

PREHISTORIC SETTLEMENT AND SUBSISTENCE ON SAN NICOLAS ISLAND

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Abstract—The main objectives of this study were to provide insights regarding prehistoric settlement, subsistence, and cultural sequences on San Nicolas Island. Investigations included the mapping and recording of all the prehistoric sites on the island and the excavation of a single index unit within a representative sample of sites. A total of 535 sites was recorded. Sixty-eight radiocarbon samples from 41 sites were submitted for analysis. These, together with radiocarbon data from previously excavated sites, indicate that the island was occupied for at least 7,000 years. The majority of the sites were occupied during the late Holocene. Fifteen percent of the 535 sites were identified as residential sites, 15% as camps, and the remainder was identified as shellfish processing and/or flaked stone reduction areas. Late Holocene sites are distributed throughout the island, whereas middle Holocene sites are almost exclusively located within the west end topographic zone. Calibrated radiocarbon dates seem to cluster during the periods before and after the region-wide drought that has been postulated for the late Holocene ca AD 1100–1250. The large quantities of fish remains from the excavated sites suggest that fishing was the most important subsistence strategy. Interestingly, sea mammal hunting seems to have played a minor role in the subsistence system.

Keywords: California prehistory, cultural sequences, island settlement and subsistence, maritime hunter/fishers

INTRODUCTION

San Nicolas Island is the smallest, most remote and inhospitable of the settled California Islands. It exposed to severe northwest winds, the climate is semi-arid, there are few important edible plants, and there are no trees, terrestrial game animals, or quality stone tool materials. The rugged coastline, rough seas and lack of harbors make it difficult to land boats even today.

Perhaps because it is so isolated and inhospitable and there is so little ethnographic information about the San Nicolas Islanders, the island has an aura of mystery. This is reflected in the statement by J.P. Harrington's informant, Jose de Los Santos Juncos: "The island Indians were powerful witches. They used to pass to and from the islands on balsas of Tules" (Harrington 1986: R104F40). To add to the mystique, it is also known as the "Island of the Blue Dolphins" after the children's book and movie inspired by the San Nicolas Island Indian who survived alone on the island for 18 years (O'Dell 1960). The few conflicting references to the removal of the last

remaining Indians on San Nicolas Island in 1835 and the discovery and removal of the Lone Woman in 1853 are all we know about the San Nicolas Island Indians. The rest has to be gleaned from the archaeological record.

Today San Nicolas Island serves as an off-shore landing base and missile proving ground for the U.S. Navy and our research was part of the Navy's cultural resource management program. The primary goals of this study were to determine settlement patterns, subsistence strategies, and cultural sequences on the island. In addition, information regarding the midden constituents and depth and complexity of the sites was used to identify research potential and eligibility for listing on the National Register of Historic Places. Data from previous excavations on the island provided additional radiocarbon dates and insights regarding subsistence strategies.

Settlement pattern analysis has been described as extremely complex and difficult to implement. This has been attributed to the poor state of preservation and ephemeral nature of many mainland hunter and gatherer sites, the difficulties

of defining regional boundaries, and the magnitude of the work that would be needed to identify contemporaneous sites and site function through time and identify the environmental and social variables that could account for the observed patterns (Goldberg et al. 1993). While these problems should not be underestimated, they may be alleviated somewhat by certain conditions on San Nicolas Island. For example, preservation is generally good and, given the large number of sites (over 500), there is reason to believe that all of the components of the settlement pattern are present. Also, because the island is small and geographically discrete, the magnitude of the task is greatly reduced. A great deal of time, effort and resources are required, but the sites are not threatened by development and the Navy has committed to a long-term program of academic archaeological research. Our project represents the initial stage of this extensive research effort.

Environmental Setting

San Nicolas Island is located approximately 140 km southwest of Los Angeles and 90 km from the nearest inhabited islands. It is approximately 15 km long and 6 km wide and covers 5,411 ha (Dulka et al. 1993). With a maximum elevation of 277 m above sea level, the island lies low and exposed in the ocean. The northwest winds sweep the island at 14 knots. On stormy days, the winds average 30 knots with gusts up to 80 knots (Naval Facilities Engineering Command, Southwest Division 1997). There are no good harbors and with the exception of the west end, the coastline is rugged. Most of the precipitation arrives as mist and although there are many springs and seeps, the island has no permanent streams.

Despite the small size of the island the landscape is one of contrasts. A treeless plain covers the central plateau above the 120 m elevation. The west end of the island consists of an extensive dune field that provides easy access to the ocean and contains the majority of the springs and seeps. Steep cliffs make access to the rocky southern coast difficult, while the gentler cliffs of the northern coast represent the above sea level portion of a series of terraces that were gradually drowned by rising sea levels at the end of the Late Wisconsin (Vedder and Norris 1963, Bickel 1978, Johnson 1983; Fig. 1).

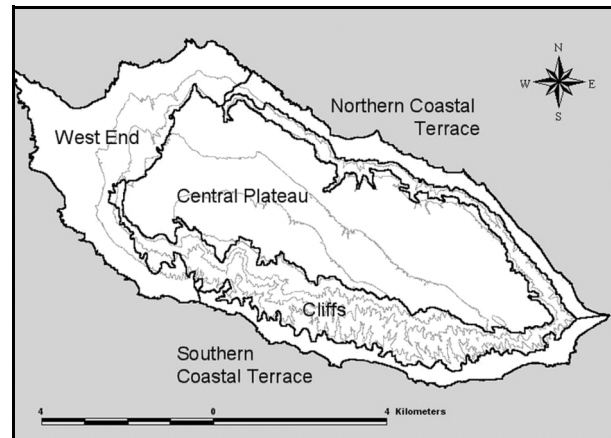


Figure 1. San Nicolas Island topographic zones.

