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Ecological Transformation and Indigenous Demographic Collapse at Mission Santa Clara

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AUTHOR BIOGRAPHY

Aaron He, Ayush Iyengar, Leo Casey Billante, and Caleb Wang are high school seniors at Bellarmine College Preparatory in San José, California. They are interested in local history and Indigenous justice, working closely with the Muwekma Ohlone Tribe of the San Francisco Bay Area to support their efforts toward federal recognition. The students lead the Indigenous Justice Coalition, a youth-led nonprofit that supports unrecognized tribes across the United States. Aaron, Ayush, Leo, and Caleb regularly lobby on behalf of marginalized Indigenous communities before city councils and congressional offices. All students developed their critical thinking and public speaking skills through competition in state and national level speech and debate.

ABSTRACT

The Mission Santa Clara de Asís leveraged California Indigenous labor as a means to boost economic growth, displacing Native communities in the process. We analyzed demographic and economic data spanning from 1778-1832. The data centered around the correlational relationship between the demographic collapse and the growth of the mission's agricultural production. We used multiple methods of analysis and charts that took into account a variety of variables, including birthrate, deathrate, and cattle exports. These conclusions illustrate the extent to which the Mission Santa Clara de Asís exploited the Indigenous communities as a means of economic expansion.

***Keywords**: Santa Clara Mission de Asís, California missions, Indigenous demographic collapse, Mission agriculture, Colonial economy, Native population decline, Settler colonialism, California history, Mission system impacts, and Indigenous studies.*

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INTRODUCTION

The focus of recent scholarship studying the California mission system has often been on the moral and cultural aspects of the Spanish colonisation (Jackson & Castillo, 2005). Analyzing this area of research, we have found that these approaches, although shedding light on the ideological and controlling aspects of the missions, have not always accounted for the ecological disaster that came with settling and its toll on the well-being of Indigenous populations.

The Santa Clara Mission, established on January 12th, 1777, in the heartland of the Muwekma Ohlone, is a prime example of the destructive ecological and economic policies of the missions (Understanding Santa Clara University and Its Indigenous Legacy, n.d.). Despite functioning as a religious house, Santa Clara evolved into a regional economic powerhouse, and its financial success was heavily reliant on tearing up the surrounding landscape, bringing over invasive species, and knocking out the delicate balance of the systems that the indigenous communities had been living on for generations (Panich, 2015). Because of the lack of available and nutritious food and being forced to rely on the mission for survival, the Indigenous population eventually started to dwindle (Leventhal, 2021a). This paper will investigate the harm that Indigenous communities suffered as a result of the California Mission system. Using the Santa Clara Mission as a case study, our analysis suggests that the economic growth of the mission was inversely correlated with the well-being and nutritional autonomy of the indigenous people.

LITERATURE REVIEW

Extensive literature has established that the economic systems of Missions Santa Clara, San José, and Dolores permanently impacted the Muwekma Ohlone Tribe. Leventhal et. al (1994) place the Muwekma's ancestors within the historical context of forced relocation, religious conversion, and exploitative labor, which increased mission productivity at the cost of the demographic collapse of Native populations. In spite of the devastating population decline brought on by these regimes, the Muwekma Ohlone maintained kinship networks, cultural customs, and cohesive community. While earlier anthropological narratives, most notably A. L. Kroeber's declaration (1925) of the "extinction" of the Muwekma Ohlone Tribe erased Indigenous presence (Leventhal et al., 1994). More recent archaeological work has reversed such claims. By demonstrating how modern archaeological excavation has evolved into a form of political resistance, Field et al. (1992) expand on larger ethnohistorical findings that Indigenous communities resisted colonial erasure by maintaining cultural traditions. Their documentation of the Muwekma Ohlone's resistance efforts contributes to the idea of "consciousness-raising" for Indigenous movements (p. 430). Additionally, a thorough historical account of the Muwekma Ohlone Tribe can be found in Leventhal's report on the burial site beneath the Holiday Inn in downtown San Jose (Leventhal, 2021b).

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A significant difference exists between scholarly interpretations of the California mission system that emphasize coercion and economic exploitation and those that present Native participation as voluntary or advantageous. Duggan (2016) challenges the “conventional wisdom” that eighteenth-century mission Indians labored without compensation, arguing instead that significant uncompensated labor occurred only after the Spanish imperial structure began to unravel in the nineteenth century. She highlights that missions were not physically walled compounds and suggests that ecological damage and disease, not continuous military coercion, were the primary causes of Indigenous resistance's decline. Although Duggan conducts thorough archival research through the mission account books, her framing of ecological collapse and disease as an external inevitability rather than a byproduct of colonial systems runs the risk of downplaying the coercive aspects of mission life. Here, our study intervenes, pointing out that Spanish livestock introduction, settlement, and land transformation were the root causes of these ecological and epidemiological crises.

