ARCHAEOLOGY OF *OSTREA LURIDA* IN DRAKES ESTERO, POINT REYES NATIONAL SEASHORE

REPORT ADDENDUM: ANALYSIS OF OYSTER REMAINS AT CA-MRN-296

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INTRODUCTION AND STATEMENT OF PURPOSE

This study was undertaken to gather additional information not included within the original report (Konzak and Praetzellis 2011). The original report, along with this addendum report, will assist the National Park Service (NPS) with the cultural resources section of an Environmental Impact Statement (EIS) conducted to evaluate a Special Use Permit for commercial oyster operations in Drakes Estero. These studies will also assist resource management planning for the waters of Drakes Estero by providing additional information on the Estero's historical ecology with regard to shellfish species.

The objective of this study was to identify and quantify the amount of disturbance present at CA-MRN-296. This was done by examining the quantity of non-native oyster shells present on the site. While the presence of native and non-native species at CA-MRN-296 was noted in the original report, due to time restrictions and the large quantity of non-native shell initially identified by the biologists, non-native oysters were not included within the shell counts.

The other site included in the initial report, CA-MRN-242, was not examined as part of this study. As no non-native oysters were identified at CA-MRN-242 during the initial survey and as the site has no history of non-native shell deposits, there was no need to include the site in a study quantifying the presence of non-native oyster.

METHODS

INTRODUCTION

This study was undertaken to identify and quantify the non-native oyster, oyster, and other shellfish remains present on the archaeological site CA-MRN-296, Sensitive ARPA information Sensitive ARPA information The use of standard archaeological field and analytical techniques will allow for comparison studies in the future.

Fieldwork was conducted by a team of archaeologists from the Anthropological Studies Center at Sonoma State University (ASC) and the National Park Service (NPS), and a representative of The Federated Indians of Graton Rancheria (FIGR). The archaeological team consisted of Staff Archaeologist Michael Konzak, M.A.; Archaeological Technician Natalie Sadler, B.A.; and NPS archaeologist Paul Engel, B.A. Nick Tipon was the Tribal representative from the Federated Indians of Graton Rancheria.

Laboratory work was conducted by Michael Konzak, Annamarie Leon Guerrero, and Natalie Sadler of the ASC. Marine biologists Edwin Grosholz, Ph.D. of University of California, Davis, Chela Zabin, Ph.D., of the Smithsonian Environmental Research Center in Tiburon, and Jennifer McGowan, B.A., of the Marine and Coastal Conservation and Spatial Planning Center, San Francisco State University, assisted in identifying and speciating the oyster samples.

Methods

Archaeological investigations conducted during this phase were based on the methods used during the previous fieldwork. Although some aspects were modified to streamline identification and analysis of the shell samples, this phase was conducted using methods as

parallel as possible to the original work. No archaeological excavation or other ground disturbing activities took place due to the recorded presence of human remains at the sites and out of respect for the wishes of FIGR. Prior to ASC's fieldwork, sample locations were defined and the surrounding areas were cleared of Poison oak by Mark Rudo and Paul Engel, NPS archaeologists.

Archaeological investigations were conduced in a series of 3.3 by 3.3 ft. (1 meter square) surface collection units (SCUs). The SCUs were cardinally aligned and their locations recorded using a Trimble GeoXH, sub-foot accurate GPS receiver. The previous phase of fieldwork identified the majority of material in the field. During this additional phase of work, all potentially identifiable shells on the surface were collected for extended laboratory analysis. Shell fragments smaller than 0.75 in (2 cm) and without distinguishing characteristics (intact hinges) were not collected. Other cultural materials present in the SCU were noted but not collected.

Shells were collected and separated into oyster and non-oyster specimens in the field. In the lab, the samples were examined for potential field discrepancies and to count the total number of shells. Non-oyster shells were identified and speciated by the ASC and a minimum number of individuals (MNI) was calculated for each unit. Oyster shells were counted and prepared to be sent to the biology team for further identification.

