Five Thousand Years of Fishing at a Shell Midden in the Broken Group Islands, Barkley Sound, British Columbia

by

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Abstract

This thesis critically examines the archaeological history of fishing at a five thousand year-old shell midden on the southwest coast of Vancouver Island. To do this, I use fish bones identified from Ts'ishaa (DfSi 16 and 17), a large ethnographically identified Nuu-chah-nulth village, to describe the taxonomic composition of marine fish recovered from spatially and temporally distinct areas of the site. After evaluating the depositional and taphonomic history of the assemblage, I examine evidence of fishing at a variety of spatial and temporal scales. I identify periods of change and continuity in the use of abundant and ubiquitous fish taxa throughout the site and conclude that similarities between contemporaneous deposits demonstrate the existence of community-wide fishing practices. I then characterize changes observed in the archaeological record by linking them to community-level changes in the use of the site at different points in time.

This thesis is dedicated

to

Mary Forbes and Ewen McKechnie

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All the mistakes are mine. Happy reading.

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Chapter One: Introduction

In the historic era, Northwest Coast peoples had elaborate systems of collecting, processing, and redistributing marine foods (e.g., Suttles 1987; Drucker 1951, 1965; Sapir and Swadesh 1955). These aboriginal societies were stratified, meaning that territorial ownership, differential access to wealth and status, and entrenched hereditary inequality were basic features of life (Ames 2003; Arnold 1996; Donald 1997). A great deal of archaeological research in the region has focused on 'detecting' the emergence and development of these aspects of social organization, much of it involving studying peoples' economic use of marine resources in the prehistoric past (e.g., Ames 1998; Burley 1980; C. Carlson 2003; Croes and Hackenberger 1988; Cannon 1991; 2002; Monks 1987; Matson 1992; Matson and Coupland 1995). Archaeological investigations of shell midden deposits have contributed greatly to these studies because these sites typically contain (*I*) a long temporal record, (*II*) an abundance of preserved marine resources (bones and shells), and (*III*) are associated with the aggregated village communities encountered by European explorers during the early contact period (ca. 1774-1805 AD).

As archaeological deposits, shell middens have often proven difficult to interpret and relate to the complex social dynamics observed during the historic period. This is due in part to the massive area, depth, and volume of these deposits, often requiring immense logistical effort simply to excavate one area of one site (e.g., Dewhirst 1980). The considerable stratigraphic complexity of shell middens further complicates the identification of structures and depositional contexts, particularly if they are not visible from the surface (e.g., Stein 1992; Waselkov 1987). Similarly, aerial excavation of horizontal surfaces allows for a detailed picture of specific deposits but is time intensive and difficult to replicate in multiple areas of a site (e.g., Matson 2003).

A central and defining feature of shell midden deposits is that much of the 'sediment' consists of a distinctive matrix containing an abundance of food waste (animal bones, shells, fire altered rock). During conventional excavation, the sheer number and ubiquity of these materials, particularly fish bones and shells, often precludes the detailed study of their occurrence. The labour intensive analysis of vertebrate faunal material that does get recovered tends to be focused on larger skeletal elements (e.g., >6mm), in spite of the fact that the most abundant and ubiquitous skeletal remains are typically small fish bones (e.g., Calvert 1980; Huelsbeck 1994; Wigen and Stucki 1988).

For the coast as a whole, zooarchaeological studies have tended to focus on identifying temporal changes in the use of marine resources (e.g., Cannon 1991; Wigen and Stucki 1988; Matson 1992). The prevailing research strategy is to lump faunal remains from spatially and temporally distinct deposits into assemblages that correspond to cultural historical sequences (e.g., Croes and Hackenberger 1988; Mitchell 1988). Much less attention has been given to demonstrating how this change occurs at the regional scale (Cannon 2000, 2003). Even less common are studies of the variability in the use of resources within different areas of a single site (e.g., Coupland et al. 2003; Huelsbeck 1994; Trost 2005) but even these approaches are not well suited to describing temporal change.

Thus, although the archaeology of shell middens has contributed greatly to the knowledge of human prehistory on the Northwest Coast, it is still the case that relatively little is known about the complex depositional and taphonomic processes involved in the production of these cultural deposits (e.g., Stein 1992). That is, how do small scale depositional events collectively relate to broad scale trends and patterns within a site?

Given that marine resources are the most numerous and ubiquitous constituent encountered in these sites, the detailed study of these remains is fundamental to understanding the larger picture of change over time and space at the scale of the household, the site, and the region.

In this thesis I examine a focal aspect of the archaeological record (fish bones) at a large shell midden on the southwest coast of Vancouver Island. This particular site was once the location of a major Nuu-chah-nulth village and is where the Tseshaht First Nation came into being (Golla 2000; McMillan and St. Claire 2005; Sapir and Swadesh 1955). Fish at this site represent an overwhelming majority of the vertebrate faunal remains, indicating that the people who lived in this ancient community did a lot of fishing and did it over an extraordinarily long period of time (5000 years). The objective of the research described in this thesis is to examine how evidence of fishing is expressed in this archaeological context and to examine how it changes over time. I approach this topic by asking four related questions (Table 1).

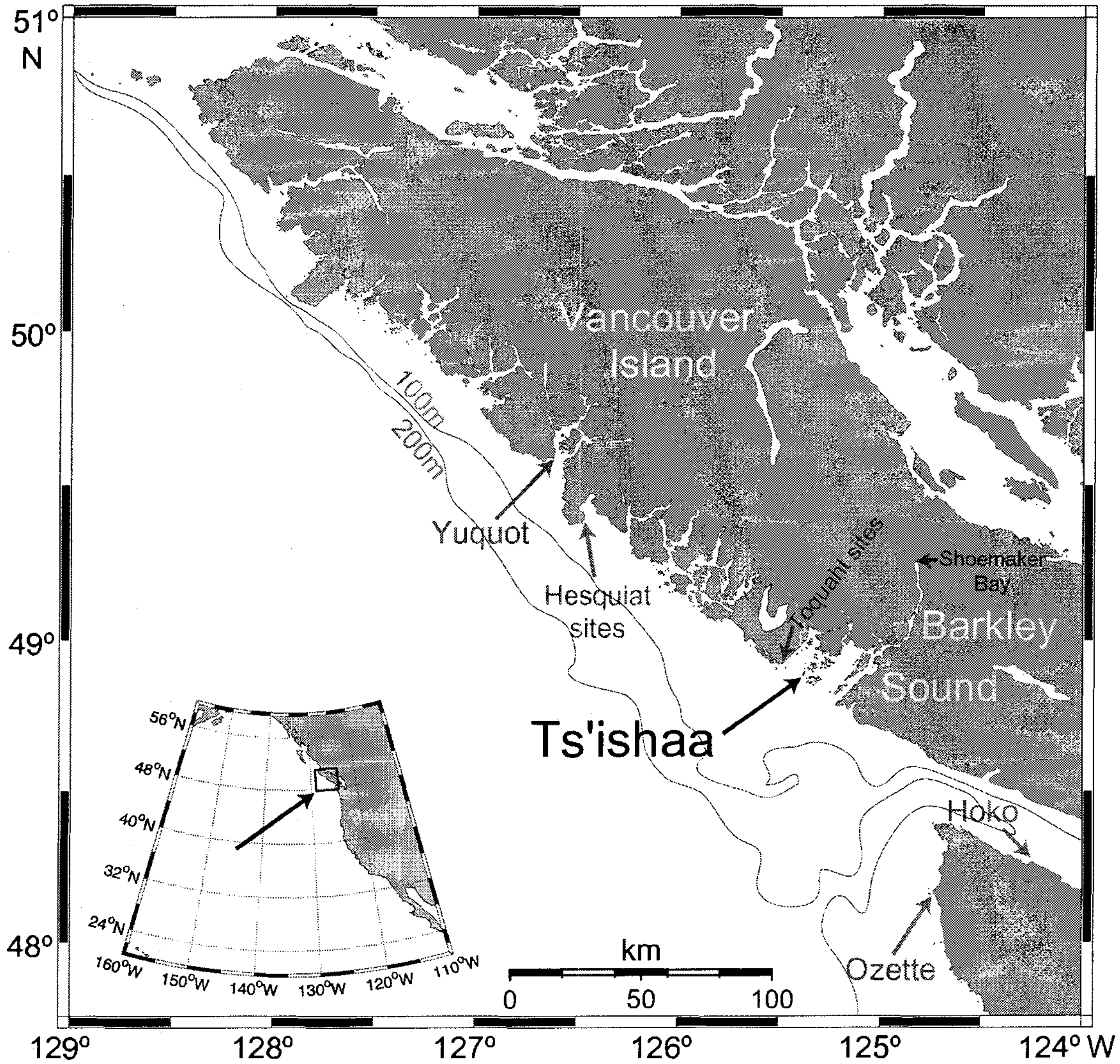
Table 1. Research questions and methods.

Research questions	**Specific questions**	**Sources of data**	**Methods**
How is evidence of fishing expressed at a large shell midden on the outer Northwest coast?	Are there certain species that dominate the assemblage? Is this similar throughout the site? Does this appear to be affected by taphonomy, sampling, etc.?	Fish remains recovered in multiple deposits; from small volumes of fine-screened matrix (3mm) and from larger volumes of 'coarse' screened matrix (≥6mm).	Examine the taxonomic composition (%NISP) and density (NISP/litre) of the fish assemblage at multiple spatial and temporal scales (whole site-> excavation unit -> individual level, Chpt 2).
How is temporal change in fishing expressed at a large shell midden on the outer Northwest coast?	Are similar temporal trends in fish use occurring in separate but contemporaneous areas of the site? Is this occurring at multiple temporal scales?	Same as above but categorize the assemblage into spatially distinct but contemporaneous deposits (chronologically overlapping 14C dates, appendix A).	Examine the abundance and density of the six most abundant fish in individual level assemblages from temporally distinct areas of the site (Chpt 3).
What is the cultural significance of prehistoric changes in fishing practices?	With respect to fishing: What are people 'doing' on a regular basis? How did that 'change' over time?	Combination of archaeological data about fishing (Chpt 2 and 3) and ethnographic knowledge about community organization (Chpt 1).	Describe evidence of prehistoric fishing practices in the context of how peoples use of resources changed over long periods of time (Chpt 3 and 4).
What are the cultural and ecological consequences underlying widespread trends in fishing?	Are there different strategies and consequences of fishing in a highly circumscribed social landscape? Are these responsible for widespread patterning?	Prehistoric evidence of fishing (particularly measurements of rockfish and greenling) in the context of ethnographic knowledge of territoriality and resource ownership.	Determine if there is a detectable impact on important nearshore fish populations (reduced abundance, size) which are vulnerable to human overexploitation (Chpt 3 and 4).

These sequential questions address the use of fish in time and space by the people who inhabited this one location over five thousand years. Providing answers to these questions is possible because excavation and faunal analysis at this site was conducted in several spatially distinct areas and involved both fine-screen (<6mm) and conventional (Δ6mm) faunal recovery (McMillan and St. Claire 2005). An extensive radiocarbon chronology associated with deposits containing identified fauna allows for the determination of contemporaneous deposits (Appendix A). Collectively, these qualities provide a context for evaluating periods of change and continuity in fishing practices at multiple spatial and temporal scales (e.g., the site as a whole, individual deposits, individual excavation levels).

In the remainder of this chapter, I review the environmental, cultural, and archaeological context of my study. In particular, I focus on how Nuu-chah-nulth communities in the early historic period (ca. 1774-1860) were organized and how this relates to the archaeological record of the use of fish at Ts'ishaa. I conclude by briefly describing the explanatory structure of the following chapters.

Figure 1. General location of the Ts'ishaa village site and other excavated archaeological sites in the region. Image obtained and modified from freeware developed by Paul Wessel and Walter Smith (http://gmt.soest.hawaii.edu/).



Environmental Context

The archaeological site of Ts'ishaa is situated on a 43 acre (17.4 ha) island on the western periphery of the Broken Group Islands in the midst of Barkley Sound–a large coastal embayment (Figure 1). A large variety of marine fish species inhabit this area (Table 2), many of which would have been readily accessible from within the immediate vicinity of the site (<1km). Kelp beds in high-relief rocky substrate are a common occurrence in the more exposed areas and are ideal habitat for a variety of nearshore reef fish. In areas containing sediment substrate, smaller species of flatfish are common. Larger species such as halibut, pacific cod, and sablefish are typically found further offshore (Table 2).

Travelling by boat northwards and eastwards from the site, one encounters the relatively shallow (<50m) channels and passes characterizing the many small islands of the Broken Group (Figure 2). While this area is still exposed to powerful tidal currents, it is quite protected from the open ocean swells that occur persistently during winter (Figure 3). Extensive areas of exposed bedrock fringe the islands at low tide and characterize the high relief rocky substrate of the ocean floor in this area. Interspersed with kelp forests and rock reefs, this is ideal habitat for the many species of nearshore reef fish (Lee and Bourne 1977; Tomasik and Holmes 2003).

Figure 2. The Broken Group Islands looking east into Barkley Sound. Ts'ishaa (Benson Island) is off the frame to lower left. Photo courtesy of the Royal British Columbia Museum (PN17844-15A). Used with permission.

As one travels southwest towards the open ocean, the numerous kelp beds and rocky outcrops that fringe the seaward side of the Broken Group give way to the deeper waters of the submerged continental shelf (~80-120m), known locally as La Perouse Bank. This expansive network of rocky reefs and sediment plains stretches more than 70km offshore and in summer is an area of concentrated marine biomass (Robinson 2000; Tanasichuck 2002).

Sources of Environmental Variability

Western Vancouver Island spans the latitudinal boundary between the two oceanic domains of the Eastern Pacific Ocean: (*I*) the sub-arctic Alaskan Gyre prevalent during winter and (*II*) the coastal up-welling domain of the California Current prevalent during summer (Thompson 1981). This means that there are pronounced seasonal changes in atmospheric and oceanographic conditions that have consequences for the marine ecosystem and the many species of fish that seasonally frequent or permanently inhabit these waters (Table 2).

Table 2. Seasonal abundance and habitat preferences for selected fish which are present at Ts'ishaa. ⊚ = nearshore (<80m depth); ⊖ = most prevalent offshore or in deep water (>80m depth); ⊙ = period of inshore spawning (increased abundance).

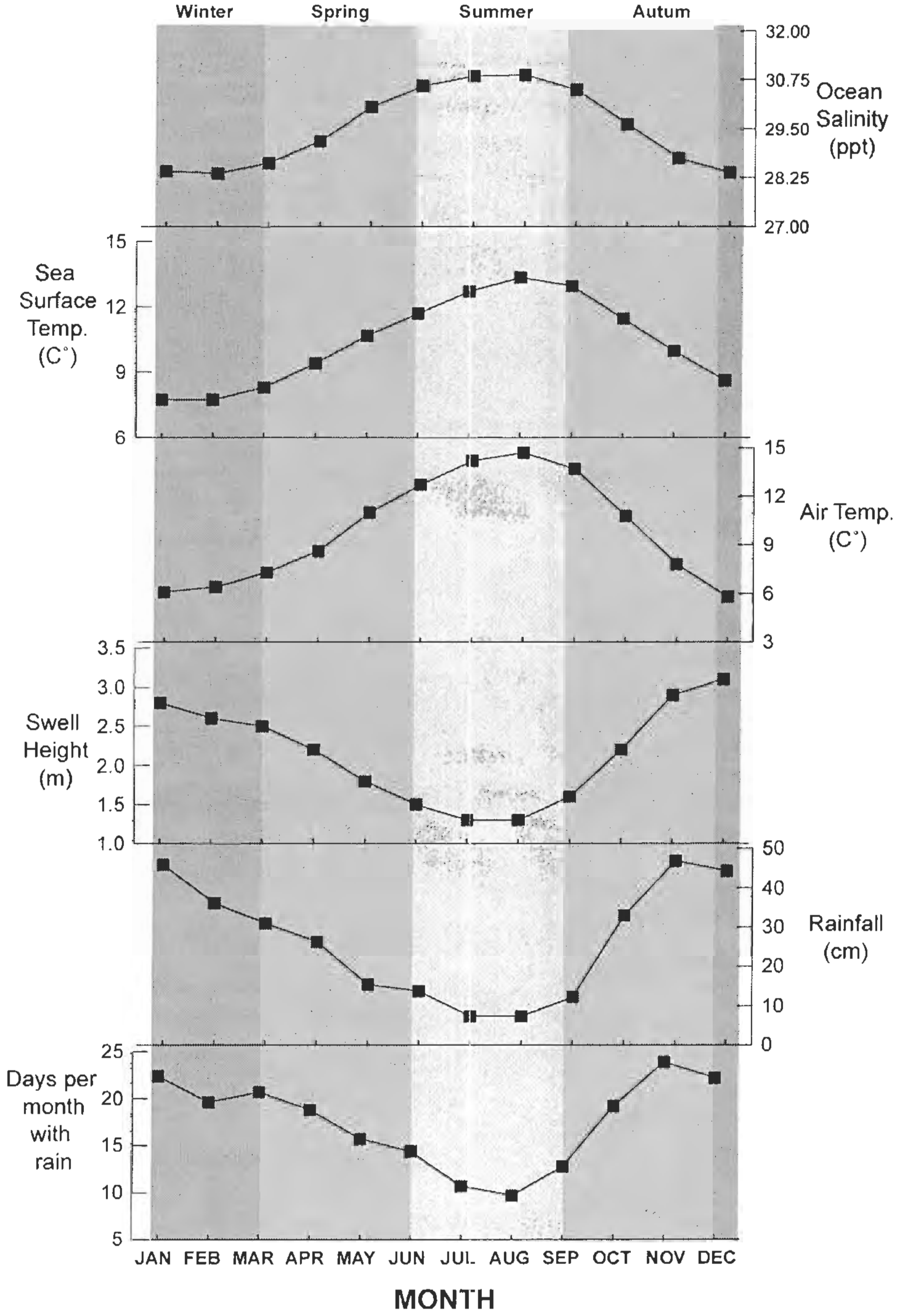
Habitat structure	Taxa	Season Winter	 Spring	 Summer	 Fall	Reference	Comments
Low relief sediment substrate	Petrale Sole	⊖	⊚	⊚	⊖	1, 22	juveniles occupy nearshore habitat
	Starry Flounder	⊚	⊚	⊚	⊚	1	generally found inshore
	Halibut	⊖	⊖	⊖	⊖	1, 23	spawn in deep water in winter
	Rock Sole	⊚	⊚	⊚	⊚	1	
	English Sole	⊚	⊙	⊚	⊚	1	generally found inshore
	Skate sp.	⊚	⊚	⊚	⊚	1	
	Ratfish	⊚	⊚	⊚	⊚	1	consumes shellfish
	Sculpin sp.	⊚	⊚	⊚	⊚	1, 17	prevalent in intertidal habitat
	Plainfin Midshipman	⊚	⊙	⊙	⊚	1, 17	most active at night
High relief rocky substrate	Rockfish sp.	⊚	⊚	⊚	⊚	1, 3, 6, 7, 8, 17	larger fish found in deeper water
	Greenling sp.	⊚	⊚	⊚	⊚	4, 5, 13, 17	
	Lingcod	⊙	⊚	⊚	⊚	1, 2, 17, 20	
	Perch sp.	⊚	⊚	⊚	⊚	1, 17	pile perch eat mussels
	Cabezon	⊚	⊙	⊚	⊚	1, 21	
	Pacific cod	⊙	⊙	⊖	⊖	1	prefers colder deeper water
	Sablefish	⊖	⊖	⊖	⊖	1, 14	juveniles occupy nearshore habitat
	Irish Lord sp.	⊚	⊙	⊚	⊚	1, 17	
Mid-water schooling fish	Herring	⊙	⊙	⊖	⊚	1, 11, 17	offshore in summer
	Anchovy		⊚	⊚		1, 24	present in warmer water
	Salmon sp.	⊚	⊚	⊚	⊙	1, 18	occupy nearshore prior to spawning
	Dogfish	⊚	⊚	⊖	⊚	1, 16, 17	aggregations offshore in summer
	Hake	⊖	⊚	⊖	⊖	15, 16	strong diel migrants
	Bluefin Tuna			⊚		12	follows prey into inlets in summer

1. Hart 1973; 2. King and Winchell 2002; 3. Johnson et al. 2003; 4. Dean et al. 2000; 5. Abookire et al. 2000; 6. Murie et al. 1993; 7. Matthews 1989; 8. Richards 1986; 9. Mackinson 1999; 10. Haelele and Hamey 1977; 11. Taylor 1969; 12. Crockford 1997; 13. Gomelyuk and Leunov 1999; 14. King et al. 2000; 15. Benson et al. 2002; 16. Tanasichuck et al. 1991; 17. Lee and Bourne 1977; 18. Mackas 1992; 19. Allen et al. 2001; 20. Cass et al. ; 21. O'Connel 1953; 22. Ketchen 1966; 23. Trumble 1993; 24. DFO 2002

In summer, persistent high pressure systems cause northwest winds to generate a equator-ward flow of north pacific water that collides with the continental shelf to generate nutrient and oxygen rich upwelling (Allen et al. 2001). This initiates a period of intense biological productivity sustaining massive quantities of diatoms, copepods and euphausiids (phyto and zoo plankton) from spring through fall that in turn provide food for large populations of pelagic fish (e.g., salmon, hake, herring, anchovy, dogfish) and sea mammals (whales, pinnipeds, and porpoises) (McFarlane et al 1997; Mackas et al.

1997; Robinson 2000; Robinson and Ware 1999). Although the bulk of biological productivity tends to be concentrated in the offshore environment, it also sweeps through the inner reaches of Barkley Sound and the Broken Group Islands (Smith et al. 2001). In winter, frequent storm systems lower the salinity of the nearshore waters and create pole-ward ocean currents, effectively lowering the overall biological productivity in the marine environment. However, this is also a period when vast herring populations begin to congregate in the inlets and more protected areas of the coast attracting an array of predators (e.g., humpback whales, pinnipeds, birds). From fall through spring, storm systems in the central North Pacific generate persistently large ocean swells, making boat travel on the outer coast difficult if not extremely hazardous, particularly when combined with a localized wind-storm.

Figure 3. Modern environmental data showing seasonal fluctuations in the marine environment in Barkley Sound. Data points represent monthly means at the Amphitrite Point Lighthouse (Ucluelet, B.C.) for the period between 1934-2003 (data obtained from Department of Fisheries and Oceans 2004a, used with permission) except for swell height data which represents the period between 1987-2002 at the Cape Elizabeth buoy (46041), 45 nautical miles west of Aberdeen, WA (data obtained from National Oceanic and Atmospheric Administration [USA] 2004, used with permission).



Paleo-climate and the Marine Ecosystem

While sources of environmental variability are seasonally present, longer-term changes in the marine ecosystem also affect the regional climate, including marine fish populations (Table 3). Interannual climatic anomalies such as ‘El Niño’ or ‘La Niña’ and various ‘multi-decadal’ climatic cycles have also been shown to affect marine fish populations in this region but the antiquity of these phenomena are poorly documented prior to the 20th century AD. Nevertheless, the recent expression of these physical and biological processes point to multiple sources and temporal scales of environmental variability in the past. Events of sufficiently long duration (millennial scale) are the most likely to be detectable in archaeological contexts and are listed in Table 3.

