 1968a, 1968c; DePratter, 1975, 1975b; Marrinan, 1975), suggesting that they were occupied at a time when sea level was (at least) 1–2 m below present. The basal zone at Bilbo, which contains fiber-tempered ceramics (dating to cal 1700 B.C.–2200 B.C.), is overlain by a lens of gravel lag deposits and freshwater mussel shell; Brooks et al. (1986) argue that this stratigraphic sequence reflects a changing sea level, with the St. Simons occupation lying more than 1 m below modern levels and the mussel level reflecting a drop in sea level and a seaward movement of the saltwater system

4. With the shrinkage of the estuarine marshland, it is doubtful that the westward-moving marsh margin separated from the maritime forest margin because the edge of the Pleistocene core could not correspondingly expand. This would create a distance between the two highest ranking resources patches, thereby undermining the central place foraging expectations under higher sea level conditions.

5. DePratter (1977b: 11) hypothesized a somewhat later hiatus in shellfishing, between cal 800 B.C. and 400 B.C., because a sea-level regression reduced the potential of the estuarine shellfishery on the northern Georgia coast (see also DePratter and Howard, 1977, 1981). He further argues that sites established in the cal 900 B.C.–A.D. 300 (3100 to 2100 B.P.) range should actually be submerged or buried seaward of the present shoreline, if not completely destroyed by subsequent sea-level rise. By cal 350 B.C. (2600 B.P.), sea level arose again, and extensive oyster beds reformed (Crusoe and DePratter, 1976: 2).

6. The small sample sizes clearly contribute to these results.

7. The small sample sizes involved for St. Simons period are thus insufficient to distinguish between the central place theory and the diet-breadth projection that aboriginal settlements should be randomly distrib-

uted through space, without any significant degree of nonrandom modality or centrality.

8. Another possible lacustrine association was recorded at 9Li232 (transect E1), located within the boundaries of Meeting House Field, 310 m inland from the Walburg scarp. Although this site contains primarily Euro-American occupational debris, and a Wilmington-age component, it does near the margin of the Rutledge soil type.

9. One potential problem is that such nonshell sites, lacking in the calcium carbonates contributed by marine shells, will tend to have soil with acidic pH and correlatively poor preservation. The test excavation strategy would have to seek out concentrations of charred plant and/or animal remains (perhaps through remote sensing techniques such as proton magnetometry).

10. We have previously, in footnote 1, explained our usage of the classic Willey and Phillips (1958: 21) definition of an *archaeological component* (see also chap. 19). Further, the concept of *archaeological landscape*, as employed here, allows us to employ "nonsite" archaeological perspectives as well.

11. Similarly, Brooks et al. (1986: 300) note the presence of a basal freshwater peat (dating to approximately cal 1700 B.C.) at the Refuge and Second Refuge sites (located 20 km upriver from Bilbo), shifting toward saline conditions that corresponds to the initial (Refuge period) occupation dated to cal 900 B.C. (3100 B.P.). As sea levels rose, oysters became more common, then returned to freshwater conditions during the terminal Refuge period (which lasted from the Deptford through Irene periods).

12. The small peak at about cal 750 B.C. consists of five radiocarbon dates, four of which derive from burials mounds (Seaside Mounds I and II and McLeod Mound); only a single date from this era derives from a midden context (Li173).

13. The sole exception is Shell Field 2 (9Li15), which produced a single radiocarbon date of cal A.D. 80–440).

14. As with the previous St. Simons occupations, we believe that many Refuge-Deptford occupations eroded away with the remnants of Guale Island.

15. Two additional, nonlacustrine outliers were noted for the Refuge-Deptford period. South New Ground Field 4 (9Li223) is a discontinuous scatter of surface and buried shell midden, located on a ridge of Echaw/Centenary soils, in the middle of the Refuge-Deptford ceremonial complex, and there is no lacustrine association. North Pasture 1 (9Li238) is located on Echaw/Centenary soils (distance to marsh = 455 m), without any apparent lacustrine association.

16. Per our previous interpretation (Thomas and Larsen, 1979: 22–49, 142–143), the Central Tomb interments at McLeod Mound took place sometime prior to the deposition of the shell ring, which previously produced dates of cal 880–470 B.C. (UGA-1554) and cal 340 B.C.–A.D. 80 (UGA-1555). But as noted in chapter 24, we now have four AMS radiocarbon dates on human bone from the Central Tomb at the McLeod Mound; the pooled age of the AMS dates is cal A.D. 430–580 (1540 ± 25 B.P.), meaning that these four McLeod burials are several centuries younger than indicated from the previous stratigraphic interpretation.

17. "Adult" in this case includes all individuals 16 years and older (Larsen and Thomas, 1982: 325).

18. Because of the clear-cut continuities between the Refuge-Deptford and subsequent Wilmington mortuary activities, we will defer discussion of stable isotope analysis until the next section.

19. The lone exception, Beta-217239, dated even later, to the St. Catherines period.

20. Because each of the roughly 48 midden dates was processed on marine shell, we can discount all CSD effects from the shape of this curve (see chap. 16).

21. Setting aside, for the moment, the minor gap appearing at cal A.D. 680—A.D. 710.

22. The t-statistics are as follows: Beta-223518 versus Beta-223516 [t = 0.95]; Beta-223518 versus Beta-223515 [t = 3.92]; Beta-223518 versus Beta-223517 [t = 8.82].

23. The t-statistics are as follows: Beta-223515 versus Beta-223518 [t = 3.92]; Beta-223515 versus Beta-223516 [t = 1.28]; Beta-223515 versus Beta-223516 [t = 0.98].

24. The t-statistics are as follows: Beta-223516 versus Beta-223515 [t = 1.28]; Beta-223516 versus Beta-223518 [t = 0.72]; Beta-223517 versus Beta-223515 [t = 0.98]; Beta-223517 versus Beta-223518 [t = 8.82]. The new AMS results from McLeod Mound presented in the text of chapter 24 are based on the IntCal04 (terrestrial) calibration curve (see chaps. 13 and 19). But because stable isotope analysis indicates that individuals 16 and 17 likely had a diet comprised of 30–50 percent marine resources, perhaps a marine calibration curve (Marine04) is more appropriate. The 30-percent marine recalibrations are Beta-223517 (burial 16, cal A.D. 590–770) and Beta-223518 (burial 17, cal A.D. 380–600); the 50-percent marine recalibrations are Beta-223517 (burial 16, cal A.D. 620–830) and Beta-223518 (burial 17, cal A.D. 420–600). Use of these marine calibration curves suggests a later sidereal age for burials 16 and 17, making these ages statistically the same as ages for burials 14 and 15.

25. DePratter (1979a, 1991) previously estimated that the Savannah period ranged between A.D. 1200 and A.D. 1325 (in uncalibrated ^{14}C years), which translates to cal A.D. 1280—1310/1390. The available ^{14}C evidence from St. Catherines Island indicates that whereas Savannah ceramics do define a unique temporal span (estimated to be roughly cal A.D. 1000–1500), this interval overlaps completely with the St. Catherines and Irene periods. So, for the purposes of the St. Catherines Island chronology, we will not employ the "Savannah period" as a distinct archaeological interval. Instead, we now recognize that the Savannah ceramic complex spans the late St. Catherines and early Irene periods.

26. Because Reitz (chap. 22) retained the Savannah period in her analysis, the St. Catherines and Irene period totals are artificially reduced relative to earlier periods.

27. Since we know that aboriginal mortuary activities persisted into the late prehistoric era), this is clearly a sampling problem, since we lack Irene period radiocarbon dates (see chap. 24).

28. This question is one reason that, beginning early in 2005, we have harvested monthly oyster samples from several collection stations on St. Catherines Island; we are presently investigating the month-by-month changes in nutrient proportions (see Blair and Thomas, chap. 7, this volume).

29. This is because carbon isotope values are confounded when marine foods are eaten (i.e., a carbon isotope value of –15 can mean either the major nitrogen source is marine or it is a mixture of C_3 and C_4).

30. The Irene period sample of zooarchaeological remains is actually somewhat larger than indicated here, because Reitz retained the "Savannah period" sample in her analysis.

31. An expanded study is presently underway, and we hope that the results, when available, will significantly expand the stable isotope information regarding the Irene period on St. Catherines Island.

32. Worth (1999) continues: "Furthermore, during the late spring of 1565, long after chief Saturiwa had denied additional corn to French soldiers, claiming there was none to be had, he was nonetheless able to offer René de Laudonnier substantial quantities of corn as an incentive for his help in waging war against chief Outina in the riverine interior. Saturiwa was clearly hiding surplus corn from the French, and only revealed its presence for an obvious political goal."

33. "During the early summer of 1565, the Indians all along the St. Johns River were able to report on the relative ripeness of corn at various points along the valley, including at the mouth, and were very protective of their fields before harvest. Two French carpenters were even murdered during May when they picked corn from fields near the village of Atore near the mouth of the river, since the harvest would not arrive for several weeks" (Worth, 1999).

34. We also note the presence of at least one historic period interment in Johns Mound, apparently accompanied by pig bones. These remains are not included in the bioarchaeological analysis discussed here.

35. Worth (1999) continues: During the "primary mission period … the total missionized population of Guale and Mocamo ranged from a high of perhaps 1600 Indians over age 12 in 1595 to a lower of under 150 in 1711. Nevertheless, even at the start of the mission period these coastal chiefdoms were able to muster some 13,000 pounds of corn in annual tribute to the Spanish. Under the later system of maritime corn trade, these same provinces routinely sold 25,000 pounds of surplus corn to the missions despite the absence of a number of laborers from these towns who worked to produce an additional crop of corn in St. Augustine. This means that each year a combined labor force of probably only a few hundred men and women were able to produce not only enough corn to supply their own families and lineages, in addition to those of the chiefs and their noble relatives and other public officials such as the local missionary, but they were also able to produce tends of thousands of pounds of additional corn for barter to Spanish ships. And I would also hasten to add here that even unmissionized coastal groups such as the Orista-Escamazu were also routinely producing surplus corn and other agricultural products for sale during this same period. Spanish ships commonly visited these northern provinces to barter for corn, and early English exploratory expeditions under William Hilton and Robert Sandford in the 1660s described substantial fields of corn in this same region."

CHAPTER 33. POPULATION GROWTH, INTENSIFICATION, AND THE EMERGENCE OF SOCIAL INEQUALITY ON ST. CATHERINES ISLAND

DAVID HURST THOMAS

We return to the four deceptively simple questions that guided our research regarding the aboriginal lifeways of St. Catherines Island:

1. How and why did the human landscape (settlement patterns and land use) change through time?
2. To what extent were subsistence and settlement patterns shaped by human population increase, intensification, and competition for resources?
3. What factors account for the emergence of social inequality in the Sea Islands?
4. Does the newly available archaeological evidence resolve the conflicting ethnohistoric interpretations of the aboriginal Georgia coast (the so-called Guale problem)?

Having already addressed the first question (chaps. 29 through 32), the next two chapters will focus on (a) the effects of increasing population density on competition for resources and intensification of subsistence practices, and (b) the emergence of social inequality. The final chapter revisits the "Guale problem" in light of new data generated from archaeological investigations on St. Catherines Island.

MEASURING HUMAN POPULATION GROWTH BY PROXY

We begin by asking yet another deceptively simple question: *Is there evidence of human population growth during the 5000-year-long aboriginal occupation of St. Catherines Island?*

To address the question using archaeological data, the St. Catherines Island archaeological program long ago shifted from a single-site to a regional (or "landscape") orientation. By focusing on the relationships between the land and the people who lived there, so-called *landscape archaeology* holds the promise of transcending single site archaeology to focus on overarching relationships within the complex cultural geographies defined by human societies.

First, there was the obvious problem that the St. Catherines Island of, say, 2500 B.C. was vastly different in shape than the same island during the mission period. The modern configuration of St. Catherines Island results from a complex blend of noncultural processes, and this is why (for the past 3 decades), we have worked with a team of paleoenvironmental specialists, who conducted numerous vibracore sample transects and processed three dozen associated "noncultural" ^{14}C dates from St. Catherines Island (chap. 3, this volume; see also Morris and Rollins, 1977; Fierstien and Rollins, 1987; Groce, 1980; Booth et al., 1999a; Linsley, 1993). Chapter 29 melded these geomorphic and chronometric data with evidence derived from a host of historical maps to establish a geographical baseline for understanding the shifting shape of the Island throughout its 5000-year lifespan.

It was also necessary to engage the archaeological record of St. Catherines Island in a manner that avoided the fallacy of the single site, no matter how compelling those "typical" sites might be. Our survey strategy attempted to seek out variability between contemporary sites within a settlement pattern. Employing the Island-wide, probabilistic, transect survey method, we tried to generate an unbiased sample of the surviving archaeological record. The randomized survey strategy also required that we examine the most unlikely, inaccessible places (even when we didn't expect to find anything), in the attempt to generate meaningful negative evidence. In addition to documenting what archaeological evidence survives in specific settings, the transect data likewise indicated those places that contain no archaeological data at all.

This is why we executed the systematic, probabilistic approach to archaeological survey on St. Catherines Island and why we feel that resulting archaeological data provide a useful first-order heuristic for approaching the shifting human population densities on St. Catherines Island.

One cannot, of course, measure human population growth directly from the archaeological evidence. Instead, we have relied on four proxy measures selected to monitor various archaeological signatures of human population increase:

- the cumulative ^{14}C record,
- the relative frequency of archaeological components through time,
- the relatively frequency of landscape indicators through time, and
- the changing size of archaeological components through time.

The following sections detail the archaeological evidence for each of these proxy measures.

THE CUMULATIVE RADIOCARBON RECORD

Chapter 16 addressed the following statement in considerable detail:

If the summed probability distribution of radiocarbon dates can somehow be taken as a proxy reflecting the intensity of human population density—and this is a huge "if"—then the aboriginal occupation on St. Catherines Island was characterized by massive cycles of boom-and-bust, periods of dense human populations followed by lengthy episodes of virtual abandonment.

Citing John Rick (1987: 55–58)—who likened an individual radiocarbon date to a "self-dated artifact"—we explored the complex linkages between ^{14}C dates and human occupational patterns, attempting (in Rick's felicitous terminology) to view radiocarbon "dates as data". Chapter 16 discussed various methods of assembling ^{14}C histograms and considered the relevance of *calibration stochastic distortion* (CSD) effects in the calibration curves, emphasizing that very process of calibrating ^{14}C dates creates a potential problem because the radiocarbon time scale is not ac-

tually linear (see fig. 16.5). Acknowledging the potential skewing effects of various temporal, geographical, and geomorphological biases, we believe that John Rick (1987) was basically correct when he argued that "despite intervening biases, I assume that the number of dates is related to the magnitude of occupation, or the total number of person-years of human existence in a given area" (Rick, 1987: 55; see also Fitzhugh, 2003: 213–217).

This is why we explored the implications of the various ^{14}C histograms available for the more than 250 radiocarbon dates presently available from St. Catherines Island (chap. 16). The step-by-step process can be summarized this way:

- The cumulative ^{14}C histogram of the 2005 Dataset—the suite of 116 "cultural" radiocarbon dates available from St. Catherines Island research in early 2005—is characterized by a number of distinctive valleys (or "gaps"; see fig. 16.11). Although the radiocarbon peaks likely have cultural significance of some sort, one must question whether the five major ^{14}C gaps mean anything in behavioral terms. Does each gap represent an actual break (or hiatus) in the radiocarbon record of St. Catherines Island? Or do the gaps result from sampling bias?
- In March 2006, we processed an additional 49 radiocarbon dates (the 2006 Dataset), attempting to close the gaps in the cumulative radiocarbon record. Despite these additional dates, only one of these five major gaps in the radiocarbon record could be closed decisively (Gap D, The Wilmington–St. Catherines Boundary, cal A.D. 800). The four remaining gaps cannot, we believe, be dismissed as the product of sampling error or stochastic distortion. Chapters 16 and 32 attempted to explain the natural and cultural significance of these various peaks and valleys in the ^{14}C histogram combining the 2005 and 2006 Datasets.
- After completing the gap hunting exercise, several additional radiocarbon dates were processed on archaeological samples (chap. 20) and the Pooled Dataset from St. Catherines Island presently contains 174 cultural ^{14}C dates.

Despite the obvious biases in sampling and radiocarbon calibration technology, we believe that the ^{14}C histogram in figure 33.1 a useful proxy for approximating the relatively short-term shifts in human

The Pooled "Cultural" Radiocarbon Dataset (n = 174)
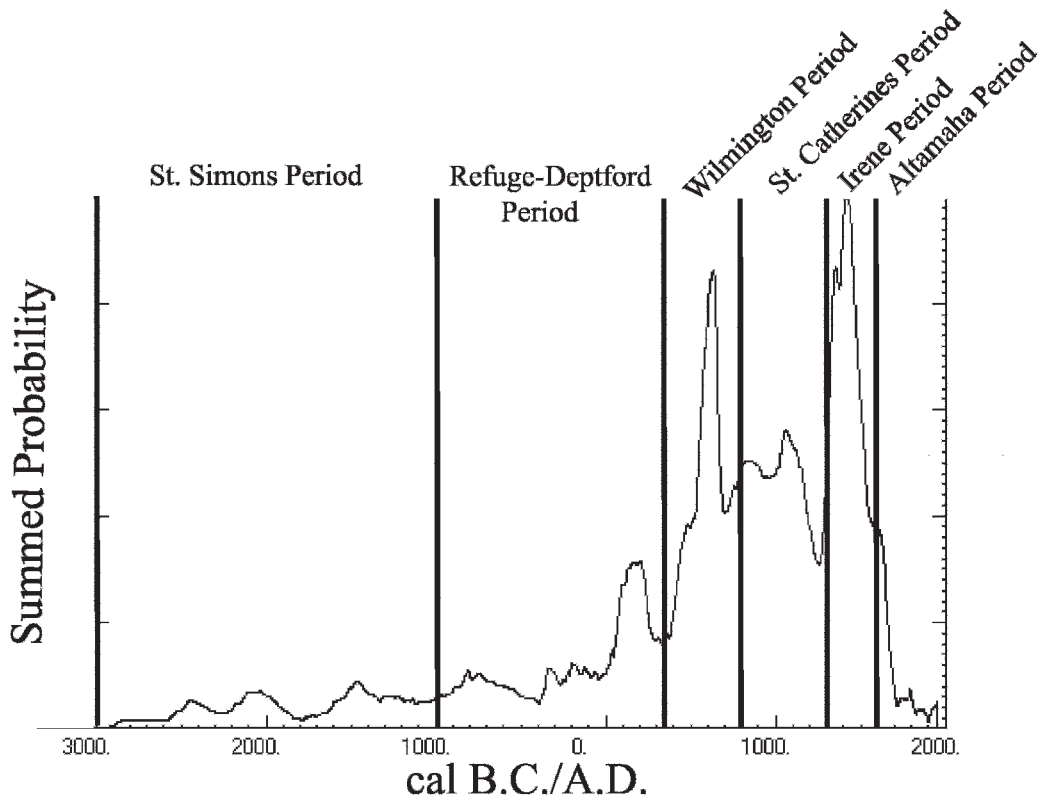
Fig. 33.1.   The distribution of cultural radiocarbon dates through time on St. Catherines Island.

population density on St. Catherines Island.

COMPONENTS PER CENTURY

An archaeological *component* was defined previously as "a culturally homogeneous unit within a single archaeological site" (per Willey and Phillips, 1958: 21; see chaps. 12 and 30, this volume). The concept of "archaeological component" has been critical to this study because it provides an operational mechanism for assigning intrasite contexts to the various kinds of evidence employed here, including ceramic chronology, radiocarbon dates, zooarchaeological assemblages, and seasonality estimates. Tables 20.1 and 20.2 summarize the distribution of the 129 archaeological components defined from the systematic regional sample of St. Catherines Island.

The St. Catherines Island chronology assigned temporal limits to the known archaeological components (chap. 15, especially table 15.3). For present purposes, then, the *temporal duration* of each cultural period will be used to estimate the number of components per century for each period; table 30.2 synthesizes the distributional data according to temporal period. These temporal limits can also be compared to the archaeological record of St. Catherines Island (as synthesized in the previous chapter on a synchronic, period-by-period, basis).

Shifting to a diachonic perspective, figure 33.2 plots the distribution of archaeological components/century for each of the archaeological components recorded in the probabilistic, Island-wide survey. Clearly, the number of components/century progressively increases throughout the precontact aboriginal occupation of St. Catherines Is-
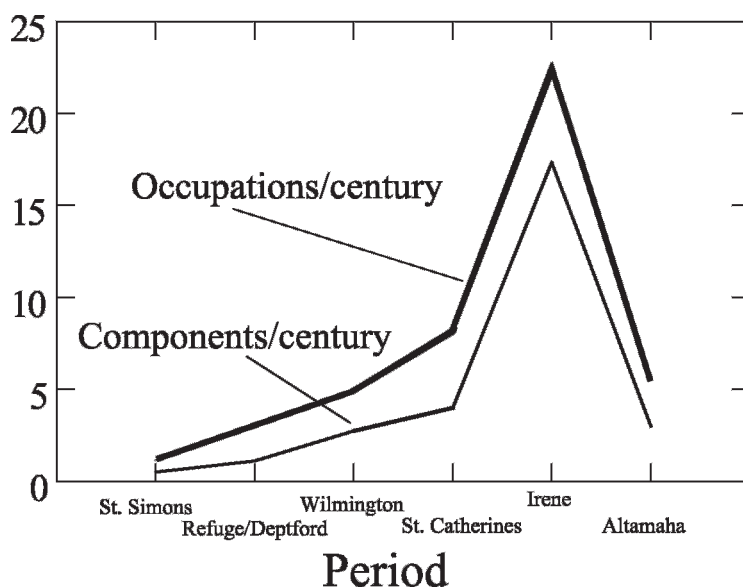
Fig. 33.2.   Changes in occupations/century and components/century through time.

land. The St. Simons period lasted 20 centuries, and the Island-wide survey recorded only 10 St. Simons period components, translating to an average of 0.50 components per century—the lowest density of components recorded on St. Catherines Island.[1] Most of these Late Archaic sites clustered along the eastern margin of the Pleistocene core (commonly overlooking Guale Marsh); the lone exception is the St. Catherines Shell Ring (9Li231), situated along the westernmost extent of St. Catherines Island.

During the Refuge-Deptford periods, the density of archaeological components doubles (to 1.11 components/century), then doubles again (to 2.74 components/century) in the succeeding Wilmington period, as the number of western marshside settlements increases dramatically (likely due to the demise of Guale Marsh). Then, although the absolute number of St. Catherines period components actually declines ($n = 20$), the relatively short (5-century) temporal duration of this period once again doubles the index of components/century (to an average of 4.0 components/century).

The archaeological record for the Irene period shows a marked increase in the number of archaeological components, skyrocketing to $n = 52$ components recorded in the

Island-wide survey (for an average of 17.33 components/century), the densest concentration recorded for any aboriginal period on St. Catherines Island.

An equally dramatic shift occurs during the Spanish occupation of St. Catherines Island, when the number of Altamaha period components drops to six (clearly reflecting the prevalent *reducción* policy instituted during the mission period). Except during the St. Simons period, the period components/century statistic of 3.0 for the Altamaha period is the lowest density of components during the 5000-year-long aboriginal period.

Components/century is, to be sure, an imperfect proxy for long-term trends in population growth. We have already documented the changing shape of St. Catherines Island over the past 5000 years (chap. 29). The significant sea-level change during the late St. Simons, Refuge, and Deptford periods also likely modified the distribution and availability of salt marsh resources (the highest ranking resource patch available to St. Catherines Island foragers) and triggered notable settlements shifts masked by averaging across an entire culture period (chap. 4). Without doubt, the components/century statistic glosses over some

significant variability on a century-to-century scale, but it still provides a useful summary proxy on, say, a millennium-to-millennium scale. As such, the cumulative radiocarbon record and the components/century statistic compliment one another by providing rather different perspectives on human population growth.

OCCUPATIONS PER CENTURY

The regional research design employed on St. Catherines Island remained sensitive to a nonsite perspective on regional patterning by defining the "archaeological landscape" as the totality of all available archaeological indicators (Thomas, 1973, 1975; see also Dunnell and Dancey, 1983), Accordingly, the terms "presence" and "occupation" have been employed to define the various time-sensitive, geographically specific archaeological evidence regardless of their abundance or stratigraphic context; these landscape indicators were then partitioned according to specific temporal period and plotted across a well-defined and bounded geographical space (see also chaps. 19 and 30). So defined, then, an archaeological presence might be one or more potsherds recovered from an archaeological provenience, one or more time-diagnostic lithic artifacts, or even an apparently reliable cultural radiocarbon date (in context, but not necessarily in the presence of ceramics).

As when evaluating the temporal distribution of archaeological components, the St. Catherines Island chronology provides the temporal limits necessary to circumscribe the various archaeological periods—defining the temporal duration of each cultural period and computing the number of occupations per century for each period (table 30.2). This has been done for each of the 234 occupations recorded in the Island-wide archaeological survey of St. Catherines Island.

As Figure 33.1 clearly demonstrates, the archaeological landscape indicators follow precisely the trends described above for components/century: The density of aboriginal occupations increases notably from St. Simons through St. Catherines times, spiking dramatically during the Irene period, then falling off in equally dramatic fashion during the Altamaha period.[2]

COMPONENT SIZE

Figure 33.3 addresses aboriginal population growth from a rather different perspective, focusing instead on the size of each archaeological component recorded. As discussed in chapters 20 and 30, the subsurface extent of all archaeological components was estimated by probing and shovel testing during the Island-wide survey. These field estimates were then grouped into three ordinal categories: large components (>500 m^2), medium-size components (50–500 m^2), and small components (>50 m^2). Figure 33.2 plots these interrelated indices, documenting the relative proportion of large-, medium-, and small-sized archaeological components through time.

The proportional distribution of large components (>500 m^2) throughout the aboriginal sequence on St. Catherines Island increases from zero large sites during the St. Simons period to nearly 40 percent (18 of 48) during the Irene period.[3] Four of five Altamaha period components covered more than 500 m^2 (chap. 20). This trend mirrors that of both component/century and landscape/century proxies discussed above (fig. 33.1).

The proportional distribution of components sized 50–500 m^2 and >50 m^2 is, of course, logically and statistically linked to the distribution of large components, and both proxies decrease irregularly through time on St. Catherines Island (fig. 33.2). During the mission period, "small" archaeological components disappear altogether, with very large components (e.g., Mission Santa Catalina de Guale) dominating the post A.D. 1580 era.

SUMMARY OF EVIDENCE REGARDING ABORIGINAL POPULATION GROWTH ON ST. CATHERINES ISLAND

The four proxy measures discussed above (each derived from data generated in the probabilistic Island-wide archaeological
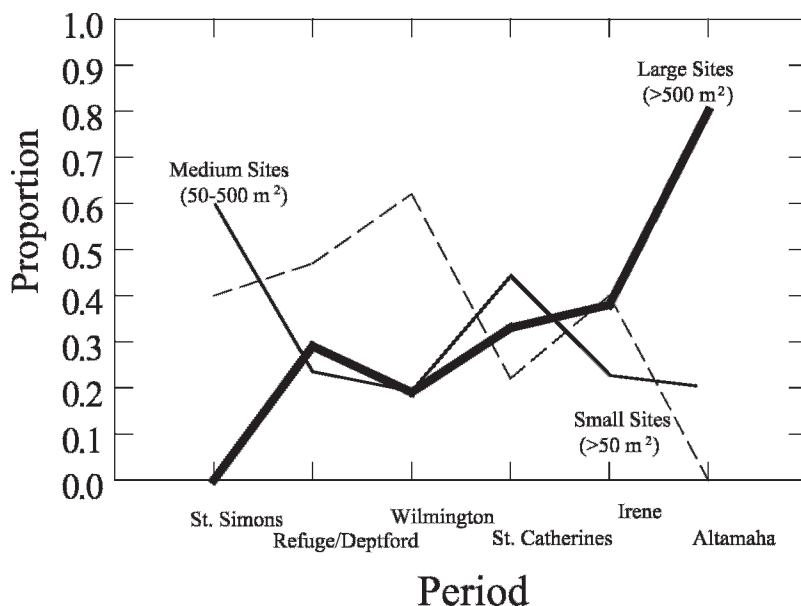
Fig. 33.3.   Changes in site size through time.

survey) suggest three important conclusions about human population growth on St. Catherines Island.

First, it is clear that the number of archaeological components and occupations (per century) increases exponentially throughout the precontact aboriginal period. In such exponential growth processes, the larger a quantity becomes, the faster it grows, and this is precisely what happens with the population proxies from St. Catherines Island.

The Island-wide survey data also indicates that the size of the 129 individual components tends to become increasingly larger through time. Specifically, the proportion of ''large'' archaeological sites (those with an estimated subsurface extent exceeding 500 m^2) increases significantly through time, with a particularly dramatic increase under the Franciscan *reducción* system employed at Mission Santa Catalina de Guale. Except for a blip during the Irene period, the proportional distribution of medium-sized components (between 50–500 m^2) decreases correspondingly through time. The number of ''small'' components (less than 50 m^2 in extent) also decreases through the

aboriginal period (except for a slight increase during the St. Catherines period).

Finally, we employed a ^{14}C histogram for 174 cultural dates presently available from St. Catherines Island. The exponential growth rate (posited above) is generally reflected in figure 33.1, as the probability distribution of radiocarbon evidence increases steadily from the St. Simons through Irene periods, with three notable exceptions:[4]

- cal 1350 B.C. through cal 350 B.C.: Virtually no marine shell middens were created during this interval on St. Catherines Island, likely due to lowered sea level during late St. Simons–Refuge–Early Deptford times undermining marsh productivity and triggering a significant settlement shift on St. Catherines Island.
- circa cal A.D. 400: A significant gap in radiocarbon evidence separates the Deptford and Wilmington periods. This hiatus probably reflects a cessation of both shell midden accumulation and mortuary activities.
- cal A.D. 1160–1290: The St. Catherines Period Drought (A.D. 1176–A.D. 1220) correlates almost precisely to a gap in the ^{14}C histogram spanning the interval cal A.D. 1160–A.D. 1290 (Blanton and Thomas, chap. 28, this volume). Although CSD effects become an issue during this time interval, such effects cannot explain

this demonstrable decline in both midden and mortuary evidence during the late St. Catherines period.

The cumulative ^{14}C record thus confirms the overall trend of increasing aboriginal population density, but also highlight three significant time periods when populations drop dramatically (if not catastrophically; as detailed in chap. 32).

These are imperfect proxies, averaged over long time periods and doubtless masking considerable short-term population shifts. We also lack the community-level archaeology necessary to document more precisely the century-to-century shifts in human population density. That said, we believe the Island-wide archaeological data establish (beyond reasonable doubt) that human population levels on St. Catherines increased at an exponential rate over the 5000 years of aboriginal occupation.

CONSEQUENCES OF HUMAN POPULATION GROWTH

Human population growth has conventionally been considered to be unintended consequence of agricultural productivity (where practiced) and/or low residential mobility (e.g., Cohen, 1977, 1985; Bettinger, 1991: 59; Winterhalder and Goland, 1993). Specifically with respect to complex foragers, Keeley (1988) implicated population growth as the key factor driving social complexity among hunter–gatherers living in habitats with a potentially abundant, predictable, and defendable resource base (Dyson-Hudson and Smith, 1978).

The following sections examine the archaeological record of St. Catherines, looking specifically at the multiple consequences of human population growth.