The large numbers of oyster shell collected made it necessary to sample the oyster shell. An approximate 20% random sample of oyster shells was taken for each unit. Using a divider that separated each sample into four random portions, shells from each unit were poured through the divider twice. First the divider was used to obtain an approximate 25% sample and then the 25% sample was taken and again divided into approximate fourths. Three of these samples were then taken to approximate 20% of the sample[1]. This 20% sample of oyster shells was sent to the biology team for identification at the Romberg Tiburon Center. After the oyster shell was identified, ASC calculated the MNI for the various categories defined by the biologists.

ARCHAEOLOGICAL SITE DESCRIPTION

CA-MRN-296

Changes in site structure

The site setting had not changed in the months between field phases. Sensitive ARPA information

Sensitive Archaeological Resource information protected in accordance with 16 U.S.C. 470hh, confidentiality of information concerning nature and location of archaeological resources.

ost of the previous unit locations were overgrown and their exact locations could not be relocated without the use of a GPS.

[1] Though this numerically amounts to a sample of 18.5%, the randomness of the division provided a sample at or in excess of 20%.

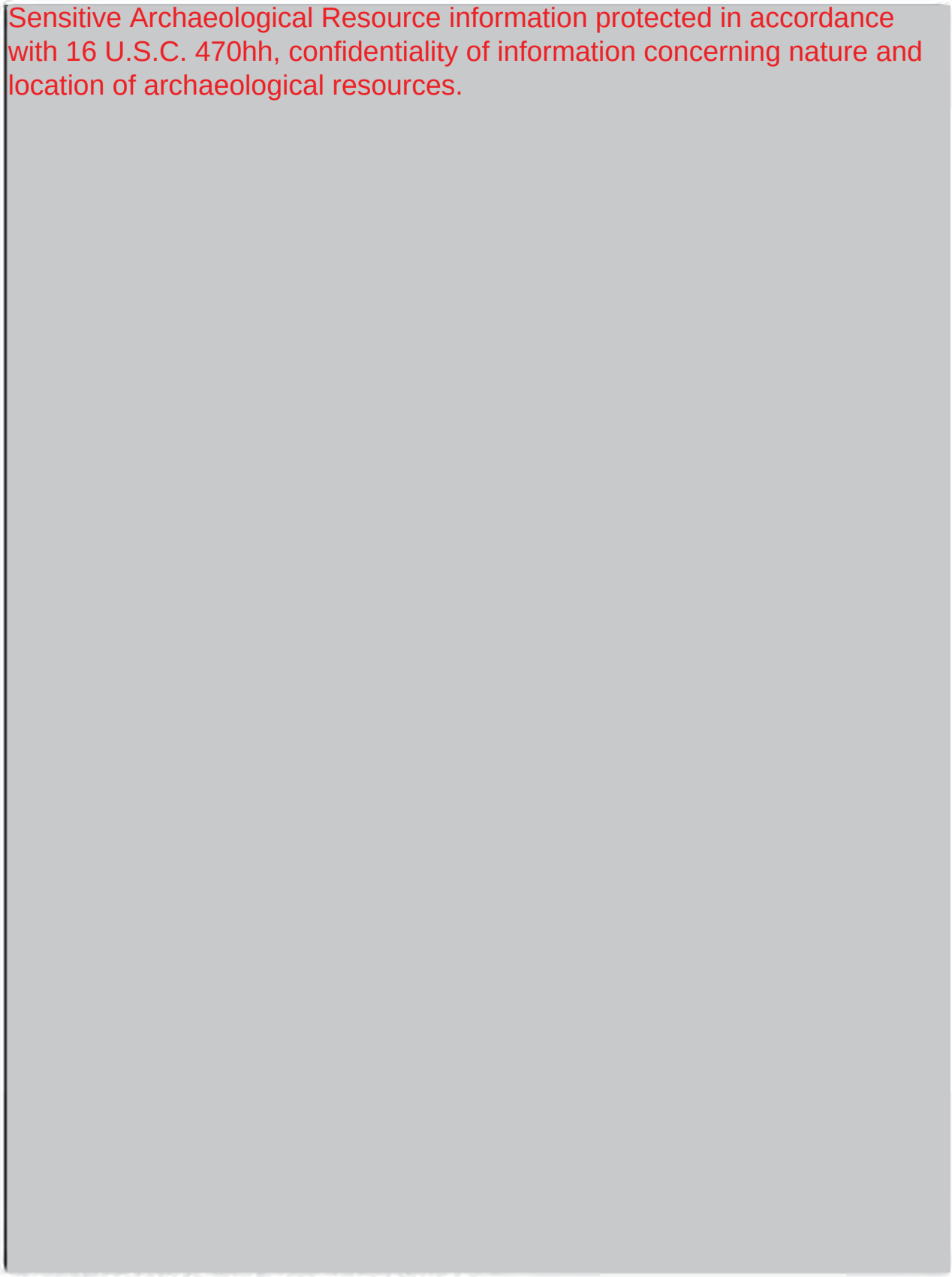

Figure 1. CA-MRN-296: Archaeological Site Map

SITE CONTENT

A January 2008 letter (Lunny 2008) from the Drakes Bay Oyster Company to the California Coastal Company lists three species of oysters cultivated by Johnson's Oyster farm: the Pacific oyster, *Crassotrea Gigas*, the Kumamoto oyster, *Crassotrea sikamea*, the European Flat oyster, *Ostrea edulis*. Before the seeing this letter in June 2011, Kumamoto oyster and the European Flat oyster were not known by the authors of the initial report to have been cultivated at that location. Consequently, the possibility that oyster species were present at the archaeological site other than the Pacific oyster and the Olympia oyster was not considered in initial analysis and report.

During the 2010 fieldwork carried out for this project, six SUs and two exposed vertical cuts were analyzed (Figure 1). The six SUs were placed in areas that contained shells in addition to the non-native Pacific oyster.