Despite acknowledging violence and cultural loss, Doti (2019) also concludes that "virtually all the coastal Native Californians willingly joined the missions and stayed" because of material inducements like regular food, clothing, and housing. However, she also contends that the Indian’s own efforts brought about these comforts, which were not present in pre-contact life, implying a kind of reciprocal advantage. In a similar vein, Milliken (1995) downplays the use of military force by portraying Native American admission into missions as the "only rational choice" in the face of the general breakdown of tribal culture. Although he portrays Indigenous people as refugees escaping resource depletion and settler encroachment, he treats joining missions as a voluntary adaptation rather than a last resort forced by colonialism. Our critique reframes this as an illusion of choice created by Western colonialism: a "rock and a hard place" where both options were shaped by dispossession.

Other scholars take a more critical stance toward the mission treatment of Indigenous populations. Archibald (1978) admits that the system “decimated and destroyed” Native peoples but argues against the label of slavery by contending that Franciscans prioritized religious conversion over economic profit. His own cited testimony, however, documents excessive flogging, hunger, and high mortality as key drivers of desertion, corroborating accounts of violent discipline toward Native peoples. Drawing from eyewitness reports, Lightfoot (2006) characterizes missions as "penal institutions," pointing out actions like limiting freedom of movement outside of mission grounds and locking Indigenous people in at night. Hackel (2017) expands on this criticism and contends that, without the ecological destruction and epidemics spread by Spanish cattle, the Spanish could not have maintained dominance over California’s Indigenous peoples. Hackel’s linkage of environmental transformation to social control reinforces our study’s argument that mission economic productivity and Indigenous demographic collapse were causally connected.

Native American subsistence methods drastically shifted when agriculture was introduced under the California missions. According to Noe (2022), the Spanish diet, which consisted of atole (grain soups) and

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pozole (stews of vegetables and meat), was very different from the native Californian diet, which was centered on hunting, fishing, and plant gathering. The interior Miwok, Northern Valley Yokuts, and Ohlone were also reduced to an agrarian workforce with rigidly regulated meal, prayer, and work schedules. There were significant effects from this ecological change. This ecological shift had major impacts. Spanish livestock introduced what scholars call "cattle colonialism" and the "ecological hypothesis" by displacing native vegetation, bringing invasive plants, and competing with native animals (Fischer, 2017). By the nineteenth century, 44% of plant species at mission sites were non-native, such as corn, wheat, and cheeseweed (Allen, 2010). Hackel notes a "rough correlation" between the introduction of cattle and increased baptism rates, implying that ecological disruption compelled Native communities to join the missions (2017).

In particular, the Muwekma Ohlone Tribe's cultural erasure and demographic decline were largely caused by the California mission system. Archaeological work at Mission Santa Clara shows how the narratives of “white public heritage” have erased histories of thousands of Ohlone people who lived, worked, and perished (Panich, 2022). Field (2003) similarly situates the Muwekma within a pattern of demographic collapse directly linked to missionization, noting that the ethnonym “Ohlone” refers to a native group whose postcontact history was shaped by mission-driven population decline and regrouping during the Mexican period. Many historical archives are consistent with larger trends of the Muwekma being displaced by "anthropological and bureaucratic tools," which frame their identity through constrictive interpretations. Field also shows how, despite some lineages' resistance to assimilation by staying in their ancestral homelands, missionization at Mission Dolores, Mission San José, and Mission Santa Clara contributed to the Muwekma's loss of autonomy. Collectively, this literature underscores that the Muwekma experience with the mission system was neither benign nor voluntary but embedded in structures of exploitation and erasure that still shape public memory today

Theoretical Gap

Contemporary research on the Alta California Missions solely upholds narratives of Indigenous assimilation into Spanish religious life or frames demographic collapse as a consequence of external diseases. Economic analyses, on the other hand, tend to isolate mission output from population change or aggregate results across multiple missions; in doing so they muddle dynamics at a mission-specific level.

What is needed is a mission-specific analysis that ties grain and herd output to ecological degradation and demographic decline. At Mission Santa Clara de Asís, few studies have measured how rising production correlated with diminishing fertility, child share, and population stability. This absence creates a notable gap between descriptive histories and quantitative evidence linking mission production to Indigenous demographic outcomes. To address this, our study poses the following research question: How did agricultural and livestock productivity at Mission Santa Clara de Asís intersect with patterns of demographic decline among the Indigenous population?

