ZOOARCHAEOLOGICAL AND ISOTOPIC INSIGHTS INTO LOCALLY VARIABLE SUBSISTENCE PATTERNS:

A Case Study from Late Holocene Southern Haida Gwaii, British Columbia

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INTRODUCTION

Economic trends and resource-use patterns have long been placed at the root of major social and cultural developments. On the coast of British Columbia, for example, intensive use of seasonally abundant, storable resources, such as salmon (*Oncorhynchus* spp.), herring (*Clupea pallasii*), and various shellfish, has been argued to form the basis for the rise of more complex, sedentary societies (Matson 1983; Matson and Coupland 1995; but see Monks 1987; Moss 1993). Such focal subsistence economies are broadly described in ethnographic descriptions of First Nations groups of coastal British Columbia, which often characterize these groups as complex, stratified, hunting-fishing-gathering societies, the majority of which relied heavily on salmon (Donald 2003; Drucker 1965). Similarly, archaeological reconstructions have tended towards broad, generalizing models. The Salish Sea and Prince Rupert Harbour (Figure 1) have dominated these models, a result of the historical focus of the bulk of the archaeological effort for the culture area (Ames and Maschner 1999; Matson and Coupland 1995). It has become increasingly clear, as research on the nature of pre-contact coastal BC cultures has accumulated, that long-term patterns of economic and cultural development are highly variable across the culture area (e.g., Cannon and Yang 2006; Monks 2006; Moss 2012; Orchard 2009; Orchard and Clark 2014). New data from other areas of the wider region are revealing considerable variability in the timing of developments and the nature of traditional subsistence economies on coast-wide, regional, and local scales (Cannon, Yang, and Speller 2011; McMillan et al. 2008; Moss 2012; Orchard 2009), highlighting the need for a greater consideration

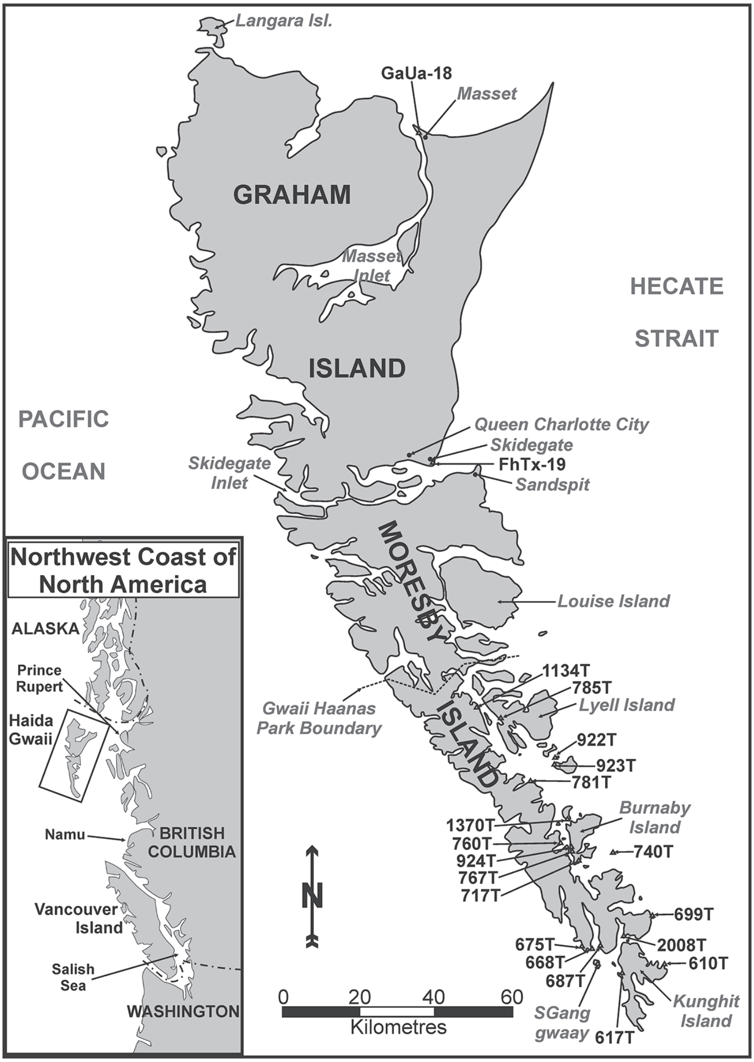

Figure 1. Study area showing locations of archaeological sites and other locations discussed in the article.

of local subsistence variations. Given the ubiquitous role of coastal First Nations cultures from British Columbia, and from the broader region of the Northwest Coast of North America (NWC), in global discussions of the rise of social complexity and inequality (e.g., Arnold 1996; Sassaman 2004), a better understanding of the variability in NWC subsistence is critical (Moss 2012).

While considerations of variability in coastal British Columbia subsistence economies are increasingly common, we would highlight two factors that have limited the detailed consideration of variability on a local, sub-regional scale. First, few sub-regions of the coast have produced sufficient numbers of well analyzed, substantial faunal assemblages suitable for a detailed consideration of intra-regional variations in subsistence practices over limited time periods (e.g., Orchard and Clark 2014; but see Hanson 1991 for a good early example). This problem is increasingly lessened through the accumulation of additional archaeological data (e.g., Butler and Campbell 2004; McKechnie and Wigen 2011; McMillan et al. 2008). Arguably more problematic, though underconsidered in the current literature, are the problems imposed on detailed, regional perspectives by the limits of traditional zooarchaeological analyses. In coastal British Columbia, major foci of traditional subsistence economies were taxa such as salmon, rockfish (*Sebastes* spp.), and, in some cases, whales – that is, broad taxonomic categories comprised of multiple species that cannot typically be distinguished based on skeletal morphology (e.g., Cannon 1988; Monks, McMillan, and St. Claire 2001; Orchard and Szpak 2011). These species may, however, differ significantly in their life history and/or habitat use (Groot and Margolis 1991; Love, Yoklavich, and Thorsteinson 2002), which has implications for when, where, and how these taxa may have been harvested. This problem has been most extensively considered for salmon, with considerable focus on the problems and prospects of identifying salmon species from archaeological remains using metric, genetic, and isotopic approaches (Cannon 1988; Cannon and Yang 2006; Huber et al. 2011; Orchard and Szpak 2011). More recently, genetic analysis of rockfish has aimed to explore species diversity within rockfish assemblages (Rodrigues et al. 2014). Even within single species, however, considerable diversity in ecology, diet, and behaviour is possible between subspecies or populations. Herring, for example, another very prominent coastal subsistence resource, is increasingly recognized to have traditionally lived in numerous, distinct, local populations (Haida Marine Traditional Knowledge Study Participants 2011; McKechnie et al. 2014; Speller et al. 2012).

Stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) can provide insight into the diet of animals through chemical analysis of their tissues (Kelly 2000). The carbon and nitrogen in animal tissues (including bone recovered from archaeological sites) is ultimately derived from dietary carbon and nitrogen, and the isotopic composition of the tissue reflects a weighted average of the isotopic compositions of the foods consumed.

Thus, variations in proportions of stable isotopes in animal bones result from the foraging practices and life histories of the animals, and can reveal patterns of local ecological variability at the level of individuals or populations within larger, more diverse species. While locality in the strictest sense is generally determined using isotope systems such as strontium or lead that predominantly reflect local geology (e.g., Outridge et al. 2003), various environmental factors have the capacity to create local isotopic "signatures" in plant and animal carbon and nitrogen isotopic compositions that can provide insight into local ecological processes (West et al. 2010).

Local isotopic variability is largely determined by factors affecting producers at the base of the food web, with consumer tissues reflecting these patterns. Carbon isotopic compositions change very little between trophic levels and thus consumer $\delta^{13}C$ values vary predominantly according to the relative contributions of isotopically distinct sources of primary production. In the northeast Pacific, these sources are pelagic phytoplankton (with relatively low $\delta^{13}C$ values) and kelp and other benthic macroalgae (with relatively high $\delta^{13}C$ values). Various environmental factors (e.g., nutrient availability, wave exposure, coastal topography, light intensity) can influence the relative abundance of these producers (Steneck et al. 2002), and this local or regional variation in producer abundance can alter consumer tissue $\delta^{13}C$ values (Duggins, Simenstad, and Estes 1989). In addition to any differences in $\delta^{13}C$ that occurs *between* these two classes of producers, environmental factors such as light intensity, growth rate, water temperature, water velocity, and salinity can all influence the extent to which plants discriminate against ^{13}C and, in turn, influence their $\delta^{13}C$ values (Raven et al. 2002).

Stable nitrogen isotopes undergo large changes (fractionation) at each successive trophic level and are thus not a faithful indicator of primary production, but they are indicative of the trophic position (e.g., herbivore, primary carnivore, tertiary carnivore) of an animal (Kelly 2000). Unlike the terrestrial environment, which is generally characterized by three trophic levels (producer, herbivore, carnivore), marine environments are characterized by longer food chains (~5 trophic levels). Thus, changes in the types of prey consumed by carnivores on land (e.g., variable proportions of elk versus bison consumed by wolves) may result in a negligible difference in tissue $\delta^{15}N$ values, but, in the marine environment, a shift in the diet of a marine predator from predominantly fish to zooplankton (a difference of one or more trophic levels) would result in a large shift in tissue $\delta^{15}N$ values (e.g., Emslie and Patterson 2007). The trophic position of marine predators is determined by a number of factors, particularly prey availability, which will be determined by local environmental conditions and reflected in consumer tissue isotopic compositions (e.g., Beaudoin et al. 1999). The analysis of stable isotopes of carbon and nitrogen of faunal remains from archaeological sites, then, holds the potential to identify local ecological variability that may be masked by morphological identification alone.

This article challenges general, homogenizing, archaeological models of subsistence practices among coastal First Nations of British Columbia. Through a combination of detailed syntheses of traditional zooarchaeological data and targeted isotopic analyses we explore locally variable subsistence adaptations in late Holocene assemblages from Haida Gwaii. Our aim is not to present a comprehensive overview of what these variable subsistence patterns actually looked like but, rather, to highlight, drawing particularly on our work from the region of Gwaii Haanas National Park Reserve and Haida Heritage Site (hereafter Gwaii Haanas) in southern Haida Gwaii, our increasing understanding of local variability in these subsistence economies. We want to emphasize that it is difficult to meaningfully generalize, beyond a very coarse level, about subsistence practices across even a small area of coastal British Columbia, let alone across the whole region (cf. Orchard and Clark 2014). Moss (2008), for example, argued that local, intra-cultural variability precluded the identification of a clear Haida subsistence pattern from archaeological analyses. In addition, we want to highlight the ways in which isotopic analyses of faunal remains have revealed additional variability and patterning in the faunal data.

