Utilizing Repository Collections in Archaeological Research: A Groundstone Tool Example

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This article demonstrates the value of curated collections to current archaeological research by elaborating consistent methods to compare collections obtained using differing field and laboratory techniques. The specific application of these methods to mainland and island Middle and Late Period Chumash groundstone tool collections from southern California suggests that the examination of temporal and spatial groundstone density (number of artifacts per unit volume) may reveal patterns of prehistoric diet, technology, and exchange. For a detailed discussion of the relevant theoretical issues see Delaney-Rivera (2001).

Introduction

In this day and age of salvage archaeology and Native American Graves Protection and Repatriation Act (NAGPRA), large archaeological data sets from excavations are less likely to be obtained. Furthermore, the methods employed to collect many of the large collections sitting in repository and museum storerooms throughout southern California vary widely from those employed more recently within the last two decades. These earlier data sets, however, are invaluable resources that can be added to more recent collections to address contemporary archaeological research questions. The researcher must consider the excavation methods, as well as the treatment and retention of collections in a laboratory or repository setting, in order to successfully assess and interpret the curated collections and the resulting data.

The groundstone artifacts discussed below come from 15 collections from 11 archaeological sites excavated between 1929 and 1994. Collection procedures vary widely and present substantial problems for interpretations. The data were originally gathered to compare the mainland and island collections to test ideas about subsistence and the complex trade networks between the regions (Delaney-Rivera 1996; in press). In this article I will outline the steps taken to compare these data sets and will demonstrate how curated collections can provide valuable information that adds to contemporary archaeological analyses and interpretations.

Assessing Archaeological Collections

The first step in this type of study is the selection of the primary data set, as the data need to be comparable. In my study, I use only manos, metates, mortars and pestles, groundstone tools whose primary function was the processing of plant materials. Additionally, only groundstone artifacts from midden contexts were examined. Artifacts from burial contexts were not included in the analysis because not all of the sites produced artifacts from cemeteries. Additionally, artifacts from questionable provenience were excluded. The temporal designations necessary to compare the artifacts through time were estimated using available radiocarbon dates, diagnostic shell bead artifacts, and established obsidian hydration rates (Delaney-Rivera 1996).

The second step is to understand the data and collection methods which will allow comparisons between collections. Excavation methods play a major role in the ultimate constitution of archaeological collections, as do the recognition, treatment and retention of these artifacts in the laboratory or museum setting. Projects such as this one focused on the comparison of collections that were gathered using widely varying excavation methods must make careful use of these collections.

The final step is to compare the data after the collections have been standardized and comparisons are possible.

The primary data analysis tool used here is the calculation and comparison of groundstone densities. Understanding variations in the excavation and retention methods is vital in order to accurately interpret and assess the densities. Volume estimates permit the calculation of artifact densities. The total volume of midden excavated per site was based on directly reported figures or was estimated from depths and unit sizes recorded in field notes or technical reports (Delaney-Rivera 1996).

Methods and Materials

The collections employed in this study are from five Santa Cruz Island and six mainland sites (Table 1). All but one site are coastal and/or located along freshwater sources (lagoons, streams). Furthermore, the majority were residential villages. Collections were selected using several criteria:

a) sufficient groundstone quantities are present to allow meaningful quantitative analyses;
b) sites are occupied during the Middle and/or Late periods; and
c) adequate field/museum notes exist to interpret the context of recovery and determine the total volume of midden/earth excavated.

The UCLA Santa Cruz Island excavations at SCRI-191, -192, -240, -330 and -474 involved the use of 1/8-inch wire mesh screen and the excavation of 1-by-1 meter units by hand in 5-cm levels and all screened midden was sorted in the laboratory. These techniques

Table 1. Archaeological sites employed in this study.

