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Discussion of screen size and resource depression:
Using an examination of Faleloa, Tonga

Nadia Densmore
McMaster University, Department of Anthropology

Resource depression has become prominent in the study of faunal material from the archaeological record in recent years. One of the chief concerns in these studies is the difference in amount of material between that has been collected, versus that which has been lost during the excavation process. This paper addresses some of the theoretical and methodological issues of resource depression as well as the use of screen size in zooarchaeological studies. The fish material collected from unit 16 of the site of Faleloa, Tonga is analysed through three different mesh sizes, to address the importance of the 1/8" and 1/16" screen sizes.

Introduction

Resource depression is a prominent and complicated topic in zooarchaeological investigation and as such it is important for researchers to eliminate as much bias as possible in their samples (Butler 2000; Butler 2001; Wing 2001; Nagaoka 2002; Barber 2003; Cannon 2003; Reitz 2004). Simply put, resource depression is the decline in availability of a once prominent species (Charnov et al. 1976, 247). Charnov et al. (1976, 247-248) propose three forms of resource depression: Exploitation (over-exploitation by a predator), behavioural (change in prey behaviour due to presence of a predator or other factors), and microhabitat (environmental changes affecting the survival and/or reproductive success of the prey). In this paper I explore the potential bias of mesh size on the interpretations of resource depression in archaeological studies. Specifically I examine a sample of the fish material from unit 16 of the 1997 excavation at the Faleloa site in the Ha'apai Islands of Tonga in order to understand the potential impacts of introduced bias through the sole use of 1/4" screen mesh size on interpretations of changing fish use at the site.

Archaeologists are most often attempting to identify the occurrence of *exploitation resource depression* (human induced resource depression). The incidence of resource depression is difficult to determine in the archaeological record since many of the observable patterns indicative of resource depression can also be explained by other causes. With taphonomic and recovery biases it becomes even more difficult to identify resource depression in the past. One recovery bias is screen mesh size used during excavation. I argue that the use of a finer mesh size can provide a more comprehensive data set of archaeological faunal material.

Issues

Screen size and recovery

One widely debated issue in zooarchaeological literature is the screen size used during the recovery of archaeological material, and whether smaller screens, 1/8" and 1/16", should always be employed (Shaffer and Sanchez 1994; James 1997; Vale and Gargett 2002; Nagaoka 2005). There are some researchers who maintain that using the finer mesh sizes (1/8" and 1/16") does not yield any more significant results in the faunal sample

Author correspondence should be directed to *densmone@mcmaster.ca* (Department of Anthropology, McMaster University, CNH Room 524, 1280 Main St. West, Hamilton, Ontario, Canada L8S 4L9)

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than the standard 1/4" screen (Vale and Gargett 2002, 57). In order to test this, there have been controlled studies conducted to determine the benefits of the finer mesh sizes by examining the yields of each screen size in a laboratory setting (Shaffer 1992; Shaffer and Sanchez 1994; Nagaoka 2005), as well as on real archaeological material (Gordon 1993; Vale and Gargett 2002; Nagaoka 2005). Many of these studies conclude that if the 1/8" and 1/16" screens are neglected, there will be a loss of information concerning the site's history (Shaffer 1992; Gordon 1993; James 1997). Due to the energy investment in screening through the finer mesh sizes, there have also been studies devoted to providing recovery methods that increase energy efficiency and maintain the recovery success. These methods include defloccation, chemical flotation, sugar flotation and auger sampling (Casteel 1976; Ross and Duffy 2000).

Resource depression

Resource depression as a phenomenon can be observed by researchers in a number of lines of evidence, such as the trophic levels of fish being exploited, age distributions, size distributions, species abundance indices, the diversity of species in the sample, and patch of exploitation. A patch is a geographically bounded region of exploitation (coastal vs. off-shore) (Nagaoka 2002, 422). It is most common to examine two or three of these forms of evidence, to produce a stronger argument for the presence of resource depression (Reitz 2004; Wing 2001). Studies considering alternative forms of evidence have focused on the behaviour of the targeted prey, and how that may affect their capture (Broughton 2002), or the study of post capture decisions such as carrying capacity and butchery (Burger et al. 2005; Cannon 2003; Nagaoka 2001).