THE ARCHAEOLOGY OF LATE HOLOCENE HAIDA GWAII

Haida Gwaii is an archipelago of more than 150 islands located off the coast of northern British Columbia (Figure 1). The archipelago is dominated by two major islands, Graham and Moresby, which are surrounded by numerous smaller islands, creating complex and variable marine ecosystems. Graham Island is a broad, relatively low plain, while Moresby Island is a more rugged, mountainous region dominated by steep coastlines (Sutherland Brown and Yorath 1989). The insular nature of Haida Gwaii is very important to Haida subsistence, which is predominantly focused on marine resources with only limited terrestrial input (Haida Marine Traditional Knowledge Study Participants 2011). Though dynamic sea level changes in Haida Gwaii throughout the Holocene have shifted the position of the shoreline considerably, coastlines appear to have always been a focus for subsistence and settlement (Fedje et al. 2005a).

For the purposes of the current article the late Holocene is considered to span roughly the past two thousand years (i.e., 2000 BP to the recent past). This corresponds to the Late Graham Tradition in the current culture historical sequence for Haida Gwaii (Fedje and Mackie 2005, 161), and it is also a period when sea levels were relatively stable at elevations near modern levels (Fedje et al. 2005a). As a result of this sea level history, and the related high levels of archaeological visibility (Fedje et al. 2005a), the late Holocene has seen considerably more archaeological excavation and faunal analysis in comparison to earlier time periods. In particular, our understanding of subsistence practices in late Holocene Gwaii Haanas is largely the result of two major regional research projects. Steve Acheson's (1998, 2005) Kunghit Haida Culture History Project, conducted in the 1980s, involved excavations at eighteen sites in southernmost Haida Gwaii, with faunal analysis conducted by Rebecca Wigen (1990). More recently, the Gwaii Haanas Environmental Archaeology Project involved excavations at eight sites in eastern Gwaii Haanas (Orchard 2009). This later project has subsequently been expanded to additional sites (Orchard 2008, 2011a; Orchard et al. 2013) and forms the basis for our ongoing collaborative work on understanding resource use and faunal isotopic variability in the region.

These two projects, with the addition of an isolated assemblage from Hotspring Island (Sumpter 1999; Wigen 1999), provide a substantial sample of shell-midden sites with abundant faunal assemblages dating to the past two thousand years, providing a good regional late Holocene sample. Our focus here is on those sites that represent villages, as evident in the presence of house depression features, or large shell middens, namely, those greater than one thousand square metres in surface area (Acheson 1998, 33). These sites are, with few exceptions (discussed below), locations of substantial, multi-seasonal occupations, thus representing the cumulative results of general activities that characterized human subsistence behaviours within the late Holocene (e.g., Mackie 2003, 262; Orchard and Clark 2014). Smaller shell middens, rockshelters, and cave sites, also tested through previous field projects, arguably represent more short-term, seasonally limited activities and contain less diverse, more specialized, and often much smaller faunal assemblages (Acheson 1998; Orchard 2009). Significantly, these smaller, specialized assemblages represent a subset of the subsistence diversity present within the larger, more general activity sites that we are highlighting here.

Based on these caveats, a sample of eighteen late Holocene sites from Gwaii Haanas with well analyzed faunal assemblages is included in the current overview (Table 1). Three of these sites (610T, 675T, 687T) can be meaningfully split into two temporally distinct components,[1] producing a total of twenty-one late Holocene faunal components from villages and large middens in southern Haida Gwaii. Elsewhere in Haida Gwaii research intensity has been considerably less, with few comparable late Holocene sites producing detailed analyses of vertebrate and invertebrate faunal remains. Two notable exceptions, FhTx-19 in Skidegate (Christensen, Stafford, and Lindberg 1999) and GaUa-18 in Masset (Christensen, Stafford, and McKechnie 2010), are included here to provide some broader, regional context for the southern Haida Gwaii analyses. Relatively few sites from Haida Gwaii dating prior to 2000 BP have produced substantial, well analyzed faunal assemblages, with some important exceptions (Christensen and Stafford 2005; Fedje et al. 2005b; Orchard et al. 2013). The few pre-2000 BP sites analyzed from Haida Gwaii are not included here as they do not allow examination of variability between contemporaneous, or near-contemporaneous, sites from any period prior to 2000 BP.

Not all of the assemblages included in this analysis have produced useable published data for both vertebrates and invertebrates. Vertebrate remains, derived from field-screened excavation matrix assemblages typically processed through one-eighth-inch (3.2-millimetre) or one-quarter-inch (6.4-millimetre) mesh screens, are included from seventeen components in southern Haida Gwaii and from the three northern components. Variable use of vertebrate taxa is here measured as the relative proportion of an assemblage contributed by a particular taxon, quantified by the number of identified specimens (NISP).[2] Sample size can influence measures of taxonomic richness and relative abundance in zooarchaeological assemblages (e.g., Grayson 1981). Total sample sizes are variable, though generally very robust, in all of the assemblages included here (Table 2), and, with minor exceptions noted below, these samples are more than sufficient to highlight variability in local subsistence patterns in Haida Gwaii (e.g., Orchard and Clark 2005). Significantly, the use of

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[1] Two site designation systems exist for sites in Haida Gwaii. All sites prior to the designation of Gwaii Haanas as a national park reserve were assigned Borden numbers (e.g., FhTx-19); sites in Gwaii Haanas recorded more recently have been assigned only Parks Canada site numbers (e.g., 610T). In this article, all sites in Gwaii Haanas are identified using the Parks Canada system, while sites outside of the reserve are identified by Borden numbers.

[2] NISP, or number of identified specimens, is a count of the number of bones or bone fragments identified as belonging to a particular taxonomic group, here referring to identification to a taxonomic level below that of the class.

TABLE 1

Late Holocene (ca. 2000 BP to present) components from Haida Gwaii with well analyzed vertebrate faunal assemblages

Sites 760T, 767T, 1370T, and 2008T are included for invertebrate data only. The first 21 assemblages (i.e., those above the dotted line) represent southern sites from the Gwaii Haanas region; the three assemblages at the bottom of the table are from Graham Island.

Site Code	Site name/Location	Houses	Setting	Approx. dates	Screening*	Source(s)
610T (FaTr-3)-C2	Prevost Point - Comp. 2	3	Exposed	800 BP to contact	6mm & 3mm	Acheson 1998; Wigen 1990
610T (FaTr-3)-C1	Prevost Point - Comp. 1	3	Exposed	1470 to 800 BP	6mm & 3mm	Acheson 1998; Wigen 1990
617T (FaTs-3)	Bowles Point	2	Exposed	745 BP (±)	6mm & 3mm	Acheson 1998; Wigen 1990
668T (FaTt-9)	Louscoone Point	4	Exposed	935 to 300 BP	3mm	Acheson 1998; Wigen 1990
675T (FaTt-16)-C2	SW Moresby - C2 + EU1		Exposed	<800 BP	6mm & 3mm	Acheson 1998; Wigen 1990
675T (FaTt-16)-C1	SW Moresby - Comp. 1		Exposed	1431 to 1170 BP	6mm & 3mm	Acheson 1998; Wigen 1990
687T (FaTt-28)-C2	Louscoone Inlet - Comp. 2	1	Semi-protected	590 to 300 BP	6mm & 3mm	Acheson 1998; Wigen 1990
687T (FaTt-28)-C1	Louscoone Inlet - Comp. 1	1	Semi-protected	1120 to 995 BP	6mm & 3mm	Acheson 1998; Wigen 1990
699T (FbTs-4)	Benjamin Point	16+	Exposed	500 BP to AD 1880	1/8" (3.2 mm)	Orchard 2009
717T	Swan Bay	1?	Semi-protected	1000 BP to contact	1/8" (3.2 mm)	Orchard 2009
740T	East Copper Island	1+	Exposed	440 to 390 BP	1/8" (3.2 mm)	Orchard 2009
760T	Island Bay	1+	Protected	2000 to 1000 BP	1/8" (3.2 mm)	Orchard 2008
767T	Burnaby Narrows	2+	Protected	2000 to 1000 BP	1/8" (3.2 mm)	Orchard 2008
781T	Marco Island	1+	Semi-protected	1000 BP to contact	1/8" (3.2 mm)	Orchard 2009
785T	Lyell Bay	4+	Protected	1500 BP to contact	1/8" (3.2 mm)	Orchard 2009
922T	Hotspring Island		Semi-protected	1880 to 1100 BP	3mm	Sumpter 1999; Wigen 1999
923T	Ramsay Island	1?	Exposed	500 BP to contact	1/8" (3.2 mm)	Orchard 2009
924T	Burnaby Narrows	4+	Protected	1000 BP to contact	1/8" (3.2 mm)	Orchard 2009
1134T	Darwin Sound	3?	Protected	Contact	1/8" (3.2 mm)	Orchard 2009
1370T	Huxley Island		Semi-protected	1000 to 300 BP	1/8" (3.2 mm)	Orchard 2011a
2008T	Ross Island		Exposed	post-2000 BP	1/8" (3.2 mm)	Orchard 2011a
FhTx-19	Second Beach			1200 BP to contact	1/4" (6.4 mm)	Christensen et al. 1999
GaUa-18 - C1	Masset - Comp. 1			900 to 450 BP	1/4" (6.4 mm)	Christensen et al. 2010
GaUa-18 - C2	Masset - Comp. 2			1500 to 900 BP	1/4" (6.4 mm)	Christensen et al. 2010

* Represents screen sizes for field-screened excavation unit sediments only; all sites also included fine-screened bulk samples (Table 7). With the exception of 668T (FaTt-9), Acheson's (1998) Kunghit region sites were subject to only limited 3 mm screening; most material was recovered from only 6 mm screens.

TABLE 2

Vertebrate data from field-screened excavation unit assemblages by class

Note that fish are likely under-represented in sites (610T, 617T, 675T, 687T, FhTx-19, GaUa-18) that were not subject to consistent fine screening (i.e., ≤ 3.2 mm). Sources listed in Table 1.

