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Agriculture, Drought, and Chumash Congregation in California Missions (1782-1834)  
By Robert H. Jackson with Anne Gardzina

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INTRODUCTION

In examining European-Native American interaction in the centuries following 1492, scholars have studied missions as an interface of cultural, religious, and social change. One question that has received attention is why native peoples abandoned their traditional way of life in favor of the missions, which, as recent studies have shown, could become unhealthy and in some instances very exploitative. The question of the motives
of native peoples for accepting life in the missions has gained recent scholarly attention in the case of the California missions operated by the Spanish government and staffed by the Franciscans between 1769 and 1834.

In a study of the decline and collapse of tribal life in the San Francisco Bay region, Randall Milliken suggested a number of motives for native peoples to enter the missions. Initially, some Indians were attracted by a desire to take part in something new, and perhaps obtain new material goods brought by the Spaniards. However, as disease and mission livestock spread, the missions became the only option available. The Indians lost faith in their traditional way of life, that could not cope with the changed circumstances. Moreover, the political and social system, trade, and festival networks collapsed. Newly introduced livestock destroyed food resources. Finally, disease and migration reduced the size of villages, leaving them vulnerable to attacks by interior groups.

Another recent study that built on earlier lines of interpretation interjected environmental factors and the risk minimalization theory to explain why the Chumash entered the missions, and did so quite rapidly. Eighty-five percent of the Chumash entered the missions between 1786 and 1804, and more than 1,200 moved to the missions in the year 1803 alone. Based on an analysis of climatic variability and shifts in sea surface temperatures caused by El Niño effects, this interpretation maintained that Chumash consciously elected to move to the missions to minimize the risk of variable food supplies caused by unpredictable weather and disruption of Santa Barbara Channel fisheries. The collapse of traditional trade and political alliances coupled with the impact of epidemics and subsistence insecurity made the missions an attractive alternative to a dying traditional way of life.

Dendroclimatic, sea surface temperature data, and archaeological and ethnohistorical evidence seem to support the contention that climatic variability, both dry and excessively wet years, increased during the pre-mission (1670-1750) and mission (1780-1830) periods. Tree rings show dry years/drought in 1794-1795, 1805-1813, and 1821-1825. There was also a strong El Niño effect in 1815-1816 that disrupted the Santa Barbara Channel fishery and caused a famine among the Santa Rosa Chumash who depended heavily on the fishery. Skeletal remains from the pre-mission and mission periods show evidence of nutritional stress, such as Harris lines.

Studies of Chumash congregation have pointed to a relationship between food supply and the decision to relocate to the emerging mission communities, but in doing so they have largely ignored other broader and complex social, economic, and political factors that may have contributed to the decision to move to the missions. The ecological thesis provides a compelling explanation for the Chumash groups wholly dependent on fish and other marine animals as sources for food, and who probably saw the missions as a more reliable source of food during a period of decline in the local fisheries. However, the discussion of rainfall variability as a source of subsistence insecurity needs further refinement, particularly as regards the mainland groups that relied more heavily on plant foods and hunting, supplemented by trade with coastal groups. Tree ring analysis provides an idea of the range of wet, normal, and dry years, but does not provide specific evidence for the effect of variable rainfall on the plant foods the Chumash depended on. Did low or excessive rainfall reduce the supply of acorns, grass seeds, and other plant foods? Moreover, if the insecurity of traditional food sources caused by climatic variability was a factor that pushed the Chumash into the missions, what effect did the same climatic variability have on the agricultural based mission economies? Furthermore, was the mission food supply a strong pull factor for the Chumash to enter the missions? An alternative interpretation might be that the influx of population and labor enabled an expansion of grain production to satisfy the needs of the growing mission populations, and of the Spanish military stationed in the province and supplied by mission surpluses.
As argued elsewhere, tree ring analysis provides the general range of rainfall levels, but equally important was when rainfall occurred. In the case of agriculture, low rainfall during the farming cycle will not necessarily lead to crop loss. A drought following the planting of a crop could lead to losses; however, lower yet fairly constant rainfall throughout the maturation of a crop might lead to smaller harvests, but not crop failure. The same might apply to the wild plant foods on which the Chumash relied. For example, prolonged drought might significantly reduce the acorn crop, but low rainfall levels over a longer period might not. Drought also affects individual fields differently. For example, plants in the center of a field may receive less water and would wither, whereas the plants on the edges would not. The impact of drought was anything but uniform.