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While prior scholarship has examined mission economies or demographic collapse in isolation, few works connect them at the level of a single site. Our study provides scholars with a framework for reinterpreting mission behavior through the lens of economic-demographic correlation. For tribal advocates, it offers historical grounding to link Mission Santa Clara's prosperity with the Muwekma Ohlone's loss of nutritional autonomy and family formation; in doing so, it allows the Tribe to reinforce contemporary advocacy with historical precedent.

Roadmap

The remainder of this paper is organized as follows. In Methods and Materials, we outline the archival sources used to find data and describe the criteria for analysis. In Results, we present findings and correlation from mission records and archaeological data, focusing on patterns in agriculture, livestock growth, and demographic change in the missions. The Discussion interprets these results in relation to colonialism, emphasizing how environmental disruption and demographic decline sustained mission productivity. Finally, the Conclusion summarizes the study's contributions and implications for understanding the links between ecology, labor, and Indigenous survival in the California missions.

METHODS AND MATERIALS

Data Sources and Collection

We constructed our dataset year by year for Mission Santa Clara de Asís between 1777 and 1840. All quantifiable measurements were taken directly from sacramental registers, with missing entries marked as "n/a." Agricultural and livestock outputs were transcribed from mission ledgers and annual reports preserved in the Archivo General de la Nación, Mexico, and the Santa Barbara Mission Archive-Library. When crops were listed in mixed units (fanegas and almudes), we converted them to fanegas using the standard 1:12 according to Castilian measurements. Livestock numbers were recorded as raw head counts by species. Where historian Robert H. Jackson produced demographic indicators such as crude birth rate and death rates, life expectancy, and reproduction ratios, we collected those values one-to-one to maintain consistency across our analysis. Every entry was transcribed exactly as printed, any zero value was preserved as zero, and missing values were either left blank or marked "n/a." Each datapoint was aligned to the report year without aggregating or averaging reports across adjacent years. All data points were linked and cited such that future researchers may trace each value to its original source.

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Data Analysis

With the aforementioned data set established, we tested how Indigenous demographic indicators correlated to mission economic output. This approach is suitable for examining historical demographic and economic data, including population counts, crop yields, and livestock indices, because it quantifies the magnitude and direction of linear relationships between two continuous variables. We examined variable pairs using Pearson's correlation coefficient (r) to quantify the strength and direction of linear relationships. Coefficients range from -1 (perfect negative correlation) to +1 (perfect positive correlation), with a value of 0 indicating no association. Every numeric entry in the analytic panel is traceable to a printed cell or ledger line in the Santa Clara series or its published reproductions, with original unit labels retained. The processing choices described above are implemented consistently across pairs so that a reader can rebuild the analytic samples from the same materials.

We define the study's data points and measurement conventions as follows. Population refers to the Indigenous population for each mission year. Annual aggregate values of agricultural and livestock output were measured in fanegas and raw head count, respectively. Crude birth rate refers to births in a year divided by the population totals recorded for given years, then multiplied by 1,000 (Jackson, 1992). Crude death rate refers to burials in a year divided by population totals recorded for given years, then multiplied by 1,000.

RESULTS

The data from Mission Santa Clara between 1777 and 1840 demonstrates an ever-shifting balance between agricultural production, livestock growth, and Indigenous demographic indicators. Annual records show that while herds and crop yields often expanded, the Native population experienced severe fluctuations; this pattern indicates that periods of population decline correspond with failing fertility brought on by ecological strain. With all these taken into consideration, the figures and tables below suggest that the mission's economic growth did not sustain the indigenous community; rather, they provide a widening gap between material output and demographic stability.

Raw Data

Figure 1 presents annual crop quantities recorded at Mission Santa Clara over the years 1778 to 1832 (Jackson & Castillo, 2005).

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Figure 1
Annual crop quantities by crop, 1778 to 1832