One of the most common problems when examining a site for over-exploitation resource depression is that patterns in the data presented above can be created by multiple influences, such as environmental conditions, shifts in fishing strategy, cultural constraints, taphonomic conditions of the site and/or recovery biases (Leach and Davidson 2001). In order to address these alternative explanations, material outside the faunal data is often considered (i.e. material remains of fishing technology) (Luff and Bailey 2000; Reitz 2001; Wing and Wing 2001; Allen 2002).

Due to the convoluted nature of the connections between the data used to explore resource depression and the possible patterns observed in the data, Figure 1 was created to visually represent these connections. There are five explanations presented in Figure 1: resource depression is the over-exploitation of a prey resource to the point of population failure for the targeted species (Butler 2000, 650); fishing

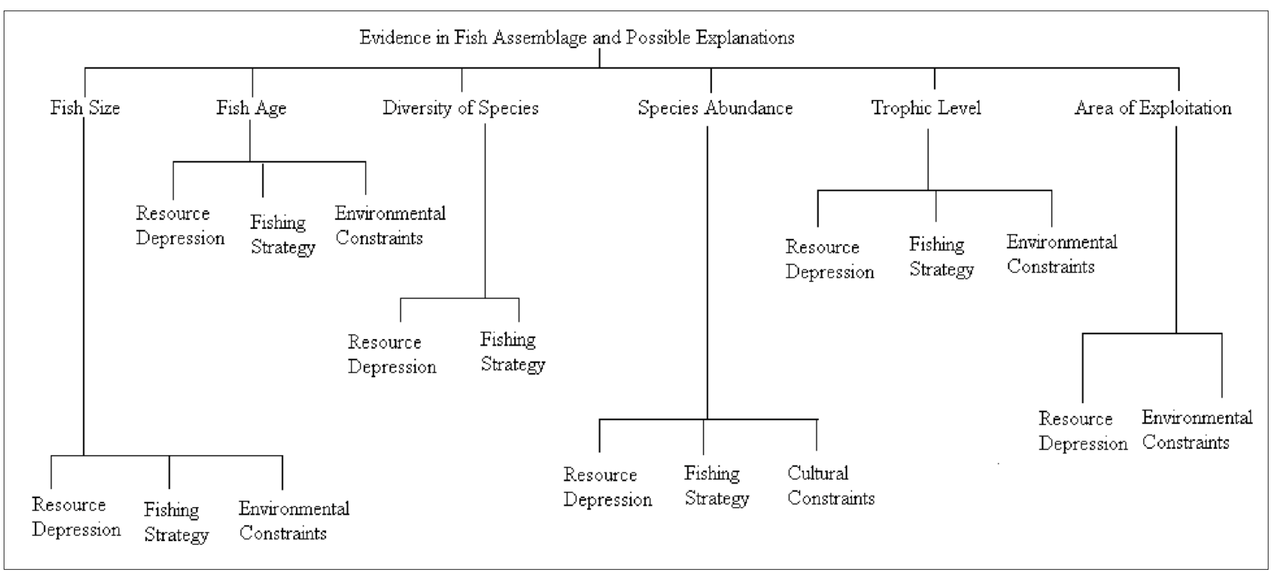

Figure 1. Flowchart of the evidence available in an archaeological fish assemblage and the possible explanations.

strategy is the method of capture mass vs. single (nets/poisons vs. hooks and lines); environmental constraints include climatic and sea level changes creating an unfavourable habitat for the targeted species; cultural constraints consist of cultural beliefs or practices, which limit and/or influence the capture of the targeted species; and lastly, taphonomic and recovery conditions are the preservation and subsequent excavation conditions that alter the assemblage by deleting certain specimens. Taphonomy and recovery issues are not presented in the above chart because they are present in any archaeological excavation and should always be a consideration of the researcher. It is important to note that within each line of evidence, multiple patterns and multiple interpretations are possible. For example, the size of fish through time could increase, decrease, or there could be a wider or restricted range of sizes. Variability in observations is possible within each of the categories in Figure 1. The key to understanding resource depression is eliminating as many other explanations for the observed patterns as possible. This can be done by analyzing all of these lines of evidence to illustrate a comprehensive pattern including all data provided by the fish. Table 1 illustrates two potential situations in which resource depression is one of the most likely explanations for the observed pattern.