Table 3. Sources and scales of variability in the marine environment affecting fish populations in Barkley Sound. SST= sea surface temperature.

Time scale	Seasonal	Annual	Decadal	Millennial
Sources of environmental variability	Winter-cold SST, downwelling, less saline	El Niño: weak upwelling, higher winter SST, less primary productivity in the offshore environment (phyto/zoo-plankton).	Pacific Decadal Oscillation, Positive phase: weaker upwelling, lower primary production	Earthquakes and Tsunamis: rapid uplift, subsidence depending on location, gradual isostatic rise in sea level (3-4m), regional/global climate change.
	Summer-warmer SST, more up-welling, higher salinity	La Niña: strong upwelling, high primary productivity.	Negative phase: greater primary production, more upwelling	
Potential impact on fisheries	Presence/absence of migratory species	El Niño: Increased presence of warm-water species, increased Hake biomass and predation, negative effect on recruitment of resident species (herring, rockfish)	Positive phase: less salmon, rockfish, herring, more anchovy at this latitude.	Sea level: expanded inshore habitat, more area for nearshore fish and shellfish, Earthquakes and tsunamis: will have a immediate and highly localized impact on nearshore environments, destroying some fish habitat while expanding others, Changes in regional climate: should have a prolonged effect on fish populations.
		La Niña: positive effect on recruitment of resident species (subsequent year-classes), fewer warm water species (e.g., hake).	Negative phase: more salmon, rockfish, herring, less anchovy at this latitude.	
Predicted archaeological expression of fish remains	Difficult to observe given the temporal resolution of midden deposits unless seasonal use is repetitively practiced.	The anomalous and abundant presence of species associated with warm water, difficult to detect without better data on a suite of indicator species.	Abrupt but cyclical shifts in the abundance of ecologically important fish species (e.g., salmon, hake, herring, anchovy) .	Prolonged shifts in species composition occurring throughout the site, broad scale changes may facilitate but not 'cause' different human responses. Tsunami/ earthquake effect is probably negligible in the long term.
Biological references	Mackas 1992; McFarlane et al. 1997	Mackas et al. 1997, 2001; Tanasichuk 1997, 2002	Beamish et al. 2004; Benson et al. 2002; Chavez et al. 2003; Mantua et al. 1997; Mackas et al. 1998; Schweigert 1995; Patterson et al. 2004	Hebda 1995; Cumming et al. 2002; Finney et al. 2002; Tunnicliffe et al. 2001; Chang et al. 2003; Walker and Pellatt 2003
Archaeological / ethnographic references	Drucker 1951; Jewitt 1807; Sapir and Swadesh 1955; Koppert 1930; Sproat 1987	Jewitt 1807, Drucker 1951	Drucker 1951; Sandweiss et al. 2004 (Peru); cf. Jones et al. 1999 (Western US)	Cannon 1991, 1998, 2000; Hutchinson and McMillan 1997; McMillan and Hutchinson 2002; Losey 2005; Connolly 1992; Graham et al. 2003

Cultural Context

Nuu-chah-nulth territories

Historic accounts and archaeological evidence demonstrates that Nuu-chah-nulth people lived in villages dispersed along the coast during and before European contact (ca. A.D. 1774; Arima and Dewhirst 1990; Drucker 1951; Haggarty and Inglis 1985; Inglis and Haggarty 1986; Jewitt 1807; Koppert 1930; Mackie and Williamson 2003; Marshall 1993; McMillan 1999; Mozino 1970; Sproat 1987). Villages were coastal settlements with numerous large plank houses arrayed along the shoreline, where the majority of travel was conducted by dugout canoe. Hundreds of people occupied these villages and dozens of people would live in or be affiliated with each house (Marshall 2000). These expansive human settlements were sustained by the collective efforts of the inhabitants who obtained large quantities of food from the surrounding marine environment. Food would be transported (predominately by canoe) to these large settlements where it would be processed, consumed, and eventually discarded. Depending on the number of people living there, the amount of suitable land for house construction, and the length of time people occupied a particular location, large volumes of human refuse would accumulate at these sites to become 'shell middens'.

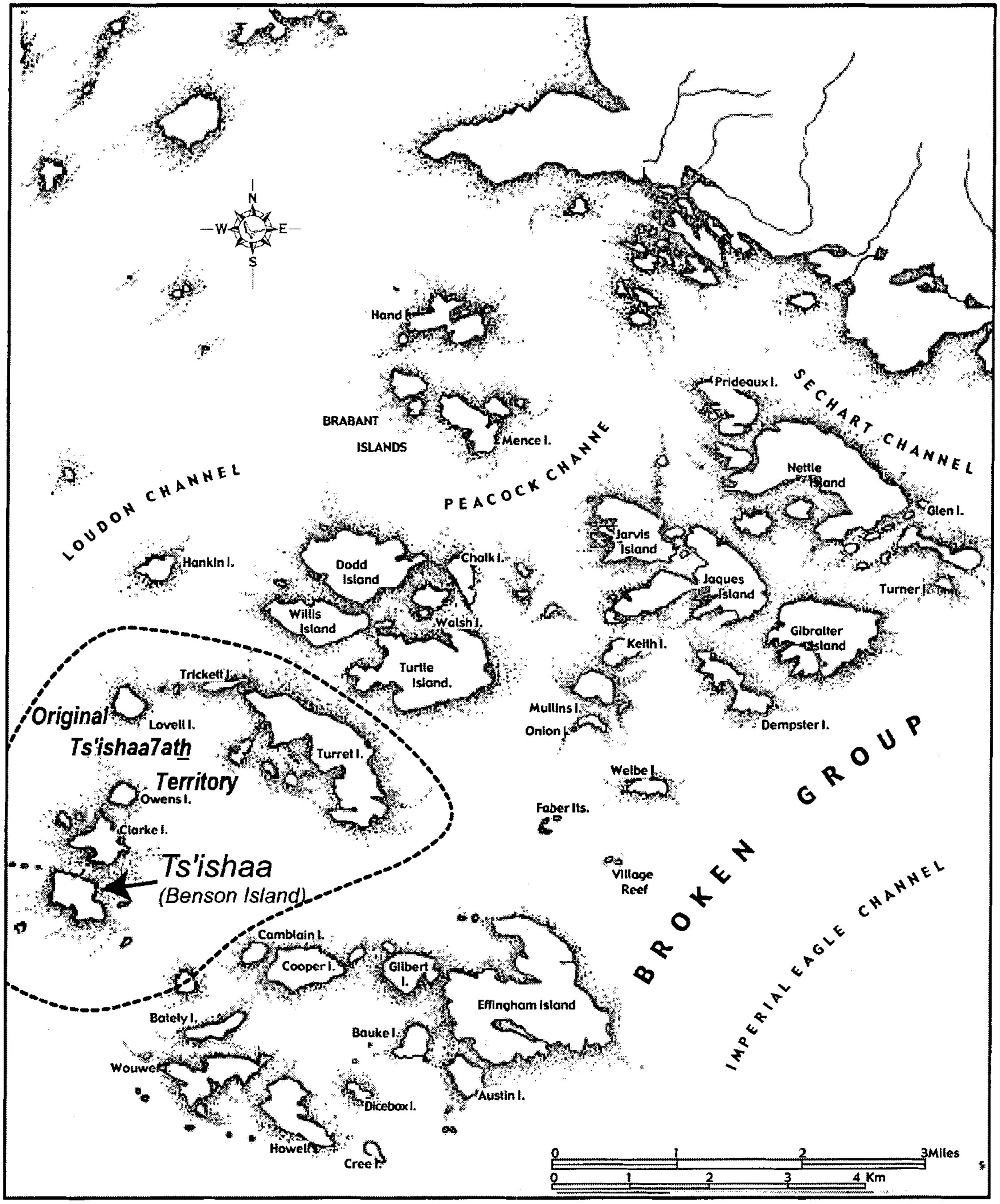
Barkley Sound, and the Broken Group Islands in particular, is a region where there is a particularly dense concentration of shell midden sites, many of which–due to their large size, age, and extent–have been interpreted as primary village locations (McMillan 1999; Haggarty and Inglis 1985:85). This impression of a crowded prehistoric landscape matches well with early historic and ethnographic accounts (ca. A.D. 1774-1805) that document the existence of at least four independent Nuu-chah-nulth local groups who occupied separate parts of the Broken Group Islands (McMillan and St. Claire 2005;

Sapir n.d.; St. Claire 1991, 1998). The territorial extent of the Tseshaht local group at contact was limited to the western portion of the Broken Group Islands (Figure 4).

The tightly spaced clusters of large shell midden sites provide evidence to suggest that the commonly attributed pattern of seasonal movement of Nuu-chah-nulth village settlement between inside and outside parts of the coast (Drucker 1951; Dewhirst 1980) was not the prevailing pattern in this region (St. Claire 1991). Rather, these settlements appear to have been occupied by independent groups that maintained a year-round presence on the outer coast (Haggarty and Inglis 1985; cf. Calvert 1980). At Ts'ishaa, this circumstance provided the most direct access to rich fishing and hunting grounds but it also notably lacked access to a salmon stream (McMillan and St. Claire 2005).

In Barkley Sound, as well as elsewhere on the Northwest Coast (e.g., Acheson 1998; Calvert 1980; Marshall 1993; Martindale 2003), the amalgamation and territorial expansion of local groups became widespread during and after the tumultuous period of early European contact (ca. A.D. 1774-1805) (Inglis and Haggarty 2000; St. Claire 1991). Access to resources such as salmon streams is one of the key motivating factors during this period of small scale warfare and territorial expansion (McMillan 1999; St. Claire 1991).

Figure 4. Map of the Broken Group Islands showing the ethnographic territory (after St. Claire 1991) of the Tseshaht (Ts'ishaa7th) local group at the time of European contact (adapted from McMillan and St. Claire 2005, used with permission).



Nuu-chah-nulth resource use

Drucker (1951:220) has famously described the structure of Nuu-chah-nulth communities:

> The fundamental Nootka [Nuu-chah-nulth] political unit was a local group centering in a family of chiefs who owned territorial rights, houses, and various other privileges. Such a group bore a name, usually that of their 'place' (a site at their fishing ground where they 'belonged'), or sometimes that of a chief; and had a tradition, firmly believed, of descent from a common ancestor.

This definition adequately summarizes the ethnographic accounts of the origin and emergence of the Tseshaht local group. Long ago at Ts'ishaa, Kapkimyis, the brother or son of Kwatyat, the transformer/creator of Barkley Sound, created the first Tseshaht woman and man and their descendants multiplied until "the tribe became numerous, reaching to the other end of the village on Hawkins [Benson] Island" (Sapir and Swadesh 1955:53; *see also* Golla 2000:138-139; St. Claire 1998:8). This oral narrative recounts how the Tseshaht people came to occupy this settlement and how their descendants inherited the privileges associated with the use and occupation of the territory surrounding this village (McMillan and St. Claire 2005).

The strongly emphasized connection between place, community, and lineage history is a widely shared aspect of Nuu-chah-nulth identity (Atleo 2004; George 2003; Marshall 1993; McMillan 1999). A critical point of articulation between these concepts is the practice of 'using' the landscape of a group's territory. Thus, in the case of the Tseshaht origin narrative, Kapkimyis sequentially itemizes 87 different types of animal foods and 29 different plant foods that occur within the Tseshaht territory, telling the first people "there will be this much to eat" (Golla 2000:139). From the high-stakes act of hunting whales and towing the carcass back to the village, to the repetitive labour of gathering and processing shellfish on specific rocky outcrops, the practice of obtaining food was critically linked to an intimately known physical and social landscape (McMillan 1999). Likewise, the territorial local group was an important social formation that was based in part on the rights to harvest resources in particular locales (Drucker 1951; McMillan 1999). Both ethnographic and archaeological evidence indicates that this form of social organization appears to have an extensive history in the Nuu-chah-nulth culture area (Calvert 1980; Inglis and Haggarty 2000; Marshall 1993; McMillan 1999; St. Claire 1991).

From ethnographic accounts, we know that people in these communities depended heavily on fish as a regular source of food (Folan 1984; Drucker 1951; Sproat 1987). Larger predatory fish tended to be caught by hook and line while smaller inshore (<1km) and schooling fish were captured by mass harvesting using dip-nets, weirs and fish traps (Table 4). Collection and distribution of fish resources was overseen by chiefs who controlled and managed access to fishing grounds and also were entitled to a portion of the catch, much of which could be used as form of wealth distributed at feasts, potlatches, and naming ceremonies (Sapir and Swadesh 1955:30). Eating food was a decidedly public activity (Drucker 1951:338). In a village and household setting, meals were always shared and feasts were held on regular occasion. Much of the processing and storage of food occurred in household contexts.

Fishing is the most commonly mentioned subsistence activity described in John Jewitt's (1807) Yuquot journal. However, aside from a few specific taxa (e.g., herring, salmon, "cod fish") Jewitt does not specify the full range of fish species consumed by the inhabitants of the village. Similarly, ethnographic descriptions of Nuu-chah-nulth fishing tend to focus on particularly large or abundant taxa such as salmon, halibut, and herring (e.g., Koppert 1930; Drucker 1951; Sproat 1987) while neglecting to mention the many other fish taxa present in the region consumed by Nuu-chah-nulth people.

Table 4. Ethnographically described methods of capture for the fish species present in the midden deposits at Ts'ishaa. ⊙= Mentioned directly, ◎= not mentioned directly but inferred due to habitat preferences. Compiled from Arima and Dewhirst 1990, Drucker 1951, Koppert 1930, Sapir and Swadesh 1955, Mozino 1970, Sproat 1987, Swan 1967, and White 2003.

			Method of capture							
Habitat	Species name	Common name	Net	Rake	Basket trap	Stone fish trap	Hook and line	Harpoon / leister	Spinner lure	Max length (cm)[a]
Low relief sediment substrate	*Eopsetta jordani*	Petrale Sole					⊙			70
	Platichthys stellatus	Starry flounder					⊙			91
	Hippoglossus stenolepis	Halibut					⊙			267
	Lepidosetta sp.	Rock Sole					⊙	⊙		60
	Parophrys vetulus	English Sole					◎	◎		57
	Hydrolagus colliei	Ratfish					⊙			97
	cf. Raja sp.	Skate sp.						⊙		146
	Cottidae	Sculpin sp.			◎	◎	⊙			30
	Porichthys notatus	Plainfin Midshipman			◎	◎	⊙			38
High relief rocky substrate	*Sebastes sp.*	Rockfish sp.			⊙		⊙		⊙	97
	Hexagammos sp.	Greenling sp.			◎	◎	⊙			61
	Ophiodon elongates	Lingcod					⊙		⊙	152
	Embiotocidae	Perch sp.			⊙	⊙	⊙			44
	Scorpaenichthys marmoratus	Cabezon					◎			76
	Anoplopoma fimbria	Sablefish					⊙		⊙	100
	Gadus macrocephalus	Pacific Cod					⊙		⊙	100
	Hemilepidotus sp.	Irish Lord sp.			◎	◎	◎			51
Mid-water schooling fish	*Clupea pallasi*	Pacific Herring	⊙	⊙		⊙				33
	Engraulis mordax	Northern Anchovy	◎	◎						19
	Oncorhynchus sp.	Salmon sp.					⊙	⊙		147
	Squalus acanthias	Dogfish Shark	⊙				⊙	⊙		130
	Merluccius productus	Pacific Hake					◎			91
	Thunnus thynnus	Bluefin Tuna						⊙		250

[a] Compiled from Hart 1973.

Titleholders, commoners and slaves

Early in the historic era (ca. 1774-1860), people who lived in Nuu-chah-nulth villages belonged to one of three social categories – chiefs or titleholders, commoners, and slaves (Donald 1997; Drucker 1939, 1951; McMillan 1999; Wike 1958). Drucker (1951:247) describes the distinction between chiefs and commoners as:

> Whatever authority a chief had derived... from the various rights he had inherited. The head chiefs, the "real chiefs," were those who held the most, the lower chiefs, those who owned less, and the commoners were simply people who possessed none at all. The Nootkans [Nuu-chah-nulth] carried the concept of ownership to an incredible extreme. Not only rivers and fishing places close at hand, but the waters of the sea for miles offshore, the land, the houses, carvings on a house post, the right to marry in a certain way or the right to omit part of an ordinary marriage ceremony, names, songs, dances, medicines, and rituals, all were privately owned property.

Chiefs were individuals who could legitimise their positions of power by demonstrating their relationship to individuals who previously held and bestowed upon them specific privileges. 'Ownership' and 'property' in this context refers to the ability to formally sanction other people's actions and have others recognize and conform to these expressions of authority. It also means that chiefs were 'entitled' to certain protocol and privileges, such as demanding a portion of resources harvested from a particular territory or granting approval for a new house to be built. Chiefs came to assume positions of power formally and publicly, but their authority was ultimately recognized by the community at large (Marshall 2000).

Commoners were those who did not have individual privileges attached to their name. Thus, commoners were "granted rights" to participate in certain activities by titleholders (Donald 1997:276). Because of the fluid nature of inter-group relations and the political dynamics of leadership strategies, commoners had the ability to choose to affiliate themselves with particular houses and chiefs (Marshall 1989, 2000).

Slaves on the other hand, were individuals (typically captives taken in warfare) who were 'owned' by titleholders and whose lives were ultimately subject to the control of other individuals (Donald 1997). Slaves were forced to contribute labour and perform tasks for titleholders and the community at large. Titleholders used this labour to enhance their own economic wealth and social prestige. Slaves contributed to routine tasks in a village such as collecting firewood, fishing, and preparing food (Donald 1997:126-128). A key feature of being a slave was the absence of kin-based identity within a group. Once removed from their network of social and kin-based relations, slaves became people without history and were regarded as having no status.

In the historic era, membership in one of these social classes constrained the types of subsistence activities in which one could participate. Chiefs and titleholders tended to be those who hunted whales and other sea mammals, whereas fishing was something that was mostly conducted by commoners and slaves (Donald 1997:276). The ritual preparation required in order to participate in certain subsistence activities also differed according to the prestige associated with successfully obtaining certain animals. For example, whaling and sea mammal hunting required a great deal of fasting and ritual observance beforehand, whereas nearshore fishing and collecting shellfish did not (Drucker 1951:33-61).

Archaeological Context

Archaeology in the region

Archaeological research in Nuu-chah-nulth territory on the west coast of Vancouver Island has demonstrated the existence of an extensive record of human occupation spanning the past 5000 years before present[1] but the overwhelming majority of sites appear to date to the past 2000 years (reviewed in McMillan 1999). Much of archaeological work in this area has focused on site survey conducted in proximity to the modern shoreline where large shell midden deposits constitute the predominant site type (Arcas 1989; Haggarty and Inglis 1985; Mackie 1983; Mackie and Williamson 2003; Marshall 1993; McMillan and St. Claire 1982). Mackie (2001:47) notes the presence of 576 known shell midden sites between Point Owen (opposite Port Renfrew) and Kyuquot Channel, a straight line distance of 250km. In contrast, extensive excavation and subsequent analysis has only been conducted at relatively small number of large shell middens identifiable as village sites (Dewhirst 1980; Calvert 1980; Haggarty 1982; McMillan 1969, 1999; McMillan and St. Claire 2005).

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[1] All chronological ages (including calibrated ^{14}C dates) described in this thesis refer to years before present (cal yr BP), where according to international convention, the 'present' is A.D. 1950 (Reimer et al. 2004).

Researchers have discussed the antiquity of several aspects of prehistoric subsistence, most notably whaling (Fournier and Dewhirst 1980; Marshall 1989; Monks 2003; Monks et al. 2001), sea mammal hunting (Dewhirst 1979; Calvert 1980; Crockford et al. 2002; McMillan, 1999), and the capture of enormous (2m+) Bluefin Tuna (*Thunnus thynunus*) which is found at several sites on the west coast of the island (Calvert 1980; Crockford 1997; McMillan 1979). A common element of these studies is the strong correspondence between activities conducted at contact and those which are present in the archaeological record (McMillan 1999).

Despite the rich record of prehistoric resource use at sites on western Vancouver Island, zooarchaeological identification and quantification of all classes of faunal remains (birds, mammals, fish, and shellfish) have been conducted for only three sites in Hesquiat Harbour (Calvert 1980), the Shoemaker Bay site on the inner coast near Port Alberni (Calvert and Crockford 1982), and the Ts'ishaa village site discussed in this thesis (Frederick and Crockford 2005, Sumpter 2005). Calvert's (1980) work at Hesquiat Harbour has had a broad impact on the understanding of the persistence of local group territories and resource use throughout the coast (e.g., Inglis and Haggarty 2000; Matson 1983; Huelsbeck 1988; Ames and Maschner 1999).

On the Olympic Peninsula in nearby Washington state (USA), extensive studies have been conducted on fauna from the Ozette site (DePuydt 1994; Fiskin 1994; Etnier 2002; Huelsbeck 1988, 1994; Huelsbeck and Wessen 1994; Wessen 1988) and the Hoko River rock-shelter (Croes and Hackenberger 1988; Wigen 2005; Wigen and Stucki 1988) (Figure 1).

Archaeology at Ts'ishaa

The data presented in this thesis come from archaeological excavations at a Nuu-chah-nulth village in what is now Pacific Rim National Park Reserve in Barkley Sound, British Columbia. It was collected during a collaborative archaeological research project funded by the Tseshaht First Nation and Parks Canada which was initiated and directed by archaeologists Alan McMillan (Simon Fraser University and Douglas College) and Denis St. Claire (Coast Heritage Consulting). Extensive excavation, conducted during the summers of 1999-2001, explored some 219m^3 of prehistoric deposit dispersed throughout several areas of this large shell midden (McMillan and St. Claire 2005).

Thirty-nine radiocarbon dates obtained from throughout the cultural deposits demonstrate an effectively continuous human presence over the past five thousand years (Figure 6). While deposits dating to the interval between ca. 2000-3000 cal yr BP are absent from the project excavations, a previously conducted auger survey in a separate area of the site demonstrated the existence of cultural deposits dating to between 2130-2350 cal yr BP (2 sigma range, CAMS-28075, Sumpter et al. 1997). The examined cultural deposits in the site as a whole can be broadly categorized into two spatially and temporally distinct deposits: 1) the main village midden (ca. 250-1800 cal yr BP), and 2) the back terrace midden (ca. 3000-5000 cal yr BP)(Figure 5).

Excavations at Ts'ishaa initially focused on the areas in the main village which were named locations of lineage households identified in ethnographic descriptions of the village (i.e., Golla 2000; Sapir n.d.; St. Claire 1991). Each of these lineage households was ranked with the highest status household (Ts'ishaa7atẖ) located in the middle of the village while the lowest status household (Himayisatẖ) occurring in a physically separate but contemporaneously occupied area of the main village midden (Figure 5). Because it is physically separate, this particular area of the village has been designated as a distinct archaeological site (DfSi 17 - Himayis).