This essay re-examines the relationship between mission agricultural production and the decision made by Chumash to abandon their traditional way of life in favor of a radically new life in the missions. It does so within a comparative context that relies on data for other California missions. It tests population and grain supply, and the performance of different cultigens during the years identified by tree ring analysis as having been characterized by extremely variable but generally dry weather. It draws on data on grain production for four missions established among the Chumash: San Luis Obispo (1772); San Buenaventura (1782); Santa Barbara (1786); and La Purísima (1788). Within a larger context this study examines the reliability of tree ring analysis for measuring potential agricultural production levels, using an extensive data set of figures for actual agricultural production abstracted from detailed annual reports prepared by the missionaries stationed at each establishment. It also explores in a broader sense the factors that led California natives to enter the missions, and the ways in which the introduction of European agrarian economies modified or changed the way of life of non-European populations brought under colonial control.

Grain supplies best clarify the amount of food available to the Indians congregated at the missions, although there are also limitations to its use. The missionaries directed the raising of large herds and flocks of cattle, sheep and goats, and horses, but most of the animals were not used to supplement the diet of the Indians. The missionaries had cattle slaughtered to produce hides and tallow, and sheep produced wool and hence were generally not slaughtered for meat. After 1800, the Franciscans also exported hides and tallow. The Franciscans also supplied the military garrisons in California with food, and had to set grain aside for future planting. Grain constituted the largest part of the diet of the Indians in the missions.

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CONGREGATION AND FOOD SUPPLY
We have tested twenty year samples of data on the population of selected California missions and total grain production, using two statistical tests, regression and correlation, that establish the level of statistical significance between two or more variables. The t-test and the adjusted r-squared statistic show the statistical significance and relationship between two sets of variables, while the correlation coefficient shows if changes in two serial sets of data follow a similar trajectory. The stronger the statistical significance and relationship, the more likely that a causal relationship exists between the two sets of data. These statistical tests, however, only suggest a relationship, and do not identify actual cause and effect. The first test examined the relationship between population and total grain production at five missions: San Diego (established 1769); San Gabriel (established 1771); San Antonio (established 1771); San Carlos (established 1770); and Santa Clara (established 1777). The sample years chosen are 1785-1804 and 1812-1831. The results show that a statistically insignificant relationship existed between the two variables. The negative values of correlations for several of the samples suggest a decrease in grain production with an increase in population, a finding that runs contrary to the assumed relationship between levels of grain production and population.

We ran the same tests for the four missions established among the Chumash, with somewhat different results. The adjusted r-squared shows the strongest statistical relationship between grain production and population for the 1812-1831 San Buenaventura sample, the 1787-1804 Santa Barbara sample, and the
1785-1804 San Buenaventura sample. The results of the t-test show the strongest relationship for the same three samples. The correlation coefficient is highest for the San Buenaventura and Santa Barbara samples, and the 1812 to 1831 La Purísima sample. Patterns for the Chumash missions were different than for the other missions in the region, and between the Chumash missions the strongest statistical relationship is for San Buenaventura and Santa Barbara missions. If levels of grain production were a factor in the recruitment of converts, it would have been a significant factor at the two missions established among the Chumash that heavily recruited from the populations of the Channel Islands that were dependent on a fish diet, and would have been more attracted by offers of food supplies as the fish supplies fluctuated.

Analysis of a second set of data suggests that the relationship between food supply and congregation was weak, although the nature of the evidence is such that it only supports the suggestion of a hypothesis. It consists of total grain production and the number of baptisms of converts only recently settled on the missions, which is a more accurate indication of a possible cause and effect relationship between population levels and the food supply as measured by grain production. We have taken twenty year samples for San Luis Obispo (1785-1804) and Santa Inés (1804-1823) missions, the years of heaviest recruitment of converts to the missions, and again tested the data using regression and correlation. For San Luis Obispo the statistical tests show a weak relationship, but a somewhat stronger relationship for Santa Inés. In the case of the two missions that drew primarily from interior populations more dependent on the collection of plant foods, grain production had only a weak to moderate relationship to the number of converts entering the missions.

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THE PERFORMANCE OF MISSION AGRICULTURE

The dendroclimatic criteria used by Larson, et al., as the basis for the analysis of the risk minimalization hypothesis suggests that mission crops might also have been deficient during the years the tree rings identified as having been dry. Any analysis of mission agriculture must first begin with a description of the crops being grown. Wheat was the single most important crop cultivated, and, as indicated above, was grown during the winter, when coastal California receives most of its rainfall. Corn and barley were secondary crops, and the relative importance of the two varied from mission to mission. The Franciscans directed the planting of corn in the spring and barley in the spring or summer. At San Luis Obispo corn was far more important than barley, and barley was not even planted in most years. Corn and barley were of about equal importance at San Buenaventura and Santa Barbara, while corn was more important at La Purísima.