During the 2011 fieldwork, six SCU were placed in locations throughout the site, in locations determined in the field and prior to clearing by NPS. A GPS with locations of previous SUs was used to locate areas not previously examined (Figure 1).

During the 2010 fieldwork, visual observation determined that non-native oyster shell was the main constituent in all units and throughout the site. In the 2011 phase, it was decided to collect the shells and perform a more detailed analysis in a laboratory setting. This allowed for a more detailed examination of all shells but specifically the various oyster shells that were originally identified as non-native oyster.

Most material recovered from the site was oyster shell. In raw shell material, oyster consisted of 92% of the shell assemblage (1520 shells out of 1646 recovered). Given the immensity of the oyster sample only 20% of the shell was examined for each unit. The rest of the shell, which equated to approximately 8% of the assemblage, was comprised primarily of various clam species, some land snails, and an individual example of limpet and crab. This non-oyster portion of the assemblage contained a much greater variety of shell than what was identified during the initial report (Table 1 and Figure 2).

The laboratory identification of approximately 20% oyster shell sample (see Table 2a, 2b, and the Appendix: Zabin, Grosholz, and McGowan 2011) could not positively identify the entirety of the sample to the species level. Approximately 37% of the sample was positively identified to the species level, with 49 shells identified as Olympia oysters, 71 as the Pacific oyster, and 1 as the Kumamoto oyster (Table 2a). Approximately 51 shells were identified to the genus (*Ostrea*) but could not be identified to a species level and are either the Olympic oyster (*Ostrea lurida*) or the European Flat oyster (*Ostrea edulis*). A total of 152 shells could not be positively identified; 132 of these did not contain the chomata usually indicative of the genus *Ostrea*. These shells may be additional Pacific or Kumamoto oysters or may represent *Ostrea* sp. shells that do not have chomata or where the chomata may have worn off. The other 20 shells could not be identified. The MNI calculated for the oyster remains (Table 2b) was nearly identical to the shell count as only one shell fragment in the sample did not include an intact hinge or other non-repeating feature.