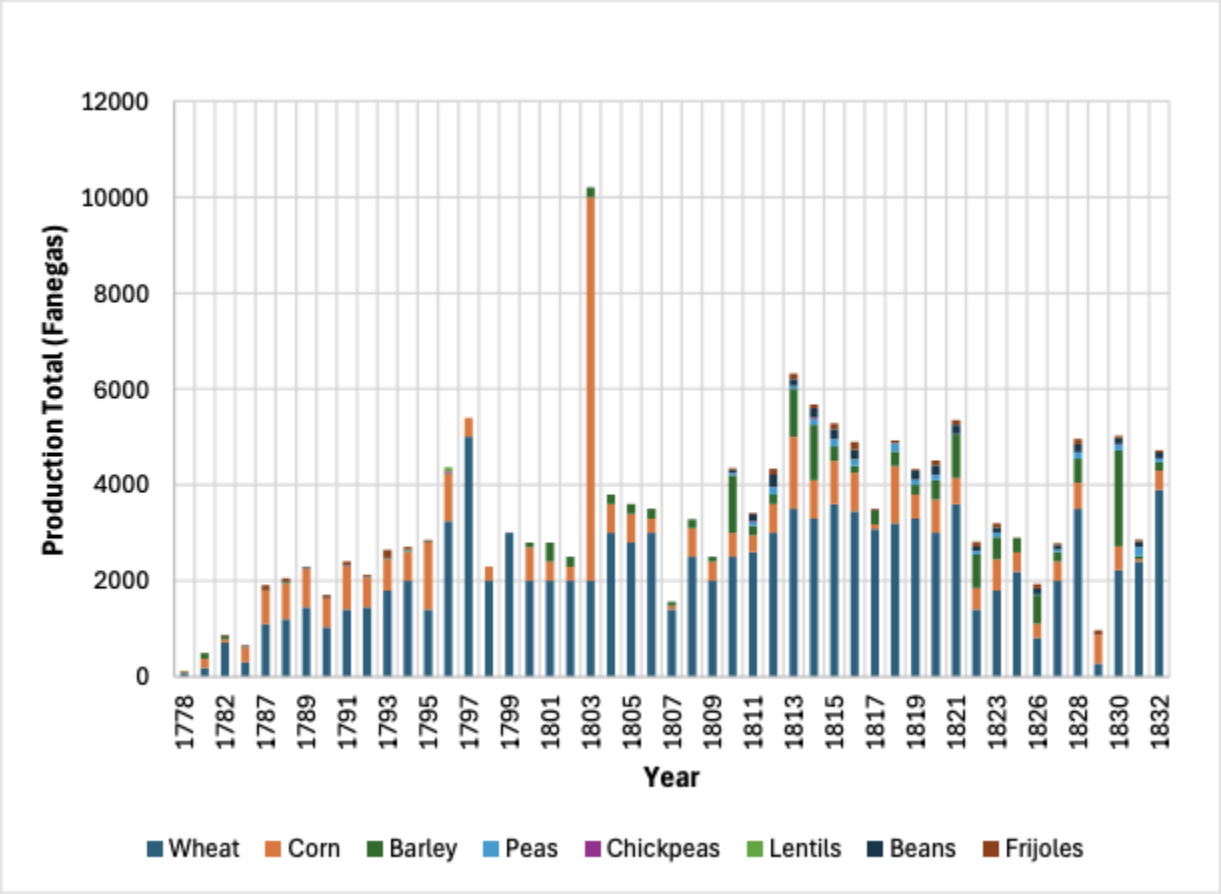

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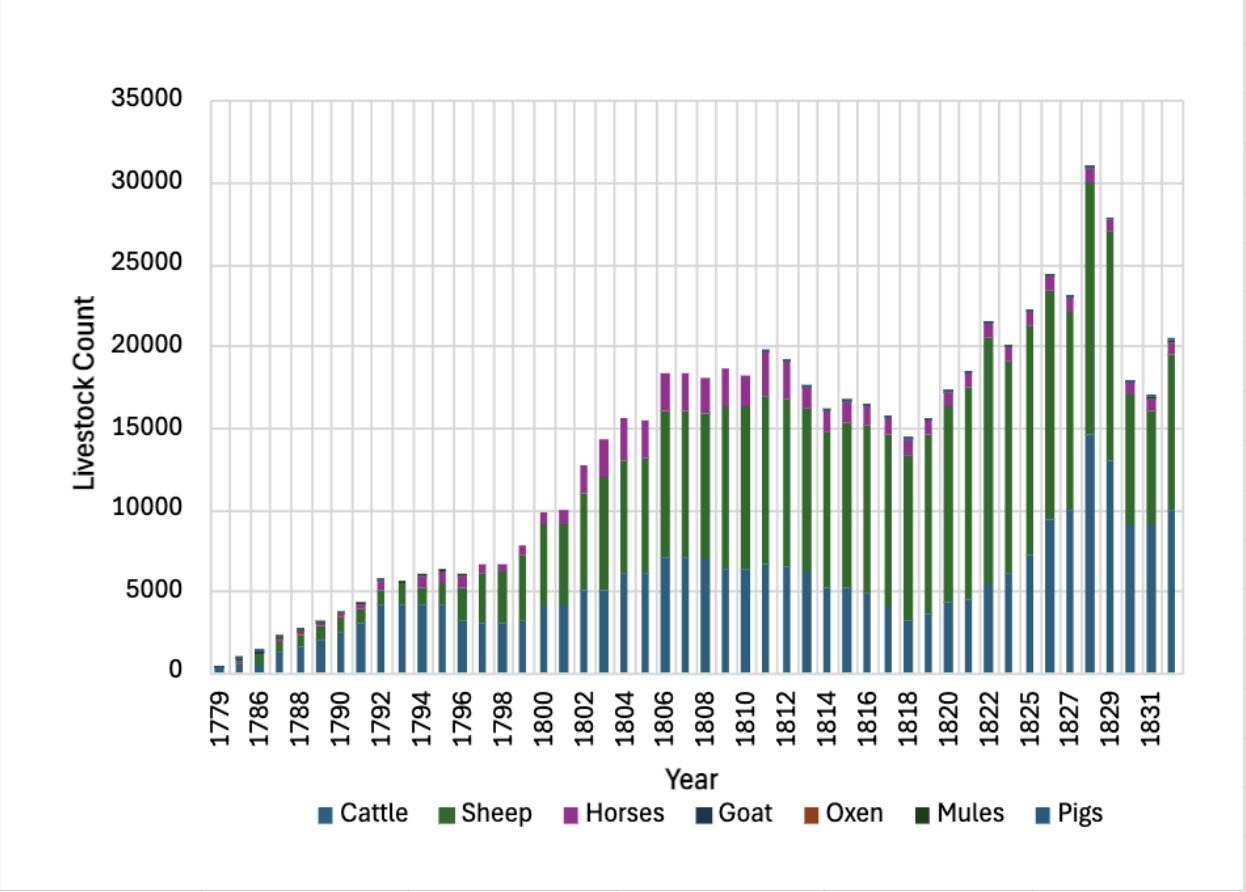
Figure 2 presents annual livestock counts recorded at Mission Santa Clara (Jackson & Castillo, 2005).