The flora consists mainly of low shrubby vegetation, such as giant coreopsis (*Coreopsis gigantea*), lupine (*Lupinus albifrons*), sage (*Artemisia californica*), and buckwheat (*Eriogonum grande*). There is no evidence to suggest that trees were ever present. Native terrestrial fauna are represented by three species, a lizard, a deer mouse, and a land snail. The distinctive island fox (*Urocyon littoralis*) and dogs (*Canis familiaris*) were brought to the island by the Indians (Von Bloeker 1967, Collins 1982, Shelley 2001). The earliest fox remains on the island date to 5,000 years ago (Vellanoweth 1998).

A rich marine biota contrasts with the sparse terrestrial resources. The abundant marine life can be attributed in part to the both warm and cold water currents that flow around the island (Browne 1994). The island also has numerous sandy beaches and the most extensive kelp forests of all of the Channel Islands (Browne 1994, Engle 1994). The abundant marine resources and the numerous springs help to explain the continuous occupation of this remote and seemingly inhospitable island.

Culture History

Early investigators suggest that San Nicolas was occupied sometime between 2,000 and 1,000 years ago with most of the settlement occurring later than 1,000 years ago (Meighan and Eberhart 1953). The settlement of the southern Channel Islands has been attributed to the migration of Shoshonean hunter-gatherers from the rapidly desiccating basins in the interior to the southern California coast where some groups continued on to the southern Channel Islands (Kroeber 1925,

Shiple 1978, Heizer and Elsasser 1980). However, the timing of the Shoshonean entry into southern California intrusion has generated considerable debate with estimates ranging from 1,000 to more than 6,000 years ago (Wallace 1962, Hopkins 1965, Warren 1968, Drover and Spain 1972, Koerper 1979, Moratto 1984). It appears that by the time of European contact the southern Channel Islands were occupied by Takic speakers of the Uto-Aztecan linguistic stock, having replaced an earlier genetically distinct population who closely resembled the ancestors of the Chumash (Kroeber 1925, Gifford 1926, Koerper 1979, Moratto 1984, Titus 1987, Munroe 1994, Ezzo 2002).

There is no evidence that the Spanish ever landed on San Nicolas Island (Wagner 1929). This contention is strengthened by the scarcity of glass beads or other European materials of that era (Meighan and Eberhart 1953). During the 1880s, Russian fur traders brought Aleut Indians from Alaska to the island to hunt sea otters (*Enhydra lutris*). The Aleut and other hunters decimated the sea otters and apparently were responsible for the near extinction of the Indians (Kroeber 1925). In 1835, the mission fathers sent a ship to remove the few remaining San Nicolas Island Indians. These survivors included a few women, children, and old men. Somehow one woman, later known as Juana Maria, was left behind and survived alone on the island for 18 years. In 1853, another ship was sent to the island to fish, hunt, explore and look for the woman. They found her and took her to Santa Barbara. Her patrons brought Indians from the region to try and communicate with her, but none spoke her language. Although she was treated well, she died within a few weeks (Hardacre 1880, Ellison 1937, Heizer and Elsasser 1961). The island was used for sheep ranching from 1857 to the 1940s. Overgrazing decimated vegetation and caused severe erosion. The last of the sheep were removed by the United States Army in 1943 (Swanson 1993).

Previous Archaeological Investigations

From 1870 to 1950, archaeological interest in the island was mainly in collecting artifacts for museums rather than analyzing and reporting results. From all accounts, the early investigations consisted mainly of surface collections. Artifacts were lying on the surface just as the Indians had left

them, and erosion exposed cemeteries; there was no need to excavate. Literally tons of artifacts were removed and collections from San Nicolas Island are housed in museums across the nation and throughout most of the world (Schumacher 1877, Bowers 1890, Bryan 1926, Rogers 1930, Woodward 1940, Orr 1945, Hamy 1951, Meighan and Eberhart 1953, Reichlen and Heizer 1964, Bryan 1970). Intact artifacts are rarely found in archaeological contexts on the island today. Instead, we are mostly left with ecological data. It is highly likely that a description of the San Nicolas Indians based on the museum collections would bear very little resemblance to the description based on our data. Ideally, we need to put the two lines of evidence together.

More problem-oriented research began in 1959 and continued through 1980s, resulting in the excavation of 10 sites (Rozaire 1959, Reinman and Townsend 1960, Reinman 1962, Lauter 1982, Reinman 1982). Excavation of six of the sites was limited to removal of exposed burials and midden areas were not tested (Reinman and Townsend 1960). Two sites were excavated for the express purpose of locating preserved woven materials for an analysis of weaving techniques (Rozaire 1959) and two sites were excavated to recover and analyze a systematic sample of the cultural deposit (Lauter 1982, Reinman 1982). In 1983 and 1984 the entire island was systematically surveyed by Fred Reinman and his students as part of a cooperative research agreement between the Navy and California State University, Los Angeles (CSULA), during which 358 sites were mapped and recorded (Reinman and Lauter 1984). More recent investigations include test excavations at a residential site on the plateau (Martz 1994b), data recovery at a site on the west end of the island as mitigation for the construction of a bird blind (Vellanoweth 1996), data recovery excavations at a site on the west end as mitigation for military activities (Rosenthal and Jertberg 1997), and the excavation of index units at 10 sites on the west end (Rosenthal and Jertberg 1997, 1998a, 1998b).

METHODS

The prehistoric archaeological sites were mapped using Global Positioning System (GPS)

receivers, with a base station receiver for differential correction of the GPS data collected in the field. The GPS data were integrated into the San Nicolas Island Geographic Information System (GIS). A systematic survey was not conducted. During the 1980s, the island was systematically surveyed and over 300 prehistoric archaeological sites were mapped, recorded, and plotted on the San Nicolas Island 1956 USGS 7.5-minute topographic quadrangle using conventional techniques of compass and tape measure. An additional 170 problematic sites were circled on the map, but not mapped or recorded (Reinman and Lauter 1984). Natural and human activities have changed the landscape since the 1980s and technical advances such as the GPS and GIS provide greater accuracy and efficiency in the location and management of cultural resources. The current investigations were designed to provide accurate site location, boundary definition, and descriptive data to assess the eligibility of the sites for the National Register of Historic Places and to make observations regarding the settlement pattern and subsistence strategies. The sites were relocated using the GPS and the laptop computer loaded with GIS generated background maps, which displayed our location against topographic data and the previously plotted site locations. For the most part, the previously discovered sites were accurately plotted. It was necessary to redefine the boundaries of a number of sites where previously buried cultural deposits were exposed due to erosion, or portions had been destroyed by natural or human activities. In addition, several new sites were located, mapped and recorded.

