Subsistence Remains and Intensification on the Newport Coast, Orange County, California

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Abstract

Subsistence data from the Newport Coast Archaeological Project (NCAP) in coastal Orange County, California, are discussed. The project's subsistence remains include marine invertebrate shell, fish bone, non-fish bone, and macrobotanical remains. The data for each of these categories indicates that subsistence intensification took place in the Late Prehistoric period., but not in the Milling Stone period. There is some evidence indicating that intensification began in the Intermediate period. There was a shift from collection of larger shellfish (mussels) and capture of larger fish (sheephead, *Semicossyphus pulcher*) in the Milling Stone period to exploitation of smaller, but more numerous shellfish (small gastropods) and smaller fish (blacksmith, *Chromis punctipinnis,* and señorita, *Oxyjulis californica*) in the Intermediate and Late Prehistoric periods. There is also some evidence for managed burning to promote seed production and management of native barley to increase seed size during the Late Prehistoric period when resources were transported greater distances from their source to the residential base.

Introduction

The Newport Coast Archaeological Project (NCAP) provided a unique opportunity to study coastal settlement systems on a regional scale. All 37 sites located along the coast and in the adjacent San Joaquin Hills of Orange County, California, were investigated using the same research design (Mason 1991) and field and analytic methods. The NCAP was a data recovery program to provide mitigation for cultural resources that would be impacted by development of the Newport Coast Planned Community (NCPC). The NCAP was funded by Coastal Community Builders, a division of The Irvine Company.

The NCPC was developed within a tract of land about 4.5 square miles in area which extends from the Pacific Ocean to Signal Peak, a high point within the San Joaquin Hills with an elevation of 355 m asl (1,165 ft) (Figure 1). Topography includes marine terraces along the ocean coast, Pelican Hill which rises steeply above the marine terraces reaching an elevation of 217 m asl (711 ft), and a series of ridges and steep canyons located further inland in the San Joaquin Hills. Two of these canyons, Buck Gully and Los Trancos Canyon, are major drainages within the tract that extend from the flanks of Signal Peak to the ocean.

The project began in 1988, and during the following five years hundreds of units were excavated. The sampling strategy at open sites was to excavate systematically spaced 2 x 2 m units across the site. Each 2 x 2 m unit was divided into four 1 x 1 m quadrants. At most sites the spacing was 7 m from unit datum to unit datum which left 5 m unexcavated between each unit. This resulted in an 8 percent sample of the site area. The systematically spaced units provided the statistical sample and was quasi-probabilistic in the sense that all parts of the site were equally represented. The statistical sample provided a picture of the heterogeneous spatial distribution of all categories of cultural material across the site. The large unit size (2 x 2 m) increased the likelihood of encountering features.

Figure 1. Location of Newport Coast Archaeological Project (NCAP) shown on a portion of the 1901 USGS Santa Ana topographic map (scale = 1:62,500).

In addition to the systematic, statistical sample, a purposive sample of judgmentally placed units was excavated in open sites to find and expose fire-affected rock features. In most cases, placement of the purposive units was based on the location of magnetometer anomalies. When features were encountered, purposively placed 1 x 1 m "expansion" units were excavated to fully expose the feature and recover the associated cultural material. These purposive or judgmentally placed units provided increased samples of areas of more concentrated cultural material associated with the features. Soil samples for flotation were also taken purposively from features to maximize recovery of macrobotanical remains.

In rockshelters, site areas were small, and much larger samples could be excavated. In small rockshelters 100 percent of the archaeological deposit was excavated using contiguous 1 x 1 m units. In large rockshelters over 60 percent of the deposit was excavated.

All excavated material was waterscreened using 1/8 inch mesh. All the material that remained in the screen was sorted and identified except for material from CA-ORA-662, a large dense open site, and from the rockshelter sites with dense deposits. Samples were selected for sorting and identification in these sites. In some small rockshelters, numbers of artifact types and faunal taxa (richness) are low, but this cannot be attributed to small sample size.

Recovered materials were sorted and cataloged using a coding system. The coded data from over 1,700 m^3 of excavated material were entered into a database, proofed, and computer verified. The resulting database contains over 200,000 records and was used to generate the data tables in this paper (Mason and Peterson 1994).

Chronology for the NCAP was based on 300 radiocarbon dates. The dates are expressed in calibrated radiocarbon years BP. Dates based on marine shell samples were corrected for upwelling using a locally derived correction factor. The chronological unit names are based on Wallace (1955) as applied to Orange County by Koerper and Drover (1983). The beginning and end points for the periods and subperiods were defined based on a frequency distribution of the 300 radiocarbon dates. The periods and subperiods used in the NCAP are given in Table 1.

Table 1. Periods and Subperiods with Their Temporal Ranges.

Periods and Subperiods	Temporal Range
Paleo-Coastal period	
PC	Prior to 8000 BP
Milling Stone period	
MS1	8000–5800 BP
MS2	5800–4650 BP
MS3	4650–3000 BP
Intermediate period	
IM	3000–1350 BP
Late Prehistoric period	
LP1	1350–650 BP
LP2	650–200 BP

The excavated material was analyzed by component (material from a specific time period at a site). There were 23 Late Prehistoric period components and 7 Milling Stone period components (Table 2).

The Milling Stone period components are from sites located on the marine terraces. Most of the Milling Stone period material comes from components that date to the Milling Stone 2 subperiod (5800–4650 BP). The sites on the hills and ridges and in the canyons were mostly occupied during the Late Prehistoric period (1350–200 BP) (Mason and Peterson 1994). Characteristics of the analyzed sites are presented in Table 3. Site locations are shown in Figure 2.

There were no sites in the NCAP project area that date to the Intermediate period (3000–1350 BP). Data from the Intermediate period used later in this paper are from the related Bonita Mesa Archaeological Project (BMAP) (Peterson 2000). The methods used in the NCAP were also those used in the BMAP. The BMAP project area is northwest of the NCAP project area on a terrace at the lower north slope of the San Joaquin Hills. The terrace (Bonita Mesa) is south of Bonita Creek which drains to Newport Bay. The major site investigated as part of the BMAP is CA-ORA-106. This site has components that date to the Intermediate period and to the Late Prehistoric period. All data on faunal use in the Intermediate period used in this paper are from the Intermediate period component of ORA-106.

All NCAP sites are located within a few kilometers of the ocean, and the sites in the San Joaquin Hills are located about 6 km from upper Newport Bay. ORA-106 is located about halfway between Newport Bay and the Newport Coast Late Prehistoric sites on the hills and ridges of the western San Joaquin Hills.

A large number of marine habitats and terrestrial plant communities were available to occupants of the Newport Coast sites. Marine resources consist of two

Table 2. NCAP Components Listed by Subperiods.