Unfortunately, the extensive depth (3m+) of the excavated main village deposits required the use of shoring and hindered the identification of definitive house structures

(Appendix A). After a series of trenches and isolated excavation units were dug in these deposits, the focus of the excavation shifted to a forested area behind and above the main village (Figure 5). This back terrace area, located above (~8-10m) and away (~70m) from modern shoreline, dates to between ca. 3000-5000 cal yr BP (McMillan and St. Claire 2005). The higher elevation and older age of these deposits matches well with the hypothesized relative sea level curve for the outer coast of Vancouver Island which indicates that gradual isostatic uplift resulted in mid-Holocene sea levels that were approximately 3-4 metres higher than at present between ca. 6000-4000 cal yr BP (Boxwell et al. 2000; Friele and Hutchinson 1993). Similar archaeological cases have been documented during the same temporal interval in other parts of Barkley Sound (Arcas 1991; McMillan 1999:62-83; Sumpter et al. 2002).

The vertebrate faunal remains described in this thesis were identified from fine-screened (<6mm) matrix samples by myself in 2002 and 2003 while the fauna recovered from the 6mm excavation units were identified by Susan Crockford and Gay Frederick in 2000-2003 (Frederick and Crockford 2005). All vertebrate faunal material was identified to the highest possible taxonomic level using the comparative collection at the University of Victoria Zooarchaeological Laboratory (Victoria, BC). Identified faunal elements were recovered from six different localities at the site, three from the back terrace and three from the main village. The examined main village deposits are associated with the locations of ethnographically identified households while the deposits in the back terrace were not identified in the ethnographic descriptions of the village (McMillan and St. Claire 2005). Several burial cairns were encountered in the back terrace portion of site but fish remains were not associated with these features. More extensive description of recovery and identification procedures is presented in chapter two.

Figure 5. Map of Ts'ishaa showing the named locations of Ts'ishaa lineage households, the extent of the archaeological deposits in the main village and back terrace (shaded), and the location of the excavation units and trenches (black squares). Map adapted and modified from McMillan and St. Claire (2005). Used by permission.

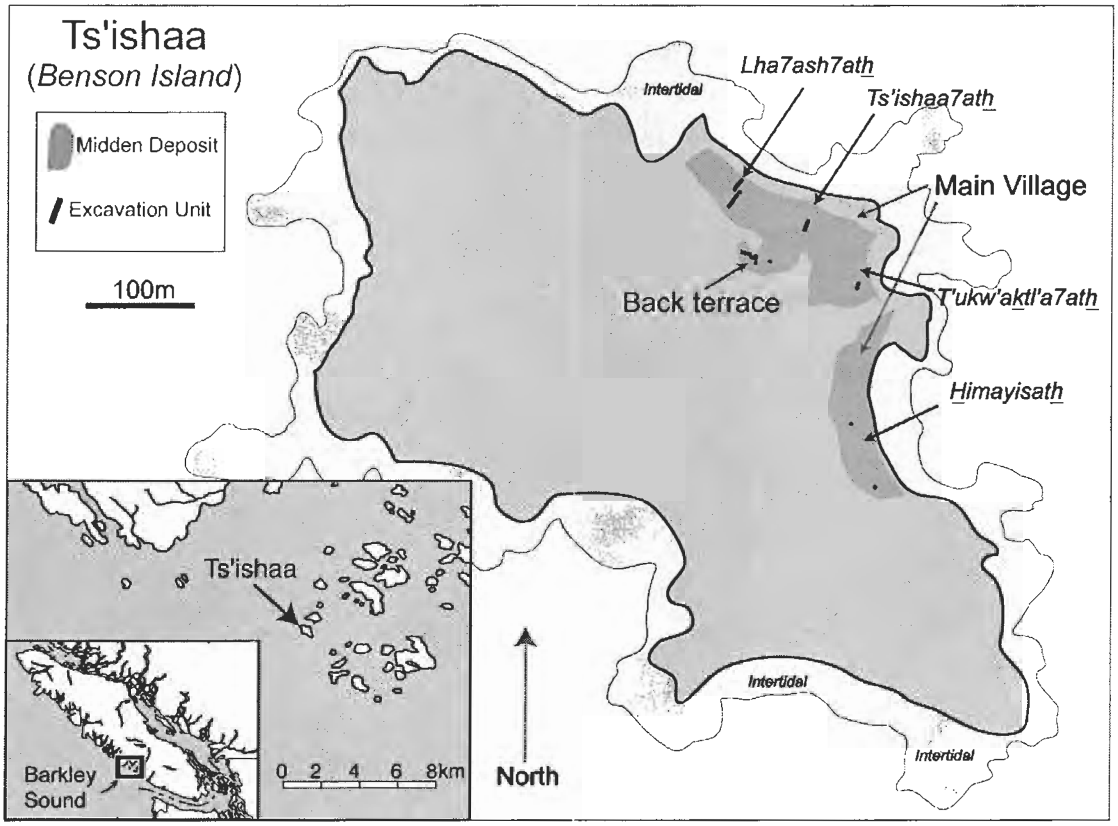
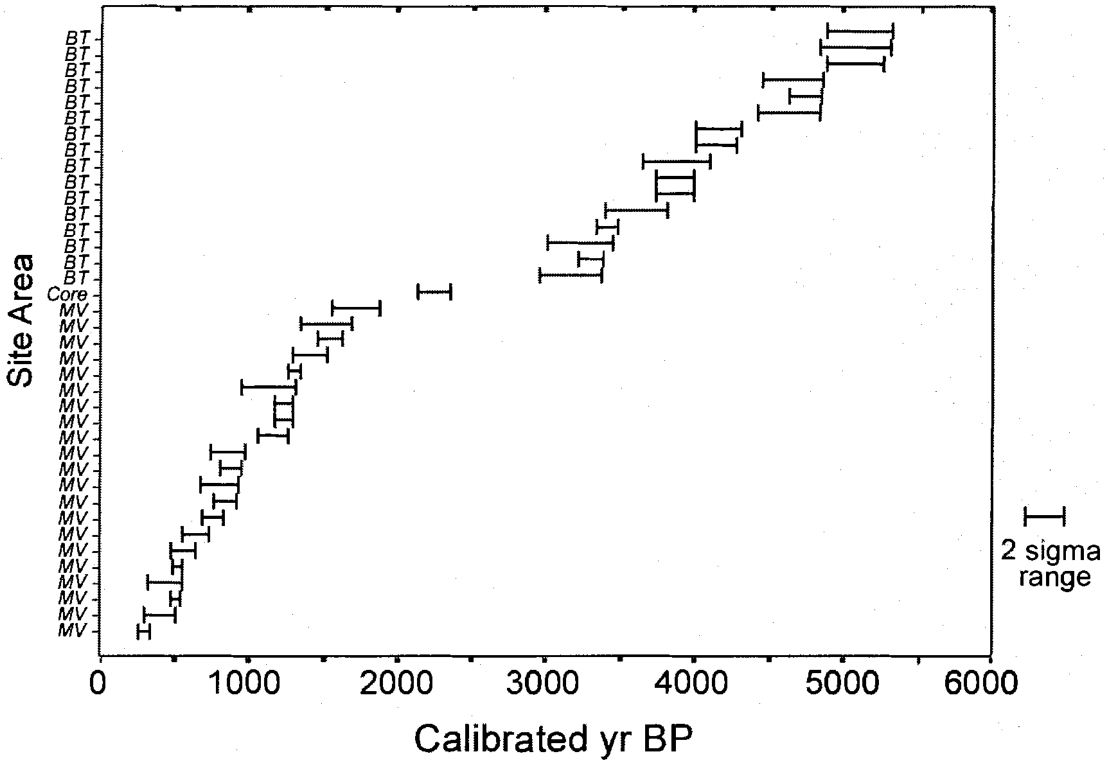


Figure 6. Calibrated radiocarbon ages (2 sigma range) obtained from throughout the deposits at Ts'ishaa. Calibration was achieved using *Intcal 98* (Stuiver et al 1998a,b). BT=back terrace, core=auger test conducted by Sumpter et al. (1997), MV=main village (see McMillan and St. Claire (2005) for further radiocarbon documentation).



Structure of Thesis

As discussed previously, this thesis has four primary research objectives (Table 1). The first is to examine evidence of fishing at the site as a whole and the second involves exploring how the use of fish at the site changes over time. The third and fourth objectives place these primarily methodological concerns in the context of understanding the cultural and ecological significance of fishing at a prehistoric Nuu-chah-nulth village. Collectively, these analyses aim to provide insight into how fishing was conducted in the community, how it changed over the course of five thousand years, and to evaluate the possible reasons this occurred. Here I give a brief overview of the goals of each chapter.

Evidence of fishing in an archaeological context (Chapter 2)

A primary goal of the zooarchaeological research described in this thesis is to determine how evidence of human resource use is expressed in an archaeological context associated with stratified maritime hunter-gatherers. Thus, in chapter 2, I examine fine-screened faunal remains recovered from spatially and temporally dispersed deposits throughout the site. I employ a variety of quantitative methods to explore the taxonomic composition, taphonomic history, and sampling distribution of the faunal assemblage, particularly in how it relates to the large assemblage of fish remains recovered from excavation units (i.e., Frederick and Crockford 2005). I then use both sets of data to show how fish remains represent the overwhelming majority of vertebrates throughout the site and that just six taxa appear to constitute the bulk of the assemblage at all times and places during this 5000 year period. This chapter seeks to establish that these faunal data represent a vitally important aspect of resource use at this locale.

Temporal change in fishing in a spatial context (Chapter 3)

After showing how fish represent a significant aspect of resource use at this site, I then explore different ways to characterize the changes in the use of the six most commonly occurring taxa (Chapter 3). This analysis uses multiple measures of abundance (%NISP, NISP/litre, %NISP in excavation units) to examine how fish use may have changed over the course of 5000 years throughout the site. Thus, I quantify broad-scale temporal trends in the fish assemblage in order to determine if evidence of fishing is similarly represented in separate areas of this large site (Chapter 3). To do this I use individual level assemblages (fauna from arbitrary 10cm levels) from spatially and temporally discrete deposits to characterize the taxonomic abundance of the fish in these separate but contemporaneous areas of the site (Appendix A). I then evaluate if these changes are due to taphonomic factors, sampling, or quantification.

Temporal change and spatial similarity in a cultural context (Chapter 3 and 4)

Based on these results, I explore the significance of temporal trends in resource use and argue that the most commonly utilized fish taxa also appear to be the most similarly distributed throughout contemporaneous areas of the site (Chapter 3 and 4). I demonstrate this using assemblages that more closely approximate the depositional scale of short-term subsistence practices (individual level assemblages). Being able to see that patterns of resource use are similarly expressed on this fine-grained scale, I argue that fishing was conducted in a similar way throughout the site and that widespread changes in the use of particular taxa reflect community-wide changes in fishing practices.

Temporal change and human impact on marine resources in a cultural context (Chapter 3 and 4)

Using measurement data on two important nearshore fish taxa that are vulnerable to over-exploitation (rockfish and greenling), I evaluate temporal changes in their size and abundance throughout the site (Chapter 3 and 4). I focus particularly on the three separate but contemporaneous deposits in main village that are the named locations of ranked household societies (Sapir n.d.). This analysis provides insight into the consequences and strategies of territorial ownership in late prehistory (ca. 1800-250 cal yr BP) but also sheds light on how an important aspect of human resource use was sustained over the 'long term' without widespread negative impacts to the 'natural' environment.

Chapter Two: The Archaeology of Fish at Ts'ishaa

Introduction

Fish are often the most numerous and ubiquitous vertebrate taxa present in shell midden deposits on the Northwest Coast (e.g., Calvert 1980; Huelsbeck 1994; Wigen and Stucki 1988) but the analysis of fine-screened (<6mm) fish remains are not often included in the spatial, temporal, and quantitative investigation of prehistoric subsistence practices. Archaeologists working in the region have periodically employed the use of core and column sampling (Casteel 1970, 1976a) to describe the taxonomic composition of fish recovered from small volumes of fine-screened archaeological deposit (Cannon 2000; Casteel 1976a; Coupland 1991; Fawcett 1991; Hanson 1991; Monks 1977; Moss 1989; Wigen and Eldon 1987). These studies have shown that the controlled recovery and laboratory processing of fine-screened matrix samples is an effective way to describe the composition of fish in a shell midden deposit. However, this type of analysis is rarely conducted in more than a single area of a site, and the results are not often explicitly compared to fauna identified from adjacent excavation units (but *see* Cannon 2000; Wigen and Eldon 1987).

In this chapter, I describe fish remains recovered from five fine-screened (<6mm) column samples and compare this with the large assemblage of fish remains identified from excavation units at Ts'ishaa (Frederick and Crockford 2005). My purpose in doing so is to assess the context and significance of the fauna recovered from the site as a whole. My column sample analysis is based on an assemblage of 20,245 fine-screened fish remains and is compared to an assemblage of 45,333 fish specimens recovered in the field from 6mm screens, where fish account for the overwhelming majority of the fauna identified (66-98% NISP, Frederick and Crockford 2005).

I first describe the methods I used to identify and quantify the column sample assemblage. I then explore how sample size affects the richness of fish taxa found in both the unit and column assemblages and how this variation is expressed among the different recovery methods. I show that large numbers of herring and anchovy are present throughout the examined deposits and this affects the composition of species throughout the entire faunal assemblage. I then demonstrate how the average body-size of the two most abundant fish species in the unit assemblage (rockfish and greenling) is smaller and recovered in different relative proportions in the fine-screened columns. I also quantify the temporal rate of midden accumulation and examine how shell and bone frequency vary within deposits. Collectively, the analysis of the fauna recovered from the fine-screened column samples reveals a fundamentally important aspect of the prehistoric Nuu-chah-nulth fishery in the Broken Group Islands of Pacific Rim National Park Reserve.

Methods

The site of Ts'ishaa is a large cultural shell midden deposit extending roughly 300m across the northeast shoreline of Benson Island in Barkley Sound. Ethnographically documented as the former location of the principal Tseshaht village (Sapir and Swadesh 1955; St. Claire 1991), extensive excavation at the site sampled approximately 219m^3 of cultural deposit from 35 excavation units (2x2m) spanning ca. 5000-250 cal yr BP (McMillan and St. Claire 2005). Vertebrate fauna was recovered using 6mm mesh screens in the field and fauna has been identified for five excavation units (*see* Frederick and Crockford 2005). The fine-screened fauna (Δ6 mm) reported in this chapter was collected from 'columns' of archaeological matrix sampled from within unit quadrants or directly adjacent to excavated units (e.g., Casteel 1976a). Column matrix samples consisted of bulk sediments removed in ten-centimetre levels of known volume (Table 5). The deposits containing identified fauna fall within the two chronological periods archaeologically documented at Ts'ishaa: 1) the back terrace component which dates to between ca. 5000 and 3000 years before present and 2) the 'main village' component which dates to between ca. 1800 and 250 years ago (cal yr BP).

Four of the five column samples described in this chapter were recovered from areas directly adjacent to excavation units with identified 6mm fauna (Columns S62-64/W62-64 [back terrace]; S56-57/W50-52 [back terrace]; S14-16/W25-27 [main village]; N2-4/W102-104 [main village]). Fauna from column S5-7/W11-13 [main village] does not contain identified 6mm unit fauna. Although the column samples are from dispersed areas of this large site (see Figure 14 in chapter 3), the three columns from the main village are broadly contemporaneous with each other, as are the two columns from the back terrace (Table 5-8).

Bulk matrix from the column samples was wet-screened through nested geological sieves (6mm-1.5mm) at the Parks Canada Laboratory (Victoria, BC). Due to the large number of skeletal elements encountered during this process, a limited number of individual column levels was selected for identification (Table 5 and Table 6). Individual levels were selected to maximize the temporal and spatial coverage of the site and to ensure the stratigraphic independence of individual level assemblages (i.e., >10cm separated each examined level). Every odd level was identified for three of the five column samples (Columns S56-57/W50-52, S5-7/W11-13, S62-64/W62-64, Table 5). In the remaining two column samples (Columns N2-4/W102-104 and S14-16/W25-27), only select levels from stratigraphic layers defined in the adjacent excavation unit were analysed (Table 5). Faunal recovery from 1.5mm mesh was limited to three column samples and fauna from these samples was further subdivided into portions representing 250cc of the original excavated volume (Table 6).

Table 5. Archaeological context of the >1.5mm column sample fauna.

Column sample	Age range (cal yr BP)[a]	Column size (cm)	Screen size (mm)	Examined levels [n. lvls.]	Layers	Depth (m)	Vol. per level (litres)[b]	Total vol. (L)	NISP[d]	NSP[c]	NSP/ litre
N2-4/ W102-104	250-1500	20x20 x10	3+6	1, 3, 5, 9, 13, 15, 17, 19, 23, 27, 31 [n=10]	A-E [n=6]	3.1 m	4.0	40	**2876**	6267	156.7
S14-16/ W25-27	250-1800	25x25 x10	3+6	3, 7, 11, 15, 17, 19, 21, 25, 28, 31, 33, 35 [n=12]	A, B, C, E, F, G [n=5]	3.5 m	6.25	75	**1956**	4874	65.0
S5-7/ W11-13	250-1000	2 litres (bulk)	2	1-23, odd lvls. [n=12]	A-C [n=3]	2.3 m	2.0	24	**565**	3403	141.8
S56-57/ W50-52	3000-5000	10x10 x10	3+6	1-25, odd lvs. [n=13]	A, B [n=2]	2.5 m	1.0	13	**942**	1854	142.6
S62-64/ W62-64	3000-5000	20x20 x10	3+6	1-9, odd lvs. [n=5]	A-D [n=4]	0.9 m	4.0	20	**704**	1557	77.9
Totals				[n=52]				172L	**7043**	17955	104.4

[a] Age-range based on one or more calibrated ^{14}C dates from the adjacent excavation unit (Table 11).
[b] Volume calculated by dimensions of individual matrix sample (i.e., before sediment removal).
[c] Number of identified specimens positively identified to genus or above (e.g., rockfish, herring, etc.).
[d] The total number of examined skeletal specimens (including unidentified specimens).

Table 6. Archaeological context of the 1.5mm column sample fauna.

Column Sample[a]	Age range (cal yr BP)[b]	Screen size (mm)	Examined Levels [n levels.]	Volume per level (litres)[c]	Total volume (litres)	NISP[d]	NSP[e]	NSP/ litre
N2-4/ W102-104	250-1500	1.5	1,3,5,9,13,15,17, 19,23,27,31 [n=10]	0.25	2.50	**465**	2057	823
S56-57/ W50-52	3000-5000	1.5	5, 15, 25 [n=3]	0.25	0.75	**68**	234	312.0
S62-64/ W62-64	3000-5000	1.5	1, 5, 9, [n=5]	0.25	0.75	**77**	318	424.0
Totals			[n=16]		4.00	**610**	2609	652.3

[a] Columns S14-16/W25-27 & S5-7/W11-13 were previously processed and did not retain 1.5mm specimens.
[b] Age-range based on one or more calibrated ^{4}C dates from the adjacent excavation unit (Table 11).
[c] Volume calculated by splitting the screened matrix into portions representing 250cc of the original excavated volume.
[d] Number of identified specimens positively identified to genus or above (e.g., rockfish, herring, etc.).
[e] The total number of examined skeletal specimens (including unidentified specimens).

Identification

I identified vertebrate fauna with the aid of a binocular dissecting microscope (6.3-40x) and the use of the extensive comparative fish collection at the University of Victoria Zooarchaeology Laboratory (Victoria, BC). Identification data were recorded by skeletal element in a *Paradox 35* database, which noted relevant modification and provenience information. The completed database was converted to an *Excel* spreadsheet that was then imported into *SPSS* for statistical analyses. With the exception of fish spines, branchials, scales, and gill-rakers, identification was attempted for all skeletal elements recognizable to species or genus level. Confidence codes were assigned to each examined specimen to indicate the certainty of identification (for criteria, see Frederick and Crockford 2005). Using the same comparative collection, Rebecca Wigen conducted a review and verification of all identifications. Considerable effort was taken to employ the same procedures followed during the identification of the unit fauna (i.e., Frederick and Crockford 2005).

Quantification

Faunal remains described in this thesis are quantified according to the number of identified specimens identifiable to species/taxon (NISP, e.g., rockfish, herring, etc.) or the number of specimens recognizable to class (NSP, e.g., mammal, fish, etc.). Relative abundance refers to the percentage of skeletal specimens attributable to a particular taxon in relation to the total number of identified taxa (i.e., %NISP). Although the use of relative abundance is an imperfect measure of species frequency, it is the most widespread method of describing abundance in archaeological faunal assemblages (Grayson 1984:92; Lyman 1994:100). Clearly, significant differences exist in the number and durability of skeletal elements found in different fish taxa and calculating the specimen abundance will cause some species to be under- or over-represented in a given assemblage (e.g., Rick et al. 2002). Some researchers attempt to compensate for this uncertainty by choosing to identify a limited number of skeletal elements from fish species (e.g., Leach 1997; Vale and Gargett 2002), but this strategy neglects to include a number of identifiable elements and does not easily facilitate comparisons with analyses that do not utilize this approach. In contrast, identifying the greatest possible number of elements and specimens most completely documents a given assemblage and can be subsequently modified to accommodate alternative approaches to quantification. The latter identification strategy was used during this analysis, principally in order to establish a comparable dataset with the larger unit assemblage.

Table 7. Frequency and relative abundance (%NISP fish) of faunal specimens from fine-screen column sample deposits (Table 5). Species are grouped by class (i.e., fish, mammal, bird).