Scientific Name	Common Name	Unit Designation					
		A	B	C	D	E	F
Macoma nasuta	Bentnose Clam	1	0	2	1	1	0
Protothaca staminea	Pacific littleneck Clam	1	0	1	2	2	1
Tresus nuttalli	Pacific Gaper Clam	3	0	1	1	2	1
Saxidomus nuttalli	Washington Clam	3	0	3	4	3	0
Clinocardium nuttalli	Nuttall's Cockle	0	0	2	1	1	0
Lottia digitalis	Finger Limpet	0	0	0	1	0	0
Cancer sp.	Crab	0	0	1	0	0	0
	Clam Undifferentiated	0	0	0	0	0	2
Helix aspersa	Garden Snail	4	1	1	1	4	0
Haplotrema minimum	California lancetooth	0	0	1	5	1	0

Table 1: CA-MRN-296: Quantities of Non-oyster Shellfish per Surface Collection Unit (SCU)

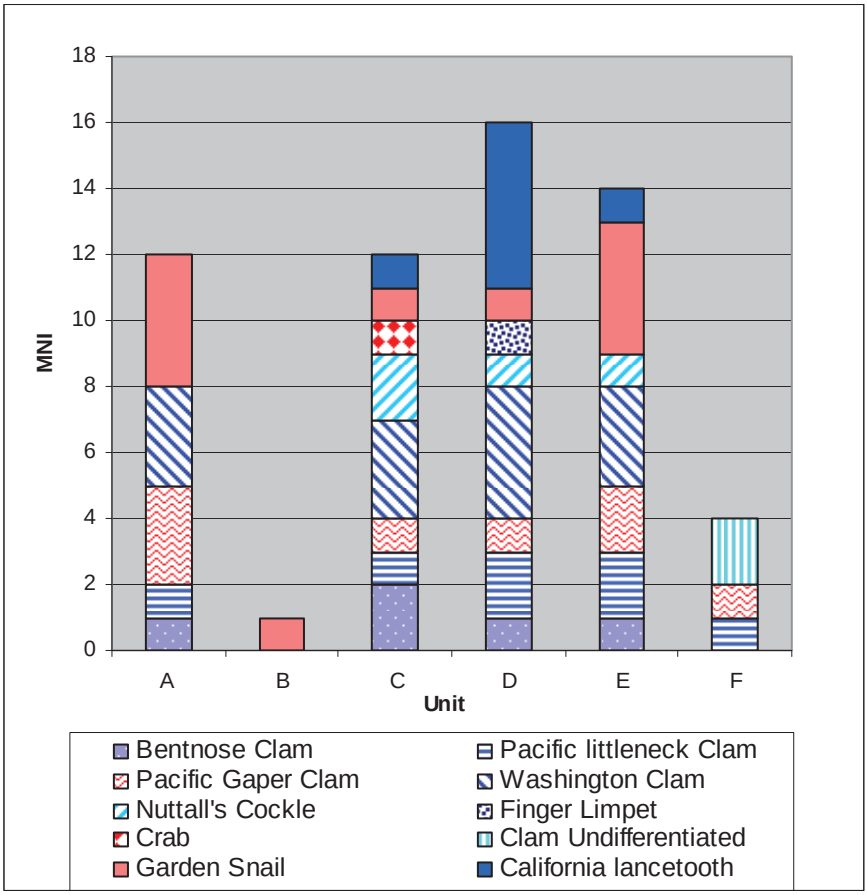

Figure 2: CA-MRN-296: Graph of Non-oyster Shellfish per Surface Collection Unit (SCU)

Scientific Name	Common Name	Unit Designation						Total
		A	B	C	D	E	F	
Sample Percentage		**20.94%**	**22.73%**	**20.80%**	**21.78%**	**20.22%**	**21.30%**	
Ostrea lurida	Olympia oyster	12	0	18	14	0	5	49
Ostrea lurida / Ostrea edulis	Olympia oyster / European Flat oyster	5	0	9	20	10	7	51
Crassotrea sikamea	Kumamoto oyster	1	0	0	0	0	0	1
Crassotrea gigas	Pacific oyster	11	1	33	18	6	2	71
No Chomata Visible[2]	Unidentified	33	2	39	30	20	8	132
Unknown Species	Unidentified	6	2	8	2	1	1	20

