PALEODEMOGRAPHIC CHANGE ON SAN CLEMENTE ISLAND DURING THE MEDIEVAL CLIMATIC ANOMALY

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Two regional sampling surveys on San Clemente Island show a significantly reduced frequency of dated archaeological sites for periods of drought associated with the Medieval Climatic Anomaly (AD 650 to 1250). Temporal and spatial relationships among dated sites indicate changes in paleodemography in apparent response to deteriorating paleoenvironmental conditions, including decreased numbers of sites, depopulation of upland terrain, and occupation near reliable water sources. Parallels exist between San Clemente Island and other areas of western North America where evidence for abandonment and population movement correlate with the Medieval Climatic Anomaly.

Participation in the 2002 SCA symposium honoring Mark Kowta was occasion for me to again reflect on the influence his mentoring had on my approaches to archaeological research. As a graduate student at Chico State in the mid-1970s, seminars and lab classes with Mark included a firm grounding in regional sampling and analysis. I made use of some of these lessons in my thesis research there, and have found many other opportunities during my now 23 years as a federal archaeologist to apply them to cultural resources management. This has been especially true since 1984, when I came to work for the Navy and assumed management responsibility for the rich archaeological resources on San Clemente Island. An example of Mark's intellectual legacy is reflected in two regional sampling surveys I've conducted on San Clemente Island in the last decade where the frequency of dated archaeological sites on the island is significantly reduced for periods in the late Holocene associated with deteriorating paleoenvironmental conditions.

Much recent research on late Holocene archaeology in the California Channel Islands has addressed questions on the influences such conditions had on regional prehistoric populations. Archaeologists working in the region postulate that at least two paleoenvironmental factors — changes in sea-surface temperature (Arnold 1992; Arnold and Tissot 1993; Colten 1992; Glassow 1996; Glassow et al. 1988; Walker and Snethkamp 1984) and persistent drought conditions (Larson and Michaelsen 1989; Raab and Larson 1997; Yatsko 2000) — separately or together exerted a significant influence on prehistoric cultural evolution in maritime southern California. The research reported here used the products of the two sequential sampling surveys to address the probable role adverse paleoclimatic conditions played in influencing the size and distribution of late Holocene human populations on San Clemente Island, one of the southern California Channel Islands.

Island-wide Sampling Survey

The first of the two island-wide sampling surveys reported here was developed in response to observations made in the mid-1980s during my resurvey of areas of San Clemente Island previously inventoried by UCLA (McKusick and Warren 1959), San Diego Mesa College (Axford 1984), and others (Zahniser 1981). These selective resurveys assessed the adequacy of the previous surveys' recovery of site locations and the quality of the record data. In all cases, between 40% and 90% of identifiable sites had not been found by the earlier surveys, with most previously recorded sites inadequately documented or poorly provenienced.

In response to these findings, I designed a stratified, random cluster, probabilistic survey to gain a more representative inventory of island sites (Yatsko 1991). The island's terrain provinces provided a logical basis for stratifying the sample (Yatsko 1996) (see Figure 1). Differences observed in archaeological site density and distribution among these topographically defined strata during

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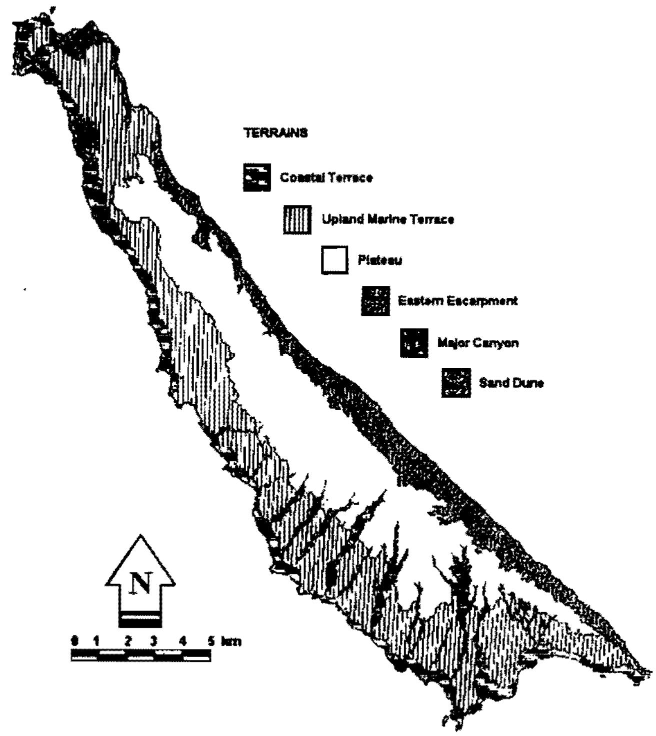