		Column Sample											
		N2-4/ W102-104		S14-16/ W25-27		S5-7/ W11-13		S56-57/ W50-52		S62-64/ W62-64			
Species	Common name	NISP	%	NISP	%	NISP	%	NISP	%	NISP	%	Total NISP[a]	%NISP fish[b]
Clupea pallasi	Herring	1404	49	1096	57	449	48	300	54	473	68	**3722**	53.33
Engraulis mordax	Anchovy	769	27	175	9	246	26	19	3	34	5	**1243**	17.81
Sebastes sp.	Rockfish sp.	338	12	335	17	64	7	18	3	15	2	**770**	11.03
Hexagrammos sp.	Greenling sp.	121	4	129	7	88	9	149	27	137	20	**624**	8.94
Oncorhynchus sp.	Salmon sp.	57	2	43	2	65	7	15	3	1		**181**	2.59
Embiotocidae	Perch sp.	58	2	44	2	8	1	26	5	23	3	**159**	2.28
Squalus acanthias	Dogfish shark	25	1	20	1	3	*	15	3		0	**63**	0.9
Ophiodon elongatus	Lingcod	14	*	11	1	2	*	11	2	3		**41**	0.59
Merluccius productus	Hake	25	1	6	*	6	1				0	**37**	0.53
Porichthys notatus	Plainfin midshipman	3	*	18	1					4	1	**25**	0.36
Hippoglossus stenolepis	Halibut	4	*	14	1	2	*	3	1	1	*	**24**	0.34
Anoplopoma	Sablefish	8	*	14	1					1	*	**23**	0.33
Pleuronectiformes	Flatfish spp.	7	*	3	*	1	*			1	*	**12**	0.17
Hemilepidotus hemilepidotus	Red Irish lord	3	*	7	*	2	*					**12**	0.17
Scorpaenichthys marmoratus	Cabezon	6	*	2	*	3	*					**11**	0.16
Hydrolagus colliei	Ratfish	3	*	5	*			1	*			**9**	0.13
Damalichthys vacca	Pile perch	7	*	1	*							**8**	0.11
Platichthys stellatus	Starry flounder	2	*					1	*			**3**	0.04
Eopsetta jordani	Petrale sole	1	*	2	*							**3**	0.04
Raja sp.	Skate sp.			1	*					1	*	**2**	0.03
Cymatogaster gracilis	Shiner perch	1	*							1	*	**2**	0.03
Cottidae	Sculpin sp.			1	*	1	*					**2**	0.03
Embiotica lateralis	Striped seaperch					1	*					**1**	0.01
Lepidopsetta bilineata	Rock sole	1	*									**1**	0.01
Gadus macrocephalus	Pacific cod			1	*							**1**	0.01
Odocoileus sp.	Deer sp.							1				**1**	
Peromyscus sp.	Deer mouse			2						1		**3**	
Mustela vison	Mink							3				**3**	
Mammalia	Undet. Ind mamml.	1										**1**	
Callorhinus ursinus	Fur seal			2				2		3		**7**	
Phocoena phocoena	Harbour porpoise									1		**1**	
Pinnepedia	Pinnepedia, sm	2										**2**	
Delphinidae/ Phocoenidae	Porpoise/Dolphin			1								**1**	
Mammalia	Und. sea mamml.					1		1				**2**	
Mammalia	Undet.mammal	41		98		32		100		8		**279**	
Mammalia	Undet.mammal	1		1								**2**	
Aves	Unidentified bird	2		3								**5**	
Aves (lg)	Unident. lrg. bird	1										**1**	
Aves (med)	Unident. med. bird	1		1		1						**3**	
Amphibian	salamander sp.			5								**5**	
Unidentified bone	Unident.taxa							2				**2**	
	NISP fish[a]	**2857**		**1928**		**941**		**558**		**695**		**6979**	
	NSP fish[a]	**6218**		**4761**		**3369**		**1745**		**1544**		**17637**	
	TOTAL NSP	**6267**		**4874**		**3403**		**1854**		**1557**		**17955**	
	Age range (cal yr BP)[c]	250-1500		250-1800		250-1000		3000-5000		3000-5000		250-5000	
	Examined volume	40 L		75 L		24 L		13 L		20 L		172 L	

• = Less than 1% of identified fish (NISP). [a] NISP = Number of identified specimens (species/taxon). NSP = Number of specimens (including unidentified fragments) [b] % NISP = relative abundance of identified fish. [c] Age-range based on one or more calibrated ^{14}C dates from the adjacent excavation unit (*see* Table 11).

Table 8. Frequency and relative abundance (%NISP fish) of faunal specimens from 1.5mm column sample deposits.*

		Column Sample							
		N2-4/ W102-104		S56-57/ W50-52		S62-64/ W62-64		Total	%NISP
Species	Common name	NISP	%	NISP	%	NISP	%	NISP[a]	fish[b]
Engraulis mordax	Anchovy	385	83	7	10	26	34	**418**	68.52
Clupea pallasi	Herring	61	13	56	82	45	58	**162**	26.56
Embiotocidae	Perch sp.	5	1.1		0	3	3.9	**8**	1.31
Hexagrammos sp.	Greenling sp.	4	0.9	3	4.4		0	**7**	1.15
Oncorhynchus sp.	Salmon sp.	5	1.1		0	1	1.3	**6**	0.98
Sebastes sp.	Rockfish sp.	3	0.6	1	1.5		0	**4**	0.66
Ophiodon elongatus	Lingcod		0	1	1.5		0	**1**	0.16
Gadidae	Gadid sp.		0		0	1	1.3	**1**	0.16
Stichaeidae	Prickleback sp.		0			1	1.3	**1**	0.16
Hemilepidotus hemilepidotus	Red Irish lord	1	0.2					**1**	0.16
Squalus acanthias	Dogfish shark	1	0.2					**1**	0.16
	Undet. mammal	1						**1**	
	NISP fish	465		68		77		**610**	
	NSP fish	2056		234		318		**2608**	
	Total NSP	2056		234		318		**2608**	
	Approx. age range (cal yr BP) [c]	250-1500		3000-5000		3000-5000			
	Examined volume (litres)	2.50L		0.75L		0.75L		4.00L	

*1.5mm estimates reported here should be considered highly tentative due to sampling effort that was disproportionately focused on column N2-4/W102-104, the small examined volume (4L), and sub-sampling that prevented the inclusion of specimens that were recovered in larger mesh sizes (Table 6).

[a] NISP = Number of identified specimens.

[b] % NISP = relative abundance of identified fish

[c] Age range based on one or more calibrated ^{14}C dates from the adjacent excavation unit (Table 11).

Results

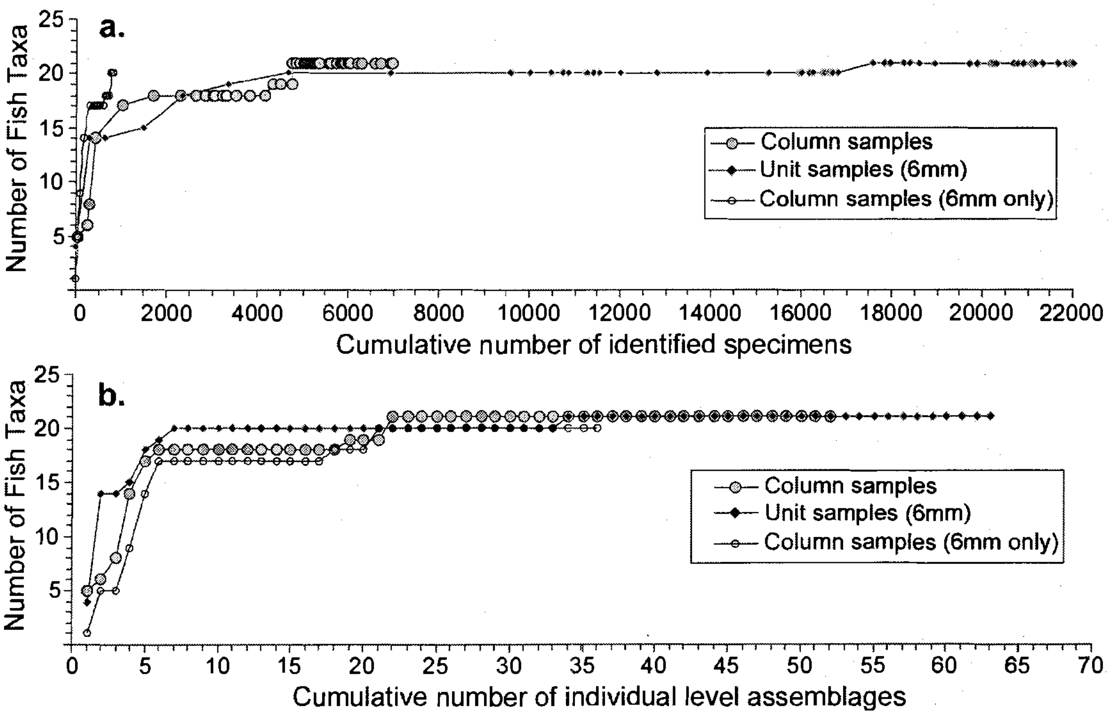
The column sample assemblage contains 20,564 skeletal specimens from 52 discrete 10cm levels representing an excavated volume of 172 litres (Table 5-8). Fish comprise the overwhelming majority of skeletal specimens (NSP=20,245, 98.45%). In contrast, small numbers of specimens were identifiable as mammal (NSP=303, 1.47%) and bird (NSP=9, 0.04%). Fish specimens were found in every one of the 52 examined column sample level assemblages and vastly outnumber mammal and bird specimens. From the initial total, 6979 fish specimens were identified to species or genus (i.e., NISP) from 3 and 2mm mesh (Table 5 and Table 7). An additional 610 fish specimens (NISP) were identified to species from 1.5mm mesh (Table 6 and Table 8). Since the 1.5mm assemblage represents fauna identified from sub-sampled portions of individual levels and do not include specimens from the larger mesh sizes (Table 6), these data are evaluated and discussed separately. The low abundance and taxonomic richness of bird and mammal remains recovered from the column sample assemblage demonstrates the infrequent distribution of these animals in the deposits but also precludes the use of these data for evaluating species composition.

Assessing sample size and sample richness

A perennial question in faunal analysis is whether assemblages are large enough to adequately assess differences between them without these comparisons being unduly influenced by differences in sample size (e.g., Grayson 1984). To evaluate whether insufficient sample size (NISP) is a factor that prevents an effective comparison of the unit and column assemblages, I generated cumulative frequency curves illustrating the relationship between taxonomic richness and sample size in both assemblages (Figure 7). This was accomplished by cumulatively adding the identified fish specimens from individual level assemblages and recording the sample size at which new fish taxa are added to the assemblage (e.g., Lepofsky et al. 1996). This relationship was plotted by cumulatively adding identified specimens (NISP) recovered from each individual level assemblage (Figure 7a) as well as by adding numbers of individual level assemblages (Figure 7b). In order to equably compare taxonomic richness between the two assemblages, certain taxa identified beyond a genus level were collapsed into taxon-specific categories (irish lords - *Hemilepidotus* sp.; perches - Embiotocidae; greenlings - *Hexagrammos* sp.; and salmon - *Onchorhynchus* sp.). Specimens not identified to genus level were not considered taxa (e.g., flatfish) with the exception of perch (Embiotocidae) and sculpins (Cottidae).

The result of this analysis illustrates that taxonomic richness in both assemblages appears to similarly plateau after reaching twenty taxa, indicating that a degree of sampling redundancy has been achieved (Reitz and Wing 1999:107). It also shows that species richness is numerically equivalent in both assemblages (n=21 fish taxa), despite the presence of many more identified specimens in the unit assemblage (NISP=22100) than in the column assemblage (NISP=6979). Moreover, even the comparatively tiny assemblage (NISP=817) recovered exclusively from the 6mm fraction of the column samples reaches 20 taxa and plateaus after the analysis of 22 individual level assemblages (Figure 7b).

Figure 7. Cumulative frequency graphs showing the number of fish taxa in relation to (a) the cumulative number of identified specimens grouped according to individual level assemblages and (b) the cumulative number of individual level assemblages (the same data but shown in different presentation formats). The separate lines represent fauna from the unit (6mm, appendix B2), column assemblages (6+3 or 2mm, Table 5 and appendix B1), and column sample fauna recovered exclusively from the 6mm fraction (6mm only, appendix B3).



Thus, after an initially dramatic increase in species richness, the rate at which new fish taxa are discovered becomes considerably reduced until the addition of more samples and specimens appears less likely to influence the richness of the assemblage. This is not to say that taxonomic richness has reached its theoretical maximum nor does it mean that the unit assemblage is more diverse than the column assemblage or vice-versa. For as Figure 7a suggests, richness can increase even after many thousands of specimens have been examined (e.g., ~17,000 NISP). Another important aspect of the comparing the two assemblages is the observation that two taxa in each assemblage were not present in the other assemblage,[2] effectively cancelling out the cumulative richness of both assemblages (n=23 fish taxa, Figure 7). Nevertheless, despite considerable differences in recovery technique and sample size, this analysis indicates that the two assemblages contain a large enough sample to reliably evaluate the taxonomic composition in each assemblage without those differences being the result of differences in sample size.

Assessing relative abundance and ubiquity

The multitude of spatially and temporally distinct contexts represented by the column sample fauna and their proximity to units containing identified fauna provides an opportunity to evaluate the taxonomic composition of fish remains for the site as a whole. In the following discussion, I use these data to describe some of the basic characteristics of the fish assemblage and contrast this with the fish identified from the excavation units.

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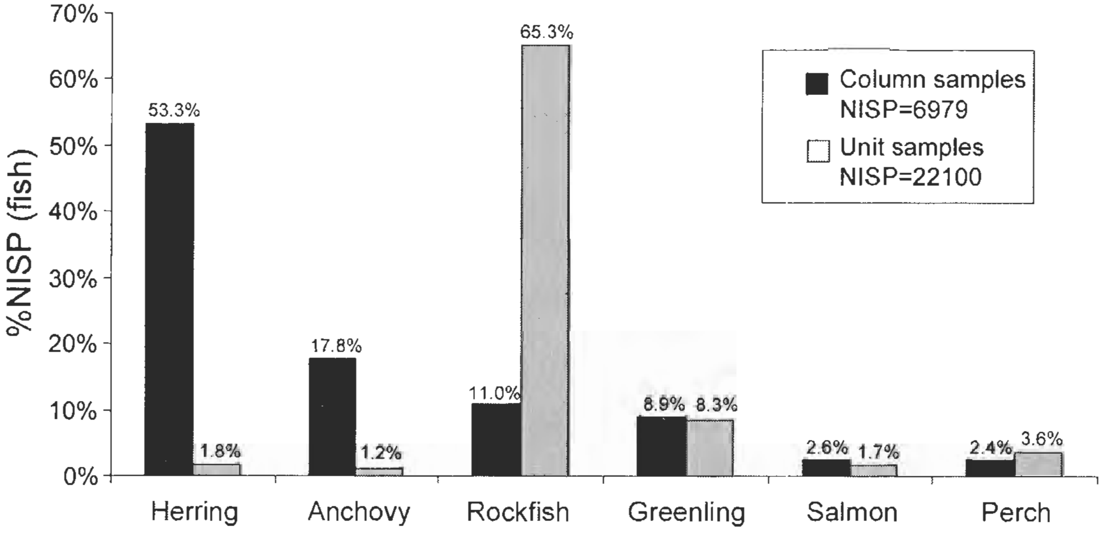
[2] Sablefish (*Anoplopoma fimbria*) and Starry flounder (*Platichthys stellatus*) were recovered in the column but not the unit assemblage. Conversely, Bluefin tuna (*Thunnus thynunus*) and English Sole, (*Parophrys vetulus*) were found in the unit assemblage (Frederick and Crockford 2005) but not in the column assemblage.

A considerable variety of fish taxa are present in both the unit and column assemblages, but only a limited number of these taxa have relative abundance values of greater than 1% (Table 7, Frederick and Crockford 2005). For instance, the six most abundant taxa in the unit assemblage account for more than 88% (NISP) of the identified fish specimens (Frederick and Crockford 2005). In the column assemblage, the six most abundant taxa account for more than 95% (NISP) of the identified fish specimens (Table 7). This suggests that the bulk of the fishing activity at Ts'ishaa was focused on a relatively narrow range of taxa. As discussed below, however, some of the taxa representing large proportions of the unit assemblage are not present in similar quantities in the column sample assemblage.

The six most abundant fish taxa recovered from the column samples are herring, anchovy, rockfish, greenling, salmon, and perch, respectively (Figure 8). These same taxa are also the six most abundant in each of the five individual column sample assemblages, though not all in the same rank order (Table 7 and Table 8). The relative abundance of fish specimens in the column samples differs substantially from the unit assemblage (Figure 8). The latter is dominated by rockfish (65%, NISP) and followed distantly by greenling (8%), lingcod (7%), perch (4%), petrale sole (3%) and hake (2%) (Frederick and Crockford 2005).

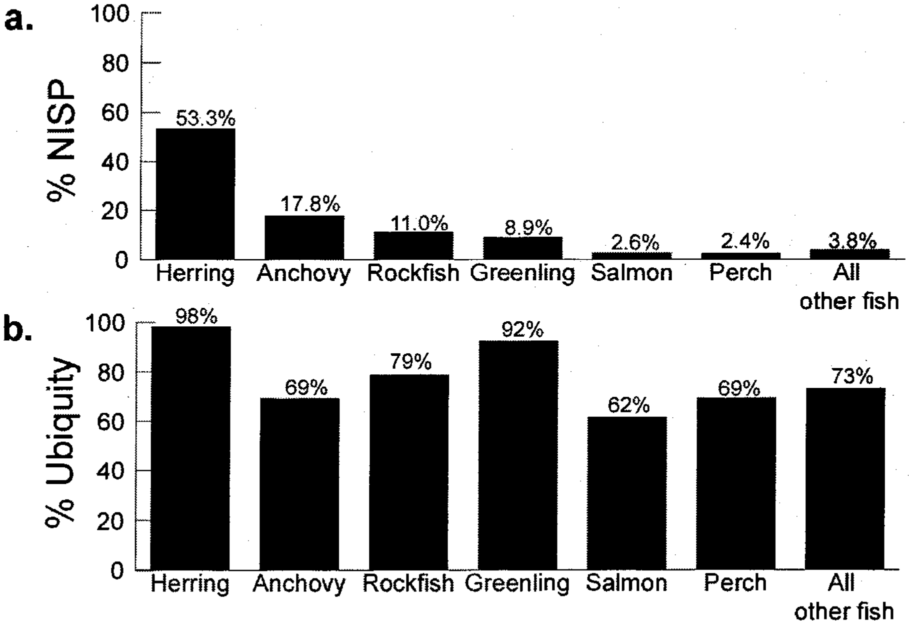
Figure 8. Relative abundance of the six most abundant fish taxa from the column samples (Table 7) compared with the same taxa identified from the excavation unit assemblage (Frederick and Crockford 2005). Rockfish, greenling, salmon, and perch represent pooled taxonomic categories (i.e., combined genus, species or family level identifications).



Herring is by far the most abundant (53% NISP) and frequently occurring (98% ubiquity) fish taxon in column sample assemblage (Figure 8 and Figure 9). The mean relative abundance of herring in the 52 column sample level assemblages is 49% NISP (SD±28%). Calculated for each of the five column samples, is similarly the most abundant taxon (mean %NISP = 55.2, SD±8, Table 7). These multiple measures of abundance suggest that, herring accounts for at least half of all the fish remains throughout the deposits at Ts'ishaa. The consistently dominant abundance and widespread use of this species suggests that herring was central to the subsistence practices of the residents of Ts'ishaa for the duration of human occupation of this site.

Anchovy is the second most abundant taxon in the column sample assemblage and is less ubiquitous and abundant than herring in all five columns (Table 7). However, in the 1.5mm sub-sampled assemblage, anchovy is more abundant than herring, which indicates that this small fish (<20cm, Hart 1973) is recovered more readily in screen sizes smaller than 3mm (Table 7 and Table 8). In spite of this, it is difficult to evaluate the rank order abundance of anchovy in the 1.5mm assemblage because: 1) sampling effort was disproportionately focused on a single column sample (N2-4/W102-104), 2) the sub-sampling procedure prevented the inclusion of specimens recovered from larger screen sizes and 3) collectively, these data only represent 4 litres of examined deposit (Table 6 and Table 8). Irrespective of the inadequacies of the 1.5mm assemblage, however, the fact that anchovy is less abundant than herring in both the 1.5mm and 3mm fractions from the two back terrace column samples provides evidence to suggest that anchovy were less abundant than herring between ca. 5000-3000 cal yr BP (Table 7 and Table 8).

Figure 9. Relative abundance (a) and ubiquity (b) of the six most abundant fish taxa from the column samples (Table 7). Ubiquity measures the presence/absence of species in the 52 column sample levels. 'All other fish' refers to the combined percentage of the remaining 15 taxa in the column sample assemblage. Greenling, salmon and perch represent pooled taxonomic categories (i.e., combined genus, species or family level identifications).



Rockfish dominate the assemblage of fauna recovered from the excavation units (65% NISP) but are much less abundant in the column sample assemblage (11% NISP). This striking contrast is partly explained by the fact that 82% (NISP=11863) of the rockfish in the unit assemblage were identified from two adjacent excavation units in the main village (Units N2-4/W102-104 and N4-6/W102-104). Thus, the high number of rockfish specimens recovered from this one area of the site produces a spatially uneven sampling distribution which is further compounded by the biasing effects of 6mm mesh recovery. In the column sample assemblage, rockfish abundance is only marginally greater than the relative abundance of greenling (Figure 8).

Greenling represents a slightly higher relative percentage in the column assemblage (8.93%) than the unit assemblage (8.35%) despite the large increases in the abundance of herring and anchovy (Table 7). Greenling is also the second most frequently occurring taxon in the 52 individual column level assemblages (Figure 9), suggesting that it is consistently found in small volumes of deposit throughout the site.

Salmon is also found in an incrementally greater proportion of the column sample assemblage than in the unit assemblage and is present in 62% of the examined column sample levels (Figure 8 and Figure 9). One of the reasons for the greater abundance may be the increased recovery of fragmented but highly identifiable salmon vertebrae (e.g., Wigen and Stucki 1988:108). For instance, vertebrae in the column assemblage represent 83% (NISP=151) of the identified salmon specimens and 66% of these have intact vertebral centra (NISP=99). In the unit assemblage, 88% (NISP=295) of salmon vertebrae are intact suggesting that fragmentation partially explains the increased recovery for this taxon, a difference that amounts to a three fold increase in fragmented vertebrae. In spite of this taphonomic factor, however, the abundance and ubiquity of salmon is only slightly exceeded when specimens from the 15 remaining taxa are combined and compared to salmon (Figure 9).

Perch is also a consistently low percentage of both the unit and column assemblages (Figure 8 and Figure 9). Perch and salmon exhibit similar abundance values but perch is slightly more ubiquitous than salmon (Figure 9b). The consistent recovery of perch, albeit in low frequencies, suggests that it was regularly utilized.

Some of the taxa that are abundant in the unit assemblage are prominently absent from the list of top six taxa in the column assemblage (Table 7; Frederick and Crockford 2005). In particular, the conspicuously low abundance of taxa such as lingcod, petrale sole and hake suggests that a combination of increased body size, skeletal robusticity, visibility during field recovery, and low overall density (NSP/litre) contributed to the disproportionately high recovery and rank order abundance of these fish in the unit assemblage. There is a notable absence of sardine or 'pilchard' (*Sardinops sagax*) elements in both the unit and column assemblages. This is surprising given the unique skeletal morphology of this species, its historically documented presence along the southwest coast of British Columbia (e.g., Hart 1973:102; McFarlane and Beamish 2001), and the 5000 year record of human fishing activity represented at Ts'ishaa.

Assessing recovery in bones per litre

The analysis of the fine-screened column samples indicates that a much higher density of fish specimens was recovered from the 3mm mesh than from the 6mm mesh. Estimating the magnitude of this difference is important because it helps to clarify the amount of faunal data missing from the excavation unit assemblage and provides a reference point from which to evaluate how separate rates of recovery affect the relative abundance of fish taxa. To characterize differences in recovery, I used the number of fish specimens per litre in each assemblage (calculated as the amount of excavated volume divided by the number of specimens) to compare the unit and column assemblages (Table 9).

Comparisons of the different mesh sizes provide evidence to suggest that a large proportion of the fish remains are absent from the unit assemblage (Table 9). For instance, among the four column samples that utilized nested 6 and 3mm mesh, 88% of the fish specimens (NSP) and 86% of the *identified* fish specimens (NISP) were recovered in the 3mm screens (Table 9). This shows that fewer than 15% of the fish remains are recovered during the use of 6mm mesh even when fauna is recovered in laboratory conditions. The considerable loss of fauna is similar to the differences observed for fish remains recovered from 1/4" mesh in other archaeological contexts (e.g., Casteel 1972; Gordon 1993; Hanson 1991:158; James 1997; Stein et al. 1992:102).

Table 9. Estimates for numbers of fish specimens per litre in the column and unit assemblages.