Designation	Location	Period of Occupation
SCRI-191	Santa Cruz Island	Middle, Transitional and Late
SCRI-192	Santa Cruz Island	Late, Historic
SCRI-330	Santa Cruz Island	Late, Historic
SCRI-474	Santa Cruz Island	Middle, early Transitional
SCRI-240	Santa Cruz Island	Early, Middle, Transitional(?), Late and Historic
SBA-117	Santa Barbara County	Middle and Late
VEN-27	Ventura County	Middle and Late
VEN-24	Ventura County	Middle
VEN-11	Ventura County	Middle, Late and Historic
LAN-52	Los Angeles County	Middle, Late and Historic
LAN-264	Los Angeles County	Early, Middle, Late and Historic

virtually guarantee the recovery of all groundstone artifacts from each unit and ensure that all fragmentary and whole groundstone artifacts were retained and catalogued. Additionally, the techniques ensure precise dating, and Santa Cruz Island occupations used in this study are divided into Middle, Transitional, Late and Historic periods. Groundstone tools dating to the Transitional period were excluded from this study; collections from mainland occupations cannot be clearly defined as this phase was not recognized until the 1980s.

The mainland collections used in this study, however, were recovered using methods that varied widely. Some sites were excavated using 5-by-5 foot units excavated by 12-inch levels, and the soil was not screened, while others were salvage operations that used trenches without the screening of midden. Some collectors excavated in smaller levels (e.g., 6-inch or 10-cm levels) and screened the midden through a 1/4-inch wire mesh. The few excavators who used 1/8-inch screens used them only in control sample contexts. Precise temporal designations are not possible for a variety of reasons, and mainland occupations are designated simply as occurring during the Middle, Late and/or Historic periods.

In addition to the varying excavation methods that affect artifact recovery, it is possible that the excavators of many of these older mainland collections may have not retained all the groundstone artifacts recovered during excavation. For example, Ruby (1961) reports that fragmentary manos were not saved from local collections. Additionally, institutions were often interested in collecting or accessioning complete artifacts and were not interested in fragmentary artifacts that could not be put on public display. Also, museums often did not retain large, bulky collections with many similar specimens. The elimination of such fragmentary or duplicate specimens, assuming that it occurred to some degree, means that these older collections no longer represent the full range of groundstone artifacts collected from these sites.

The effect that excavation methods and subsequent collection treatment had on the recovery and retention of groundstone artifacts used in this study will be discussed in more detail below.

Screening and Artifact Recovery

The recovery and retention of groundstone tools is clearly influenced by the excavation and screening methods employed by the excavators. For example, the VEN-11 groundstone collection was recovered through salvage excavations and the midden was also not screened. Consistent with the absence of screening, the mean length measurement of groundstone artifacts is 11.63 cm, and only 5 per cent of the fragments have a maximum length 5.0 cm or smaller.

The excavators of SBA-117, VEN-27, LAN-52 (Accession 566 and Curtis [1963]), LAN-264 (Accessions 505 and 573), and SCRI-240 (1974 Spaulding excavations) screened the midden using 1/4-inch mesh, with the use of 1/8-inch mesh in selected situations. This excavation strategy no doubt recovered most small groundstone fragments, although the quantities are still modest (just 10 per cent of the fragments remaining in the collections had a maximum length of 5.0 cm or smaller).

Jeanne Arnold's collections from Santa Cruz Island recovered and retained all small and large groundstone fragments; 42 per cent of the groundstone fragments have maximum lengths 5.0 cm or smaller. The average length of groundstone fragments from Arnold's Santa Cruz Island excavations was 5.83 cm, compared to 10.33 cm for mainland groundstone artifacts. The differences between the mainland and island groundstone fragment sizes indicate that artifact recovery and retention, as well as choice of excavation location, are major factors. By examining the length and thickness measurements on a scatterplot, it is possible to assess these (Fig. 1). I conclude that many small fragments have not been retained from these earlier collections.