MS2	MS3	LP1	LP2
ORA-660	ORA-664 Upper	ORA-662 Area 2	ORA-662 Area 3 W
ORA-664 Lower	ORA-928	ORA-662 Area 6	ORA-662 Area 3 E
ORA-665		ORA-662 Area 13	ORA-662 Area 5
ORA-667		ORA-663	ORA-671 Upper
ORA-929		ORA-673 East	ORA-672 Upper
		ORA-671 Lower	ORA-673 West
		ORA-672 Lower	ORA-674
		ORA-675	ORA-676
		ORA-682	ORA-678
		ORA-1203	ORA-679
		ORA-1206	ORA-1204
			ORA-1205

sets of marine fauna, one from Newport Bay and the other from the ocean coast. Midden analysis of sites around Newport Bay indicates that the most important Newport Bay resources were fish from the shark/ray family, especially the bat ray (*Myliobatis californica*) and the shovelnose guitarfish (*Rhinobatis productus*), and shellfish, especially cockles (*Chione* spp.), scallops (*Argopecten* sp.), and oyster (*Ostrea lurida*). The most important ocean coast resources were the California sheephead fish (*Semicossyphus pulcher)* and the mussel (*Mytilus californianus*). The availability of marine resources, especially shellfish, provided a reliable daily source of protein that reduced survival risks. The most important terrestrial resources were hard seeds from the sage family, goosefoot, native grasses, and native barley. These supplied most of the calories in the diet. The most important terrestrial animal food was rabbit.

Site types were defined through statistical analysis based on the proportions of functional artifact types. The site types were identified through exploratory analysis using correspondence analysis (dual optimal scaling). The site types were confirmed using canonical discriminant analysis (Mason and Peterson 1994). Two site types, residential bases and locations, were defined for the Milling Stone period. The site types defined for the Late Prehistoric period were the major residential base, the minor residential base, and specialized activity loci. The Milling Stone period residential bases consisted of numerous fire-affected rock (hearth features) with associated tools, debitage, and subsistence waste (shell, animal bone, and charred seeds) located on the marine terraces near the ocean shoreline. They were likely seasonally occupied during the summer. The locations were places where resources were procured or processed. There is no evidence for overnight stays (no fire-affected rock). The Late Prehistoric major residential bases were multi-seasonal (probably occupied during late spring, summer, and fall), had numerous hearth features, and had high densities of tools and subsistence waste (see Mason [2008] for a description of an NCAP major residential base). Minor residential bases had hearth features but were smaller and had lower densities of tools and subsistence waste. They were probably occupied for a few weeks at a time by people who came from a major residential base to procure resources near the minor residential base.

Table 3. Characteristics of Sites Investigated by the NCAP.

Site (ORA-)	Landform	Open/RS	Type Invest.	Period	Area (M^2)
339	Marine Terrace	Open	DR	MS/LP	2,000
340	Marine Terrace	Open	DR	MS/LP	1,050
660	Marine Terrace	Open	DR	MS	3,210
664	Marine Terrace	Open	DR	MS	7,000
665	Marine Terrace	Open	DR	MS	2,950
667	Marine Terrace	Open	DR	MS	14,000
928	Marine Terrace	Open	DR	MS	5,000
929	Marine Terrace	Open	DR	MS	30,000
1208	Marine Terrace	Open	DR	MS	580
1231	Canyon Floor	Open	DR	MS	130
232	Ridge	Open	DR	LP	3,300
233	Ridge	Open	SC	?	1,030
662-1	Hilltop	Open	DR	LP	85
662-2	Hilltop	Open	DR	LP	960
662-3W	Hilltop	Open	DR	LP	6,260
662-3E	Hilltop	Open	DR	LP	7,490
662-4	Hilltop	Open	DR	LP	5,750
662-5	Hilltop	Open	DR	LP	1,220
662-6	Hilltop	Open	DR	LP	3,030
662-13	Hilltop	Open	DR	LP	9,120
663	Hilltop	Open	DR	LP	4,720
671	Ridge	Open	DR	LP	520
673	Hilltop	Open	DR	LP	15,000
675	Ridge	Open	DR	LP	700
683	Hilltop	Open	DR	MS?/LP	9,000
684	Near Ridge	Open	DR	MS/LP	1,500
1203	Ridge	Open	DR	LP	970
1205	Ridge	Open	DR	LP	100
672	Ridge	RS	DR	LP	450
674	Side of Canyon	RS	DR	LP	40
676	Side of Canyon	RS	DR	LP	230
677	Side of Canyon	RS	DR	LP	25
678	Side of Canyon	RS	DR	LP	145
679	Side of Canyon	RS	DR	LP	85
682	Side of Canyon	RS	DR	LP	50
1204	Side of Canyon	RS	DR	LP	35
1206	Side of Canyon	RS	DR	LP	30
1210	Side of Canyon	RS	DR	LP	35

Note: RS = rockshelter; MS = Milling Stone period; DR = data recovery; SC = surface collection; LP = Late Prehistoric period.