To provide subsurface information regarding settlement, subsistence, and cultural sequences, one 1.5- x 1.5-m index unit was excavated at 58 (11%) of the 535 recorded prehistoric sites. Ten of the index units were excavated as mitigation for military activities (Rosenthal and Jertberg 1998a and b). The sites were selected to provide a representative sample from each of five distinctive topographic zones: Plateau, West End, Northern Coastal Terrace, Southern Coastal Terrace, and Cliffs (Fig. 1). The southern coast is underrepresented due to the logistical constraints of sampling sites within the southern escarpments and of excavating sites within a marine mammal sanctuary. The index units were excavated in 10

cm levels and screened through 1/8-in. (0.32-cm) mesh. After field sorting, the materials were further sorted in the laboratory to recover small fish bones, beads, thinning flakes, and other small items. Sixty-eight radiocarbon samples from 41 index units were submitted to obtain dates.

RESULTS

Settlement

A total of 535 prehistoric archaeological sites were mapped and recorded. Of these, 36 were new previously undiscovered sites, 350 had been originally mapped and recorded and 147 had originally been discovered but not mapped and recorded (Reinman and Lauter 1984, Martz 2002). Based on surface observations and in a few cases excavation data and the notes of early investigators, the sites were categorized as follows: 80 residential sites; 79 camp sites; 164 stone artifact manufacture and shellfish processing locations; 90 shellfish processing locations; 100 flaked stone reduction locations; 14 deflated hearth features; and eight sites that were too damaged to be categorized (Martz 2002). The criteria for a residential site include the presence of artifacts representing a wide range of social, manufacturing, maintenance, and resource exploitation and processing activities. Based on these criteria, 80 sites (15%) appear to represent substantial habitations. The artifact assemblage observed at the sites designated as camps represent a narrower range of activities than the residential sites. There appears to be a focus on flaked stone manufacturing and the procurement and processing of a variety of faunal resources. Seventy-nine sites (15%) were placed in the camp category. The stone artifact manufacture and shellfish processing locations are distinguished by the presence of flaked stone and shellfish and very little else. A total of 164 sites (30%) were placed in this category. Shellfish processing locations were identified by the presence of shellfish middens, concentrations, or scatters and the absence or scarcity of other cultural materials. A number of the locations appear to represent short-term events involving the processing of one particular species, such as black abalone (*Haliotis cracherodii*), California mussel (*Mytilus californianus*), or giant

chiton (*Cryptochiton stelleri*). Ninety sites (17%) were identified as shell processing locations. Flaked stone reduction locations were distinguished by the predominance of flaked stone materials, including battered and tested cobbles. A total of 100 sites (19%) were placed in this category. Fourteen sites (3%) consisted of deflated sandstone hearth features. Some of the hearth features contained ashy soil and charcoal and excavation may provide clues to their function. Eight sites (1%) were completely destroyed and the part they played in the prehistoric settlement system is unknown (Table 1).

Forty percent of the 535 sites are located within the Plateau topographic zone, 22% within the West End, 18% within the Southern Coastal Terrace, 15% within the Northern Coastal Terrace and eight percent within the Cliffs. The West End topographic zone has the highest percentage of residential sites (48%). Camps cluster within the Southern Coastal Terrace (33%), the West End (29%) and the Plateau (22%); with the remainder (10%) situated on the Northern Coastal Terrace and (6%) within the Cliffs. The majority of the stone artifact manufacture and shellfish processing locations (58%) are situated within the Plateau. The majority of shellfish processing locations are located within the Plateau (29%) and Southern Coastal Terrace (28%). Seventy-seven percent of the flaked stone reduction locations are situated within the Plateau. This can be attributed to the numerous Pleistocene cobble exposures on the plateau. The island was formed through the uplifting of sedimentary rock rather than volcanic activity, and the cobbles, which mainly consist of metavolcanics, constitute the only suitable

materials for flaked stone tool manufacture (Vedder and Norris 1963). The majority of the deflated hearth features (57%) are located along the Northern Coastal Terrace. These may represent the remains of signal fires to guide canoes to the island (Hudson et al. 1978). Seventy-four percent of the unknown (destroyed) sites were situated within the Plateau (Table 2).

The calibrated results of 68 radiocarbon samples from 41 index units and 106 radiocarbon samples from 16 previously excavated sites, indicate that the majority (42) of the sites sampled were occupied during the late Holocene (3,350 RYBP– present), 22 were occupied during the middle Holocene (6,650–3,350 BP), and three were occupied during the early Holocene (10,000–6,650 RYBP). Two of these sites, CA-SNI-11 (hereafter the “CA-” prefix for California sites will not be used) and SNI-351 have late, middle, and early Holocene components. Nine of the sites have late and middle Holocene components: CA-SNI-16, 21, 39, 43, 105, 131, 161, 168, and 171 (Rozaire 1959, Reinman and Townsend 1960, Lauter 1982, Reinman 1982, Schwartz and Martz 1992, Martz 1994b, Vellanoweth 1996, Rosenthal and Jertberg 1996, 1997, 1998a, b, Martz 2002). Sites that were occupied during more than one time period account for the discrepancy between the 57 sites sampled and the 67 dated occupations. The 57 sites with radiocarbon dates represent 11% of the total prehistoric site inventoried and provide insights regarding changes in settlement patterns through time. The late Holocene sites include 20 (48%) residential, 10 (24%) camps, 10 (24%) stone artifact manufacturing and shellfish processing locations and two (4%) shellfish processing locations. Although only half as many of the sampled sites were occupied during the middle Holocene (22), a higher percentage (68%) was identified as residential. Only three sites produced dates indicating occupation during the early Holocene and all are residential sites. The lack of representation of flaked stone reduction sites can be attributed to the lack of suitable materials for radiocarbon dating (Table 3). Late Holocene sites are found in all of the topographic zones with a slightly higher percentage (31%) located within the Plateau. Twenty-six percent are located within the West End, 26% are located within the Southern Coastal Terrace, 14% are located within the

Table 1. Prehistoric site categories.