Groundstone Artifact Analysis

Measurements were recorded for all groundstone artifacts to help assess the recovery and retention of various groundstone fragment sizes in each collection. Measurements for mortars and metates include maximum fragment length and width (thickness). The length measurement reflects the long axis of the fragment if a rim was not present to orient the fragment. If a rim was present, the length measurement reflected the measurement from the rim of the mortar down the interior of the vessel. The thickness measurement represented the maximum thickness of the vessel fragment and reflected the maximum distance between the outside of the vessel and the processing

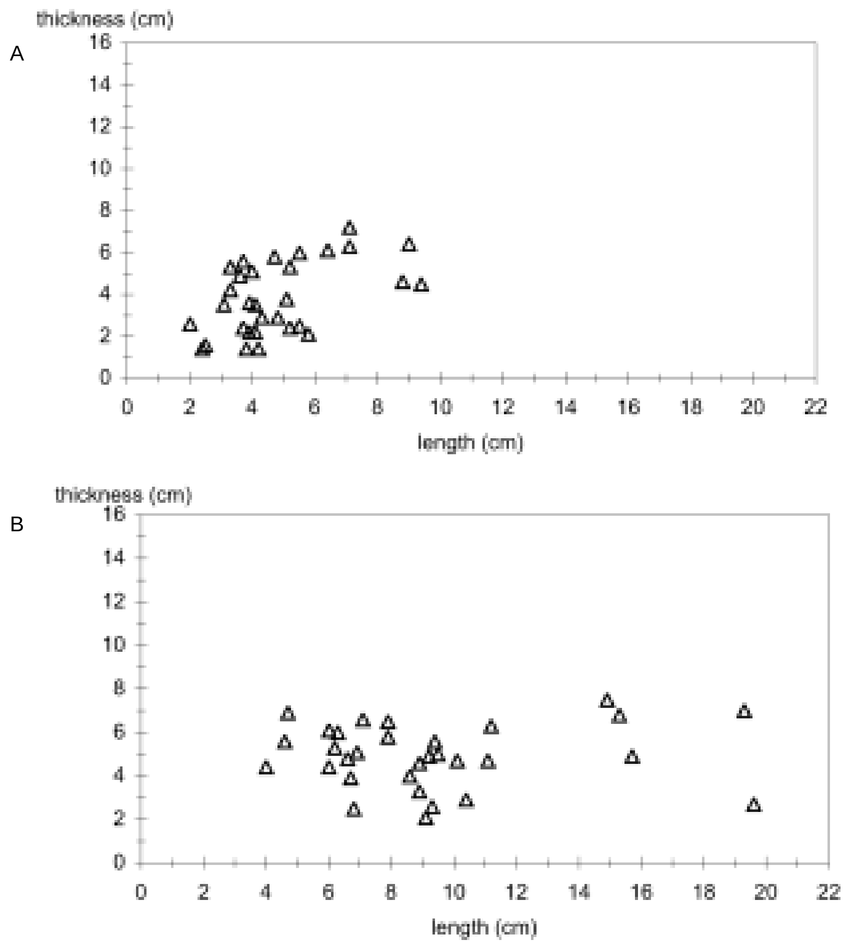

Fig. 1 Scatterplot of length and thickness measurements from groundstone afrtifacts employed in this study. Compare the two assemblages and note the differences in size between the two collections. A: a typical groundstone asemblage from recent excavations with full recovery (from SCRI-474). Note that many artifacts are in the smaller measurement range. B: A typical groundstone assemblage from the mainland collected during the 1950s (from VEN-24: Accession 117). Note few of the artifacts are in the smaller artifact range.

surface of the mortar. All artifacts originally labeled as “bowl” fragments were designated here as mortars because (1) the processing surface of most fragments is simply too small to accurately distinguish between the two, and (2) in most instances it appears that excavators did not consider functional differences and randomly assigned the ‘bowl’ category. Measurements also were taken for mano and pestle groundstone tools. For both artifact types, the length measurement was taken along the long axis, while the width (diameter for pestles) represents the short axis.