HEALTH CONSEQUENCES (BIOARCHAEOLOGY)

For more than a century, bioarchaeology has been a major research focus on St. Catherines Island, and we have been fortunate to work with Clark Spencer Larsen throughout the American Museum of Natural History investigations. Mortuary excavations have recovered the remains of more than

725 individuals from St. Catherines Island; Larsen and his colleagues have analyzed more than 90 percent of these remains using a diverse array of bioarchaeological techniques (see esp. chaps. 12, 24, and 32).

This chapter has already documented the dramatic increase in human population growth throughout the aboriginal occupation of St. Catherines Island. Bioarchaeological theory predicts that the correlative changes in diet breadth and demography accompanying a significant population increase should result in an overall decline in health among the aboriginal groups involved (Larsen, 1997; Walker, 2001; Pearson and Buikstra, 2006).

This is exactly what happened on St. Catherines Island. Specifically addressing changes from early foragers through mission period farmers, Larsen (1990: 13) documented an increase in nonspecific bone infection, increase in dental caries, increase in degenerative joint disease (osteoarthritis), decrease in craniofacial, tooth, and postcranial size, decrease in skeletal robusticity and bone strength, and decrease in body size and stature.[5] Arrayed against the evidence of exponential population growth on St. Catherines Island, we can explore the nature of these changes.

The femora and humeri from Deptford–Wilmington period burials, for instance, tend to be quite robust, with a marked degree of sexual dimorphism, likely reflecting differential gender roles, especially long-distance travel by males (Ruff and Larsen, 2001; see also Ruff et al., 1984; Ruff and Larsen, 1990; Larsen and Ruff, 1994; Larsen et al., 1996). Deptford–Wilmington males also had an increased overall mechanical loading of the lower and upper limbs. Compared with later aboriginal burials from St. Catherines Island, people of the Deptford–Wilmington periods suffered relatively few infectious diseases (as reflected by the lack of periosteal reactions), and they enjoyed superior dental health (as indicated in the low rate of dental caries and carious lesions; per Reitz et al., 2002: 52–53).[6] This difference could well reflect the differing foraging goals and practices of males and females during the Deptford–

Wilmington periods (with males involved in long-distance logistic transport and females concentrating on mast and shellfish procurement, reflecting more home-centered fitness objectives).[7]

Based on stable isotope analysis, Schoeninger et al. (1990: 92) conclude that the Deptford–Wilmington individuals probably enjoyed diets that ranged from less than 30 percent of calories from marine foods to over 50 percent from marine sources. But evidence from the Central Tomb at McLeod Mound demonstrates a surprising dietary variability (chaps. 20 and 32). Three individuals had been raised on a predominantly marine-based diet (similar to that available on St. Catherines Island and nearby coastal environment). But another female, buried about the same time in the common grave, had been raised on more terrestrial diet, ingesting significantly fewer marine resources. The overall range of variability within these five females is greater than that expected from a single dietary regimen.[8]

We presently have stable isotope results for a dozen burials dating to the St. Catherines period (based on individuals buried at Johns and Marys Mounds (see Thomas and Larsen, 1982; table 32.2, fig. 32.12). The overall trend toward decreasing nitrogen and carbon isotope levels suggests a mixed foraging pattern—still dependent on marine foods, but perhaps augmented by gradual adoption of maize-based agriculture. Schoeninger et al. (1990: 88–89) speculate that some Deptford–Wilmington period individuals, and everyone represented by the St. Catherines period sample, likely ingested C_3-rich resources. While consumption of maize (or some other C_4 plant) could certainly account for this result, the same could be said for several Deptford–Wilmington period individuals (and we have a problem with serious maize consumption during Deptford–Wilmington times [cal 350 B.C.–A.D. 800]). Dental pathologies in the Johns and Marys Mounds skeletal series are relatively rare (suggesting nondomesticated resources), and the overall quality of skeletal and dental health is high (Larsen and Thomas, 1982: 327–329); this is why we question the importance of maize

consumption during the St. Catherines period as well.

Evidence for the late prehistoric Georgia coast comes primarily from the Irene Mound, a large Mississippian ceremonial complex and population center, located at the mouth of the Savannah River, 50 km to the north of St. Catherines Island (Caldwell and McCann, 1941; DePratter, 1991; Anderson, 1994: 172–192). Several centuries before Europeans contact, the Irene Mound population experienced an increase in population size and social complexity, in an economic shift from mostly foraging to mostly farming (Powell, 1990; Larsen et al., 2001: 64–66). Despite the fact that maize has only rarely been recovered archaeologically, stable isotope analysis of late prehistoric remains provides "unequivocal" evidence (Larsen, 2001: 29) that maize was clearly a major part of the diet for people of the Irene period who were living along the Georgia coast after about A.D. 1300 (Schoeninger et al., 1990; Larsen et al., 1992; Hutchinson et al., 1998). Larsen and his colleagues found a decrease in maize consumption in coastal Georgia, and southward in Florida, where maize was not generally adopted until the mission period (Larsen et al., 2001).

The implications of increased maize consumption include a decreased ability to absorb iron (leading in some cases to iron deficiency anemia), an increase in dental caries, and generally poor dental health. Moreover, because "malnourished people are more susceptible to infection, and people with an infection have a worsened nutritional status" (Larsen et al., 2001: 75), an increase porotic hyperostosis and cribra orbitalia also accompany the adoption of a maize-based diet (Walker, 1985; Hutchinson and Larsen, 2001; Schultz et al., 2001; Simpson, 2001).

By about A.D. 1000, a treponemal disease (probably endemic syphilis) had also spread across coastal Georgia (Powell, 1990; Hutchinson and Larsen, 1990). Modern analogs suggest this may have been due to impoverished living conditions and poor sanitation (Walker 2001: 278). But the frequency of porotic hyperosity, a condition

commonly associated with iron deficiency, did not increase in precontact coastal populations (Powell, 1990; Larsen and Sering, 2000), suggesting that greater maize dependency did not "disrupt the balance between iron intake and iron loss sufficient to increase the prevalence of anemia" (Walker 2001: 278).

Stable isotope data are limited for the Irene period on St. Catherines Island (tables 32.2 and 32.3). The significant increase in observed δ carbon values indicated to Larsen (2002: 64) that the Irene population "ate maize in appreciable amounts", a dietary shift likely accompanied by a reduced consumption of marine resources. Reitz et al. (2002: 45) suggest that carbon isotope ratios for individuals buried in South End Mound I are "consistent with the trend for the regional as a whole—late prehistoric populations ate more maize than did early prehistoric populations, but less maize than did the mission-era groups, and late prehistoric populations ate somewhat less marine foods than did early prehistoric populations, but more marine foods than during the mission era."

The frequency of periosteal lesions and dental caries increases significantly during the Irene period, likely reflecting poor sanitation conditions and the spread of infectious disease prior to the arrival of Europeans (Reitz et al., 2002: 50, 53, 54). Biomechanical studies of Irene period remains further suggest decreased mobility and shorter stature than pre-Irene populations on St. Catherines Island (Larsen, 2002: 58, 61).

Additional bioarchaeological studies support this finding. Periosteal lesions are "not an uncommon occurrence" among individuals interred at South End Mound I (Reitz et al., 2002: 46, 48) and this evidence likely reflects an aboriginal population living "in a relatively sedentary village community with poor sanitation and an environment conducive to the maintenance and spread of infectious disease." The frequency of dental caries increases notably in the Irene period sample and the increased evidence of infectious disease likely reflects the increased population density from earlier times (Reitz et al., 2002: 50, 53, 54). Biomechanical studies reinforce the suggestion of decreased mobility through time. People become shorter during the late precontact period, likely due to poor nutrition. Adult males of the Irene period "are generally more physically active (more mobile) than females" who are "perhaps less mobile than the prehistoric and early historic Guale" (Larsen, 2002: 58, 61).

The only known cemetery at Mission Santa Catalina exists beneath the floor of the nave and sanctuary of the mission church (the *iglesia*), containing the remains of at least 431 individuals buried (see especially Larsen, 1990, 2001). Twenty-two of the individuals buried at Mission Santa Catalina de Guale were analyzed for stable carbon and nitrogen isotopes (tables 32.2 and 32.3; fig. 32.15). Maize was clearly a dietary staple during the mission period, and the observed $\delta^{15}N$ values for the Mission Santa Catalina samples overlap those with pueblo agriculturalists of the American Southwest (Schoeninger et al., 1983, 1990: 90), but a continued reliance on marine resources depresses the overall distribution of $\delta^{15}N$ values.

Investigators have documented major changes in body form, suggesting that during the early contact period, St. Catherines Islanders appear to have lived more sedentary lives than precontact times (likely involving a relative static workload and experiencing greater body weight, probably due to increased carbohydrate consumption). Females living at Mission Santa Catalina exhibited increased limb loadings (which had decreased marginally during late prehistoric times), but had increased notably during the mission period. Upper limb loading had also decreased from the early to late prehistoric periods, but stayed low during the mission period (Ruff and Larsen, 2001: 137). Male locomotor activities appear to have reduced during the transition from foraging to farming, which is consistent with ethnographic observations. This could be due to a greater workload during mission times, or an "increase in corpulence" triggered by greater sedentism and consumption of carbohydrates during

missionization (see also Ruff et al., 1984; Ruff and Larsen, 1990; Larsen and Ruff, 1994; Larsen et al., 1996).

Hutchinson and Larsen (1990) found that enamel hypoplasias were more common among individuals from the Mission Santa Catalina than among precontact St. Catherines Island foragers. This suggests that people living during the Deptford, Wilmington, and St. Catherines periods experienced more single-stress events than did contact period populations, despite the fact that the mean width of the hypoplasias was relatively narrow (suggesting shorter duration or less severe stress intervals; Hutchinson and Larsen, 1990: 64). This implies that some people living at Mission Santa Catalina most likely experienced longer periods of increased stress, a higher intensity of stresses, or perhaps both.

Larson (1990: 40) and Russell et al. (1990: 36) conclude that the mission period population had a longer survivorship profile than their sample from the Irene period population. This demographic shift could represent either a "rebound" in overall population health and demographic robusticity or perhaps certain segments of the mission period population was not interred in the church cemetery (thereby biasing the age profiles).

Overall, then, the bioarchaeological evidence from St. Catherines Island is consistent with expectations given an exponential population growth, increased crowding, and adoption of a maize-based diet (at least during the mission period). As expected, we find a general decrease in health and an overall increase in the presence of infectious disease.

Before leaving the bioarchaeological evidence, a cautionary note is required about bridging between the archaeological and ethnographic data. Investigators have typically assumed that during the 16th and 17th centuries, the people living at Mission Santa Catalina de Guale (and several other nearby missions along the Georgia coast) were the direct descendants of aboriginal people who lived at the precontact Irene Mound (e.g., Larson, 1980a: 195; Larsen et al., 1996: 98–99). New bioarchaeological data now suggest this relationship may be more complex than initially assumed.

Working from a sample of 510 individuals from 17 archaeological sites along the Georgia coast, Griffin et al. (2001: 232) caution that the degree of dissimilarity evident from univariate and multivariate analyses "casts some doubt on this relationship." Specifically, Griffin (1989, 1993; Griffin and Nelson, 1996) found that the Guale samples were "particularly diverse" in their dental and cranial nonmetric morphology (Griffin et al., 2001: 232). Based on statistical criteria of biological distance, the population living at Santa Catalina de Guale appears to be an aggregate, clouding the biological relationship to those buried in the Irene Mound, itself an aggregate ceremonial center.

The dissimilarity between Guale and Irene bioarchaeological samples cannot be explained by random genetic drift. This means that any assumption of continuity between the Irene Mound population and the later Guale people must be questioned. As noted by Jones (1978), Spanish explorers used the term "Guale" to mean both a physical location and also a culturally/linguistically affiliated social group (Jones, 1978: 186; see also Worth, 2004: 238–240 and Saunders, 2000b)—leaving the distinct possibility that the term "Guale" (used so frequently in 16th-century ethnohistoric accounts) might have referenced merely geographic placement along the Georgia coastline, without any necessary linkage to linguistic, biological, and/or cultural identity. Or, perhaps "Guale" might have distinct linguistically and/or culturally significance, but not necessarily denote a biological breeding population. But if the Guale did indeed descend from the Irene Mound population, then a substantial biological change took place in a surprisingly short time period.

DIET-BREADTH CONSEQUENCES

Kennett (2005: 4, 14) has made the point that archaeologists working with maritime foraging populations have long been stranded "in a theoretical vacuum without the tools necessary to explore cultural evolutionary processes. These processes are complex, and Human Behavioral Ecology is well positioned to fill this theoretical void.

… [T]he purpose of HBE is not to reduce all aspects of human behavior into foraging equations but to explore specific questions with a set of models that can be tested with ethnographic or archaeological data.'' This section will examine the implications of the diet-breadth implications for the issue of resource intensification on St. Catherines Island.

We began by developing a series of first-order heuristics, estimating the relative foraging efficiencies involved with each target taxon and the ecological circumstances making each resource set attractive to aboriginal people on St. Catherines Island. The diet-breadth model predicts that foragers will optimize the time spent capturing prey and employs the simplifying assumptions that all resources are randomly distributed (without patches) and that ''capture/handling'' and ''search'' times represent the sum total of all time spent foraging (Winterhalder, 1981, O'Connell and Hawkes, 1981, 1984; Smith, 1991). An understanding of these individual cost/benefit decisions permits an estimation of how the various hunt types might relate spatially to the well-defined patch types contained within the barrier island ecosystem. We then assumed that, on a hunt-to-hunt basis, aboriginal foragers on St. Catherines Island would allocate foraging time to the hunt type that yields the highest expected return rate *at that point in time.* The diet-breadth model further assumes that individual foragers make short-term decisions based on immediate and often quite limited environmental and cultural circumstances. ''The sum of these decisions across space and through time results in the long-term subsistence shifts that may be evident in the archaeological record'' (Kennett, 2005: 20).

In its most elemental form, the diet-breadth model predicts that foragers will select foods as to maximize net energy, and as forager population density increases, a disproportionate number of high-ranked prey will harvested, resulting in decreasing encounter rates. Specifically, we used the diet-breadth model to generate certain testable predictions regarding the archaeological record of St. Catherines Island (Broughton,

1994a, 1994b, 2002; Cannon, 2000a; Kennett, 2005: 18):

1. If the abundance of higher ranked prey species increases, the diet breadth should decrease (meaning that the variety of resources exploited will be smaller).
2. If the abundance of high-ranking resources decreases (inflating search costs), then diet breadth will increase; this is why potential prey types enter the diet based on the abundance of higher ranked resources, not just because of immediate value.
3. As human population densities increase, we expect the availability of high-ranked prey species to decrease (although environmental change can be an important factor here as well).

Although the diet-breadth model has been used primarily to predict prey choice (as above), these decisions also have ramifications for human settlement patterning. When high-ranked resources become depleted, foragers can chose to broaden their diet breadth or they can shift residential patterning to decrease search and/or transport costs. Similar pressures might cause some foragers to create better storage facilities or perfect more intensive food processing technologies.

Rather than simply pooling all potential prey items (which would, in effect, trigger an assumption that all resources are distribution homogeneously in space), we defined a series of seven hunt types, enabling us to preserve the assumption of fine-grained foraging within each set of prey taxa. The changing availability of resources on St. Catherines Island throughout the annual cycle—especially mast, small seeds, and sea turtles—also imposed a distinctly seasonal pattern on the subsistence forager, who exploited resources in both terrestrial and marine ecosystems simultaneously (often on the same day).

The prey-choice model projects that a forager's most efficient strategy will be to take the highest ranked prey when encountered, shifting to lower ranked resources only when the density of high-ranking prey is reduced. Thus, as foraging pressures increase, the abundance of higher-ranking prey should decline, and several researchers

have investigated archaeological evidence relating to this hypothesis (Hildebrandt and Jones, 1992; Broughton, 1994a, 1999; Jones and Hildebrandt, 1995; Lyman, 1995; Janetski, 1997; Cannon, 2000a; Grayson, 2001; Butler and Campbell, 2004; Byers and Broughton, 2004; see chap. 11, this volume). Chapter 31 developed a variety of *indices of relative abundance* to explore the issue of prey choice and resource depression (see also Bayham, 1979; Szuter and Bayham, 1989; Broughton, 1994a; Ugan and Bright, 2001: 1309; Butler and Campbell, 2004: 338; Wolverton, 2005; Betts and Friesen, 2006).[9] Such abundance indices are most useful when checked against other indications of hunting pressure and foraging efficiency, such as changing age structure in the prey population (Broughton, 2002). Differential transport and butchering patterns (as reflected in the changing element distributions) can likewise reflect an increased cost of using more distant resources, and intensified technology can be employed to more effectively exploit lower ranking animals (Bright et al., 2002; Ugan et al., 2003).

TERRESTRIAL HUNTING: Black bear and American alligator have the highest post-encounter return rates for any taxon in the terrestrial hunt type. But their virtual absence in the archaeological record suggests that they were rarely harvested (table 31.1). This somewhat surprising result certainly points up new avenues of inquiry for future archaeological investigations on St. Catherines Island.

When humans first arrived, the white-tailed deer living on St. Catherines Island were much larger than those of today (with an average live weight in the range of 70–80 kg) and a high post-encounter return rate in the neighborhood of 12,000–20,000 kcal/hr (chap. 8). As the archaeological evidence makes abundantly clear, white-tailed deer were commonly hunted during the St. Simons period, as were raccoons, opossum, and pond and mud turtles. The lower threshold for diet breadth in the terrestrial hunt type is perhaps 1300 kcal/hr (the return rate for diamondback terrapins, the lowest ranking terrestrial game animal evident in St. Simons period middens).

Over the next 3000 years, the relative abundance of white-tailed deer bones fluctuated somewhat in the archaeological middens of St. Catherines Island. Whereas venison remained the staple for the aboriginal foragers—accounting for 60–80 percent of the biomass contributed by marine and terrestrial vertebrates—the post-encounter return rates decreased in proportion to the shrinking body size (see fig. 8.1 and table 8.4). The same suite of lower ranking taxa was also hunted, and the relative abundance of diamondback terrapin remains increased significantly with respect to deer bones. These data suggest that the overall diet breadth for terrestrial hunting on St. Catherines Island was relatively broad, remaining constant at 1300 kcal/hr for nearly 4000 years. Because of the nature of the archaeological indices employed, we cannot determine whether deer hunting actually decreased or use of diamondback terrapin increased.[10]

Figure 31.4 plots the variability in White-tailed Deer Indices across the six temporal periods on St. Catherines Island, using three intercorrelated abundance measures (NISP, MNI, and Biomass). The diet-breadth model predicts that when human population increases through time (as it demonstrably does on St. Catherines Island), a disproportionate number of high-ranking prey taxa (especially white-tailed deer) should be harvested. Over time, the total encounter rates for the most desirable prey ishould decrease and diet breadth should increase as lower ranking taxa are included to compensate for the overall decrease in net energy intake.

The St. Catherines Island data do not support this hypothesis. Although white-tailed deer remains comprise only 5 percent of the individual vertebrates recovered from St. Simons period deposits (Reitz, chap. 22; fig. 31.4; table 31.1), the importance of white-tailed deer utilization on St. Catherines Island actually *increases* during Refuge-Deptford through Irene times (hovering roughly between 20 and 30% of MNI and NISP in the overall vertebrate faunal

sample; table 31.2). During this 2000-year interval, venison contributes 60–80 percent of the biomass available from terrestrial and marine vertebrate sources.

During the mission period on St. Catherines Island, venison intake increases again, to 88.8 percent of biomass derived from vertebrates, and the proportion of white-tailed deer bones (NISP) increases to 66.4 percent and 31.4 percent of MNI (tables 31.2 and 31.4). By any measure, this is the most intensive utilization of white-tailed deer throughout the entire aboriginal period on St. Catherines Island. Looking strictly at the terrestrial vertebrate faunal remains, these results suggest that during the mission period, the Guale people shifted from a relatively broad diet (that included turtles, fish, and venison) to a surprisingly narrow dietary focus on white-tailed deer. As Reitz observes in chapter 22, the huge quantity of venison consumed at Mission Santa Catalina stands in marked contrast to Spanish diets reconstructed for coastal Spanish Florida, the Caribbean, or Spain.[11]

The results from St. Catherines Island conflict with many other archaeological studies; clearly we must avoid assuming that high-ranking prey populations must inevitably and universally decline under human hunting pressure (see also Grayson, 2001: 16; Butler and Campbell, 2004: 398).[12] Despite continued and intensive utilization on St. Catherines Island, a very highly ranked terrestrial source (white-tailed deer) persisted for millennia, with no evidence of resource depression.[13] But in the broader context of the Georgia coast, the relative abundance of white-tailed deer remains on St. Catherines Island is surprising, even extraordinary. "This is the most unexpected result of the transect study" notes Elizabeth Reitz, "and one that is difficult to explain based on present knowledge" (chap. 22, this volume; see also Reitz, 1982b).[14]

MARINE VERTEBRATES: We can also explore diet-breadth implications for the marine vertebrates exploited by the aboriginal foragers of St. Catherines Island (fig. 31.14). During the St. Simons period, the marine vertebrate assemblage is dominated by hardhead catfish bones (a relative small taxon, averaging only 0.15 to 0.30 kg). The Big Fish Indices (for NISP and MNI) are correspondingly low. But the presence of numerous large fish bones (including rays, sharks, gar, gafftopsail catfish, and black drum) raise the biomass indicator to 0.651, the largest value observed for any period in this study.

Throughout the precontact period, Big Fish Indices tend to peak during the Refuge, Deptford, and Wilmington periods, followed by a precipitous decline during the St. Catherines and Irene periods (figs. 31.14 and 31.15). That is, unlike white-tailed deer, the relative frequency of "big fish"—that is, those taxa with an average live weight greater than 1.0 kg—decreases significantly through time, especially after cal A.D. 800, the beginning of the St. Catherines period.

This trend is consistent with the diet-breadth predictions that through time, the highest ranked taxa should be harvested disproportionately, thereby stimulating an expansion in diet breadth as foragers turned to lower ranking taxa. Within the saltwater fishing hunt type, this is precisely what happened on St. Catherines Island. Although we do not know the actual mechanism driving this change, the zooarchaeological evidence makes it clear that diet breadth did indeed expand in the saltwater fishing hunt type between about cal A.D. 800 and the mission period on St. Catherines Island.[15]

We can also compare the relative distribution of marine and terrestrial abundance indices through time (fig. 31.16). Across the entire 5000-year sequence, marine taxa contributed about NISP = 30 percent of the total vertebrate elements recovered, roughly MNI = 18 percent of the vertebrate individuals, and only about 5 percent of the overall biomass from vertebrate sources (table 31.3).[16] These results are, to some degree, biased by our use of 1/4-in. screens throughout most of the excavations described here; Reitz (chap. 22) estimates that the relative bias against the recovery of fish bones might reach 25 percent. Nevertheless, the St. Catherines Island data indicate that (despite the high projected post-encounter

return rates), marine vertebrates never contributed more than about one-quarter of the total biomass from vertebrate sources. Specifically, the zooarchaeological samples obtained from 85 archaeological components (distributed across 71 individual sites) indicate that terrestrial vertebrates always contributed at least three times the biomass as marine vertebrate sources, and during most of the aboriginal occupation of St. Catherines Island, terrestrial taxa contributed more than 10 times the biomass as marine vertebrates.

SHELLFISHING: Based on 3 years of experimental research on St. Catherines Island, we understand that energetic return rates for clams, oysters, whelks, and other shellfish taxa are relatively low ranking, falling within the range of mast crops and small seeds, and ranking considerably lower than marine resources (especially fish and reptiles) and most terrestrial vertebrates on St. Catherines Island (table 7.3). Not only are the ''meat packages'' of shellfish quite small, but the proportion of usable meat is quite low (often well below 30%). This means that shellfishers must be willing to collect (and likely transport) heavy loads of shellfish (only a small part of which is edible) and spend considerable time extracting the meat from each shell package.

We lack systematic, quantitative data for nonvertebrate faunal remains from the aboriginal shell middens of St. Catherines Island. This is a major shortcoming in our previous research design because without knowing midden constituents (especially the relative frequencies of shellfish taxa) across the temporal and functional range of sites discussed, one cannot assess biomass or diet breadth within this important hunt type. But even lacking the empirical data, it is clear that—the low energetic rankings notwithstanding—shellfish were extensively exploited by aboriginal foragers throughout the precontact and mission periods on St. Catherines Island. Even a cursory examination of the archaeological record demonstrates that the Guale people and their ancestors discarded hundreds of tons of shellfish remains in the estimated 700

aboriginal settlements that survive on St. Catherines Island.

This, then, is the *shell midden paradox*: Whereas the diet-breadth model defines shellfish as a relatively low ranking resource, why is St. Catherines Island littered with thousands of aboriginal shell middens that span the last 5 millennia?

We believe that the answer lies in the various gender-specific ''foraging types'' that conditioned the range of foraging behavior on St. Catherines Island (chaps. 6–8). The prey-choice model assumes that individual foragers make short-term decisions based on situation-specific environmental and cultural concerns; the archaeological record reflects the long-term summation of those decisions. The shell middens of St. Catherines Island are comprised mostly of oyster and clam shells (resources associated with return rates in the range of 1000–4000 kcal/hr); but many of these same middens also contain ribbed mussel and periwinkle shells (taxa with far lower post-encounter return rates of only 25–1260 kcal/hr). Female foragers who collected such low-ranking shellfish resources likely also collected small seeds (chenopods, knotweed, and little barley if available) and dug freshwater cattail and bulrush roots when they elected to harvest terrestrial wild plants. After about cal A.D. 1300, they probably also cultivated maize, and the more intensive technologies for growing corn likewise fall into the energetic range of 220–370 kcal/hr. All of this suggests that a diet broad enough to include intensive maize cultivation would also include extremely low-ranked items in the female foraging set, such as ribbed mussels and periwinkles.

Viewed in a larger context, human diet breadth must be parsed more closely to fit the specific foraging goals at hand. Whereas female reproductive success is generally constrained by access to resources critical for offspring survival, male fitness is likely constrained by mating opportunities. This suggests that male and female foragers operating within the same environment quite likely pursued different reproductive goals, which translated into differing foraging strategies, each with an associated diet

breadth (Trivers, 1972). Women probably targeted resources that maximized their efficiency in daily provisioning of themselves and their offspring; men favored prey whose occasional capture attracted attention, contributed to the "public good," and drew "favorable, potentially fitness-enhancing attention to the provider" (Bird and O'Connell, 2006: 154). In other words, while clams and oysters might be low ranking relative to prey items within male hunt types, *Crassostrea* and especially *Mercenaria* are extremely highly ranked in the context of female foraging on St. Catherines Island.

Given the rapidly increasing aboriginal population, it seems likely that mollusk procurement intensified during the precontact period. Chapter 7 reviewed the history of the commercial oyster industry along Georgia's coast, and some lessons can be learned from this recent history. Injudicious harvesting of edible-sized individuals can readily wipe out an oyster bed; but if the mature oysters are merely thinned out, the survivors have more space and greater access to nutrients, enhancing their size for successive harvests (e.g., Crook, 1992: 494–495). This is why the very act of harvesting oysters fosters "cultivation," in the sense that judicious foragers can increase the post-encounter return rates by targeting and husbanding specific patches for immediate culling and subsequent harvesting.[17]

It seems likely that the post-encounter returns for American oysters have been anthropogenically enhanced along the Georgia coast and we suspect that such practices date back to Late Archaic times. Whenever such "cultivation" of oyster beds took place, it created the potential for poaching and likely increased the need for territorial defense of resources. Changes in oyster habitat and management practices over the past century along the Georgia coast make it difficult to estimate the accelerated return rates possible when oyster beds are "nurtured" through thoughtful harvesting. But we do know that one of the primary causes for the destruction of the Georgia oyster industry was commercial poaching and inadequate protection of planted and managed oyster beds.[18]

HARVESTING MAST AND OTHER WILD PLANTS: We lack the empirical data necessary to discuss patterns of aboriginal foraging in the maritime plant communities of St. Catherines Island, and this is a problem for most archaeological sites of the Georgia coast (Ruhl, 2003: 189). To date, systematic paleoethnobotanical recovery and analysis on St. Catherines Island have been conducted only at the Fallen Tree site (chap. 25) and at Mission Santa Catalina de Guale (Ruhl, 1990, 1993, 2003). Although this is another major shortcoming in the research reported here, 3 years of experimental research on St. Catherines Island have produced numerous estimates of energetic return rates for maritime mast resources (chap. 8). These foraging experiments continue at this writing, and we look forward to articulating the contemporary energetics with meaningful paleobotanical results from our on-going excavations.

One expects that as human population increased, foragers likely intensified their harvesting practices of maritime forest resources. Chapter 8 demonstrated that live oaks (*Quercus virginiana*) are the most important acorn-producing species for aboriginal people on St. Catherines Island, for several reasons: (1) Live oak trees can today be found almost everywhere on the island, comprising approximately 60 percent of the living oak trees; (2) live oak acorns are relatively large; (3) live oak trees grow with multiple stalks (an individual tree cover can cover up to one ha of land), which typically produce an abundant, if localized, acorn crop yield; and (4) the live oaks of St. Catherines Island produce "sweet" acorns, with nutmeats that can be consumed without leaching.

Live oak acorn harvest could be intensified in several ways. Although live oaks are ubiquitous on St. Catherines Island, they are much more productive when rooted in the first-tier, Pleistocene-age sandy soils of old dune ridges (especially the Foxworth/Echaw series). The maritime live oak forest is a long-lived, near-climax community that becomes established under conditions of re-

duced competition from other species. Oak trees increase in size toward the interior of the island, developing large trunks and spreading crowns. Harvesting return rates could be readily enhanced by clearing out underbrush and leaf litter, so that acorns are more readily spotted and collected after falling to the ground. Live oaks are particularly sensitive to fire, but a limited, controlled burn could greatly speed up collection time. Improving mast harvesting conditions is more difficult on the Holocene beach ridges because individual trees are smaller (due to the relatively young, thin soils) and oak trees grow in fragmented and scattered patches). Mast production is inferior in such second-tier habitats, where mature trees generally grow as isolates (rather than in stands) and the palmetto understory severely hampers visibility and access to acorns lying on the ground.

With respect to wild plants other than mast, Winterhalder and Goland (1997) have argued that weedy taxa (such as sunflower, sumpweed, and goosefoot) are low-ranking resources that should be incorporated in human diets only (1) when their profitability improved significantly through domestication or (2) other more highly ranked resources are unavailable. Although nutrient rich and inexpensive to collect (in season), small seeds generally require considerable processing to render them edible, nutritious, and/or palatable. Because of the low return rates involved, small seeds are often considered to be ''famine foods,'' generally marginal to the diet (e.g., O'Connell and Hawkes, 1981; Basgall, 1987; Hawkes and O'Connell, 1992; Gremillion, 2004).

Gremillion (2004: 228–229) has also argued that small grains might have been more valued as stored crops than their return rates might suggest. Throughout eastern North America, food resources are generally abundant during the late summer/early fall harvest season—when nuts, seeds, and flesh fruits were ripe, and animals still relatively fat. Because of the multiple hunt types available to male and female foragers in many environments, this may have created a labor shortage during the late summer and early fall, the result being that the opportunity cost of taking a low-ranked resource such as small grains might be overlooked. Because seeds could be quickly collected, stored, and processed later (during the wintertime, when food was scarce), Gremillion (2004) believes that seed cultivation may have been an energy efficient way to avoid overwinter starvation risk. This is particularly an issue for female foragers who are more risk sensitive and might respond by foraging suboptimally. Zeanah (2003, 2004) has made similar arguments for Great Basin foragers.