Quantification	Unit samples (6mm only) [a]	Column samples (6mm only)	Column samples (3 + 6mm) [b]	2mm column samples [c]	1.5mm column sub-samples*	Column/ unit ratio [d]
Total NSP/litre	1.828	12.04	96.41	140.3	652.0	**52.7**
Total NISP/litre	0.887	5.52	40.8	39.2	152.5	**45.9**
Herring/litre	0.016	0.87	22.11	18.71	40.5	**1367.7**
Anchovy/litre	0.013	0.13	6.74	10.25	104.5	**509.3**
Rockfish/litre	0.580	2.67	4.77	2.67	1.0	**8.2**
Greenling/litre	0.074	0.74	3.62	3.67	1.75	**48.8**
Perch/litre	0.032	0.28	1.09	0.34	2.0	**33.9**
Salmon/litre	0.015	0.13	0.78	2.71	1.5	**53.3**
Examined volume (litres)	24800	148	148	24	4	
Total NISP fish	22100	817	6038	941	610	
Total NSP fish	45333	1782	14268	3369	2608	
Id rate (NISP/NSP)	46%	45%	42%	27%	22%	

*1.5mm estimates should be considered highly tentative due to sampling effort that was disproportionately focused on column N2-4/W102-104, the small examined volume (4L), and sub-sampling that prevented the inclusion of specimens that were recovered in larger mesh sizes (Table 6 and Table 8).

[a] Data from Frederick and Crockford (2005).

[b] Excluding 2mm fauna from column S5-7/W11-13.

[c] Fauna recovered exclusively from column S5-7/W11-13 (Table 5).

[d] 3 and 6mm column fauna divided by 6mm unit fauna.

An even greater proportion of the fish remains appears to be absent from the excavation unit assemblage (Table 9). Corrected for volume, the total number of fish specimens (NISP and NSP) recovered from the 3mm column samples is approximately 45 to 55 times greater than the 6mm excavation samples (Table 9). Moreover, a greater number of fish specimens were recovered from the 6mm column samples screens than in the 6mm field screens (Table 9), indicating that differences in recovery extend beyond the differences in screen size. This latter result suggests that faunal recovery is considerably higher when sorting is conducted in controlled laboratory settings where it is possible to take greater care to sort small bones from the matrix. This roughly six-fold increase is considerably larger than the differences observed between wet and dry screening at other sites on the Northwest Coast (i.e., Cannon 1991:6; Huelsbeck 1994:56).

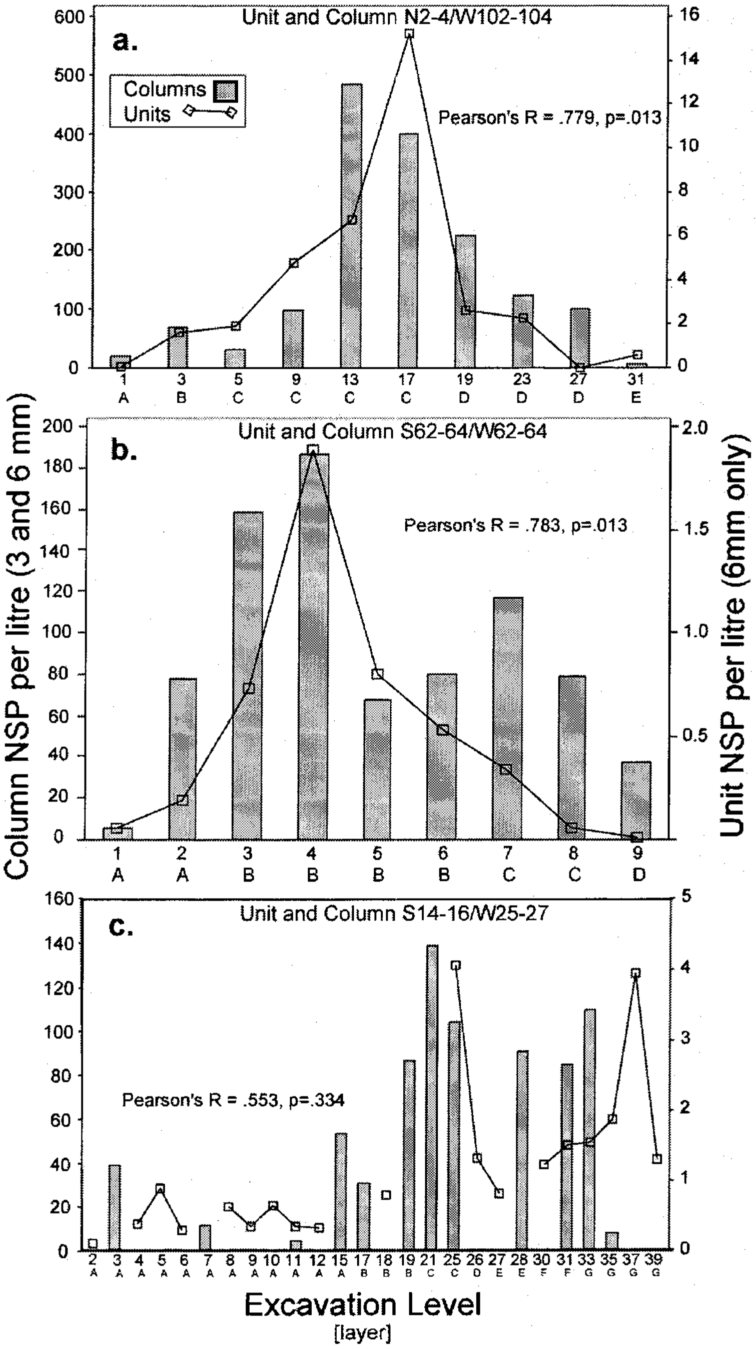
At the species level, differences in the recovery of individual fish taxa are more variable but depict how particular taxa are differentially represented in both assemblages and in relation to each other (Table 9). Specifically, herring and anchovy exhibit the greatest disparity in recovery between the column and unit samples whereas rockfish exhibits the least. This result helps to account for the over-representation of rockfish and the under-representation of herring and anchovy in the unit assemblage. Greenling, perch, and salmon are also recovered in much greater quantities in the 3mm screen sizes than in the 6mm screens. Despite the sheer scale of the increased recovery of fauna in the column sample assemblage relative to the unit assemblage, it is surprising that herring and anchovy appear to be the only two taxa to significantly increase in relative abundance in the column sample assemblage.

Correlating recovery in the unit and column levels

Although the quantification of column sample fauna is generally assumed to reflect the abundance and density of taxa in the surrounding matrix (e.g., Casteel 1976a), this assumption is rarely tested against data obtained from adjacent excavation units (but see Wigen and Eldon 1987). This notion is critical, however, because estimates of the density and taxonomic composition of column sample fauna are often projected from small to large volumes of examined deposit (e.g., Fawcett 1991; Moss 1989). Consequently, extrapolating numbers and proportions of fish remains recovered from different mesh sizes may inaccurately characterize the variable or 'patchy' distribution of these specimens, particularly if this conversion is based on a small number of examined contexts (e.g., Maschner 1997:90; Wigen and Eldon 1987).

As discussed above, the use of multiple measures (abundance, ubiquity, and NSP/litre) and multiple examined deposits (individual level assemblages, column samples, and excavation units) provides a general way to assess the level of variation in the fish assemblage. However, in order to determine whether small scale patterns are similarly expressed in adjacent column and unit assemblages, I further examined the fine-grained association between the adjacent column and unit levels (i.e., arbitrary 10cm increments). To accomplish this, I investigated whether the number of fish specimens per litre found in individual column sample levels is correlated with the number of fish specimens recovered in the adjacent excavation unit levels (Figure 10).

Figure 10. Fish specimen frequency (NSP/litre) in excavation unit and column sample levels for the three columns with associated excavation unit data; a. N2-4/W102-104, b. S62-64/W62-64, c. S14-16/W25-27. Levels missing bars or lines indicate the absence of quantified data. Excavation level numbers refer to arbitrary 10cm levels (i.e., higher numbers represent deeper levels). Layers are stratigraphic "natural layer" designations assigned in the field (McMillan and St. Claire 2005).



The result of this analysis indicates that for the three columns adjacent to units with identified fauna (Columns N2-4/W102-104, S14-16/W25-27, and S62-64/W62-64), there is a significant positive relationship between the number of fish specimens present in the total number of comparable levels (Pearson's R=.764, p<.01, n=23). This suggests that the overall density of fish remains is similarly expressed between these two sampling strategies. However, on an individual basis, the density (NSP/litre) of fauna in the column and unit levels is significantly correlated in only two of the three cases (Figure 10a-b) The one instance in which there was not a significant relationship between the unit and columns was also the column which had the fewest number of paired levels (n=5, Figure 10c). In this respect, the lack of a significant correlation between the fauna recovered from individual column and unit levels in S14-16/W25-27 is most likely due to the small number of paired levels as opposed to a consistently different density of fish in adjacent arbitrary levels (Figure 10c).

Rockfish and greenling length in different screen sizes

Archaeologists have generally observed that the use of smaller mesh sizes recovers smaller-bodied taxa more readily (e.g., Gifford 1916; Gordon 1993; James 1997; Shaffer 1992; Thomas 1969). In the Ts'ishaa column sample assemblage, the increased recovery of herring and anchovy clearly demonstrates an increased abundance for these small fish taxa (<25cm, Hart 1973). However, it is difficult to know the size range of some of the other species found in the assemblage because many of these marine fish continue to grow throughout their often lengthy lifetimes (e.g., Munk 2001) and this makes singular estimates of body size a dubious proposition (Casteel 1976b:119). As discussed previously, both rockfish and greenling represent significant proportions of the unit and column assemblages, but the abundance of rockfish is dramatically lower in the column assemblage whereas the abundance of greenling is incrementally larger in the column sample assemblage (Figure 8). To investigate whether these differences are related to the differential recovery of larger or smaller-bodied individuals, I used the allometric regression formulae developed by Orchard (2003). These formulae provide estimates for the lengths of rockfish and greenling by measuring select skeletal elements recovered from different mesh sizes in the column sample assemblage (Figure 11 and Table 10).

Briefly, these length estimations are based on skeletal measurements taken from a suite of modern fish specimens where the length of the fish and the size of the skeletal element is known and the relationship is evaluated for a sample of multiple individuals (>10). Linear regression is then used to generate equations capable of predicting total length based on the dimensions of individual skeletal elements (Orchard 2003:43-55). For rockfish and greenling, length estimates with high predictive accuracy are available for 16 skeletal elements (mean rockfish R^2=.84±.06; mean greenling R^2=.96$^{\pm}$±.03).

Figure 11. Fish size distribution for measured rockfish (a) and greenling (b) elements from the column sample assemblage recovered from separate screen sizes (box-plots show median, inter-quartile range and outliers). Rockfish (c) and greenling (d) mortality profiles for measurable specimens from all column screen sizes compared against a derived normal curve (Norusis 2000).

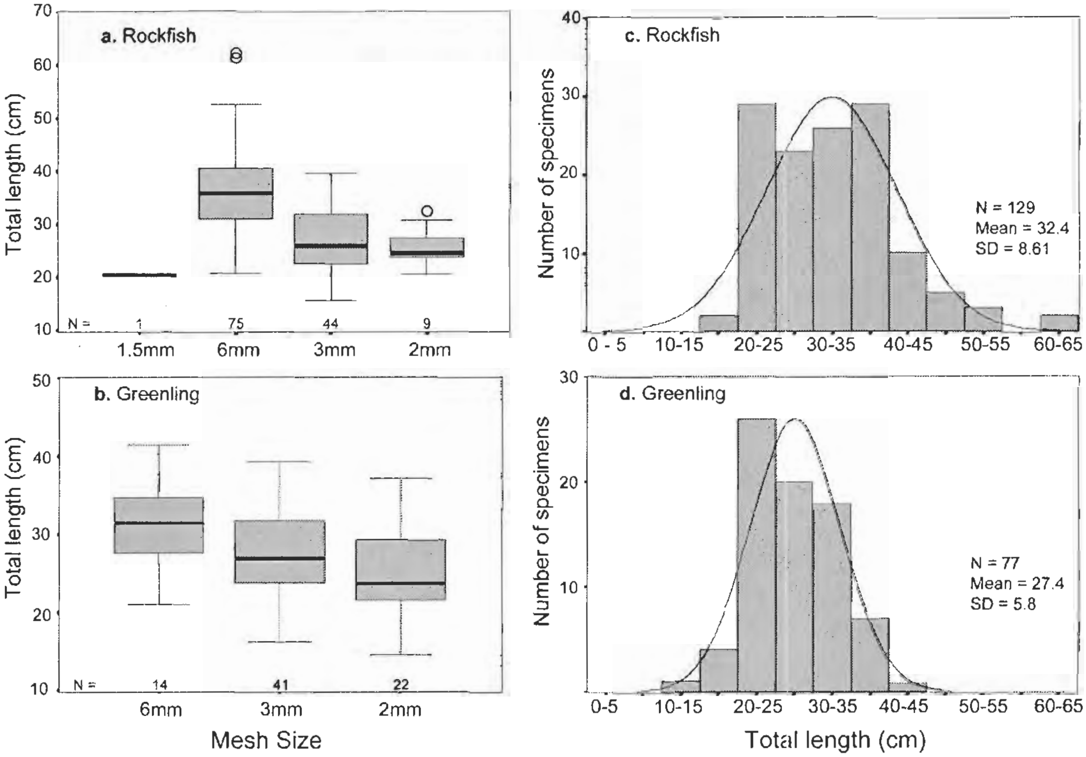


Table 10. Mean total lengths (cm), counts and other measures of rockfish and greenling body size recovered from the different mesh sizes in the column sample assemblage.

		Mesh size				
Taxon	Length (cm)	6mm	3mm	2mm	1.5mm	Total
Rockfish	mean	36.4	27.2	26.0	20.6	32.4
Greenling	mean	30.2	27.9	24.7		27.4
Rockfish	max	62.4	39.6	32.8		62.3
Greenling	max	40.3	39.4	37.1		40.3
Rockfish	min	20.9	15.7	20.6		15.7
Greenling	min	21.0	16.3	14.6		14.6
Rockfish	std. dev.	8.2	5.9	4.0		8.6
Greenling	std. dev.	5.9	5.6	5.1		5.8
Rockfish	count	75	44	9	1	129
Greenling	count	14	41	22		77

By measuring a total of 77 greenling and 129 rockfish elements which could be used to predict total length (TL), I generated estimates of the distribution of fish length for the different screen sizes throughout the column sample assemblage (Figure 11a-d). These analyses illustrate a consistent difference in the average size-class of both rockfish and greenling, with smaller individuals recovered in smaller screen sizes (Figure 11a-b). This demonstrates that 6mm mesh does not adequately represent the range of rockfish and greenling size-classes present in the deposits. Moreover, comparisons of mean length demonstrates that the average size of greenling is 5cm smaller than rockfish, indicating that a substantial portion of the greenling length distribution is smaller than the mean length of rockfish (Figure 11c-d). This is further suggested by the differences in the mean length of greenling and rockfish in the separate screen sizes, where the greatest disparity in fish length is in the 6mm fraction of the column sample assemblage (Table 10). Conversely, the greatest similarity in rockfish and greenling length is in the 3mm mesh (Table 10). Combined with the relative abundance and ubiquity data (Figure 8 and Figure 9), these differences indicate that the reason for the greater proportion of rockfish in the excavation unit assemblage is due to the preferential recovery of larger-sized rockfish relative to the smaller-sized greenling.

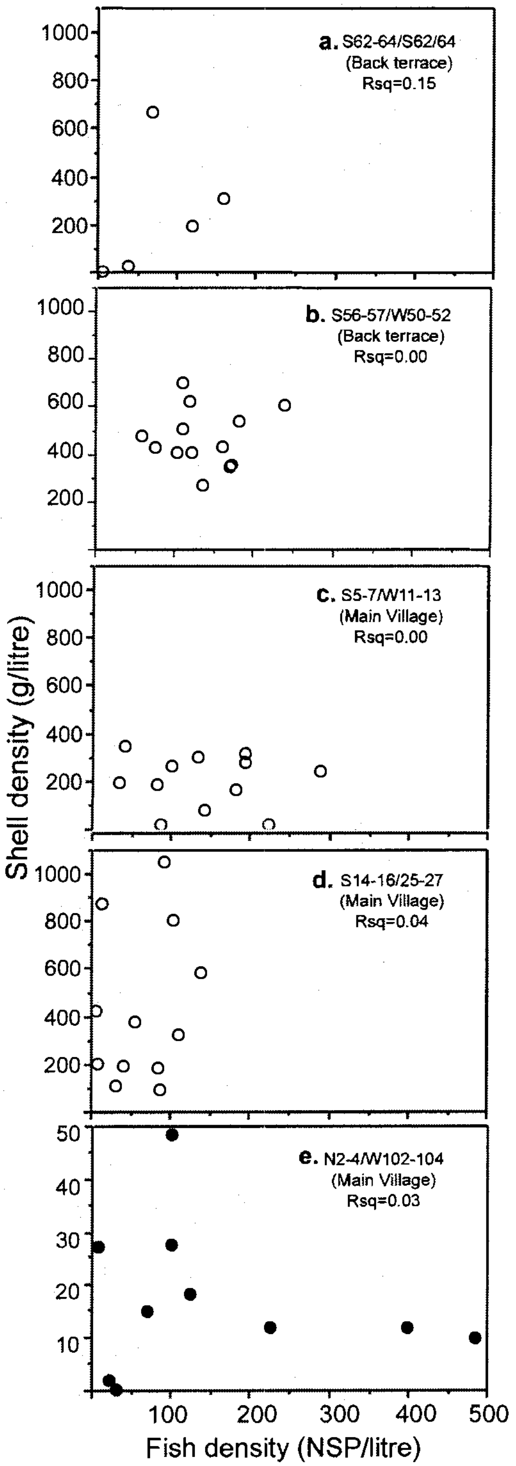
Assemblage Formation and Taphonomy

The excavations at Ts'ishaa exposed rich deposits of molluscan and vertebrate fauna, but the archaeological expression of these remains varies among deposits, levels and within stratigraphic layers. Modelling the distribution of these ubiquitous constituents provides a basis for evaluating their formation and potential degradation over time. The following section examines the influence of taphonomic factors on the faunal assemblage.

Exploring the association between bone and shell

Alkaline conditions created by the abundant presence of shell is considered to be an influential factor that structures the burial environment in shell midden deposits and is conducive to the preservation of bone (Linse 1992; Waselkov 1987:155). However, while the preservation of vertebrate fauna is generally ascribed to the presence of shell (e.g., Ames and Maschner 1999:89; Erlandson 2001:302), the fine-grained association between bone and shell is a rarely reported aspect of shell-midden archaeology. To investigate if the amount of recovered bone is related to the amount of shell in the surrounding matrix, I compared the number of fish specimens per litre (NSP/litre) to the amount of shell (grams/litre) using data collected from the 52 discrete column level samples (unpublished shell data kindly provided by Ian Sumpter). Thus, if there is a positive or negative relationship, this would be indicative of a taphonomic affect. Conversely, if there is not a detectable relationship, this would be suggestive of a random depositional sequence expected for human waste disposal practices (cf. Beck and Hill 2004).

Figure 12a-e. The relationship between shell density (g/litre) and fish density (NSP/litre) for each of the 52 examined levels grouped by individual column sample (Table 5). Note different scale on the y axis of column N2-4/W102-104, where shell data were collected only from the 6mm fraction (filled circles).



The result of this analysis indicates that the frequency of bone fragments and the weight of shell in individual levels from the five column samples is not linearly related (Figure 12). This lack of a correlation suggests that the sequence of faunal deposition is not the result of chemical or taphonomic degradation, at least among the examined deposits containing identified fauna. Rather, this analysis appears to indicate that the depositional sequence of bone and shell is random. Thus, the patterning in shell and bone density cannot be explained by preservation factors alone. This suggests that human-mediated deposition is primarily responsible for the frequency of bone and shell in individual level assemblages.

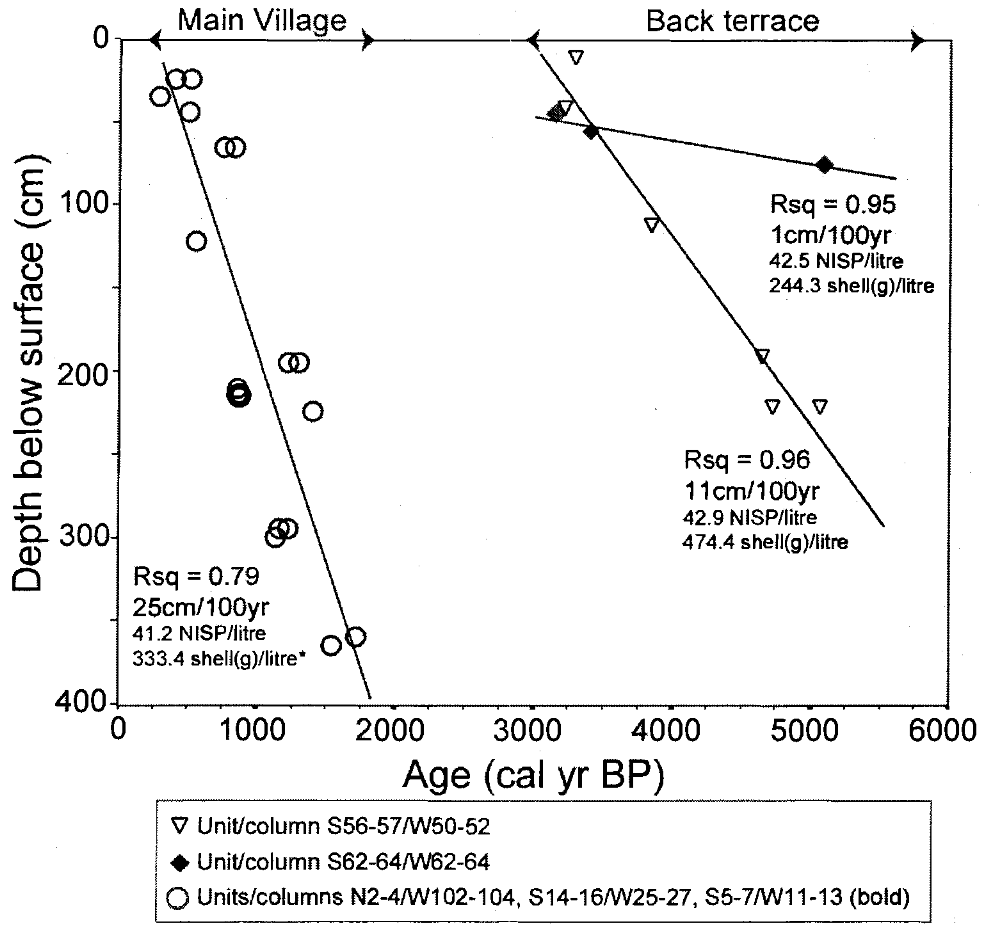
The comparison of the amount of bone and shell present in these spatially and temporally distinct areas of the site also provides an opportunity to evaluate whether the preservation of bone and shell in the older back terrace component of the site (ca. 3000-5000 cal yr BP) differs from the younger main village deposits (ca. 250-1800 cal yr BP). Based on a visual assessment of the plots in Figure 12, it is apparent that broadly similar densities of bone and shell are found in both components of the site. This suggests that chronological differences do not have an effect on the density of shell or fish specimens present in the midden deposits. In fact, only in a few of the 52 examined individual column sample levels do deposits contain a low density of both bone and shell (i.e., S62-64/W62-64, N2-4/W102-104).