In addition to the length and width/thickness measurements, a designation of fragment completeness was assessed for each groundstone piece: ‘1’ if the piece was approximately 25 per cent complete, ‘2’ if 26-50 per cent complete, ‘3’ if 51-75 per cent complete, and ‘4’ if 76-100 per cent complete. The designations were assigned to determine whether excavators were only retaining groundstone artifacts that were relatively more complete. If most unscreened collections consist of groundstone artifacts classified as fragment types ‘3’ or ‘4,’ then the excavators were not retaining all groundstone artifact fragments.

Results

Although I initially gathered information on all groundstone artifacts recovered from these sites, my analysis focused on a subset of the data. The frequencies and densities of artifacts employed in this analysis are listed in Table 2.

Density Analysis and Comparisons

Average densities of groundstone are the sum of the densities for each collection in a given time period divided by the total number of collections for that time period. For example, the average density of groundstone artifacts for the Middle period is based on a sum of 37.36 artifacts per cubic meter, divided by 11 collections = 3.4 groundstone artifacts per cubic meter (see Table 3). The average density normalizes the results and allows the comparison of data from different periods and sites. The densities of groundstone artifacts excavated from Santa Cruz Island by Arnold are extremely high, especially when compared to the mainland densities. These higher densities are a result of the excavation methods, high fragmentation rates, possibly the raw material quality, and retention practices, and will be discussed in more detail below.

After normalizing densities, the results indicate that overall Late Period densities (6.98 per cubic meter) increase by 105 per cent from the Middle Period (3.4 per cubic meter). This huge increase, however, is spurious. The Santa Cruz Island data, which are dominated by Late Period assemblages and numerous fragments per cubic meter, skew this comparison. When the data are separated into island and mainland groups, we can better assess actual changes in groundstone densities (Table 3), which are much smaller. When separated, the average density of groundstone tools at mainland Late Period sites increases by 3 per cent compared to Middle Period mainland site densities. Santa Cruz Island groundstone density declines by 3 per cent from the Middle to the Late Periods.

This possibility is further supported by an examination of Santa Cruz groundstone densities from sites excavated by Arnold (Table 3). If the Spaulding data (1974 excavations) from SCRI-240 are momentarily excluded from the island analysis, the Late Period groundstone densities decrease by 15 per cent. Reasons for excluding the Spaulding data will be discussed later.

Collections Differences

Upon close examination, the notable difference between the average density of groundstone objects from mainland sites and Santa Cruz Island sites (Table

Table 2. Groundstone tool frequencies and densities from collections employed in this study. The collections are arranged by region.

Collections	Frequency	Excavated Midden Vol.(cu. m.)2	Density	Time Period(2)
SBA-117(1)	6	8	0.75	Middle
VEN-27(1)	99	132	0.75	Middle
VEN-27(1)	75	145.63	0.52	Late
VEN-11	150	231.32	0.65	Late/Historic
VEN-24: Acc. 117	24	18.42	1.3	Middle
VEN-24: Acc. 219	10	15.56	0.64	Middle
LAN-52: Acc.566(1)	2	5.34	0.37	Middle
LAN-52: Curtis	33	32.94	1	Middle
LAN-52: Acc.566(1)	12	9.92	1.21	Late
LAN-264: Acc. 505	69	83.95	0.82	Middle
LAN-264: Acc. 573(3)	69	138.95	0.5	Middle
SCRI-191	7	1.15	6.09	Middle
SCRI-191	9	1.05	8.57	Late
SCRI-192	45	1.55	29.03	Late
SCRI-240	5	0.9	5.56	Late
SCRI-240: Spaulding	12	9.28	1.29	Middle
SCRI-240: Spaulding	16	6.72	2.38	Late
SCRI-330	17	2.15	7.91	Late
SCRI-474	31	1.3	23.85	Middle

Key:
1 – some levels not included; temporal designations are unclear
2 – time period included in this study (some sites are also represented by other time periods)
3 – some units not included in the density calculations because artifacts related to this study were not recovered from these units
Acc. – Accession

Table 3. Groundstone densities by time period and region. The far right column represents the change in densities between time period.