The data on agricultural production analyzed includes the reported amount of grain sown and harvested reported as fanegas and almudes. It is used to calculate the ratio of grain harvested to grain sown, and indices of grain sown and harvested. These data are presented as five year means, and show the variations in harvests and productivity. Variations in production levels and productivity could be caused by a variety of factors. These factors included too little or too much rain at key points in the agricultural cycle, the destruction of crops by pests, and, in the case of production levels, decisions about the amount of grain to be sown from year to year and labor shortages.

An analysis of the ratio of grain harvested to grain planted shows that an average return for wheat would be about 10 units for every unit of grain planted, and for corn from 50-100. The ratio shows considerable variation over time. In particular, the decade between 1822 and 1831 showed diminished returns for wheat and corn at all four missions, and for barley at the three missions where it was an important crop. A number of factors may explain the poor returns. Climatic variation certainly was an important factor, but other variables must also be considered. In the late 1820s (1827-1831), the Franciscans directed the planting of less wheat at all four missions, and less corn at two. The decision to plant less most likely was related to
rapid declines in the Indian populations at the missions, and thus the availability of less labor to harvest the crops. The annual reports from San Luis Obispo and other missions mention the scarcity of labor, and the chronically ill Indian adults who could not work as hard as the missionaries might have wanted. However, the worst wheat harvests at the four missions during the decade did not coincide with the dry years (1821-1825) identified by Larson, et al., but rather at the end of the decade. The same was the case for corn production at two of the missions.

How did mission agriculture perform during the dry years 1805-1813 and 1821-1825? During these years there were only a handful of poor crops at the four missions, as measured by the size of the crop when compared to the crops in other years. At San Luis Obispo the corn crop in 1807, 1812, and 1813 was low, and the wheat crop in 1812. San Buenaventura had perhaps the largest number of poor crops: corn from 1809-1812 and 1822; and wheat in 1805, 1807, and 1824. At Santa Barbara it was 1823-1824 for wheat, and 1807 and 1809 for corn. For La Purísima the wheat crop was low in 1807 and 1809, and corn in 1812. However, there was no region-wide drought that destroyed or limited crops at all four missions. The central Chumash missions, Santa Barbara and La Purísima, both had poor wheat crops in 1807, and 1812 was a poor year for both wheat and corn at three missions. But none of the dry years produced true famine conditions.

Crop totals varied during the dry years, but still averaged large returns for most years. The wheat crops were still large, and averaged between 2,000 and 3,300 at all establishments, although the crops in the early 1820s were a bit lower than during the earlier sample period. The ratio of seed harvested to seed sown also shows evidence of only a few very bad crops. At San Luis Obispo the wheat crop in 1809 and 1824 was poor, as was the 1807 corn crop. For San Buenaventura the wheat crops in 1805, 1807, and 1824 were low, as was corn in 1822. For Santa Barbara the wheat crops in 1823 and 1824 were low, but there were no low corn crops. Finally, the only poor crops at La Purísima were wheat in 1806 and 1824.

The analysis of agricultural production shows that dry conditions as recorded in tree rings did not necessarily translate into poor crops. Some but not all mission crops were irrigated, and while dry conditions reduced the level of streams and springs used for irrigation, a more detailed analysis of the water requirements and seasons of different crops would be necessary to show the exact consequences of water shortage. Dry conditions recorded in tree rings may also not have a direct correlation to the destruction of the plants in the traditional Chumash diet.