Figure 1. San Clemente Island terrains.

the resurveys suggested that they presented an unequal range of residential and subsistence opportunities to the island's prehistoric residents (Yatsko 1989). To investigate variability across these terrains, I selected a 15% sample size for this Probabilistic Survey. Random 500-meter-square (25 ha) sample units were proportionally drawn from the approximately 79% of the island encompassed by its three predominate topographic provinces – the Coastal Terrace, Upland Marine Terraces, and Plateau.

In collaboration with Mark Raab and the CSU Northridge Center for Public Archaeology, the Probabilistic Survey was conducted during the fall and winter of 1991-1992. The survey documented 1,143 sites within the selected 73 twenty-five-hectare sample units. The project also tested a typologically stratified, random sample of these sites, recovering ^{14}C samples from the 27 selected that yielded a total of 68 radiocarbon (^{14}C) dates (Yatsko and Raab 1997).

California researchers have suggested that ^{14}C -date frequencies, like those from the Probabilistic Survey data, can be a reasonable proxy measure of general paleodemographic patterns, or at least a basis for hypothesizing about such patterns (Breschini et al. 1996; Glassow et al. 1988; Glassow 1999). Assuming a regional sampling of ^{14}C dates reasonably reflects all of this variation, it should be possible to perceive general population trends in the form of shifting date frequencies.

To examine this issue, Raab and I plotted 57 Probabilistic Survey dates against 93 dates from an "all-island" sample of dates drawn from a variety of sources (Breschini et al. 1996; Erlandson et al. 1998; Gallegos 1994; Raab et al. 1994, 1997) (Figure 2). Because many of the "all-island" dates lacked sufficient documentation to be corrected and calibrated to current standards, only mean uncalibrated ^{14}C ages were used, plotted in one-century increments.

The configurations of the frequency distributions shown in Figure 2 for the Probabilistic Survey and island-wide samples are strikingly similar for the time range from about 5,000 RYBP to the present. Most important to this discussion are where the consistently high frequencies of dates in the Probabilistic Survey and all-island samples after about 2,000 RYBP are punctuated by a dramatic and synchronous drop to zero at 800 RYBP. This decline is significant because it occurs in the midst of an overall trend that is otherwise characterized by increasing date