Collections	Middle Period	Late Period	Density Difference
All densities combined	3.40 / m^3	6.98 / m^3	105%
Mainland average density	0.77 / m^3	0.79 / m^3	3%
Island average density	10.41 / m^3	10.69 / m^3	3%
Island, excluding Spaulding collection	14.97 / m^3	12.78 / m^3	-15%

3) requires explanation. It is clearly largely due to (1) the differing collection and retention methods employed by the excavators, and (2) possibly the caliber of the sandstone raw material available on the island, which resulted in tools fragmenting into many pieces. As discussed above, the methods employed by Arnold at Santa Cruz Island sites most likely resulted in the full recovery and retention of all groundstone artifacts, including small fragments. Many archaeologists who excavated the mainland collections during the 1950s and 1960s, especially during salvage operations, however, did not screen the midden. Poor recovery and retention of groundstone objects in the field, especially fragments, resulted. Additionally, it is likely that many small fragments were discarded in the field, laboratory, or museum.

Because of the poor retention of groundstone artifacts from these particular mainland collections, I revisited the issue of fragment size (as introduced above). A comparison of maximum length reveals distinct differences between the mainland and Santa Cruz Island collections. Almost half of the Santa Cruz Island groundstone artifact maximum length measurements (42 per cent) are 5.0 cm or smaller, but only 10 per cent of the mainland groundstone lengths are smaller than 5.0 cm. I believe that smaller fragments were missed by, or did not interest, excavators who did not screen the soil, or were not retained after recovery. Figure 2 demonstrates these differences. The frequency histograms indicate that the majority of the Santa Cruz Island groundstone fragments cluster in the smaller length categories, and that they do not extend beyond 13 cm in length. The average length of the mainland artifacts is 10.33 cm, while the average length of the Santa Cruz Island groundstone fragments is 5.83 cm. This observation is supported by a statistical test. The computed t-value is 25.89, with a critical t-score of 1.745 (95 per cent level), and the result is statistically significant.

The groundstone collection excavated by Spaulding at SCRI-240 was excluded from the t-test and frequency analyses mentioned above because the field methods differed greatly from those employed by Arnold. Just two of the groundstone fragments recovered by Spaulding are smaller than 5 cm, and the largest is 20 cm.

Additional statistical tests were performed to determine whether the mainland groundstone artifacts are more complete. T-tests were conducted to assess whether a higher proportion of mainland groundstone artifacts are fragment types 3 and 4 (greater than 50 per cent of the artifact present) while a high proportion of the Santa Cruz Island groundstone artifacts are fragment types 1 and 2 (less than 50 per cent present).

In the first t-test, fragments of size 1 and 2 from the mainland and island were compared. The computed t-value was -3.157, while the critical t-score was 1.645 (95 per cent level) which suggests that type categories 1 and 2 (the less complete artifacts) were significantly less frequently recovered at the mainland excavations.

In the second t-test, fragments of size 3 and 4 from the mainland and island were compared. The computed t-value was 2.24, while the critical t-score was 1.645 (95 per cent level). This result suggests that the proportion of mainland size categories 3 and 4 is significantly greater than the Santa Cruz Island proportions of the same categories.