Site code	Screening	Mammals		Birds		Fish		Total
		(nisp)	(%)	(nisp)	(%)	(nisp)	(%)	(nisp)
610T - C2	6mm & 3mm	296	2.84	1346	12.92	8777	84.24	**10419**
610T - C1	6mm & 3mm	198	1.55	1299	10.20	11240	88.25	**12737**
617T	6mm & 3mm	58	2.25	915	35.45	1608	62.30	**2581**
668T	3mm	1099	2.36	394	0.85	45100	96.80	**46593**
675T - C2	6mm & 3mm	86	8.22	72	6.88	888	84.89	**1046**
675T - C1	6mm & 3mm	32	5.55	16	2.77	529	91.68	**577**
687T - C2	6mm & 3mm	109	1.65	93	1.41	6416	96.95	**6618**
687T - C1	6mm & 3mm	72	2.63	27	0.99	2636	96.38	**2735**
699T	1/8" (3.2mm)	152	1.27	185	1.54	11651	97.19	**11988**
717T	1/8" (3.2mm)	35	0.50	50	0.72	6877	98.78	**6962**
740T	1/8" (3.2mm)	25	7.46	198	59.10	112	33.43	**335**
781T	1/8" (3.2mm)	76	1.32	116	2.02	5563	96.66	**5755**
785T	1/8" (3.2mm)	32	0.50	73	1.14	6317	98.36	**6422**
922T	3mm	19	1.51	14	1.11	1224	97.37	**1257**
923T	1/8" (3.2mm)	7	3.43	183	89.71	14	6.86	**204**
924T	1/8" (3.2mm)	14	0.08	25	0.15	16721	99.77	**16760**
1134T	1/8" (3.2mm)	13	1.41	7	0.76	904	97.84	**924**
FhTx-19	1/4" (6.4mm)	29	3.53	13	1.58	780	94.89	**822**
GaUa-18 - C1	1/4" (6.4mm)	130	7.50	86	4.96	1517	87.54	**1733**
GaUa-18 - C2	1/4" (6.4mm)	108	15.49	20	2.87	569	81.64	**697**

variable screen sizes for field screening of excavation unit matrices can also affect the relative abundances of vertebrate taxa. In particular, the relative abundance of small fish taxa, such as herring, has been shown to be heavily affected by the use of coarse-mesh versus fine-mesh screens (McKechnie 2005; Partlow 2006). Unfortunately, the Kunghit region assemblages were variably screened through six-millimetre and three -millimetre mesh screens, and the published vertebrate data represent a combined sample of both mesh sizes (Acheson 1998; Wigen 1990). Laboratory-analyzed bulk-matrix samples can provide a more controlled basis for quantifying small fish remains (McKechnie 2005), though in the current sample, as discussed below, comparable bulk sample data are not available from all of these components. Despite the use of variable screen sizes, these excavation unit assemblages provide the best, most comparable set of late Holocene data available. Furthermore, "the use of large samples from multiple sites across a large geographic region minimizes the impact of potential biases in the data from sampling and other sources" (Orchard and Clark 2014, 212), with the result that trends in local variability should be robust and visible despite issues arising from variable screening.

Invertebrate assemblages, based on laboratory-analyzed bulk sediment samples (column samples, bulk samples, or auger samples), are included for all eighteen southern Haida Gwaii sites and for GaUa-18 in Masset. However, due to the nature of the presentation of the bulk sample data in Acheson (1998), the two temporal components for sites 610T, 675T, and 687T have been aggregated into site-level data for invertebrates. Invertebrate relative abundance is measured as the relative proportion of an assemblage contributed by a particular taxon quantified by weight.

All of the analyzed assemblages date within the past two thousand years, with the majority directly dated through radiocarbon dating (see sources in Table 1). More generally, the location of these sites on the current shoreline at relatively low elevations constrains the likely occupation of these sites to within roughly the past two thousand years due to the complex sea-level history of the region (Fedje et al. 2005a). Prior to that time, sea levels were higher during the earlier Holocene and were substantially lower during the terminal Pleistocene, with the effect that most pre-2000 BP sites are variably isolated on raised terraces at some distance back from the current shorelines or are now submerged under modern sea levels (e.g., Christensen and Stafford 2005). Additionally, European trade goods were recovered from the upper layers of six of the sites (610T, 699T, 781T, 785T, 923T, and 1134T), pointing to the occupation of those sites into the early contact period (Acheson 1998; Orchard 2009). Finer chronological control within these sites is, for the most part, not possible, with the assemblages representing general, late Holocene palimpsests of human activity. As a result, our discussion is largely restricted to static, ahistorical considerations of local variability, with the exception of the transition to the early European contact period for which we have good evidence of changing subsistence patterns.

Finally, these sites represent a range of ecological settings as measured through the degree of wave-exposure of each site (Table 1). Exposure to physical disturbance through wave activity is known to be an important factor in structuring the distribution, abundance, and species composition of nearshore marine floral and faunal communities (Dayton 1971). While the attribution of ecological settings is coarse, based on a general consideration of the wave exposure of site locations (Acheson 1998, 29), this provides some insight into the ecological variability of the immediate site environments.

ZOOARCHAEOLOGICAL AND ISOTOPIC VARIABILITY IN LATE HOLOCENE HAIDA GWAII

Fish are almost invariably the most abundant class among the twenty vertebrate faunal assemblages included in this overview (Table 2, Figure 2), highlighting the focus on marine environments in Haida Gwaii. All but three of the assemblages are comprised of greater than 80 percent fish remains, with ten showing greater than 95 percent fish remains. Significantly, this high relative abundance occurs despite the fact that fish are likely under-represented in the Kunghit sites and the three northern assemblages due to the use of coarse screens. Only three sites show variation from this pattern. Most extreme, in this regard, is site 923T, where birds predominate at roughly 90 percent of the assemblage by NISP. Despite the presence of probable house platform features at 923T, the faunal assemblage suggests that the site may have functioned as a seasonal bird hunting location. Site 740T also contains a relatively large proportion of birds (59 percent; Figure 2), though again associated with clear house features, suggesting a permanent village. The location of 740T on a very exposed island off the east coast of southern Haida Gwaii known in modern times as a breeding colony for the small alcids (Family Alcidae) that dominate the bird assemblage (Harfenist, Sloan, and Bartier 2002) may account for the unusually high proportion of birds at the site. Significantly, these two sites contain the smallest total sample sizes of all the sites included in this analysis (923T total NISP = 204; 740T total NISP = 335), which may influence these patterns. Finally, 617T contains a relatively large proportion of bird remains (35 percent by NISP), though fish are the most abundant class at this site.

Other inter-site variability is evident through a consideration of relative frequencies of finer taxonomic categories within the three classes of vertebrate remains. Though mammals are typically present in small numbers in these assemblages (Table 2, Figure 2), they tend to be larger animals than the more prevalent birds and fish and, thus, were likely a significant contribution to the total diet. Relative frequencies of prominent mammalian taxa (Table 3, Figure 3) highlight the general abundance of marine

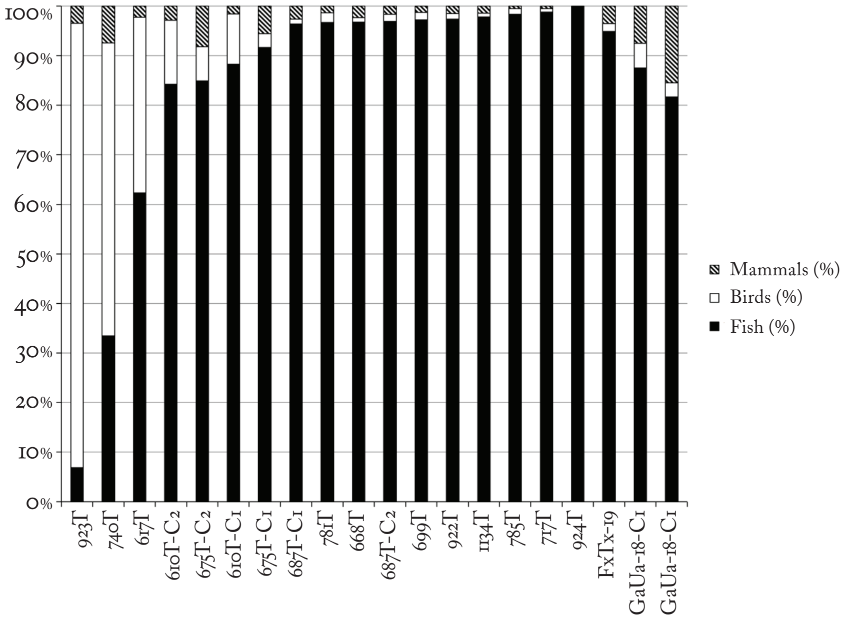

Figure 2. Relative proportions (% NISP) of vertebrate remains by class. Sources listed in Table 1.

resources. Sea otter (*Enhydra lutris*) and "seal/sea lion," predominantly harbour seal (*Phoca vitulina*), are nearly ubiquitous and are relatively abundant in the majority of the mammalian assemblages. Only site 1134T, occupied entirely during the post-contact period, lacks sea otter remains. This possibly represents the local extirpation of sea otters precipitated by the onset of the European maritime fur trade (Orchard 2009; Szpak et al. 2012, 2013), though this may also result from the very small sample of mammal remains recovered from this site (total mammal NISP = 13). Notably, the three components from Graham Island contain the greatest relative abundances of sea otter remains (> 65 percent in all cases). The relative abundances of porpoises and dolphins and of other whales are highly variable, suggesting a large degree of local variability in some aspects of mammalian resource use. The high proportions of whale bone in some Kunghit-region sites (as high as 70 percent of mammal remains by NISP) has led to the suggestion that whales were actively hunted by the Haida (Acheson and Wigen 2002), though this may, in part, result from an inflation of relative abundances due to the relative ease with which large pieces of fragmentary whale bone may be identified as whale. The high proportion of dolphin and porpoise remains at 781T,

TABLE 3

Summary of mammal abundance from field-screened excavation unit assemblages

“Other mustelid” includes river otter, marten, and ermine; “Seal/Sea lion” includes harbour seal, fur seal, northern sea lion, and unidentified pinnipeds; “Terrestrial Mammal” includes black bear and cervids. Sources listed in Table 1.