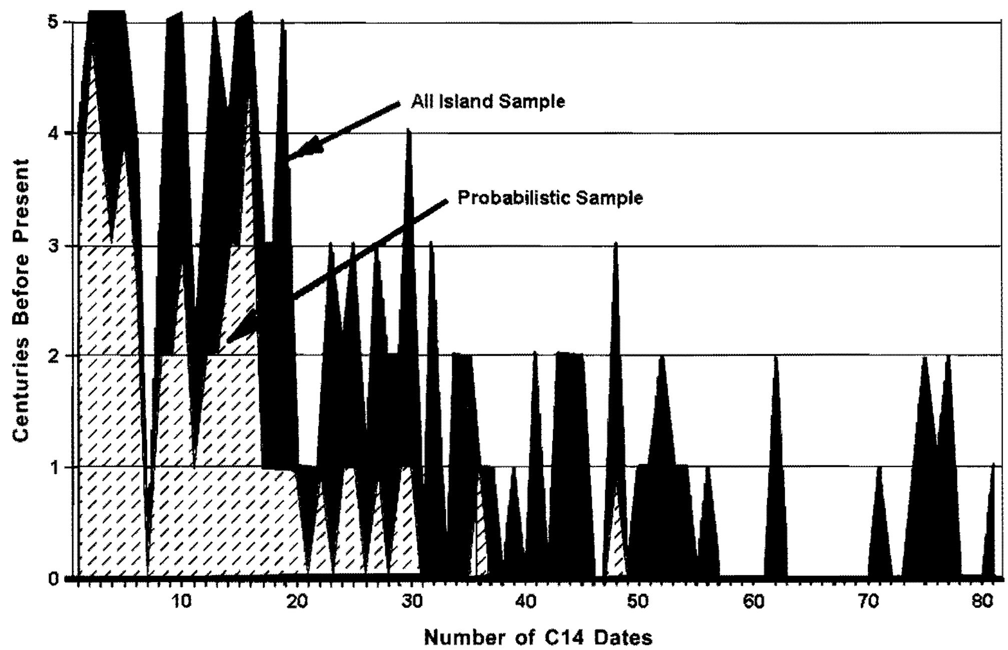

Figure 2. Frequency distributions of San Clemente Island radiocarbon dates.

frequencies.

It was noted that this hiatus corresponded to the Middle-to-Late Period Transition between about A.D. 1100 and 1300 (ca. 650 - 850 RYBP) that has been linked to periods of late Holocene paleoenvironmental stress in coastal southern California associated with elevated marine paleotemperatures (Arnold 1992; Arnold and Tissot 1993; Colten 1992; Glassow 1996). The hiatus also correlates with the period of widespread decreased precipitation and frequent prolonged drought between A.D. 650 to 1250 known to climatologists as the Medieval Climatic Anomaly (Larson and Michaelsen 1989; Stine 1994). Larson and Michaelsen (1989) documented periods of very low rainfall and drought for coastal southern California between approximately A.D. 650 and 1250 with sustained droughts between A.D. 750 and 770, A.D. 980 and 1030, and A.D. 1100 and 1250, punctuated by a period of high rainfall between A.D. 800 and 980.

On the basis of a broad range of available paleoclimatic data (e.g., Davis 1992; Enzel et al. 1989; Graumlich 1993; Larson and Michaelsen 1989; Mehringer 1986; Stine 1994), Raab and Larson (1997) have argued that regional cycles of severe drought probably played a larger role than sea temperature in affecting the size and distribution of marine-adapted populations in the southern Channel Islands. This is partly because the southern Channel Islands' comparatively small, isolated precipitation catchments would have been extremely sensitive to such adverse paleoclimatic trends.

Fundamentally, the goal of both these lines of research has been to understand how the interaction of particular paleoenvironmental stresses and archaeologically detectable cultural responses affected cultural change, including subsistence intensification, adoption of new technologies and settlement patterns, development of regional exchange networks and long-term alterations to human health. However, the precise nature and cultural impact of forces like drought or elevated sea surface temperatures, individually or in combination, remains a matter of debate (see Arnold et al. 1997; Raab and Larson 1997).

As postulated by Larson (1987) for the Southern California Bight, San Clemente Island represents an extreme case of a high-risk prehistoric littoral environment. It presents a context where the "epic droughts" (Stine 1994)

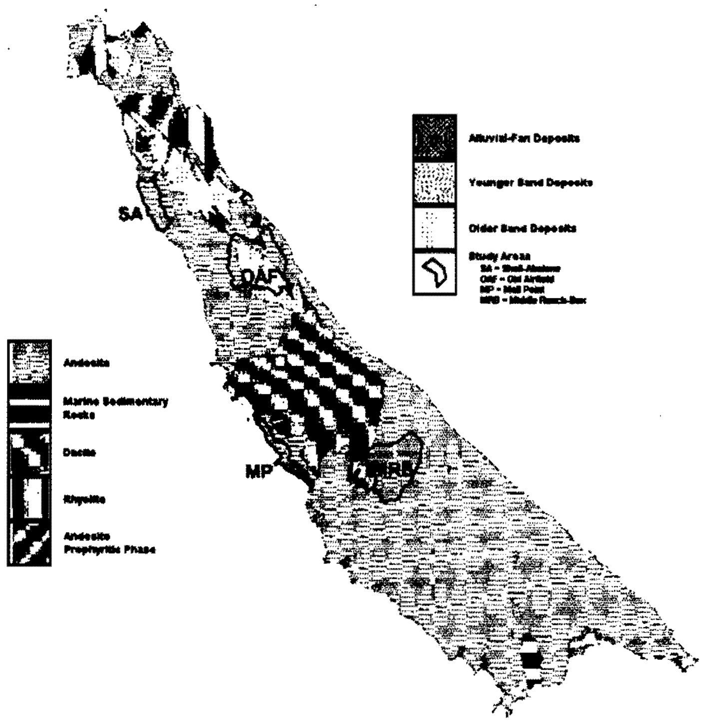

Figure 3. San Clemente Island geology and supplemental survey study areas.