This is a difficult scenario in the Sea Island context. To be sure, pignut hickory nuts are a storable resource, but unless rendered into oil, acorns of live oak and laurel oak are not easily stored. In our foraging experiments, acorns became completely bug-infested within days of falling to the ground (and some were infested while still on the branch), raising serious issues regarding the storability for unprocessed acorns.

On St. Catherines Island, we also see a dip in the exploitation of *Mercenaria* (hard clams) during the fall, which may reflect a shift in female foraging objectives to the rich mast resources in the fall. Because winter is the prime season for shellfish in the coastal Georgia setting, this likely offset the need to store low-ranking seeds.

CULTIVATING MAIZE: As noted above, the research design employed here did not adequately sample the paleobotanical record on St. Catherines Island, and this shortcoming likewise limits our knowledge of maize cultivation during the aboriginal period.

But bioarchaeological data from St. Catherines Island, as summarized above (see also chaps. 11, 24, and 32), provide some critical information. To reiterate, there is no convincing bioarchaeological evidence suggesting maize consumption on St. Catherines Island prior to cal A.D. 1300. The isotope data are equivocal (Schoeninger et al., 1990), and the indicators of skeletal and dental infections (commonly associated with the adoption of maize cultivation) are virtually absent prior to the Irene period (Larsen and Thomas, 1982: 327–329). Dur-

ing the subsequent Irene period, the significant increase in $\delta^{13}C$ values and additional bioarchaeological studies suggest the presence of significant maize consumption, and this finding is supported by an increase in dental caries and periosteal lesions (results consistent with populations living in relatively sedentary villages with poor sanitation and probably an increase in the spread of infectious disease). But we cautioned that these results depend heavily on comparisons from the Irene Mound, at the mouth of the Savannah River (Larsen, 2002: 64; Reitz et al., 2002: 45). The extensive stable isotope and additional bioarchaeological analyses of human remains from Mission Santa Catalina de Guale (chaps. 24 and 32, this volume; see also Larsen, 1990, 2002) indicate that maize was a dietary staple during the mission period.[19]

One of the important conclusions from the probabilistic transect survey is that the introduction of maize cultivation did not trigger a significant shift in settlement pattern on St. Catherines Island (chap. 30). The earliest components of the Late Archaic aboriginal landscape conform to central place expectations, hugging the scarps along the western marsh margin. Later during the St. Simons period, settlements shift to the eastern margin of St. Catherines Island, clustering along the high ground overlooking Guale Marsh. During the next 2 millennia, archaeological components and landscape elements virtually disappear from the northern end of St. Catherines Island as the aboriginal center of gravity shifted southward, primarily due to geomorphological factors (chap. 30).

Accordingly, prey-choice and patch-choice models assign the highest ranking to the resources of the saltwater marsh, and central place theory hypothesizes that proximity to the nearshore marshland as the most critical factor in settlement positioning for the aboriginal foragers of St. Catherines Island. As Guale Island eroded away and Guale Marsh moved southward, marshside settlements shifted accordingly.

In other words, human behavioral ecology suggests that the optimal placement of central places should respond to the changing geography and geomorphology of St. Catherines Island. Despite the neat convergence between soil type, antebellum agricultural fields, and Irene period forager/farmer landscapes (chaps. 5 and 30), there is no evidence that Irene period settlements were deliberately sited near arable land.[20] When maize cultivation became a viable option for the aboriginal foragers of St. Catherines Island—likely sometime after cal A.D. 1300—Irene period settlements were already positioned on the most arable soil available on the island. Over a 5-millennium period, it was the energetic cost–benefit considerations relative to the evolving geomorphic configuration of St. Catherines Island—not the introduction of maize-based cultivation—that conditioned the distribution of archaeological sites. By positioning their central places at the intersection of the two most highly ranked resource patches (the saltwater marsh and the maritime forest), the aboriginal foragers of St. Catherines Island were "pre-positioned" to pursue the possibilities raised by maize cultivation.

CONSEQUENCES FOR RESIDENTIAL MOBILITY

One of the key objectives of the Island-wide transect survey was to generate empirical archaeological evidence about the degree of residential mobility during the aboriginal occupation of St. Catherines Island. While we feel confident that high-quality archaeological data has indeed resulted, we have no interest in overselling these data or pushing the interpretive envelope beyond credibility.

Specifically, we must be candid about the lack of meaningful community-level archaeology available to date from St. Catherines Island. To define an archaeological central place as a "sedentary village" requires more sophisticated and accurate measures of sedentism and population size than are available from the transect survey data presented here. Except for the long-term excavation of Mission Santa Catalina de Guale (Thomas, 1987, 1988b, 1991) and to some extent, the work at Meeting House Field (chaps. 25 and 27, this volume), we

lack high-quality, community-level data for the aboriginal settlements of St. Catherines Island. This is a significant shortcoming in our knowledge of St. Catherines Island archaeology and a current focus on ongoing research.

Lacking such community-level studies, we have no specific way to determine settlement population size and settlement organization. Future archaeological investigations are necessary to document the distribution of features (including subsurface storage facilities, evidence of food processing, fire hearths, and/or burials), the spatial association of features with household architectural patterns, and the distribution of domestic refuse (including evidence of small-scale feasting, unusually large cooking facilities, burnt soil, and other heat-altered materials). At the artifact level, we must document patterns for raw material procurement, attribute-level ceramic analysis, and patterns of lithic tool procurement and production. By exploring the variable densities of artifacts, structures, burials, and features, we should be able to differentiate among settlements of low-use duration and low-residential stability (with brief, single-use occupations) from settlements of high-use duration/high-residential stability (longer term, continuous occupations over many years) and places of high-use duration/low-residential stability (see, e.g., Gallivan, 2003: 85–87). We must explore methods of house construction (including postmold patterning) and the presence of nondomestic constructions such as drying racks, arbors, maize cribs, palisades, sweat lodges, ball fields, and council houses. Such community-level investigations should also identify household clusters (evident in the distribution of archaeological features linked with postmold patterns, activity areas, and the contents of pit features). At the regional level, we need more compelling evidence demonstrating how social organization articulates with the domestic and communal contexts, perhaps reflecting more formalized social boundaries and long-distance exchange across those boundaries. We also lack the prerequisite studies to document the regional distribution of ceramic attributes and architectural stylistic patterns throughout the Sea Islands.

This said, we do believe that a couple of meaningful proxy measures have emerged from the Island-wide archaeological survey of St. Catherines Island.

The Effective Foraging Radius

St. Catherines Island is a geomorphological accident, one of the rare ''composite'' barrier islands known in the world (chap. 30). Because of the confluence of past and present sea levels, St. Catherines Island brings into immediate proximity two enormously productive ecosystems, which coexist side by side as an artifact of the maritime geomorphology (Clayton et al., 1992; Pilkey, 2003: 29; Davis and FitzGerald, 2004: 133).

The salt marshes and estuaries surrounding St. Catherines Island are one of the world's most naturally fertile areas, with a net production amounting to 2000 gm/m^2/year (about 10 tons, dry weight) per acre of organics. This means that the salt marsh is several times more productive than America's most fertile farmland (Johnson et al., 1974: 82).

Immediately adjacent to the marshland is the large Pleistocene remnant on St. Catherines Island, which is ringed by mature, relatively high-quality soils (the Echaw–Foxworth–Centenary complex; fig. 5.2). During the aboriginal period, the mature maritime forest growing on the Pleistocene core produced important mast crops (critical to foragers and white-tailed deer populations alike) and these soils are admirably suitable to slash-and-burn methods of maize cultivation. The interior of the Pleistocene core is today characterized by two rather poorly drained soils (Manderin and Rutledge fine sands), occurring in 10–125-ha patches along shallow depressions and embayments (Looper, 1982; chap. 5, this volume). Although these extremely acidic soils are ill suited for modern agriculture due to their lack of natural fertility and organic matter, prior to the artificial lowering artesian water pressure, these low-lying

areas provided excellent freshwater lacustrine habitat, and were also attractive for maize cultivation with aboriginal technologies (see chap. 5).

Chapter 11 emphasized the importance of *effective foraging radius*, the catchment that could be systematically searched and exploited by foragers and farmers working from a residential base, but capable of returning home daily (fig. 11.12). A broad range of resource procurement activities can take place within the foraging radius, including plant and shellfish harvesting, fishing, encounter and limited intercept hunting, salt collection, and clay procurement. In essence, the effective foraging radius permitted aboriginal foragers and farmers to exploit these two enormously productive, adjacent ecosystems. Beyond this distance, foragers and farmers would generally establish field camps for overnight accommodation of work parties. The effective foraging radius defines the distance that one is willing to travel on daytime trips away from the central place, delimiting the point of diminishing returns before moving the residential base (Kelly, 1995: 135).

In terrestrial landscapes, the foraging radius rarely involves more than a 2-hr, one-way trek—commonly considered to be less than 10 km away from the residential base (e.g., Binford, 1980; Kelly, 1995: 135; Bettinger et al., 1997: 896).[21] But the use of dugouts, rafts, and canoes can dramatically increase the effective foraging range and lower the transport costs of conveying food resources back to the island-based central place, "easing potential problems in intensification of production and simultaneously opening possibilities for intensification that would otherwise not be economical" (Ames, 2002: 47). Lacking an operational means for estimating water-transport costs, our terrestrial transport models (chap. 10) almost certainly *overestimate* the effective foraging radius for marine and estuarine foragers.

On St. Catherines Island, the maximum longitudinal (north–south) distance is 16.4 km, with a maximum latitudinal (east–west distance) of 5.5 km. Because the Pleistocene core is less than 3 km across at its widest point (and much narrower in most places), the distance between the two highest ranking central places—in this case, the marshside and seaside settlements—will always be less than the lower limit of the effective foraging radius. Thus an effective foraging radius of 10 km would include huge tracts of prime maritime forest, extensive salt marsh flats, the St. Catherines and/or Sapelo sounds, the seaside shorefront, and the Atlantic Ocean.

This means that a forager carrying a 10-kg load could walk to anyplace on St. Catherines Island within 3 to 5 hr. Looking strictly at the energetics of terrestrial transport, then, we hypothesized that aboriginal foragers would (1) only rarely field process food resources of St. Catherines Island and (2) almost never move the residential base to the area of procurement. In terms of the effective foraging radius, this means that all St. Catherines Island foragers—except for those living on the second-tier habitats on the extreme northern or southern reaches of St. Catherines Island—could systematically search and exploit any patch on the island, and still return home daily. Even ignoring the dramatically greater potentials offered by watercraft transport, this geographical fact enables all St. Catherines Island foragers the opportunity to pursue a strategy of logistic procurement and low residential mobility should they choose to do so.

COMPONENT SEASONALITY

Against this background, we also assessed the seasonality of resource procurement at the various aboriginal components on St. Catherines Island using evidence from both vertebrate and invertebrate zooarchaeological assemblages. For vertebrate faunal elements, we relied primarily on the presence of unshed antlers of white-tailed deer, juvenile deer bones, and the remains of sharks and sea catfish (see Reitz, chaps. 22 and 27 for the empirical data and specific analytical protocols employed). We also examined incremental growth on hard clams (*Mercenaria*) to assess the invertebrate evidence on St. Catherines Island (chaps. 17 and 18; table 30.4).
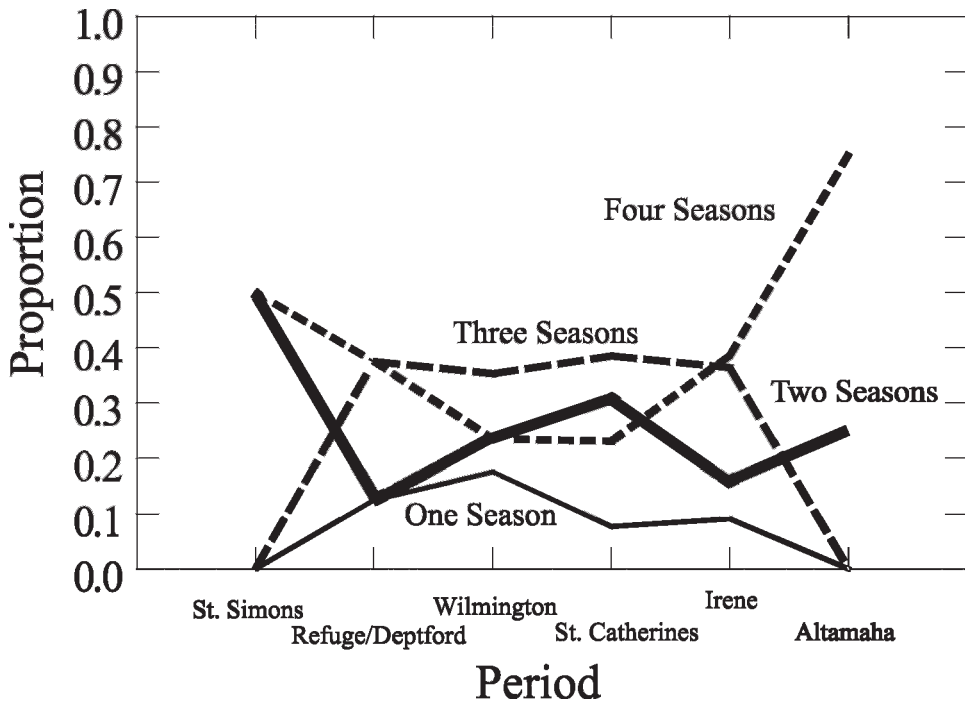
Fig. 33.4.   Changes in seasonal indicators through time.

Figure 33.4 charts the trends in seasonality for the 256 seasonally specific components documented in the Island-wide transect survey. The proportion of four-season occupations is greatest during the earliest and the latest aboriginal periods; but the relatively small sample sizes from St. Simons and Altamaha contexts do not inspire confidence (and the small number of components likewise skews the correlative distribution of components with three or fewer seasons represented).

Setting aside the extremes, figure 33.4 defines a surprisingly flat, relatively consistent distribution of seasonal indicators across aboriginal St. Catherines Island. To be sure, four-season components are somewhat more prevalent during the Refuge-Deptford and Irene periods, and two-season components are proportionately more common during the St. Catherine period. But the overall uniformity in the distribution of seasonality is striking: From the Refuge-Deptford period through the late prehistoric Irene period, the seasonal patterning is quite constant.

OCCUPATIONAL INTENSITY

Seeking yet another perspective on population growth, we have monitored the absolute density of aboriginal potsherds that were recovered at various archaeological components on St. Catherines Island. The thinking here is pretty basic: More people over prolonged periods should produce a higher density of archaeological "stuff" than less "intensive", more ephemeral usage of the same space (e.g., Steponaitis, 1991: 200–201, fig. 9.2). Sherd density compares the standardized volume of archaeological deposit excavated at each site with the number of aboriginal potsherds recovered from these excavations. Figure 33.5 plots the distribution of "sherds/m^3" across the 129 archaeological components recorded in the Island-wide survey.

Aboriginal ceramic density is highest (by far) during the mission period, with the various components associated with Mission Santa Catalina de Guale containing an extraordinarily dense concentration of aboriginal ceramics (averaging 1758 sherds/
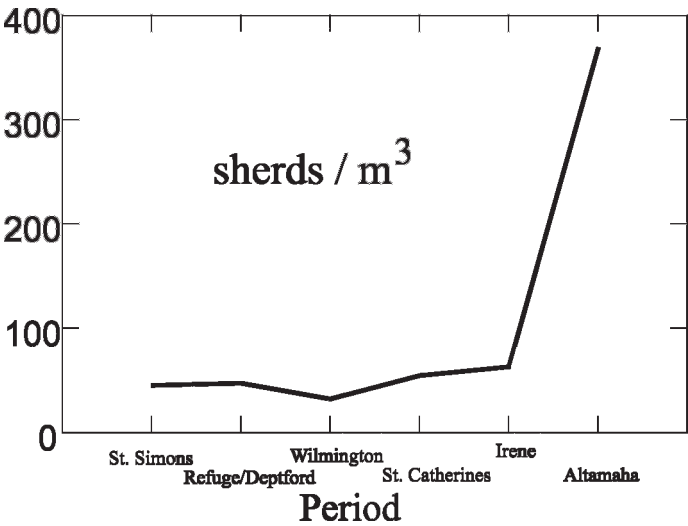
Fig. 33.5.   Changes in sherd density through time.

m^3 at Wamassee Head [9Li13]; see chap. 20). But *mean sherd density* is virtually constant throughout the precontact aboriginal period, and this result is surprising.

SUMMARY OF EVIDENCE REGARDING RESIDENTIAL MOBILITY ON ST. CATHERINES ISLAND

Sedentism is commonly considered to be unintended consequence of human population increase, with a correlative intensification of residential exploitation (e.g., Cohen, 1985; Price and Brown, 1985b: 11–12; Keeley, 1988; Bettinger, 1999; Ames, 2002: 22–23). But as Marcus and Flannery (1996: 73) point out, the reverse may also be true, because when high-mobility foragers settle down into sedentary villages, infant mortality sometimes lowers and the birth spacing interval decreases (see also Binford and Chasko, 1976).

One might predict that as aboriginal population size increases on St. Catherines Island during the past several thousand years—as it demonstrably does—then overall residential mobility should decrease through time, with central place residences being more intensively occupied as a result of increased sedentism.

This is not what happened on St. Catherines Island. Neither proxy measure em-

ployed in this section—component seasonality and mean sherd density—shows a significant change in "sedentism" through time.

- Setting aside the earliest and latest aboriginal occupations (during Late Archaic and mission times), figure 33.4 demonstrates a surprisingly consistent distribution of seasonal indicators from the Refuge-Deptford through Irene periods. Four-season components are as common during the earliest as the latest aboriginal periods; similarly, seasonally-specialized components are nearly as frequent during the latest occupational periods as during the earliest.
- Mean sherd density, a proxy for intensity of site usage, remains virtually constant throughout the aboriginal occupation of St. Catherines Island (except for the extraordinarily high sherd density at Mission Santa Catalina de Guale).

Based on these proxy measures, we conclude that whereas the human population numbers increased exponentially throughout the aboriginal period, there is no corresponding change in either intensity of occupation or sedentism until the mission period on St. Catherines Island. The conventional wisdom of increased sedentism through time apparently does not characterize the aboriginal occupation of St. Catherines Island.

It is difficult to overemphasize the critical distinction between *residential mobility* (movement of the entire group or some subset from one residential base to another) and *logistical mobility* (movements of individuals or small task-specific groups in and out of the residential base; chap. 11). We doubt that St. Catherines Islanders ever pursued a strategy of high residential mobility (sensu Binford, 1980; Thomas, 1983a; Kelly, 1995; Habu and Fitzhugh, 2002). Such ''pure foragers'' typically gather low-bulk resources on an encounter basis, rarely store their food, return home almost daily, and move their residential bases frequently as local resources are expended. A strategy of high residential mobility most effectively plays out across a landscape of largely undifferentiated habitats, where food is available (more or less) year-round, typically in the tropical rainforest and other equatorial settings.

The contrasting strategy of logistical mobility minimizes residential movements in favor of mobilizing task-specific groups that are capable of staying away from the residential base for considerable intervals (when necessary). Relying more heavily on food storage (at least during part of the year), so-called collectors are commonly found where resources are patchy and/or available only seasonally (where maximum efficiency is obtained by aggregating in a central place and sending out foraging parties; see Kelly, 1995: chap. 6).

The residential-logistic continuum recognizes numerous organizational alternatives that may be employed in varying mixes in different settings (e.g., Thomas, 1983a). Binford (1980, 1982) argued that spatial incongruity between two resource sets available simultaneously would encourage logistic (rather than residential) mobility as a way of bringing people and resources together; this means that patchy environments should favor logistic procurement strategies and decreased residential mobility. This is precisely the situation on St. Catherines Island, where any forager can exploit any resource patch and consistently return home on a daily basis.

The combined evidence from seasonality and settlement pattern studies leave no doubt that the aboriginal St. Catherines Islanders relied heavily on a ''collector'' strategy of low residential mobility, spending the greater part of the year in larger encampments, with rarely dispersing into family groups. Rather than moving people to patches of plant and animal resources, St. Catherines Islanders dispatched smaller logistical groups to bring the plants and animals back home. Even Late Archaic foragers seem to have pursued a strategy of mostly logistical movement, likely establishing a pattern of settled village life that lasted for thousands of years. But we must caution (yet again) that the available archaeological data are insufficiently fine-grained to support the generalization that the earliest St. Catherines Islanders were ''sedentary'' (although that is certainly our impression).

CENTRAL PLACE FORAGING CONSEQUENCES

Part I of this series explored the spatial implications of the patch-choice and central place foraging models, asking (1) where, specifically, should the residential bases (the ''central places'') be located and (2) what, specifically, should have been the mobility strategy? The archaeological evidence (presented in Part II) answered both questions.

As previously discussed, males and females likely pursued different reproductive and foraging goals, even when operating within the same environment. If females targeted resources to maximize efficiency in daily provisioning of themselves and their offspring, and if men favored the occasional capture of high profile prey, then these conflicting goals could pose contrasting perspectives about how best to situate an optimal central place: Whose fitness goals should prevail when establishing a residential base in patchy habitats?

Such central places should reflect a compromise facilitating the various activities carried out by people with vastly different foraging goals (male and female, young and old, elite and low status). Relying on central place foraging theory, we hypothesized

that, all else being equal, aboriginal foragers should have established their residential bases on St. Catherines Island to maximize the net central place foraging returns given the pursuit, handling, and transport costs of resources from different patches (Elston and Zeanah, 2002; Cannon, 2003; Zeanah, 2004; Kennett, 2005: 225).

Specifically, the optimal positioning for primary *marshside* settlements should be along the intersection of the two highest ranking patches. These central place settlements should be constructed on the high ground situated along the extreme leeward margin of the maritime forest and directly adjacent to the salt marsh. So defined, the optimally positioned marshside settlements should define parallel bands of probability, each running along the edge between the highest-ranking patch types. The variances associated with such marshside settlements should be asymmetrical—steeper toward the salt marsh/maritime patch margin, then trailing off across the terrestrial habitat. We projected this idealized settlement patterning across the generic barrier island landscape, then fine-tuned the model to fit the spatial specifics of St. Catherines Island.

The prey-choice model offers an alternative approach to aboriginal settlement patterning on St. Catherines Island. Although prey choice models are mostly about diet choice, they also have settlement implications because the same microeconomic principles undergird both diet-breadth and central place modeling. As Kennett (2005: 220) has noted ''population-dependent decreases in diet breadth often promote residential stability, because less time is spent pursuing higher-ranked prey items and lower-ranked prey usually occur in relatively high densities near settlements. This usually corresponds with an increase in food processing and storage.''

To be sure, the diet-breadth model has the advantage of simplicity, providing useful questions and testable hypotheses. But this model assumes that resources are distributed homogeneously in space, and that all foragers share the goal of maximizing net energy intake. Results are less satisfactory for environments in which resources are not distributed evenly (as on St. Catherines Island) and in locales where the foraging goals of men and women, young and old, might differ considerably (again, as on St. Catherines Island).

Aboriginal Settlement Patterning

Combined with the consideration of logistic foraging radius (chap. 11), the analysis of terrestrial transport costs (chap. 10), the overall patterning of component seasonality in the Island-wide probabilistic transect survey (chap. 30), and the expectations from both normal/lognormal and uniform frequency distribution models (expectations derived from central place foraging and diet-breadth modeling, respectively) demonstrate that aboriginal foragers on St. Catherines Island generally followed a strategy of logistic procurement, with low residential mobility during all time periods.

With few exceptions, the archaeological record of St. Catherines Island is remarkably consistent with expectations from central place foraging theory. Of the roughly 130 archaeological components spanning the last 5 millennia, more than 80 percent of the archaeological components encountered in the Island-wide survey are fully consistent with the marshside settlement model derived from central place foraging theory. Only two dozen components are (even potential) outliers from the normal/lognormal statistical models.[22]

First- and Second-Tier Landscapes

Significant increases in human population have a spatial component because people should congregate at resource patches with the highest overall return rates. When population increases and settlements expand, the higher ranking habitats (based on central place foraging returns) should fill up first. If human population levels continue to increase, then the best habitats should become overcrowded and protected, with some settlements forced into more expensive, second-rate habitats.

St. Catherines Island is differentiated into the first-tier terrestrial habitats of the

Pleistocene island core and second-tier habitats of the Holocene beach ridge complexes on the extreme northern and southern ends of St. Catherines Island (chap. 11). The Pleistocene island core of St. Catherines Island enjoys superior, first-tier terrestrial productivity (as enumerated above). The rolling, Holocene-age beach ridge topography creates difficult conditions for human lifespace. In places, the ground cover is almost impenetrable, flat ground is difficult to find, and the underlying Fripp-Duckston soils are unsuitable for agriculture in any form. The relatively young soils of the Holocene beach ridges support live oak and hickories, but the individual trees are small and the mast production inferior to their counterparts on the Pleistocene core. The highly fragmented patch size of the Holocene beach ridge complex supports relatively few mast-producing trees, with little redundancy between patches. The dense palmetto understory makes harvesting mast a difficult task. The extensive edge exposure and low-lying elevation offer scant protection from maritime storms, especially in the wintertime. Resource transport costs are high, and while burning might temporarily reduce the understory, little can be done to change the second-tier problems with topography, soils, water, and exposure. When compared with the patches on the expansive Pleistocene island core, then, Holocene beach ridges remain expensive, less productive habitats, generally lacking in the lifespace conditions necessary for an effective central place.

We have already employed some fairly coarse-grained archaeological proxies that define an exponential increase in aboriginal population levels on St. Catherines Island during the past 5000 years. We hypothesized that, as a consequence of this higher human population, subsistence practices should intensify and second-tier habitats should be increasingly exploited due to increased competition over high-ranking resource patches.

A test for this hypothesis is provided by comparing the specific relationships between dated archaeological components and the growth of accretionary Holocene terrain on the southern margin of St. Catherines Island (esp. chaps. 29 and 32, tables 32.2 and 32.3). To summarize the findings from the probabilistic Island-wide archaeological survey:

- St. Simons period (cal 3000–1000 B.C.): Holocene accretionary terrains begin to form along the southern margin of St. Catherines Island; all known archaeological components and occupations are restricted to the first-tier, Pleistocene core (fig. 29.2).
- Refuge-Deptford periods (cal 1000 B.C.–A.D. 350): Holocene accretionary beach ridges continue to evolve on the southeastern margin of St. Catherines Island, extending roughly 1.5 km from the Pleistocene core margin. Only one archaeological component and a single occupation are known from this second-tier, Holocene-age landscape.
- Wilmington period (cal A.D. 350–800): Holocene beach ridges still accrete along the southeastern margin of St. Catherines Island, extending roughly 2.5 km from the Pleistocene core margin. Only one archaeological component and four occupations are known from this beach-ridge landscape.
- St. Catherines period (cal A.D. 800–1300): Holocene beach ridges continue to grow along the southeastern margin of St. Catherines Island, extending almost 4.5 km from the Pleistocene core margin. Four archaeological components and five occupations are known from this second-tier landscape.
- Irene period (cal A.D. 1300–1580): A few more Holocene beach ridges develop along the southeastern margin of St. Catherines Island, extending about 5.5 km from the Pleistocene core margin. Thirteen archaeological components and 14 occupations are known from Late Holocene landscape (particularly clustered around Beach Pond).
- Altamaha period (cal A.D. 1580–1700): The configuration of Holocene beach ridges approximates their configuration along the southeastern margin of St. Catherines Island, extending almost 6 km from the Pleistocene core margin. Three mission-period archaeological components and no additional occupations are known from the Holocene beach ridges.

Figure 33.6 plots the utilization of second-tier habitats on St. Catherines Island as a proportion of the total number of archaeological components and occupation

Utilization of Second-tier Habitats
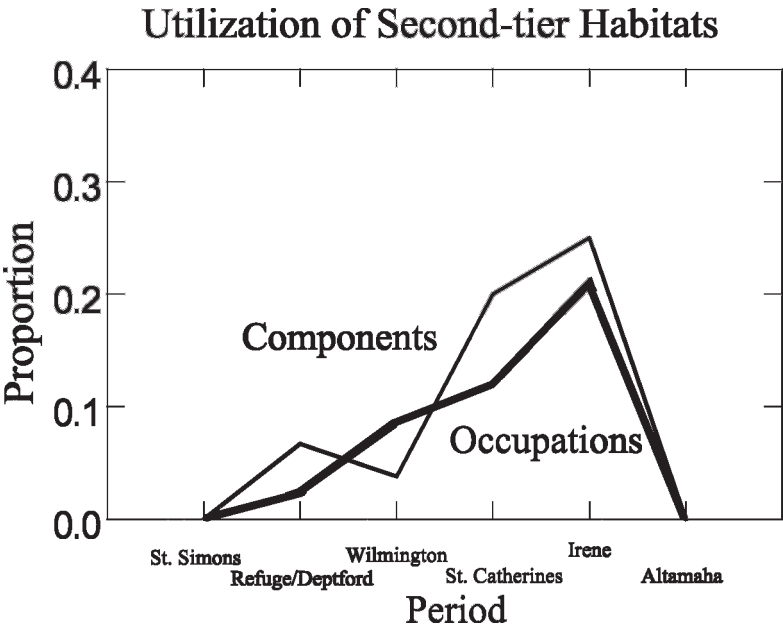
Fig. 33.6.   Changes in utilization of second-tier habitats through time.

landscapes recorded in the Island-wide survey.

The trend is clear. During the St. Simons phase, immediately after St. Catherines became an island, all known archaeological evidence occurs in the first-tier habitats of the Pleistocene island core (hardly a surprise, since the accretionary beach-ridge topography only began building at the onset of the Late Holocene). Commencing with the Refuge-Deptford periods, foragers on St. Catherines Island began utilizing the second-tier habitats of the Holocene beach ridges at an increasing rate. Except for a slight decrease of second-tier utilization during the Wilmington period, there is a clear-cut trend as increasingly higher proportions of archaeological components and occupations are relegated to the second-tier Holocene habitats on St. Catherines Island.

THE EVOLUTION OF HERITABLE SOCIAL INEQUALITY

The first St. Catherines Islanders were likely complex hunter–gatherers, organized into what David Anderson called "post-band, pre-chiefdom societies" (2002: 246).[23] Tribal organization probably emerged in

eastern North America during the Late Archaic, between 5000 and 6000 years ago (Anderson, 2002: 248) and these egalitarian, tribal-level societies probably lived in economically self-sufficient, politically autonomous villages (Sahlins, 1961, 1968: 15–16; Carneiro, 2002: 35). Whereas a "band is a simple association of families … a tribe is an association of kin group which are themselves composed of families" (Sahlins: 1961: 93). Tribes are comprised of "congeries of equal kin group blocks" (Sahlins, 1961: 93), multiple matrilineages, each comprised of kin related through the female line (and perhaps melded into dual, exogamous moieties). Tribes are held together by a number of "pan-tribal sodalities", including intermarrying clans, age grades, military and/or religious societies.

But ethnohistoric records from the middle and late 16th century clearly document that the Guale people were organized into complex chiefdoms, multicommunity polities with centralized political control and an emphasis on ranked hierarchy. Chapters 2 and 12 considered the social and political organization of the Guale people, who populated St. Catherines Island and the central Georgia coastline during the mid-/late 16th

century (Jones, 1978, 1980; Worth, 1995, 1998a, 2004; Milanich, 2004b). At the time of Spanish contact, the Guale existed as several complex chiefdoms, each a ranked society, in which social status and political power were determined by the genealogical distance to a single noble lineage, from which the ruler must be drawn.

The next section explores the evidence available to document the emergence of social inequity on St. Catherines Island.