Site code	Whale		Porpoise/ Dolphin		Seal/Sea lion		Sea otter		Other mustelid		Terrestrial mammal		Total
	(nisp)	(%)	(nisp)	(%)	(nisp)	(%)	(nisp)	(%)	(nisp)	(%)	(nisp)	(%)	(nisp)
610T - C2	66	22.30			94	31.76	106	35.81	25	8.45	5	1.69	**296**
610T - C1	75	37.88			62	31.31	49	24.75	8	4.04	4	2.02	**198**
617T	41	70.69			10	17.24	5	8.62	2	3.45			**58**
668T	449	40.86	3	0.27	227	20.66	387	35.21	22	2.00	11	1.00	**1099**
675T - C2	40	46.51			25	29.07	13	15.12	8	9.30			**86**
675T - C1					27	84.38	5	15.63					**32**
687T - C2	2	1.83	3	2.75	57	52.29	19	17.43	28	25.69			**109**
687T - C1					56	77.78	13	18.06	3	4.17			**72**
699T	1	0.62	1	0.62	66	43.42	80	52.63	1	0.66	3	1.97	**152**
717T			4	11.43	18	51.43	12	34.29	1	2.86			**35**
740T					9	36.00	16	64.00					**25**
781T			45	59.21	19	25.00	10	13.16	2	2.63			**76**
785T			3	9.09	12	36.36	9	27.27	7	21.21	2	6.06	**33**
922T					10	52.63	6	31.58	3	15.79			**19**
923T					3	42.86	4	57.14					**7**
924T					6	42.86	7	50.00	1	7.14			**14**
1134T			3	23.08	8	61.54					2	15.38	**13**
FhTx-19			1	3.45	6	20.69	21	72.41			1	3.45	**29**
GaUa-18 - C1					45	34.88	84	65.12					**129**
GaUa-18 - C2					15	15.00	85	85.00					**100**

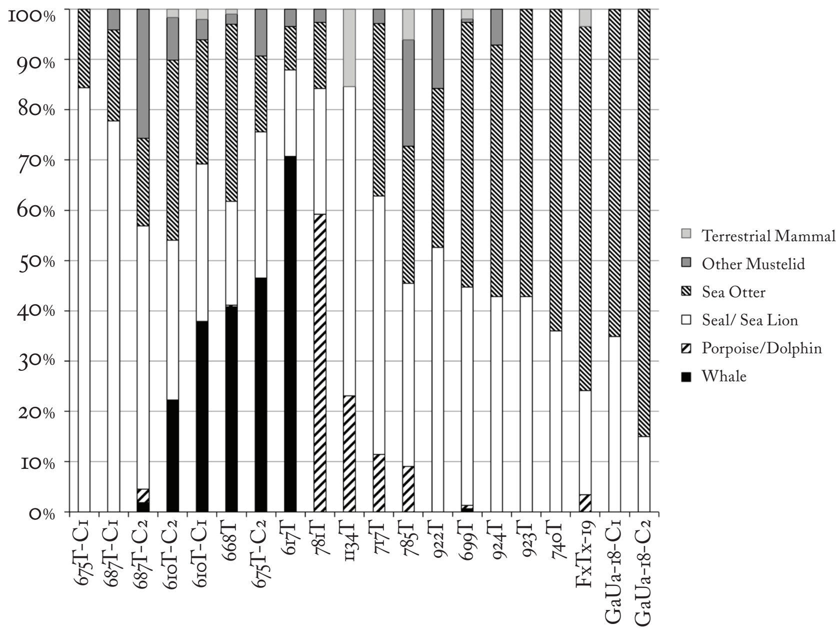

Figure 3. Relative proportions (% NISP) of mammalian taxa in Haida Gwaii sites. Sources listed in Table 1.

and to a lesser extent at other sites in eastern Gwaii Haanas (717T, 785T, 1134T), suggests that the active hunting of these species likely occurred at locations along the east coast of Moresby Island. Generally, mammal assemblages from late Holocene Haida Gwaii show a predominance of marine taxa – namely, harbour seals and sea otters – though there is a degree of local variability within this broader pattern.

Among the mammals, we have examined the carbon and nitrogen isotopic compositions of sea otters most extensively (Table 4, Figure 4a). Both within Haida Gwaii and more broadly across the central and northern coasts of British Columbia our analysis reveals a consistent pattern of low variability and little differences between regions in pre-contact sea otter isotopic compositions (Szpak et al. 2012). We hypothesize that this lack of variability in sea otter diet results from consistently moderate otter densities due to top-down impacts on sea otter populations by persistent hunting, or threat of hunting, by Indigenous peoples through the late Holocene. This top-down limitation on otter populations would have resulted in the relatively high availability of preferred sea otter prey items, decreasing the likelihood of significant individual-level dietary specialization (and, in turn, isotopic variation)

TABLE 4

Mean values for stable nitrogen and carbon isotopes ratios in select fauna from Haida Gwaii sites

Represents a combination of new data and data previously reported in Orchard (2011b) and Szpak et al. (2009, 2012, 2013). *Two outliers from 699T are not included in the site mean and standard deviations plotted in Figure 4.

	$\delta^{13}C$	St. dev.	$\delta^{15}N$	St. dev.	No.	Sources
Sea otter (n=32)						
699T	−10.81	1.14	13.61	0.43	9	Szpak et al. 2012
699T*	−12.50		13.20		1	Szpak et al. 2012
699T*	−14.27		13.19		1	Szpak et al. 2012
717T	−10.71	0.34	14.05	0.71	3	Szpak et al. 2012
740T	−10.97	0.74	13.93	0.49	3	Szpak et al. 2012
781T	−10.94	0.27	13.77	0.53	5	Szpak et al. 2012
785T	−10.80	0.52	14.10	0.44	3	Szpak et al. 2012
924T	−10.90	0.71	13.15	0.49	2	Szpak et al. 2012
GaUa-18	−11.63	0.34	12.71	0.55	5	Szpak et al. 2012
Ancient murrelet (n=15)						
699T	−14.49	0.51	17.91	0.30	2	Szpak et al. 2009
781T	−14.21	0.47	17.75	0.96	7	Szpak et al. 2009
785T	−14.15	0.57	17.98	0.56	6	Szpak et al. 2009
Salmon (n=19)						
699T	−14.58	0.86	12.66	0.83	5	Szpak et al. 2009; Orchard 2011b
717T	−15.02	0.63	12.02	0.62	7	Szpak et al. 2009; Orchard 2011b
924T	−15.37	0.63	12.14	0.84	7	Szpak et al. 2009; Orchard 2011b
Rockfish (n=75)						
699T	−11.23	0.76	15.77	0.65	17	Szpak et al. 2013
740T	−11.95	0.81	15.82	0.72	8	Szpak et al. 2013
781T	−10.32	0.41	16.33	0.88	31	Szpak et al. 2013
785T	−10.09	0.77	16.43	0.51	9	Szpak et al. 2013
924T	−11.60		15.00		1	Szpak et al. 2013
1134T	−11.37	0.38	16.35	0.74	6	Szpak et al. 2013
2008T	−11.53	0.15	15.00	0.87	3	Previously unpublished

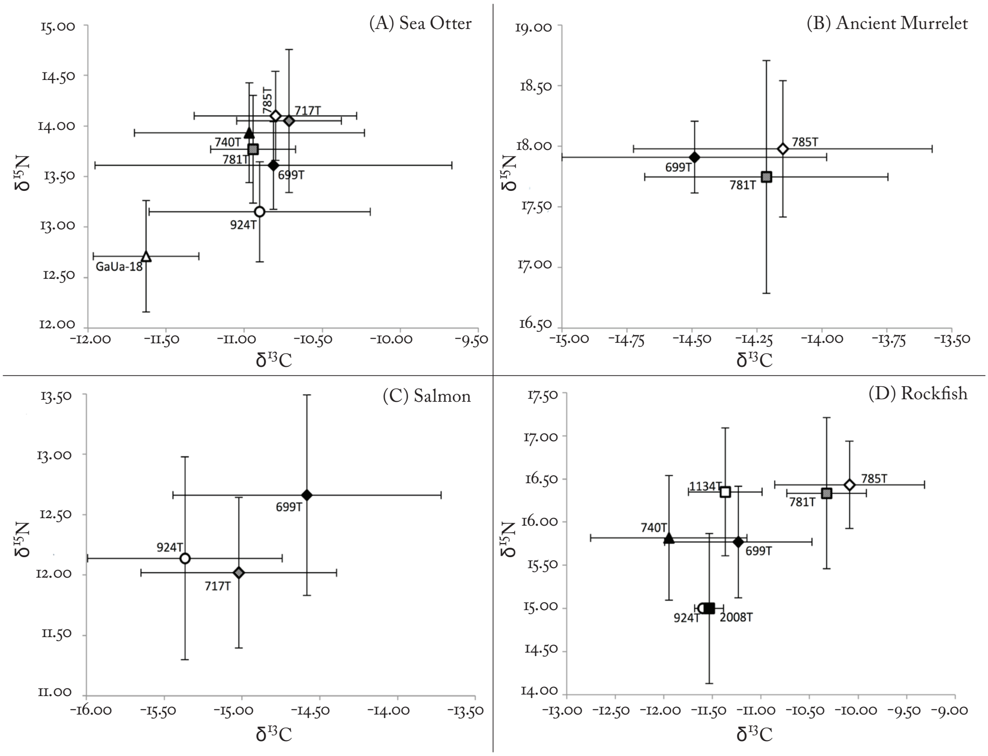

Figure 4. Mean stable carbon and nitrogen isotope ratios for analyzed taxa: (A) sea otter, (B) ancient murrelet, (C) salmon, (D) rockfish. Data points represent site means; error bars represent one standard deviation. Mean values for sea otter from site 699T exclude two outliers (see Table 4). Sources listed in Table 4.

within a given population (see Tinker, Bentall, and Estes 2008). The particularly wide range of δ13C values for otter elements from site 699T (Figure 4a) is somewhat anomalous and particularly prominent when two individuals with unusually low δ13C values are considered (see Table 4; these two outliers are excluded from the data in Figure 4a). Site 699T is a large, post-contact village, and these carbon isotope values may result from a broadening of the foraging range of Haida hunters in response to increased demands for otter furs and decreased local otter populations during the fur trade period (Szpak et al. 2012). Nonetheless, the isotopic variability for sea otters from 699T is still relatively low compared to other modern and archaeological sea otter populations analyzed to date from the Aleutian Islands, southeast Alaska, and California (Szpak et al. 2012).

The bird remains from the majority of the late Holocene assemblages in southern Haida Gwaii are predominantly small alcids (Table 5, Figure 5), particularly ancient murrelets (*Synthliboramphus antiquus*) and Cassin's

TABLE 5

Summary of bird abundance from Haida Gwaii assemblages

"Other seabirds" includes loons, grebes, albatross, petrels, fulmars, shearwaters, and cormorants; "Waterfowl" includes ducks, geese, and swans; "Other Birds" includes corvids, shorebirds, songbirds, other raptors, and owls. All data reflect field-screened excavation unit assemblages with the exception of GaUa-18 which, as presented in the original source (Christensen et al. 2010), includes combined values from excavation units, fine-screened bulk samples, and specimens collected during monitoring. Sources listed in Table 1.