punctuating the Medieval Climatic Anomaly would have had direct negative effects on San Clemente Island's marginal terrestrial ecosystems by reducing both available water sources and primary production of the island's already limited terrestrial biological resources. Given these environmental realities, prolonged drought would certainly have caused the island's human population significant subsistence stress. During periods of stress, the island's prehistoric occupants would have responded within an available range of "risk minimization" subsistence strategies from retreat to more productive or less stressed areas of the island's environment to abandoning the island. Because some of the best indicators of culture change are found in archaeological settlement patterning, how prehistoric cultures deployed themselves on the landscape in functionally differentiated modes of settlement can be highly informative (Binford 1980; Kelly 1995). As hunter-gatherer cultures organize themselves to exploit vital resources, patterns of settlement are likely to reflect related patterns of social organization, economics, and technology.

In 1994, I proposed testing two alternative hypotheses for the prehistoric San Clemente Island population's response to periods of severe medieval drought as the subject of my dissertation research at UCLA (Yatsko 2000). First, that the island's pattern of settlement during the Medieval Climatic Anomaly would have involved a reduced number of residential localities increasingly concentrated around a small number of water sources. Alternatively, prehistoric populations on San Clemente Island would have migrated off island during the Medieval Climatic Anomaly in response to worsening drought conditions, leaving no residential localities.

A Supplemental Regional Survey

To address these hypotheses, I developed a Supplemental Survey built on the earlier Probabilistic Survey, with an island-wide sampling strategy designed to investigate spatial and temporal relationships between dated island sites and sources of available surface water. Based on considerations of alternative water source areas (e.g., surface-held runoff vs. groundwater) and their geological associations, I defined a set of hydrologically- and topographically-differentiated sampling strata. The presence or absence of fossil dune deposits on the Plateau were used to differentiate upland source areas, with geologically mapped areas of the Plateau overlain by these deposits constituting one sampling

Table 1. Supplemental Survey Study Area radiocarbon dates.