Figure 2
Livestock inventories and indices, 1779 to 1832



Note. The stacker bar graph displays annual livestock inventories at Mission Santa Clara, disaggregated by species: cattle, sheep, horses, goats, oxen, mules, and pigs.

Table 1 reports annual population in Mission Santa Clara from 1777 to 1840. The series accelerates through the 1790s, peaks in 1795 at 1,541, then contracts between 1798 and 1815 with counts falling to a low of 291 in 1839 (Jackson, 1992). Entries marked "n/a" indicate years with no surviving or usable records. Values are raw counts; no interpolation or smoothing was applied.

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Table 1
Mission Santa Clara Annual Population Levels 1777 to 1840

Year	Population Level
1777	13
1778	91
1779	111
1780	270
1781	n/a
1782	373
1783	618
1784	n/a
1785	n/a
1786	n/a
1787	647
1788	672
1789	787
1790	910
1791	957
1792	1,001
1793	1062
1794	1418
1795	1541
1796	1433
1797	n/a
1798	n/a
1799	1343
1800	1318
1801	1322
1802	1291
1803	1291
1804	1240
1805	n/a
1806	1406
1807	n/a

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1808	1410
1809	n/a
1810	1332
1811	1371
1812	1348
1813	1347
1814	1306
1815	1306
1816	1336
1817	1336
1818	1321
1819	1313
1820	1359
1821	1388
1822	1394
1823	1395
1824	1450
1825	1403
1826	1428
1827	1462
1828	1369
1829	1269
1830	1226
1831	1184
1832	1125
1833	n/a
1834	n/a
1835	n/a
1836	n/a
1837	n/a
1838	n/a
1839	291
1840	344

Note. "Population level" refers to the recorded annual count of people for each year.

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Table 2 provides period totals of grain production recorded at Mission Santa Clara (Jackson, 1991). Quantities are in Fanegas.

Table 2
Period grain production totals (fanegas), 1790 to 1832

Period	Production
1790-1796	2685
1810-1816	4889
1817-1823	4091
1826-1832	3306

Table 3 presents demographic indicators recorded at Mission Santa Clara (Jackson, 1992). Crude birth and death rates are as reported in the source. GRR denotes the gross reproduction ratio, and NRR denotes the net reproduction ratio.

Table 3
Demographic indicators, 1784 to 1829

Year	Population	Crude Birth Rate	Crude Death Rate	GRR	NRR	Life Expectancy
1784	428	0.61	14.5	1.85	0.07	2.7
1789	787	0.52	16.3	1.36	0.02	1.2
1794	1418	0.40	14.0	0.98	0.01	1.3
1799	1343	0.38	12.6	0.98	0.02	1.5
1804	1240	0.31	13.4	0.98	0.01	1.2
1809	1398	0.29	10.0	0.9	0.03	2.5
1814	1306	0.28	7.8	1.07	0.1	6.1
1819	1313	0.25	7.6	1.11	0.11	6.5
1824	1450	0.27	8.8	1.22	0.08	4.5
1829	1269	0.19	8.7	0.83	0.05	4.1

Table 4 presents the share of párvulos as a percentage of the total population in selected years recorded at Mission Santa Clara (Jackson, 1992).