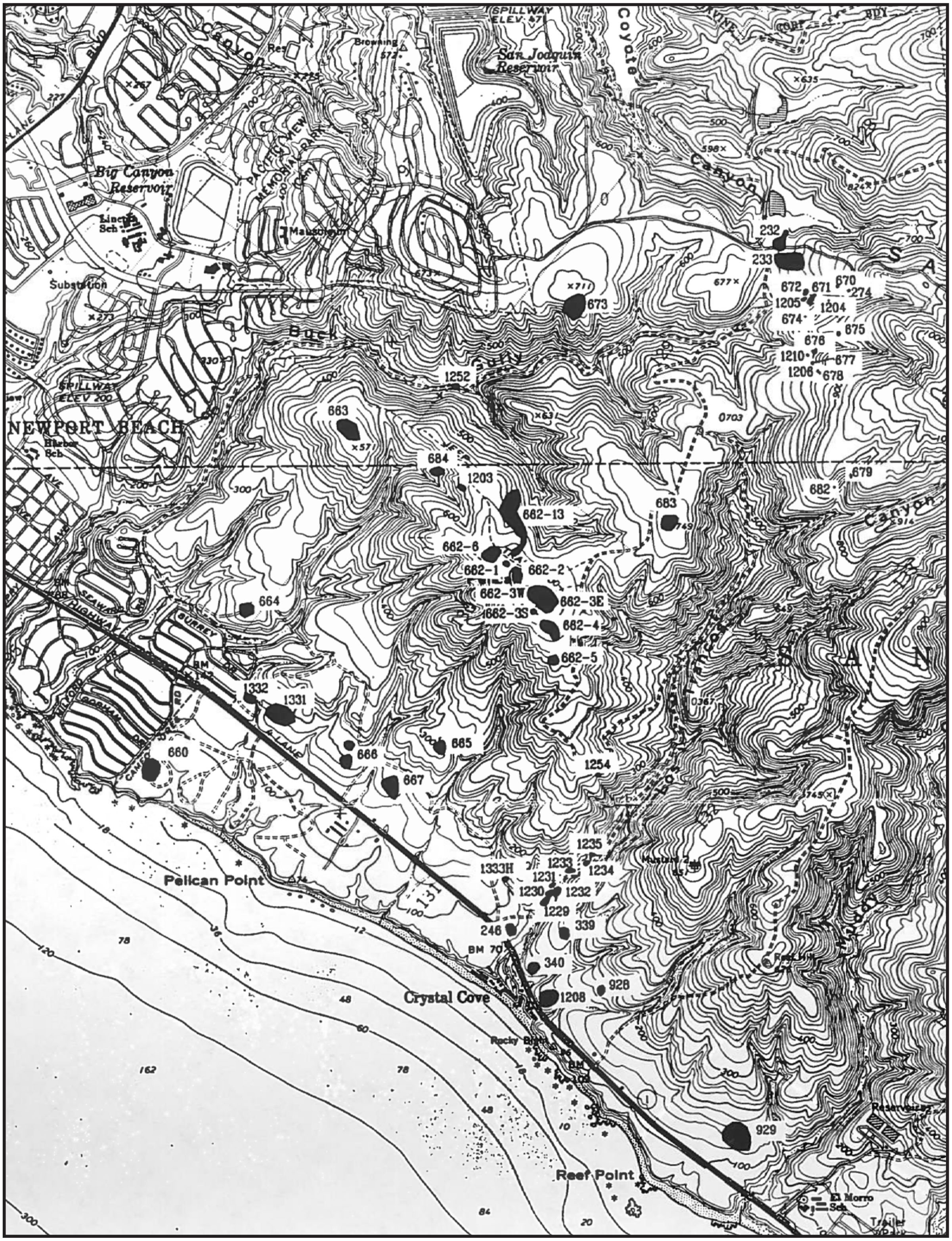

Figure 2. Location of the Newport Coast Archaeological Project sites.

Major residential bases are differentiated from minor residential bases by having much higher densities of subsistence waste and tools. Major residential bases have an average of 5.2 tools per 1 m^3 while minor residential bases have an average of 1.5 tools per 1 m^3. Major residential bases have substantially higher quantities of beads and ornaments, awls, and projectile points. These are items that would have been stored in a house, and it is likely that houses were only found at major residential bases. Specialized activity loci were places where one or two activities were carried out without staying overnight. They were often gender-specific and included places where either women ground seeds (artifacts consisted almost entirely of ground stone tools) or places where men manufactured or maintained flaked stone tools (artifacts consisted mostly of debitage).

All the NCAP Late Prehistoric site types occurred within an area of about 4 km^2, and sites were no more than 2.5 km apart. It is unusual that the minor residential bases should be so close to the major residential bases, since it is hypothesized that people stayed overnight in minor residential bases when they were too far from a major residential base to make a round trip from the major residential base on the same day. It is possible that the minor residential bases were used by people from major residential bases located outside the NCAP project area. It is thought that the NCAP Late Prehistoric sites were within the territory of the village of Genga (CA-ORA-58) located on the lower Santa Ana River (Koerper et al. 1996). The territory of Genga probably included the east bank of the Santa Ana River, Newport Bay, the western San Joaquin Hills, and the Tustin Plain. Thus, there were many major residential bases outside the NCAP project area but within the territory of Genga. It is hypothesized that the people who occupied the major residential bases throughout the territory lived in the village of Genga during the winter.

This paper provides quantitative data on the subsistence remains found in the NCAP sites which date to the Milling Stone period and Late Prehistoric period. Data for the Intermediate period comes from ORA-106 on Bonita Mesa. The subsistence remains include shell from marine invertebrates, fish bone, terrestrial and marine animal bone, and charred seeds. The data provide the basis for a discussion of the various forms of subsistence intensification that took place in the Newport Coast area.

Marine Invertebrate Faunal Remains

Minimum number of individuals (MNI) was calculated for each identified marine invertebrate taxon (shellfish) recovered from all analyzed components. The taxa were then rank ordered from most to least MNI and were segregated by time period . Shellfish MNI estimates were obtained by dividing the number of hinges from bivalve taxa by two and counting apices and other non-repetitive elements (NRE) from univalves as single individuals (Mason et al. 1998). The percentage of the total MNI represented by each taxon was also calculated. The major taxa for each time period were defined as those taxa that made up at least 1 percent of the total MNI for the time period. Table 4 presents the major taxa for the Milling Stone period, and Table 5 presents the major taxa for the Late Prehistoric period. All taxa, including those that make up less than 1 percent of the total MNI, are shown in Mason and Peterson (1994:Table 4-47).

Tables 4 and 5 show very different proportions of major species between the Milling Stone period components and the Late Prehistoric period components. During the Milling Stone period there was a subsistence focus on mussels (*Mytilus* sp.) from the rocky shores habitat near the sites located on the marine terraces. Milling Stone period shellfish procurement (Table 4) emphasized collection of a single species from a nearby habitat. Most of the other major species (those that make up more than 1 percent of the total MNI) also came from the rocky shores habitat and were probably collected if found in association with

Table 4. Major Shellfish Taxa of the Milling Stone Period.

Taxa	Common Name	Percent	Habitat
Mytilus spp.	Mussel	78	Rocky Shores
Pollicipes polymerus	Gooseneck barnacle	5	Rocky Shores
Acmaea sp.	Limpet	3	Rocky Shores
Ostrea lurida	Oyster	3	Bay/Outer Coast
Chione spp.	Venus clam	2	Bay/Outer Coast
Balanus spp.	Barnacle	2	Rocky Shores
Septifer bifurcatus	Bifurcate mussel	2	Rocky Shores
Argopecten sp.	Scallop	1	Bay/Estuary

Table 5. Major Shellfish Taxa of the Late Prehistoric Period.

Taxa	Common Name	Percent	Habitat
Argopecten sp.	Scallop	39	Bay/Estuary
Ostrea lurida	Oyster	19	Bay/Outer Coast
Crepidula sp.	Slippersnail	14	Rocky Shores
Chione spp.	Venus clam	11	Bay/Outer Coast
Mytilus spp.	Mussel	7	Rocky Shores
Crucibulum sp.	Cup-and-saucer	4	Rocky Shores
Pollicipes polymerus	Gooseneck barnacle	3	Rocky Shores

mussels. Three of the major species, *Ostrea lurida* (oyster), *Chione* spp. (cockle), and *Argopecten* sp. (scallop), occur in other habitats. *Chione* and *Ostrea* can be found along the protected outer coast and in bays and estuaries. *Argopecten* is found only in bays and estuaries. It is not known whether these shellfish were collected in Newport Bay or whether protected habitats, possibly even small estuaries, were present at the mouths of canyons along the coast 5,000 years ago prior to sea level stabilization. Sea level may have been slightly lower at this time and may have been conducive to estuary formation at canyon mouths. In any case, these three species combined comprised only 6 percent of the Milling Stone period MNI.