Site code	Alcids		Other seabirds		Waterfowl		Bald eagle		Gulls		Other birds		Total
	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)
610T - C2	1237	91.90	25	1.86	7	0.52	52	3.86	6	0.45	19	1.41	**1346**
610T - C1	1201	92.46	60	4.62	11	0.85	13	1.00	2	0.15	12	0.92	**1299**
617T	904	98.80	2	0.22	2	0.22	4	0.44	1	0.11	2	0.22	**915**
668T	151	38.32	64	16.24	46	11.68	15	3.81	46	11.68	72	18.27	**394**
675T - C2	64	88.89	6	8.33					1	1.39	1	1.39	**72**
675T - C1	6	37.50	1	6.25			1	6.25	1	6.25	7	43.75	**16**
687T - C2	18	19.35	16	17.20	6	6.45	23	24.73	4	4.30	26	27.96	**93**
687T - C1	3	11.11	12	44.44			7	25.93	3	11.11	2	7.41	**27**
699T	154	83.24	5	2.70	7	3.78	14	7.57			5	2.70	**185**
717T	41	82.00	3	6.00	1	2.00			5	10.00			**50**
740T	193	97.47	4	2.02			1	0.51					**198**
781T	106	91.38	4	3.45	5	4.31					1	0.86	**116**
785T	57	78.08	4	5.48	7	9.59	3	4.11			2	2.74	**73**
922T	5	35.71	1	7.14	5	35.71	2	14.29			1	7.14	**14**
923T	182	99.45									1	0.55	**183**
924T	17	68.00	1	4.00	1	4.00	3	12.00	2	8.00	1	4.00	**25**
1134T							1	14.29	5	71.43	1	14.29	**7**
FhTx-19	1	7.69	5	38.46	3	23.08			1	7.69	3	23.08	**13**
GaUa-18 - C1	1	0.97	2	1.94	99	96.12					1	0.97	**103**
GaUa-18 - C2			1	3.70	23	85.19	2	7.41	1	3.70			**27**

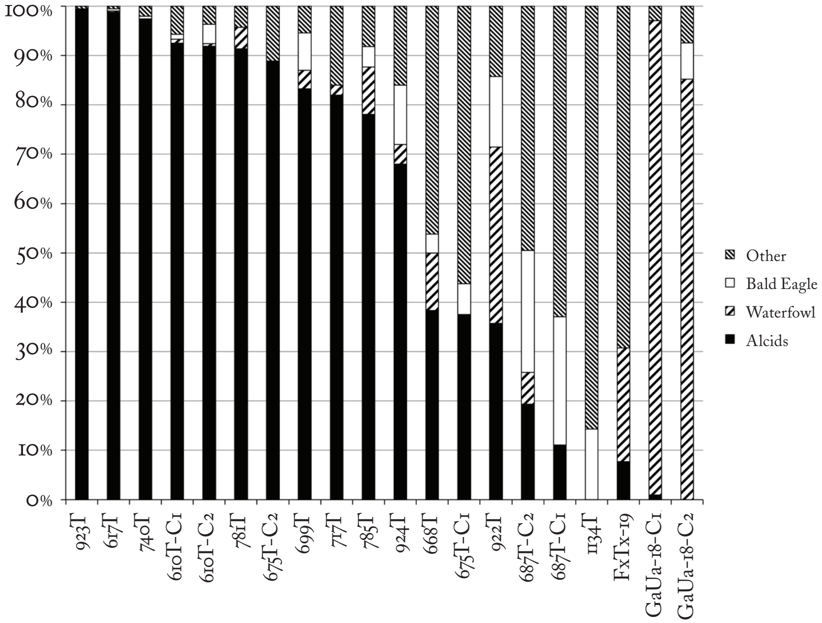

Figure 5. Relative proportions (% NISP) of major bird taxa in Haida Gwaii sites. Sources listed in Table 1.

auklets (*Ptychoramphus aleuticus*). Variability in the relative importance of these species appears to relate to seasonal breeding concentrations in the region that have been documented in recent times (Harfenist, Sloan, and Bartier 2002). This suggests both a local focus in bird-harvesting activities and considerable time depth of historically documented alcid breeding patterns through the late Holocene (Orchard and Clark 2005). Isotopically, a sample of fifteen ancient murrelet elements from three sites (Table 4, Figure 4b; Szpak, Orchard, and Gröcke 2009) shows relatively little variability, a result of the general and ecologically homogeneous offshore feeding behaviour of these birds. There is a slight indication of a latitudinal variation in carbon isotopic compositions, with the more southerly site of 699T showing slightly lower mean $\delta^{13}C$ values than the more northern sites of 781T and 785T. Latitudinal variation in planktonic $\delta^{13}C$ values has been recorded, although this pattern tends to be evident at large (continental) spatial scales and is strong in the southern hemisphere and weak or absent in the northern hemisphere (Rau, Sweeney, and Kaplan 1982). Conversely, this may represent a trend from more exposed sites (699T) to more protected sites (781T, 785T). Regardless, this reveals variations in the diet of local alcid populations resulting from local ecological and oceanographic variability, and suggests that local populations of ancient murrelets may have been targeted by the occupants of these sites. In the absence of significant relative quantities of alcids, assemblages generally show a more equitable distribution across a range of other taxa, with waterfowl (Family Anatidae), particularly a range of duck species, bald eagle (*Haliaeetus leucocephalus*), gulls (*Larus* spp.), and various other species common (Figure 5). While the sample from FhTx-19 on southeastern Graham Island is too small to highlight clear trends for that region, the more robust samples from GaUa-18, in Masset, contain an abundance of waterfowl (Family Anatidae), likely resulting from the proximity of this site to the protected inland waters of Masset Inlet. Broadly, while a focus on marine species is clear, these results highlight considerable local and regional diversity in bird hunting patterns in late Holocene Haida Gwaii.

Salmon, rockfish, herring, or some combination thereof, are invariably the most abundant fish taxa in assemblages from Gwaii Haanas, though with considerable variability between sites (Table 6, Figure 6). The sites from northern Haida Gwaii are strikingly different. Flatfish, predominantly starry flounder (*Platichthys stellatus*), are the most abundant fish at FhTx-19, likely relating to the less rocky, soft-sediment marine environment in the vicinity of that site. At GaUa-18 on northern Graham Island sculpins (Family Cottidae) are common in the recent component, while the earlier component at the site shows a focus on salmon.

Salmon and rockfish are ubiquitous, though highly variable in their relative abundances, in all of the Haida Gwaii assemblages. As discussed elsewhere (Orchard 2009; Orchard and Clark 2005; Wigen 1990), the variable abundance of salmon and rockfish in southern Haida Gwaii represents, in part, a temporal trend, with salmon increasing in abundance over the past twelve hundred years and rockfish predominating in all sampled sites from the region dating between twelve hundred and two thousand years ago. More insight into patterns of salmon use is gained by looking at coarse estimates of the species compositions of a selection of these salmon assemblages (Orchard 2011b; Orchard and Szpak 2011). Salmon bones are notoriously difficult to identify to species, so we have employed a methodology that identified the size (via measurements of vertebral diameters), age (using radiography to identify growth annuli), and isotope ecology (through analysis of stable carbon and nitrogen isotopes) of salmon represented in these assemblages (Orchard and Szpak 2011). While aspects of this approach, particularly the identification of radio-opaque growth annuli as an estimate of age, have recently been

TABLE 6

Summary of fish abundance from field-screened excavation unit assemblages

"Other fish" includes dogfish, skate, ratfish, smelt, clingfish, Gadids, prickleback, gunnel, wolf-eel, sablefish, greenling, lingcod, sand lance, perch. Note that small-bodied fish, including herring, are likely under-represented in sites (610T, 617T, 675T, 687T, FhTx-19, GaUa-18) that were not subject to consistent fine screening (i.e., ≤ 3.2 mm). For comparison, fine-screened bulk sample data for fish abundance are presented in Table 7. Sources listed in Table 1.

Site code	Screening	Salmon		Herring		Rockfish		Sculpin		Flatfish		Other fish		Total
		(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)
610T - C2	6mm & 3mm	6876	78.34	13	0.15	1142	13.01	56	0.64	287	3.27	403	4.59	**8777**
610T - C1	6mm & 3mm	2893	25.74	84	0.75	6966	61.98	104	0.93	312	2.78	881	7.84	**11240**
617T	6mm & 3mm	161	10.01	4	0.25	1231	76.55	6	0.37	16	1.00	190	11.82	**1608**
668T	3mm	37419	82.97	3829	8.49	1831	4.06	26	0.06	1078	2.39	917	2.03	**45100**
675T - C2	6mm & 3mm	505	56.87	13	1.46	237	26.69	11	1.24	41	4.62	81	9.12	**888**
675T - C1	6mm & 3mm	53	10.02	2	0.38	392	74.10			32	6.05	50	9.45	**529**
687T - C2	6mm & 3mm	3676	57.29	78	1.22	1445	22.52	19	0.30	564	8.79	634	9.88	**6416**
687T - C1	6mm & 3mm	2309	87.59			225	8.54	2	0.08	56	2.12	44	1.67	**2636**
699T	1/8"(3.2mm)	6979	59.90	3228	27.71	245	2.10	31	0.27	166	1.42	1002	8.60	**11651**
717T	1/8"(3.2mm)	3763	54.72	2958	43.01	5	0.07	7	0.10	12	0.17	132	1.92	**6877**
740T	1/8"(3.2mm)	40	35.71	15	13.39	18	16.07	2	1.79	12	10.71	25	22.32	**112**
781T	1/8"(3.2mm)	674	12.12	3083	55.42	921	16.56	75	1.35	101	1.82	709	12.74	**5563**
785T	1/8"(3.2mm)	4853	76.82	211	3.34	502	7.95	88	1.39	67	1.06	596	9.43	**6317**
922T	3mm	537	43.87			214	17.48	225	18.38	37	3.02	211	17.24	**1224**
923T	1/8"(3.2mm)	6	42.86			5	35.71					3	21.43	**14**
924T	1/8"(3.2mm)	5807	34.73	10549	63.09	19	0.11	17	0.10	36	0.22	293	1.75	**16721**
1134T	1/8"(3.2mm)	768	84.96			131	14.49	1	0.11	2	0.22	2	0.22	**904**
FhTx-19	1/4"(6.4mm)	69	8.85	15	1.92	9	1.15	39	5.00	492	63.08	156	20.00	**780**
GaUa-18 - C1	1/4"(6.4mm)	203	13.38	12	0.79	1	0.07	1040	68.56	137	9.03	124	8.17	**1517**
GaUa-18 - C2	1/4"(6.4mm)	383	67.31			2	0.35	169	29.70	9	1.58	6	1.05	569