Beta No.	NRO No.	^{14}C Age[1]	? ^{13}C	^{13}C Adj.[2]	Calib. YBP[3]	Calendar Age[4]
				OAF Study Area		
76785	OAF-79	220 ± 60	-24.9	220 ± 60	308 – 271 (290)	*cal AD* 1642 - 1679 (1660)
51146	P4-B	320 ± 60	-23.9	340 ± 60	478 - 303 (381)	*cal AD* 1472 - 1647 (1569)
76777	OAF-23	350 ± 70	-26.6	320 ± 70	466 - 294 (403)	*cal AD* 1484 - 1656 (1547)
76780	OAF-22C	450 ± 70	-25.9	440 ± 70	526 - 340 (507)	*cal AD* 1424 - 1610 (1443)
51141	P4-2	490 ± 70	-23.1	520 ± 70	552 - 506 (529)	*cal AD* 1398 - 1444 (1421)
76782	OAF-32	610 ± 70	-24.6	620 ± 70	659 - 539 (587)	*cal AD* 1291 - 1411 (1363)
76778	OAF-22A	600 ± 80	-24.5	610 ± 80	659 - 539 (601)	*cal AD* 1291 - 1415 (1349
51137	P3-3/4-C	670 ± 60	-24.8	670 ± 60	664 - 557 (650)	*cal AD* 1286 - 1393 (1300)
51139	P3-3/4-D	1080 ± 70	-24.0	1100 ± 70	1065 - 936 (977)	*cal AD* 885 - 1014 (973)
51132	P3-3/4-C	1570 ± 80	-20.1	1650 ± 80	1683 - 1415 (1535)	*cal AD* 267 - 535 (415)
				MRB Study Area		
120897	MRB-8	90 ± 50	-26.1	70 ± 50	130 – 30 (N/I)[5]	*cal AD* 1820 – 1920 (N/I)[5]
120896	MRB-61	70 ± 60	-24.9	70 ± 60	135 – 30 (N/I)[5]	*cal AD* 1815 – 1920 (N/I)[5]
120900	MRB-54	160 ± 40	-23.6	180 ± 50	225 – 135 (180)	*cal AD* 1725 – 1815 (1770)
120898	WMR-1	210 ± 50	-24.6	210 ± 50	285 – 270 (280)	*cal AD* 1655 – 1680 (1670)
120899	MRB-A	260 ± 60	-25.9	240 ± 60	310 – 275 (290)	*cal AD* 1640 – 1675 (1660)
120901	P17-3	270 ± 40	-25.0	270 ± 40	310 – 285 (300)	*cal AD* 1640 – 1665 (1650)
51121	P14-B	1500 ± 60	-24.8	1500 ± 60	1413 – 1315 (1354)	*cal AD* 537 – 635 (569)
76776	P4-6	3020 ± 70	-13.6	3200 ± 80	3275 - 3472 (3398)	*cal BC* 1522 - 1325 (1448)
				SA Study Area		
120906	SAN-19	80 ± 50	-25.3	80 ± 50	135 - 30 (N/I)[5]	*cal AD* 1815 - 1920 (N/I)[5]
120910	SAN-21	380 ± 50	-26.4	340 ± 50	475 – 305 (380)	*cal AD* 1475 - 1645 (1570)
120911	SA-74	510 ± 60	-24.9	510 ± 60	545 – 505 (525)	*cal AD* 1405 - 1445 (1425)
120912	SA-61	520 ± 40	-23.1	550 ± 40	550 – 525 (540)	*cal AD* 1400 - 1425 (1410)
120902	SAN-7	620 ± 70	-24.6	630 ± 70	660 – 540 (595)	*cal AD* 1290 - 1410 (1355)
120909	SAN-29	880 ± 70	-23.3	910 ± 70	920 – 730 (785)	*cal AD* 1030 - 1220 (1165)
93264	SAN-11	990 ± 110	-25.2	990 ± 110	980 – 760 (923)	*cal AD* 970 - 1190 (1027)
120914	SA-62	1560 ± 50	-24.8	1560 ± 50	1515 – 1375 (1415)	*cal AD* 435 - 575 (535)
120915	SA-59	3460 ± 50	-21.0	3520 ± 50	3850 – 3705 (3755)	*cal BC* 1900 - 1755 (1805)
				MP Study Area		
120907	C3-051	130 ± 50	-26.4	100 ± 50	140 – 20 (60)	*cal AD* 1810 – 1930 (1890)
120908	MPS-28	230 ± 50	-26.4	220 ± 50	300 – 270 (285)	*cal AD* 1650 – 1680 (1665)
120904	C3-49	310 ± 50	-26.5	280 ± 50	320 – 285 (300)	*cal AD* 1630 – 1665 (1650)
120903	C3-4	310 ± 50	-24.3	320 ± 50	455 – 300 (405)	*cal AD* 1495 – 1650 (1545)
120905	MPS-20	540 ± 50	-24.0	550 ± 50	555 – 525 (540)	*cal AD* 1395 – 1425 (1410)
51115	C3-68	1390 ± 70	-25.2	1390 ± 70	1333 – 1269 (1293)	*cal AD* 617 – 681 (657)

Notes:

1. All from charcoal, processed by Beta Analytic. Dates are in RCYBP (radiocarbon years before present; present = 1950 A.D.) Errors represent 1 standard deviation (68% probability).
2. C13/C12 ratios were calibrated relative to the PDB-1 international standard, and the RCYBP ages were normalized to -25 per mil
3. Dendrocalibrated age in YBP (years before present; *present* = A.D. 1950), with 1-s range, and mean intercept in parenthesis; calibrated by *Calib rev. 3.0.3* (Stuiver and Reimer 1993)
4. Dendrocalibrated calendar years, with 1-s range, and mean intercept in parenthesis; calibrated by *Calib rev. 3.0.3* (Stuiver and Reimer 1993)
5. N/I = no intercepts. *Calib rev. 3.0.3* (Stuiver and Reimer 1993) plotted no intercepts for these recent conventional dates. However, Beta Analytic's calibration analysis provided the indicated YBP & cal AD/BC range based on -s range for proximity to the dendrocalibrated curve.