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Table 4
Párvulos as a percentage of population in selected years

Year	%
1789	56
1796	18
1798	21
1810	12
1832	7
1839	3

Note. Values are percentages of total population. "Párvulos" refers to children under 9 years of age.

Units and Definitions

We define the study's data points and measurement conventions as follows. Population refers to the Indigenous population for each mission year. Annual aggregate values of agricultural and livestock output were measured in fanegas and raw head count, respectively. All grain quantities are recorded in fanegas, where historical Spanish practice places 1 fanega at roughly 55–60 liters, which is about 1.6–1.7 U.S. bushels. Almudes refer to a Castilian quantity equivalent to 1/12th of a fanega, which represents approximately 5 liters within the context of contemporary measurements. (Naylor et al., 2021). We preserve the original ledger notation by using fanegas and use approximate rational conversions for multi-unit fanega and almude values when necessary. Crude birth rate refers to births in a year divided by the population totals recorded for given years, then multiplied by 1,000 (Jackson, 1992). Crude death rate refers to burials in a year divided by population totals recorded for given years, then multiplied by 1,000. The gross reproduction ratio measures the average number of daughters a group of women would bear under observed fertility rates, without accounting for mortality. The net reproduction ratio adjusts that figure by factoring in female mortality, showing whether a population replaces itself across generations (Jackson, 1992).

Summary of Trends

Between 1795 and 1832, Mission Santa Clara saw its Indigenous population decline while livestock herds expanded dramatically, creating extreme cattle and sheep-to-person ratios before both herds and population contracted in the early 1830s. In 1795, the Indigenous population reached 1,541 persons, and the mission reported herds of 4,100 cattle and 1,350 sheep. The ratios were determined as 2.66 cattle and 0.88 sheep per person. By 1828, the population had decreased to 1,369 persons, despite a large increase in livestock numbers to 14,500 cattle and 15,500 sheep. In other words, there was a ratio of 10.59 cattle to 11.32 sheep per

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person. By 1830, the livestock count had fallen to 9,000 cattle and 8,000 sheep, with a population of 1,226 persons producing 7.34 cattle and 6.53 sheep each.

In contrast to the population decline, grain production at Mission Santa Clara initially rose on a per-capita basis in the early 19th century before declining after 1816, as wheat came to dominate while corn and other cereals sharply diminished. Per capita production increased from 2.26 fanegas per person in 1790-1796 to 3.66 per person in 1810-1816, before declining to 3.01 between 1817 and 1823 and 2.55 in 1826-1832. Crop composition shifted considerably across the observational scale. Wheat and corn yields were roughly similar in 1795, at 1,400 fanegas each; however, by the late 1820s, wheat was harvested at 3,500, while corn was reported at a meager 550; other cereals were insignificant in production relative to their sister populations, if not unrecorded at all.

Finally, demographic indicators at Mission Santa Clara declined to sub-replacement levels by the 1820s, as both the gross reproduction ratio (GRR) and the net reproduction ratio (NRR) contracted despite concurrent agricultural expansion. In 1789, the NRR was 0.02 and the GRR was 1.36 when the amounts of corn and wheat were 800 and 1,450 fanegas, respectively. By 1794, NRR had dropped to 0.01 and GRR to 0.98, while corn had dropped to 600 and wheat to about 2,000. Between 1814 and 1819, wheat averaged about 3,300, GRR ranged from 1.07 to 1.11, while NRR stayed in the 0.10 to 0.11 range. In 1824, barley reached 900, corn reached 550, and wheat reached 3,600, while NRR remained at 0.08. While wheat declined to 272 and corn remained near 600, barley registered zero, GRR dropped to 0.83, and NRR dropped to 0.05 by 1829. Overall we observe that while crops like wheat and corn sometimes increased, the population was not replacing itself, which demonstrates that agricultural success was not positively correlated with community survival.

Conclusions from Data

Table 5

Correlation Summary

Pair	Pearson *r*	N (Pairs)
Population vs. Wheat	0.6195	43
Population vs. Cattle	0.5298	42
Population vs. Crude Birth Rate	-0.8323	10
Population vs. Crude Death Rate	-0.595	10
Crude Birth Rate vs. Cattle	-0.734	8
Crude Death Rate vs. Cattle	-0.595	8

Note. N (Pairs) refers to the number of paired observations used to determine the r value

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Table 5 represents a Pearson correlation analysis between Population rates and multiple variables that represent the impact of an increasing Indigenous labor pool on the exports of the mission. An *r* value of +1 represents a perfect positive relationship, where each increase in variable x leads to a proportional increase in variable y. An *r* value of -1 represents a perfect negative relationship, where each increase in variable x leads to a proportional decrease in variable y. The N value represents the number of pairs of each variable used in the correlation analysis calculation.

