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Reconciling oxygen isotope sclerochronology with interpretations of millennia of seasonal shellfish collection on the Pacific Northwest Coast

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ABSTRACT

The results of high-resolution stable oxygen isotope (δ18O) sclerochronology of 139 butter clam (*Saxidomus gigantea*) shells from nine archaeological shell midden sites on the central coast of British Columbia, Canada demonstrate clear patterns of multi-season harvest at most sites and specific seasonal harvest at particular site locations. Although the results are based on small numbers of shells relative to an unknown number of seasonal clam harvesting events over the centuries or millennia of site occupation, they can be interpreted with confidence based on regional inter-site consistency, fit with a broader range of ancillary archaeological evidence, and the relative stability of seasonal patterns through iterative increases in sample size. On the basis of these results we outline a pragmatic approach to the selection of shells for seasonality analysis and for the interpretation of seasonal harvest patterns. This approach depends neither on the indeterminate reliability of probabilistic sampling of midden deposits and constituents or the prohibitively costly and still potentially unreliable use of large shell samples drawn from deposits distributed across sites.

1. Introduction

Archaeological interpretation of seasonal shellfish harvest and site occupation requires reconciliation of the demands of high-precision methods, the resulting limits on the numbers of shells analyzed, and the ultimate goal of identifying patterns that encompass centuries or millennia of activity. Critical evaluation of the results of oxygen isotope sclerochronology analysis (Andrus, 2011) of relatively small numbers of shells from the central coast of British Columbia (Fig. 1) show it is possible to gain confidence in their broader representativeness even in the absence of probability sampling. In this case, the robustness and reliability of patterns are assessed through multi-site comparisons, contextual evaluation, and programs of iterative shell selection and analysis. Similar strategies could be the basis for the routine application and robust interpretation of high-precision analyses in other situations where probability sampling and large-scale studies are not feasible.

Whatever their level of sophistication, methods for accurate and precise determination of seasons of shellfish collection are only useful archaeologically to the extent that the shells reliably represent the contexts of interpretation. Sampling is a well established method for obtaining an accurate assessment of population characteristics, but successful archaeological sampling requires clear definition of the population being studied and some means of obtaining unbiased access to its constituent units (Claassen, 1998, p. 100; Orton, 2000). In selecting shells from midden deposits for seasonality studies, we ostensibly select samples of individual shells that represent the population of shells present in the site. Although it is common to refer to sampling of shell middens and to individual shells as 'samples', we cannot engage in formal probability sampling if we cannot reliably characterize the temporal, behavioural, or depositional contexts from which the shells are derived. While much has been written about sampling shell middens to obtain 'representative' samples of their constituents (Orton, 2000, pp.146–147; Peacock, 1978; Waselkov, 1987, pp. 150–153), the reliability and accuracy of the methods and their results typically can be assessed only in relation to varying scales of excavation, not the patterns of behaviour responsible for midden deposition and transformation. We argue that the selection of archaeologically recovered shells for seasonality assessments is not directed toward understanding the population of shells or shell deposits

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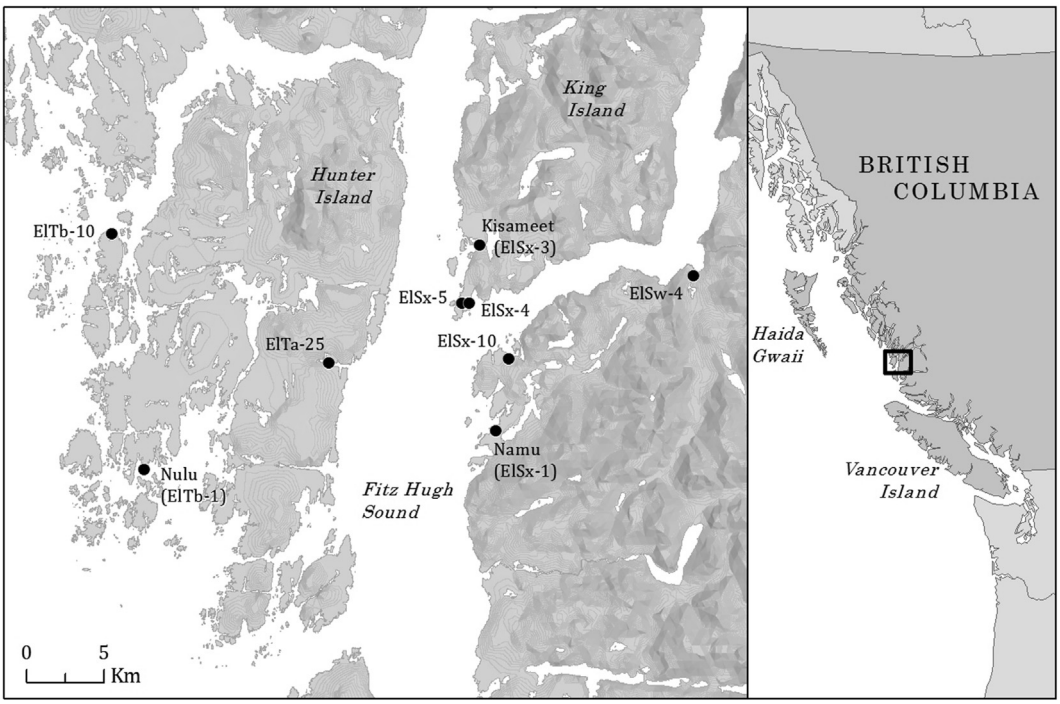