In Late Prehistoric components (Table 5) the taxa are more evenly distributed among bay, bay/outer coast, and rocky shores habitats. Of the major taxa, *Argopecten*, an exclusively bay taxon, comprises 39 percent of the MNI, while bay/outer coast taxa make up 30 percent of the MNI. Rocky shores taxa comprise 28 percent. The *Argopecten* must have been collected from Newport Bay. It is also likely that most of the *Ostrea* and *Chione* were also collected in the bay. If the taxa from the bay/estuary habitat and the bay/outer coast habitat are combined, 69 percent of the shellfish MNI came from Newport Bay and 28 percent came from the rocky shores of the open coast. The Late Prehistoric components are located in the hills and canyons and were not directly adjacent to either the bay or the ocean coast; both habitats were being exploited, and much greater effort was being expended in transporting shellfish to residential bases. Although there are major differences in species composition between Milling Stone components and Late Prehistoric components, there is little difference in number of taxa (richness). The average richness of taxa for Late Prehistoric major residential bases is 49, and the average richness for Milling Stone residential bases is 44.

It is significant that among the taxa from the rocky shores habitat found in Late Prehistoric components, *Crepidula* sp. represents a greater proportion of the MNI than *Mytilus*. *Crepidula* and *Crucibulum* are small gastropods (snails) with less meat per individual compared to *Mytilus*. These two gastropods together comprise 18 percent of the total MNI, while *Mytilus* comprises only 7 percent. The collection of large numbers of small gastropods from the rocky shores habitat, rather than *Mytilus*, indicates that there may not have been enough *Mytilus* to supply the needs of the Late Prehistoric population, necessitating a switch to the smaller gastropod taxa. There are no known environmental factors that could account for a natural reduction in the availability of *Mytilus.* A comparison of the percentage of mussel to the combined percentage of *Crepidula* and *Crucibulum* from the rocky shores habitat during the Milling Stone, Intermediate, and Late Prehistoric periods shows that the change in emphasis from mussels to gastropods began in the early Intermediate period (Table 6). Data from the Intermediate period comes from ORA-106 on Bonita Mesa (Peterson 2000).

Because these gastropods presumably provided less meat per individual, more of them would have been collected, resulting in greater labor expenditure. The shift to lower ranked taxa is a form of intensification where greater amounts of labor are expended to obtain more food for an expanding population.

The richness of taxa and the proportions of *Argopecten* and *Chione* vary by Late Prehistoric period site type, as summarized in Table 7. Late Prehistoric period major residential bases are clearly distinguished from the other two site types by richness (over twice as many taxa were found at major residential bases compared to minor residential bases and over three times as many taxa compared to specialized activity loci). The greater number of taxa at major residential bases indicates that most shellfish were transported from where they were collected to the major residential bases for processing. Perhaps only selected taxa were taken from major residential bases to minor residential bases for consumption during times when activities at more distant locations were being conducted. The

Table 6. MNI Percentages of Mussels and Gastropods from the Rocky Shores Habitat in Three Periods.

	Milling Stone		Intermediate		Late Prehistoric	
Taxa	**MNI**	**Percent**	**MNI**	**Percent**	**MNI**	**Percent**
Mytilus sp.	59,058	99	6,537	30	34,751	27
Crepidula sp. and *Crucibulum* sp.	355	1	14,945	70	92,205	73
Total	59,413		21,482		126,956	

Table 7. MNI Percentages of *Argopecten* and *Chione* and Total Taxa Richness by Site Type during the Late Prehistoric Period.

	Major Residential Base	Minor Residential Base	Specialized Activity Area
Argopecten sp.	40%	23%	20%
Chione spp.	8%	46%	57%
Richness	49	22	15

distribution of *Chione* supports this suggestion. *Chione* is the predominant shellfish in minor residential bases and specialized activity loci. In some of the specialized activity loci, it comprises over 90 percent of the shellfish MNI, and few other taxa are present. *Chione* appears to have been the preferred shellfish for consumption at minor residential bases and specialized activity loci. It may have been brought to major residential bases along with other shellfish and then may have been selected to take along while working at the other site types. At specialized activity areas (where people did not stay overnight) *Chione* may have served as "snack food" to meet nutritional requirements while carrying out other activities away from the major residential base. The reasons for selection of *Chione* for this purpose are unknown, but one suggestion is that they lasted longer before spoiling compared to other shellfish.

Major residential bases are also distinguished from the other site types by evenness measures. Sites with similar quantities of different taxa have a high evenness index. Low evenness indicates predominance of a few species, such as at the specialized activity loci where shellfish consist almost entirely of *Chione*. The major residential bases are more even using both Shannon's and Simpson's evenness measures (Magurran 2003). The major residential bases have Shannon's indices between .3 and .45 and Simpson's indices between .7 and .85 (higher numbers indicate more even assemblages). The minor residential bases have lower evenness compared to major residential bases. Shannon's index for minor residential bases ranges from .04 to .28, with one exception. The Simpson's index for minor residential bases shows a similar pattern. Specialized activity loci are highly variable in evenness measures, ranging from sites with a low evenness index like CA-ORA-1203 that consist almost entirely of *Chione*, to sites like CA-ORA-679 and CA-ORA-1204 which have a distribution of major species more similar to major residential bases. This discussion indicates that the distribution of shellfish at a particular site should not be compared to the shellfish taxa at other sites without taking into account site type. If, for instance, unbeknownst to the investigator, a sample of Late Prehistoric period sites consists only of specialized activity loci with shellfish taxa consisting mostly of *Chione,* then the investigator might erroneously conclude that *Chione* alone were being collected from bay/estuary habitats during the Late Prehistoric period. However, if major residential bases were investigated, the investigator would find that many shellfish taxa were being exploited from bay/estuary habitats.

Fish Remains

The fish remains consist of bony fishes (teleostei) and cartilaginous fishes (chondrichthes). The cartilaginous fishes are made up mostly of sharks and rays (elasmobranchii). Only 34 percent of the fish bone specimens were identified to genus or species level, unlike shell where almost all nonrepetitive elements were identified to genus and species level. Of the 69 taxa identified to genus and species level, only 10 are present in quantities making up more than 1 percent of the total NISP (number of identified specimens) of taxa (see Mason and Peterson 1994, Table 4-55). These ten major species account for 92 percent of the fish NISP identified to genus or species level.

In Milling Stone period components the specimens that could be identified to genus or species level represent only 16 percent of the total NISP. Nine taxa are present in quantities representing more than 1 percent of the number of specimens identified to genus or species level (Table 8). These nine major taxa make up 96 percent of the NISP identified to genus or species level. These nine taxa are defined as the major fish taxa for Milling Stone period components. One species, *Semicossyphus pulcher* (sheephead), comprises 75 percent of the genus or species level NISP. The sheephead is found only in the kelp bed habitat (Allen 1985). The next most prevalent taxon, *Sebastes* spp.