Site Type	Number	Percent of Total
Residential Sites	80	15
Camp Sites	79	15
Stone Artifact Manufacture and Shellfish Processing Locations	164	30
Shellfish Processing Locations	90	17
Flaked Stone Reduction Locations	100	19
Deflated Hearth Features	14	3
Unknown	8	1
Total	535	100

Table 3. Site categories with radiocarbon calibrated dates (*2 sigma, 95% probability) and time of occupation.

Site Category	Late Holocene (ca 3,350 – Present)		Middle Holocene (ca 6,650 – 3,350)		Early Holocene (ca 10,000 – 6650 BP)		Total	
Residential	20	48%	15	68%	3	6%	38	57%
Camp	10	24%	3	14%	0	0%	13	19%
Stone Artifact Manufacture/ Shellfish Processing Location	10	24%	3	14%	0	0%	13	19%
Shellfish Processing Location	2	4%	1	4%	0	0%	3	5%
Flaked Stone Reduction Location	0	0%	0	0%	0	0%	0	0%
Total	42	100%	22	100%	3	100%	67	100%

one (SNI-147) is situated within the Northern Coastal Terrace. The majority of the sites on the West End of the island represent middle Holocene occupations. The sites on the Plateau, the Southern Coastal Terrace, and the Northern Coastal Terrace were occupied during the late Holocene (Table 5).

The Thousand Springs site (SNI-11) is an extensive shell midden that overlooks the northwest coast of the West End topographic zone. The site is named for the freshwater springs located approximately 130 m to the west. The midden covers a series of large, linear dunes and includes four mounds. Three mounds contain late and middle Holocene occupations and one mound produced an early Holocene date. The large quantities of fish remains from all occupational strata suggest that fishing was the most important subsistence activity and that the fishing effort intensified during the late Holocene. Rockfish (*Sebastes* sp.) constitute 63% of the total minimum number of individuals (MNI) in the sample. Shellfish were second in importance in the diet, with black abalone seemingly the preferred species (Salls 1988, Martz et al. 1999). Sea mammal remains do not appear to constitute a significant portion of the faunal assemblage (Bleitz-Sanburg 1987). According to Bleitz-Sanburg (1987), by the

late Holocene hunters from SNI-11 had shifted from onshore hunting of large pinnipeds to the hunting of pelagic animals such as cetaceans and sea otter. Her analysis of the avian remains from SNI-11 also indicated a shift toward pelagic species.

SNI-25 is a large late Holocene residential and cemetery site that overlooks the northwest coast from the Plateau topographic zone (Rogers 1930). The site consists of three large sand mounds connected by relatively flat swale areas and adjacent slopes to the north, east and west. The main focus of the occupation appears to have been from ca AD 1200 to 1400, but there is some artifactual evidence suggesting minimal occupation after European contact, perhaps just prior to the removal of the islanders in 1835 (Martz 2002). Based on the fish bone analysis, a wide variety of marine habitats: rocky reefs, kelp beds, open ocean, and sandy near shore habitats were exploited by the prehistoric inhabitants. Rockfishes and surfperches (Embiotocidae) dominate the fish remains sample. The next two prominent family groups are California sheephead (*Semicossyphus pulcher*) and Pacific mackerel (*Scomber japonicus*) (Mariani 2004).

SNI-39 is situated on a series of northwest to southeast trending dunes along the southern coast of

Table 4. Site location and time of occupation.

Topographic Zone	Late Holocene		Middle Holocene		Early Holocene		Total	
Plateau	13	31%	7	32%	1	33.3%	21	31%
West End	11	26%	14	64%	1	33.3%	26	39%
Northern Coastal Terrace	6	14%	0	0%	0	0.0%	6	10%
Southern Coastal Terrace	11	26%	1	4%	1	33.3%	13	19%
Cliffs	1	3%	0	0%	0	0.0%	1	1%
Total	42	100%	22	100%	3	99.9%	67	100%

Table 5. Sites with subsistence data

Site #	Site Category	Topographic Zone	Time of Occupation	Units Excavated	Faunal Analyses Completed	References
SNI-11	Residential	West End	Late and Middle Holocene	15 1.5 x 1.5 m	All Faunal	Reinman 1982, Martz et al. 1999
SNI-25	Residential	Plateau	Late Holocene	Index 1.5 x 1.5 m	Fish	Mariani, in Martz 2004
SNI-39	Residential	West End	Late and Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-40	Residential	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-72	Camp	Southern Coastal Terrace	Late Holocene	Index 1.5 x 1.5 m	Fish	Mariani, in Martz 2004
SNI-73	Residential	Southern Coastal Terrace	Late Holocene	Index 1.5 x 1.5 m	All Faunal	Wake, in Martz 2004
SNI-74	Residential	Southern Coastal Terrace	Late Holocene	Index 1.5 x 1.5 m	Fish	Mariani, in Martz 2004
SNI-76	Stone Artifact Manufacture and Shellfish Processing Location	Southern Coastal Terrace	Late Holocene	Index 1.5 x 1.5 m	Shellfish, Fish	Mariani, Stosel, in Martz 2004
SNI-84	Stone Artifact Manufacture and Shellfish Processing Location	Plateau	Late Holocene	Index 1.5 x 1.5 m	Shellfish, Fish	Mariani, Stosel, in Martz 2004
SNI-102	Camp	Plateau	Late Holocene	Index 1.5 x 1.5 m	All Faunal	Merrill, in Martz 2004, James 2003
SNI-147	Camp	Northern Coastal Terrace	Late Holocene	Index 1.5 x 1.5 m	All Animal Bone	Wake, in Martz 2004
SNI-157	Residential	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-160	Residential	West End	Late Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-161	Residential	West End	Late and Middle Holocene	6 1.5 x 1.5 m	All Faunal	Vellanoweth 1996
SNI-163	Stone Artifact Manufacture and Shellfish Processing Location	West End	Late Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-164	Residential	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-165	Residential	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1998
SNI-168	Residential	West End	Late and Middle Holocene	32 1 x 1 m	All Faunal	Rosenthal and Jertberg 1997
SNI-169	Camp	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1997
SNI-170	Stone Artifact Manufacture and Shellfish Processing Location	West End	Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1997
SNI-171	Residential	West End	Late and Middle Holocene	Index 1.5 x 1.5 m	All Faunal	Rosenthal and Jertberg 1997