All three of these statistical tests support the casual observations that the mainland and Santa Cruz Island groundstone assemblages are significantly different. Specifically, these tests indicate that mainland collections have a much higher proportion of complete/nearly complete groundstone artifacts, and we have seen that the mainland artifacts are also significantly larger than those recovered by Arnold from Santa Cruz Island contexts. Several factors contribute to this pattern, the primary ones being the preferential

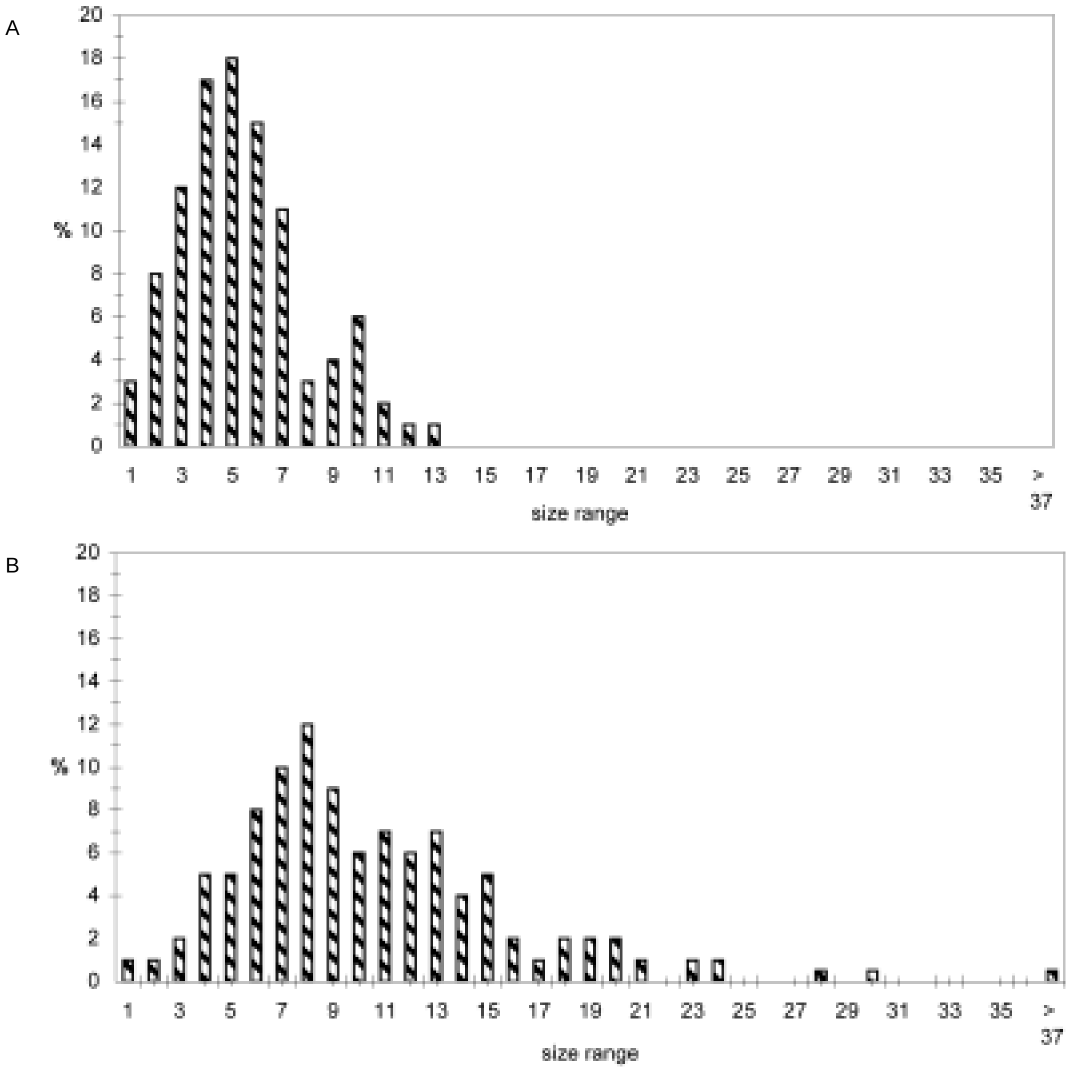

Fig. 2. A comparison of the percentage of groundstone artifacts by size (in centimeters) from collections employed in this study. The artifacts are arrange by region, and the measurement represents the maximum length of each artifact. A: Santa Cruz Island collections (excluding SCRI-240: Spaulding artifacts). B: Mainland collections.