Table 2a. CA-MRN-296: Oyster Shell Counts, Individual Shells

Scientific Name	Common Name	Unit Designation						Total
		A	B	C	D	E	F	
Sample Percentage		**20.94%**	**22.73%**	**20.80%**	**21.78%**	**20.22%**	**21.30%**	
Ostrea lurida	Olympia oyster	12	0	18	14	0	5	49
Ostrea lurida / Ostrea edulis	Olympia oyster / European Flat oyster	5	0	9	20	10	7	51
Crassotrea sikamea	Kumamoto oyster	1	0	0	0	0	0	1
Crassotrea gigas	Pacific oyster	11	1	33	18	6	2	71
No Chomata Visible[2]	Unidentified	33	2	39	30	20	8	132
Unknown Species	Unidentified	6	2	7	2	1	1	19

Table 2b. CA-MRN-296: Oyster Shell Counts, Minimum Number of Individuals (MNI)

Every SCU examined contained Pacific oysters while only four units contained identifiable Olympia oysters. However, five of the SCUs also contained additional samples that were

[2] "No Chomata visble" indicates that those samples were not observed to contain chomata, a feature that is on some but not all *Ostrea* shells and not present on *Crassotrea* shells. These shells also could not be positively identified as either *Crassotrea* species, the Pacific oyster or the Kumamoto oyster.

identified as *Ostrea* sp. but could not be identified beyond the genus. Similarly, every SCU also contained shell samples that may be the genus *Crassostrea* (shells did not contain chomata) but could not be confirmed (not all *Ostrea* shells have chomata). This, being merely an approximate 20% sample of the oyster shell, indicates that a much larger portion of the assemblage is native and non-native oyster. While the initial study indicated that approximately 26% of the assemblage was Olympia oyster (Konzak and Praetzellis 2011:9), the high number of Olympia oyster shells present in just 20% of the collected assemblage was six times as many as had been identified in the original study.

CONCLUSION

In the initial study (Konzak and Praetzellis 2011), most of CA-MRN-296 was identified as consisting of non-native, Pacific oyster shell. The exact amount of non-native oyster shell present at the site was not quantified in that report. The data gathered in this addendum study revises this statement.

A large proportion of the site is non-native oyster shell. However, some of the oyster shell initially determined to be non-native during fieldwork for the initial report is likely to be Olympia oyster. The differences in the identification are likely the result of more exhaustive laboratory investigation rather than a difference in spatial distribution of species between the units.

The number of positively identified Olympia oyster shells is less that the positively identified Pacific oyster; however, unidentifiable shells are still the majority of the assemblage. This level of uncertainty makes exact ratios between native and non-native oysters at the site difficult or impossible to determine. The quantity of shell identified as O*strea* sp. is greater than the number identified as Olympic oyster (*Ostrea lurida*) and indicates a possibility that even greater numbers of Olympia oysters are present at CA-MRN-296 than were positively identified. However, given the large number of Pacific oyster shells identified, the larger number of oysters that did not have genus *Ostrea*'s distinguishing characteristics, and the fact that those identified as *Ostrea* sp. may include examples of the non-native European flat oyster, there is likely a greater proportion of non-native than native oyster shells in the deposit.

These results must be also weighed with the recorded history of the site (see Konzak and Praetzellis 2011: 7-8). CA-MRN-296 has been a highly disturbed site as long as it has been known to the archaeological community. Riddell's initial record in 1948 noted that a portion of the site was destroyed to make room for a house and an iron trap was located "at depth" (Riddell 1948). Edwards' insisted that CA-MRN-296 needed "immediate salvage" in 1976 (Edwards 1976). Riley reported the site had been a dumping ground for shell refuse and she identified modern refuse at a depth of 3.28 ft. (1 meter) in a cut bank (Riley 1976:58). The previous examinations of CA-MRN-296 all indicate a highly disturbed environment. The large amount of non-native shell identified by this addendum study is consistent with these assessments.