the West End topographic zone. The site meets the criteria for a residential site and was occupied during the middle and late Holocene. Fish remains dominate the vertebrate fauna and demonstrate a relatively rich diversity with 21 taxa represented.

Surfperches are the dominant taxa, followed by rockfishes, sardines (*Sardinops sagax caeruleus*), California sheephead and cabezon (*Scorpaenichthys marmoratus*). Mammal remains are underrepresented and consist mainly of metacarpals (flippers)

of two individuals, a harbor seal (*Phoca vitulina*) and a sea otter. Three genera and two species of birds were identified: albatross (*Diomedea* sp.), Brandt's cormorant (*Phalacrocorax penicillatus*) and mew gull (*Larus canus*). The presence of burned avian bones suggests that birds were probably included in the diet (Rosenthal and Jertberg 1998). The black turban snail (*Tegula* sp.) was the dominant shellfish species, followed by owl limpet (*Lottia gigantea*). Small percentages of both black and red abalone (*H. rufescens*) were also present (Rosenthal and Jertberg 1998b).

SNI-40 is a middle Holocene residential site that is situated on a raised, steep dune overlooking the southern coast of the West End topographic zone. A large faunal sample was recovered from this index unit. Fish remains were the dominant fauna and were relatively evenly distributed among surfperch, cabezon, sardines, rockfishes, California sheephead, and Pacific mackerel. Mammal remains were relatively common (194 elements) and included fossil whale (cetacea), sea otter, harbor seal, and California sea lion. The small bird bone sample included northern fulmar (*Fulmarus glacialis*) and cormorant. Shield limpets (*Collisella* sp.) and black abalone dominate the shellfish sample followed by black turban snail (Rosenthal and Jertberg 1998b).

SNI-72 is a late Holocene camp site situated on the eastern portion of the Southern Coastal Terrace topographic zone. Analysis of the fish bone assemblage from this index unit suggests that rockfishes and surfperch, were the dominant fish taxa followed by California sheephead and Pacific mackerel. The marine habitats exploited include rock reefs, sandy near shore, and open ocean (Mariani 2004).

SNI-73 is a late Holocene residential site situated on the eastern portion of the Southern Coastal Terrace topographic zone. Fish remains dominate the faunal assemblage with the emphasis on rock bottom and/or kelp forest species such as rockfishes, cabezon, and California sheephead. The presence of pelagic species such as yellowtail (*Seriola lalandi*), jack mackerel (*Trachurus symmetricus*), Pacific mackerel, barracuda (*Sphyraena argentea*), and ocean sunfish (*Mola mola*) suggest that fishing practices at SNI-73 included the use of watercraft to access the open ocean habitats beyond the kelp forests. Cartilaginous fish are underrepre-

ented and include leopard shark (*Triakis semifasciata*), requiem sharks (*Carcharhinidae*), Pacific angel shark (*Squatina californica*), and Pacific electric ray (*Torpedo californica*). Mammal remains constitute a minor portion of the faunal remains. Sea otter were the most numerous of the identified mammals, followed by pinnipeds, deer mice (*Peromyscus maniculatus*) and dog. Bird remains include geese (Anserinae), Cassin's auklet (*Ptychoramphus aleuticus*), and one toe bone from a hawk (Falconiformes) (Wake 2004). Sea urchin (*Strongylocentrotus* sp.) was the dominant shellfish species with a MNI of 4,764 followed by *Tegula* sp. with a MNI of 2,230. California mussel and black abalone are next with a MNI of 155 and 133 respectively (Stosel 2004).

SNI-74 is a late Holocene residential site situated on the eastern portion of the Southern Coastal Terrace topographic zone. The fish remains sample from this index unit was very small and suggests that fishing was not a main subsistence activity at this site. California sheephead was the dominant fish species followed by rockfishes. There was no evidence for exploitation of the open ocean habitat (Mariani 2004).

SNI-76 is a late Holocene site where the main activities appear to be stone artifact manufacturing and shellfish processing. The site is located within the eastern portion of the Southern Coastal Terrace topographic zone. Rockfishes constitute over 50% of the fish bone assemblage. Surfperch, California sheephead, cabezon, and Pacific Mackerel make up the remainder. The high percentage of rockfishes and to a lesser extent, surfperches (*Amphistichus* sp.), indicate a tendency to focus on rocky reef and sandy nearshore habitats (Mariani 2004).

SNI-84 is a late Holocene stone artifact and shellfish manufacturing location that is situated on the central portion of the Plateau topographic zone. Black abalone appears to have been the main food resource processed at the site. Fish remains include a small number of surfperch, rockfishes, and California sheephead (Mariani 2004). A very small quantity of bird and mammal bones were also recovered (Stosel 2004).