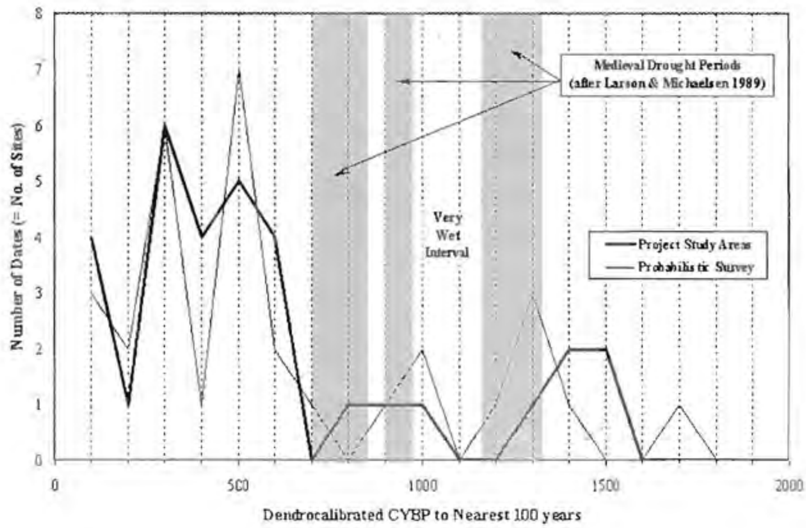

Figure 4. Frequency curves for supplemental Survey study area and Probablaistic Survey charcoal dates.

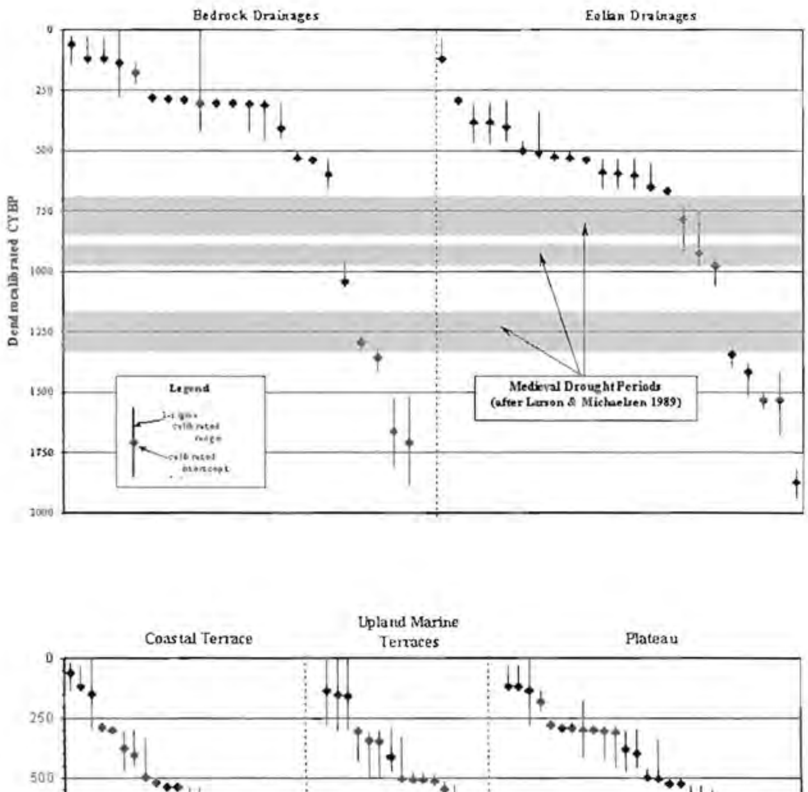

Figure 5. Temporal distribution of Supplemental Survey and Probabalistic Survey charcoal dates by hydrologic province.