Accumulation rates and the formation of the faunal assemblage

Comparisons of the age, rate of burial (accumulation) and density of fauna provides an additional way to assess whether human or taphonomic factors are responsible for the fauna preserved in the examined deposits. Rates of accumulation are produced by complex interplay between the regularity of deposition, the *in situ* deterioration of this material and the erosion or physical attrition of the deposits (Kidwell 1986). However, if bones or shells are subject to slower rates of accumulation, they should tend to be present in lower densities compared to younger or more quickly accumulating deposits (cf., Olszewski 1999). In shell midden contexts, several of these processes presumably affect and are affected by the deposition of vertebrate and molluscan fauna (i.e., the regularity of consumption and deposition, the preservational conditions of the burial environment, and the human and animal use of the immediate landscape).

To explore how these factors may have affected the preservation and density of the fish assemblage at Ts'ishaa, I first estimated the accumulation rates for the five spatially separate deposits containing identified column sample fauna and subsequently examined whether the density of bone and shell varies with the differing rates of accumulation. To generate estimates of accumulation rates (cm/100yr), I compared the age (cal yr BP) and depth below surface (cm) using the 26 ^{14}C dates directly associated with the column sample fauna (Table 11, Figure 13). I determined accumulation rates using correlation coefficients on the group of dates from the three columns dating to the main village occupation (S14-16/W25-27; N2-4/W102-104; and S5-7/W11-13) and individually for the two separate column sample deposits from the back terrace (S56-57/W50-52; S62-64/W62-64) (Figure 13). Each of the column deposits is associated with three or more radiocarbon ages, with the exception of S5-7/W11-13 which is incorporated into the contemporaneous sample of 15 dates from the main village occupation (i.e., DfSi 17, Table 11).

Figure 13. Age of column sample deposits measured against depth below surface based on associated radiocarbon dates (Table 11). Lines represent least squares regression for sub-groups and are shown with the corresponding correlation coefficients. Estimated accumulation rates (cm/100yr) and fish bone density (NISP/litre) are also shown for each group. Asterisk (*) denotes the absence of adequate shell data for column N2-4/W102-104.



This analysis indicates that midden accumulation occurred more rapidly over the past 1800 years in the main village (ca. 250-1800 cal yr BP) than in the back terrace (ca. 3000-5000 cal yr BP, Figure 13). Thus, midden deposits in the highly dispersed (>100m apart) locations of the main village appear to have accumulated at a similarly consistent rate of approximately 25cm every 100 years (Figure 13). In contrast, the two columns from the older back terrace deposits accumulated at distinctly slower rates (~11cm/100yr in col. S56-57/W50-52 and ~1cm/100yr in col. S62-64/W62-64).

Despite considerable differences in accumulation rate, fish bone density (NISP/litre) is strikingly similar among these three separate deposits (Figure 13). On the one hand, this similarity provides reason to suspect that *in situ* degradation over time is not a factor influencing the preservation of the faunal assemblage. On the other hand, the differing rates of midden accumulation indicates that fish bone deposition is higher in areas of rapid accumulation. That is, more bones were deposited per unit of time in deposits with higher rates of midden accumulation. Supposing that higher rates of midden accumulation is a result of more intensive human occupation at the site, the greater number of fish bones per litre(per unit of time) suggests that a more intensive fishery existed at the site during the main village occupation versus the back terrace occupation.

Comparison of the three accumulation rates and the deposition of shellfish indicates that the deposit with the slowest rate of accumulation does have the lowest density of shell (244.3g/litre, S62-64/W62-64, Figure 13). However, the deposit with the highest density of shell (S56-57/W50-52) does not have the fastest accumulation rate, suggesting that rate of accumulation is more complex than the quantity of shell deposited in a single location. It is unlikely that shell deposition is due to deflation of the

Another interesting aspect of this analysis is that three separate areas of the main village show a consistent pattern of midden accumulation over the same temporal interval (ca. 250-1800 cal yr BP). This suggests that the consumption and deposition of midden material was occurring relatively rapidly and on a consistently large scale throughout the site. This finding is consistent with a village occupation, where large quantities of food are processed and consumed over a broad spatial area. This is further supported by the ethnographic information describing Ts'ishaa as a large prehistoric village site (Golla 2000; McMillan and St. Claire 2005; St. Claire 1991).

This analysis has shown that deposits in separate areas of the site represent considerably different scales of temporal resolution (i.e., 10 vertical cm ~40-1000 yrs). Despite these differences, the rate of accumulation does not appear to reflect the *in situ* degradation of the shell midden deposits but rather the intensity of fish deposition.

Table 11. Radiocarbon dates associated with the column sample deposits and used in the calculation of accumulation rates (Figure 13). Calibration achieved using Calib. 4.3 (Stuiver et al. 1998a,b). Marine samples were calibrated with a delta R of 250±0 (100% marine), based on discussion in Southon and Fedje (2003).

Lab number	Site area[a]	Unit	Level/ layer	^{14}C age	Material	d^{13}C **	2 sigma range (cal yr BP)	Midpoint cal yr BP[b]	Depth below surface (cm)	Midpoint depth below surface (cm)
Beta-158744	BT	S56-57/W50-52	4B	3050±70	charcoal	-25	3440-3000	3220	35-45	40
CAMS-97186	BT	S56-57/W50-52	1B*	3100±35	charcoal	-25	3380-3210	3295	5-15	10
CAMS-97177	BT	S56-57/W50-52	11C*	3575±35	charcoal	-25	3980-3730	3855	105-115	110
CAMS-97176	BT	S56-57/W50-52	11C*	3585±40	charcoal	-25	3980-3730	3855	105-115	110
Beta-158747	BT	S56-57/W50-52	17+	4160±70	charcoal	-25	4850-4450	4650	165-235	190
CAMS-97181	BT	S56-57/W50-52	23C*	4210±35	charcoal	-25	4840-4620	4730	225-235	220
CAMS-97182	BT	S56-57/W50-52	23C*	4415±35	charcoal	-25	5260-4870	5065	225-235	220
Beta-158740	BT	S62-64/W62-64	5B	3000±70	charcoal	-25	3360-2950	3155	40-50	45
CAMS-N48305	BT	S62-64/W62-64	6B	3770±35	fur seal	-14.5	3470-3330	3400	50-60	55
Beta-158741	BT	S62-64/W62-64	7/8D	4470±70	charcoal	-25	5320-4870	5095	70-80	75
CAMS-97191	MV	N2-4/W102-104	3B*	350±45	charcoal	-25	510-300	405	20-30	25
CAMS-97192	MV	N2-4/W102-104	3B*	475±35	charcoal	-25	550-480	515	20-30	25
CAMS-85651	MV	N2-4/W102-104	5C	1145±30	fur seal	-14.4	540-470	505	40-50	45
CAMS-85650	MV	N2-4/W102-104	7C	1545±30	fur seal	-14.6	910-760	835	60-70	65
CAMS-97203	MV	N2-4/W102-104	20D*	1385±35	charcoal	-25	1350-1260	1305	190-200	195
CAMS-97204	MV	N2-4/W102-104	20D*	1300±35	charcoal	-25	1290-1170	1230	190-200	195
CAMS-97198	MV	N2-4/W102-104	30D*	1230±35	charcoal	-25	1260-1060	1160	290-300	295
CAMS-97197	MV	N2-4/W102-104	30D*	1310±35	charcoal	-25	1290-1170	1230	290-300	295
Beta-147074	MV	N2-4/W102-104	31E	1230±90	charcoal	-25	1310-950	1130	300	300
CAMS-85649	MV	N4-6/W102-104	7C	1470±30	fur seal	-14.4	830-680	755	60-70	65
CAMS-85648	MV	N4-6/W102-104	21D	1595±35	fur seal	-13.4	950-800	875	210-220	215
CAMS-85647	MV	S14-16/W25-27	4A	895±30	fur seal	-14.1	330-250	290	30-40	35
Beta-134655	MV	S14-16/W25-27	25C	1490±60	charcoal	-25	1520-1290	1405	220-230	225
CAMS-85646	MV	S14-16/W25-27	37G	2235±35	fur seal	-15.3	1620-1460	1540	360-370	365
Beta-134656	MV	S14-16/W25-27	35-37G	1800±60	charcoal	-25	1870-1560	1715	350-370	360
Beta-134657	DfSi17	S5-7/W11-13	24C	970±60	charcoal	-25	970-740	855	210-213	211

[a] BT= back terrace; MV= main village, DfSi 17=Main village deposits associated with Himayisath (Figure 5).

[b] Midpoint of the 2 sigma calibrated range.

* ^{14}C sample obtained from within column sample level..

**^{13}C values given without decimal places are the assumed values according to Stuiver and Polach (1977:335).

Summary

The recovery and analysis of the fine-screen column sample fauna provide significant insight into the taxonomic composition and depositional context of the fish assemblage recovered from the examined shell midden deposits at Ts'ishaa. Through my analyses, I have shown that the overwhelming majority (>85%) of the fish specimens present in the fine-screened (~3mm) deposits are absent from conventional 6mm (1/4") recovery. Despite considerable recovery differences as well as differences in sample size, the assemblage of specimens identified from column and unit samples can be reliably compared and contrasted to assess the relative importance of different fish taxa over time and space. In this respect, the evaluation of the taxonomic composition of the column sample assemblage indicates that six taxa dominate the assemblage in all contexts and chronological periods, implying a focused utilization of fish resources throughout the 5000 year occupation of this site. This is further supported by the examination of the increased species-specific recovery rates as well as an analysis of the biasing effects of larger sized mesh on the recovery of smaller-sized rockfish and greenling. I have also shown that the density of fish remains can be measurably integrated between the small and large volumes of deposits in the column and unit samples. In relation to formation processes and taphonomy, I discovered that there is no apparent relationship between the amount of bone present and the amount of surrounding shell, at least for the deposits containing identified fauna. In addition, the age of the deposits does not appear to affect the density of fish remains recovered from the midden deposits. Thus, human-mediated deposition appears to be the primary factor responsible for the density and taxonomic composition of the fish remains at the site.

Together, the analysis of these data suggest that human participation in the prehistoric marine ecosystem of Barkley Sound was intensively focused on a narrow range of fish resources which vastly outnumbered all other vertebrates consumed at the site. This appears to be the case in all areas of the site and at all time periods. This knowledge provides an important perspective on the cultural and economic practices of the people who inhabited Ts'ishaa for the past 5000 years and serves as a basis for developing further interpretations which are explored in the following chapter.

Chapter Three: Identifying Temporal and Spatial Variability in a Shell Midden

Introduction

A fundamental interpretive goal of zooarchaeological research is to investigate human subsistence as it is commonly practiced over broad time scales. However, this is not the scale at which people live their lives nor is it the tempo at which people procure, consume, and dispose of food resources. Nevertheless, zooarchaeological approaches to measuring human foraging patterns commonly compare a small number of faunal assemblages to depict changes in human behaviour occurring over large temporal and spatial scales (Lyman 2003). On the Northwest Coast, such analyses typically combine all the identified faunal specimens from roughly contemporaneous deposits (i.e., layers, units, or sites) into single assemblages representing broad temporal and/or spatial intervals (e.g., Ames 1998; Calvert 1980; Cannon 1991; Matson 1992; Mitchell 1988; Wigen and Stucki 1988). A drawback of this particular approach is that it often collapses the outcome of many generations of human subsistence into a small number of analytical categories and this limits the amount of observable spatial and temporal variation within those categories. Consequently, the small-scale spatial and temporal variation of human subsistence is not commonly explored in separate areas of coastal shell middens, despite the fact that these large and complex human settlements are considered to differ according to a variety of social, economic, and taphonomic factors (e.g., Coupland et al. 2003; Matson 1992; Stein 1992).

Fishing is a pervasive activity that is highly visible in the archaeological record of Northwest Coast shell middens. Fish are often the most abundant and ubiquitous vertebrates recovered from these sites (e.g., Calvert 1980; Cannon 1991; Hueslbeck

1994) and this presumably reflects how a majority of the population regularly obtained, consumed, and disposed of these important subsistence resources. One way to characterize the archaeological expression of this subsistence activity is to use the most numerous spatially and temporally distinct units of analysis available (e.g., individual level assemblages) to repeatedly measure the abundance of particular fish taxa within and between individual deposits. Through this approach, it is possible to identify differences and similarities in how fish were used over space and time and in a way that more closely approximates the depositional scale of short-term subsistence practices. Moreover, this method provides a way to describe the outcome of subsistence at a variety of spatial and temporal scales (i.e., levels within a deposit, between contemporaneous deposits, and for the site as a whole).

This approach to zooarchaeological analysis does not aim to satisfy conventional criteria of maximizing sample size and taxonomic diversity (e.g., Grayson 1984:127). Rather, the smaller standardized volume of individual level assemblages (litres as opposed to cubic meters) necessarily contains a smaller number of individual animals and less taxonomic diversity. Thus, this method of analysis is only suitable for sites with large numbers of comparable individual assemblages and then only when applied to taxa which are numerically abundant and regularly occur in small volumes of archaeological matrix. In the previous chapter, I used a variety of measures to determine the most abundant and frequently utilized fish throughout the examined deposits. Irrespective of sample size, six particular taxa account for approximately 95% of the fish remains throughout the site, thereby making it possible to assess abundance across multiple depositional contexts without a minimum sample size.

In this chapter, I use fauna identified from individual level assemblages to characterize temporal changes in the abundance of the six most numerous and ubiquitous fish taxa recovered from the Ts'ishaa village site. My goal in doing so is to describe the use of fish at this site over broad time scales without excluding sources of spatial and temporal variation. To do this, I use multiple proxies of abundance to evaluate the archaeological expression of fish remains in different areas of the site (i.e., %NISP, NISP/litre and %NISP from excavation unit material). At the broadest temporal and spatial scale, I compare the abundance and length of fish taxa in two temporally and spatially distinct deposits (i.e., ca. 250-1800 cal yr BP vs. ca. 3000-5000 cal yr BP). I then explore temporal and spatial variation occurring within these broad deposits, using six temporal periods defined on the basis of 28 associated radiocarbon dates.

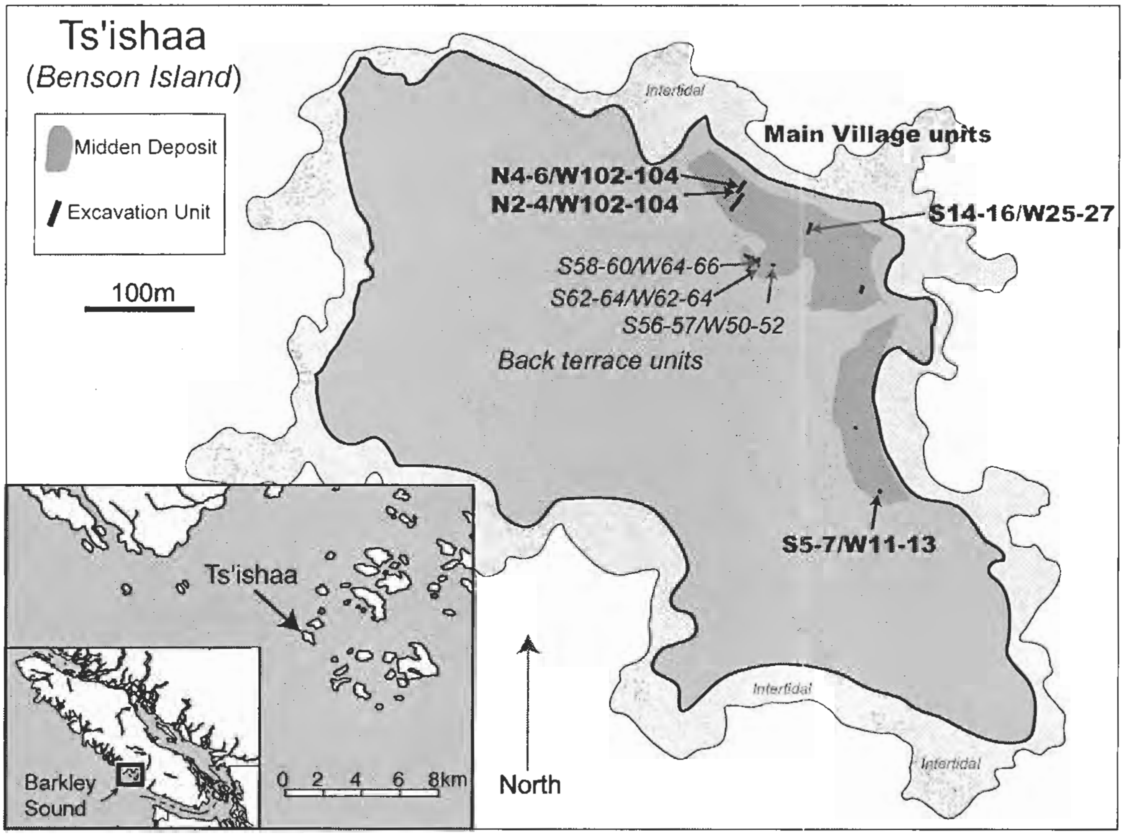
Distinguishing fine-scale temporal and spatial variation of fish in the midden deposits allows me to evaluate the social and ecological context of fishing practices at this large prehistoric village site (Figure 14). By grouping spatially separate deposits by temporal periods, I am able to determine if evidence of fishing practices is similar throughout the site and whether comparable trends in abundance occur over time and space. In this respect, individual level assemblages from specific column samples and excavation units provide a frame of reference for understanding how fish taxa were regularly used in particular areas of this large site (household level), while combined they provide a perspective on the use of these resources throughout the site (community level). Collectively, these analyses help to refine our understanding of the culturally specific use of resources and the context of everyday life in a prehistoric Nuu-chah-nulth village.

Archaeological Context

The Ts'ishaa archaeological site is the ethnographically identified origin village of the Tseshaht people (McMillan and St Claire 2005) and specific areas of this site are named locations of subgroup household societies (*ushtak̲imilh*, Sapir n.d.). Faunal remains have been identified from six physically separate areas of the site (Figure 14, and Table 13).

Three of these deposits are in areas of the site associated with the named locations of households. These are adjacent to the modern shoreline in deposits ranging from ca. 250-1800 cal yr BP (N2-6/W102-104; S14-16/W25-27; S5-7/W11-13). The three other deposits containing identified fauna are considerably older (ca. 3000-5000 cal yr BP) and are not directly identified in the oral history pertaining to the island (S56-57/W50-52; S62-64/W62-64; S58-60W64-66). Thus, the archaeological deposits in the site as a whole can be broadly categorized into two spatially and temporally distinct deposits: 1) the main village midden (ca. 250-1800 cal yr BP), and 2) the back terrace midden (ca. 3000-5000 cal yr BP) (Figure 14). In both deposits, the smallest temporal and spatial scale at which fish remains were recovered and identified is by individual excavation level (10cm). These broad temporal categories provide an initial framework from which to evaluate the composition of species in these two areas of the site.

Figure 14. Map of the archaeological deposits at Ts'ishaa showing the multiple excavation units and column samples containing identified fauna (Table 12 and Table 13). Map adapted and modified from McMillan and St. Claire (2005). Used by permission.



Methods

To study the temporal and spatial variation of the fish remains recovered from Ts'ishaa, six fish taxa from individual level assemblages in the back terrace and main village are first compared using multiple measures of abundance (analyses 1-5). Subsequently, the temporal and spatial variation *within* the main village and back terrace deposits is explored from a variety of scales (analyses 6-9). The goal of these analyses is to measure the composition and density of fish remains occurring throughout the deposits at the site in order to determine if there is spatial or temporal coherence in the way fish resources were used at the site in prehistory.

Measures of abundance comparing two distinct areas of the site

Analysis 1. Using cluster analysis to describe fish fauna from dispersed deposits

To explore how fishing practices are archaeologically expressed among the examined deposits at the site, I first investigate whether there are non-random differences in the composition of fish taxa recovered from spatially and temporally separate areas of the site. The purpose of this analysis is to understand whether faunal assemblages from the separate areas of back terrace and main village contain a similar composition of specific fish species. To do this, I use hierarchical cluster analysis (Norusis 2000) to measure the degree of similarity among the five column samples and six excavation units containing identified fauna. This analysis is based on the relative abundance of fish taxa quantified by the total number of identified specimens in each column sample or excavation unit (i.e., not individual level assemblages). Two cluster analyses are conducted: the first is based on the composition of fish remains recovered from the five column samples and the second is based on the fish remains recovered from the six excavation units. The analysis performed on the excavation unit fauna does not include herring and anchovy specimens as these two species were too small to be adequately recovered in 6mm mesh (Table 9). In addition, two of the excavation units are from areas not directly associated with a column sample (e.g., N4-6/W102-104 and S58-60/W64-66). Combined with the separate recovery strategies, these differences increase the analytical independence of the two cluster analyses.

Analysis 2. Comparing relative abundance values in the main village and back terrace

After initial exploration of spatial and temporal variation using cluster analysis, I examine the differences and similarities in the relative abundance (i.e., %NISP) of the six most abundant fish taxa (anchovy, greenling, herring, perch, rockfish, and salmon) between the main village and back terrace deposits. A goal of this analysis is to determine if there are significant differences in the relative abundance values of selected fish taxa between these temporally and spatially separate deposits. To do this, I graphically and statistically compare the abundance values in the individual level assemblages from the main village and back terrace deposits among the five column samples recovered from spatially discrete locations. This comparison provides a context for establishing if some taxa are consistently a specific proportion of the assemblages and whether these values are present throughout the deposits.

Analysis 3. Comparing volumetric abundance values in the main village and back terrace

To further explore differences between the individual level assemblages recovered from the back terrace and main village column sample deposits, I use a measure of volumetric abundance (NISP/litre) to evaluate differences among each of the six fish taxa. Unlike relative abundance values, this approach is not influenced by the effects of closed arrays (Grayson 1984:17-20). To achieve this comparison, I transform the number of specimens found in the individual level assemblages into number of specimens per litre (NISP/litre). I recognize that this conversion has the potential to be influenced by a variety of depositional factors (e.g., shellfish, fire altered rock, taphonomic degradation, etc.). However, it is used here as an additional proxy for evaluating trends in abundance among specific fish taxa. Thus, if both the relative and volumetric abundance values show similarly significant trends, this will provide additional evidence for a substantial shift in the proportion of species.

Analysis 4. Searching for similar differences among the fauna from the excavation units

Although the fine screen (3mm) mesh recovery from the column samples provides the most appropriate basis for measuring differences in fish abundances between the back terrace and main village middens, these samples are derived from a relatively small excavated area of the site (i.e., 172 litres). In contrast, the fish remains identified from the unit samples represent a much larger excavated volume (i.e., 26.4m^3), but this dataset is limited to larger fish taxa collected in the field through 6mm mesh (discussed in Chapter 2). To explore whether patterns observed in the column samples are represented in a larger spatial area of the site, I utilize the individual level assemblages from the six excavation units containing identified fauna to measure differences in the relative abundance values from the main village and back terrace deposits. Thus, if there are significant trends in the column samples that are also present in the unit samples, this provides a high level of confidence that patterns observed are expressed in a large spatial area of the site. This comparison is based on only four taxa: perch, rockfish, greenling, and salmon. It excludes herring and anchovy as the use of 6mm mesh prevented the recovery of these species in large enough quantities to warrant comparison.