Table 1 demonstrates two scenarios in which all of the above lines of evidence are considered together. In both of these scenarios resource depression is a likely cause for the observed patterns, however both may also be explained by alternative factors. This demonstrates that even when considering all possible observations in the faunal sample it may still be difficult to determine if resource depression occurred. This example illustrates the importance of using outside lines of evidence independent of the faunal sample. Looking at the fishing strategies and time of alterations may help to understand if the fishing strategy changed before or after the emphasized species began to decline in a sample (Allen 2002). Similarly, if the environmental conditions caused the decline of the emphasized species there should be other data indicating an environmental shift (Luff and Bailey 2000).

Table 1: Observable patterning in an archaeological fish assemblage suggesting resource depression.

Possible scenario	Possible explanations
An assemblage that was abundant in the large and old individuals of the high-trophic level barracuda from the offshore patches begins to include barracuda of varying age and size. There is also the introduction of reef fish and coastal fish in smaller quantities.	I. *Resource Depression* The over-exploitation of the large and old individuals of the emphasised species forces a diversification of species. II. *Fishing Strategy* The shift from specific or single capture methods (hooks) to mass capture and indiscriminate methods (nets/poison) leads to an increase in the relative abundance of diverse species.
An assemblage that was once abundant in large and old Halibut (a high-trophic level fish) from the offshore patch shifts to emphasize the large and old Salmon (another high-trophic level fish) from the coastal patch.	I. *Resource Depression* The over-exploitation of the initial patch forces the movement to a different patch. II. *Environmental Constraints* The habitat of the initial patch changes and becomes unfavourable forcing the exploitation of alternative areas.

Faleloa Site, Ha'apai Island Group, Tonga

The site of Faleloa is a village site located 200 m from the shore on the Northern edge of Foa Island in the Kingdom of Tonga (Shutler et al. 1994, 60). The Faleloa site was first surveyed by Burley in 1990, and then excavated by Shutler and Carlson in 1991 and 1992 (Shutler et al. 1994, 60). The excavations consisted of 12 1x1m units in the two excavation seasons (Shutler et al. 1994, 61). The assemblage gathered from Faleloa is the largest collection from the Kingdom of Tonga (Shutler et al. 1994, 61). Radiocarbon dating of the Faleloa site indicates that it was initially colonised by the Lapita people within the last 3000 years, and the occupation lasted approximately 300 years after that (Shutler et al. 1994, 62). The initial excavation utilized only 1/4" screens. The second field season, however, was conducted with 1/4" and 1/8" screens for all of the excavation units (Shutler et al. 1994, 61). Unit 16, discussed here, contains samples from 1/4", 1/8", and 1/16" screens (Burley 1998, 18). There are 11 levels excavated in arbitrary 10cm depths (Burley 1998, 18-19). This discussion concerns only the fish from the faunal assemblage. There were also samples of shell and a large collection of plainware and Lapita ceramics recovered from the site (Burley 1998, 18-19).

Data

In order to determine the relevance of the smaller screen sizes it was not necessary to identify the specimens to their taxa and, therefore, none of the elements other than the vertebra are considered in this analysis. Figure 2 shows that the 1/4" screen sample comprises less than 10% of the total sample. Since the concern of this paper is to demonstrate the usefulness of the 1/8" and 1/16" screen sizes, the 1/4" sample will not be used in the following discussion.

Figure 3 indicates the vertebra counts within each level of Unit 16 for both the 1/8" and 1/16" screen size. While Level 11 appears to indicate that initially fish were not heavily exploited, it is important to note that this level is the initial occupation level mixed with culturally sterile beach sands which may explain the relatively small number of remains recovered (Shutler et al. 1994, 61).

Since the excavation was done in 10cm levels, the individual levels are not indicative of different depositional periods. The data from level eight was not included in the following discussion due to potential taphonomic factors and excavation decisions.