The data gathered in this report indicate that Olympia oysters are a larger constituent of the prehistoric deposit than initially determined. However, if CA-MRN-296 had a significant

percentage of Olympia oysters in the prehistoric assemblage, as it appears possible from our data, the site is an anomaly on the prehistoric landscape of Drakes Estero. As summarized by Rudo (2009) and Konzak and Praetzellis (2011:20-22), with the exception of CA-MRN-296 and CA-MRN-242, the archaeological sites around Drakes Estero are not known to contain deposits of oyster shell, while oyster shells can be found in sites along Tomales Bay.

While the present study cannot attribute a definite origin to the native oyster shells at CA-MRN-296, it can supply two hypotheses. The concentration of oyster shells at CA-MRN-296 may indicate trade and travel from the neighboring Tomales Bay. Alternatively, or perhaps in addition, the shells may indicate the presence of a small colony of Olympia oysters easily accessible from the shell mound. However, even with the possibility of oyster habitat adjacent to CA-MRN-296, the absence of other prehistoric sites in the area containing quantities of native oyster shells makes it unlikely that Drakes Estero was a habitat for a large oyster population in prehistory.

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Zabin, Chela, Ted Grosholz, and Jennifer McGowan

2011 Identification of Oysters From Drakes Estero Midden. Prepared for Anthropological Studies Center, Sonoma State University, Rohnert Park, California.

Appendix

Identification of Oysters from Drakes Estero Midden.

By Chela Zabin, Edwin Grosholz and Jennifer McGowan

Report to the Anthropological Studies Center
Sonoma State University

Identification of Oysters From Drakes Estero Midden

Prepared for:
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Project Objective

The objective of this project was to provide technical expertise to Dr. Adrian Praetzellis and Michael Konzak in the identification of oysters collected by the Anthropological Studies Center (ASC) from a midden/modern shell deposition site at Drake's Estero, Inverness, CA.

Methods and Materials

Shell samples

The documents sent to us from the ASC at Sonoma State University recorded 320 total samples from six sample units (A-F) collected in July 2011 from Site CA-MRN-296 in Drakes Estero. Approximately twenty percent of the samples from each sublocation were bagged by ASC with the objective of identifying each shell species within the collected sample units to quantify the presence of non-native species throughout the historic site.

We found an additional five shells in the samples of shells sent to us, distributed through the Sample Units A, C, and D (see Table 1). ASC asked us to sort samples into species level classifications for four taxa previously cultivated and/or suspected to occur in Drakes Estero: *Ostrea lurida, Ostrea edulis, Crassostrea gigas,* and *Crassostrea sikamea*. An additional sample of *O. lurida* in Sample Unit F was included as it had an unusual shell sculpture.

Samples ranged in quality from unidentifiable fragments to complete valves with distinguishable shell shapes (Table 1). The majority of samples contained ligaments and at least one margin of the valve where chomata would be visible for identification near the umbo. Erosion, dirt and splintering of the valve were common in all samples making it difficult to accurately identify at the species level by vision alone.

Table 1. Sample details

Unit (~percent of sample)	Sample Selected (ASC)	Sample Counted (SERC)	State of Samples
A (20%)	67	68	Majority of valves near complete; margins intact
B (20%)	5	5	Majority of valves incomplete; margins eroded

C (20%)	104	107	Majority of valves almost complete; margins intact
D (20%)	83	84	Majority of valves near complete; margins intact
E (20%)	37	37	Majority of valves near complete; some margins very worn
F (20%)	23(+1 with unknown growth)	23 (+1)	Majority of valves incomplete; margins dirty and eroded
Totals	319 (+1)	324 (+1)	

Methods for Identification

We used descriptions and photographs in Coan et al. (2000) to distinguish oyster taxa. Shells were initially sorted by a graduate student (McGowan) using a 10 x 20.5 mm magnifying lens and checked by Zabin and Grosholz, using binocular dissecting scope using standard fiber-optic light source, generally under 20x magnification.