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REGIONAL CROP FAILURE

Was there a problem with crop failure across the Alta California mission frontier? An analysis of very poor harvests of wheat (a ratio of harvest: sown of 5 or less) and corn (a ratio of harvest: sown of 20 or less) shows that there were few instances of conditions leading to very poor crops in at least one crop across southern and central coastal California. We have divided the twenty-one missions into six groups based on general geographic match. Group One consists of San Diego, San Luis Rey, and San Juan Capistrano, all located in coastal valleys; Group Two, San Gabriel and San Fernando in the Los Angeles Basin; Group Three, the five missions established among the Chumash, including San Luis Obispo, San Buenaventura, Santa Barbara, La Purísima, and Santa Inés; Group Four, the missions located in the Salinas and San Benito Valleys, including San Miguel, San Antonio, Soledad, and San Juan Bautista; Group Five, being San Carlos and Santa Cruz on Monterey Bay; and Group Six, the five missions in the San Francisco Bay region, which are San Francisco, Santa Clara, San Jose, San Rafael, and San Francisco Solano. In order to filter out instances of very poor harvests at a single mission, we have recorded only instances of very poor harvests at the majority of establishments. This means that for the Group Two and Group Five missions, the very poor harvest had to have occurred at both missions.
The largest number of very poor crops was in Group One, the establishments located in the driest part of Alta California. Group three, the Chumash missions, had the second highest number. There were several instances of regionally centered poor harvests: the control imposed for the two groups with only two missions each means that the establishments in the Los Angeles Basin are not counted, although the drier climate in the Los Angeles Basin may have produced an equally large number of very poor harvests at one of the two missions that would not be included in the data analyzed here. In southern Alta California there were poor crops in 1807, and in 1809 in some parts of southern Alta California and the Salinas-San Benito Valleys. Both coincided with the one of the dry periods identified in the dendroclimatic data. The only years with very poor harvests across all or most of Alta California were 1827 and 1829, which did not coincide with the dry periods, but occurred at the time of a serious measles epidemic that probably incapacitated many Indian workers.

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CONCLUSIONS: A LARGER CONTEXT

This examination of the performance of mission agriculture has shown that climatic variability and periods of below normal rainfall did not in every instance limit grain production at the missions established among the Chumash. There were only a few very poor crops at the missions. What does this mean for a discussion of the use of climate and the variability of rainfall to explain the congregation of the Chumash? It is our contention that the analysis of dendroclimatic data does not provide direct evidence of food shortages among the Chumash resulting from insufficient plant foods. Moreover, there is a need to go beyond the tree ring evidence to document the specific effect of low and poor rainfall levels on the different wild plant foods collected by the Chumash. On the other hand, the data on mission agriculture also shows that during most dry years the missions did produce grain that would have been available had the wild plant foods sources been limited. The only conditions leading to very poor harvests across all of Alta California did not coincide with the dry periods identified in the dendroclimatic data used in support of the ecological thesis as used to explain Chumash congregation on the missions.

The statistical relationship between total grain production and population or the baptism of converts also suggests a rethinking of one of the basic premises of the ecological model: does the high statistical relationship between total grain production and population mean that increases in the grain supply lead to population growth? Or does it mean something else, such as that increases in labor supply result in higher levels of grain production? Statistical analysis does not establish cause and effect relationships, and merely suggests possible hypotheses. Our view is that both factors were at play, but the weaker correlation between total grain and baptisms of converts suggests that the labor-grain production relationship was perhaps stronger. An examination of non-climatic factors involved in the decision to enter the missions, such as the social, political, and economic (trade) factors outlined in the study by Randall Milliken for the northern California missions, would be equally revealing.

What factors did convince the Chumash to enter the missions? It is our intention here to suggest possible lines of future investigation. The missionaries frequently targeted traditional political leaders for conversion in the belief that the conversion of leaders would result in the rapid conversion of commoners. Did internal divisions and conflicts between the different Chumash tribes result in some leaders seeking alliances with the Spanish, alliances facilitated by baptism? Did the less socially prestigious members of Chumash society see alliances with the Spanish as beneficial? The missionaries in other parts of California also targeted children, and used control over children as leverage over the parents. Did this occur in the Chumash missions?
Once the exodus to the missions began, did existing social, political, and economic networks begin to disintegrate, as posited by Milliken for the northern missions? Put into broader terms, the Chumash suffered the fate of other tribal peoples brought under European colonial control: social disruption and disintegration. Increased mortality, both inside and outside the missions, undermined the traditional Chumash religious beliefs and world-view that could not explain the existence of new and terrifying maladies. Did the missions become an acceptable solution viewed as the lesser evil to remaining outside of the missions in an increasingly unfriendly and isolated world?

One other factor related to the possibly increasingly unreliability of the supply of wild plant foods may have contributed to the decision to move to the missions. Variable rainfall probably did not cause sufficient shortages of wild plant foods to force the Chumash into the missions, but the introduction of European livestock, particularly cattle and sheep, may have modified the environment and reduced the supply of wild plant foods. A recent study analyzed and compared the effect of the introduction of sheep to central Mexico in the sixteenth century and Australia in the nineteenth century, and possible parallels can be drawn with the experience of the Chumash.

The livestock, particularly sheep, destroyed many of the native plants. In Australia the sheep and cattle destroyed plants used as foods by the Aborigines. Moreover, the English settlers stopped the Aborigines from using fire to control and promote the growth of plants that provided food, leading to the expansion of scrub into grasslands and the impoverishment of wild food supplies. Grazing also destroyed ground cover, particularly in semi-arid areas, leaving baked and eroded soils.