SNI-102 is a late Holocene camp site that is situated in the southwestern portion of the Plateau topographic zone and is located over 2 km from the nearest coastline. The difficulty of reaching the ocean is exacerbated by the rugged cliffs that rise

above the southern coast. The site covers a medium sized sand mound. A deflated area of flaked stone, bone, and shell surrounding the base suggests that the site was much larger prior to the erosion caused by overgrazing during the historic sheep ranching era and that the portions that were not armored by shell have eroded away. Fish comprise 97% of the vertebrate assemblage and include salmon shark (*Lamna ditropis*), cabezon, surfperch, and California sheephead. Mammals account for only 2.4% of the assemblage. Terrestrial mammals include the San Nicolas Island deer mouse (*P. maniculatus dexterus*) and an island fox sized canid (*U. littoralis dickeyi*). Marine mammal remains are few and indicate the procurement of a pinniped and sea otter. A small amount of bird bone is also present (James 2003). After fish, shellfish are the second most important food source at the site. The dominant species is the turban snail. Black abalone, California mussel, and owl limpet were also important (Stosel 2004). Merrill (2004) suggests that increases and decreases in California mussel and black turban snails through time indicate that the inhabitants of SNI-102 followed an alternating procurement strategy with respect to the harvesting of California mussel and *Tegula* sp. In this scenario, California mussel populations were intensively harvested for a lengthy period of time. The removal of the mussels promoted growth in *Tegula* sp. as the algae they feed on covered the bare patches of rock. The *Tegula* sp. were harvested for an equivalent period of time, giving the mussel populations time to recover.

SNI-147 is a late Holocene camp site that overlooks the ocean on the western portion of the Northern Coastal Terrace topographic zone. Both cartilaginous and bony fish are well represented at SNI-147 with rockfishes, and surfperch the dominant species. These along with cabezon, bass (*Paralabrax* sp.) and California sheephead indicate fishing in rocky bottom and the kelp forest. California halibut (*Paralichthys californicus*) occur in greater quantities at SNI-147 than at any of the sites in this study. Herrings (Clupeidae) are also well represented. The ocean sunfish is represented by two specimens. The ocean sunfish along with yellowtail and Pacific mackerel suggest the use of watercraft to capture these open ocean species. The bat ray (*Myliobatis californica*) is the dominant cartilaginous fish in the assemblage.

Carcharhinidae (requiem sharks, dogfish [*Squalus* sp.]), skates (Rajidae) and the Pacific electric ray were also exploited from the site. The relatively high frequencies of California halibut and bat ray suggest a secondary focus on fishing in sandy bottom habitats. Mammals are underrepresented. The most numerous mammal remains were those of pinnipeds and sea otter. Birds are represented by just two bone fragments and are notably rare when compared to their presence in other San Nicolas Island faunal assemblages (Wake 2004).

SNI-157 is a middle Holocene residential site that is situated within the dune fields of the southern portion of the West End topographic zone. The quantity of fish remains in this index unit is relatively small when compared to SNI-40, where an index unit of equal depth was excavated. Also of interest is the fact that sardines comprise 43% of the fish remains. Surfperch are next in importance, while common species, such as California sheephead and rockfish are few in number. Mammal remains are represented by three individuals of three taxa: harbor seal, Guadalupe fur seal (*Arctocephalus townsendi*), and California sea lion. Bird remains are numerous with 852 elements, six genera and eight species. Albatrosses and northern fulmars (*Fulmarus glacialis*) are the dominant species in the bird bone assemblage. The black turban snail and the black abalone constitute the majority of the shellfish species (Rosenthal and Jertberg 1998b).

SNI-160, a late Holocene residential site, is situated on the coast within the southern portion of the West End topographic zone. This index unit was excavated to 120 cm and produced extensive artifact, fish, marine mammal, and shellfish remains. Rockfishes are the most prevalent fish and constitute 33% of the total MNI. Surfperch are the next most common followed by the California sheephead. Pacific sardine and jack smelt (*Atherinopsis californienus*) are also present in relatively large numbers. Pelagic fishes such as the bill fish (*Istiophoridae* sp.), yellowfin tuna (*Thunnus albacares*), Pacific mackerel and jack mackerel are also present. The fish bone assemblage also includes a species that has not been previously observed in the archaeofauna at San Nicolas Island, the diamond turbot (*Hypsopsetta guttulata*). The fish remains indicate that the prehistoric occupants exploited four

marine habitats: rocky intertidal (rockfishes), kelp forest (California sheephead and perch species), outer ocean (Pacific mackerel), and sandy bottom (Pacific sardine and jack smelt). Land mammal remains indicate the presence of deer mouse, dog, and Island fox. Sea mammal remains include sea otter, harbor seal, and California sea lion. Fragments of a Cetacean and an unidentified dolphin were also recovered. A minimum of nine bird taxa were identified. These include black-footed albatross (*Phoebastria nigripes*), cormorant, common raven (*Corvus corax*), fulmar, and peregrine falcon (*Falco peregrinus*). The eatable shellfish fauna is dominated by black abalone, purple sea urchin (*S. purpuratus*) and black turban snail. (Rosenthal and Jertberg 1998b).

SNI-161 is a residential site situated on the coast within the southern portion of the West End topographic zone. The site was occupied during the late and middle Holocene. Fish remains were identified using otoliths. Surfperch comprised 75% of the otolith sample followed by rockfishes. For the purposes of dietary reconstruction, fish, sea mammal, and bird were identified at the class level. Based on this analysis, fish was the most important source of protein and accounted for approximately 49% of the total amount of protein consumed at the site. Shellfish, with 43% of the protein total, contributed only slightly less. Sea mammal and bird account for seven and one percent respectively of the available protein. Red abalone was the dominant shellfish species and accounted for 70% of the protein provided by shellfish (Vellanoweth 1996).

SNI-163 is a stone artifact manufacturing and shellfish processing location that was in use during the late Holocene. It is situated on the southern coast within the West End topographic zone. The index unit produced a relatively large quantity of fish remains with kelp forest species such as surfperch and California sheephead dominating the assemblage. Rockfishes are next in importance and pelagic fishes, such as Pacific mackerel, indicate some outer ocean fishing was practiced by the inhabitants of the site. A very small number of marine mammal elements were present and were identified as sea otter and harbor seal. A large number of bird remains were found at the site including the greatest number of cormorant bones of any of the sites analyzed to date. The black turban snail is the most common shellfish species

followed by owl limpet and black abalone (Rosenthal and Jertberg 1998a).