Because the degree of variability is so high, and each sample size is small when separated into individual levels, a discussion of temporal succession is more effective if the units are divided into an upper/younger (containing levels one through five) component and a lower/older (containing levels six through eleven) component. Furthermore, statistical analysis can be conducted on the distributions to understand if the importance of fish changed throughout the site's history.

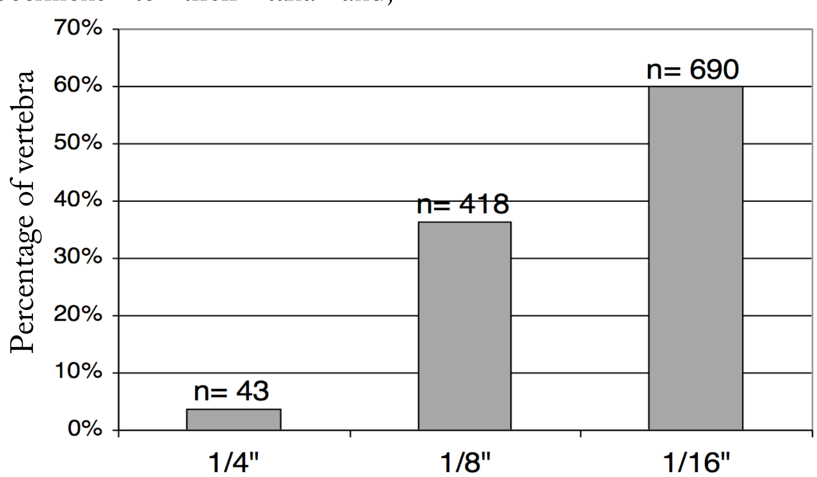

Figure 2. Percentage of vertebra per mesh size, Unit 16, Faleloa

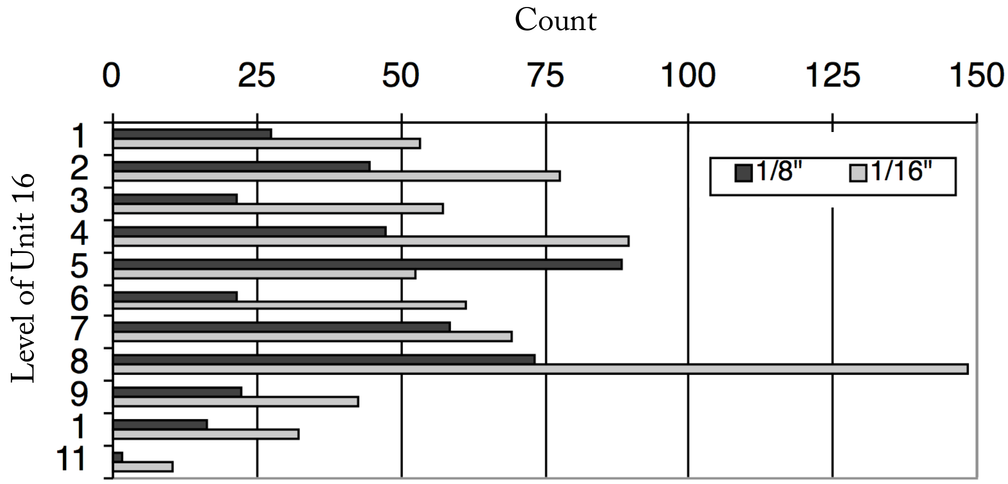

Figure 3. Distribution of vertebra in 1/8” and 1/16” mesh per level of Unit 16, Faleloa

Table 2. Chi-square for the upper and lower levels, Unit 16, Faleloa, Tonga

	1/8" screen	*1/16" screen*	*Totals*
Upper level	227	328	555
Lower level	191	362	553
Totals	418	690	1108

Table 2 illustrates the Chi-square (X^2) test for the upper and lower components for only the 1/8” and 1/16” samples. The Chi-square was preformed to test the null hypothesis that there is no difference between the upper and lower components. The test resulted in a significant P value (*P*=.043), thus we can reject the null hypothesis and argue that there is a significant difference between the two temporal components of the site.