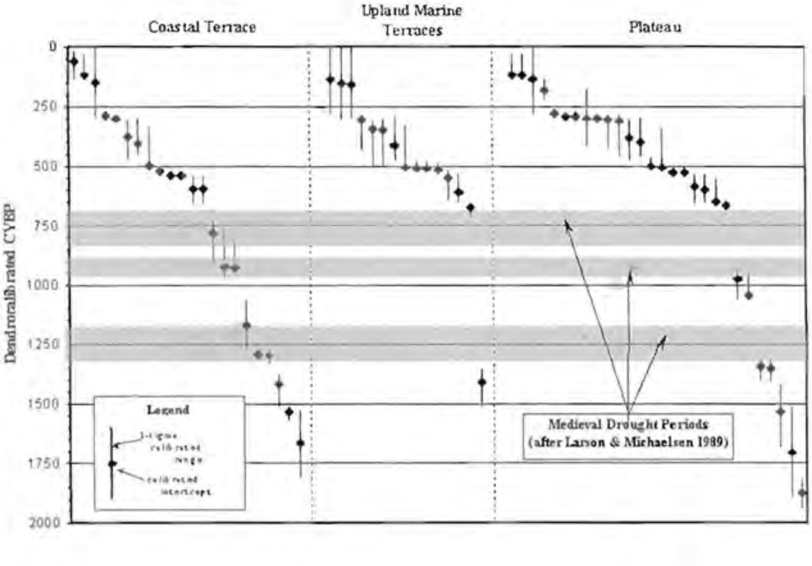

Figure 6. Temporal distribution of Supplemental Survey and Probabalistic Survey charcoal dates by topogrphic province.

stratum and Plateau bedrock areas another (see Figure 2). For the island's lower elevations (i.e., the Coastal Terrace), I defined the sampling strata on the basis of their corresponding upland geology. Here I assumed that the geological character of different drainages' upland source areas (i.e., aeolian vs. bedrock) created different potentials for water availability along their lower courses. For example, fossil dune source areas are expected to have buffered the release of precipitation to the associated downstream areas of the Coastal Terrace. Alternatively, drainages originating within bedrock uplands, where rapid runoff releases water more quickly downstream, would be more episodic and less persistent in flow.

The samples surveyed in each of these hydrological strata were sized to cover portions of the Plateau and the Coastal Terrace sufficiently large to investigate the correlation of archaeological sites to likely ancient water sources within any individual drainage. To appropriately contain the scale of the Supplemental Survey, the Upland Marine Terraces topographic stratum and its hydrology were excluded from the sample. The design of survey areas was determined with regard to average coverage of Plateau terrain encompassed within individual dendritic drainage catchments originating on both fossil dune and bedrock upland geologies. Mapped extents for both upland geological contexts indicated that survey areas of approximately 4.0 km^2 were required to cover both bedrock and eolian drainage catchments on the Plateau (see Figure 3). Because the Plateau terrain is roughly four times larger than the Coastal Terrace (Yatsko 1996), appropriate proportional samples of the Coastal Terrace were approximately 1.0 km^2. To maximize dispersal of the Supplemental Survey's sample across the island, the survey areas selected were drawn from different drainages in each terrain province rather than both ends of a single drainage system. These criteria were used to define four study areas, two on the Plateau (Old Airfield (or OAF) and Middle Ranch-Box (MRB)) and two on the Coastal Terrace (Shell-Abalone (SA) and Mail Point (MP) (see Figure 3).

Primary Supplemental Survey data collection occurred between 1994 and 1998, with selected data sets also coming from work done prior to the dissertation research, including investigations in the OAF Study Area during 1991 and 1993 (Raab et al. 1997; Yatsko and Raab 1997). All or parts of each study area had been subject to earlier site surveys, including portions encompassing between one and five Probabilistic Survey sample units. Data collection involved systematic survey or resurvey of the collective 9.85 km^2 within all four study areas, which cumulatively contained 559 cultural loci, documented as 497 archaeological sites. A stratified, random sample of fifty-two Supplemental Survey sites was tested for the presence of charcoal for ^{14}C dating. Thirty-three charcoal samples from 33 sites were ^{14}C dated, fourteen of which derived from the Probabilistic Survey research. Mean intercept ages for these dates range from cal BC 1805 to cal AD 1890 (Table 1).

ANALYSES

Analysis of the temporal site data presented in Table 1 proceeded as a largely graphic exercise. First, I plotted radiocarbon date frequencies by time interval as markers of population during different periods of time. Then, after grouping these dates with regard to the island's topographic and hydrological provinces, I evaluated their geographic distribution for variability in settlement patterns through time.

Figure 4 compares frequency curves for two suites of charcoal dates from the Supplemental and Probabilistic surveys. These curves display synchronous frequency depressions clearly coincide with Larson and Michaelsen's (1989) drought periods. These chronological data define a significant decline in the frequency of ^{14}C dated San Clemente Island sites between 1300 and 600 B.P., with dates apparently absent for the periods between 900 and 700 B.P. and between 1200 and 1000 B.P. (Yatsko and Raab 1997). Along with the "all-island" plot, this concurrence supports the inference that, rather than being the product of sampling error (an opinion tendered by some observers), these San Clemente Island date curves likely represent actual, island-wide site frequencies across the last 1,500 years.