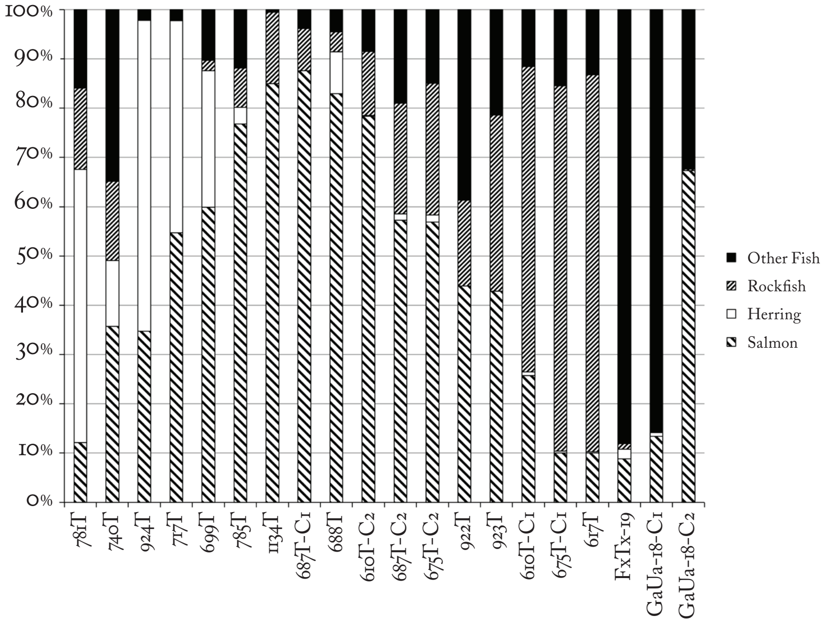

Figure 6. Relative proportions (% NISP) of major fish taxa in Haida Gwaii sites. Sources listed in Table 1.

questioned (Hofkamp and Butler 2013), this multivariate methodology, particularly the use of vertebral diameters (e.g., Cannon and Yang 2006; Moss, Judd, and Kemp 2014), unarguably highlights variations in the salmon present in site assemblages, the majority of which likely relates to inter-species variability. Applied to a sample of almost two thousand salmon vertebrae from five sites, previous analysis has suggested that many of the salmon in southern Haida Gwaii are chum salmon (*Oncorhynchus keta*), with significant numbers of pink salmon (*O. gorbuscha*) and small numbers of coho (*O. kisutch*) (Orchard 2011b). Isotopic analysis of a small subset of these salmon vertebrae reveals a slight trend towards increasing carbon isotope values from north to south (Table 4, Figure 4c). This likely relates to species variability as estimated abundances of salmon species highlight a trend of decreasing pink salmon and increasing chum salmon abundance from north to south, mirroring a trend evident in historic escapement data for the region (DFO 2007; Northcote, Peden, and Reimchen 1989). Because salmon species have variable life history strategies and foraging habits, we would expect some isotopic differentiation along these lines (Johnson and Schindler 2009). As a whole, these data suggest that salmon harvesting in late Holocene Haida Gwaii was localized, and they further suggest long-term stability in fisheries trends within the region through the late Holocene.

Like salmon, rockfish species are largely indistinguishable based on skeletal morphology (Cannon 1988; McKechnie 2007), despite the presence of numerous, ecologically diverse species in the waters around Haida Gwaii (Love, Yoklavich, and Thorsteinson 2002; Workman et al. 2008). Given the abundance of rockfish in many of the southern Haida Gwaii assemblages, and in order to take advantage of their ecological variability, rockfish represent our most robust isotopic sample to date (Table 4, Figure 4d; Szpak, Orchard, and Gröcke 2009; Szpak et al. 2013). The seven sites for which rockfish isotope values are available show a strong trend towards increasing $\delta^{15}N$ values from south to north. The single exception, site 924T, is represented by only a single value, which may not be typical of broader patterns for that site. This geographic pattern may result from differences in rockfish diet due to variable species composition at the sites (Bosley et al. 2014), differences in the availability of prey that feed at different trophic levels (Markel 2011), variation in nutrient $\delta^{15}N$ values due to larger oceanographic factors (Wu, Calvert, and Wong 1997), or some combination of these factors. The analysis of bulk bone collagen $\delta^{15}N$ values, as presented here, does not permit a more refined analysis of the determinative factors, but the isotopic analysis of individual amino acids within the collagen and a comparison of essential and non-essential amino acid nitrogen isotopic compositions have the potential to resolve the relative importance of animal diet (variation in rockfish trophic position) and processes occurring at the base of the food web (differences in nutrient regimes) (Sherwood et al. 2011).

Carbon isotope values also reveal variations in rockfish diet and local ecology, with clear patterns of local variability. Sites from relatively protected settings, towards the right side of Figure 4d, differ significantly from more exposed sites, towards the left, consistent with variable contributions of kelp- and phytoplankton-derived carbon at exposed and protected sites, respectively (Szpak et al. 2013). Again, this suggests a high degree of local focus in rockfish harvesting. Site 924T is again anomalous, though the single value from this site does not provide a good indication of general site trends. Rockfish from 1134T, located in protected waters, are characterized by $\delta^{13}C$ values consistent with a more exposed pattern than 781T and 785T located nearby. As mentioned above, this site was occupied entirely during the post-contact period, and these isotope values likely represent changes in local ecology resulting from the extirpation of sea otters (Szpak et al. 2013). Site 699T, the large, amalgamated village mentioned previously, shows an intermediate pattern, combining both exposed and protected signatures despite its exposed location. We return to a discussion of this site below.

Herring vary in abundance from completely absent to as much as 63 percent of the total identified fish remains in these assemblages (Table 6; Orchard 2009; McKechnie et al. 2014). Variability in herring is in part a factor of sampling, with recovery of small herring elements being heavily affected by the use of coarse-mesh versus fine-mesh screens (McKechnie 2005; Partlow 2006). The reliance here on field-screened excavation unit assemblages means that assemblages from one-quarter-inch mesh screens (six or 6.4 millimetres; Table 1) – namely, the Kunghit-region and northern sites – will heavily underestimate the relative abundance of herring. Fish data from laboratory-screened bulk-matrix samples (Table 7), which often provide a better understanding of the relative abundance of small fish taxa (e.g., McKechnie 2005), are problematic in this case due to sample sizes and variable methods. Fish remains from bulk samples from the Kunghit sites were quantified by weight (Acheson 1998), which again will under-represent the relative abundance of small taxa. Bulk sample assemblages from other Haida Gwaii sites, quantified by NISP, are in many cases very small, raising questions about representativeness. Regardless, these bulk sample data (Table 7) suggest that, in most cases, herring were somewhat more heavily utilized than is evident from the excavation unit assemblages alone.

Screen-size issues aside, the herring abundance data also clearly demonstrate a degree of geographical variation relating to herring spawning locations (Figure 7). The dark-highlighted stretches of coastline in Figure 7 are regions of herring spawning activity recorded by the Department of Fisheries and Oceans between 1946 and 1998 (after Sloan 2006, 68). While such historic observations are difficult to confidently extend to the pre-contact period, the relationship between these historic spawning areas and the abundance of herring in archaeological assemblages is striking. Setting aside the coarse-screened assemblages, which almost certainly heavily under-represent herring abundance, virtually all herring-rich assemblages, using either excavation unit or bulk sample data, are located in direct association with historically identified spawning locations. This suggests that historically recorded herring activity represents long-term continuity in herring behaviour in the region stretching back at least several millennia (McKechnie et al. 2014). This pattern also suggests that herring fit into a pattern of locally focused fisheries, being heavily utilized only by villages located near

TABLE 7

Summary of fish abundance from laboratory-processed bulk samples sieved through fine screens (i.e., ≤ 3 mm)

Kunghit area samples (first five sites) are quantified by weight (Acheson 1998: 57), while the remaining sites are quantified by specimen count (NISP). As a result, the Kunghit data likely under-represent the relative abundance of small fish (i.e., herring) and overrepresent the relative abundance of larger-bodied fish. Sources listed in Table 1.

SITE CODE	SALMON		HERRING		ROCKFISH		SCULPIN		FLATFISH		OTHER FISH		TOTAL
Kunghit sites	(GRAMS)	(%)	(GRAMS)	(%)	(GRAMS)	(%)	(GRAMS)	(%)	(GRAMS)	(%)	(GRAMS)	(%)	(GRAMS)
610T	11.74	24.55	0.45	0.94	31.53	65.93	0.09	0.19	0.31	0.65	3.70	7.74	**47.82**
617T	0.32	9.33	0.03	0.87	2.62	76.38	0.04	1.17	0.05	1.46	0.37	10.79	**3.43**
668T	49.84	69.76	0.87	1.22	11.77	16.47	0.07	0.09	6.61	9.25	2.29	3.21	**71.45**
675T			0.03	0.46	6.37	97.25			0.05	0.76	0.10	1.53	**6.55**
687T	12.52	53.97	0.04	0.17	6.72	28.97	0.01	0.04	2.43	10.47	1.48	6.38	**23.20**
Other sites	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)	(%)	(NISP)
699T	84	60.00	44	31.43							12	8.57	**140**
717T	16	42.11	20	52.63							2	5.26	**38**
740T			3	50.00							3	50.00	**6**
781T	6	2.32	217	83.78	26	10.04			1	0.39	9	3.47	**259**
785T	33	61.11	12	22.22	3	5.56	1	1.85			5	9.26	**54**
922T	178	25.32	37	5.26	83	11.81	139	19.77	10	1.42	256	36.42	**703**
923T					*No identifiable fish recovered from the 923T column samples.*								
924T	33	43.42	40	52.63	1	1.32					2	2.63	**76**
1134T	32	100.00											**32**
GaUa-18 - C1	119	23.29	42	8.22			317	62.04	13	2.54	20	3.91	**511**
GaUa-18 - C2	83	49.70	16	9.58			39	23.35	7	4.19	22	13.17	**167**