Although the Chi-square test indicates significance, we need to correct for the small sample size as this statistical test is sensitive to sample size where a small sample can give a falsely significant value. The X^2 value was corrected for using the Phi coefficient, resulting in a phi value of 0.066. The corrected value indicates that the differences between the upper and lower components for the 1/8” and 1/16” samples are not statistically significant.

Discussion

Figure 2 demonstrates that the 1/4” screen size yielded a sample that contained less than 10% of the total vertebra sample, exemplifying the concern over excluding the 1/8” and 1/16” screen sizes. Had the 1/4” screen been the only recovery method used at the Faleloa site, not only would the fish assemblage have been significantly smaller, but the interpretations concerning the importance of fish may have been markedly different. For example, when considering the entire faunal assemblage (including bird and mammal in addition to the fish), had only the 1/4” screen been used, the fish may be considered less important due to the relative abundances, but this interpretation would be based on less than 10% of the true fish assemblage.

The analysis of the distribution of vertebra in each level indicates no discrete patterning between levels. The significance test indicates that there is no statistically significant difference between the upper and lower components of the site in the fish resources. This lack of significant difference between the upper and lower component of the site in both the 1/8” and 1/6” samples leads to the conclusion that there was not a change in the reliance on small fish resources. While statistically the results of this study are not significant, it is important to note that the statistical results do not address the qualitative aspect of resource depression.

As noted above, it is not only frequency changes of fish remains that may imply resource depression at a site but also changes between different species. The fact that the 1/8" and 1/16" screens contained identifiable material validates their use at a site. Since the constraints of this study did not allow for species identification, there is no way of telling if the frequency of species changed between the different components. It is entirely possible that while the importance of small fish did not change through time, the importance of different species of small fish did.

One of the arguments raised against the use of the smaller mesh sizes, in particular the 1/16", is that the sample retrieved will not add anything significant and will result in a more fragmentary sample containing more unidentified specimens (Vale and Gargett 2002, 57). The case study presented here discredits the validity of this argument. Even with the fragmentary elements being discounted, the results still show that the majority of the specimens were recovered, though not identified, in the 1/8" and 1/16" screens, indicating that without the 1/8" and 1/16" material, entire families of fish may be lost.

The results of this case study at Faleloa indicate that the importance of the smaller fish did not significantly increase or decrease through time but remained relatively unchanged. These results, however, cannot be used to argue that resource depression did not take place at Faleloa. Since there was no identification of the specimens it is not possible to say whether all of the vertebra from each level are from the same selection of fish or whether the diversity of species changed over time from one small fish to a different small fish. Even if this were the case, there is the possibility of different factors such as environmental conditions or fishing strategies causing the same effect.

This discussion demonstrates the importance of meticulous recovery methods, extensive laboratory methods, and multiple lines of evidence. The complexities of resource depression cannot be understood by a cursory analysis of the fish assemblage alone; a more thorough investigation of not only the diverse information available from the fish, but also outside lines of evidence such as the shell remains, other faunal remains, and the material culture, are needed before the effects of human subsistence strategies on their prey resources can fully be understood.

Conclusion

This study examines the potential biases inherent in only using 1/4" screening during an archaeological excavation, particularly when there are fish remains present at the site. The vertebra remains from the 1/8" and 1/16" screens are quantified and analysed to look for changes over time that would indicate that resource depression had occurred at the Faleloa site in the Kingdom of Tonga. The results indicate no significant change over time between the upper and lower components in the material from the 1/8" and 1/16" screens. Though the results are not significant, they do not disqualify the validity of using the smaller screen sizes, as the quantification does not address the qualitative aspect of the remains recovered.

It can be argued from this study that without having excavated with the smaller mesh screen sizes, the relative abundance of the fish in relation to other faunal material may have led to the assumption that fish were a less important resource at the site since less than 10% of the fish assemblage was recovered from the 1/4" screen. I argue that without the smaller screen size data the diversity of fish at the site would not have been accurately identified. Vale and Gargett (2002) argue that the use of smaller than 1/4" screen sizes do not necessarily create a more comprehensive dataset since their inclusion will lead to a higher proportion of the assemblage being fragmentary and unidentifiable. The results of this study indicate that the use of the smaller screen sizes during excavation do, in fact, lead to a more comprehensive dataset.

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