Table 8. Major Fish Taxa of the Milling Stone Period.

Taxa	Common Name	NISP	Percent	Habitat
Semicossyphus pulcher	Sheephead	1171	75	Kelp Bed
Sebastes sp.	Rockfish	105	5	Rocky Reef
Scomber japonicus	Pacific mackerel	55	3.5	Nearshore
Myliobatis californica	Bat ray	44	3	Nearshore, Bay/Estuary
Atherinopsis californiensis	Jacksmelt	42	3	Nearshore, Open Coast
Rhinobatus productus	Shovelnose guitarfish	25	2	Nearshore, Bay/Estuary
Oxyjulis californica	Señorita	21	1	Kelp Bed, Rocky Reef
Trachurus symmetricus	Jack mackerel	20	1	Nearshore
Chromis punctipinnis	Blacksmith	17	1	Kelp Bed, Rocky Reef

(rockfish from rocky reef habitats) comprises only 7 percent of the genus or species level NISP.

The other seven major taxa combined account for 14 percent of the genus- or species-level NISP and include *Scomber japonicus* (Pacific mackerel) and *Trachurus symmetricus* (jack mackerel) from the nearshore midwater habitat and *Atherinopsis californiensis* (jacksmelt), which can be found in the nearshore midwater, nearshore soft bottom, and open coast sandy beach habitats (Allen 1985). *Oxyjulis californica* (señorita) and *Chromis punctipinnis* (blacksmith) can be found in both the kelp bed and shallow rocky reef habitats. Two cartilaginous fishes, *Myliobatis californica* (bat ray) and *Rhinobatos productus* (shovelnose guitarfish), are among the major species and come from nearshore soft bottom zones and from bays and estuaries. Milling Stone period fish procurement was focused on one large species, the sheephead, which can weigh up to 9 kg (20 lbs.). They were probably caught using a baited gorge and line from a boat or raft in the kelp beds. Sheephead probably provided the most meat per individual fish that could be caught using the available technology. The blacksmith and señorita may have taken the bait intended for sheephead when fishing occurred in the kelp bed or may have taken bait intended for rockfish when fishing occurred in the shallow rocky reef zone. The other fish, Pacific mackerel, jack mackerel, jack smelt, bat ray, and shovelnose guitarfish, were probably caught close to shore, possibly by netting or spearing.

The major fish taxa from the Late Prehistoric period components are shown in rank order by number of identified specimens (NISP) in Table 9. Fish specimens from 63 taxa representing 45 percent of the total NISP were identified to genus or species level. The left column of Table 9 lists the nine taxa that are present in quantities representing more than 1 percent of the number of specimens identified to genus or species level (defined as major taxa); these nine major taxa make up 92 percent of the genus or species level NISP. These nine taxa are defined as the major fish taxa for Late Prehistoric components. The Late Prehistoric period fish assemblage, with 63 identified taxa, is much more diverse than the Milling Stone assemblage, with only 29 identified taxa. In addition, no one species dominates the assemblage as sheephead did during the Milling Stone period. *Semicossyphus pulcher* (sheephead) now accounts for only 10 percent of the NISP identified to genus or species level, and two other taxa, *Oxyjulis californica* (señorita) and *Chromis punctipinnis* (blacksmith), each account for about 26 percent of the genus and species level NISP. All three of these fish species could have been taken from the kelp bed habitat. The next highest ranked taxa are *Rhinobatos*

Table 9. Major Fish Taxa of the Late Prehistoric Period.

Taxa	Common Name	NISP	Percent	Habitat
Oxyjulis californica	Señorita	1845	27	Kelp Bed, Rocky Reef
Chromis punctipinnis	Blacksmith	1791	26	Kelp Bed, Rocky Reef
Semicossyphus pulcher	Sheephead	724	10	Kelp Bed
Rhinobatos productus	Shovelnose guitarfish	666	10	Nearshore, Bay/Estuary
Myliobatis californica	Bat ray	454	7	Nearshore, Bay/Estuary
Sardinops caeruleus	Sardine	378	5	Nearshore Midwater
Porichthys sp.	Midshipman	274	4	Nearshore, Open Coast
Porichthys myriaster	Specklefin midshipman	116	2	Nearshore, Open Coast
Scomber japonicus	Pacific mackerel	84	1	Nearshore

*productu*s (shovelnose guitarfish) and *Myliobatis californica* (bat ray) at 10 percent and 7 percent, respectively. These were easily captured from shallow bay/estuary waters.

The other four taxa that comprise more than 1 percent of the NISP are *Sardinops caeruleus* (Pacific sardine), *Porichthys* sp. (undifferentiated midshipman), *Porichthys myriaster* (specklefin midshipman), and *Scomber japonicus* (Pacific mackerel). The sardine and Pacific mackerel are found in the nearshore midwater zone, and the midshipman is found in the open coast sandy beach habitat and nearshore soft bottom habitat (Allen 1985). Fish procurement during the Late Prehistoric period was more diverse and resulted in higher evenness indexes compared to Milling Stone period components. No single taxon dominated the assemblage, and many more taxa are represented. However, the kelp bed zone was still the most important habitat had the blacksmith and señorita been caught there (they can also occur in the shallow rocky reef habitat). Blacksmith, señorita, and sheephead combined account for 63 percent of the NISP identified to genus and species, but this is less than the 75 percent of the NISP accounted for by sheephead alone during the Milling Stone period. The sardines and Pacific mackerel were probably netted in the midwater zone. Sardines may be underrepresented in the sample because many of their vertebrae are probably smaller than the 1/8 inch mesh employed during field work. The midshipman was caught in nearshore waters, which may not have required a boat. The bat ray and shovelnose guitarfish can be found in nearshore waters of the open coast and in shallow waters of bays and estuaries. These two elasmobranch fishes were probably caught mostly in Newport Bay during shellfish collecting. They were probably easily speared while wading in the shallow bay waters. Together they account for 16 percent of the NISP identified to genus or species level.

The replacement of sheephead by blacksmith and señorita as the dominant fish taxa exploited during the Late Prehistoric period suggests intensification as a result of human population increase. Sheephead was probably still the preferred fish, but there may not have been enough of these large, territorial, solitary fish (Salls 1988:597) to supply the needs of the Late Prehistoric population. This appears to have resulted in a change in emphasis to two taxa (blacksmith and señorita) that are comprised of smaller, but more numerous, individuals. A comparison of the percentage of sheephead to the combined percentage of blacksmith and señorita from the kelp bed habitat during the Milling Stone, Intermediate, and Late Prehistoric periods shows that the Intermediate period was a transitional period, when emphasis changed from sheephead to blacksmith and señorita (Table 10). During the Milling Stone period, sheephead dominated the assemblage of fish collected from the kelp bed habitat. In the subsequent Intermediate period, sheephead were only slightly more important than blacksmith and señorita, but in the Late Prehistoric period blacksmith and señorita were the dominant taxa. Fish data from the Intermediate period (3000–1350 BP) come from ORA-106 on Bonita Mesa (Peterson 2000).