Analysis 5. Comparing rockfish and greenling size in the main village and back terrace

To further explore whether the differences observed in rockfish and greenling abundance between the main village and back terrace deposits extend to the body size of these two taxa, I compare the average lengths of rockfish and greenling between the main village and back terrace deposits. This analysis is based on measurements taken on 3,040 skeletal elements recovered from 6mm mesh in the excavation units. Length estimates are generated using the regression formulae defined by Orchard (2003) and size differences are evaluated using one-way analysis of variance (ANOVA) and Mann-Whitney U tests (Norusis 2000). This analysis was first conducted by lumping the total number of length estimates for each taxa between the spatially and temporally distinct areas of the site. However, in order to achieve a more equitably distributed estimate of the average body length found throughout the two deposits, an additional comparison is made using the average length for each individual level assemblage.

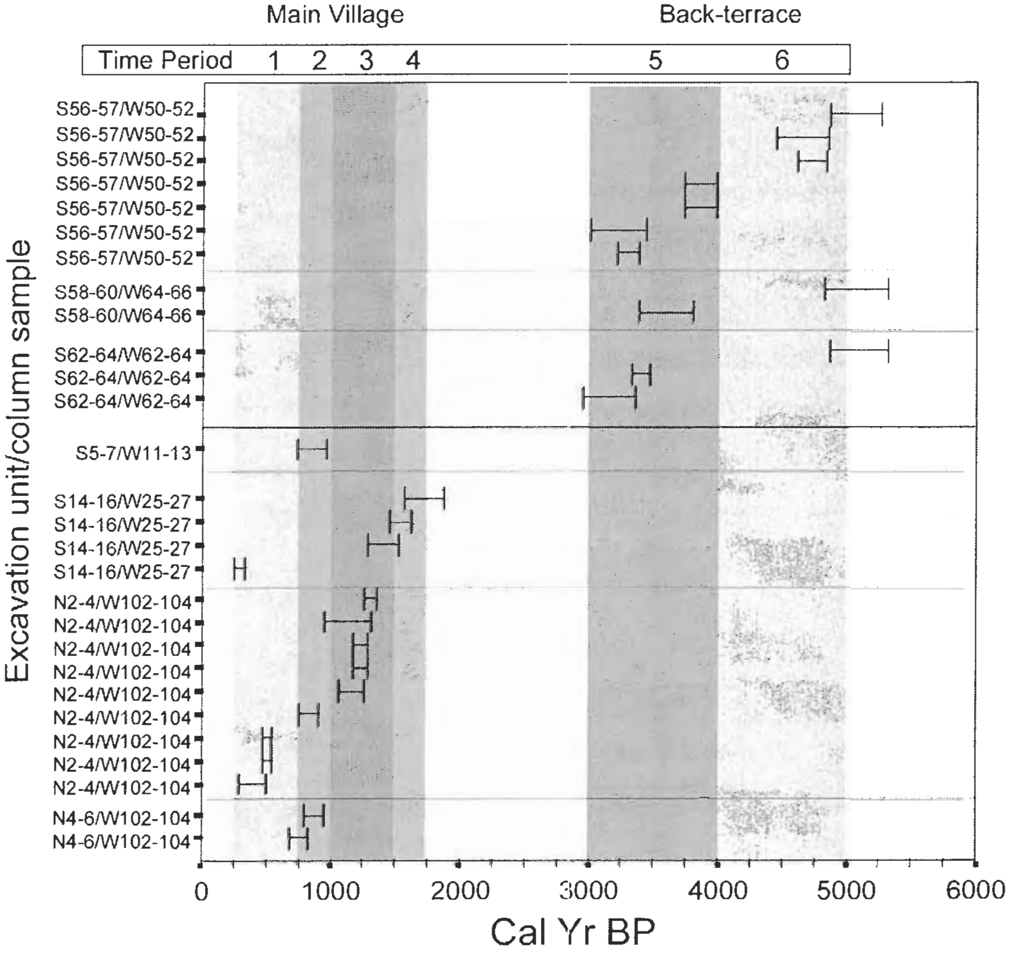
Measures of abundance comparing six temporally and spatially distinct areas of the site

Analysis 6. Assessing temporal variation within the back terrace and main village deposits

Building upon the differences identified between the back terrace and main village portions of the site, I further explore internal temporal variation within these specific deposits. To accomplish this, I categorize the individual level assemblages in the main village and back terrace into six discrete temporal intervals (Figure 15, and Table 13). This requires judgementally determining chronological sequences for each excavated area using the 28 radiocarbon dates directly associated with the five column samples and the six excavation units containing identified fauna (Table 12 and Table 13). This analysis provides a context for exploring whether broad-scale trends in the use of fish taxa are occurring at a narrower temporal scale.

For deposits from the back terrace, I use the 12 radiocarbon dates directly associated with each of the three excavated areas containing identified fauna to divide the back terrace deposits into two temporal periods, one spanning the period between ca. 3000-4000 cal yr BP and the other dating to between ca. 4000-5000 cal yr BP (Figure 15). In the main village deposits, I use 16 radiocarbon ages to distinguish four temporal periods (Figure 15). Since only a single radiocarbon date was recovered from the base of column S5-7/W11-13 (ca. 970-740 calibrated range yr BP), I included the bottom third of this deposit within time period 2 while the upper two thirds of this deposit is designated as dating to time period 1. Each temporal period contains fish remains from more than one spatially dispersed area of the site (Table 12 and Table 13) with the exception of period 4 (ca. 1500-1800, unit S14-16/W25-27). The stratigraphic context of these temporal distinctions can be found in Appendix A.

Figure 15. Calibrated radiocarbon ages directly associated with the six excavation units from the main village and the back terrace deposits containing identified fauna (2 sigma calibrated range). Note the single radiocarbon date from unit S5-7/W11-13 (*see* analysis 6). Shaded vertical columns denote temporal periods.



Once the sequence of six temporal periods is established, I graphically and statistically compare temporal variation using the abundance values from all individual level assemblages to characterize trends and differences occurring over the six time periods. As in the comparisons between the main village and back terrace, this analysis employs three measures of abundance to establish differences between time periods: 1) relative (%NISP) and 2) volumetric (NISP/litre) abundance values for the column samples and 3) relative (%NISP) abundance for the excavation unit samples (the latter including only rockfish, greenling, salmon, perch). To evaluate if there are significant changes in abundance over time, statistical comparisons of abundance for the six taxa are made between adjacent temporal periods with the exception of period 4. Boxplots are used to graphically evaluate trends over time.

Table 12. Number of individual level assemblages by time period from each of the five column samples. See appendix B1 for faunal data.

		Main Village column samples			Back-terrace column samples		
Time period	Temporal interval (cal yr BP)	N2-4/ W102-104	S14-16/ W25-27	S5-7/ W11-13	S56-57/ W50-52	S62-64/ S62-64	Total
1	250-750	3	3	5			11
2	750-1000	3	3	7			13
3	1000-1500	4	3				7
4	1500-1800		3				3
5	3000-4000				6	3	9
6	4000-5000				7	2	9
Total		10	12	12	13	5	52

Table 13. Number of individual level assemblages by time period from each of the six excavation units. See appendix B2 for faunal data.

		Main Village excavation units			Back-terrace excavation units			
Time period	Temporal Interval (cal yr BP)	N2-4/ W102-104	N4-6/ W102-104	S14-16/ W25-27	S56-57/ W50-52	S62-64/ W62-64	S58-60/ W64-66	Total
1	250-750	4	3	9				16
2	750-1000	5	2	1				8
3	1000-1500	5	3	4				12
4	1500-1800			5				5
5	3000-4000				6	6	6	18
6	4000-5000				2	3	6	11
Total		14	8	19	8	9	12	70

Analysis 7. Exploring temporal trends within individual column samples

To further explore if temporal differences in fish abundance are similarly expressed in different areas of the site, I examine temporal trends among each individual column and unit sample. The purpose of this analysis is to provide additional insight into the variation and trends observed in the previous analysis by showing how variation in the abundance of fish taxa is expressed in individual deposits, particularly whether assemblages from contemporaneous deposits show similar directional trends in abundance over time. To achieve this, I graphically compare the mean abundance values for the multiple level assemblages from individual column or unit samples by temporal period. The use of small sample numbers of individual level assemblages prevents statistically meaningful comparisons between time periods, but this analysis helps to identify which fish taxa show similar trends over time and how these trends are expressed in spatially separate areas of the site.

Analysis 8. Linking changes in rockfish and greenling size to trends in abundance

The extensive record of human occupation and resource use at Ts'ishaa provides an opportunity to evaluate the prehistoric human impact on the marine ecosystem in the Broken Group Islands. Among the many ways to investigate this topic, I focus on the changes in relative abundance and size of two important fish taxa: rockfish (*Sebastes sp.*) and greenling (*Hexagrammos sp.*). These two taxa comprise the third and fourth most abundant vertebrate remains present throughout the site (Chapter 2) and were most likely captured on an individual basis (e.g., hook and line, basket trap). Moreover, both are long-lived (Munk 2001), non-migratory taxa that inhabit high-relief rocky reef habitat (Murie et al., 1994) as surrounds Ts'ishaa and the Broken Group Islands (Tomascik and Holmes 2003). These qualities make these taxa vulnerable to overexploitation and are principal reasons for the current marine protected area status encompassing the Broken Group Islands (Deptartment of Fisheries and Oceans 2004b).

To evaluate whether human fishing activity may have negatively affected the population structure of the nearshore rockfish and greenling populations (cf. Broughton 1997; Butler 2000), I graphically and statistically compare changes in rockfish and greenling length over the six temporal periods. To achieve this, measured elements recovered from excavation units throughout the site (6mm mesh, n=3,040) were lumped into temporal periods and rockfish and greenling size is compared using one-way ANOVA with post-hoc tests (Norusis 2000). The purpose of this comparison is to establish whether there are progressive trends in the length of these two abundant fish taxa over the six temporal intervals throughout the site.

Analysis 9. Linking trends in the size and abundance of rockfish and greenling by individual deposit (excavation unit)

Subsequent to examining changes in fish length throughout the site as a whole, I investigate whether variation in rockfish and greenling fish length is similar among contemporaneous but spatially dispersed deposits. This analysis provides further insight into how the trends in fish length are differentially expressed throughout the site. I then compare the results of this analysis with mean relative abundance values (analysis 7) to determine if coeval reductions in fish length and abundance are occurring in specific areas of the site or vice-versa. Based on these comparisons, I am able to assess whether human fishing activity in particular areas of the site negatively affected the nearshore (<1km) populations of these long-lived fish taxa.

Results

Analysis 1. Using cluster analysis to describe fish fauna from dispersed deposits

The cluster analyses of both the five column samples and the six excavation units strongly suggests there is a clear distinction between the fish assemblages from the main village and the back terrace (Figure 16 and Figure 17). These results hold even though there are considerable differences in recovery technique, sample size, and species composition between faunal remains in the column and unit samples. In both cases, the composition of fish species in the back terrace samples are more similar to each other than they are to the main village samples. Given that each of these two areas of the site is dominated by the same six fish taxa (chapter 2), it seems reasonable to conclude that these differences are likely due to the relative proportion of these specific taxa. This possibility is explored further in the next three sections.

Figure 16. Hierarchical cluster analysis of the identified column sample fish remains based on the relative abundance for all non-overlapping fish taxa identified from each of the five column samples. Measures are squared euclidian distances using the average between group linkage (Norusis 2000).

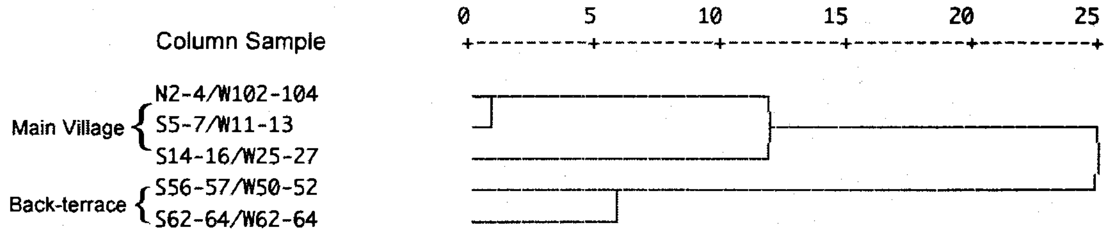
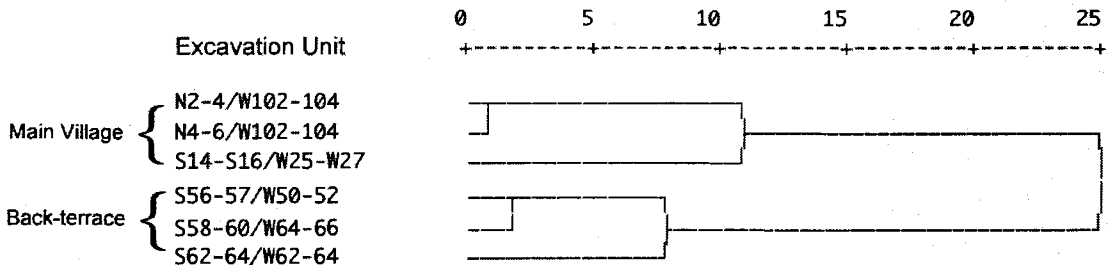


Figure 17. Hierarchical cluster analysis of the fish remains from the six excavation units. Clusters are based on the relative abundance values for all non-overlapping fish taxa. Distance measures are squared euclidian and the cluster method is the average between group linkage (Norusis 2000).



Analysis 2. Comparing relative abundance values in the main village and back terrace

The relative abundance values for the individual level assemblages recovered from the main village and back terrace deposits differ for five of the six examined taxa (Figure 18, left column). Specifically, greenling is significantly more abundant in the back terrace deposits than in the main village (Mann Whitney *U* p<.0001), while rockfish and anchovy are present in significantly higher proportions in the main village (MWU p=.018, p=.003 respectively). Salmon is marginally more abundant in the main village deposit (MWU p=.056), while perch is more abundant in the back terrace (MWU p=.050). There is not a significant difference in the abundance of herring between the main village and back terrace deposits (MWU p=.715).

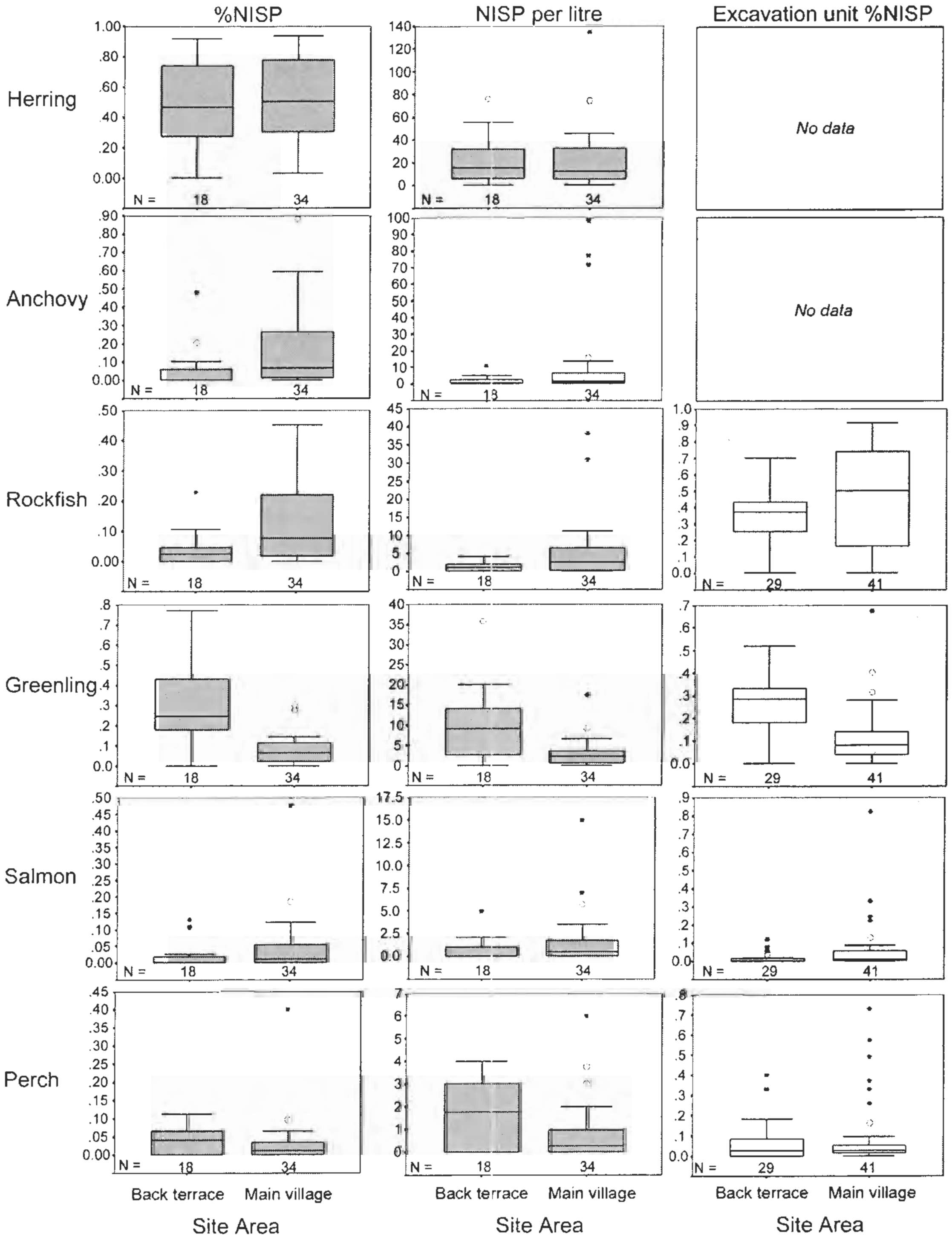
Analysis 3. Comparing volumetric abundance values in the main village and back terrace

Comparisons of volumetric abundance values (NISP/litre) from the back terrace and main village assemblages demonstrate identical patterns to those previously detected using relative abundance (Figure 18, centre column). These results indicate that the differences between the main village and back terrace deposits are not simply due to the effects of a closed sample array (cf. Grayson 1984:17-20), but most likely reflect actual changes in the abundance of five of the six fish taxa over time. Once again, both greenling and perch are significantly more abundant in the back terrace (MWU p<.001, p=.045 respectively), whereas rockfish is significantly more abundant in the main village (MWU p=.011). Likewise, there is a higher abundance of salmon in the main village compared to the back terrace, but this difference is yet again just beyond the range of statistical significance (MWU p=.070). As in the previous comparison, there is no difference in the abundance of herring between the two deposits (MWU p=.513).

Analysis 4. Searching for similar differences in the excavation unit fauna

The comparison between the main village and back terrace using the relative abundance data from the excavation units indicates largely similar trends to those identified in the column samples (Figure 18, right column). As in the two previous analyses, greenling are observed to be significantly more abundant in the back terrace deposits of the site (MWU p<.001), while salmon are significantly more abundant in the main village deposits (MWU p=.014). Rockfish are also more abundant in the main village deposits, but this comparison is just beyond the conventional level of significance (MWU p=.054). On the other hand, there is not a detectable difference between the relative abundance value of perch in the main village and back terrace (MWU p=.586). This latter result represents a departure from the two previous analyses and suggests that perch do not show a coherent trend among the column sample and unit data. This is due primarily to the high number of perch remains recovered in the upper levels of unit S14-16/W25-27 (outliers in Figure 18).

Figure 18. Abundance values for six fish taxa based on individual level assemblages from the main village (ca. 250-1800 cal yr BP) and back terrace deposits (ca. 3000-5000 cal yr BP). Graphs on the left represent column sample relative abundance values (%NISP) while graphs in the centre represent volumetric abundance values (NISP/litre) from the column samples. Unshaded graphs on the right show relative abundance values (%NISP) from the excavation units. Numbers of assemblages per category are listed below the x axis. Boxplots show the median (line), the middle 50% of cases (box), and cases which lie within 1.5 box lengths (outer lines). Circles (°) represent outliers between 1.5 and 3 box-lengths and asterisks (*) represent outliers which lie beyond 3 box lengths.


%NISP
NISP per litre
Excavation unit %NISP
Herring
Anchovy
Rockfish
Greenling
Salmon
Perch
No data
No data
N = 18 34
N = 29 41
1.00
.80
.60
.40
.20
0.00
140
120
100
80
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7.5
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.05
0.00
7
6
5
4
3
2
1
0
Back terrace
Main village
Site Area

Analysis 5. Comparing rockfish and greenling size in the main village and back terrace

Based on the comparison between all measured specimens (Figure 19), rockfish in the main village are significantly smaller than in the back terrace (MWU, p<.000), while greenling length does not differ between deposits (MWU, p=.490). Similarly, the mean length calculated for each individual level assemblage (Figure 20) shows that rockfish are again, significantly smaller in the main village deposits (ANOVA, p=.004), while greenling exhibit no difference (ANOVA, p=.139). This latter analysis was conducted in order to more equitably represent the size of fish from spatially dispersed areas of the site. Based on these results, it is possible that human fishing activity may have negatively affected the local rockfish populations during the main village occupation (cf. Broughton 1997). However, since larger rockfish are found in deeper waters (Murie et al. 1994; Richards 1986), this could also be the result of a shift in procurement from deeper to shallow(er) waters during the main village occupation. Regardless, the mean difference in rockfish length between the main village and back terrace deposits is only 3.7cm. While this is a small difference in rockfish length, the fact the difference persists among two separate measures and across broad (millennial) temporal periods suggests that the difference may be culturally or ecologically significant. A more detailed assessment of how fish length changed within these broad temporal periods is explored in a following section (Analysis 8).

Figure 19. Rockfish (*Sebastes sp.*) and greenling (*Hexagrammos sp.*) length distributions based upon all measured elements combined from throughout the examined back terrace (ca. 3000-5000 cal yr BP) and main village deposits (ca. 250-1800 cal yr BP). Number of measured specimens indicated below the x axis.