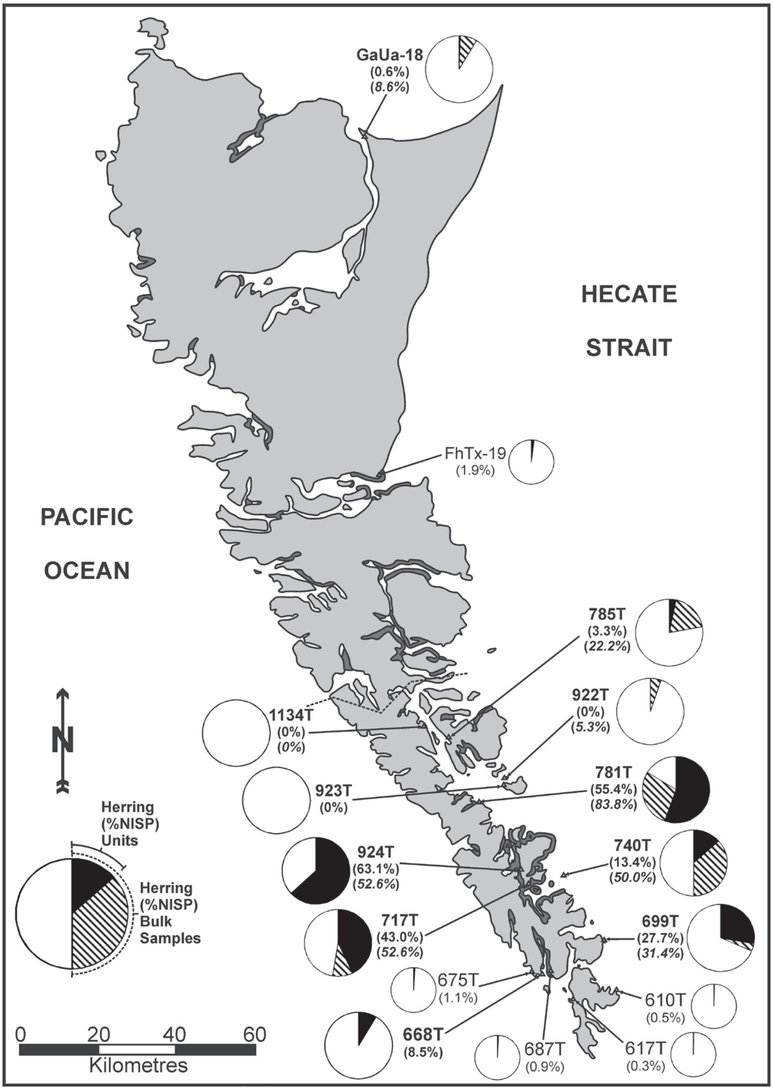

Figure 7. Herring spawning areas and herring abundance by archaeological site. Dark-shaded coastlines represent locations of herring spawning activity recorded by the Department of Fisheries and Oceans between 1946 and 1998 (after Sloan 2006, 68). Sites in bold text with large pie charts were screened through one-eighth-inch (3.2-millimetre) mesh screen or finer. Pie charts show relative abundance of herring (% Fish NISP) for both excavation unit samples (dark pies, percentage in normal font) and for bulk matrix samples (diagonal hashed pies and dark pies summed, percentage in italicized font). Sources listed in Table 1.

spawning grounds, though herring may also have been obtained during pre-spawning aggregations (Haida Marine Traditional Knowledge Study Participants 2011). The one notable exception to this pattern is the abundance of herring at 699T despite its location some distance from any historic herring spawning locations. This site is a very large village that represents the amalgamation of populations from numerous smaller villages during the late pre-contact and early contact periods (e.g., Acheson 1998, 2005). It is the large, amalgamated nature of this site that likely explains its deviation from the general patterns evident at the smaller villages, as discussed below. Our consideration of herring isotopes has been hindered by problems with collagen extraction from the very small herring vertebrae, though our methodology is being refined with some success. Preliminary data do not yet allow any consideration of herring isotopic trends.

Perhaps the most striking illustration of a systematic local variation in subsistence comes from a consideration of invertebrate remains from late Holocene sites in Haida Gwaii (Table 8, Figure 8). Variability in the most abundant invertebrate taxa – namely, clams (Order Veneroida), small mussels (cf. *Mytilus edulis*),[3] California mussel (*Mytilus californianus*), and, to a lesser extent, barnacles (Infraclass Cirripedia) – are seen to be highly related to the degree of site exposure. Exposed sites contain predominantly California mussel, protected sites contain large quantities of clams and small mussels, and semi-protected sites span this range of variation and often contain relatively greater proportions of barnacles and other taxa. The two assemblages from GaUa-18 continue this general pattern, containing large quantities of clams and mussels and occupying the relatively protected, soft-sediment habitat along Masset Inlet. Overall, these patterns in invertebrate usage point to a very local level of landscape use for the purposes of gathering invertebrate resources. Invertebrate assemblages are comprised of species available in the immediate vicinity of the sites.

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[3] The small mussel category may contain both *Mytilus edulis* and juvenile specimens of *Mytilus californianus*. Due to the difficulty inherent in distinguishing these species, McKechnie did not separate the two in the samples from GaUa-18 (Christensen, Stafford, and McKechnie 2010). In Gwaii Haanas, large, thick mussel shell was abundant and was confidently identified as California mussel (*M. californianus*). The clear separation in these assemblages between sites with abundant *M. californianus* and sites with abundant "small mussel" suggests that the majority of the small mussel category represents *M. edulis* (Orchard 2009, 92).

TABLE 8

Relative proportions (% by weight) of invertebrate taxa from late Holocene sites in Haida Gwaii, based on analyzed bulk samples

Results for GaUa-18 represent a mean value of coarse (1/4") and fine (2mm) screened column samples. "Other Inverts." includes chiton, limpet, Northern abalone, Giant Pacific scallop, crab, sea urchin, sand dollar, and marine snails. *GaUa-18 - Mussel was not differentiated by species or size classes. Sources listed in Table 1.

SITE CODE	CALIFORNIA MUSSEL	BARNACLE	OTHER INVERTS.	CLAM	SMALL MUSSEL*	TOTAL (%)	TOTAL SHELL (G)	SETTING
610T	95.34	0.29	4.01	0.36		**100.00**	3805.59	Exposed
617T	96.40	0.37	1.10	2.13		**100.00**	1677.00	Exposed
668T	92.83	4.29	0.73	2.15		**100.00**	10643.32	Exposed
675T	96.43	0.84	2.21	0.52		**100.00**	4112.49	Exposed
687T	96.52	2.06	0.75	0.68		**100.00**	13163.22	Semi-protected
699T	98.43	0.67	0.66	0.25		**100.01**	1497.76	Exposed
717T	54.34	1.96	2.14	41.51	0.06	**100.01**	158.34	Semi-protected
740T	80.40	11.50	4.85	3.24		**99.99**	1601.26	Exposed
760T		0.01	0.02	99.74	0.23	**100.00**	991.40	Protected
767T			0.15	99.08	0.78	**100.00**	206.20	Protected
781T	4.19	22.34	0.48	68.61	4.39	**100.01**	1333.69	Semi-protected
785T	1.20	0.27	0.53	75.43	22.58	**100.01**	759.84	Protected
922T	4.40	18.30	7.83	67.94	1.53	**100.00**	3513.08	Semi-protected
923T	86.85	13.13	0.01			**99.99**	219.58	Exposed
924T	0.84	0.47	0.57	73.78	24.34	**100.00**	591.35	Protected
1134T	0.19	1.76	1.60	22.27	74.19	**100.01**	62.60	Protected
1370T	20.57	6.27	0.86	51.96	20.35	**100.00**	1594.44	Semi-protected
2008T	60.66	10.76	2.08	19.49	7.01	**100.00**	2893.71	Exposed
GaUa-18 - C1	n/a*	11.31	10.01	44.87	33.82*	**100.01**	4160.80	
GaUa-18 - C2	n/a*	0.98	6.92	65.64	26.47*	**100.01**	11960.70	

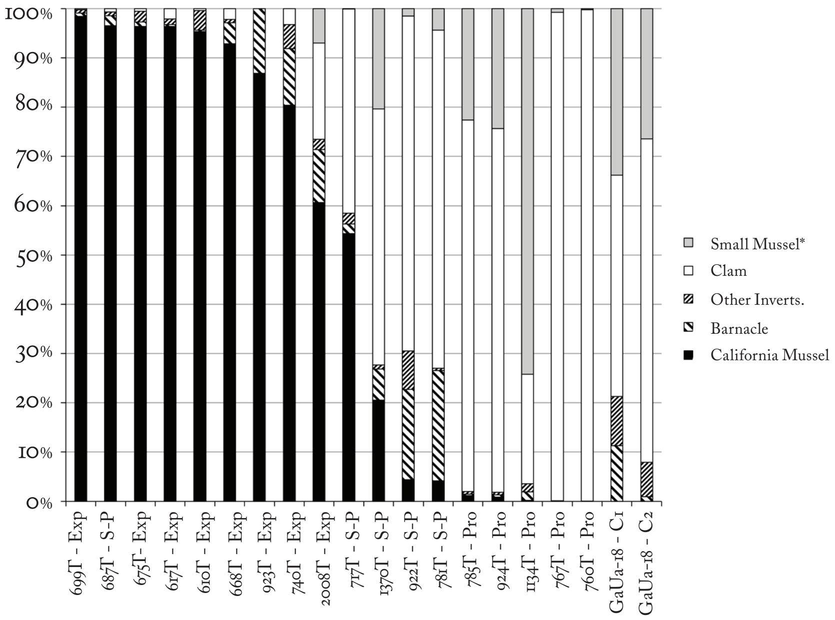

Figure 8. Relative proportions (% weight) of major invertebrate taxa in late Holocene assemblages from Haida Gwaii. Site setting codes for Gwaii Haanas sites are: Exp = Exposed; S-P = Semi-Protected; Pro = Protected. GaUa-18 represents the single site from northern Graham Island and is not included in the site setting system from southern Haida Gwaii. * The "Small Mussel" category for GaUa-18 includes all undifferentiated mussel shell from the analyzed samples and may include some California mussel. Sources listed in Table 1.

DISCUSSION: EXPLAINING THE PATTERNS

This study synthesizes faunal data from twenty late Holocene archaeological sites in Haida Gwaii, revealing a diverse pattern of relative abundances of prominent vertebrate and invertebrate taxa. Clearly, this indicates that local subsistence variability is ubiquitous in late Holocene Haida Gwaii. While some very general tendencies in Haida subsistence from this period can be identified, the range of local variation means that essentially no two sites are the same (cf. Moss 2008). This is particularly the case when isotopic data are integrated into this analysis. In fact, much of the extremely localized nature of resource use in the region is masked by the coarseness of traditional faunal analyses (i.e., relative abundance based on NISP) when used in isolation. Stable carbon and nitrogen isotopes from these fauna reveal local variations in the ecological contexts from which subsistence resources were drawn, documenting inter-site differences in the dietary behaviours of local populations of morphologically homogeneous but ecologically diverse generic groups such as salmon and rockfish.