THE RISE OF CHIEFDOMS

Chapter 12 discussed Robert Carneiro's (1981) classic discussion that identified four key archaeological correlates of the chiefdom level of social organization: monumental architecture, identification of ceremonial centers, settlement hierarchy reflecting the structural differentiation of settlement types, and "differentiated burials in which difference in the quantity and qualify of the grave goods points to a categorical distinction in status of a few individuals, presumably chiefs, and the general populace" (Carneiro, 1981: 54). We then evaluated the potential of St. Catherines Island archaeology to shed light on each of Carneiro's four correlates:

Monumental architecture: Although the presence of monumental architecture can help distinguish the archaeological remains of chiefdoms from those of autonomous villages, not all chiefdoms inevitably leave behind monumental architecture (Carneiro, 1981: 53). Given that monumental architecture is lacking from the entire Georgia coastline (except for the Irene Mound complex at the mouth of the Savannah River; see Worth 1998a: 18) and given the indisputable ethnohistorical evidence that the mid- to late 16th century Guale did indeed live as chiefdoms, Carneiro's first correlate is not directly relevant here.

Ceremonial centers: The presence of spatially discrete ceremonial centers, which are "fewer in number than the villages they ostensibly served would suggest that these villages were politically unified" (Carneiro, 1981: 53). Despite the diverse and multiple archaeological survey strategies employed on St. Catherines Island, we have not conducted adequate archaeological research *at the community level* to provide adequate information regarding the structure of discrete villages and ceremonial centers.

A structurally differentiated settlement hierarchy: Carneiro (1981: 45) emphasizes the chiefdom "as an autonomous political unit comprising a number of villages under the permanent control of a paramount chief." By focusing attention on the chiefdom-as-*political* entity, the task of the archaeologist requires generating empirical evidence that is sufficient robust to monitor the loss of village autonomy (Marcus and Flannery, 1996: 93). As previously noted, the research design employed to date on St. Catherines Island is insufficient to (1) define the major village sites and their associated satellites, then (2) establish a hierarchy between and among contemporary sites (Marcus and Flannery, 1996: 108). The archaeological data generated from the Island-wide survey strategies are not sufficiently robust to identify regional settlement hierarchies or to define interrelationships at the community/village level. Given the data at hand, we cannot characterize the hundreds of known archaeological components in terms of conventional community-based categories (such as single-family farmsteads, hamlets and villages, and a range of special-function sites). We are presently exploring ways to do this on St. Catherines Island, but until this research has been conducted on an Island-wide basis, we cannot speculate about the loss of political autonomy at the village level.

Mortuary patterning as reflective of status differentiation: Carneiro's (1981) fourth archaeological correlate provides the basis of the discussion to follow.

MORTUARY PATTERNING AND STATUS DIFFERENTIATION: SOME EXPECTATIONS

Marcus and Flannery (1996: 93) underscore the importance of documenting the shift from achieved ("egalitarian") to ascribed ("ranked") status as a milestone in understanding the emergence of chiefdoms.[24] The categories "egalitarian" and

"ranked" (or to some, "despotic") define a social spectrum that can be inferred from the archaeological record and mortuary remains, thereby providing a particularly important source of information on extinct political systems.

For decades, archaeologists have marshaled ethnographic data to demonstrate that societies having such social distinctions among living individuals will manifest parallel material distinctions among the dead (e.g., Saxe, 1970; Binford, 1971). Death, in this sense, becomes a period of separation and reintegration for both the deceased and those they leave behind. Social ties existed between the living and the once-living, and the ritual connections at death reflect these social relations. Because mortuary rituals reflect who people were and the relationships they had with others when they were alive, they should reflect the person's degree of social status in a society.

Problems can arise when the terms "egalitarian" and "ranked" are applied to the archaeological record. Marcus and Flannery (1996: 76) go so far as to suggest that "egalitarian [is] one of the most misunderstood words in evolutionary theory. ... Ask ten archaeologists to define an egalitarian society ... and five will reply, 'a society in which everyone is equal in prestige or status.'"

But this answer is wrong: No society exists in which everyone is precisely equal. Not only do gender and age differences prevail, but some foragers will always be better hunters than others, and some foragers will always collect and process shellfish or acorns better than others. The key to "egalitarian" is not "homogeneity", because status differences will always exist, but rather the extent to which "heritable" differences will be translated into the mortuary record. This approach to the archaeological record, then, stresses not the lack of status differences, but rather the fact that such differences are *achieved* during one's lifetime (rather than *inherited* at birth).

In an egalitarian system, authority is conferred on those individuals who possess certain admirable qualities or accomplish certain key tasks (the importance of these qualities and tasks being culturally defined); their authority is restricted to particular, short-term circumstances. A good hunter might assume a temporary position of leadership in a communal hunt of white-tailed deer, an accomplished dancer might take charge in communal gatherings, and the input from a gifted naturalist might convince others of the medicinal attributes of particular plants. But none of these individuals retain authority outside his/her area of expertise.

The critical feature is this: *Each member of an egalitarian society has equal access to critical, life-sustaining resources at birth, but not all members take equal advantage of those opportunities.* Leadership in an egalitarian society, then, involves gender, age, experience, productivity, and the social standing that comes with success. But one's social position *cannot* be transferred to others, by inheritance (or any other means).

Early French and Spanish explorers did not encounter egalitarian societies along the Georgia Bight. Instead, they recorded societies that rank-ordered their members at birth, without regard to personal accomplishments. By reserving the positions of highest status for a select few, these ranked polities ensured *unequal* access to life-sustaining resources. Although gender and age still played a role in the division of labor, the leadership of contact-period societies of the Georgia coast routinely received tribute and redistributed both goods and services throughout the community, raking off part of the communal wealth in the process. Clearly, then, among the Guale, "one's social position [came] to depend more on birth than on deeds" (Carneiro, 1998: 20).

This is why mortuary patterning in egalitarian societies is not about equality in status (or prestige). Prestige differences do exist in egalitarian societies, and when some individuals are singled out for special treatment, they are almost certainly community leaders (in one form or another). Individuals can enhance such prestige through advanced age, personal accomplishment (ritual leadership, community service such as leading hunting and/or warfare, political

leadership—ritual and/or community service) or the accumulation of valuables. This is also why one would expect that primary burials in an egalitarian society to be commonly accompanied by secondary burials (Marcus and Flannery, 1996: 96) because people who died earlier were sometimes exhumed for reburial with spouses or relatives. This treatment should be accorded only to those old enough to have undergone initiation at puberty; infants or young children are simply too young to have "achieved" anything of note in their lifetimes.

Among ranked societies, where prestige is manifested through inherited positions of authority and power, one expects to find certain high status burials accompanied by sumptuary items that reflect those status differences. Most of these goods are expected to accompany the elite to the afterlife, but it is difficult for the archaeologist is to distinguish between grave goods reflecting inherited, rather than achieved social status. "To demonstrate hereditary inequality we must find status differences that show up with infants or young children, individuals too young to have achieved prestige during their lifetimes" (Marcus and Flannery, 1996: 105).

Evidence of Mortuary Patterning and Status Differentiation on St. Catherines Island

Mortuary excavations conducted over the past century have documented the burial patterning for more than 725 individuals from St. Catherines Island, spanning at least the last 2000 years (chap. 24). We can now address the emergence of social inequity by tracking mortuary patterning through time and considering the implications for status differentiation on St. Catherines Island.

St. Simons Period (cal 3000 B.C.–1000 B.C.): No human remains have been recovered from St. Simons period deposits on St. Catherines Island.

Refuge-Deptford Period (cal 1000 B.C.– A.D. 350): During the Refuge-Deptford interval, a new ceremonial and religious landscape emerged on St. Catherines Is-

land, as burial mounds reflected mortuary ritual in a public and lasting manner.

Overlooking the extensive eastern salt marsh, today fringed by Black Hammock, is a cluster of three habitation sites associated with the Seaside I and II mounds. Five kilometers to the south, aboriginal foragers erected a second precinct of nine burials mounds along the high ground and hickory ridges of Cunningham and McLeod fields. Although the Cunningham and Seaside mound groups are situated in different habitats and spatially separated, the ^{14}C evidence demonstrates a remarkable contemporaneity in construction staging. A suite of 22 radiocarbon dates is available from mortuary contexts during the Refuge-Deptford interval on St. Catherines Island and, although this temporal period spans more than 13 centuries, all the available radiocarbon evidence is restricted to three tightly circumscribed clusters: the middle Refuge period (cal 750–600 B.C.), the early Deptford period (cal 360–120 B.C.) and the late Deptford period (cal A.D. 80–230).

The Refuge cluster, cal 750–600 B.C., is defined by eight radiocarbon dates from six different burial mounds on St. Catherines Island (see chap. 24; fig. 32.5). Due to the lowered sea level, occupational middens dating to the Refuge period are virtually absent (and none are contemporary with the mortuary activity). Furthermore, we cannot document any mound building on St. Catherines Island prior to cal 350–120 B.C. and deliberate mortuary activities can be demonstrated only at Cunningham Mound C (where a human cremation was buried in a premound pit during the preceding St. Simons period). All remaining activities recorded at the mortuary sites during this interval involve features that might or might not be directly related to mortuary ritual.

Radiocarbon evidence for the early Deptford period (dating cal 360–120 B.C.) demonstrates that statistically simultaneous burning and marine shell harvesting takes place within several mortuary contexts within the Cunningham Mound group. Contemporary midden deposition also took place at several sites along the western

scarps of the island, likely in response to rising sea level. During the early Deptford period, for instance, marine shells that were ultimately incorporated into the Central Pit at McLeod Mound were harvested (probably in December or January). The premound surface was burned (and occasionally nonmortuary features excavated) at four additional places where mounds would eventually stand.

After a hiatus of 2 or 3 centuries, a cluster of five statistically identical ^{14}C dates from the late Deptford period occurs in four separate mounds of the Cunningham group; their pooled age is cal A.D. 80–230 (figs. 32.5 and 32.7). Six additional marine shell dates from four midden sites also fit into this interval. The only demonstrable mortuary activity during the late Deptford period (cal A.D. 80–230) is the log-lined Central Pit that was excavated at Cunningham Mound A (but no bones were found inside this feature). We cannot establish with certainty whether the premound activities dating to this interval directly involved mortuary rituals. We likewise cannot prove that sand mounds were erected over these premound surfaces during the late Deptford period, but this seems likely at Seaside Mounds I and II, South New Ground Mound, and Cunningham Mounds A, B, and C.

Overall, about five dozen burials have been recovered in Deptford period contexts on St. Catherines Island (see chap. 24 and table 32.1), and three important trends emerge:

- Time lapse between death and burial is quite variable: About 40 percent of the Deptford individuals were buried shortly after death (in a supine-extended position). A similar proportion of the Deptford individuals were interred as bone bundles, suggesting a time of death considerably before burial. Two of the Deptford interments were cremated human remains.
- Subadults are rare: Less than 20 percent of the Deptford burials are subadults. Extrapolation of standardized actuarial tables suggest that 35–40 percent of the living Refuge-Deptford population should have died before the age of 10, meaning that subadults are significantly underrepresented in the Refuge-Deptford

burial mound population (Thomas and Larsen, 1979: 150).
- Females account for slightly more than 60 percent of the Deptford mound burial population (table 32.1).

WILMINGTON PERIOD (cal A.D. 350–A.D. 800): The radiocarbon record from St. Catherines Island defines two distinct flurries of mound construction between cal A.D. 1 and cal A.D. 800. The late Deptford cluster (cal A.D. 80–230; discussed above) is followed by a second spike in mortuary activity during the mid-Wilmington period. Although the Wilmington period lasted for 650 years, all known Wilmington mortuary activity transpired within a century or so (cal A.D. 540–640; fig. 32.7); the available ^{14}C dates from habitation midden proveniences likewise clusters around cal A.D. 600.

The 10 mid-Wilmington mortuary dates lead us to conclude that (1) additional burial mounds were built at Seaside I and Cunningham C sometime prior to cal A.D. 540–660, (2) McLeod Mound was erected sometime after cal A.D. 540–670, and (3) although the premound surface was burned at Cunningham Mounds D and E, we cannot conclusively demonstrate any specific mortuary behavior or mound building at either site.

The Central Tomb at McLeod Mound contained five adult female burials. Two of the McLeod females died almost immediately prior to burial, but the others obviously died weeks (if not months or longer) before interment at McLeod Mound. We previously suggested that "the individuals buried as bundles perhaps died on the mainland, and were then transported for burial on St. Catherines; the articulated individuals might well have died shortly before the mound itself was constructed" (Thomas and Larsen, 1979: 147).

A similar pattern holds for the rest of the Wilmington period mortuary sample. Specific burial treatment can be assigned to only 18 (of 31) burials recovered in Wilmington period contexts (table 32.1). One dozen of these were buried in a supine-extended position (obviously immediately following death). Four Wilmington individuals were interred as bone bundles (i.e., buried a considerable time after death).

One cremation was recovered at Cunningham Mound D, as was a single flexed burial. Larsen could estimate age at death for most of the Wilmington period burials (29 of 31), identifying 28 adults and only one subadult (Thomas and Larsen, 1979: 150).

Was social status in Deptford–Wilmington society allocated in an egalitarian or ascribed manner? When we first considered this question, back in the late 1970s, Clark Larson and I (1979) concluded that the prevalence of adult females as mound burials is consistent with the emphasis on matrilineal succession noted among the historic period Guale Indians (see also Thomas et al., 1979: chap. 3). We still believe this.

We further suggest that the mortuary evidence from the Deptford–Wilmington period on St. Catherines Island is entirely consistent with the mortuary patterning for a society that allocated status according to egalitarian principles (Thomas and Larsen, 1979). Within a society of people born with equal rights and status, social status will be acquired in direct proportion to one's accomplishments in life. Infants and juveniles have relatively little time or opportunity in which to acquire such status. If we assume that mound burial was an indicator of one's "fossilized terminal status" (in the terminology of Peebles, 1971: 69), then the relatively low frequency of subadult burials is entirely consistent with an egalitarian model of social organization among the Deptford–Wilmington period foragers on St. Catherines Island.

No truly elaborate burial facilities exist during the Deptford–Wilmington periods on St. Catherines Island. Most of the people interred in the Deptford–Wilmington burial mounds were buried without grave goods—at least none of these "sumptuary goods," if they existed, have survived archaeologically—and nobody seems to have received a disproportionate share of the wealth. When grave goods were present, we could detect no particular trend for association with either male or female burials.

We also believe that the number of individuals interred in the various burial mounds represents only a fraction of the contemporaneous population living on St. Catherines Island during the Deptford–Wilmington periods. Granted that several additional mounds have likely been destroyed over the past 2 millennia, but we still think that mound burial was reserved for a small number of individuals (and hence implying a degree of status differentiation). Clearly, those few individuals set aside for special mortuary treatment—and the five female burials from the Central Tomb at McLeod Mound come to mind here—were individuals of high status (likely achieved) during their lifetimes (thereby excluding infants, young children, and preadults). But, it would seem, as Anderson and Mainfort (2002: 8) have expressed it, "that some individuals and perhaps their associated lineages were becoming more equal than others."

St. Catherines Period (cal A.D. 800–A.D. 1300): As noted above, all detectable Wilmington period mortuary-related activities transpired within a single century (cal A.D. 540–640), after which the radiocarbon record from St. Catherines Island drops off markedly. Following a 4-century hiatus in mortuary activities, three St. Catherines period burial mounds were built—Johns Mound, Marys Mound, and South End Mound II—and they produced a cluster of five ^{14}C dates from almost identical mortuary features. All five dates are statistically the same, with a pooled mean age of cal A.D. 1040–1230 (the mid-St. Catherines period; fig. 32.11).

The Island-wide survey demonstrates that the landscape around (and beneath) Marys Mound (9Li20) was utilized during the Deptford and Wilmington periods. Sometime about cal A.D. 660–960, the area was burned and a large, pentagonal, log-lined pit was excavated through the primary humus. Several burials were added to an adjacent pit; then, sometime later, the mound was constructed, including a large shell feature—with marine shells dating cal A.D. 1040–1230 and associated with St. Catherines and Savannah ceramics—was draped across the premound pits, in association with St. Catherines period (and Savannah) ceramics. All the available evidence suggests that Marys Mound was

constructed and utilized exclusively during the St. Catherines period.

Johns Mound (9Li18) was built near the marsh margin of McQueens Inlet, immediately to the east of King New Ground Field. Two premound pits contained strictly St. Catherines period potsherds (Thomas and Larsen, 1982: 293–324) and the log-lined Central Pit was built about cal A.D. 1040–1230, with several human burials interred along the periphery. An oyster shell cap was added, then covered by additional mound fill. Several intrusive burials were added into this fill (some dating well into the historic period). But the available evidence indicates that Johns Mound reached its final size and configuration during the St. Catherines period, and most of the burials date to this period.

South End Mound II (9Li273) was also built during the St. Catherines period. The premound humus was littered with numerous St. Catherines period potsherds, and the Central Pit was covered with an irregular, artificially raised platform made of shell midden (dating cal A.D. 1040–1230 and containing strictly St. Catherines period ceramics). After mound fill was added, the site assumed roughly the modern configuration.

Johns Mound, Marys Mound, and South End Mound II reflect a remarkably similar architectural plan. All three commenced with a central pit feature, each containing multiple human burials. The central features at Johns and Marys Mounds were log-lined pentagonal pits (and that at South End Mound II, while conspicuous, was not sufficiently preserved for us to define the mode of construction). Each central pit feature was covered by an oyster shell mantel, and the ^{14}C dates of these features are statistically identical. Setting aside a lone humus date from Marys Mound, the available radiocarbon record defines a 4-century hiatus in mortuary activities between the middle Wilmington (cal A.D. 540–640) and late St. Catherines periods (cal A.D. 1040–1230).

Statistically speaking, then, Johns Mound, Marys Mound, and South End Mound II were constructed at exactly the same time. The ceramic complexes recovered at all three sites are likewise comparable: The shell fea-

tures at South End Mound II contained strictly St. Catherines period ceramics, as did the corresponding strata at Johns and Marys Mounds. These also contained some Savannah period ceramics, which we now realize overlap in time with St. Catherines period diagnostics (see chap. 15).

The sex ratio balances out during the St. Catherines period. Four interments at Marys Mound were associated with the central, premound (Stage I) pit: one adult female, one preadult, and one child (with a fourth individual unavailable for study; Larsen and Thomas, 1986: 287). Overall, the sex ratio at Johns Mound is almost even: 18 female, 21 male, 41 interdeterminate; Larsen and Thomas, 1982: tables 9, 10). At South End II (Larsen and Thomas, 1986: 27–29), the dental samples suggest the presence of at least three females and one male.

The St. Catherines period mortuary population contains a significantly higher number of infants and young children than buried in earlier Deptford-Wilmington contexts. The central feature at Marys Mound held a bundle burial that includes the remains of a 4-year-old child and a second bundle with the bones of a 13-year-old. At Johns Mound, the Central Pit contained a partially disarticulated child burial (age 3–5 years old) and several adult bone fragments. About 20 percent of the Stage I (Central Pit and surrounding) burials are subadults (adult, 39; subadult, 3; child, 6; infant, 1). Roughly the same age distribution holds for the overall burial population in Johns Mound (adult, 61, preadult, 16). The Central Pit at South End Mound II contained two cremations and a mass grave for 15+ individuals. Larsen estimates that at least two infants were included in this mass grave (Larsen and Thomas, 1986: 27–29).

Was social status in St. Catherines period society allocated in an egalitarian or ascribed manner? The demographics of mound burial shifted significantly from the previous Deptford–Wilmington periods, which contained the remains of mostly adults (with subadults comprised only 9.6% and 11.1%, respectively, of the total burials for which age at death could be determined).

At Marys Mound, Johns Mound, and South End Mound II, several infants, children, and subadults were singled out for special treatment, suggesting that, in life, these individuals occupied positions of authority and respect. Because these people were far too young to have achieved such high-level prestige during their lifetimes, we believe that social status and political power during the St. Catherines period must have been determined by ascribed status—their genealogical distance to a single noble lineage. Access to status and power must have been accorded at birth within a structured and formalized social hierarchy based on kin relations (rather than personal accomplishments or wealth).

We conclude that the archaeological record from St. Catherines Island documents a transition from egalitarian to ranked status that took place sometime after cal A.D. 540–640 (the latest Deptford–Wilmington period burials), but before cal A.D. 1040–1230 (the period of contemporaneous mortuary activity at all three St. Catherines phase burial mounds).

LONG-TERM DEMOGRAPHIC AND SOCIAL CHANGE ON ST. CATHERINES ISLAND: A SYNTHESIS

Several demographic and social trends emerge from this longitudinal examination of St. Catherines Island archaeology:

- A variety of proxy measures indicates that the aboriginal population of St. Catherines Island expanded exponentially from the earliest human footprint (about cal 3000 B.C.) to the abandonment of Mission Santa Catalina de Guale (in A.D. 1680).
- Bioarchaeology documents the progressive decline in health and spread of infectious disease among aboriginal foragers and farmers over the past 2000 years.
- The biogeography of St. Catherines Island is such that foragers could systematically search and exploit resources in any patch on the island and return home each night.[25] This conclusion is based on a strictly terrestrial modeling of effective foraging radius. Use of watercraft (which we think was extensive during all time periods) would have vastly extended the effective foraging radius, enabling foragers to return to their home base virtually at will.
- The common scenario of increasing sedentism through time probably does not hold for the 5000-year-old record on St. Catherines Island. Seasonality indicators, settlement pattern distributions, and intensification of occupation proxies indicate that St. Catherines Islanders employed predominantly a collector mobility strategy of logistical movement from the Late Archaic until the Spanish *reducción* policy aggregated the aboriginal population at Mission Santa Catalina de Guale.
- The diet-breadth model predicts that as human population densities increase, the availability of high-ranked prey species should decrease. This did not happen with white-tailed deer populations on St. Catherines Island, where venison remained a staple throughout the aboriginal period. There is a shift from larger fish (individuals weighing more than 1 kg) to smaller saltwater fish through time, but the reason for this change remains unclear. The adoption of maize cultivation after A.D. 1300 probably does not necessarily represent a broadening of diet breadth (because for millennia, St. Catherines Islanders had exploited several shellfish taxa with return rates comparable to those for maize cultivation).
- Central place foraging theory predicts that aboriginal foragers should have positioned their residential bases to maximize the net returns given the pursuit, handling, and transport costs of resources across different patches (effectively balancing out different fitness and foraging objectives of males and females). Specifically, primary *marshside* settlements were projected along the intersection of the two highest ranking patches, on the high ground fringing the maritime forest and the salt marsh. The probabilistic, Island-wide archaeological survey demonstrates that the placement of more than 80 percent of the archaeological components (from all time periods) is fully consistent with the marshside settlement model derived from central place foraging theory.
- During the initial occupation of St. Catherines Island, Late Archaic foragers (cal 3000 B.C.– 1000 B.C.) established their central place settlements exclusively on first-tier habitats located on the Pleistocene island core. As human population increased, so did the progressive utilization of fragmented, second-tier habitats, suggesting a significant intensification in provisioning strategies.

- Mortuary evidence indicates that an egalitarian social network (involving leadership without inherited authority) was practiced during the Deptford–Wilmington periods (cal 350 B.C.–A.D. 800) on St. Catherines Island.
- Mortuary evidence also demonstrates that after cal A.D. 800 (the onset of the St. Catherines period), leadership and social status was ranked in a despotic system of inherited asymmetry.
- The baldcypress tree-ring sequence defines a dry, cool interval—termed the St. Catherines Period Drought (A.D. 1176–1220)—that corresponds to a statistically significant gap in the cultural ^{14}C record of St. Catherines Island and suggests a partial (or perhaps complete) depopulation of the island at the end of the St. Catherines period.
- Significant maize cultivation began during the subsequent Irene period (sometime after cal A.D. 1300 and prior to European contact in the 1560s).
- Human behavioral ecology suggests that the optimal placement of central places should respond to the changing geography and geomorphology of St. Catherines Island. We believe that over a 5-millennium timespan, the shifting energetic cost–benefit considerations relative to the evolving geomorphic configuration of St. Catherines Island—not the introduction of maize-based cultivation—conditioned the distribution of archaeological sites during the Irene period (cal A.D. 1300–1580).
- Bioarchaeological evidence thus indicates that the ideological principle of ranked, inherited asymmetry predated significant maize cultivation on St. Catherines Island (which postdates cal A.D. 1300).

The archaeological and bioarchaeological evidence defines two critical transitions in the aboriginal lifeways on St. Catherines Island: The relatively abrupt shift from an egalitarian ethos to inherited asymmetry and an apparently rapid transition from forager to forager/farmer. It is clear that ranked social status developed prior to the adoption of significant maize cultivation on St. Catherines Island.

NOTES

1. We hasten to add the assumption of homogeneity implied here overlooks the significant changes in sea level (and presumed marshland productivity) that took place during the St. Simons and Refuge periods. Obviously, a component/century proxy masks such variability.

2. Keep in mind, of course, that components/century and occupations/century are not independent variables. By definition, all components are automatically included in the count of occupations, so the two indices are highly intercorrelated.

3. As noted previously, the St. Catherines Shell Ring (9Li231) is clearly a "large" archaeological site/component, by any objective measure (see chap. 20). But in order to preserve the sampling protocols upon which the Island-wide survey is grounded, we will employ the original field estimates here (based on the very limited exposure of the site available to us at the time).

4. The paucity of mission period (Altamaha) date is, of course, a spurious artifact of the radiocarbon technique and must be ignored

5. Larsen (2001: table 2.1) includes the St. Catherines Island skeletal samples from Seaside Mounds I and II, McLeod Mound, and various Cunningham mounds in his "Georgia early prehistoric (400 B.C.–A.D. 1000)" sample. The "Georgia late prehistoric/protohistoric" sample includes St. Catherines Island skeletal remains from Johns and Marys Mounds, and South End Mounds I and II, which were combined with numerous other coastal bone assemblages. The skeletal sample from Mission Santa Catalina de Guale was merged with that from Pine Harbor (Larson, 1990) into the Georgia early mission (A.D. 1600–1680).

6. Coastal Georgia: late prehistoric molars showed significantly more microwear than mission period, but mission samples had significantly wider pits and scratches. The prehistoric samples from inland localities showed significantly more microwear and significantly smaller pits than those for coastal samples, but there is no convincing explanation to explain this variability (Teaford et al., 2001).

7. In California's Channel Islands, investigators identified statistically significant differences between male and female diets during the Middle Holocene: Women clearly had greater access to plant foods than men (Walker and DeNiro, 1986; Goldberg, 1993; see also Kennett, 2005: 151). Thinking that similar diet-breadth differences might exist on St. Catherines Island, we partitioned the available stable isotope evidence (table 30.5) to see whether we could detect differences in male and female diets. Whether taken as a whole or partitioned into individual period-specific temporal increments, no such differences exist.

8. The analysis of stable isotopes in the St. Catherines Island burial population, discussed above, was conducted in 1990 (Schoeninger et al., 1990; Larsen et al., 1992; Hutchinson et al., 1998; Larsen, 2001: 29, 72; see also chap. 25 and 32, this volume). At this writing, we are conducting a follow-up study, specifically designed to expand the sample and previous sampling scheme and process additional isotope data on bone apatite carbon.

9. Whereas such indices of relative abundance provide useful tools for first-approximation comparisons, we cautioned previously about the importance of overinterpreting these results (especially given the problems of small sample sizes, differential bone transport, and the unknown age structures of the vertebrate populations involved).

10. Interpretations such as these require the assumption that diamondback terrapins were procured *only* by terrestrial hunters, but we think it entirely possible that terrapin procurement was embedded in other hunt types, including saltwater fishing, shellfish collection, and even the exploitation of terrestrial plant resources (such as mast and maize horticulture). We also think it likely that turtles and terrapins were collected upon encounter by children and elders (which likely modified the expected return rates due to different parameters of encounter and search time; see Bird and Bliege Bird, 2000, 2002; Bird et al., 2004b). In other words, because diamondback terrapin procurement does not exclusively belong to the terrestrial hunt type, the relatively low-ranking return rates associated with diamondback terrapins cannot be used to estimate diet breadth.

11. We suspect that the dramatic increase in deer bones can be attributed, in part, to the brisk trade in deerskins during the mission period, but we also presume that the venison attached to the deer hides was consumed at the mission (see also Reitz and Duke, chap. 27).

12. This situation is complicated by the fact that white-tailed deer became significantly smaller through time in the Georgia Sea Islands. At about 1600 B.C. (during the St. Simons period), the mean adult body weight was about 72.5 kg, dropping to half that size in contemporary Sea Island populations (Reitz, chap. 22; table 8.4). But because the biomass estimates derive from the allometric relationship between live weight and skeletal weight (table 22.1), these estimates are independent of the decreasing live weight among island white-tailed deer populations. This means that body mass does not account for the decreasing importance of white-tailed deer in the overall biomass contributed by vertebrates.

13. But, as noted in chapter 31, white-tailed deer populations appear to have been heavily impacted on Sea Island to the south of St. Catherines Island, and perhaps the diet-breadth predictions of resource depression hold in these cases (which should be investigated in detail).

14. In chapter 8, we noted that despite a relatively low post-encounter return rate (1260 kcal/hr, per Kick, Semon, and Thomas, this volume), diamondback terrapins are among the second most abundant terrestrial vertebrate recovered in the Island-wide survey, accounting for nearly 30 percent of all the vertebrate food bone recovered (table 31.1). These data could perhaps support an inference that the overall diet breadth for terrestrial hunting on St. Catherines Island remained relatively broad—likely at a level of 1300 kcal/hr or so—for nearly 4000 years; but such an inference requires the assumption that diamondback terrapins were procured *only* as part of the terrestrial hunting hunt type (see also footnote 10).

15. Alternatively, it is possible that some technological innovation (such as better fish traps or nets) or other form of intensification would have raised the return rates of the lower ranking (smaller) fish taxa, thereby raising their resource ranking relative to the larger fish.

16. The earliest (St. Simons period) assemblage differs markedly from subsequent zooarchaeological samples (in part because only two components are represented and also because hardhead catfish (*Ariopsis felis*) remains dominate the assemblage at the St. Catherines Shell Ring).

17. As noted in chapter 7, the downside is that separating individual oysters greatly increases their vulnerability to predication by crabs, starfish, and whelks.

18. We also note that Quitmyer et al. (1985) have shown that the mean age at death of *Mercenaria* in coastal shell middens of southern Georgia declined from Late Archaic through late prehistoric times. Mississippian people seem to have been harvesting younger clams than during earlier periods, suggesting an intensification of human exploitation of local clam beds.

19. As noted in chapter 32, we are presently conducting an expanded analysis of stable isotopes in the St. Catherines Island skeletal populations, and the present comments must be considered as preliminary.

20. The Soil Conservation Service ranks Foxworth fine sand as the most desirable agricultural soil on St. Catherines Island, followed closely by Echaw and Centenary fine sands (Looper, 1982). Roughly 85 percent of the antebellum fields were constructed on Foxworth soils, and the remaining three antebellum clearings (Long Field, Billy Field, and Jesamin Finger) were constructed on Echaw and Centenary fine sands. We also note the near complete lack of plantation fields on the southern Holocene beach ridges, with only the two patches of Rutledge fine sands (at Flag Pond and Beach Pond) providing the only agricultural potential on the entire Holocene beach ridge complex.

21. But Barlow and Heck (2002: 140) observe that tropical foragers routinely employ a 16-km daily foraging radius, returning loads of 3–18 kg of seeds or nuts from procurement locations to their base camps (see also Barlow et al., 1993; Jones and Madsen, 1989; Rhode, 1990; Zeanah, 2000).