Initial sorting was guided by the species characteristics for Family Ostreidae including the presence of chomata, shape of the left valve, sculpture and maximum size. In many cases, this method allowed for the distinction between shells belonging to taxa in the genera *Ostrea* and *Crassostrea*. The key to identification for Family Ostreidae was followed in samples large enough to examine shell sculpture. References were also made to photographic images of sculpture and ligaments, but only used in cases where the valve was nearly complete.

For each sample unit, we sorted shells into the following categories, based on the descriptions below:

1. *O. lurida*

The chomata are present, the shell is relatively small, shell shape circular to elongate and the valve relatively flat. *Note: chomata present in most (but not all) specimens of this species.*

2. *O. lurida* or *O. edulis*

Chomata present but valve is not flattened; shell shape is larger and more circular

3. *C. sikamea*
No chomata and valve deeply concave. *Note: sikamea is a subspecies of C. gigas, and is not necessarily readily distinguishable.*

4. *C. gigas*
No chomata, valves thick and large, elongate shape.

5. No visible chomata
Could not clearly distinguish sample units between genera due to the apparent absence of chomata; could not clearly identify as *C. gigas* due to worn and fragmented valves; could not assume it was not *O. lurida*, as chomata are present in most but not *all* specimens of this species.

6. Unidentifiable/unknown
Sample is too fragmented to classify, margin worn or broken.

Results

Based on morphological characteristics, the native oyster, *O. lurida*, was identified in Sample Units A, C, D, and F. *C. gigas* was identified in all sample units. Sample Unit A had one specimen with a deeply concave valve that appears to match the morphology of *C. sikamea.* There are no samples positively identified as *O. edulis.* The specimen in Sample Unit F with unusual morphology was an individual of *O. lurida* that had been bored into by a sponge (likely *Cliona* sp.). These sponges are common in estuaries and sloughs as well as along rocky shores. The results are summarized in Table 2.

O. edulis may be present in the samples. This species and *O. lurida* share many morphological similarities. For shells that are broken and worn, making a species-level classification within the sample units was not feasible. It is possible that chemical analysis of shells could be used to distinguish these two species, assuming that the species differ in the forms and amounts of calcium carbonate molecules used for shell building.

Similarly, the characteristics separating *Crassostrea* species in Coan et al . (2000) are the shape of the valve, size, color, and shell structure. Natural variability in growth forms can make positive identifications difficult in live animals. The worn nature of the shells made this distinction even more challenging. We classified as *C. gigas* only specimens that were large enough for us to have confidence that the shell morphology fit the description in Coan et al. (2000). There may be more *Crassostrea gigas* and/or *C. sikamea* in the category “no chomata visible.”

Table 2. Results of oyster shell identification work

Sample Unit	*O. lurida*	Chomata present: either *O.edulis* *O. lurida*	*C. sikamea*	*C. gigas*	No chomata visible	Unknown	Total (Rows)
A	12	5	1	11	33	6	68
B	0	0	0	1	2	2	5
C	18	9	0	33	39	8	107
D	14	20	0	18	30	2	84
E	0	10	0	6	20	1	37
F	5	7	0	2	8	1	23
Total (columns)	48	50	1	71	134	20	324

Conclusions

The native oyster *O. lurida* appears to have been present at Drakes Estero during the period of shell accumulation at the sample site. Not surprisingly, *C. gigas,* the main aquaculture species at the oyster farm, was heavily represented in the samples collected. It is unclear whether additional aquaculture species are also represented in the samples, although it is our understanding that these have been cultivated at the oyster farm and are thus not unlikely to occur at least in some small measure at the sample site. Further resolution of this issue may be possible using different methodology.

Reference

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