The blacksmith and señorita are schooling fish that swim both within and outside the kelp forest (Allen et al. 2006:235). This suggests the possibility that blacksmith and señorita may have been netted from boats positioned just outside the kelp beds. Netting of large numbers of smaller schooling fish appears to have been the most important fishing technique during the Late Prehistoric period, given the number of blacksmith, señorita, and sardine specimens (small schooling fish that comprise 2.5 percent of the Late Prehistoric fish NISP) identified among Late Prehistoric subsistence remains. In addition, sardine specimens may be underrepresented because their small bones could have passed through the 1/8 inch mesh used during water screening.

The other important Late Prehistoric fishing technique was capture of bat rays and shovelnose guitarfish in Newport Bay while collecting shellfish. This technique, which probably consisted of spearing in shallow water, likely continued unchanged throughout the Milling Stone, Intermediate, and Late Prehistoric periods. However, the small numbers of bat rays and guitarfish in the NCAP Milling Stone period components were probably caught on the ocean coast near the sites, rather than from Newport Bay. Several tuna specimens (*Thunnus* sp. and *Euthynnus pelamis*) are present in Late Prehistoric components, but not enough to qualify as major species. Tuna are large pelagic migratory fish, and their presence in Late Prehistoric components represents use of a fishing technique not present during the Milling Stone period. Capture of tuna probably required travel further into the ocean beyond the kelp beds and may also represent intensification through expansion of the foraging radius to include more distant resource zones. The average richness (number of taxa) at major residential bases is 24, while the average richness at minor residential bases is eight, but only two at specialized activity loci. The evenness measures show that the major residential bases have higher evenness indexes than the minor residential bases and specialized activity loci.

Other Faunal Remains

Other faunal remains consist of terrestrial mammals, marine mammals, birds, and reptiles and are collectively termed non-fish faunal bone (Table 11). Rabbits and hares were the most abundant terrestrial mammal remains and dominant terrestrial animal food. Identified rabbit and hare specimens include cottontail rabbits (*Sylvilagus audubonii*) and brush rabbits (*Sylvilagus bachmani*), undifferentiated rabbit (*Sylvilagus* sp.), blacktail jackrabbit (*Lepus californicus*), and undifferentiated rabbit/hare (Leporidae). When com-

Table 10. Percentages of Sheephead and Schooling Fish from the Kelp Bed Habitat in Three Time Periods.

	Milling Stone		Intermediate		Late Prehistoric	
Taxa	NISP	Percent	NISP	Percent	NISP	Percent
Semicossyphus p.	1,171	97	161	57	724	17
Chromis p. and *Oxyjulis c.*	38	3	121	43	3,636	83
Total	1,209		282		4,360	

Table 11. Non-Fish Faunal Bone from All Components Rank Ordered by NISP.

	NISP	Percent
Terrestrial Mammals		
Sylvilagus sp.	2630	60
Undiff. Large Mammal	661	15
Lepus californicus	357	9
Spermophilus beecheyi	141	3
Odocoileus sp.	97	2
Carnivora	91	2
Leporidae	81	2
Sylvilagus audubonii	74	2
Artiodactyla	74	2
Canis sp.	72	2
Taxidea taxus	51	1
Sylvilagus bachmani	22	0.5
Urocyron cinereoargenteus	9	0.2
Felis rufus	9	0.2
Canis latrans	7	0.1
Canidae	4	0.1
Mustela frenata	3	0.1
Canis familiaris	2	0.1
Procyon lotor	1	0.1
Subtotal	4396	
Marine Mammals		
Enhydra lutris	32	36
Pinniped	22	25
Arctocephalus townsendi	16	18
Phoca vitulina	13	15
Cetacea	3	3
Ottariidae	2	2
Subtotal	88	
Avifauna		
Anatidae	12	32
Passerformes	9	24
Callipela californica	7	18
Chen sp.	4	11
Anas sp.	3	8
Accipitridae	2	5
Columbidae	1	3
Subtotal	88	
Reptiles		
Clemmys sp.	80	99
Chelonia	1	1
Subtotal	81	

bined, these rabbit/hare categories comprise 72 percent of the terrestrial mammal NISP. Deer were also important terrestrial animals, but deer specimens are much less frequent than rabbit specimens. The deer NISP (Artiodactyla and *Odocoileus* sp.) represents only 4 percent of the total terrestrial mammal NISP. Specimens from carnivores such as dog/coyote, badger, fox, bobcat, and weasel are present in very small quantities. The combined carnivore NISP (including specimens identified as Carnivora) comprises slightly less than 6 percent of the terrestrial mammal NISP shown in Table 11 Specimens from marine mammals are present in small quantities and include sea otter, seals, and Cetacea (whales, dolphins, and porpoises) (Table 11). Even fewer birds are present and include ducks, quail, perching birds, goose, and hawk. The only reptiles included in the analysis are turtles.

The terrestrial mammal taxa from Milling Stone period components are rank ordered by NISP (from highest to lowest) in Table 12. The same information for Late Prehistoric components is provided in Table 13. Rabbit/hare specimens are by far the most prevalent in both time periods, followed by carnivores and deer. Relatively the same amounts of marine mammals, birds, and turtles are present in both time periods (Tables 12 and 13). Although the percentage of deer specimens (*Odocoileus* sp. and Artiodactyla) is relatively low in both periods (2.6 percent in the Milling Stone period and 4 percent in the Late Prehistoric period), the specimens classified as undifferentiated large mammal in the Late Prehistoric period may represent deer. If the undifferentiated large mammal specimens are added to the *Odocoileus* sp. and Artiodactyla specimens, they represent 28 percent of the total NISP for the Late Prehistoric period. The classification "undifferentiated large mammal" was not used for the Milling Stone period, so the percentage of deer in the Milling Stone period remains the same at 2.6 percent. The large disparity in the amount of deer specimens between the two periods may be due in part to differences in settlement-subsistence patterns. The Milling

Table 12. Non-Fish Faunal Bone from Milling Stone Components Rank Ordered by NISP.

	NISP	Percent
Terrestrial Mammals		
Sylvilagus sp.	1202	75
Lepus californicus	221	14
Artiodactyla	40	2
Carnivora	36	2
Spermophilus beecheyi	30	2
Canis sp.	21	1
Leporidae	20	1
Sylvilagus audubonii	12	0.7
Odocoileus sp.	9	0.6
Sylvilagus bachmani	5	0.3
Urocyron cinereoargenteus	5	0.3
Felis rufus	4	0.2
Mustela frenata	3	0.2
Taxidea taxus	2	0.1
Canidae	1	0.1
Canis latrans	1	0.1
Procyon lotor	1	0.1
Subtotal	1613	
Marine Mammals		
Enhydra lutris	12	43
Pinniped	7	25
Arctocephalus townsendi	5	18
Ottariidae	2	7
Cetacea	2	7
Subtotal	28	
Avifauna		
Anatidae	4	36
Callipela californica	4	36
Passerformes	3	27
Subtotal	11	
Reptiles		
Clemmys sp.	9	90
Chelonia	1	10
Subtotal	10	

Table 13. Non-Fish Faunal Bone from Late Prehistoric Components Rank Ordered by NISP.