We found a strong negative correlation (Pearson r = -0.7340) between crude birth rates and cattle quantity. This suggests that birth rates among Indigenous people decreased as cattle herds grew within the mission economy. Given the inverse relationship, it is possible that the intensification of cattle herding activities and demographic strain occurred at the same time. This could be because of increased labor burdens, cramped living arrangements, or dietary changes related to ranching, which could have reduced fertility. Cattle ranching's growth thus represented both the mission's economic development and the demographic strains on its Indigenous populace (Fischer, 2017). Previous studies have also noted that deficiencies in essential nutrients found in soil such as folic acid and iron directly impair female fertility, aligning with our finding that crude birth rates decline following an increase in cattle quantity (Nazni, 2014).

Population vs. Wheat.

We yielded a Pearson *r* of 0.6195 when looking at how population levels tied into wheat production, indicating a moderate-strong positive relationship between the two factors. This demonstrates that wheat output increased as the mission's Indigenous population grew, suggesting that demographic growth helped push agricultural expansion, since a larger workforce led to higher yields and steadier work on those staple crops.

Cattle vs. Population.

Between population and cattle numbers, we derived a Pearson *r* at 0.5298, indicative of a moderate-strong positive relationship. These findings suggest that cattle herds mostly followed the trends of the mission's Indigenous population, though not as strongly as between wheat production and the Native population. The mission managed to convert the added population into an organized labor force, expanding ranching operations and freeing up more land for herding.

Crude Birth Rate (CBR) vs. Population.

The crude birth rate and population size showed a strong negative correlation, with a Pearson *r* of -0.8323, indicating that larger Indigenous populations had lower fertility rates. Once the mission reached a certain capacity, factors such as overcrowding, epidemic shocks, and colonial life interfering with family structures affected birth rates (Scher, 2023). Due to the observed volatility of rates, any short-term spikes in birthrate are characteristics of desperate recovery, not real stability.

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Population vs. Crude Death Rate (CDR).

Our analysis of population levels and crude death rates yielded a Pearson *r* of -0.5950, revealing a moderate-strong negative relationship between the two trends. This indicates that there was an inverse relationship, meaning that as the Indigenous population grew in the mission, mortality rates tended to drop. This points to how demographic stabilization received a boost from better subsistence production, through crops and cattle, with the support of a larger, more balanced community. Populations were more disease-resilient and could facilitate quicker recoveries, ultimately bolstering the mission's labor and economic setup. This consistent rate of decline indicates that the mission population would have crashed absent a constant influx of new neophytes due to low fertility and high infant mortality rates.

Crude Birth Rate (CBR) vs. Cattle.

Our analysis on crude birth rates and cattle quantities yielded a Pearson *r* of -0.7340, or a strong negative relationship. As cattle herds grew in the mission economy, birth rates among the Indigenous population steadily dropped. The inverse correlation suggests that increased farming expenditures aligned with demographic stress: heavier labor loads, crowded living, and dietary shifts from ranching contributed to lower fertility.

Crude Death Rate (CDR) vs. Cattle.

We observed a moderately-strong negative correlation between crude death rates and cattle quantities, with a Pearson *r* value of -0.5950. This indicates that as cattle herds expanded in the mission economy, mortality rates among the Indigenous population began to fall. This inverse link shows how cattle growth improved food access to resources such as meat and dairy, boosting nutrition and cutting disease risks. At first glance, an apparent contradiction can be observed between the effect of cattle on CBR compared to CDR. However, an expansion of cattle ranching has a mixture of positive and negative impacts on the existing Native population while still acting as a barrier to fertility rates. Each factor that contributes to a low CBR, such as overcrowding and greater workloads, is an independent stressor on the daily lives of the Native population that prevents them from procreation, dropping fertility rates. The nutrients and resources from the cattle only benefit the laborers that spend most of their time working on tending to the herd and is unrelated to the factors that affect CBR. Cattle ranching demanded significant labor and altered settlement structures, having a mixed impact on demographic trends. Overall, a labor focus on cattle ranching played a dual role in driving economic development while negatively influencing health in the Santa Clara Mission Native community.