Figure 5 presents Supplemental Survey and Probabilistic Survey dates grouped by hydrologic province. The hiatuses shown suggest that spatial distributions of dated sites are influenced by factors related to their hydrological potentials. Dated sites from bedrock terrains are largely absent for periods during the Medieval Climatic Anomaly, and show higher site frequencies outside the periods of medieval droughts.

Finally, because the regional sampling approaches used in both surveys were similarly topographically stratified, Figure 6 shows the combined Supplemental Survey and Probabilistic Survey charcoal dates from the two sampled topographic provinces (the Coastal Terrace and Plateau). Also shown are the Probabilistic Survey charcoal dates from the Upland Marine Terraces, the topographic province not sampled during the Supplemental Survey. There are clear interruptions in the distribution of dates across the Plateau and Upland Marine Terraces provinces. By contrast, we see a relatively continuous sequence for the Coastal Terrace. These latter dates are uniformly associated with areas of the Coastal Terrace crossed by drainage off upland eolian terrain. This observation supports a model where eolian-source catchments are more likely to have available water during periods of drought than bedrock-source drainages.

CONCLUSIONS

The two regional surveys presented here were designed to complement one another and to avoid or minimize concerns of bias in the selection and use of ^{14}C dates as a measure of population change (Glassow 1999). They present alternative approaches to sampling among the topographic, ecological, and hydrological variables found on San Clemente Island. Used together, they can portray the prehistoric island population's responses to climatic stresses experienced during the Medieval Climatic Anomaly. The two surveys' cumulative chronological record provides some empirical evidence for a punctuated decline in San Clemente Island's prehistoric population during the Medieval Climatic Anomaly. This is archaeologically expressed as a dramatic decline in the number of sites dated during the period. Concurrent with this decline is a significant geographic shift in the pattern of residential settlement indicating a depopulation of San Clemente Island's upland bedrock terrains. Furthermore, fewer sites were occupied on lower elevation terrain, usually in association with eolian-source hydrologic provinces. This population decline appears not to have reached the point of island abandonment. Radiocarbon dates are present, if in very low frequency, across the period of the Medieval Climatic Anomaly. Consequently, the alternative hypothesis for total island abandonment during the overall Medieval Climatic Anomaly cannot be supported.

The San Clemente Island settlement chronology also suggests parallels with archaeological sequences from other areas of western North America where regional abandonments and major population movements correlate with the Medieval Climatic Anomaly. Cultural responses vary among these regions, but each shows diachronic changes that, like those on San Clemente Island, are best explained as responses to environmental deterioration and related demographic stress (Jones et al. 1999). The effects of the Medieval Climatic Anomaly on aboriginal populations in the Mojave Desert of California probably best parallel the San Clemente Island example. Frequencies of occupation dates for the Mojave Desert during three periods between ca. A.D. 300-1800 show settlement patterns indicating a significantly reduced use of the desert between A.D. 800 and 1300 (Jones et al. 1999). This period matches the Medieval Climatic Anomaly defined by Stine (1994), Leavitt (1994), and others for the Great Basin and Sierra Nevada. Of 84 radiocarbon-dated archaeological components spanning these 1,500 years, 25 date to A.D. 300-800, 12 date to the Mojave Medieval Climatic Anomaly itself, and 47 date to the 500-year period that followed (A.D. 1300-1800) (Jones et al. 1999). Spatial distribution of these dated site components also shows that occupations between A.D. 800 and 1300 are closely associated with major springs and oases along the Mojave River.

Viewed from the margin of the Southern California Bight, the late Holocene paleodemography of San Clemente Island has wider implications for the study of prehistoric human population dynamics in other Channel Islands settings and across the region as a whole. San Clemente Island's well-preserved archaeological record offers a potentially finer resolution of the influence of paleoenvironmental stress on prehistoric regional cultures than may be currently available from some other Channel Islands. This is certainly the case when compared to the more disturbed coastal mainland context. The ongoing study of these issues on San Clemente Island will continue to improve our understanding of these processes on the other Channel Islands and the southern California mainland.

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