SNI-164, a middle Holocene residential site, extends across the crest of a linear dune within the southern portion of the West end topographic zone. The dune is heavily eroded and the midden deposits are relatively shallow (40 cm). The faunal assemblage at SNI-164 had few marine mammals with fish and bird the prevalent fauna. The fish remains sample from this index unit is relatively large considering the shallow deposit. Surfperch were the dominant fish species followed by rockfishes. "A single cleithrum of a large billfish that does not match any common swordfish or marlin was collected." (Rosenthal and Jertberg 1998a:45). The authors speculate that this may be a Hawaiian or other tropical species. The sea mammal remains were badly fragmented and only one element was identified to a specific taxa, California sea lion. SNI-164 contained a large assemblage of bird bones. The bird remains demonstrate considerable taxonomic diversity with 14 taxonomic categories, including three genera and three identified species. The majority of the bird fauna are Procellariiformes (albatrosses) and fulmars. The authors describe the quantity of bird remains as the second largest bird fauna sample in the west end study area. Conversely, the MNI of shellfish is low compared to the other sites that were excavated within this topographic zone. Black abalone is the dominant shellfish species followed by California mussel (Rosenthal and Jertberg 1998a).

SNI-165 is a middle Holocene residential site situated on a northwest to southeast trending dune within the southern portion of the West End topographic zone. The excavation of the index unit revealed that in addition to shellfish processing, shell bead manufacture was an important activity in this area of the site. This may provide at least a partial explanation for the predominance of shellfish and the small quantities of fish, mammal, and bird recovered from the unit. Surfperch and cabezon constitute the majority of the fish fauna. It is interesting that rockfishes, which seem to have been a favorite target of the prehistoric fishermen, constitute only four percent of the fish remains in this sample. The small sample of marine mammal remains included sea otter, harbor seal, and California sea lion. The bird fauna included the remains of two species of cormorant (*Phalacro-*

corax auritus and *P. penicillatus*). This relatively shallow index unit (30 cm) produced over 20,000 grams of identified shellfish with a MNI of 3,832. The black turban snail was the dominant shellfish species, followed by sea urchin and black abalone (Rosenthal and Jertberg 1998a).

SNI-168 is a large residential site that was occupied during the late and middle Holocene. The site is situated within the southern portion of the West End topographic zone and consists of six spatially separate cultural deposits or loci. Four loci are within the area of potential impacts for proposed military activities and 32 1- x 1-m units were excavated as data recovery mitigation. The fish fauna sample from the 32 units is small (9,119 specimens) when compared with the yield from six index units that were excavated within this same topographic zone (14,882) (Rosenthal and Jertberg 1997, 1998a). Surfperch are the most prevalent, followed by rockfishes and cabezon. These species were captured from rocky bottom and kelp forest habitats. A few species from the sandy bottom habitat are present, but open ocean species are poorly represented. Three hundred and four marine mammal specimens were recovered. The majority of the identified specimens are sea otter. Two specimens were identified as California sea lion. The bird bone assemblage is also small (133 fragments). Cormorants are the dominant species followed by fulmers or shearwaters (Procellariidae). The shellfish sample includes 22,238 specimens with a MNI of 13,225 shellfish. Turban snails represent 66% of the individual shellfish count (Rosenthal and Jertberg 1997).

SNI-169 is a middle Holocene camp site that is situated within the southern portion of the West End topographic zone. The vertebrate faunal sample from this index unit consists of only 166 specimens. Fish fauna represent the most abundant species with eight taxa, each consisting of only one individual. The majority of the specimens represent various species of surfperch. The remainder includes California scorpionfish (*Scorpaena guttata*), cabezon and rockfish. Marine mammal remains were not present and the only mammal was the white-footed deer mouse. Bird remains were not present. Shellfish represent the dominant faunal food resource. The majority of the specimens are *Tegula* sp. with 1,250 MNI, followed by black abalone with 77 MNI, and owl limpet with 76 MNI;

both of which provide much more meat per individual than *Tegula* (Rosenthal and Jertberg 1997).

SNI-170 is a middle Holocene site that is situated within the southern portion of the West End topographic zone. The main function appears to have been stone artifact manufacturing and shellfish processing. Very few vertebrate remains were recovered from the index unit at this site. Birds, mammals, and reptiles are represented, but the assemblage is so small (10 specimens) that it is unclear whether the fauna is archaeological or natural. The shellfish assemblage is larger (97 specimens), but very limited when compared with the other index units. The majority of the shellfish specimens are California mussel (Rosenthal and Jertberg 1997).

SNI-171 is a large residential site that was occupied during the late and middle Holocene. It is situated on a longitudinal dune within the southern portion of the West End topographic zone. Fish constitute the most abundant and diverse of the faunal remains recovered from this index unit. The majority of the fish remains are rockfishes followed by surfperch, and California sheephead. Of the 76 sea mammal bones, sea otter is the most common, followed by cetacean of the Delphinidae family, and pinnipeds, including California sea lion and harbor seal. Bird remains consist of 12 specimens that include double-crested cormorant and murrelets (*Synthliboramphus hypoleucus*). The shellfish remains include 4,965 individuals. *Tegula* sp. provided the largest number of individuals (1,573). However, black abalone with a MNI of 643 and California mussel with a MNI of 568 undoubtedly provided the greater amount of meat and protein (Rosenthal and Jertberg 1997).

DISCUSSION

The earliest occupation of San Nicolas Island occurred in the early Holocene as evidenced by a single mussel shell from CA-SNI-339, a large habitation site on the southeastern end of the island, which was radiocarbon dated to 8,505 BP (Schwartz and Martz 1992). The earliest dates at the other two early Holocene sites, CA-SNI-11 and CA-SNI-351, are 6,679 BP and 5,928 BP, respectively (Schwartz and Martz 1992, Martz 1994b). The three sites are located within three of

the topographic zones: Plateau (SNI-351), Southern Coastal Terrace (SNI-339), and West End (SNI-11). Early investigators suggested that the southeastern portion of the island contained the oldest settlements because of the amount of erosion and the location facing the mainland (Bryan 1970). Radiocarbon dating of samples from the badly eroded sites in this region is necessary to test this theory. Other coastal camps may have been settled and eventually submerged. The island lost almost one-third of its land mass between 9,000 and 7,000 years ago due to rising sea levels (Bickel 1978, Johnson 1983, Minerals Management Service 1987). It has been proposed that these early settlers hunted sea mammals such as California sea lion, fur seal, otter and harbor seal (Bleitz-Sanburg 1987). They gathered mussels from the rocky shore and dove for large red abalone and large wavy turban (*Astraea undosa*) that are most abundant in cool, deep waters (McLean 1978). Small near shore fish, such as perch (Embiotocidae) were also exploited.