	NISP	Percent
Terrestrial Mammals		
Sylvilagus sp.	1428	51
Undiff. Large Mammal	657	24
Lepus californicus	150	5
Spermophilus beecheyi	111	4
Odocoileus sp.	88	3
Sylvilagus audubonii	62	2
Leporidae	61	2
Carnivora	55	2
Canis sp.	51	2
Taxidea taxus	49	2
Artiodactyla	34	1
Sylvilagus bachman	17	0.6
Canis latrans	6	0.2
Felis rufus	5	0.2
Urocyron cinereoargenteus	4	0.1
Canidae	3	0.1
Canis familiaris	2	0.1
Subtotal	2783	
Marine Mammals		
Enhydra lutris	20	33
Pinniped	15	25
Phoca vitulina	13	22
Arctocephalus townsendi	11	18
Cetacea	1	2
Subtotal	60	
Avifauna		
Anatidae	8	30
Passerformes	6	22
Chen sp.	4	15
Anas sp.	3	11
Callipela californica	3	11
Accipitridae	2	7
Columbidae	1	4
Subtotal	27	
Reptiles		
Clemmys sp.	71	100
Subtotal	71	

Stone period components may represent only part of a seasonal round. It appears that deer were not the focus of procurement when Milling Stone period groups occupied the coastal sites in the Newport Coast area. The deer to rabbit/hare ratio might be higher in other more inland Milling Stone period sites. It is likely that the Late Prehistoric Newport Coast sites represent multi-seasonal residential bases and that people did not move to inland sites during other seasons. Therefore, they intensively exploited all nearby resources, including deer. Deer hunting during the Late Prehistoric period may have been facilitated by use of the bow and arrow, which was not available during the Milling Stone period.

Floral Remains

Formation processes and preservation factors are much different for floral remains compared with faunal remains. Bone and shell are hard materials that are not consumed when eating the animals. Seeds, however, are the part of the plant usually consumed and, if not consumed, are usually not preserved unless carbonized. Only seeds that were lost (not consumed) and that were charred by fire entered the archaeological record. Thus, the macrobotanical remains represent a much smaller and more biased sample of plant foods compared to the animal foods discussed previously. There is little macrobotanical data available from the Milling Stone period sites. Flotation samples from CA-ORA-665, a Milling Stone site, yielded very little charcoal and carbonized seeds, suggesting that local conditions were not favorable for preservation of charred seeds over such a long period of time (about 5,000 years). This is not due to sample size, since sample sizes (liters of soil) were the same for Late Prehistoric sites where there were large amounts of charred seeds. Although no quantitative information was available, it is possible that sage, grasses, tarweed, and possibly goosefoot were present in the Milling Stone period samples (Klug 1994).

Most of the NCAP macrobotanical data comes from the Late Prehistoric period. Macrobotanical analysis was conducted at three Late Prehistoric sites: CA-ORA-671, ORA-662 (including Areas 3 East, 3 West, and 5), and CA-ORA-662 Area 13 (considered to be a separate site) (Klug 1994).

Flotation samples were taken from fire-affected rock features at ORA-671 and from fire-affected rock features and shell dumps at ORA-662 and ORA-662 Area 13. Charred seed density was high at ORA-671 with nine seeds per liter of sediment. Grasses and cheno-ams were the most important seeds. The grasses include maygrass (*Phalaris* sp.) and native barley (*Hordeum* sp.). Grass pollen was also found on a mano. The cheno-ams include goosefoot and possibly amaranth and saltbush. No acorns were identified. Seeds available from spring through fall were present indicating occupation during three seasons. The fall indicator is toyon berry.

At ORA-662 sage, buckwheat, grasses, and tarweed were the most important seeds. ORA-662 is different from ORA-671 in emphasizing sage rather than cheno-ams. One of the sages is tentatively identified as chia. Also present were toyon, deerweed, tarweed, peppergrass, and corms and bulbs. The mean seed density is 5.0 seeds per liter of sediment, lower than one would expect for a major residential base. However, the seed density is very high (17.6 seeds per liter) in one feature (Feature 18 in Area 3 East). Three seasons of occupation are indicated at ORA-662 with the fall indicator being toyon. Because of the variation in seed density, some combination of seasonal and more intensive multi-seasonal occupation (at Feature 18) is indicated by the macrobotanical remains. At ORA-662 Area 13, located on the north slope of Pelican Hill, the seed density is low (4.2 seeds per liter), but fall edibles are present (toyon and a small amount of acorn). The seed density is higher in Features 5 and 6 where the fall edibles are most abundant.

The most important plant foods at NCAP Late Prehistoric sites were seeds from maygrass (*Phalaris* sp., probably *Phalaris caroliniana*), native barley (*Hordeum* sp.), goosefoot (*Chenopodium* sp.), and chia sage (*Salvia columbariae*). All these seeds are high in protein and calories. *Phalaris caroliniana* yields 23.7 grams of protein per 100 grams of seeds, *Chenopodium* sp. yields 15.5 grams of protein, and *Salvia columbariae* yields 21.6 grams of protein. By contrast, acorns from coast live oak trees yield only 4.6 grams of protein per 100 grams (Mason 1991:Table 21). The grasses and goosefoot are "weedy," meaning they grow well in disturbed habitats. Disturbed habitats occur around residential sites as a result of brush clearing and of intentional controlled burning (fire management) (Klug 1994). Thus, there may have been human manipulation of the environment (land management) to encourage growth of plants that produced seeds with high calorie and protein yields.

All three Late Prehistoric sites have some evidence for fire management, a form of intensification of plant food resources. Intentional controlled burning increases sprouting and seed production during the subsequent rainy seasons. Evidence for fire management in the archaeological record consists of increased amounts of "fire-followers," plants that become much more abundant after a fire. These include deerweed, wild cucumber, and corms and bulbs of wildflowers (Hammett 1991). Food plants such as sages and grasses also produce more abundantly after a fire, but increases in numbers of these food plant seeds could be due to increased consumption as well as increased burning. Deerweed is found frequently throughout ORA-662 and is also found in ORA-671 and in ORA-662 Area 13. Wild cucumber, however, is not as prevalent, and corms and bulbs occur in low frequencies, which could be a result of poor preservation. While the archaeological evidence for managed burning is suggestive but not conclusive, intentional burning of the nearby Tustin Plain (located directly north of the San Joaquin Hills) was observed by members of the Spanish Portolá Expedition in 1769. Leaving Tomato Springs on the morning of July 27, 1769, Juan Crespí noted in his journal that they were traveling over a "far-reaching plain …, all of it very level, very grass-grown soil almost all of which had been burnt off by the heathens" (Brown 2001:311). This intentional burning of a large grassy plain would have increased production of both maygrass and native barley during the following winter rainy season. When the expedition crossed the Tustin Plain on their return trip in January 1770, Crespí noted "what good green grass there is" everywhere on the plain (Brown 2001:667).