Table 4. Artifact densities by region and through time after the removal of artifacts 5 cm and smaller. Collections from LAN-52 (Curtis) and SBA-117 were excluded from this table.

Region	Density Difference	Middle Period	Late Period
Mainland average	6%	0.66 / m^3	0.70 / m^3
Island average	-3%	6.98 / m^3	6.74 / m^3
Island average (excluding Spaulding data)	-21%	9.92 / m^3	7.83 / m^3

retention of more complete artifacts in mainland collections, and the differing excavation methods employed by excavators through time.

The scatterplots, frequency histograms, and t-tests together indicate that the fragment sizes and fragment types of the mainland and island groundstone artifacts differ significantly. In order to proceed with a more meaningful comparison of the mainland and Santa Cruz Island groundstone densities through time, groundstone artifacts with a maximum dimension of 5.0 cm or less were excluded from further analysis. This has the effect of normalizing the data by eliminating most of the smaller groundstone fragments recovered on Santa Cruz Island (Table 4).

Artifacts Greater Than 5.0 cm

The average densities of groundstone artifacts for all Middle Period collections and all Late Period collections in both regions would appear to indicate an increase in the Late Period (Table 4). However, this comparison suffers from the same problem that the previous comparison of all groundstone tools did, and is only relevant in a comparative sense. Once again, the mainland and Santa Cruz Island densities need to be separated to determine changes in groundstone densities through time in these separate regions (Table 4). The mainland Late Period densities increase by 6 per cent when compared to the Middle Period densities (Table 4). The average density of the Santa Cruz Island groundstone, however, decreases in the Late Period by 21 per cent (in both cases, excluding the SCRI-240: Spaulding collection).

Even after the groundstone tool densities are normalized and the smaller artifacts (less than 5 cm maximum length) are removed, it is clear that the mainland and island groundstone artifact collections cannot be directly compared. The average soil volume excavated on Santa Cruz Island per collection was 4.94 cubic meters, but the average volume of soil excavated on the mainland per collection was 137 cubic meters. The latter were generally large scale salvage operations. The end result is that mainland excavations had poor small artifact retention with large volumes of excavated soil, resulting in artificially low groundstone densities. The Santa Cruz Island excavations, on the other hand, had excellent artifact recovery and retention from smaller volumes of excavated soil. The total number of units and overall volume represented in the analysis, however, does not compare to the huge, multiple mainland excavations.

Discussion and Conclusions

In order to successful employ curated collections, archaeologists must understand the collection methods and the subsequent treatment of the artifacts. In the case of this example, although detailed fieldnotes were missing in several instances, the difference between the collections employed in this study were made clear visually via the scattergrams and frequency histograms, and statistically via the t-tests performed.

After the collection differences were understood, artifacts with a maximum dimension of 5 cm or less were removed from analysis. It was believed that removal would make the Santa Cruz Island and mainland groundstone collections more comparable. Excavation methods were still too different to allow direct comparison. The process, however, standardized the collections within each region that were collected in a similar fashion, and it was possible to compare the collections by region and obtain useful data. I was able to determine that a slight intensification of plant processing occurred on the mainland during the Late Period, concurrent with a decline in plant food processing on Santa Cruz Island. The findings point towards some notable changes in subsistence exchange during a time of important social evolution.

This exercise demonstrates how archaeologists can successfully use artifacts from curated museum and repository collections and apply them to current archaeological research questions. While the discussion focused on groundstone tools from the southern California region, this is just one example. These methods can be applied to other artifact classes, such as ceramics and chipped-stone, to provide equally valuable information. For example, many ceramic collections are the result of similar processes as many undiagnostic, utilitarian body sherds are not retained by excavators or curators. By applying methods similar as those presented in this article, many of these collections can be applied to contemporary research questions.

Acknowledgments

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