22. Only rarely was the archaeological evidence consistent with the uniform distribution model (derived from the diet-breadth assumption of homogeneity), and we attribute these result to the small sample size involved.

23. We cannot generalize about the foraging patterns during the early and middle Holocene because St. Catherines Island (as a distinct geomorphic entity) did not exist until the period of relative sea-level stability about 5000 years ago. Foraging theory would seem to suggest that the earliest residential groups were small, with narrow diets and limited investments in collecting and processing technology. Their foraging ranges were large and seasonal mobility high; it seems likely that both Paleoindian and Early Archaic residents of the American Southeast were organized into egalitarian bands (Anderson and Hanson, 1988; Anderson, 2002: 246). But by the time foragers came to St. Catherines Island, they were probably organized at the tribal level.

24. By *status*, we mean the rights, duties, privileges, and powers that accrue to a recognized and named social position.

25. The only exception to this statement would be foragers living in the second-tier habitats on the extreme northern and southern ends of the island (and archaeological investigations to date show both areas were barely occupied).

CHAPTER 34. WHY DID ASCRIBED SOCIAL INEQUALITY DEVELOP ON ST. CATHERINES ISLAND?

DAVID HURST THOMAS

Agriculture has been implicated in many areas of the world—along with increased sedentism, population growth, and favorable genetic changes in key crops—as a primary causal factor in the development of hereditary social inequity (e.g., Johnson and Earle, 1987: 209–211; Marcus and Flannery, 1996: 239–240). The rise of chiefdoms in the American Southeast, for instance, long been considered to be causally related to the emergence of Mississippian culture, which began in the Mississippi River Valley about A.D. 700 and was generally accompanied by a major shift in subsistence base (e.g., Reitz, 1988a: 150; Hudson, 1990; Worth, 1998a: 6, 1999; Hally and Mainfort, 2004). But the archaeological and biological evidence from St. Catherines Island, synthesized in the previous chapter, clearly establishes that ranked, inherited asymmetry arose prior the introduction of significant maize cultivation in the Georgia Sea Islands.

These results, while compelling, are hardly shocking. Anthropologists have long understood that certain "complex" hunting–gathering populations are characterized by heritable social inequity (e.g., Binford, 1980, Yesner, 1980: 728–733; Koyama and Thomas, 1982; Price and Brown, 1985b: 10–13; Winterhalder et al., 1988; Arnold, 1993, 1996, 2000; Winterhalder and Goland, 1993; Kelly, 1995: 293–331; Price and Feinman, 1995; Price and Gebauer, 1995; Raab and Larson, 1997; Erlandson and Jones, 2002; Sassaman, 2004; Bird and O'Connell, 2006).

Keeley (1988) has documented the close correlation between population pressure (defined as ratio of population density and density of available resources) and socioeconomic complexity on an ethnographic sample of 94 hunter–gatherer groups. This is particularly true in maritime foraging environments, where human population densities typically exceed that of the corresponding inland hinterlands, sometimes by several orders of magnitude (e.g., Kroeber, 1939; Birdsell, 1968).

If population growth is a catalyst, a driving force behind the emergence of social complexity among foraging societies, then the critical question becomes how, exactly, are two interlinked: "*What processes connect demographic pressure with the development of hierarchical forms of economic, social and political organization?*" (Bird and O'Connell, 2006: 168).

That's a very good question.

THE CRITICAL ROLE OF ENVIRONMENT

This chapter addresses the rise of hereditary inequality in stepwise fashion, beginning with a critical examination of the richness, diversity, and proximity of the St. Catherines Island environment, then moving to questions of demographic pressure, circumscription, and territoriality.

HARDSCRABBLE FORAGERS OR FORTUNATE BEACHCOMBERS?

Conversations about maritime foragers have long been couched in stereotypes and hyperbole. Decades of anthropologists and archaeologists have denigrated the role of marine resources and shellfishing in past human diets:

> [This] manner of procuring the essentials of life by collecting shells in itself indicates a low form of human existence. In all parts of the world, even today, people may be seen by the shore at low water collecting for food the shells uncovered by the retreating tide. … [T]hese people always belong to the lower classes of society, and lead in this manner a primitive as well as simple life. (Uhle, 1907: 31)

Osborn (1977: 158, 172) similarly ridiculed the "cornucopia" view of protein-rich resources in the oceans of the world, arguing that "shellfish collecting is a labor-intensive strategy in which not only does the food item contain less 'optimal' amounts of protein, but also producers in the society would have to spend an inordinate amount of time each day or so collecting food for dependents." Because marine habitats are generally less productive per unit area than terrestrial habitats, Osborne argued, shellfish and other aquatic foods were viewed as "emergency" or "starvation" foods—small, costly to harvest and process, nutritionally poor, unreliable, and requiring high technological investments (such as boats) to access, and susceptible to storm and potentially lethal red tide events (see also Hogg et al., 1971; Cohen, 1977; Gamble, 1986: 35–36; Renfrew and Bahn, 1996: 282; Fagan, 2001: 341). Claassen (1998: 175) also suggests that shellfishing has been marginalized as "women's work" in most of the ethnographic literature.

Although marine habitats are indeed less productive per unit of area than terrestrial habitats, this generalization applies only to open ocean waters. Certain coastal habitats exhibit extraordinarily high productivity (Yesner, 1980; Erlandson, 1988, 1991; Raab, 1992) and as noted in the previous chapter, the salt marshes and estuaries of coastal Georgia are among the globe's most productive ecosystems. The Georgia salt marsh is several times more productive than the world's best farmland, and several investigators have extolled the good life available at the seashore (e.g., Yesner, 1980; Claassen, 1986a, 1986b; Stein, 1992; Jones and Richman, 1995). Geographer Carl Sauer (1962: 262–264), in particular, stressed the "abundant and diverse food, waiting to be picked up and dug twice daily. … Primitive man could hardly find a better prospect than beachcombing, which was also conducive to social grouping and reduced mobility." So viewed, coastal environments are "essentially inexhaustible and easily harvested" (Erlandson, 2001: 291; see also Morgan, 1877; Hewes, 1968; Fisher, 1995).

So who were St. Catherines Islanders? Were they hardscrabble foragers barely getting by on the emergency, starvation rations available in the marshland? Or were they fortunate beachcomers privileged to exploit the essentially exhaustible resources of Georgia's Golden Isles?

St. Catherines Island as Coastal Foraging Habitat

Considerable ethnographic and archaeological evidence suggests that, compared to their strictly terrestrial counterparts, marine foragers tend to live in larger, more residentially stable communities (Yesner, 1980; Kelly, 1983: 292, 1995: 125), from which they forage logistically (sending out small work parties to capture appropriate prey items and generally returning on a daily basis). Coastal foragers have been termed "central place" (Orians and Pearson, 1979) because they commonly depended on several locally concentrated resources from a single settlement, typically exploiting shellfish, sea-bird colonies, free-ranging pelagic mammals (such as seals, porpoises, walruses, and whales), sea turtles, ocean fish, and anadramous fish.

Yesner (1980: 729) emphasizes the productivity of marine environments as a source of dietary calories, protein, and nutrients relative to terrestrial environments. Complex maritime foragers characteristically live in coastal habitats comprised of highly productive, yet patchy and discontinuous resources, sometimes the result of upwelling. Coastal foragers typically exploit a diversity of ecological niches crowded along the coastlines within a relatively small unit area. "Group sizes and population densities along coasts tend to be larger than adjacent interior areas because of the productivity of marine ecosystems, their juxtaposition with terrestrial habitats which increases the diversity of resources available, and the linear distribution of subsistence resources" (Kennett, 2005: 36; see also Schalk, 1977; Yesner, 1980; Smith, 1991, Erlandson, 2001; Ames, 2002). Coastal communities also commonly manifest complex decision-making hierar-

chies reflecting economic, social, and political differentiation (Ames and Maschner, 1999; Kennett, 2005).

Dyson-Hudson and Smith (1978) hypothesize that human territoriality can be expected to arise in ecosystems containing critical resources that are sufficiently abundant and predictable across time and space. Such habitats will be judged worth defending when the costs of exclusive use and defense are outweighed by the benefits gained from resource control (see also Boone, 1992; Kennett, 2005: 233–234). This is why—from the fish camps owned by nuclear families in the Bering Sea, to the clan control of halibut banks among the Tlingit, to the tribal control of shellfish beds among the Yahgan—aquatic foragers tend to exhibit a greater degrees of territoriality than inland foragers, regardless of their degree of social complexity (Cordell, 1978; Yesner, 1980: 731–732).

ARTICULATING THE MARINE, LITTORAL, AND TERRESTRIAL BIOMES

Marine and littoral systems are typically more stable—and generally more productive—than their immediate terrestrial counterparts. Today, the near-shore waters from northern Chile to northern Peru, for instance, produce at least one-fifth of the world's commercial fish (Moseley, 1975: 7). But for the maritime forager, the richness of this marine fishery must be balanced against the austerity of the immediate terrestrial habitat, one of the globe's most barren deserts (Moseley, 1975: 7; Keffer et al., 1998; Sandweiss et al., 2001).

Similarly, the highly predictable and productive marine resource base of California's Channel Islands contrasts starkly with the "depauperate" terrestrial resources of the islands proper (Kennett, 2005: 71; Kennett et al., 2007: 256–361). The availability of adequate drinking water restricts human settlements on many of the smaller islands (such as Anacapa and San Miguel). The low diversity of terrestrial flora and fauna so severely constrained marine-based foraging strategies that during the historic period, the Channel Island Chumash "heavily sub-

sidized" their economy by trading for large quantities of terrestrial resources (especially acorns) from the mainland (Arnold, 2001; Kennett, 2005: 15, 219). Potable water sources are likewise limited, particularly on the smaller channel islands of the California coastline (Kennett et al., 2007: 356).

The Northwest Coast of North America is a classic case in which a rich and productive marine resource base is "clearly responsible" for the relatively high population densities and social complexity recorded at the time of European contact (e.g., Bird and O'Connell, 2006: 169). As Ames and Maschner (1999: 113) put it, "littoral and maritime environments are so productive that large-scale complex societies are often seen as an almost inevitable outcome after humans begin to make use of them." But these investigators likewise caution that despite the apparent environmental richness, oral traditions persist among aboriginal Northwest Coast people telling of famines and food failures, pointing up important variability across in time and space.

Schalk (1977, 1981) has documented the complex relationship between the Northwest Coast resource base and aboriginal population densities, both of which vary significantly with respect to latitude. Writing about the lower Columbia River drainage, for instance, Ames (2002) emphasizes the diversity in foraging strategies across terrestrial, wetland, lacustrine, and riverine resources: "It would, in fact, be difficult to categorize them as either terrestrial or aquatic hunter-gatherers based solely on the sources of their food resources" (Ames, 2002: 21). In the south, anadromous fish and several other key resources are available throughout much of the year, limiting the incentive for storing them; but moving northward, marine seasonality becomes more pronounced, but terrestrial productivity drops off markedly. Schalk (1981: 67) terms the temperate coniferous rainforest a "food desert" and goes on to state that "strictly from the viewpoint of terrestrial resources, the areas north of the Strait of Juan de Fuca are probably some of the most food-scarce environments confronted by foragers anywhere in the world."

Rather than a simple equivalence, then, among organizational complexity, population density, and food abundance, it is the relationship between marine and terrestrial resources—specifically, the relative dispersion of key resources, mobility strategies employed, storage facilities required, and household size (the food-sharing group)—that most heavily conditions the organization complexity in northwestern North America.

Barrier Island Habitats

Nearly 2200 barrier islands protect the margins of every continent on the globe, except Antarctica, covering about 15 percent of the world's coastlines (Dolan et al., 1972; Schwartz, 1973; Hayes, 1979; Davis, 1985b: 380; Clayton et al., 1992; Davis and FitzGerald, 2004: 133; Pilkey, 2003: 29; Stutz and Pilkey, in press). Hundreds of barrier islands ring the North American shoreline, but that number remains fluid because these nearshore islands are constantly appearing, disappearing, reappearing, and reinventing themselves. Although the western shoreline of North America hosts several "barrier beaches," true barrier islands are absent from the Pacific coastline.

Most of the world's barrier islands are beach ridges—long, linear wave-built barriers, punctuated by the occasional tidal inlet, and separated from the mainland by broad, shallow estuaries (Zeigler, 1958). The Outer Banks islands of the Carolinas, for instance, are typically thin, longish island isolates that maintain a migratory equilibrium—moving back and forward, up and down—keeping pace with sea level, the variable sources of sand supply, wave energy, and storm overwash. Onshore winds blow huge quantities of aeolian sands across the beach-ridge barrier islands, and dune vegetation traps the sand necessary to stabilize the dune ridge. The thin, unconsolidated, and poorly developed soils generally foster stunted vegetation, which is subject to severe impacts from ocean winds, salt spray, and sometimes massive damage from tropical storms and hurricanes. Although the maritime forest does sometimes grow on the backside of the larger beach-ridge barrier islands, the terrestrial productivity is generally quite low and the resource patches are universally small. From an aboriginal foraging perspective, then, the typical barrier island provides little terrestrial potential; rather, it is the mainland coast that provides primary access to the resource-rich estuaries, salt marshes, and swamps.

The "Fake" Barrier Islands of Georgia, Unique in the World?

The Georgia barrier islands are fake barriers, or at least the Pleistocene components are. They have the appearance of modern barriers except they are not in equilibrium with today's waves and currents and winds. They were barrier islands at one time, and they appear to be barrier islands now, but their appearance is an accident of sea level (Pilkey, 2003: 253).

St. Catherines Island is one of 10 "composite" barrier islands that protect the modern Georgia coastline. The Georgia Sea Islands are unique accidents of sea-level history, vastly different from the typical beach-ridge islands described above (Zeigler, 1959: 225–226). Writing about the "false" barrier islands of the Georgia coastline, geologist Orrin Pilkey sees a place where "things aren't what they seem to be" (2003: 244–246).

The most ancient portion of the Georgia Sea Islands was left behind when the Pleistocene sea level peaked, then subsided. Sea level subsequently peaked again at the same level, creating a chain of paired barrier islands—an old one and a recent one—overlapped in exactly the same place. These large, "composite" islands protect enormous estuarine salt marshes, initially formed during the Pleistocene and reflooded during the Holocene sea level rise (DePratter and Howard, 1977, 1980; Oertel, 1975).

This accident of fluvial geomorphology means that—unlike the long, narrow barriers that typify the Carolina or Texas coastlines—the 10 composite islands of

coastal Georgia (including St. Catherines Island) rank among the broadest and most resource-rich barrier islands in the world. The salt marshes and estuaries behind St. Catherines Island comprise one of world's richest environments—several times more productive than America's most fertile farmland (Johnson et al., 1974: 82)—with net production amounting to 2000 gm/m^2/year (about 10 tons, dry weight) per acre of organics. Although the Georgia coastline is only 160 km long, it protects one-third of the salt marshes in eastern North America.

The mature maritime forests of the Georgia Sea Islands are highly productive terrestrial counterparts to the rich littoral and marine resource base. Not only does the terrestrial forest produce abundant mast crops in the fall (critical to foragers and white-tailed deer populations alike), but artesian freshwater sources abound throughout the Pleistocene island core and the well-developed podsols and humate zones are admirably suitable to slash-and-burn methods of maize cultivation.

Because of the extraordinary confluence of sea levels past and present, Georgia's Sea Islands are among the few places on the globe where three enormously productive ecosystems can be found in immediate proximity to one another, coexisting side by side as accident of maritime geomorphology (Clayton et al., 1992; Davis and FitzGerald, 2004: 133; Pilkey, 2003: 29). This potential is, of course, subject to considerable environmental and climatic perturbations, particularly shifts in sea level (and its attendant impact on the salt marsh), coastal erosion, and catastrophic storm damage.

EGALITARIAN FORAGERS OF ST. CATHERINES ISLAND
(CAL 3000 B.C.–A.D. 800)

Modern St. Catherines Island was formed about cal 3000 B.C., when sea level rose sufficiently to isolate the Pleistocene core from the mainland. Perhaps as early as cal 2500 B.C., Guale Island had developed along the northeastern margin of St. Catherines Island, effectively buffering the Pleis-

tocene and protecting a large inter-island marshland along the Yellow Bank Scarp. This meant that, in addition to the extensive estuary along its western margin (which characterizes all the barrier islands of the Georgia shoreline), St. Catherines Island hosted a second major salt marsh system on the seaward side. The meandering tidal creeks of Guale Marsh provided immediate access to this rich shellfishery and produced a mosaic of meander bends and levees along the creek beds (Rollins et al., 1990; Linsley, 1993: 72; chap. 3, this volume). More than 80 percent of the maritime forest edge on St. Catherines Island fronts directly on the margin of a significant salt marsh—effectively doubling the number of optimally positioned central places (fig. 11.14). Current exposures of relic marsh muds demonstrate that during the St. Simons period, Guale Marsh extended southward to Middle Beach (West et al., 1990).

For the aboriginal St. Catherines Islander, the unique accidents of sea-level history translated directly into a mosaic of closely spaced, seasonally diverse, and extraordinarily productive resource patches. Within an effective foraging radius of less than 10 km, aboriginal foragers could exploit massive tracts of prime maritime forest, almost endless salt marsh flats, the deep waters of St. Catherines and/or Sapelo sounds, the seaside shorefront, and the gradually sloping continental shelf of the Atlantic Ocean. St. Catherines Island foragers could readily pursue a strategy of logistic procurement and low residential mobility whenever they elected to do so.

This is exactly what happened at the St. Catherines Shell Ring (9Li231), the oldest known human presence on St. Catherines Island and island's the most important site of the St. Simons period. The St. Catherines Shell ring was initially occupied about cal 2900 B.C.–2500 B.C. during a time of rising sea level (Gayes et al., 1992: 159, fig. 6; see also chap. 4 and fig. 32.2). Then as now, the shell ring was perched along the westernmost (estuarine) margin of the Walburg Scarp (fig. 32.2), where the immediate juxtaposition of the high-ranking resources of

the Pleistocene core (especially the mast crop and newly isolated white-tail deer herds) and the even higher ranking saltwater marsh provided human foragers with an extraordinarily diverse and closely spaced set of marine and terrestrial patches.

The Late Holocene transgression apparently peaked about cal 2300 B.C. (fig. 32.1), and then, over the next seven centuries, sea level dropped about 2 m. This was a dramatic turn of events for St. Catherines Islanders because the saltwater marshland along the estuarine side of the Island must have been significantly reduced (if not eliminated altogether). The St. Catherines Shell Ring was soon abandoned (circa cal 2180–1890 B.C.) and apparently never reoccupied.[1]

Several St. Simons-age settlements clustered along the eastern scarps of St. Catherines Island, situated on the high ground within 1 km of the Guale Marsh margin. Placement of these marshside occupations is entirely consistent with projections from central place foraging theory.[2] But the Island-wide archaeological survey also documented a number of Late Archaic components flanking the freshwater ponds and swamps that once defined the midline of St. Catherines Island. These lacustrine settlements likely exploited freshwater resources such as turtles, migratory waterfowl, bulrush and cattails, and freshwater fish. Because we underestimated the importance of the lacustrine resources (particularly when the western marshland went away due to lowered sea level), these inland settlements were not anticipated in our central place foraging models (chaps. 7–11).

About cal 1600 B.C., sea level began rising again (at a rate of 10 cm/century) from a low-water mark of roughly 3 m below MHW to the present level. On St. Catherines Island, this meant that foragers of the late St. Simons and early Refuge-Deptford periods likely witnessed (1) a progressive deterioration (and southward migration) of saltwater marsh resources along the eastern margin of St. Catherines Island (due to the overtopping of Guale Island and disappearance of Guale Marsh) and (2) a resur-

gence of estuarine marshlands along the western island scarp.

Figures 33.1 and 33.2 plot the temporal distribution of the 129 archaeological components and the 234 occupations recorded in the Island-wide probabilistic survey. The St. Simons period lasted 20 centuries, and the Island-wide survey recorded only 10 St. Simons period components, translating to an average of 0.50 components/century. This is the lowest density of archaeological components (and occupations) recorded on St. Catherines Island and (despite the likely disappearance of numerous Late Archaic sites due to erosion of the Pleistocene core), these proxies suggest that the human population during Late Archaic times was probably the lowest of any aboriginal occupation on the island. Over the next 2 millennia, the environments of St. Catherines Island began filling up and proxies from the probabilistic archaeological survey establish (beyond any reasonable doubt) that human population levels on St. Catherines Island increased geometrically over the 5000 years of aboriginal occupation.[3]

The mortuary evidence for this period (restricted to the interval cal 1000 B.C.–A.D. 800) is entirely consistent with that expected for societies allocating social status according to egalitarian principles (Thomas and Larsen, 1979; see also chap. 33, this volume).[4] Setting aside gender differences, this was a society in which people were born with equal rights and standing. Social status was accrued in direct proportion to life accomplishments. Infants and juveniles have relatively little time or opportunity in which to acquire such status.

No truly elaborate burial facilities are known from this period, and when grave goods were present, there was no particular trend for association with either male or female burials. Moreover, despite the number of mounds that have doubtless been destroyed over the past 2 millennia, mound burial was apparently reserved for a fraction of the total population, thereby implying a considerable degree of status differentiation. Clearly, those few set aside for special mortuary treatment—and the five female burials from the Central Tomb at McLeod

Mound come to mind here—were people of high social status that had accrued during their lifetimes (hence excluding infants, young children, and most preadults).

In such a system of *achieved asymmetry*, prestige was still grounded in real-world achievement, but there were socially sanctioned ways to cash in (Marcus and Flannery, 1996: 239). Some villages inevitably grew larger than others, in part because the highest ranking habitats were the first occupied, and also due to the efforts of self-selected leaders who worked harder, accumulated more wealth, excelled at raiding and warfare, engaged in more long-distance exchange of prestige items, and hosted social events that attracted more followers. Better foragers working in top-tier habitats could afford, say, to invest in the construction of a new fish weir, a new council house, support multiple spouses, present better bride gifts, and provide a better dowry to a daughter. This enlightened self-interest must have attracted the envy and ire of less successful neighbors. But with achieved asymmetry, their leadership and authority died with them.

The first St. Catherines Islanders established a subsistence pattern that persisted for millennia, harvesting a broad range of vertebrate and invertebrate marine resources from the nearby estuarine and marine waters (including fish, clams, oysters, crabs, and shrimp). St. Simons period foragers also hunted deer and likely collected a range of terrestrial food sources including hickory nuts and acorns, berries, and edible roots and tubers. Within the limits and biases of the seasonality estimators employed to date, it is clear that during the interval cal 1000 B.C. through ca. A.D. 800, a large proportion of the archaeological sites were used during all seasons of the year. Population densities were probably quite low during the Late Archaic period, and we believe that the first St. Catherines Islanders were organized into egalitarian, tribal-level societies probably living in economically self-sufficient, virtually sedentary, and politically autonomous villages (Sahlins, 1961, 1968: 15–16; Carneiro, 2002: 35; Anderson, 2002: 246).

HIERARCHICAL FORAGERS OF ST. CATHERINES ISLAND
(CAL A.D. 800–1300)

The centuries immediately following cal A.D. 800 were a time of significant social, environmental, and ecological change on St. Catherines Island. Two important and interrelated conclusions emerge from the archaeological research available for the St. Catherines period (cal A.D. 800–1300).

The most important shift is evident in mortuary behavior. As noted previously, all the known Wilmington-period interments on St. Catherines Island took place within a single century (cal A.D. 540–640). Most of these burials were adults, with subadults comprising only 10 percent of the total burial population. Infants and young children were conspicuously absent. After a lapse of 4 centuries, when burial mound activities started up again on St. Catherines Island, the mortuary demographic had changed significantly. In the three documented St. Catherines period burial mounds, subadults comprise more than 40 percent (46 of 120) of the total interments—and many of these were infants and children singled out for special treatment.[5] As articulated in chapter 33, we believe this shift in mortuary patterning reflects a change from an egalitarian social network (involving leadership without inherited authority) during the Deptford–Wilmington periods to a ranked, despotic system of inherited asymmetry in leadership and social status during the St. Catherines period.

The second important conclusion relates to something that *did not happen* during the St. Catherines period. Although social complexity is commonly linked to the emergence of agriculture—and maize cultivation would eventually play an important role in the lives of aboriginal St. Catherines Islanders—the available archaeological evidence indicates that little (if any) maize was consumed during the St. Catherines period (i.e., prior to cal A.D. 1300). Stable isotope analyses for individuals living during the St. Catherines period shows a varied dietary pattern based on continued use of traditional marine and terrestrial resources. The general lack of

dental and skeletal pathologies (coupled with the stable isotope evidence) demonstrates that the significant consumption of maize took place later, during the Irene period of aboriginal history.

Taken together, these two conclusions mean that the ideological principle of heritable social inequity predated the advent of significant maize cultivation on St. Catherines Island, probably by several centuries.[6]

RELATING POPULATION GROWTH TO HEREDITARY ASYMMETRY

This chapter began with a difficult question: "What processes connect demographic pressure with the development of hierarchical forms of economic, social and political organization?" (Bird and O'Connell, 2006: 168). This final section addresses this question based on the available evidence from St. Catherines Island archaeology.

Behavioral ecology provides a useful paradigm for exploring how social, political, and economic organizations change, at all scales of population and extremes of inequality (esp. Dyson-Hudson and Smith, 1978; Hawkes, 1990: 155–156, 1991; Boone, 1992, 2000; Diehl, 2000a, 2000b: 19–22; Fitzhugh, 2003; Kennett, 2005: 15; Bird and O'Connell, 2006; Kennett et al., in press). This general approach assumes that decision-making mechanisms are responsive to natural selective pressures that lead to fitness-maximizing choices by self-interested individuals. Drawing upon the work of Vehrencamp (1983), Bird and O'Connell (2006) use the term *hereditary inequality* to denote "a pattern of privileged control over key resources (including the labor of non-kin) that can be passed to one's descendants" (see also Kennett, 2005: 36–38). These investigators distinguish between *egalitarian* and *despotic* societies, arguing that competition over resources is universal, even within small, localized groups of closely related individuals.

Central to this agent-based inquiry is the degree to which the size and structure of a community is mediated by self-interested individuals attempting to maximize access to limited resources (Brumfiel, 1992;

Boone, 1992; Diehl, 2000b: 17). Whereas some group members (the "dominants") can secure a disproportionate share of resources for their personal use, their less fortunate "subordinates" must confront the cost/benefits of either living with this inequity or moving away from their natal group.

But why, from an evolutionary perspective, should people submit to those wishing to subordinate and exploit them (Kennett et al., in press)? That's another good question and a useful point of departure for framing the available archaeological evidence with respect to the emergence of heritable social inequity on St. Catherines Island.

KEY ELEMENTS OF ENVIRONMENTAL RICHNESS AND DIVERSITY

Habitat suitability can be perceived as a density-dependent function that declines as population increases (Winterhalder and Kennett, 2006; Kennett et al., in press). The earliest colonists monopolize the best habitats, but with population growth, competitive forces push some self-interested individuals into second-tier habitats, and eventually an equilibrium evolves between the choices of staying put or migrating out. Human behavioral ecology predicts that communities will be led by individuals weighing the costs of living in large groups compared with the benefits of living elsewhere. Such benefits would include access to potential mates, the more efficient harvesting of resources (by employing so-called economies of scale), and defense and territorial control of key resource patches (such as intertidal shellfish beds, nearshore fishing territories, sea mammal colonies, terrestrial patches). As such, demographic pressure can serve as a catalyst driving the emergence of "complexity" among foraging societies (Keeley, 1988). Higher population densities generally correlate with greater diet breadth, occupation of closely spaced yet diverse habitats, and more environmental packing providing fewer chances to relocate (Bird and O'Connell, 2006: 168).

For the aboriginal St. Catherines Islander, the unique accidents of sea-level history

translated directly into a mosaic of closely spaced, seasonally diverse, and extraordinarily productive resource patches (Clayton et al., 1992; Pilkey, 2003: 29; Davis and FitzGerald, 2004: 133). Within an effective foraging radius of less than 10 km, aboriginal foragers could exploit massive tracts of prime maritime forest, virtually unlimited expanses of salt marsh flat, the deep waters of St. Catherines and Sapelo Sounds, the seaside shorefront, and the gradually sloping continental shelf of the Atlantic Ocean. A terrestrial forager on St. Catherines Island could systematically search and exploit any of these diverse resource patches and still return home daily. And considering the dramatic reductions in transport costs involved with watercraft—which were doubtless available throughout the entire aboriginal occupation of the Georgia Sea Islands—St. Catherines Island foragers could pursue a provisioning strategy of logistic procurement and low residential mobility whenever they so chose.

DEMOGRAPHIC PRESSURE AND CIRCUMSCRIPTION

Demographic pressure can result from intrinsic population increase, immigration, and/or environmental changes (such as sea-level change). When human population increases significantly and settlements expand, one expects the highest ranking habitats (based on central place foraging returns) to fill up first (Kennett, 2005: 230). The oldest and largest lineages are expected to control most productive resource patches, a practice that typically fosters significant intragroup inequities experienced by subordinates.

Carneiro (1970, 1988) has long argued that social and/or environmental circumscription—the inability to move elsewhere—provides conditions under which hierarchical social organization should begin to develop. Such circumscription results in differential access to the best habitats, and the increasingly disadvantaged subordinates must weigh the cost/benefits of "voting with their feet" by immigrating to new areas with a less circumscribed re-

source base (Gebauer and Price, 1992a: 9; Fitzhugh, 2003: 111).

In particular, Carneiro (1970) described the nature of resource circumscription and competition in coastal Peru, and comparable processes played out on St. Catherines Island, which is divided into distinctive first- and second-tier habitats (chap. 11; see also Kennett 2005: 234). The first-tier locations were generally established as marshside settlements along the Pleistocene island core. From the Late Archaic through the late prehistoric and mission periods, these marshside settlements comprised the most important aboriginal occupations on St. Catherines Island. The second-tier, Holocene-age beach ridge topography is generally inhospitable for human habitation, with poor soils, unreliable water sources, and little flat ground.

Because of geomorphological processes (described in chaps. 3 and 4), the St. Catherines Island environment slowly degraded over time. When the first St. Catherines Islanders arrived, about cal 3000 B.C., the island was comprised entirely of Pleistocene-age land surfaces (all first-tier terrestrial habitat). During the St. Simons phase, shortly after St. Catherines became an island, all known archaeological evidence occurs in the first-tier habitats of the Pleistocene island core (hardly a surprise, since the accretionary beach-ridge topography only began building during the Late Holocene). Subsequent sea-level shifts and onshore erosional processes have progressively carved away the eastern margins of the Pleistocene core, simultaneously creating a suite of second-tier beach ridge habitats on the north and south ends of the island. The landscape during Refuge-Deptford times changed markedly due to sea-level shifts, and only a single component/occupation during this time frame is known from second-tier habitats. Throughout the Deptford–Wilmington interval, as human population density increased geometrically, the best habitats were likely occupied in descending order of their overall suitability. As population increased, the best habitats of St. Catherines Island were becoming overcrowded, likely creating problems be-

cause social frictions could no longer be readily resolved by fissioning (splitting into smaller, more dispersed social units). So long as unoccupied territory remained available, then some individuals probably chose to emigrate and form new communities rather than accept lower status in their natal communities. Kennett (2005: 39) argues that social hierarchies should not develop so long as viable opportunities exist to relocate.