Seasonal variability in site occupations and resource harvesting *may* contribute to the patterns of local variability described here (cf. Cannon 2002; Cannon and Yang 2006). While we suggest that villages and large middens represent year-round, or at least multi-season, general activity locations, this does not preclude the possibility that seasonally restricted activities influence the faunal assemblages described above. Certainly, a distinct seasonal cycle of subsistence activities was recorded ethnographically (Curtis 1916; Dawson 1880; Haida Marine Traditional Knowledge Study Participants 2011; Harrison 1925), though Blackman (1990, 244) indicates that this cycle "varied regionally because of local variations in available species and seasonality." Unfortunately, determining seasonality in archaeological assemblages is highly complex and problematic (e.g., Monks 1981). Many of the most prominent faunal taxa present in the Haida Gwaii assemblages *may* have been harvested during limited seasonal periods. Salmon were likely targeted primarily during their spawning aggregations in nearshore waters. The movement of salmon into streams and rivers throughout Haida Gwaii varies from May through to October, with the majority spawning in the late summer and fall (e.g., Sloan 2006, 60). Salmon, however, were certainly present in nearshore waters at other times as well (Groot and Margolis 1991) and could have been taken in open water using hook-and-line technology (Blackman 1990; Haida Marine Traditional Knowledge Study Participants 2011; Harrison 1925, 181). Furthermore, salmon were widely processed and stored for delayed consumption throughout the year (e.g., Curtis 1916, 131). Likewise, herring move into nearshore waters in Haida Gwaii in the late fall and early winter, and spawn in the late winter through early spring, though the timing of this varies even within Haida Gwaii (Sloan 2006, 66-68). Herring, however, were also processed and stored for delayed consumption, both as adult fish and as roe (Dawson 1880; Harrison 1925), and could be harvested at times other than during the seasonal spawning aggregations (Haida Marine Traditional Knowledge Study Participants 2011; McKechnie et al. 2014). Other prominent fish species, such as rockfish and sculpins, would have been available in nearshore waters year round (Haida Marine Traditional Knowledge Study Participants 2011). Most prominent bird taxa are found in Haida Gwaii waters throughout the year, though many are more abundant in non-winter months (Harfenist, Sloan, and Bartier 2002). Small alcids, particularly ancient murrelets and Cassin's auklets (which are very abundant in the southern assemblages), are far more common, and more easily harvested, during breeding seasons in the spring and summer. The particularly high numbers of these small alcids at sites 923T and 740T (Table 5, Figure 5) may indicate a more limited spring-summer occupation at these sites, though small sample sizes in these two assemblages may somewhat limit their interpretive potential. Mammals, a relatively minor component of the late Holocene assemblages, as discussed previously (Table 2, Figure 2), are available year round in the waters of Haida Gwaii (Heise et al. 2003). Finally, analysis of a preliminary sample of ten butter clams (*Saxidomus gigantea*) from sites 781T and 785T (five shells from each site) using a combination of high-resolution stable oxygen isotope analysis and sclerochronology (see Burchell et al. 2013; Hallmann et al. 2009) points to a pattern of year-round clam collection at these sites (Brombacher 2012; Schöne et al. in press). None of the late Holocene sites discussed here have strong indications of seasonally limited occupations, with the possible exception of the relatively strong seasonal indicator of small alcid abundance at sites 923T and 740T. Thus, while some aspects of seasonal resource harvesting may contribute to local variability, we suggest that seasonality is neither the sole nor even the predominant factor contributing to the variability evident in assemblages from Haida Gwaii throughout much of the late Holocene. As outlined below, however, seasonality likely increased in the late pre-contact and early European contact period.

Collectively, the faunal data outlined in this article suggest that, with few exceptions, faunal assemblages in late Holocene Haida Gwaii are highly correlated with resource availability and ecology on a very local level, a pattern that has also increasingly been recognized elsewhere on the NWC (Calvert 1980; Cannon, Yang, and Speller 2011; McMillan et al. 2008; Moss 2012). People were focusing on the resources that were available in their immediate local environments. This is not meant to suggest that some sort of environmental determinism was at work. The faunal assemblages detailed here are not simple reflections of the vertebrate and invertebrate life present in the surrounding environments; rather, these patterns result from the daily practices and decisions of the occupants of these sites, with greater or lesser emphasis placed on available resources due to culturally prescribed notions of value or food preference and notions of sustainable or respectful use of the environment (Haida Marine Traditional Knowledge Study Participants 2011; Turner, Ignace, and Ignace 2000; cf. Cannon 1998). While we do not doubt that such daily practices were influential, however, the nature and coarseness of our archaeological data do not allow such issues to be directly interpreted.

More directly evident from our data is the fact that late Holocene subsistence practices in Haida Gwaii were limited by resource availability within relatively tight catchment areas around village locations. This implies that some cultural norms or decisions about territory, resource ownership, and landscape use must have been in place in Haida Gwaii throughout the late Holocene and that these behaviours were at least partly responsible for creating such an extremely local focus of resource harvesting. The diversity and productivity of environments within small catchments, or site exploitation territories (Bailey and Davidson 1983), facilitated an abundant and diverse faunal resource base accessible from these small, dispersed settlements, particularly given the ease with which resources could be transported using canoes (Ames 2002). The local variability evident in the faunal data presented here suggests that there was little overlap between the resource extraction territories of these varied late-Holocene villages, a pattern very similar to that described by Calvert (1980) for Hesquiat Harbour. This may well have formed the basis for more formally defined territories, with access to resources restricted and controlled, as described in ethnographic accounts (e.g., Curtis 1916; Haida Marine Traditional Knowledge Study Participants 2011). While the archaeological data presented here may well record the existence of such a pattern throughout the late Holocene, a more detailed consideration of the presence, nature, and temporal depth of territorial behaviour in Haida Gwaii is beyond the scope of this article. Regardless, the data from Haida Gwaii suggest that the occupants of the region were focusing on a wide range of potential resources and were using those resources in variable quantities depending on their particular local environments. Broadly, this patterning fits well with previous discussions that point to the tendency for maritime hunter-gatherers to draw on diverse but abundant and predictable coastal resources from sedentary or semi-sedentary central places in small, territorially controlled home ranges (e.g., Borrero and Barbarena 2006; Dyson-Hudson and Smith 1978).

It is also clear, however, that these patterns were not static throughout the late Holocene in Haida Gwaii. As discussed elsewhere (Orchard 2009; Orchard and Clark 2005, 2014; Wigen 1990), salmon harvesting appears to have increased, at least in southern Haida Gwaii, after 1200 BP. A precise consideration of the causes of this changing focus on salmon resources through the late Holocene is not possible given currently available information, but it undoubtedly involved a "complex interrelationship between subsistence, social organization, technology, economic organization, and broader patterns in population and environment" (Orchard 2011b, 121). Given this patterning in southern Haida Gwaii it is striking that

GaUa-18 on northern Graham Island shows the opposite pattern. This may suggest that variations in salmon use and/or abundance were far more localized, though additional samples from northern Haida Gwaii are necessary to better test this.

Perhaps the most drastic temporal changes in local resource harvesting patterns during the late Holocene are those evident in a comparison of the large village site of 699T to the more localized patterns evident at the other, predominantly pre-contact sites considered here. Site 699T represents the product of a process of amalgamation of small, dispersed villages into larger, more centralized villages, a process that began in the late pre-contact period and accelerated during the early European contact period (Acheson 1985, 1998, 2005). A result of this process of amalgamation was a widening of catchment areas, resulting in the faunal patterns discussed above. The immediate local environments surrounding sites such as 699T were no longer sufficient to support a population that was now four or five times larger than was present in the smaller, dispersed villages that predominated throughout the preceding late Holocene period. We suggest that the simplest means of dealing with such a situation was for the occupants of the large villages (i.e., 699T) to re-disperse seasonally, or through shorter-term logistical forays, to the localities that they and their ancestors had used for generations – locations highlighted by the smaller, dispersed, late Holocene and/or post-contact village sites (e.g., 1134T) (see Haida Marine Traditional Knowledge Study Participants 2011). Such a pattern of seasonal dispersal would explain, for example, the wide range of rockfish stable isotope values from 699T, which represent a range of ecological conditions; the presence of significant quantities of herring in the 699T assemblage, despite the lack of historically observed herring spawning activity in the vicinity of the site; and even the broader foraging radius recorded in sea otter isotopes from the site. This implies that the distinct pattern of seasonal movement described in ethnographic sources may have arisen largely in late pre-contact and early contact periods and that this may relate to the establishment of defined territories or concepts of resource ownership. Curtis (1916, 131), for example, indicates that "the Haida occupied their permanent villages throughout the winter, and in spring moved into scattered camps on the small islands and along the coast of the larger ones. *These locations were the inherited property of the families that occupied them*" (emphasis added; see also Haida Marine Traditional Knowledge Study Participants 2011). Notably, a very similar late Holocene pattern of amalgamation of smaller local groups and the rise of a more structured seasonal pattern of movement has been identified on the west coast of Vancouver Island (McMillan 2009; McMillan et al. 2008).

CONCLUSIONS AND PROSPECTS FOR FUTURE WORK

The detailed synthesis and analysis of late Holocene zooarchaeological data from Haida Gwaii presented here reveals a pre-European contact pattern of small, dispersed settlements that focused on a variable array of local subsistence pursuits deriving from their particular historical and ecological circumstances. In the late pre-contact and early European contact periods these data further highlight a shift to larger, centralized, amalgamated villages drawing resources from wider, regional catchment areas facilitated by increased seasonal mobility. Significantly, these suggestions are not new but, rather, fit very well within a range of previous archaeological, oral historical, and ethnographic sources that clearly highlight aspects of these demographic, cultural, and economic shifts within the late Holocene in Haida Gwaii (e.g., Acheson 1985, 1998, 2005; Swanton 1905).

This view of the locally variable subsistence economies of late Holocene Haida Gwaii stands in stark contrast to broad, general, homogenizing coastwide models that have often dominated discussions of subsistence and cultural development in coastal British Columbia. As this article demonstrates, even with the increasing data compiled in recent years the creation of regional models of Northwest Coast subsistence is at best premature, and, more likely, such models are completely incapable of explaining the range of variability now evident across the culture area. Rather, these data are better suited to the consideration of limited, localized patterns of subsistence that take into consideration variability resulting from a combination of local ecological conditions and locally variable historical developments. These insights highlight the need to further explore local variability in other areas of Haida Gwaii, elsewhere in coastal British Columbia, and globally. Fortunately, such approaches are increasingly being applied in various parts of the coast (Calvert 1980; Cannon 2001; Cannon, Yang, and Speller 2011; McMillan et al. 2008; Moss 2012), and this growing body of research contributes to wider global discussions of local variability in subsistence focus among groups of otherwise culturally related hunter-fisher-gatherers (e.g., Betts 2005; Hodgetts 2010). Ultimately, as well grounded, locally focused datasets and models are created, a picture of trends or differences across larger regions will arise. For example, though local subsistence adaptations are highly variable, we echo previous researchers (e.g., Cannon 2001; McMillan et al. 2008; Monks 2006) in seeing a general dichotomy for coastal British Columbia between areas on the inner mainland coast near large salmon rivers (Salish Sea, Central Coast/Namu, Prince Rupert Harbour) and areas on the outer insular coast without such resources, of which Haida Gwaii is a key example.

We would also add that many of the faunal data outlined here demonstrate long-term consistency in the behaviours and geographic patterning of a range of species of past and contemporary economic and ecological importance. This highlights the utility of such data as a baseline for modern resource management (e.g., Erlandson and Rick 2010; McKechnie 2007; McKechnie et al. 2014). Finally, our research demonstrates the value of incorporating isotopic techniques into zooarchaeological analyses. We are continuing to expand the scope of our isotopic analysis and hope, for example, to have similar data and insights for prominent invertebrate taxa from these sites in the near future.

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