DISCUSSION

Our correlation analysis at Mission Santa Clara showed a definite negative relationship between crude birth rates (CBR) and cattle numbers (Pearson r = -0.7340), with recorded birth rates decreasing as herd sizes increased. Decreased fertility and increased newborn vulnerability may have resulted from a variety of

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interconnected factors, such as increased labor demands, crowded living conditions, and dietary changes related to ranching. This pattern supports the idea that cattle intensification and demographic stress occurred simultaneously. The ecological pathway is highlighted: heavy grazing and trampling depleted the soil of nutrients, while expanding herds encouraged invasive pasture species that replaced native plants rich in nutrients. (Fischer, 2017)

This process simplified diets in ways known to reduce female fertility through nutrient deficiencies and decreased the micronutrient content available in wild and cultivated food sources. To put it briefly, the statistical correlation between cattle and crude birth rate hints at a relationship where the expansion of livestock deteriorated the quality of food and soil, which in turn led to a decrease in birth rates. However, it is crucial to remember that because of the low fertility and high infant mortality, the mission's population growth was mostly reliant on the ongoing recruitment of new converts from outside communities (Frost, 1996). In other words, without this influx, the mission population would have unavoidably declined. Even when taking this dynamic into consideration, our main claim about collapsing birth rates remains unaffected because declining fertility and demographic stress continue even in the face of external recruitment.

The larger production-demographic picture supports the idea that Santa Clara operated as an extractive economic engine off of Muwekma Ohlone labor and land. At the same time, mission agricultural and livestock expansion consolidated control over regional foodways. Population levels also correlate positively with wheat and cattle ($r \approx 0.62$ and $r \approx 0.53$, respectively), suggesting that a larger resident labor force produced greater aggregate output.

Evidence from ledgers and account books demonstrates recurring instances where native plants and animals were displaced by cattle and invasive crops, forcing many Indigenous people to rely on food production within mission systems (Fischer, 2017). This reorganization had a significant positive impact on the Mission Santa Clara economy in terms of crop and livestock valuation. Annual records shown in Table 1 indicate that surplus extraction was organized on a large scale, with cattle inventories peaking at 14,500 head in 1828. Wheat production also reached remarkable levels, hitting a recorded high of 5,000 fanegas in 1797 and later approaching 3,900 fanegas. The convergent demographic, agricultural, and ecological evidence supports the interpretation that Santa Clara's livestock-and grain-first economy appropriated Muwekma land and labor to the mission's economic gain while materially undermining Indigenous nutritional autonomy and reproductive recovery.

Practical Implications and Future Research Avenues

The extent to which the Mission Santa Clara de Asís exploited native labor to further economic interests justifies the use of modern-day reparations. The correlation between increased Indigenous labor on the

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mission and an uptick in agricultural production and livestock inventory reveal the profitable impact that native labor had on the mission's economic success. The specific quantities of each good help provide a foundation to start calculating the amount and extent to which the reparations should be given. The primary recipient would be the Muwekma Ohlone Tribe of the San Francisco Bay Area, as the development of the mission system scattered the Tribe's population while stragglers were forcibly assimilated. The effects of this "cattle colonization" and ecological erasure still deeply affect the tribe to this day, as the continued dispersion of the Ohlone were the precondition to not being federally recognized.

Regardless, our research is limited to the Bay Area mission system, with a clear focus on the Mission Santa Clara de Asís. While this focus allows for practical benefits for the Muwekma Ohlone tribe, it is insufficient in analyzing the impact of larger mission systems, such as the Alta California system. Future research can take the analysis model and data collection methods used in this paper to examine other missions. Our research also falls short of analyzing the impact of the Spanish military and their relationship with the local missions. This paper primarily focuses on the economic growth of the Bay Area mission system by comparing economic indicators to demographic trends. Future opportunities lie in examining the effects of the military in suppressing Indigenous resistance and facilitating the growth of the mission system.

Conclusion

This study of the Santa Clara Mission's impact on the Muwekma Ohlone indicates how colonial economies turned Muwekma Ohlone land into a place of ecological displacement and economic extraction. By importing invasive plants and displacing native vegetation, the mission turned ancestral lands into pasture for cattle, sheep, goats, horses, and oxen—creating food scarcity that forced the Muwekma Ohlone into the mission. As a result, Santa Clara's population peaked at 1,541 in 1795. However, this cow-based system had considerable ecological costs because of nutrient-depleting practices associated with intensive grazing that affected the health of the Muwekma Ohlone and the nutritional value of mission crops. (Fischer, 2017). Our data shows that crude birth rates decreased by a factor of 3.2 as cattle numbers increased, indicating a connection between increased infertility and poor nutrition and soil depletion. This research shows that settler colonialism operated not just through social and cultural pressures, but also through the material degradation of Indigenous food systems through a demographic decline situated within the ecological effects of livestock economies.

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