But under conditions of increasing social and/or environmental circumscription, outmigration becomes a more expensive option, and it is precisely those circumstances under which hierarchical social organization should begin to develop (Boone, 1992). This apparently happened on St. Catherines Island shortly after cal A.D. 800, when the proportional use of second-tier habitat jumped to 20 percent of the known archaeological components for the St. Catherines period. Although the human landscape of St. Catherines Island had not filled up entirely, fissioning became progressively less unattractive not only because of the second-tier habitat, but also due to increasingly expensive investments in dwellings, storage facilities, communal areas, and the various anthropomorphically intensified resource patches (Kennett 2005: 233). The potential costs of living in such communities include interference and competition over land and marine resource patches, and the resulting pressure on local ecosystems.

TERRITORIALITY AND INTENSIFICATION

Dyson-Hudson and Smith (1978) hypothesize that human territoriality can be expected to arise in ecosystems containing critical resources that are sufficiently abundant and predictable across time and space. It seems likely, given the relatively low residential mobility involved on St. Catherines Island, that some patches (or, more likely, the interface between differing patches) would be more productive than others, particularly in light of the anthropogenic changes involved. As demographic pressures mounted, the increasingly intense exploitation of the highest ranking habitats

probably encouraged a form of territoriality ("despotic social behavior" per Kennett, 2005: 332) that assured exclusive access to the most abundant and highly predictable resource of the St. Catherines Island environment.

The institutionalization of social hierarchies is a density-dependent phenomenon that commonly transpires when resources are unevenly distributed, when the highest ranking habitats are already occupied by the larger, more powerful communities, and when social and/or environmental circumscription shuts off emigration as a viable option (Kennett, 2005: 233–234; Kennett et al., in press). In this coastal setting, defense of key resource patches may foster competition and aggression, in turn stimulating escalating strategies of offense and defense. Larger group size is favored in such cases—through in-migration or intrinsic population growth, but within-group competition may increase. Subtle changes in salinity, for instance, can create vastly different levels of oyster productivity, even within a geographical distance of a few hundred meters. This means that oyster beds growing near artesian freshwater would be more highly valued than similar patches further away in the same saltwater creek.

We think that the resource base of St. Catherines Island fostered a high degree of resource ownership and territoriality that extended not only to the herds of white-tailed deer (which may have gone extinct on some barrier islands), oysters (which were likely cultivated), but also across the prime oceanfront beaches during sea turtle nesting season and particularly productive stands of live oak and pignut hickory (which may have attracted considerable preharvest investment to reduce procurement times).

Post-encounter return rates can shift with increasing exploitation, stimulating either movement to second-tier habitats or more intensified use of the same patch. Short- and long-term climatic change can also influence return rates, as can the distribution, availability, and productivity of critical resources within a patch. When this happens, the net foraging return may actually de-

crease, in part because the ''easy prey'' (meaning those resources most readily procured with relatively high return rates) broadens the diet breadth to include more expensive items (Broughton, 1999; Kennett, 2005: 33) or because of additional technological innovation. As Bird and O'Connell (2006: 153) have noted, ''all else equal, archaeological indications of increased investment in handling technology can be read as evidence of greater diet breadth.''

In agricultural societies, highly localized populations can improve habitat conditions, at least temporarily, by investing in horticultural effort (clearing, irrigating, etc). But in coastal settings, highly localized populations typically degrade their immediate environment, ultimately lowering net return rates (Kennett, 2005: 234). As aboriginal population increased on St. Catherines Island and the first-tier landscapes filled up, foragers doubtless intensified their provisioning strategies, attempting to increase the total productivity of a given resource patch. As a density-dependent process, such intensification means that foraging efficiency can be expected to decrease as human population increases.

For the Sea Island context, we hypothesize that habitat improvement took place in proportion to increasing human population. Some of these improvements—such as cultivating oyster beds and enhancing maritime forest yields of mast—would have improved net return rates without degrading the environment. But other, more technologically-based investments, such as construction of improved fish weirs and traps, could indeed degrade environmental conditions (at least temporarily), and one would expect an attendant lowering of net return rates.

This trend is evident in the Big Fish indices, which peaked during the Refuge, Deptford, and Wilmington periods, then declined markedly thereafter, especially during the St. Catherines period (figs. 31.14 and 31.15). The relative frequency of ''big fish''—those taxa with an average weight greater than 1.0 kg—decreased significantly after cal A.D. 800 (the beginning of the St. Catherines period). These findings are consistent with the diet-breadth projection that through time, the highest ranked taxa should be harvested disproportionately, thereby stimulating an expansion in diet breadth as foragers turned to lower ranking taxa. This is precisely what happened within the saltwater fishing hunt type on St. Catherines Island, where the human presence exerted a significantly negative impact on the nearshore marine ecosystem.[7]

CONCLUSIONS AND IMPLICATIONS

Writing about the ''Mississippian transformation,'' Charles Hudson (1990: 58) has predicted that ''within the geographic area where corn horticulture came to be practiced, certain traits should have appeared seriatim: (1) first corn horticulture, then (2) dependency on corn, then (3) organization into chiefdoms, and finally (4) the elaboration of symbols of hierarchical status, including the construction of substructure mounds.''

A different sequence transpired on St. Catherines Island. We believe that institutional, hereditary social inequality arose on St. Catherines Island sometimes shortly after cal A.D. 800. Although population growth is commonly viewed as an unintended consequence of sedentism and agricultural productivity (e.g., Marcus and Flannery, 1996: 238), the development of social complexity on St. Catherines Island apparently took place several centuries prior to the reliance on maize cultivation. Similar trajectories are known among other complex foraging populations, especially those living in coastal environments (Yesner, 1980; Erlandson, 2001; Kennett, 2005).

This is a tale of localized population aggregation, economic intensification, and territorial circumscription, played out in extraordinarily rich, diverse, and highly predictable habitat (e.g., Hayden, 1981; Blake and Clark, 1999; Kennett et al., in press). Because of the unique confluence of sea levels past and present, three enormously productive ecosystems—the marine, littoral, and maritime forest habitats—are juxtaposed in immediate proximity to one another, coexisting side by side as accident of

maritime geomorphology. Unlike most open-ocean barrier islands, the closely spaced habitats of St. Catherines Island environment exacted relatively modest terrestrial transport costs and encouraged the extensive use of watercraft; the effective foraging radius was minimal, meaning that a strategy of low residential mobility was extremely cost effective.

Because some of the archaeological specifics from St. Catherines Island remain somewhat fuzzy at this stage of research, we cannot tell if the emergence of heritable social inequity necessarily signals the presence of full-blown chiefdoms. In his classic definition of chiefdoms, Carneiro (1981: 53–54; see also chap. 12, this volume) isolated four key archaeological correlates:

Correlate 1. Monumental Architecture: Although the presence of monumental architecture can distinguish the archaeological remains of chiefdoms from those of autonomous villages, not all chiefdoms constructed such monuments (Carneiro, 1981: 53). With the exception of the Irene Mound complex, monumental architecture is lacking along the Georgia Bight, and since the ethnohistoric evidence confirms the presence of chiefdoms among the contact-period Guale, Carneiro's first correlate does not seem applicable to coastal Georgia (see also Worth, 1998: 14).

Correlate 2. Ceremonial Centers: Seeking an archaeological diagnostic for the loss of village autonomy, Carneiro (1981: 53) noted that chiefdoms typically construct a few spatially-discrete ceremonial centers. Because such centers are fewer in number than the villages they ostensibly served, this pattern suggests that the individual villages were politically unified (Carneiro, 1981: 53). One can, perhaps, make a case for two distinct ceremonial centers dominating the cultural landscape of St. Catherines Island during the period cal 1000 B.C.–A.D. 800. The Seaside Mound group overlooks the southern-most remnant of Guale Marsh (now the northern extent of Seaside Inlet). This is a preeminent central place, in the sense of human behavioral ecology. It is situated on ancient Pleistocene soils, along the extreme eastern margin of the mature maritime forest, and within a few hundred meters is the expanse of the inland marshland. The Cunningham Mound group exists about 5 km to the southwest. The two centers are contemporary, but the settlement position is vastly different. Whereas the Seaside Mounds were erected within an optimally positioned central place, the Cunningham Mound occurs well inland, within the hickory ridges of the Pleistocene core, but somewhat removed from the salt marshlands. But until we understand something about the nature of the contemporary village sites associated with these centers, the evidence from St. Catherines Island remains equivocal.

Correlate 3. A Settlement Hierarchy Reflecting the Structural Differentiation of Settlement Types: Carneiro (1981: 45) positioned the chiefdom "as an autonomous political unit comprising a number of villages under the permanent control of a paramount chief." To identify an archaeological chiefdom, then, one must demonstrate both (a) the emergence of inherited rank and (b) provide evidence for the loss of village autonomy (Marcus and Flannery, 1996: 93). Based on the research design employed here, we can address the first issue, but not the second. Archaeological data generated from the Island-wide survey strategies are entirely inadequate for identifying regional settlement hierarchies and establishing interrelationships at the community/village level. We are presently unable to characterize the hundreds of archaeological components identified in the Island-wide survey in terms of conventional community-based categories (such as single-family farmsteads, hamlets and villages, and a range of special-function sites).

Correlate 4. Mortuary Patterning that Reflects Status Differentiation: The intensive program of bioarchaeology on St. Catherines Island clearly documents the development of heritable social inequality (ranking) during the St. Catherines period (cal A.D. 800–1300).

Although inequality exists in all societies—based typically on gender, age, charisma, and achievement—the hierarchial society of the St. Catherines period, like many

others in coastal settings, was probably characterized by social status ascribed at birth (almost certainly reckoned as genealogical distance from a single noble ancestor), by permanent leadership apart from (and imposed upon) kin-based structures, and the ability to secure the labor of increasing numbers of non-kin for various communal activities (Arnold, 1993, 1996, 2000). The complex foragers of St. Catherines Island likely also had a high degree of status competition and rivalry, formation of restricted-access information-sharing groups, notions of kin-group land tenure, intragroup variation in frequency/quantity of sharing, and bias in targeting recipients of shared resources (see Kelly 1995: 161–203 for a review).

This discussion has emphasized the role of the self-interested individual, meaning that the institutionalization of social inequity was not necessarily the inevitable outcome of population growth, circumscription, and/or external threat, but rather the result of individual decision making, probably conducted within an ''atmosphere of intense competition among ambitious leaders, who had previously possessed no way of bequeathing their achieved power to their offspring'' (Marcus and Flannery, 1996: 240; see also Spencer, 1993). Although all St. Catherines Islanders descended from the same cultural tradition, sharp divisions separated their outlook, their interests, and their respective fitness benefits.

It also seems likely that some such leaders attributed their extraordinary success to support from the supernatural. How else to explain such success within an egalitarian framework? Gradually, there arose a belief that the best leaders actually *descended* from those supernatural forces. The dominants, a small and privileged chiefly class, probably flauted a certifiable genealogical relationship to the reigning matrilineage and attempted to monopolize the input from the supernaturals (who exerted life/death power over villagers). Over the generations, the fiction arose that the distinguished ancestors and their immediate elite offspring were qualified to lead—and the

more distant relatives were destined to follow. Lesser positions within the dominant elite likely varied with the genealogical distance to the elite leader.

Certain members of the emerging elite could acquire greater status and wealth by several strategies by manipulating social, economic, and political relationships to their benefit (Earle, 1987), by controlling the flow of cultural items that signal status (Flannery 1972), by monopolizing the labor of others (Arnold, 1993), and by creating ideologies that justify the inequitable uneven distribution of wealth and power (Earle, 1987; Marcus and Flannery, 1996). For their part, dominants realize the benefits of controlling and redistributing food resources, extracting their own fitness-related benefit in increasingly disproportionate amounts. They probably maintained a large-scale, multi-island perspective and traveled extensively to conduct war, diplomacy, ritual, and participate in complex, rank-enhancing marriage alliances. Caciques held important offices in the political and religious hierarchies in Guale, but whether they ruled over a number of districts remains to be established archaeologically. High-ranking individuals in such hierarchical societies clearly received more tangible social, political, and economic advantages, with average per capita rewards likely exceeding those of individuals living apart from the larger group.

The subordinates supported themselves through the products of the land and sea. They also provided virtually all the subsistence and luxury goods for the elite, and the labor necessary to tend the chiefly fish wiers, harvest and process the chiefly oysters, hickory nuts, and acorns, build and paddle the chiefly canoes, and wage war against the chiefly enemies. In short, the commoners supplied the labor, produced the chiefly wealth, and in the case of the conscripted draft, risked dying in chiefly warfare.

Why should a majority submit to the wishes of those who seek to subordinate and exploit (Boone, 1992; Arnold, 2001)? Assuming rationale and self-interest in behavior, one expects that interest-based indi-

viduals would chose to live in such large groups only when net payoff for doing so exceeds the rewards of living in smaller, more dispersed groups.

The biogeographic and ecological specifics condition both the costs of relocating and the benefits of remaining with the natal group, defining an endurance threshold after which subordinates are likely to bud off into new settlements. Because subordinates have built the council houses and granaries, collected and rendered the hickory nut and acorn oil, built and maintained the fish weirs, and cultivated the oyster beds, they enjoy the consumption of more food over longer periods of time, despite the "rake-off" by dominants (Bird and O'Connell, 2006: 169). Add to this the cost of relocating and the lack of unoccupied territories and even the self-interested, disadvantaged surbordinates individuals might benefit from such heritable inequality (Arnold, 2001).

One final point emerges here. The rise of inherited assymetry on St. Catherines Island apparently took place in the absence of significant maize cultivation. Life on St. Catherines Island could, perhaps, have remained stable, in its A.D. 1200 form, until the arrival of the French and Spanish explorers. St. Catherines Islanders were not necessarily on a trajectory pushing them to become farmers (Arnold, 1996: 83–84; Marcus and Flannery, 1996: 239).

So one must ask: What was the relevance, if any, of maize cultivation to these complex, hierarchically organized foragers who are already living in settled village communities? This fundamental question bring us back to the so-called "Guale problem" that framed the initial archaeological inquiry into the aboriginal landscape of St. Catherines Island, and this is subject of the last chapter in this volume.

NOTES

1. Virtually no marine shell middens accumulated on St. Catherines Island between cal 1350 B.C. and 350 B.C., likely due to lowered sea level that undermined marsh productivity and triggered a significant settlement shift on the island. The Island-wide survey identified a limited Refuge period presence (mostly in non-shell contexts), and it is likely that submerged Refuge sites remain undetected. Although the Refuge period spans about 650 years, virtually all of the demonstrable mortuary activities transpired during cal 600–750 B.C. Occupational middens are virtually absent during the Refuge period, and none are contemporary with the mortuary activity. A human cremation was interred at Cunningham Mound C and we have no evidence of mound building on St. Catherines Island prior to cal 350 B.C. A distinctive gap in radiocarbon record toward the end of the Refuge period may indicate an abandonment of St. Catherines Island, after which five statistically identical ^{14}C dates (from five different burial mounds) cluster at cal 360–120 B.C. (fig. 32.5). Statistically simultaneous burning and marine shell harvesting took place throughout the various mortuary contexts within the Cunningham Mound group. The occupation of Hayes Island (at cal 400 B.C.–80 B.C.), a low-lying (and partially flooded) shell midden along the southern extent of the Walburg Scarp, signals the resurgence of marshside settlements along the western scarp of St. Catherine Island. Several slightly later middens also accumulated along the western island margin (probably reflecting the rising sea level during the early Deptford period). Although these settlements overlap temporally with the mortuary activities at the McLeod and Seaside Mounds, no eastern (Guale) marshside settlements can be documented between cal 1050 B.C. and cal A.D. 50—such deposits are now submerged or, more likely, eroded away entirely with the disappearance of Guale Island. Nothing in the available radiocarbon evidence suggests that actual mound building had commenced anywhere on St. Catherines Island by cal 360–120 B.C.

2. In general, when residential mobility is reduced, logistical mobility should increase, and the various interations of these residential strategies have significant ecological and social consequences (Kelly, 1980, 1983, 1995: 117–120; Binford, 1980, 1982; Thomas, 1981, 1983; Anderson, 1996; Ames, 2002: 34–35; Barlow and Heck, 2002: 140–141; Habu and Fitzhugh, 2002). In this monograph, we have relied on the prey-choice model to project resource choice decisions within a particular patch, once somebody has chosen to forage there (chaps. 6–9). To anticipate the decisions regarding where a forager might elect to work on a given day, we switched models, from prey choice to patch choice. Taken together, these two models project that the patch breadth for St. Catherines Island foragers should include four basic habitat types, with the salt marsh always being the highest ranking patch, with the maritime forest second, well ahead of the sandy beach and the ocean front. The energetic ranking of these patch types appears to be relatively stable, even in the face of shifting diet breadth. The central place model further projects that foragers will establish settlements to ameliorate transport costs in a way that maximizes the mean return rates at a central place. But Sanger (1996) and Kellogg (1994) have demonstrated that factors other than food resources have dictated settlement choice along the coast of central Maine. In the prehistoric coastal settlement pattern of the Boothbay region (Kellogg, 1994: 78), most sites are located within 100 m of the beach shoreline, generally in places protected from storm waves. In particular, shelter from wind and the

availability of a beach suitable for landing small water-craft were more important, as was proximity to travel routes. "It should be noted, however, that, with suitable boat technology, distance from camp to food source may not be as critical as it would be to pedestrian hunt-er-gatherers" (Sanger, 1996: 517). This settlement pat-tern reflects an adaptation to the use of small boats along the coast, where the primary concern is access between the terrestrial and marine environments.

3. Even given the possibility of short-term island abandonment during the Refuge-Deptford interval, the number of archaeological components and occupa-tions/century doubled over that from the preceding St. Simons period. Then, during the succeeding Wilming-ton period, that number doubles once again (to 2.74 components/century) as the number of western marsh-side settlements increase dramatically (likely due to the demise of Guale Marsh).

4. Figure 16.20 plots the probability distribution of the radiocarbon dates recovered from midden contents for the cal A.D. 1–A.D. 1000. The frequency distribution of marine dates increases gradually during this interval, and no gaps in the radiocarbon record are evident at the two-sigma level. But a very different story pertains to the timing of mortuary events during the Wilmington period. Figure 32.7 presented the probability distribu-tion of the roughly 17 radiocarbon dates reflecting the two distinct flurries of mound construction activities between cal A.D. 1 and cal A.D. 1000 on St. Catherines Island. Following another hiatus of perhaps 2 or 3 cen-turies, five ^{14}C dates from four mounds in the Cunning-ham group define a pooled age of cal A.D. 80–230. Nu-merous radiocarbon determinations from several shell middens document the late Deptford period occupa-tion, and several of these sites are located near the Cun-ningham burial mound group. A significant gap in ra-diocarbon record separates the Deptford and Wilmington periods (about cal A.D. 350), a hiatus prob-ably reflecting cessation of both shell midden accumu-lation and mortuary activities. Then, after this flurry of mortuary activity during the late Deptford period (cal

A.D. 80–230), a second spike in mortuary ^{14}C evidence activity is evident during the mid-Wilmington period (circa cal A.D. 490–A.D. 770). This cluster of 10 mortuary dates indicates that by cal A.D. 540–660, additional buri-al mounds stood at Seaside I and Cunningham C, McLeod Mound was erected sometime after cal A.D. 540–670, and the premound surface was burned at Cunningham Mounds D and E (but we cannot conclu-sively demonstrate any specific mortuary behavior or mound building at either site). During this interval, in-trusive burials were added to existing mounds in the Seaside and Cunningham Mound groups, and two ad-ditional mounds were constructed in the Cunningham Mound group. The available evidence suggests a con-tinuation of the pattern already well established for the Deptford period, namely the burial of mostly adult in-dividuals, the preponderance of female burials, the ab-sence of specific grave furniture, and continued usage of well-defined cemeteries and mounds.

5. The three known St. Catherines period burial mounds—Johns Mound, Marys Mound, and South End Mound II—share a standardize architectural plan. Each mound contains a central pit feature with multiple human burials (a large proportion of whom are suba-dults), covered by a thick oyster shell cap during the St. Catherines period. The central features at Johns and Marys Mounds were log-line pentagonal pits (and that at South End Mound II, while conspicuous, was not sufficiently well preserved to define the mode of con-struction). All of the known mortuary activity during the St. Catherines period took place (statistically speak-ing) during exactly the same interval (cal A.D. 1040–1230).

6. We must emphasize that we are presently testing this hypothesis by processing another series of stable isotope studies to provide more complete information about the timing and intensity of maize cultivation on St. Catherines Island.

7. This was not the case within the terrestrial hunt-ing type, in which the high-ranking white-tailed deer populations seem to prosper despite hunting pressure.

CHAPTER 35. THE ''GUALE PROBLEM'' REVISITED: FARMING AND FORAGING ON ST. CATHERINES ISLAND (CAL A.D. 1300–1580)

DAVID HURST THOMAS

When compared with the populous Mississippian agricultural chiefdoms of the interior Southeast, coastal groups such as the Guale … seem remarkably underwhelming in many ways. … [T]oday armchair history buffs commonly take it for granted that the Guale were principally transhumant hunter-gatherers who resided in the barrier islands only long enough to exploit the rich estuarine and marine resources before moving back to the interior (Worth, 1999).

The two previous chapters summarized the current thinking about the complex social and environmental landscapes of St. Catherines Island over the past 5000 years. But one piece of unfinished business remains.

This concluding chapter revisits the so-called Guale Problem, highlighting the conflicting ethnohistorical interpretations that provided the catalyst that stimulated the 3 decades of archaeological research synthesized here.

WHAT'S THE GUALE PROBLEM?

This volume is dedicated to Lewis Larson, whose monumental contributions to the archaeology of coastal Georgia informed this project from the start (Larson, 1969, 1980a; see also chap. 11, this volume). Drawing from Swanton's (1922) overarching synthesis, Larson dissected the environmental potential for cultural and social development along the Georgia Bight, concluding that only a highly dispersed, seasonally mobile population could have survived along the Georgia coastline during late prehistoric times. Larson (1980a: 221) contrasted the coastal Guale with the Apalachee people of panhandle Florida, concluding that whereas maize cultivation may have been practiced along the prehistoric Georgia coastline, "its importance seems to have been slight. … The Guale were a coastal people whose economy was centered on the tidal waters where they derived a subsistence from fishing. Agriculture and hunting were of relatively minor importance" (Larson, 1978: 122, 137; see also Larson 1980a: 221).

Particularly critical to Larson's views were the ethnohistorical documents from the central Georgia Bight—specifically that sector running from Port Royal Sound (South Carolina), southward along the entire Georgia coastline, to the mouth of the St. Johns River (Florida). This was the homeland of the Orista (and later Escamazu) chiefdoms of South Carolina, the Guale chiefdom in coastal Georgia, and three important Mocamo chiefdoms (of Saturiwa, Tacatacuru, and Guadalquini) to the south (Jones, 1978; Worth, 2004). After several brief and sporadic contacts during the early 16th century, the 1560s brought the first sustained European contact to the area.

In 1562 and 1564, the French established two colonial forts (Charles Fort and Fort Carolina) at opposite ends of the central Georgia Bight. Each fort was occupied for about a year, and the subsequent Spanish towns of St. Augustine and especially Santa Elena—in roughly the same territory—continued an even more significant contact with local Indian populations after 1565. Following a brief period of Jesuit mission activity (in 1569–1570), the Franciscans launched a more sustained effort in 1574–1575. But Mocamo was not truly missionized until 1587, and the major Guale missions were established in 1595–1605 (Jones, 1978; Worth, 1998, 2004, 2007).

Larson (1969: 293–297) relied heavily on documentary accounts by Fr. Jean Rogel at Orista (Sturtevant, 1964: 170), Fr. Antonio Sedeño (who described coastal Georgia as "the most miserable thing ever discovered" (Zubillaga, 1946: 424), and René Laudoniére (Bennett, 1975: 121), who recorded similar impressions in 1564 at Outina (a Timucuan settlement located just west of the St. Johns

River in northeastern Florida (see Worth, 1998: 21). These (and other) accounts convinced Larson (1980a: 209, 218) that the infertile and patchy soils of coastal Georgia were "the primary reason for the scattered and small size of the agricultural production unit" and he concluded that along the Guale coast "permanent settlements were not the rule, for long seasonal junkets in pursuit of game mitigated against a settled populace" (Larson, 1978: 122; see also 1969: 293–297, 1980a: 206–209). Despite some modifications in the mid-1980s (addressed in chap. 11), Larson's perspectives on Guale subsistence and settlement have been accepted and amplified by a number of investigators (esp. Crook, 1984, 1986; see also Wallace 1975: 265–271; Pearson 1977a: 62–63; Reitz and Scarry 1985: 46; Reitz 1988a).

Analyzing these same documentary sources, ethnohistorian Grant Jones (1978, 1980) proposed an alternative view of late prehistoric settlement and subsistence patterns along the Georgia coast: "On the empirical level I believe that [the conventional wisdom] has led to an overstatement of the isolation of the Guale from the interior, the unproductivity of Guale horticulture, and the scattered quality of Guale settlements" (Jones, 1978: 189). Jones (1978: 179, 191) concluded that the Jesuit reports deliberately exaggerated the "misery" of the land, and argued instead that the contact-period Guale people displayed all the essential features of the classic chiefdom, including payment of tribute, military federations, matrilineality, and dual social organization.

These are vastly different interpretations of the ethnohistoric record for the Georgia coastline, and the so-called "Guale problem" became the central research question driving the archaeological research presented here (Thomas, 1987: 57–64, 1993: 46–55; see also Worth, 1999; Saunders, 2000b; Ruhl, 2003: 188–189; Keene, 2004: 672; chap. 11, this volume).

RESIDENTIAL MOBILITY DURING THE LATE PREHISTORIC PERIOD

The Guale problem turns on the twin issues of residential mobility and economic intensification. Although the details have blurred somewhat with the various restatements, the Larson and Jones reconstructions of Guale subsistence and settlement pattern provide a solid point of departure for understanding the archaeology of St. Catherines Island and beyond. Chapter 11 modeled the contrasting views of residential mobility and agricultural intensification among the late prehistoric and early contact period Guale people (esp. table 11.6). This section explores the theoretical, archaeological, and ethnohistoric evidence relevant to the issue of residential mobility.

THE ETHNOHISTORY OF RESIDENTIAL MOBILITY ON THE GEORGIA COAST

The earliest ethnohistorical sources suggest a pattern of considerable residential mobility and seasonal dispersal for the aboriginal people of the central Georgia Bight. Laudoniére's 1564 account suggested that "the Indians [of Outina, at the mouth of the St. Johns River] are accustomed to leave their houses and retire into the woods for a space of three months, namely January, February, and March, during which time you do not see an Indian anywhere, because during this time they only hunt game and live in little cabins in the woods" (Bennett, 1975: 121). Stationed at Orista (in present-day South Carolina) in the late 1560s, Fr. Juan Rogel claimed that "for nine out of the twelve months they wander without any fixed abode" (Zubillaga, 1946, as translated in Sturtevant 1964: 172–173; see also chap. 11, this volume). Similarly, Fr. Sedeño, recalling his experiences in coastal Georgia, wrote "that the few [Guale] Indians that there are so scattered; for as they have nothing with which to fell the forest for their plantings, they go where they can find a little land without woods to sow their maize; and as the land is so miserable, they move with their *ranchos* from time to time in search of other lands which can bear fruit" (Zubillaga, 1946: 424).

Following Larson's acceptance of this evidence as indicative of a long-term, high residential mobility, Crook (1986: 17–20, fig. 2, 2004; see also Crook, 1984: 260,

1986: 18–20; Larson, 1980a; fig. 11.1, this volume) proposed a *"purely aboriginal" fission-fusion settlement model for the precontact Guale people.* Crook defined the Guale wintertime settlement (mid-December through mid-March) as "minimal settlements" consisting of a single matrilineage, dispersed "adjacent to tidal streams which permitted access to the estuarine system" (1986: 22). In this interpretation, the Guale dispersed still further in the springtime into nuclear family settlements spread throughout the oak forest, located near swidden plots of maize, beans, and squash. In this "Annual Model," the Guale "resided in towns from the first part of July until the middle of September when they dispersed to gather nuts" (Crook 1986: 20), after which they once again dispersed, probably into a "matrilineage segment with four or five nuclear families forming the social core," several related families living together in dispersed settlements located throughout the oak forest, subsisting on acorns, hickory nuts, and communal deer hunts, with occasional aggregation for feasting (Crook, 1986: 21). Fall settlements were basically chiefly compounds "defined by towns composed of temporary and changing populations, as opposed to the seasonally stable population of the summer towns." Crook (1986: 53) summarized his "Annual Model" as consisting of "large villages primarily occupied during the summer, smaller settlements occupied either multi-seasonally or during the fall–winter season, and small sites occupied for very short periods of time do exist" (see also table 11.6).

This interpretation portrays the precontact Guale people as part-time "collectors," sometimes living in a residential base ("aggregate town site") situated near the swidden corn fields (Crook, 1986, 2004). Such a settlement pattern should produce archaeological evidence of both four-season and seasonally-specific settlements. The heaviest occupations should occur during the summer, with a dispersed series of archaeological accumulations during the early fall, followed by moderate occupational intensity from the late fall through winter. From the fall through springtime, the Guale were residentially mobile foragers who should have produced an archaeological record of (1) dispersed oak forest settlements (fall and springtime occupations only) and (2) dispersed marshside settlements (late fall–winter and springtime occupations only).

Grant Jones (1978: 179, 191, 194, 200, 1980) argued that the Jesuit reports were deliberately exaggerated to distort the poverty of the coastal landscape (and justify their failure to missionize the area) and proposed instead that the Guale lived in "dispersed towns" near the forest–marsh margin, with the "bulk of the population … probably distributed among individual farm plots." Although Fr. Rogel reported that the Guale dispersed seasonally to gather acorns, Jones (1978: 193) questioned the necessity of abandoning the dispersed towns simply to harvest the mast. Citing Robert Sandford's 1666 account for the North Edisto River (South Carolina; Sandford, 1911), Jones also suggested that concentrations of oysters were so close to the maize fields "that the beds could be exploited without seasonal shifts in residence" and concluded that "the location of Guale settlements along rivers and tidal creeks seems to have actually been a strategic measure to be near shellfish, hunting grounds, and horticultural lands without having to change residence seasonally" (Jones, 1978: 193).

Grant Jones was, in effect, proposing a *"collector" strategy of low residential mobility* centered on the "dispersed towns" positioned in the "forest–marsh area" (Jones, 1978: 193–194; see chap. 11, this volume). Whereas "some Guale possibly changed their winter residence in order to be nearer hunting, fishing, or shellfish collecting grounds; most individuals apparently maintained permanent residence in a single community. Trips for the purpose of hunting, fishing or collecting wood undoubtedly took individuals away from the community on a temporary basis. Guale settlements were located primarily along the banks of rivers and tidal creeks, in a pattern that seems to indicate a strategy of being simultaneously near shellfish, hunting grounds,

and horticultural lands'' (Jones, 1980: 220). In this passage, Jones describes a classic ''collector'' strategy involving large, relatively stable residential central places, out of which logistical forays of small ''task groups'' brought plants and animals back home. Such a strategy of minimal residential mobility should produce a distinctive archaeological record, characterized by sustained, four-seasonal occupation of *marshside* settlements, with only minimal evidence of single- or biseasonal occupations elsewhere.