The native barley recovered from the Late Prehistoric sites in the NCAP project area varied greatly in size (Klug and Popper 1998). It is possible that the larger seeds resulted from human selection and semi-domestication (Miksicek 1994). If this was the case, some of the larger barley seeds would not have been consumed and would have been saved for sowing after a burn. If this process repeated year after year, larger barley seeds would have been the result. However, larger seed size alone may not be sufficient to indicate semi-domestication or domestication. In the Midwest, domestication of *Hordeum pusillum* has been found to result in morphological changes in the seeds (Hunter 1992). Such morphological changes "may appear on Late [Prehistoric] period grains from our sites and others in California" (Klug and Popper 1998).

Evidence from the San Joaquin Hills and the Tustin Plain suggests there was human manipulation of the environment to encourage growth of plants that produced seeds with high calorie and protein yields. Brush clearing, fire management, and seed selection are forms of intensification for increasing the productivity of the utilized land by putting more energy into certain subsistence practices in order to increase the food supply.

Discussion

As population increases within a limited territory, more labor is necessary to procure more food. Putting more labor into subsistence activities for the purpose of increasing the amount of available food is known as intensification. Intensification refers to increasing the productivity of a given land unit (Boserup 1965; Beaton 1991; Broughton 1994; Bartelink 2006). This is accomplished by increasing labor inputs and developing more specialized technology in order to extract more resources from the same patch of land. Intensification can take many forms. In the Newport Coast area intensification included procurement of a greater number of smaller animals with less meat per individual, procurement and transport of resources over greater distances to the residential base, and application of greater labor in managing the environment, as seen in controlled burning or fire management to promote increased seed production. All these intensification techniques were practiced during the Late Prehistoric period, but not during the Milling Stone period. There is also evidence for some of them in the Intermediate period.

Evidence for a change to use of smaller animals with less meat per individual is seen when comparing major fish and shellfish taxa from the Milling Stone period components and the Late Prehistoric components. A shift to taxa that provided a smaller amount of food per individual animal in the Late Prehistoric period is seen for both shellfish and fish. The changes to procurement of smaller sized individual animals took place within the same habitat. The exploitation of rocky shores mussels during the Milling Stone period was replaced by collection of smaller gastropods from the rocky shores in the Late Prehistoric period. Capture of the large sheephead fish from kelp beds during the Milling Stone period was replaced during the Late Prehistoric period by the taking of smaller kelp bed schooling fish, blacksmith and señorita. This indicates that the same habitats continued to be exploited, but large human populations which continuously exploited these habitats depleted the taxa yielding larger amounts of meat per individual animal and were forced to switch to taxa yielding smaller amounts of meat per individual. Data from the Intermediate period show that the change from larger to smaller shellfish occurred at the beginning of the Intermediate period, since the ratio of mussels to small gastropods is nearly the same in the Intermediate and Late Prehistoric periods, a reversal from the earlier Milling Stone period (Table 6). The shift from capture of large sheephead fish in the Milling Stone period to smaller schooling fish (blacksmith and señorita) in the Late Prehistoric period was more gradual, since during the Intermediate period the proportion of sheephead to blacksmith and señorita was nearly equal, although sheephead slightly outnumbered blacksmith and señorita (Table 10). Thus, while the shift from larger to smaller shellfish occurred at the beginning of the Intermediate period, the shift from larger to smaller fish occurred more gradually. However, the shift to both smaller shellfish and fish was complete by the beginning of the Late Prehistoric period.

Additional evidence for intensification of resource procurement during the Late Prehistoric period is indicated by the distances over which resources were transported to the residential base. During the Milling Stone period residential bases were located on the marine terraces. Shellfish from the rocky shores would have been transported only about 1 km to the residential base. Rabbits and seeds were probably procured from the grasslands and coastal sage scrub on the marine terraces near the residential base. During the Intermediate period residential bases were located on terraces and along drainages on the north side of the western San Joaquin Hills. Marine resources were procured from Newport Bay, located about 3 km away, and from the ocean coast, located 4 to 5 km away. During the Late Prehistoric period residential bases were located on ridges and hills near the top of the San Joaquin Hills. Marine resources from Newport Bay would have been transported 6 to 7 km to the Late Prehistoric period residential bases, and resources from the ocean coast would have been transported 2 to 4 km. The strategy during the Milling Stone period appears to have been to locate residential bases close to the marine resources of the ocean coast. Other resources, such as seeds and rabbits, could have been obtained very near the residential bases. In the Intermediate period residential bases were located closer to where seeds from both grassland and chaparral were abundant, but marine resources had to be transported about 3 km from Newport Bay. During the Late Prehistoric period, residential bases were located closer to chaparral habitat, some of which may have been converted to grassland by means of managed burning. However, marine resources from Newport Bay had to be transported over 6 km uphill to the residential bases.

There is no evidence for intensification by putting more energy into transport of resources to the residential base in the Milling Stone period, and there is no evidence of fire management and efforts to increase the productivity of the land areas beyond the taking of resources that were already naturally abundant. In the Intermediate and Late Prehistoric periods the strategy was to locate residential bases near where seeds could be easily collected and to transport marine resources from Newport Bay to the residential base. During the Intermediate period the distance from Newport Bay to the residential bases was about 3 km, but during the Late Prehistoric period this distance was over 6 km. The increased distances between resource zones and residential sites reflect increased energy expenditure per unit of land. Intensification is measured by the higher transportation costs incurred to obtain a wider range of resources, a pattern which increased over time from the Intermediate period to the Late Prehistoric period.

There is evidence for management of the environment, another form of intensification, during the Late Prehistoric period. Although the evidence for managed burning based on seeds from fire-followers is not conclusive, there is eyewitness testimony regarding burning of the Tustin Plain (located directly north of the San Joaquin Hills) by the Native people in 1769. Managed burning promoted new growth and greater seed production in chaparral and may also have been used to convert chaparral to grassland. Burning of grasslands would have promoted grass seed production during the next wet season. Evidence for managed burning comes from recovery of seeds of “fire-follower” plants from Late Prehistoric middens and observation by Juan Crespí in 1769 of Native Americans burning the grassland on the Tustin Plain. There are also some indications of manipulation of native barley to produce larger seeds (semi-domestication).

In conclusion, intensification, or increasing the productivity per unit of land through increased labor inputs within each category of subsistence activity in order to increase the amount of available food, was characteristic of the Intermediate and Late Prehistoric periods, but not of the Milling Stone period. Future papers will explore the reasons for this difference.

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