As Milliken has suggested for the San Francisco Bay region, a similar scenario played itself out in the Chumash territory. The Franciscans introduced cattle, sheep, horses, and other animals, and the size of the herds grew quite rapidly. Thousands of cattle and sheep ranged across Chumash territory, and the numbers of livestock rapidly increased after 1800. In 1800, four missions counted a total of 16,572 head of cattle and 20,215 sheep. A decade later, in 1810, the numbers had risen to 41,425 cattle and 37,786 sheep. The common practice was to place livestock at sites close to large centers of indigenous populations, which meant that the growing number of livestock destroyed plants that were traditional sources of food in the immediate environs of mainland Chumash villages.

A statistical analysis of the relationship between population and numbers of livestock at one mission, La Purísima, highlights the possible importance of the growing numbers of livestock in forcing Chumash onto the missions. A test of the relationship between the population of La Purísima and numbers of livestock (cattle, sheep, horses) between 1789 and 1804, the year with the highest recorded population, shows a very strong statistical relationship. The adjust r-squared is .8746, the t-statistic 10.361, and the correlation coefficient .9406. This suggests, that as the number of livestock increased, more and more Chumash settled on La Purísima mission. After 1804, as the population of La Purísima mission declined, the statistical relationship between livestock and population was much weaker.

The consideration of the effect of livestock on native vegetation allows us to suggest an alternative explanation for the meaning of the numbers derived from the different statistical tests. The Franciscans stationed at San Buenaventura and Santa Barbara recruited heavily among the Island Chumash, a population vulnerable to fluctuations in the food supplies from the fisheries off of the Islands. Shifts in ocean temperatures caused by such phenomenon as El Niño would have placed considerable stress on the Island Chumash, because of the shortage of fish. At the same time increasing numbers of Europeans and Americans visited the California coast beginning in the 1790s, looking for pelts from fur-bearing animals such as sea otters, and trade in hides and tallow. The effect of increasing contacts with the Island Chumash must also be considered as a factor in pressuring the move to the missions. The missionaries on the other missions among the Chumash recruited more from among inland groups more dependent on wild plant
foods, and the increases in the numbers of livestock certainly contributed to the settlement of mainland Chumash on the missions. These factors combined with the erosion of tradition Chumash political and social relationships between communities, trade, and inter-village marriage patterns. As more Chumash moved to the missions, those people still living in traditional ways found it increasingly difficult to survive.

The arrival of the Spaniards disrupted the traditional way of life of the Island and Mainland Chumash, and the missions offered the only viable alternative to a disintegrating way of life. The introduction of livestock on the mainland certainly contributed to making the traditional way of life increasingly unstable and unsustainable. The discussion of non-statistical data, on the other hand, suggests that variable rainfall levels did not play as important a role in forcing the Chumash to move to the missions. The older ecological interpretation also, consciously or unconsciously, attempted to minimize the negative effects on the Chumash of the arrival of the Spaniards.

Burning was also a common means used to control plants and to promote the growth of the plants used for food, a practice eliminated by the Franciscans for similar reasons. If shortages of wild plants motivated Chumash to enter the missions, the shortages would have resulted more from the destruction wrought by the livestock brought by the Spaniards that proliferated rapidly. A complex set of social, economic, and demographic push and pull factors contributed to the decisions made by Chumash to abandon their traditional way of life and enter the missions. Poor rainfall may have damaged or destroyed traditional sources of food, but the tree ring data does not provide conclusive evidence. If destruction of traditional plant foods indeed was a factor in compelling Chumash to enter the missions, the proliferation of destructive herds of livestock may very well have played a far more important role than did insufficient rainfall. The reports that record the yearly numbers of livestock generally do not mention insufficient pasture. On the contrary, the numbers of livestock grew rapidly in the decades following the establishment of the missions. Pasture apparently was not a problem, except for the Chumash when the mission livestock consumed the plants they traditionally had used for food.

Finally, the analysis here highlights the limitations of the use of statistical tests and quantitative evidence in historical analysis. Care should be taken to not let statistical tests drive analysis and interpretations. These tests do not establish cause and effect relationships, and do not reveal complex factors contributing to decisions made by individuals or groups of people to abandon their traditional way of life. Dendroclimatic evidence should also be used with care, since tree rings only demonstrate relative levels of rainfall and not the distribution of rain during the year. In the case of the missions established among the Chumash, evidence from annual reports on grain production provides addition clues to rainfall levels and the availability of plant foods.

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