ARCHAEOLOGICAL EVIDENCE OF RESIDENTIAL MOBILITY DURING THE IRENE PERIOD

We have already summarized the implications of human behavioral ecology with respect to the aboriginal landscape of St. Catherines Island. The upshot is simple and conclusive: Optimal foraging considerations strongly militate in favor of logistical, rather than residential mobility. Even factoring in the shifting shape of St. Catherines Island over the past 5 millennia, it is clear that all habitats on the island could have been systematically searched and exploited by individual foragers who could easily return home daily. These biogeographic constraints suggest that St. Catherines Island foragers could usually have pursued a strategy of logistic procurement and low residential mobility (at least during times of relatively favorable climatic conditions).

Chapters 32–34 summarized evidence from the Island-wide archaeological survey relative to residential mobility and population increase between cal 3000 B.C. and A.D. 1300 on St. Catherines Island. These data demonstrate (1) an exponential increase in human population through time, and (2) a low degree of residential mobility throughout the entire aboriginal period. This pattern continued through the late prehistoric (Irene) period, characterized by the largest and most frequent archaeological occupations recorded in the Island-wide survey. Irene occupations accumulated at an extremely rapid rate (34 occupations/ century) and the number of recorded ar-

chaeological components skyrocketed to 52 (for an average of 17.33 components/ century; table 30.1). This is, by far, the densest concentration of archaeological remains recorded for any aboriginal period on St. Catherines Island. The Irene period also had the largest proportion of ''large'' sites and the smallest proportion of ''small'' sites (per the definitions in Table 30.2) recorded during the probabilistic survey.

The central place foraging model of Sea Island settlements (developed in chap. 11) was specifically designed to address the environmental specifics of the Irene period, and the fit between expected and observed distributions is excellent. During the cal A.D. 1300–1580 interval, a few additional Holocene beach ridges accumulated along the southern margin of the island, and these second-tier habitats were intensively utilized during the Irene period (with 13 archaeological components and 14 occupations recorded during the Island-wide archaeological survey). This is the most intensive utilization of second-tier habitat recorded on St. Catherines Island (suggesting extreme social and/or environmental circumscription).

Seasonality estimates are available for 42 Irene-period components (representing 124 seasonally-specific occupations). More than 40 percent of these Irene components were four-season occupations, and another 36 percent were occupied in three seasons. Conversely, only four Irene components represented a single season (each of these being a winter-only occupation). Throughout the Island-wide survey of St. Catherines Island, we found that inland components were fairly rare during all time periods, and this is especially true for late prehistoric (Irene) occupations.

Throughout this discussion, we have cautioned against equating a four-season archaeological occupation with ''sedentism'' (in the conventional ethnographic and ethnohistorical usage). To repeat: The available archaeological evidence does not permit the conclusion that Irene populations were sedentary (although we certainly believe that such was the case). But sticking to the documented archaeological specifics,

the data regarding site seasonality are conclusive: (1) Single-season sites are extremely rare during Irene times (as they are rare throughout the entire aboriginal period on St. Catherines Island) and (2) three-quarters of the known Irene components on St. Catherines Island were occupied during three or more seasons.

Relative to the archaeological implications set out in Table 11.6, then, we conclude that the vast preponderance of archaeological evidence supports a collector strategy of low residential mobility. For most of the time, Irene populations apparently lived, year round in dispersed towns located along the forest–marsh margin (per Jones, 1978: 193–194). Expressed in terms of expectations from central place foraging theory, more than 80 percent of the archaeological components encountered on St. Catherines Island (for *all* temporal periods), fit the model of sustained and multiseasonal *marshside* settlements. Only limited evidence exists for (1) single or biseasonal occupations or (2) inland, special-purpose, short-term settlements.

LATE PREHISTORIC MAIZE CULTIVATION ON THE GEORGIA COAST: FACT OR FANCY?

Contrasting the coastal Guale with the Apalachee of western Florida, Larson (1980a: 221) concluded that whereas maize cultivation might have been practiced along the prehistoric Georgia coast, "its importance seems to have been slight" (Larson, 1978: 122, 137; see also Larson 1980a: 221). Reading this same documentation, Grant Jones (1978: 179) concluded that "Guale horticulture … was sufficiently productive, in combination with other subsistence and productive activities, to account for the presence of permanent towns, a chiefdom level of social organization, temporary federations of chiefdoms under centralized leadership, and long distance trade networks."

This section explores the relevant archaeological and ethnohistoric evidence regarding maize cultivation along the Georgia Bight.

ARCHAEOLOGICAL EVIDENCE FOR MAIZE CULTIVATION DURING THE IRENE PERIOD

Archaeological research on St. Catherines Island produced little direct evidence of maize cultivation because the research design did not adequately sample the paleobotanical record. We did recover charred corn cobs at Fallen Tree (chap. 26) and during the excavation of Mission Santa Catalina de Guale, but presumably all these finds date to the Altamaha period (Ruhl, 1990, 1993, 2003).

The bioarchaeological record from St. Catherines Island provides no convincing evidence of maize consumption prior to cal A.D. 1300 (chaps. 11, 24, and 32; see also Schoeninger et al., 1990; Larsen and Thomas, 1982: 327–329). A significant increase in δ^{13}C stable isotope values suggests the presence of maize cultivation during the Irene period, and this evidence is supported by a contemporary increase in dental caries and periosteal lesions. But we previously cautioned about the small size of the St. Catherines Island samples and the fact that these results depend heavily on comparisons from the Irene Mound, at the mouth of the Savannah River (Larsen, 2002: 64; Reitz et al., 2002: 45).[1]

REVISITING THE ETHNOHISTORY OF ABORIGINAL MAIZE CULTIVATION ON THE GEORGIA COAST

The bioarchaeological evidence meshes neatly with John Worth's (1999) recent ethnohistorical research on the same topic.[2] The Laudoniére account from Fort Caroline leaves little doubt that the native people of the Georgia Bight were intimately familiar with the details of growing corn: These people knew precisely when to plant, how to judge crop maturation across variable habitation conditions, and when to harvest each locality. The earliest European colonists commented on the extensive agricultural fields already in operation and quickly adopted the long-standing Native American scorched-earth policy of burning the enemy's corn fields.[3] It is clear that during the 1560s (the timing of initial, sustained European contact in the area), the

Guale—and the neighboring coastal chiefdoms—were already storing away an ample surplus of maize and other agricultural products. This surplus was sufficient to barter (or give away) substantial quantities of provisions to the newly arrived European colonists, while simultaneously holding back sufficient seed corn for the next planting season and saving enough surplus corn to finance chiefly negotiations for political purposes.

The early French and Spanish sources also document a high degree of agricultural productivity throughout the mission period, demonstrating (at a minimum) that "the soils around these comparatively nucleated mission villages were in fact perfectly capable of producing substantial agricultural harvests each and every year" (Worth, 1999). In fact, the Pleistocene-age soils of the Georgia Bight seem to be rather well suited for indigenous maize cultivation using shifting cultivation and other specialized techniques in the precontact period.[4] Milanich (1999: 146) suggests that basic aboriginal slash-and-burn cultivation continued unchanged into the mission period, and Worth (1999) concludes that "annual corn crops and the fields used to produce them were very important resources for coastal chiefs … [and] the coastal Guale and Orista-Escamazu were behaving very much like sedentary agricultural chiefdoms" long before the Europeans had a chance to introduce their own agricultural techniques.

Even during the initial mission period, the Guale and Mocamo chiefdoms contributed a significant annual tribute of maize (despite the alleged poor and patchy soil conditions). As time passed, not only did the caciques of coastal Georgia continue to pay their tribute to the Crown (which eventually would double from earlier levels), but their slash-and-burn technology was routinely capable of producing tens of thousands of pounds of maize for barter to the Spanish ships that frequently called for fresh water and provisions.[5] The documents further verify that during the mission period "a combined labor force of probably only a few hundred men and women were able to produce not only enough corn to supply their own families and lineages, in addition to those of the chiefs and their noble relatives and other public officials such as the local missionary, but they were also able to produce tens of thousands of pounds of additional corn for barter to Spanish ships" (Worth, 1999).[6]

The combined archaeological and ethnohistoric evidence confirms Grant Jones' (1978: 179) interpretation of Guale horticulture. The aboriginal people of the Georgia Bight cultivated maize in considerable quantity during the late prehistoric and early historic periods.[7]

WHY DID THE GUALE DECIDE TO GROW CORN?

Since we now understand that the Guale did indeed grow considerable quantities of corn during the last prehistoric period, it seems worthwhile to explore why these complex foragers elected to include maize in their diet.

Traditional views of maize cultivation in the American Southeast (e.g., Griffin, 1967: 189; Hudson, 1976: 288–289, 1990: 53–55) assume that as increasing labor is invested in maize farming, greater harvest yields will inevitably result. While this is sometimes true, Barlow (2002, 2006) found no significant relationship between increased investments in field time and the average maize yields per field, suggesting that factors other than the abundance of maize at harvest time may well condition the decision to invest in agricultural activities.

MAIZE CULTIVATION AND HUMAN BEHAVIORAL ECOLOGY

In approaching the Guale problem, we are well aware of Barlow's warning that "maize farming should be viewed not as a transition from 'being' a forager to 'being' a farmer, but as the outcome of a series of foraging decisions made at various points throughout the growing season" (Barlow, 2006: 97; see also Bettinger, 2006: 312–314, 316–317; Tucker, 2006: 24; chap. 9, this volume). Approaching maize horticulture as a sequence of subsistence-related beha-

viors—analogous to hunting white-tailed deer, rendering "sweet oil" hickory nuts, or collecting hard clams—permits a focus on the self-interested individual's expectations of anticipated yield relative to expected costs. So viewed, individual foragers can be expected to weigh the options of investing time in a particular farming activity (such as preparing the patch, sowing the seeds, weeding the garden, and harvesting the ripened ears) against the expected returns from net energy gains available from (nonfarming) foraging pursuits (Barlow, 2006: 95; see also Gremillion, 1996; Winterhalder and Goland, 1997: 126).

Chapter 9 likewise took exception to the proposition that farming necessarily alleviates the uncertainties of foraging—providing leisure time and inevitably leading to cultural elaboration (as expressed in art, public architecture, public feasting, and so forth). From a strictly energetic perspective, the degree to which one forages and/or farms depends on the anticipated returns in food energy for each activity, meaning that the decision to cultivate (or not) is the outcome of sequential foraging decisions made throughout the growing season.

The long-term aggregate of such self-interested decisions determine whether an individual, a household, or a community pursued a "farming", a "foraging", or a "mixed" subsistence strategy for that given year. Farming investments should intensify whenever higher ranked foraging opportunities diminish, and cultivation should decrease when higher ranked foraging opportunities increase. This conclusion—to forage when you can and farm when you must—situates maize horticulture *not* as a cultural complex or all-encompassing lifestyle, but as an amalgam of individual economic behaviors of varied intensity and complexity, each depending entirely on the circumstances at hand.

This approach emphasizes the expected increases in projected harvest yields relative to present foraging opportunities—regardless of investments already made in the current agriculture cycle. As previously noted, springtime foraging opportunities are relatively constrained on St. Catherines Island,

largely restricted to hunting terrestrial mammals (at a time when white-tailed deer are fairly lean), harvesting mollusks and gastropods in the salt marsh, or taking smallish estuarine fish (chap. 9, this volume). With the last frost (generally mid-March), the new agricultural cycle begins and the immediate decision is whether to clear and plant a maize field or to continue foraging. Despite the uncertainties involved in future harvests, the springtime forager knows that if she elects not to plant a field, she will be locked out of the agricultural cycle for an entire year (so she might be expected to plant a maize crop, in anticipation of future harvests). Over the next several weeks, that same forager/farmer will face similar decisions about whether to forage or to weed that same maize field (again, in anticipation of expected yields). "Whether she invests time weeding," Barlow (2006: 96) points out, "should be strongly influenced by foraging opportunities at 'weeding time.'"

From the perspective of the self-interested individual, farming investments should intensify as higher ranked foraging opportunities are diminished, and farming activities should decrease when higher ranked foraging opportunities increase. This is also why—from a strictly energetic perspective—one can view maize cultivation as an amalgam of economic behaviors, dependent upon the circumstances at hand, rather than as a cultural complex or an all-encompassing lifestyle, to be embraced or rejected.

ENERGETICS OF MAIZE CULTIVATION

Prey- and patch-choice models provide one way of modeling the adoption of plant domestication (Keegan, 1986; Hawkes and O'Connell, 1992; Piperno and Pearsall, 1998; Gremillion, 2004; Kennett and Winterhalder, 2006; see also chap. 9, this volume). The St. Catherines Island research draws upon Barlow's (2002, 2006) estimated return rates for various traditional technologies from Chiapas, Mexico (Cancian, 1965), Panajachel, Guatemala (Tax, 1963), and the Upper Montaro Valley of Peru (Hastorf, 1993). In her analysis of these da-

ta, Barlow concluded that, overall, maize agriculture using simple hand tools produces a gross energetic gain of 300–1800 kcal/hr, with average maize harvesting of approximately 3–50 bushels/acre, but "there is no single, average field-investment strategy that typifies maize farming" (2002: 73). Figure 9.3 demonstrated the diminishing returns involved in maize cultivation, plotting the caloric return estimates (in kcal/hr) against the average annual maize harvest (in bushels/acre); the peak energetic yield for these Latin American ethnographic cases is about 1700–1800 kcal/hr—regardless of the volume of harvest yield.

Zinacatan slash-and-burn gardening (Cancien, 1965) seems to be an appropriate analog for modeling the maize cultivation observed along the Georgia Bight during the 1560s. A relatively low investment yields a net caloric return rate of about 1650 kcal/hr (even with yields as low as 12 bushels/acre), and this is the highest single energetic return among the modern full-time subsistence farmers studied in Latin America (Barlow, 2002: 74–75, 80; Piperno, 2006: 164). Such slash-and-burn horticulture, as commonly practiced in tropical lowland habitats (e.g., Kennett et al., 2006: 126), was almost certainly the predominant form of aboriginal horticulture practiced by the part-time forager–gardeners on St. Catherines Island, who probably worked the most arable soils (the Echaw–Foxworth–Centenary complex), clearing and burning the natural vegetation, then planting and eventually harvesting a maize crop without spending much effort on the fields during the growing season. This strategy of maize cultivation probably returned about 1100–1500 kcal/hr (for a 200 hr/acre investment).

We also modeled a less intensive "plant and harvest strategy" in which subsistence gardeners simply plant their maize kernels with a digging stick, without any field preparation at all (Barlow, 2002: 79; fig. 5). This strategy approximates returns realized by aboriginal horticulturalists planting the margins of island sloughs and freshwater ponds on St. Catherines Island (basically cultivating the poorly drained Rutledge

soils). Assuming planting costs of roughly 25 hr/acre and hand-harvesting time ranging from 20 to 28 hr/acre, this low-investment strategy should return an estimated net energetic gain of about 1300–1700 kg/hr (for a 2–5 bushels/acre yield).

The intensified agricultural system employed during the primary mission period in Spanish Florida—including the sabanas at Mission Santa Catalina de Guale—probably resembled the "typical Latin American" agricultural strategy, as practiced today in Chiapas, Guatemala, and Peru (Barlow, 2002: tables 2 and 3). Using traditional technology, typical farmers might have invested 30–50 person-days/acre, produced 2–50 bushels of maize, and returned an energetic rate of 300–1700 kcal/hr (depending on the yield at harvest and the intensity of field investment).

INTENSIFICATION AND MAIZE CULTIVATION

A variety of ecological, demographic, and cultural factors have been implicated to explain the adoption of food production technologies, including low residential mobility, social complexity (typically accompanied by a degree of social circumscription), abundant resources, a diet characterized by high resource diversity, sufficient population numbers to encourage resource intensification, a technology for using domesticates effectively, and a long period of availability of cultivated plants prior to the full-fledged emergence of agriculture (e.g., Price and Gebauer, 1995; Piperno and Pearsall, 1998: 321). Each of these factors, to one degree or another, seems to characterize the aboriginal population of St. Catherines Island during the post-A.D. 800 era.

St. Catherines Island foragers could have intensified a number of provisioning practices to increase post-encounter return rates (see Kelly, 1995: 78–90; Winterhalder and Goland, 1997: 128). They could improve harvest technology (such as fish nets, weirs, leisters, and poisons for fishing and firearms for procuring terrestrial prey), increase capacity for transporting harvested resources (such as light-weight containers, dugouts, and rafts), improve methods for

food processing (more efficient ways of cutting, cracking, grinding, better fuels, and better ways of cooking, such as improved heat transfer through better pottery), and reduce storage losses by storing in more efficient ways (for instance, smoking oysters and jerking venison). Any such change that increases the pursuit and handling efficiency of an unharvested resource above the marginal foraging efficiency could potentially move that item into the optimal set.

Given the documented increase in human population on St. Catherines Island, maize horticulture provided another option for intensification, to be weighed against short-term foraging options listed above. The availability of various wild food resources (and their respective post-encounter return rates) likely had a major impact on the decision to forage or to farm, as intensifying field efforts probably accompanied increasingly lower returns and lower overall economic success (Barlow, 2002: 75, figure 4). These lowered expectations reflect an apparent reality in moderate-to-rich agricultural settings; modern subsistence farmers in Latin America get better energetic returns when they minimize their agricultural investments. If so, then "intensification" can be expected to occur only in times of *decreased* energetic efficiency (that is, an overall broadening of diet breadth).

Human behavioral ecology suggests that if higher ranked options exist, then female foragers will likely invest only sporadic and minimal efforts in cultivating maize crops. If foraging rates are lowered (for whatever reasons) and if potential horticultural locations are available locally—then foragers might find it worthwhile to become part-time farmers. By the same token, both low-ranking foraging and intensive agriculture should be abandoned whenever encounter rates of higher ranked wild foods increase, or when a chance to engage in less intensive foraging is present. In other words, farming became an everyday way of life not because agricultural productivity was so high, but rather because the foraging alternatives were so poor (Barlow, 2006: 101).

The shift to domesticated crops typically occurs when human population increases sufficiently to require some degree of resource intensification, improvement in foraging efficiencies, and/or a broadening of diet breadth (Piperno and Pearsall, 1998: 323). So some questions remain:

- What specific conditions on St. Catherines Island mandated the decisions that led to the large-scale cultivation of maize and other domesticates shortly after cal A.D. 1300?
- Why not earlier?
- Why not later?
- Why grow corn at all?

ENVIRONMENTAL AND SOCIAL CONTEXTS

The late prehistoric (Irene) period was a time of significant climatic, demographic, and social change along the Georgia Bight. We believe that dynamics *at a regional level* are implicated in the adoption of significant maize cultivation on St. Catherines Island, and the following sections explore the nature of those changes.

THE ST. CATHERINES PERIOD DROUGHT: The St. Catherines period ended with a dramatic drought (A.D. 1176–A.D. 1220) that corresponds almost precisely to a significant gap in the ^{14}C histogram spanning the interval cal A.D. 1160–A.D. 1290 (Blanton and Thomas, chap. 28, this volume). Although calibration stochastic distortion (CSD) effects cannot be discounted, these systematic biases do not explain the disruption of the radiocarbon record (from both midden and mortuary contexts) during the late St. Catherines period.

The St. Catherines Period Drought also immediately predates the projected interval for the Savannah period in the northern Georgia chronology, cal A.D. 1280–1310/1390 (converted from estimates by DePratter, 1979a, 1991). Despite the impressive Savannah period constructions at the Irene Mound, near the mouth of the Savannah River (chap. 16; see also Caldwell and McCann, 1941; Waring, 1968c; Anderson, 1994: 172–187), we were unable to recognize a distinctive Savannah period presence on St. Catherines Island (chap. 15), suggest-

ing considerable variability at the regional level.

REGIONAL DEMOGRAPHY: "Something dramatic happened in the 15th century in the Savannah River Basin" (Anderson, 1994: 326) and the regional demographics changed forever during the Irene period.[8]

At A.D. 1250, four chiefdoms dominated the 300-km-long Savannah River Valley (Anderson, 1994: 160, 237; Blitz, 1999: 588; fig. 2), from a paired single-mound cluster at Tate–Beaverdam Creek to the Irene Mound, at the mouth of the Savannah River.[9] Anderson suggests that the first half of the 13th century was a time of "modest climatic deterioration" in the Savannah River Basin, with food shortfalls projected for about one-third of the years between 1201 and 1250. At A.D. 1350, four chiefdoms were still spaced evenly along the Savannah River Valley (Anderson, 1994: figs. 40–45), but their locations had shifted somewhat, with continuity evident only at the Irene Mound, which was revitalized about A.D. 1350–1400.

Between circa A.D. 1359–1377, the Savannah River Basin experienced another severe climatic downturn, with food shortages projected for 12 of 19 years. Based on site structure, Blitz (1999: 588–589) has argued that the Irene Mound was an autonomous, simple chiefdom, located as far as possible downstream from the two powerful multiple-mound (complex) chiefdoms at Mason's Plantation and Rembert. By A.D. 1400–1450, massive areas, from the central Piedmont to the river mouth (at Irene), had been entirely abandoned.

In other words, from about A.D. 900 through 1450, there was a progressive buildup of Mississippian components in the Savannah River Basin, followed by a pronounced drop-off, likely reflecting a political and settlement vacuum left by the abandonment of the Savannah River area.

Such political instability is characteristic of Mississippian chiefdoms, a chiefly cycling with polities rising in power, then declining, and sometimes abandoned altogether, with a new center of power arising elsewhere (Hudson, 1990: 60; Anderson,

1994: 328). This regional depopulation was apparently caused by a combination of environmental stress and a shifting political landscape (Anderson, 1994: 326, 1996; Blitz, 1999). The mid-15th century was a time of decreased rainfall, adding additional stress due to shortage of stored food. Anderson (1994: 327) suggests that the elites of the Savannah River chiefdoms faced local difficulties (crop failures).

By the time of De Soto's entrada in 1540, the Savannah River Basin was a vast empty buffer zone between the more powerful chiefdom at Ocute and Cofitachequi, where "the country on both sides of the entire length of the river became a wilderness" (Hudson, 1990: 60–61).[10] Having been told that the two chiefdoms of Ocute and Cofitachequi had been at war "forever", De Soto found that the central and lower Savannah River basin was entirely devoid of people, a buffer zone that measured more than 200 km side to side (Hudson et al., 1984: 71–72; Hudson, 1990: 60–61).

This was a dramatic relocation of the Savannah River Basin population, as people migrated to escape the sociopolitical constraints further inland. At least some went northward, into the headwaters of the Savannah River; Anderson (1994: 328) suggests that the development of the historic Lower Cherokee towns might be the result of 15th century political dislocations along the Savannah River. Perhaps some of the Savannah River Basin refugees headed southward, along the Georgia coastline.

PROVISIONING OPTIONS IN TIMES OF STRESS

Considering the linkages among the tree-ring data, radiocarbon evidence, mound construction sequences, and ceramic frequencies, we believe that the prolonged drought of A.D. 1176–1220 exerted a serious and negative impact on the foragers of St. Catherines Island, likely triggering at least a partial depopulation of the island immediately prior to the Irene period (cal A.D. 1300–A.D. 1580).

The late prehistoric period spanned a turbulent era of environmental and political disruptions in the Savannah River Basin,

only 50 km to the north of St. Catherines Island. Unlike the 15th century abandonment of the Savannah River Basin, the aboriginal population on St. Catherines Island increased dramatically during this time period. Whether or not this population increase reflects a southward movement of people from the former Savannah River chiefdoms, there is undoubtedly a significant increase in social circumscription during the Irene period. Although we cannot establish a firm boundary for the Savannah River no-man's land, St. Catherines Island was certainly situated near its southern margin.

This is a familiar scenario: significant environmental and sociopolitical flux coupled with a significant (if localized) population increase, leading to intensification of provisioning strategies. We have already discussed the multiple ways through which the Guale could have intensified their subsistence practices—they could cultivate more oysters, build and maintain more durable and extensive fish traps, clear and burn more mature maritime forest stands to increase procurement return rate of mast crops (esp. live oak acorns and pignut hickory nuts), leach the more expensive laurel oak acorns (to augment live oak acorns), weave better fish nets, build better dugouts, and so forth. Through these various measures, foragers could work harder, either by paying higher procurement and processing costs (i.e., lower post-encounter energetic return rates) or by increasing their investments in creating and/or maintaining specialized technologies.

Maize cultivation offered another option for the female forager to intensify her provisioning possibilities. But we have already addressed the myth that maize cultivation somehow provides a miraculous new technology for tapping an unrealized energy source. Farming does not provide additional leisure time and does not inevitably lead to monumental architecture and/or works of public art.

Instead, the experimental data presented in Part I suggest that the energetic returns from slash-and-burn maize horticulture (yielding 1100–1500 kcal/hr) are roughly equivalent to collecting oysters and ribbed mussels, spearing small fish, hunting gray squirrels, and preparing acorn meal (fig. 9.4). Hunting rabbits, ducks, collecting clams, and preparing hickory nut oil provide better energetic returns than slash-and-burn cultivation of maize, and only collecting lower ranking shellfish (such as periwinkles) and harvesting small seeds have lower energetic returns. The lower investment, "plant and harvest" gardening strategy (fig. 9.4) ranks slightly higher than slash-and-burn cultivating, overlapping return rates for resources that rank lower than American oysters. The "typical Latin American" agricultural strategy—a proxy for mission period agriculture at Mission Santa Catalina—has a return rate of only 100–1100 kcal/hr.

Figure 9.4 translates the diet-breadth implications for the three female-specific foraging types on St. Catherines Island: harvesting mast, collecting wild plants, and cultivating maize (per table 8.27). From these comparisons, we conclude that (depending on year-to-year conditions) maize cultivation *might* generate slightly better caloric returns than many shellfishing and wild plant food-collecting options. In other words, *if energetic returns were the only consideration*, female foragers would do much better rendering oil from hickory nuts and acorns (in the fall) or collecting hard clams (all year round) than by tending slash-and-burn fields throughout the agricultural cycle.

If growing corn is less energy efficient than harvesting most marsh resources—and it certainly seems to be—then why did the Guale invest so heavily in maize cultivation? Could it be that the late Guale people adopted maize cultivation for reasons other than "energy efficient provisioning?"

BEYOND KILOCALORIES AND ENERGETICS

Gamble and Roebroeks (1999: 10) have parodied the "walking stomach" scenario of foragers as energy-obsessed prisoners of their own provisioning strategies. Because "fitness" cannot be measured directly, conventional foraging models tend to maximize

the net rate of energy gain while foraging, generally assuming that more energy is better (Stephens and Krebs, 1986: 7–9; see also Winterhalder, 1981: 20). But net energy intake is only one of several currencies available to optimal foraging theorists (Winterhalder, 1987; Erlandson, 1989: 15; Moss, 1993; see also chap. 31).[11]

Each aboriginal foraging pursuit exists within "both a gastronomic and social context, each with potential evolutionary consequences" (Hildebrandt and McGuire, 2002: 232). Although both approaches can be subsumed under the rubric of human behavior ecology, models assuming efficient energy maximization differ significantly from those assessing social costs. Chapter 31 posed the following questions: If "efficient provisioning" is always the primary goal of human foraging, then (1) why do Meriam men (of the Torres Straits of Melanesia) elect to engage in high-risk spearfishing rather than doubling their return rate by collecting shellfish in the same location, as do women (Bliege Bird, 1999)? (2) Why do the Aché men of the Paraguay rainforest elect to hunt large game when they could realize higher energetic returns by collecting palm starch and small animals, as do women (Hill et al., 1987; Hawkes, 1990, 1991)? (3) Why do the Hiwi men of Venezuela insist on hunting when they could realize higher returns by digging roots, as do women (Hurtado and Hill, 1989)?

From a strictly energetic perspective, the hunting of singly pursued large animals might be a poor provisioning strategy, particularly if too much time elapses between successful hunts. Bliege Bird et al. (2001: 17) discovered that Meriam turtle hunters actually operate at a very low (sometimes even negative) return rate (see also Bliege Bird and Bird, 1997: 58–60, Bliege Bird et al., 2001; Hawkes and Bliege Bird, 2002). If efficient provisioning were the only foraging goal, why should Meriam men bother to hunt sea turtles at all? Why should we simply assume that high energy returns are the only motivation when it comes to provisioning strategies of foraging populations? What other motivations could exist?

COSTLY SIGNALING AND MATERIAL DISPLAY

There is every reason to question the proposition that "efficient provisioning" constitutes the lone goal of human foraging (Hill et al., 1987; Hurtado and Hill, 1989; Hawkes, 1990, 1991; Bliege Bird, 1999; Hildebrandt and McGuire, 2002: 232; McGuire and Hildebrandt, 2005). As noted in chapter 11, certain foraging activities are probably better understood in terms of their social and competitive values, meaning that rather than merely their nutritional contribution, "symbolic" behavior can confer significant fitness-related advantages. Several investigators argue for the importance of "social capital" or "signal value" as a means of conveying information about successful hunters (Smith and Bliege Bird, 2000).[12] Costly signaling theory attempts to explain how apparently inefficient (or expensive) behaviors evolve through natural selection, stressing the importance of *information* gained by others as a key to evolutionary stability (e.g., Bliege Bird et al., 2001, 2002; Hawkes and Bliege Bird, 2002; Smith et al., 2003; Bliege Bird and Smith, 2005).

Hawkes (1991) coined the term "show-off hunting" to characterize prestige-based subsistence, and she hypothesizes that by returning with a large game kill, the successful hunter is visibly demonstrating his fitness to potential mates, allies, and competitors (Hawkes, 1990, 1991, 1992, 1993). Meat in this context becomes "a medium of communication through which the hunter transmits information to potential mates, allies, and competitors" (McGuire and Hildebrandt, 2005: 698). Those receiving the signal would seem to benefit immediately, not only because they receive a meat share, but also because they learn something about the underlying qualities of the hunter, such as physical prowess (strength, stamina, and agility), cognitive skills (knowledge of habitat and prey behavior), leadership ability (charisma, organization skills), and generosity (the ability to bear costs without need for immediate compensation; see McGuire and Hildebrandt, 2005: 696). By this view, men receive deferential

treatment simply by virtue of paying the signaling cost and the benefits accrue without even having to distribute the meat (Hawkes and Bliege Bird, 2002: 61). Viewed as costly signaling, the value of shared public goods may have little to do with calories, and return rates for certain forms of prestige hunting and fishing turn out to be lower than expected (Hill et al., 1987; Bleige Bird, 1999; Hawkes and Bliege Bird, 2002).

What about other forms of "wasteful" behavior? Why should Northwest Coast foragers stage lavish potlatches, giving away and wasting massive quantities of foodstuffs and luxury items (Codere, 1990; Suttles, 1991)? Why should the Classic Maya invest in the substantial costs of quarrying, transporting, and engraving the monumental calendrical stelae that adorn so many of their principal sites (Neiman, 1997)? Are these merely egocentric expressions from the self-interested elite, or could there be underlying fitness-related benefits that accrue from such "wasteful" behaviors?

Bird and O'Connell (2006: 163–164) suggest that such "irrational" behaviors might provide a signaling function, beneficial both to the person displaying the symbol and also those receiving the message. According to Boone (2000: 87, 107), the Northwest Coast potlatch is understandable as an expression of *social power*—coloring the perception of others that translate into social status. Reinforcing social status and its attendant costly displays may have evolved as individual- or kin-group-level strategies to increase the probability of survival during infrequent, if potentially catastrophic shortfalls in resource availability. Social status guarantees priority of access during such periods of adversity. But to accomplish this, it is first necessary to establish and maintain access priority, even in periods of normal conditions. This necessity, suggests Boone, explains why some would be willing to "waste" large quantities of resources conducting potlatches during times of plenty.