Fig. 1. Locations of sites on the central coast of British Columbia.

within the midden, but rather the events of shellfish gathering that occurred over the period or periods of site occupation. Achieving that understanding is based more on reasoned evaluation of observed seasonal determinations and their overall consistency and fit with ancillary archaeological evidence (e.g. Thompson and Andrus, 2011) than any definable standards for sample size or selection criteria.

Claassen (1998, pp. 172–173) noted that an understanding of sample sizes of archaeological shells for seasonality study was underdeveloped, yet archaeologists still have not addressed this issue. For studies based on low-resolution visual inspection of annual growth lines, she recommended the use of large samples from any one provenience and samples drawn from multiple locations in the site. Although we agree in principle, the costs involved prohibit this scale of analysis using high-resolution oxygen isotope sclerochronology. Archaeological applications of this type of method are typically based on substantial, but relatively modest numbers of shells. In recent studies in California, numbers have ranged from 92 shells from 10 sites (1–22 shells per site) (Jones et al., 2008), and 20 shells from a single site (Jew and Rick, 2014), to 120 shells from two sites (Eerkens et al., 2013). Thompson and Andrus (2011) examined 58 shells in their study of the Sapelo Island shell ring complex in Georgia. The British Columbia central coast study discussed here is based on numbers that fall within the broader range of these recent studies (139 shells, 9 sites, 7–28 shells per site).

The value of more extensive analysis cannot be evaluated beyond the expectation that larger numbers of shells from more locations are more likely to be, to some unknown degree, more representative than smaller numbers taken from fewer locations. In our analyses of Northwest Coast shell middens, we had to accept that we could not legitimately assess the representativeness of seasonal determinations from individual shells relative to the total number of shellfish harvesting events that occurred over centuries or millennia. As early critiques made clear, archaeologists commonly lack the information necessary to evaluate the effectiveness and reliability of even formal sampling methods (Hole, 1980).

Further, reliance on radiocarbon dating to establish the chronology of shell midden deposits means that all shells are selected from time-averaged contexts. Error terms and calibration mean that individual shell dates can span multiple centuries. The shell middens in our study developed as the products of potentially hundreds, thousands, or even tens of thousands of deposition events over centuries to several millennia of occupation (see Stein et al., 1992, pp. 97–98). It would be prohibitively costly to date directly more than the smallest fraction of these events. It would also be impossible to separate the extensive overlap in calibrated dates that would result. Chronological resolution of Pacific Northwest Coast shell middens is further complicated by their stratigraphic complexity (Luebbers, 1978; Stein et al., 2003). Stratigraphic units are frequently difficult to define, limited in horizontal extent, and lacking in dateable associations (Hester, 1978, pp. 6–7; Peacock, 1978, p. 185), which inhibits statistical resolution of radiocarbon dates. But even the highest possible chronological resolution would be at a scale far removed from the day-to-day activity of shellfish gathering.

So how can the selection of shells for seasonality study provide any meaningful insight into the seasonal distribution of shellfish gathering over the centuries- or millennia-long occupations of particular localities? To answer this question we present the results of high-resolution stable oxygen isotope ($\delta^{18}O$) sclerochronology (OIS) of 139 individual butter clam (*Saxidomus gigantea*) shells collected from nine shell midden sites on the central coast of British Columbia (Fig. 1). We argue for comparative, contextual, and iterative interpretation of individual site results within the framework of their collective regional pattern. We show that it is possible to gain confidence in an understanding of prevailing patterns and site-specific exceptions. We then outline a pragmatic approach to the selection of shells from dispersed contexts within multiple sites. We see this strategy of shell selection and interpretation of OIS results as the only viable alternative to extensive and costly shell selection and analysis or smaller-scale probabilistic sampling that would require a degree of depositional and temporal resolution impossible to achieve for most Northwest Coast shell middens.

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