Twenty-two sites were occupied during the middle Holocene ca. 6,000–3,000 BP with the majority situated within the West End topographic zone where fresh water is available and there is easy access to the ocean. The high percentage of residential sites (68%) suggests that the occupants were able to support the middle Holocene population with the resources that were readily available from the village and that there was little necessity to establish camps or special activity areas for this purpose. As the population increased the response appears to have been a change in subsistence practices rather than settlement pattern. There is a notable increase in the diversity of fish taxa as kelp forest dwelling rock fish, cabezon and California sheephead are added to the diet (Rosenthal and Jertberg 1998a, b). The exploitation of large marine mammals for food becomes less important and the fur-bearing sea otter replaces the larger marine mammals (Bleitz-Sanburg 1987, Bleitz 1993). Ethnographic and historic data indicate that sea otter furs were worn by high status individuals and were traded widely (Kroeber 1925, Priestly 1937). There are changes in shellfish exploitation as well, as mussels, red abalone and wavy turban become less important and are gradually replaced by black abalone, turban snail, limpets (*Collisella* sp. and *L. gigantea*) and sea urchin (Rosenthal and Jertberg 1998a, b).

Population expansion during the late Holocene is evidenced by an increase in the number and types of sites and the development of large dense middens. The distribution of sites throughout the island, the increase in the number of residential sites, and the increase in the number of camps and special activity sites suggest that significant changes in the settlement pattern were necessitated by the growing population. The majority of the plateau midden sites were occupied during the late Holocene. The numerous shell middens within the Plateau topographic zone are notable. These sites are situated at or above the 120-m elevation and anywhere from 0.8 to 2.5 km from the coast. This indicates that the islanders were bringing the fish and shellfish to these locations for processing even though the sites were not near the ocean. A possible explanation is that the relatively flat Plateau topographic zone can accommodate large gatherings. There is evidence to suggest that SNI-351, a residential site with a significant midden deposit, was a summer gathering place (Martz 1994b). The location away from the coast may also be ideal for fish and shellfish processing and feasting because it is away from annoying kelp flies. SNI-73 and SNI-351 produced calibrated radiocarbon dates that range between AD 1005–1200 and AD 1194–1295, respectively. However, the majority of the late Holocene radiocarbon dates do not fall within the range of the 150-year drought that occurred AD 1150–1250. Therefore, it is likely that the island experienced a population decrease in during this period.

As the late Holocene develops, pelagic fish such as Pacific mackerel, yellowtail, jack mackerel, bill fish, barracuda and ocean sunfish become prominent seasonal resources. By 2,000 years ago, sardines and cartilaginous fish (Elasmobranchiomorphi) are added to the diet and large sea mammals all but disappear from the middens (Mariani 2001). The near absence of large sea mammals from the late Holocene sites seems incomprehensible given the large population of sea lions and elephant seals that occupy the island today. A possible explanation may lie in the increase in the number of late and middle Holocene residential sites that were situated within or near the sea mammal haul out areas. It follows that the proximity of a large human population would result in the reduction of the sea mammal

population. An additional factor could be the lack of fuel for the rendering of the animals due to the absence of trees on the island. The replacement of red abalone by the near shore black abalone appears to have occurred throughout the California Channel Islands during the late Holocene and has variously been attributed to sea temperature change and/or human predation (Glassow et al. 1988, Salls 1992, Rosenthal and Jertberg 1998a and b).

The quantity of marine resources at the excavated sites suggests an almost total reliance on the ocean for subsistence. At CA-SNI-160, a large coastal dune site on the west end of the island, slightly more than a cubic meter of deposit produced 238 kg of shellfish with MNI count of over 38,000. Fish elements in the same unit totaled 64,000 with a MNI of 489. At CA-SNI-11, units placed in the middle to late Holocene component and screened with 1/4-inch (0.64-cm) mesh, produced an estimated density of 5,293 fish elements/m³. This led Salls (1988) to compare the intensity of the fishing effort with that of a modern commercial fishery.

New equipment and techniques accompany the subsistence changes during the late Holocene. In addition to watercraft, the most important innovation was hook and line technology featuring the incurved, circular fishhook and cordage equal to a greater than 20-pound (9.07-kg) test line (Mariani 1997). Fish processing and storage techniques also change during the middle to late Holocene. A high incidence of fish cranial elements at the coastal sites suggest that the fish were beheaded, filleted and either smoked or dried for storage or trade (Mariani 2001).

The relative isolation and dependence upon marine resources may have led to changes in cultural behavior. Ritual behavior manifested on the mainland and other southern Channel Islands was absent on San Nicolas Island. Evidence for ceremonies involving raptor burials, cairn offerings, or *Datura* consumption attributed to the Takic speakers of the Uto-Aztecan stock who reportedly occupied the southern Channel Islands at the time of European contact has not been identified. Instead, effigies and rock art indicate an emphasis on elements of the ritual cosmos relating to marine animals, such as seals, porpoises, sharks, and whales.

SUMMARY

Changes in settlement and subsistence from the earliest known settlements, approximately 7,000 years ago, to just prior to European contact include a significant population increase during the late Holocene, an increase in the number of camp and special activity sites, expansion into all five topographic zones, and shifts in subsistence strategies culminating in an intensive fishery. These changes are supported by improved fishing technology and ritual behavior emphasizing marine animals. The radiocarbon dates suggest that there was a significant population decrease during the 150-year drought that affected the region during the period of AD 1100–1250.

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