Neiman (1997) suggests that a pattern of "wasteful advertisement" accounts for the distribution and timing of Mayan calendrical monuments. Because they set out a history of the elite lineage responsible, the Maya stelae helped establish the basis for their claim to the surrounding economic support zone. The size of such monuments vary according to the size and influence of the polities involved, reflecting the intensity of social competition (which in turn could reflect agricultural productivity, climatic conditions, and the demographic pressure on resource base). In this case, the degree of cultural elaboration in social-status reinforcement displays seems to reflect the frequency and severity of kinds of productivity upon which the individual/lineage is immersed. False signals are invalidated because only individuals of "higher quality" are capable of financing elaborate signal displays. If so, then perhaps the cost of producing the signal provides a measure of its validity, meaning that more capable, more highly motivated individuals can afford to provide more expensive ("more wasteful") signals (Bird and O'Connell, 2006: 163).

MAIZE CULTIVATION AS COSTLY SIGNALING?

We have seen how complex foragers of the St. Catherines period (cal A.D. 800–1300) became involved in a system of inherited ranked asymmetry prior to the significant cultivation of maize. Having explored the energetics of maize cultivation in the Sea Island contexts, we concluded that the return rates for maize cultivation strategies are unimpressive when compared to those for harvesting the resources of the marshland and terrestrial forest. Considering the risks and uncertainties involved with the agricultural cycle, one must reiterate the questions asked earlier: Why did the Guale choose to invest so heavily in maize cultivating? What are the fitness-related benefits of growing corn? Could it be that the late Guale people adopted maize cultivation for reasons other than "energy efficient provisioning"?

Perhaps costly signaling considerations, discussed above, are relevant here. We have already explored the fitness benefits that might accrue from a costly signaling of show-off hunting and perhaps an analogous set of fitness benefits could result from

"show-off maize farming." If maize cultivation were to become a medium of communication, then the cultivator would be in a position to transmit information to potential mates, allies, and competitors. Those receiving the signal would seem to benefit immediately, not only because they might receive a harvest share, but because they learn something about the underlying qualities of the farmer. Such qualities might include cognitive skills (knowledge of the agricultural cycle and short-term seasonal fluctuations in rainfall), hard work (tending and protecting swidden fields), generosity (ability to pay up-front costs without immediate payoff), and perhaps leadership ability (charisma, ability to convince others to help clear the land, weed, and harvest).

Given the political and environmental turmoil of the mid-15th century in the Savannah River Basin, it seems likely that the complex foragers of St. Catherines Islanders were propelled into the intense political competition between the rival chiefdoms of the Mississippian world. Like their inland neighbors (known archaeologically as the Lamar culture; Williams and Shapiro, 1990), the Guale had transformed themselves into a complex chiefdom by the time of European contact (and probably long before that).

The ethnohistoric Guale had at least two administrative levels overarching five (or more) local chiefdoms (Worth, 2004: 238). Accounts from the earliest European explorers leave little doubt that a system of chiefly tribute was well-ensconced along the Georgia Bight. Lesser elites paid tribute to those higher up the hierarchy—defining and formalizing power relationship, both within and between, chiefdoms "in a society obsessed with status positions, alliances, and trade" (Anderson, 1994: 77). As among the Timucua, the productive land and resources were likely owned by chiefly matrilineages, meaning that subordinate lineages were required to pay tributary obligations for use of the chiefly land (Worth, 1998: 162–168; 2004: 242).

Subordinates within the ethnohistoric Guale chiefdoms could readily produce and mobilize an annual agricultural surplus as the tribute underwriting their system of public finance (Jones, 1978: 189–193; Worth, 2004: 241).[13] During the 1560s, the Guale polities maintained a maize surplus sufficient for barter, for saving seed corn, and to finance their chiefly negotiations for political purposes. Fr. Rogel's commentary makes it clear that the local Orista people were accustomed to paying tribute (Jones, 1978: 191). All coastal groups of the central Georgia Bight seem to have maintained significant maize fields "behaving very much like sedentary agricultural chiefdoms" long before the Europeans introduced their own agricultural technology (Worth, 1999).

Members of chiefly and noble lineages were exempt from manual labor and supported by subordinates. Each community must have contributed both goods and services to the chiefly establishment, and such tribute became the "economic glue of the chiefly social structure" along the Georgia Bight (Worth, 2004: 242). Because it was easily stored, readily transported, and simple to quantify, maize became "the pivotal grain" throughout Spanish Florida, feeding the locals and fueling the military expeditions. Corn was also the primary currency that fueled the local economy and fostered private speculation and profiteering: "St. Augustine was a massive consumer of corn … [and] the maintenance of this corn supply was (at least in the view of its seventeenth-century inhabitants) paramount to the survival of the city and colony" (Worth, 1998: 132–133).

Despite the importance of maize as currency, it was human labor that constituted the primary tribute in Guale society (Worth, 1998: 166; see also Arnold, 1993).[14] Subordinates were required to provide manual labor in exchange for the rights to hunt, fish, and collect the natural resources within the chiefly domain. They sowed and cultivated designated *sabana* fields for the cacique, the principales, the medicine man/woman, the interpreter, the ballplayers, and others deemed worthy of tribute. The Guale probably also maintained a large, communal *sabana* to feed widows and orphans, travelers, to finance public

feasts, and provide rations for those working on construction projects, long-distance trade, or military campaigns.[15]

Although dealing with services rather than goods obviated the need for the transfer of large quantities of produce, it is clear that maize remained the currency of exchange within Spanish Florida (Milanich, 1999: 153) where Native American men, the "indios de cava," were required twice annually to clear, dig, and plant the fields, weed and protect the maturing crop, and harvest the ripe ears. Maize was also the currency of choice within missionary communities of the Georgia coast, where the *doctrineros* cleared, cultivated, and harvested a *sabana* sufficient to cover church expenses (Bushnell, 1994: 111).

Maize was typically stored in large communal and privately owned granaries called *barbacoas* (Swanton, 1922, 1928: 443–444, 1946; Hudson, 1976: 299; Milanich, 2004: 222). Such corn cribs were commonly raised 7 or 8 feet above the ground, supported by polished poles (to deter rodents), and sometimes sealed with mud plaster. Le Moyne depicted one such Timucua granary, in which both agricultural and wild resources were stored together (Lorant, 1946: 79; reproduced as fig. 9.2, this volume). Members of the DeSoto entrada described the chiefly *barbacoas* of the interior as "a house raised up on four posts, timbered like a loft and the floor of cane … [there are] many large barbacoas in which they gather the tribute paid them by the Indians, which consists of maize and deerskins and native blankets resembling shawls" (cited in Anderson, 1994: 71). The early sources describe the *barbacoas* maintained by chiefs, filled with food in outlying settlements, where the elite could call in these supplies at will.

Stored resources, especially maize and mast, may have assumed an importance even greater than during the time of initial harvest. With respect to maize cultivation among the late prehistoric Guale people, we think it likely that—as among modern Merriam sea turtle hunters—sociopolitical ("signaling") considerations could have outweighed net energetic returns.

Successful corn farming is impossible to fake, and the public display of maize products—both the ripening crops in the field and stored maize in the conspicuous *barbacoas*—conveys reliable information, in a valid and public manner, to potential allies, competitors, and mates. In this way, the community learns something about the underlying qualities of the farmer, and the farmer benefits in terms of personal prestige or renown. To the dominants, the public signals demonstrating successful maize cultivation enhance their own prestige status by ensuring that guests have plenty of maize to consume and to barter. Assuming that successful maize cultivation is a reliable signal of the farmer's ability, then subordinates benefit because their harvesting success is publicly signaled to their community. Farmers of lesser ability can be expected to fail more frequently, and in the long run, they will contribute less maize per capita as tribute. Failure to pay tribute is evident to all, and because high-quality farmers have a lower probability of failure, their social standing is enhanced.

Fitness benefits may also come to successful farmers even in the absence of distributing material goods to observers. Simply displaying the prospering maize field is perhaps sufficient to signal farming to all interested parties. Guale farmers tended *sabanas* and supplied corn for tribute, but even if the tribute is ultimately redistributed among the subordinates, the public display of harvests broadcasts that skill to the larger audience. The fact that maize is shared might, perhaps, be incidental (Bliege Bird, 1999: 71–72).

These scenarios also have some relevance to gender differences in foraging and farming behaviors. Rather than assuming that men prefer meat and women prefer plants and shellfish, rather than assuming that women prefer small resource packages and men prefer larger prey, and rather than assuming that shellfish are easier to harvest and swiddens easier to tend with children present, Bliege Bird et al. (2002: 17) propose that sex-based foraging preferences reflect differential benefits from signaling behaviors, and perhaps similar cost/benefit rela-

tionships attend maize cultivation: "Where there is a choice in foraging method, men seem to prefer to acquire meat through more risky methods that more easily differentiate the skill of individual foragers, while women seem to prefer less risky methods carrying little potential for discriminating forager quality." This suggests that many of the differences noted between male and female foragers could result from disparities in signals rather than from social competition (Bliege Bird et al., 2001; Smith et al., 2003); "Women may compete to gain notoriety as consistent provisioners, men to demonstrate intrinsic, hidden qualities relating to gaining social benefits. Women may not compete as men do because the costs of doing so are high relative to their provisioning goals; men do not compete as women do because provisioning competes with their goal of demonstrating hidden qualities" (Bliege Bird and Bird, 2005: 478).

This suggests that signaling behavior may have contravened the conventional notion that sexual division of labor tends to maximize the productivity of a cooperative male–female pair (Bliege Bird et al., 2001). Perhaps the positive signaling benefits attached to certain foraging and farming strategies can overshadow the actual energetic return rates. A Guale woman, for instance, might chose to bypass clam collecting in the marsh (a higher-return activity that might have little attendant signaling value) in favor of tending her own swidden field because of the positive messages sent by farming. Although the higher-risk decision to farm corn might result in less net energy capture, it does provide the farmer with high signaling value (the ripening maize crop). This might explain why a women might tend the chiefly *sabana*, despite the little provision afforded to their own households.

Such signaling considerations might also explain why Guale women elected to cultivate maize during the Irene period. Although growing corn might be an inefficient (or expensive) endeavor relative to harvesting most marsh and terrestrial resources, the social costs and benefits could well have outweighed the concerns for net energy-efficient provisioning. From the perspective of human behavioral ecology, the collection of tribute, offerings, and taxes represented the social payment for the costs of performing rituals and conducting warfare for the polity as a whole—basically the cost of protecting the group within their (culturally defined) global world system, as they knew it (Hommon, 2000: 144).

DID THE JESUITS GET IT WRONG?

Given the compelling evidence for low residential mobility and significant maize cultivation among the coastal Guale people, one must ask: What happens to the French and Jesuit accounts? These early eyewitness accounts consistently describe high residential mobility, seasonal dispersal, infertile soils, and minimal horticultural productivity during the 1560s along of the central Georgia Bight.[16] *Did the Jesuits and the French simply get it wrong?*

Probably not.

PALEOENVIRONMENTAL PERSPECTIVES ON GUALE ETHNOHISTORY

Blanton and Thomas (chap. 28, this volume) discuss the relevance of recent paleoclimatic research on baldcypress (*Taxodium distichum*) in the American Southeast. In this final chapter, it seems worthwhile to relate this new data source to the ethnohistorical accounts that spawned the Guale problem in the first place.

The tree-ring record provides a proxy for charting climatic trends in the American Southeast (Stahle and Cleaveland, 1992; Anderson, 1994: 277–289; Anderson et al., 1995; Stahle et al., 1998; Blanton, 2000, 2004). Using the baldcypress tree-ring record for the outer coastal plain of Georgia, Blanton and Thomas reconstructed the growing season precipitation using a 1055-year-long series of tree-ring data generated by the University of Arkansas for the lower Altamaha River near the central Georgia coast. By appropriately calibrating the tree-ring data, one can estimate the moisture availability throughout the growing seasons of the past 1000 or more years. Specifically, the Palmer Hydrological Drought

Index (PHDI; after Stahle and Cleaveland, 1992) generates drought reconstructions that provide clues as to the sustainability of food supply, especially maize provisioning strategies.

The period of extended dryness during the latter part of the 16th-century is particularly relevant to the present discussion—a time when "megadrought" conditions plagued much of North America (Stahle et al., 2000). During the early European contact period, Stahle et al. (1998: 545) document "a prolonged drought from 1562 through 1571 that was most severe from 1565 to 1569." Whereas this intensely warm and dry interval has been little discussed in the recent literature, it signals an extraordinarily difficult time for forager–farmers along the Georgia coastline—one of many challenges facing Europeans and Native Americans alike. We can now see that the Jesuit missionaries of Georgia and Carolina were facing the prolonged drought from 1562–1571, the driest interval of the entire 16th century (Worth, 1999; Saunders, 2000b).[17]

The warm and dry interval of A.D. 1527–1567 was punctuated by torrid conditions from A.D. 1554 to A.D. 1564. Menendez de Aviles (and the Jesuit missionaries who followed him) left vivid accounts of meager poor harvests, empty storehouses, rampant hunger, and local unrest.[18] The worst drought conditions took hold during the growing season of 1569, precisely when the missions at Guale and Orista missions were established and immediately preceding the only winter that Juan Rogel and Antonio Sedeño spent among the coastal Indians (Worth, 1999). During this drought-stressed interval, when the Guale were war at with the Orista-Escamacu chiefdom living to the north of the abandoned Savannah River corridor (Jones, 1978: 204; Worth, 2004: 240), the Jesuit priests had no way of knowing that they were witnessing the driest period of the 16th century. Add to this the newly imposed European demands for foodstuffs and the new burden of epidemic, it is clear that these early ethnohistoric accounts were describing native coastal populations under extreme duress.[19]

It seems likely that the two Jesuit missionaries were still smarting from their public failures in Spanish Florida and may have exaggerated their accounts regarding the poverty of the Georgia Bight (Jones, 1978, 1980; Worth, 1999). But when combined with the tree-ring evidence from this same area, these accounts gain considerable credibility because they document how these coastal chiefdoms adapted their normal seasonal and annual routines to accommodate environmental challenges and social stress.

BACKUP MOBILITY AND FORAGING STRATEGIES

We evaluated the energetics of aboriginal foraging on the barrier islands of coastal Georgia, developing a hypothetic settlement model in which foragers could maximize energetic returns in the food quest. Such energy-optimizing decisions have obvious payoffs in terms of long-term fitness goals (despite the fact that male and female foraging objectives might diverge considerably). At the level of efficient provisioning, then, these mobility strategies were hypothesized using the assumptions and constraints of diet-breadth, patch-choice, and transport-cost models.

But one cannot assume (1) that a single currency underwrote the provisioning strategies of the protohistoric Guale people or (2) that a single subsistence strategy played out among the protohistoric people of the Georgia coast. Instead, we must appreciate how the logistic and residential strategies might vary in different localized landscapes across the Sea Islands and how they might respond to short-term climatic fluctuations—despite the fact these coastal foragers pursued identical hunt types across identical patch types using identical technologies (Thomas, 1983; Zeanah, 2002: 251–252).

In casting the Guale problem along the forager–collector continuum, we also warned that mobility patterning is never strictly about efficient provisioning. People move across the landscape, individually and communally, for multiple reasons—includ-

ing a desire to position themselves relative to food and other resources, but also to minimize social stress, maintain kin ties with distant relatives, foster and maintain trade relationships, and provide certain defense advantages.

It seems clear, combining the tree-ring records and surviving ethnohistoric accounts, that the foraging farmers of Guale and Orista did indeed adapt their provisioning strategies, when necessary, to prevailing environmental and/or social circumstances, employing short-term backup tactics to exploit the relatively drought-resistant prey taxa.

Ethnohistoric documents also testify that, from the earliest European contact, the French and Spanish newcomers clearly harassed the Guale on St. Catherines Island with demands for food tribute (Jones, 1978; Worth, 1999). We know that multiple epidemics swept across peninsular Florida before 1562 (Dobyns, 1983), and aboriginal people along the Southeastern coastline seem to have avoided contact with the French and Spanish newcomers whenever possible to escape the epidemic diseases they brought with them (Bushnell, 1978; Larsen, 1990: 18).[20] The Guale and other nearby coastal groups in the late 16th century were deliberately avoiding contact with the early French and Spanish newcomers for multiple reasons—to feed themselves and to avoid paying tribute to the colonizers, to minimize religious harassment, to avoid resettlement in so-called *reducción* settlements (Bushnell, 1994: 22–23, 65, 126; Geiger, 1937), and to avoid epidemic disease. We suspect that residential mobility likewise was involved in attempts to maintain redistributive patterns that reinforced chiefly alliances.

RESOLVING THE GUALE PROBLEM: CONCLUSIONS AND IMPLICATIONS

Several important conclusions emerged from this investigation of the Native American landscapes of St. Catherines Island:

- St. Catherines Island was separated from the mainland shortly after cal 3000 B.C. and aboriginal foragers arrived shortly thereafter.

The first St. Catherines Islanders established a subsistence pattern that persisted for millennia, harvesting a broad range of vertebrate and invertebrate marine resources from the nearby estuarine and marine waters. They also hunted deer and collected a range of terrestrial food sources including hickory nuts and acorns, berries, and edible roots and tubers.

- Prior to cal A.D. 800, aboriginal foragers on St. Catherines Island were organized into egalitarian, tribal-level societies, likely living in economically self-sufficient, virtually sedentary, and politically autonomous villages.

- Sometime before cal A.D. 1300, the aboriginal social system on St. Catherines Island began ascribing positions of social status and wealth at birth. Currently available data suggest that heritable social inequality developed on St. Catherines Island before the advent of significant maize cultivation.

- During the Irene period (post-cal A.D. 1300), St. Catherines Islanders began the intensive cultivation of maize and other domesticates. Guale labor and the agricultural products it produced translated directly into the tribute payments that fueled both domestic subsistence and political power among the coastal chiefdoms.

This concluding chapter has revisited the so-called Guale Problem, the conflicting ethnohistorical interpretations that initially stimulated the 3 decades of archaeological research discussed here.

Although the details have blurred in recent years, the Guale problem clearly turns on the twin issues of residential mobility and economic intensification (esp. table 11.6). In evaluating the energetics of aboriginal foraging on the barrier islands of coastal Georgia, we developing a hypothetic settlement model in which foragers could maximize energetic returns in the food quest, and at level of efficient provisioning these mobility strategies were hypothesized using the assumptions and constraints of diet-breadth, patch-choice, and transport-cost models. These models make it clear that the aboriginal forager–farmers on St. Catherines Island *should have* pursued a strategy of low residential mobility, with most procurement taking place through logistical movement. Given the physical and biological constraints of St. Catherines Island, late prehistoric settlements should

have been occupied nearly year-round and positioned along the interface between the two highest ranking patches (in this case, along the marshside margins of the maritime forest). Clearly, the various optimal foraging models correspond closely to the scenario set out by Grant Jones (1978, 1980) for the contact period Guale people.

The Island-wide systematic survey conclusively demonstrates that a very high proportion of late prehistoric components did indeed cluster in a predictable series of three- and four-season marshside settlements, along the interface of the two highest ranking resource patches. The archaeological evidence corresponds exactly to the "dispersed town", low-residential-mobility model, suggested by Jones (1978: 193–194), in which the placement of Guale settlements was "a strategic measure to be near shellfish, hunting grounds, and horticultural lands without having to change residence seasonally." We see little archaeological evidence to support a fission–fusion settlement pattern of high residential mobility.

The combined archaeological and ethnohistoric evidence likewise confirms Grant Jones' (1978: 179) interpretation of Guale horticulture. Aboriginal people of the Georgia Bight did indeed cultivate maize in considerable quantity during the late prehistoric and early historic periods. Given this evidence, we explored why the complex foragers of the Irene period elected to include maize in their diet. Analyzing the experimental results from the various post-encounter return rates, we concluded that growing corn is an inefficient and expensive provisioning strategy when compared to foraging results for harvesting most marsh and terrestrial resources. We believe that social costs and benefits likely overshadowed narrow concerns for net energy intake and suggest that adoption of maize cultivation is best understood in light of the social and competitive framework of the late prehistoric period. The fitness-related advantages of "social capital" or "signal value" seem to have promoted the cultivation of tributary maize fields as social payment for the costs of protecting the Guale

polities within the context of larger Mississippian society, to minimize social stress, to maintain kin ties with distant relatives, to foster and maintain trade relationships, and provide certain defense advantages.

The combined evidence from ethnography, ethnohistory, archaeology, and human behavioral ecology seems to resolve the Guale problem, overwhelmingly confirming and amplifying ethnohistorian Grant Jones' (1978, 1980) perception of the contact-period Guale people: These were largely sedentary foraging farmers, who lived in optimally positioned marshside dispersed towns, grew significant quantities of maize and other domesticated crops, and maintained a complex chiefdom level of social organization with centralized, inherited leadership and long-distance trade networks with the interior (1978, 1980).

But we cannot assume that a single provisioning or mobility strategy dominated throughout the protohistoric occupation of the Georgia coast. Judging from the combined tree-ring records and surviving ethnohistoric accounts, it seems that the foraging farmers of Guale also adapted their provisioning strategies, sometimes using backup tactics to exploit the relatively drought-resistant prey taxa. Additional research is required to understand how the logistic and residential strategies might vary in different localized landscapes across the Sea Islands and how they might respond to short-term climatic fluctuations—despite the fact these coastal foragers pursued identical hunt types across identical patch types using identical technologies.

NOTES

1. As noted in chapter 32, we are presently conducting an expanded analysis of stable isotopes in the St. Catherines Island skeletal populations, and the present comments must be considered preliminary.

2. We are grateful to John Worth for calling our attention to his 1999 paper on the Guale problem and for allowing us to draw upon this important research.

3. Describing the aftermath of the so-called Juanillo Rebellion of 1597 (Oré, 1936; Zubillaga, 1946: 418; Barcia, 1951: 182; Jones, 1978: 183–185), Oré discussed the tactics of Spanish retaliation and the complex problems it created for the Guale rebels: "Since all the Indians were hidden in the woods, the governor could neither punish them nor get in touch with them.

They burned the foodstuffs of the Indians; the Indians themselves already burned their houses when they left. On this account and due to what followed, during the subsequent years they had no maize harvest. Moreover since they were removed from the sea, they could neither fish nor gather shellfish, with the result that they suffered great hunger. Though the Indians sowed, it was little, while the Spaniards destroyed it every year'' (Oré, 1936: 95). Worth (1999) also notes that "during the early summer of 1565, the Indians all along the St. Johns River were able to report on the relative ripeness of corn at various points along the valley, including at the mouth, and were very protective of their fields before harvest. Two French carpenters were even murdered during May when they picked corn from fields near the village of Atore near the mouth of the river, since the harvest would not arrive for several weeks'' (Worth, 1999).

4.   Shortly after Mission Santa Catalina de Guale was abandoned in 1680 (Bushnell, 1994: 145–147; Worth, 1995: 30–32), Spanish Governor Márquez Cabrera was scheming to import 100 families from the Canary Islands to repopulate St. Catherines Island "because it is fertile and abounding in provisions" (cited in Bushnell, 1994: 149). After speaking to soldiers formerly stationed on St. Catherines Island, Alonso de Leturiondo added that "the settlement of Santa Catalina was of very great utility … And unanimously and in agreement everyone from Florida said that since the said island has been abandoned … they have experienced a very great need because from the said island they brought to sell to the presidio the maize, beans, hogs … pumpkin (*calabasas*), sweet potatoes (*boniatos*) and other necessities that it produced in such abundance that it was the role recourse of the *presidio* [at St. Augustine] for its necessities … because of the fecundity of the said island … for the sowing of grain and fruits that they gather at a good rate and in great abundance" (Hann, 1986: 197–198).

5.   Worth further questions the argument that late 16th century Franciscans were capable of forcing coastal Indians into adopting European-style farming practices and sedentary village life: "European-influenced agricultural intensification, which definitely did occur during the primary Franciscan mission period, probably did not even begin until the late 1590s, post-dating first contact by as much as three or more decades" (Worth, 1999). During the primary mission era, these same chiefdoms routinely sold 25,000 pounds of surplus corn to the Spaniards on an annual basis (despite the fact that numerous laborers from these same towns were required to work the Spanish-controlled cornfields in St. Augustine).

6.   "And I would also hasten to add here that even unmissioned coastal groups such as the Orista-Escamazu were also routinely producing surplus corn and other agricultural products for sale during this same period. Spanish ships commonly visited these northern provinces to barter for corn, and early English exploratory expeditions under William Hilton and Robert Sandford in the 1660s described substantial fields of corn in this same region" (Worth, 1999).

7.   John Worth (1999) concurs, concluding that "beyond any shadow of doubt" the Guale people

(and their neighboring coastal chiefdoms) grew corn "and I would say they grew a lot of it. … [T]hey can be unequivocally characterized as small-scale agricultural chiefdoms … [forming] one regional variant of the broader phenomenon of agricultural rank societies we call the Mississippian culture. … [T]hese coastal chiefdoms do not, in fact, depart substantially from commonly-held perceptions regarding all late prehistoric groups in the Southeast. Indeed … the Guale and other coastal groups fall easily within the range of variation already posited for subsistence and settlement systems within the Mississippian culture."

8.   Blanton and Thomas (chap. 28, this volume) have commented on the correspondence between the baldcypress tree-ring records for the Altamaha River and Ebenezer Creek, a tributary of the lower Savannah River (fig. 28.3). Anderson (1994: 284–286) concluded that the climatic conditions for maize agriculture were comparatively "benign" during the A.D. 1000–1100 interval (during the middle of the St. Catherines period, in the St. Catherines Island chronology). Then, based on the cluster of successive years experiencing below-average rainfall, Anderson predicted food shortfalls for about half the years between A.D. 1124 and A.D. 1152. The tree-ring evidence likewise indicates a time of generally favorable climatic conditions corresponding to the earliest mound construction at the Irene Mounds, sometime around A.D. 1150–1200 (Caldwell and McCann, 1941: 78; see also Anderson, 1994: 174).

9.   Recent research at mound complexes on the lower Savannah (specifically, Hollywood, Lawton, Red Lake, and Spring Lake) establish that the most intensive occupation occurs between A.D. 1275 and A.D. 1375 (Adam King, personal commun., cited in chap. 28, this volume).

10.   One of the elite at Ocute complained that his people were "intimidated and submissive, not daring to go any distance or leave their own boundaries" due to the power of their rivals at the Cofitqchequi chiefdom (Vega in Shelby, 1993: 274; cited in Anderson, 1994: 327). Upon leaving Ocute and preparing to cross the Savannah River buffer zone, he was warned that no clear-cut trail was available, and his men should carry with them all necessary food. Ocute warriors ventured here only to conduct raids on Cofitachequi, and Hudson (1990: 60–61) suggests that the "wilderness of Ocute" was widest in the Fall Line area, with some coastal Indian groups living both north and south of the mouth of the Savannah River.

11.   There is also reason to question whether the *average* post-encounter return rate is the most useful parameter for measuring prey choice (e.g., Hill et al., 1987: 17–19; Sih and Christensen, 2001; Bliege Bird and Smith, 2005; see also chap. 31, this volume).

12.   For the original expression of costly signaling theory, see Zahavi (1975, 1977).

13.   "Not only was corn grown and used among the coastal Indians, but … it was also a fundamental component of both domestic subsistence and political power in coastal chiefdoms. This kind of behavior was no recent innovation among coastal groups, but rather reflected what I would argue was a centuries-old cultural adaptation for coastal chiefdoms within the

broader Mississippian period world of the Southeast'' (Worth, 1999).

14. Among the local Timucuan chiefdoms, maize does not appear to have been a major item of tribute (Worth, 1998: 165–167). The documentary evidence of direct chiefly tribute mentions mostly deer hides, beads of shell and glass, and wild plant foods (including acorns and palmetto berries). Instead, it was human labor rather than material goods that comprised the primary commodity of tributary value, at least among the Timucuan chiefdoms.

15. In the 17th century, the Spanish established a "sabana" system in which missionized Southeastern Indians grew maize for local consumption, for barter, for tribute, and for export (Bushnell, 1994: 22–23). The *sabana* was a cornfield—likely intercropped with beans, squash, and tobacco—that was maintained in each mission to support the missionaries, to pay for maintenance and improvements of the church, and to provide the necessary articles of worship (Bushnell, 1994: 111; Worth, 1998: 163).

16. Describing the native population at Santa Elena and Orista, Fr. Jean Rogel wrote that the Indians "were congregated together [to plant and tend crops], but when the acorns ripened they left me quite alone, all going to the forests, each one to his own quarter. … For nine out of the twelve months they wander without any fixed abode" (Sturtevant, 1964: 169–170). Father Antonio Sedeño, stationed at the town of Guale, noted that "the few Indians that there are so scattered. … [T]hey go where they can find a little land without woods to sow their maize; and as the land is so miserable, they move with their *ranchos* from time to time in search of other lands which can bear fruit (Zubillaga, 1946: 424). In 1564, René Laudoniére recorded similar impressions for the Timucua at Outina (present-day northeastern Florida) in 1564: "The Indians are accustomed to leave their houses and retire into the woods for a space of three months, namely January, February, and March, during which time you do not see an Indian anywhere. … This is the reason why we could get no foodstuffs from them during this period" (Bennett, 1975: 121).

17. "In addition to the years of drought, all the accounts were authored precisely during the initial years when newly-arrived European colonists were most in need of foodstuffs received, bartered, or taken from neighboring coastal Indians, significantly reducing any annual surpluses remaining after drying growing seasons. Laudonniérre's 1565 description of winter hunting and spring famine came after his own purchase of most of the surplus from the 1564 growing season,

and Jesuit letters were authored during a period of extreme dependence by the settlers of Santa Elena on local Indian food, a practice which had begun with the French soldiers at Charles Fort in 1562. Indeed, there are several direct textual references to Indian comments that they had indeed sold virtually all their surplus food during those first years, and would have to seek out other foods until spring planting" (Worth, 1999).

18. In the spring of 1566, Pedro Menendez de Aviles sailed northward from St. Augustine to Guale, noting that "it had not rained for 8 months in this country and their corn fields and farming lands were dry" (Solís de Merás, 1964: 170–171; see also Barcia, 1951: 112–119; Jones, 1978: 181; Quinn, 1979: 492–493). At Orista, to the north, Menendez confirmed the severe drought conditions. His men complained that food was in such short supply at Orista that "even if the Indians had been willing to give their food … they had none, for it had not rained for many months" (Solís de Merás in Waddell, 1980: 147). This severe drought had apparently created immediate food shortages and likely would precipitate warfare with the Orista chiefdom (to the north), where food was also scarce due to drought conditions (Barcia, 1951: 112–119; Jones, 1978: 181; Quinn, 1979: 492–493).

19. "In addition to the years of drought, all the accounts were authored precisely during the initial years when newly-arrived European colonists were most in need of foodstuffs received, bartered, or taken from neighboring coastal Indians, significantly reducing any annual surpluses remaining after drying growing seasons. Laudonniérre's 1565 description of winter hunting haunts and spring famine came after his own purchase of most of the surplus from the 1564 growing season, and Jesuit letters were authored durin a period of extreme dependence by the settlers of Santa Elena on local Indian food, a practice which had begun with the French soldiers at Charles Fort in 1562. Indeed, there are several direct textual references to Indian comments that they had indeed sold virtually all their surplus food during those first years, and would have to seek out other foods until spring planting" (Worth, 1999).

20. Thousands died during the decade of 1649–1659 (Larsen, 1990: 18) and missions became a nexus for the spread of disease, where populations were centralized, providing ideal conditions for introduction of pathogens. In 1657, the governor of Spanish Florida commented on the drastic reduction of native population in the province of Guale "because they have been wiped out with the sickness of the plague and small-pox which have overtaken them in the past years" (quoted in Hann, 1986: 378).

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