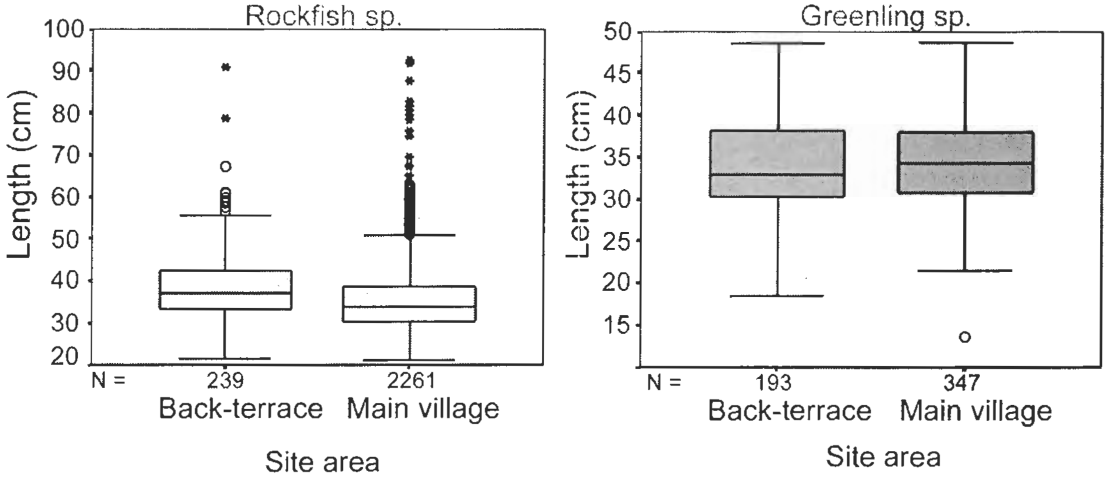


Figure 20. Rockfish (*Sebastes sp.*) and greenling (*Hexagrammos sp.*) length distributions based on the mean length among individual level assemblages and grouped by the back terrace (ca. 3000-5000 yr BP) and the main village component (ca. 250-2000 yr BP). Number of individual level assemblages indicated below the x axis.

Summary of changes in abundance between the main village and back terrace

Collectively, these results provide evidence to suggest that fishing practices exhibit widespread and significant differences in the abundance of four of six fish taxa (anchovy, greenling, rockfish, and salmon) throughout the temporal and spatial deposits in the main village and back terrace. Because these taxa are among the six most numerous vertebrate remains present in the site as a whole (Chapter 2), this implies that a comprehensive shift occurred in the way people procured and used fish resources during these two periods of occupation.

While these results strongly demonstrate that the use of important fish taxa changed over time, they also show that there was considerable stability in the archaeological expression of fishing practices over broad temporal and spatial scales (e.g., ca. 3000-5000 cal yr BP). The level of analytical resolution provided by the use of individual level assemblages more closely approximates the temporal and spatial scale of everyday depositional activity and suggests that specific fish taxa were procured, consumed, and deposited in a consistent manner over thousands of years throughout the site. This implies a level of patterned human behaviour that extends over multiple human generations.

This approach successfully characterized changes in fish use from spatially dispersed areas of a large site among three independently derived measures of abundance (%NISP, NISP/litre, EU %NISP). In particular, there are significantly more greenling in the back terrace deposits, while there are significantly more rockfish, anchovy, and salmon in the main village deposits. Conversely, the relative abundance of herring does not appear to differ between these two deposits. Rockfish body size is reduced in the main village deposits, whereas there is not a detectable change in the size of greenling. Perch does not appear to demonstrate a consistent pattern between the column and unit samples. To further explore if these temporal and spatial patterns are present at a finer level of temporal resolution, the remainder of the chapter explores how patterns in the abundance of fish taxa are similarly expressed within dispersed areas of the main village and back terrace over time.

Analysis 6. Assessing temporal variation <u>within</u> the back terrace and main village

The analysis of temporal trends suggests that herring, anchovy, rockfish, and greenling exhibit dramatic fluctuations in abundance in one or more of the six temporal periods. These fluctuations are observable among the multiple abundance measures but can only be statistically evaluated among adjacent temporal periods. Nevertheless, these analyses provide evidence to suggest that the variation in abundance of these six fish taxa reflect site-wide patterns in the use and deposition of fish, the most abundant and ubiquitous vertebrate food resource present in the site. This is discussed for each taxon in turn below.

Herring

During time period 2 (ca. 750-1000 cal yr BP), herring comprise a low relative and volumetric abundance, suggesting that the use of herring may have been reduced throughout the site during this temporal interval (Figure 21). Although herring appears to exhibit pronounced fluctuations in abundance between periods 1-4, this is only statistically significant between periods 2 and 3 (%NISP – MWU p=.002; NISP/litre – MWU p=.017). Likewise, while herring appears to increase in abundance from time periods 2 to 1, this difference is only significant among the relative abundance values (%NISP – MWU p=.002). As for all taxa, the different abundances observed in period 4 cannot be statistically compared with adjacent periods as this period is represented by only one excavation locality (e.g., S14-16/W25-27) and contains less than 5 individual level assemblages (Table 12 and Table 13).

Anchovy

Anchovy is significantly more abundant during time period 2 than in time periods 3 and 1 (period 3 [*%NISP* – MWU p=.003; *NISP/litre* – MWU p=.021] period 1 [*%NISP* – MWU p=.003; *NISP/litre* – MWU p=.007]), suggesting that anchovy comprised a high proportion of the fish assemblages throughout the site between ca. 750-1000 cal yr BP. Aside from this one period of increased abundance, however, anchovy represent a consistently low proportion of the fish remains (Figure 21). Notably, during period 5, anchovy are virtually absent amongst the nine individual level assemblages dating to that period (Figure 21). Considering that anchovy are warm water associated species at this latitude (Hart 1973), it is possible that the dramatic spike in abundance observed in period 2 (ca. 750-1000 cal yr BP) could be associated with higher sea surface temperatures associated with the medieval warm period (ca. 600-1000 cal yr BP; Lamb 1995).

Rockfish

Rockfish is significantly less abundant in time period 1 than in time period 2 among all available measures of abundance (*%NISP* – MWU p<.001; *NISP/litre* – MWU p<.001; *EU %NISP* – MWU p<.001). This result strongly indicates that the use of rockfish was dramatically reduced during the final period of occupation at the site (time period 1, ca. 250-750 cal yr BP). Excluding time period 4 due to small sample size, rockfish abundance appears to steadily increase between periods 6 and 2, suggesting a site-wide trend towards increased use of this taxon (Figure 21). Considering that rockfish are abundantly available in the nearshore environment year-round and represent a significant portion of the fish assemblage, the near absence of this taxon during period 1 would seem to reflect a fundamental shift in the way fishing was practiced throughout the site during this interval.

Greenling

Overall, the trends in greenling abundance are strikingly similar across abundance measures, showing high abundance values in the two back terrace temporal periods (time periods 5 and 6) and a progressive increase between periods 4 and 1 (ca. 1800-250 cal yr BP, Figure 21). There is a significant decrease in the abundance of greenling among all three abundance measures between periods 5 and 3 (%NISP – MWU p=.007; NISP/litre – MWU p=.012; *EU* %NISP – MWU p<.001) (Figure 21). The consistently high abundance of greenling in the two back terrace time periods replicates the differences observed between the main village and back terrace (analyses 2-4, Figure 18). Aside from the two back terrace periods, the highest abundance of greenling appears during period 1 (ca. 250-750 cal yr BP).

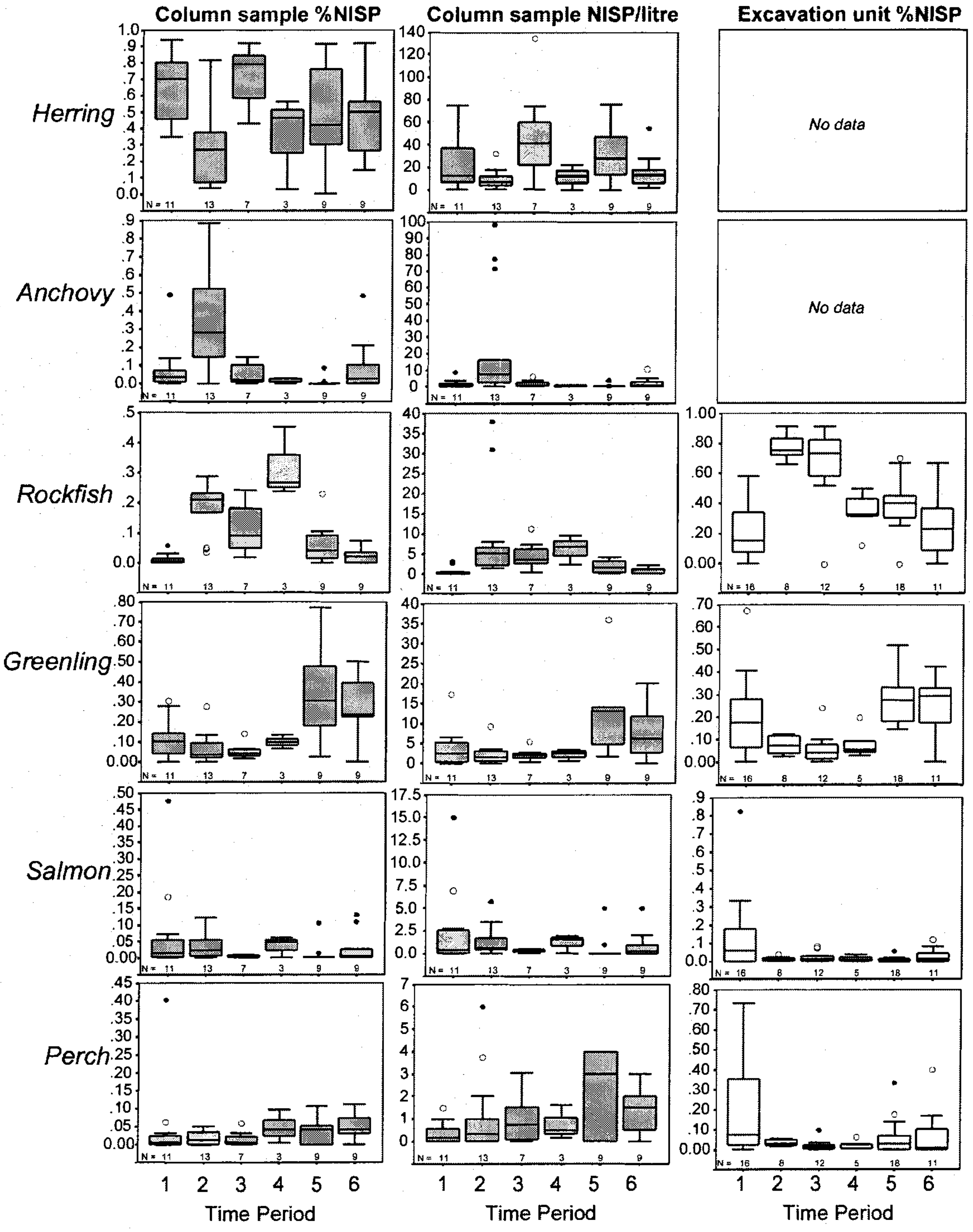
Salmon

Excluding time period 4, there appears to be an increased abundance of salmon among the column samples between period 2 and 3 but this is just beyond the range of significance among the column samples (%NISP- MWU p.=056; NISP/litre – MWU p=.056) and is not observed among the excavation unit samples until period 1 (Figure 21). Salmon abundance appears lowest in time period 5 where salmon is virtually absent from the numerous level assemblages dating to this time period. The seemingly substantial increase observed between periods 1 and 2 in the unit samples is not statistically significant (*EU* MWU p=.325)

Perch

Overall, there are no significant differences in the abundance of perch between temporal periods (Kruskal-Wallis *H* p=.079-.326) but there appears to be a slight downward trend in abundance from period 6 through 1 among all abundance measures with the exception of period 1 in the unit samples (Figure 21). While the spike in abundance observed during period 1 among the unit samples is not significantly different than period 2 (MWU=40, p=.142), it represents a departure from the pattern observed in the column samples (Figure 21). This discrepancy is caused by a high abundance of perch in the upper levels of the S14-16/W25-27 unit and column sample (Figure 21) which is not present in the two other localities dating to this temporal interval.

Figure 21. Abundance values for six fish taxa across six temporal periods based on individual level assemblages collected from throughout the site (*see* Table 12 and Table 13). Graphs on left represent relative abundance values (%NISP) from the column sample material. Centre column shows volumetric abundance values (NISP/litre) from the column samples while the graphs on the right show relative abundance values from the excavation units. Number of individual level assemblages indicated just below the x axis. Periods 1-4 are from the main village (ca. 250-1800 cal yr BP) and periods 5 and 6 are from the back terrace (ca. 3000-5000 cal yr BP). Note the different scales on the y axis.


Column sample %NISP
Column sample NISP/litre
Excavation unit %NISP
Herring
Anchovy
Rockfish
Greenling
Salmon
Perch
No data
No data
N = 11 13 7 3 9 9
N = 16 8 12 5 18 11
1 2 3 4 5 6
Time Period
Time Period
Time Period

Summary of changes in abundance over the six temporal periods

Herring, anchovy, rockfish, and greenling significantly differ in abundance in one or more of the adjacent temporal periods within all three abundance measures. This in turn demonstrates that smaller scale temporal patterns are present throughout the site. Moreover, each taxon shows graphically similar patterns in abundance over time across the three abundance measures, with the exception of perch in period 1, rockfish in period 4, and salmon in period 2 (Figure 21). Because this analysis utilizes individual level assemblages from spatially dispersed areas of the site (Table 12 and Table 13), these results provide further evidence to suggest that the variation in abundance of these six fish taxa reflect site-wide patterns in the use and deposition of these fish taxa. Thus, the temporal and spatial differences observed between the back terrace and main village deposits are similarly present on a narrower temporal scale and reveal important variation occurring within these broad temporal categories. The most striking examples of this are the increased abundance of anchovy during period 2 and the dramatic decrease in the abundance of rockfish during period 1 (Figure 21).

An inevitable consequence of using a higher number of temporal periods to explore a limited number of individual level assemblages is that a smaller number of cases are available to determine differences between periods (i.e., 3-18 individual level assemblages). In this case, the power of statistical comparisons is reduced, making it more difficult to evaluate differences and trends. Nevertheless, the fact that three independently derived measures of abundance were employed to determine statistically significant differences between periods provides a conservative way to identify dramatic differences in abundance between adjacent periods. Visual and graphical techniques provide an alternative means for modelling the variation and trends in abundance throughout the site. However, while the analysis conducted above provides a perspective on the patterns determined from spatially dispersed areas of the site, it does not distinguish between patterning within individual deposits (individual column and unit samples). Thus, one way of exploring the results of this analysis further is to determine if the same patterns in abundance occur within individual column samples. This is briefly explored in the next section.

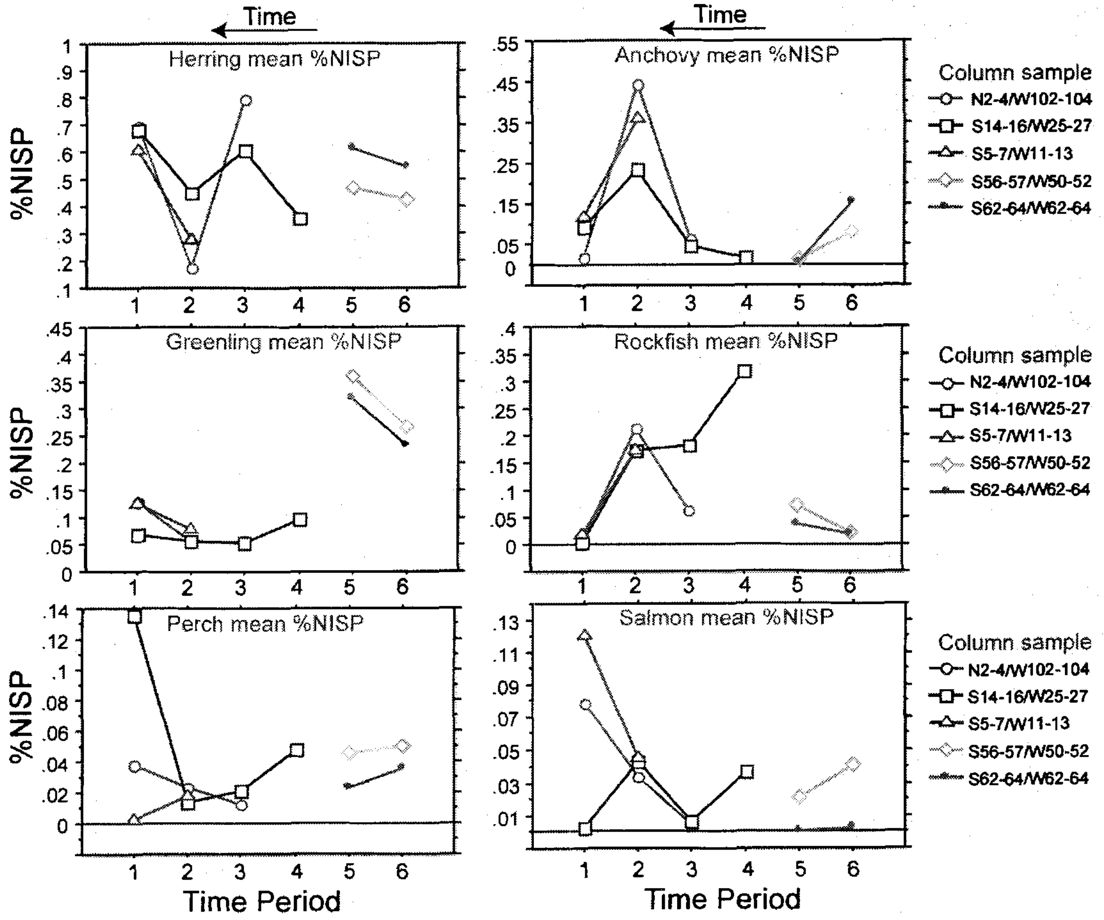
Analysis 7. Exploring temporal trends within individual column samples

The comparison of temporal trends in relative abundance among individual column samples shows that largely similar directional trends are present among contemporaneous deposits for the six most frequently occurring fish taxa at the site (Figure 22). The fact that there appears to be broad similarity in both taxonomic composition and temporal trends provides reason to suggest that for these taxa, the procurement and consumption of fish may have been practiced similarly throughout the site. This is a surprising result given the complex depositional processes thought to be associated with the formation of coastal midden deposits (e.g., Fladmark 1975; Stein 1992; Waselkov 1987).

In particular, the abundance values of herring, anchovy, and greenling show directionally similar trends for all comparable time periods among the five column samples (Figure 22). Moreover, both rockfish and salmon reveal directionally similar trends in six out of the seven instances for which there are temporally overlapping cases. While perch is the most variable of the examined taxa, it still exhibits similar trends in five out of seven comparable temporal cases. However, in column S14-16/W25-27, perch increases dramatically while salmon decreases dramatically during period 1, indicating a different pattern for these two species than in the other two column samples (Figure 22). While the broad similarities in the abundance values and trends are noted for the majority of cases, these analyses are not amenable to statistical measurement due to the small sample size of individual level assemblages (Table 12).

Nonetheless, considering that the contemporaneous assemblages are derived from entirely separate areas of this large shell midden site, the similar patterns in abundance strongly indicate that fishing practices underwent site-wide fluctuations.

Figure 22. Mean relative abundance (%NISP) of individual level assemblages from the six temporal periods (x axis) among the five column samples recovered from spatially separate areas of the site (*see* Table 12 for temporal definitions and number of assemblages). Periods 1-4 are from the main village (ca. 250-1800 cal yr BP) and periods 5 and 6 are from the back terrace (ca. 3000-5000 cal yr BP). Note the different scales on the y axis (relative abundance values).



Analysis 8. Linking changes in rockfish and greenling size to trends in abundance

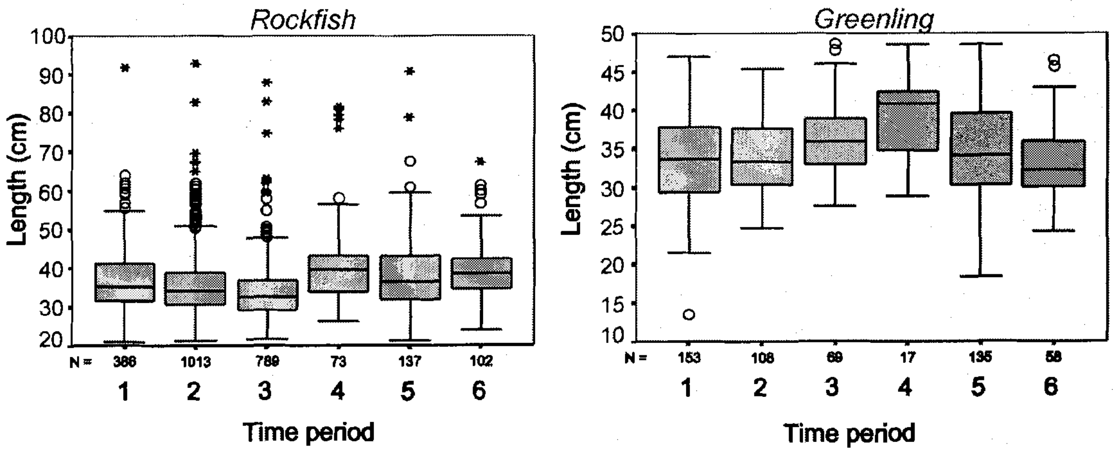
Rockfish

The site-wide temporal trend in rockfish length does not show a progressive decrease over time even though rockfish in the earliest three periods (4-6) are significantly larger than in periods 2 and 3 (Tamhane's T2 ANOVA, p=.002-.0001) (Figure 23). Rather, there is a progressive increase in the length of rockfish between periods 3 and 1 (Tamhane's T2 ANOVA, p=.001), precisely when human occupation at the site is most extensive (*see* Chapter 2, accumulation rates). In this respect, the upward trend in rockfish size between periods 3 and 1 may be due to the human-mediated depletion of the nearshore (shallow) environment, whereby rockfish were increasingly targeted in deeper offshore waters as they became less abundant in nearshore waters (cf. Leach and Davidson 2001). Alternatively, the increased focus on smaller individuals in the main village may have facilitated a higher overall level of rockfish harvesting, as older (and larger) females produce the majority of viable offspring in the overall population (Berkeley et al. 2004). Regardless, combined with the evidence of a site-wide increase in the relative abundance of rockfish between periods 6 and 2 (analysis 6), rockfish appear to have become a progressively more important subsistence resource throughout the site until the use of rockfish ceased abruptly during the final period of occupation throughout the site (ca. 250-750 cal yr BP).

Greenling

The site-wide temporal analysis of greenling length indicates a progressive increase between periods 6 and 4 (Tamhane's T2 ANOVA, p=.004) and a progressive decrease between periods 4 and 2 (Tamhane's T2 ANOVA, p=.005) (Figure 23). However, this trend is strongly influenced by specimens in time period 4, which has the fewest number of measured elements and represents only one spatial area of the site (e.g., unit S14-16/W25-27, Table 13). Thus, in contrast to rockfish, greenling does not appear to significantly differ in size between the back terrace and main village even though greenling exhibits significant differences in abundance between these two deposits (analysis 5). Nevertheless, greenling length does appear to decrease as greenling abundance gradually increases throughout the main village deposits (periods 4 thru 1, Figures 21 and 23). This provides evidence to suggest that the increased abundance of greenling may be associated with decreasing greenling length, as opposed to rockfish, where length *and* abundance increase over the same temporal interval (Figures 21 and 23).

Figure 23. Total length distributions for rockfish (*Sebastes sp.*) and greenling (*Hexagrammos sp.*) over six temporal periods based on measured specimens from the excavation units (6mm mesh). Number of measured specimens indicated below the x axis. Outliers are highly visible among rockfish due to high number of measured elements, particularly in the later time periods. Note the different scales for the y axes. Periods 1-4 are from the main village (ca. 250-1800 cal yr BP) and periods 5 and 6 are from the back terrace (ca. 3000-5000 cal yr BP).



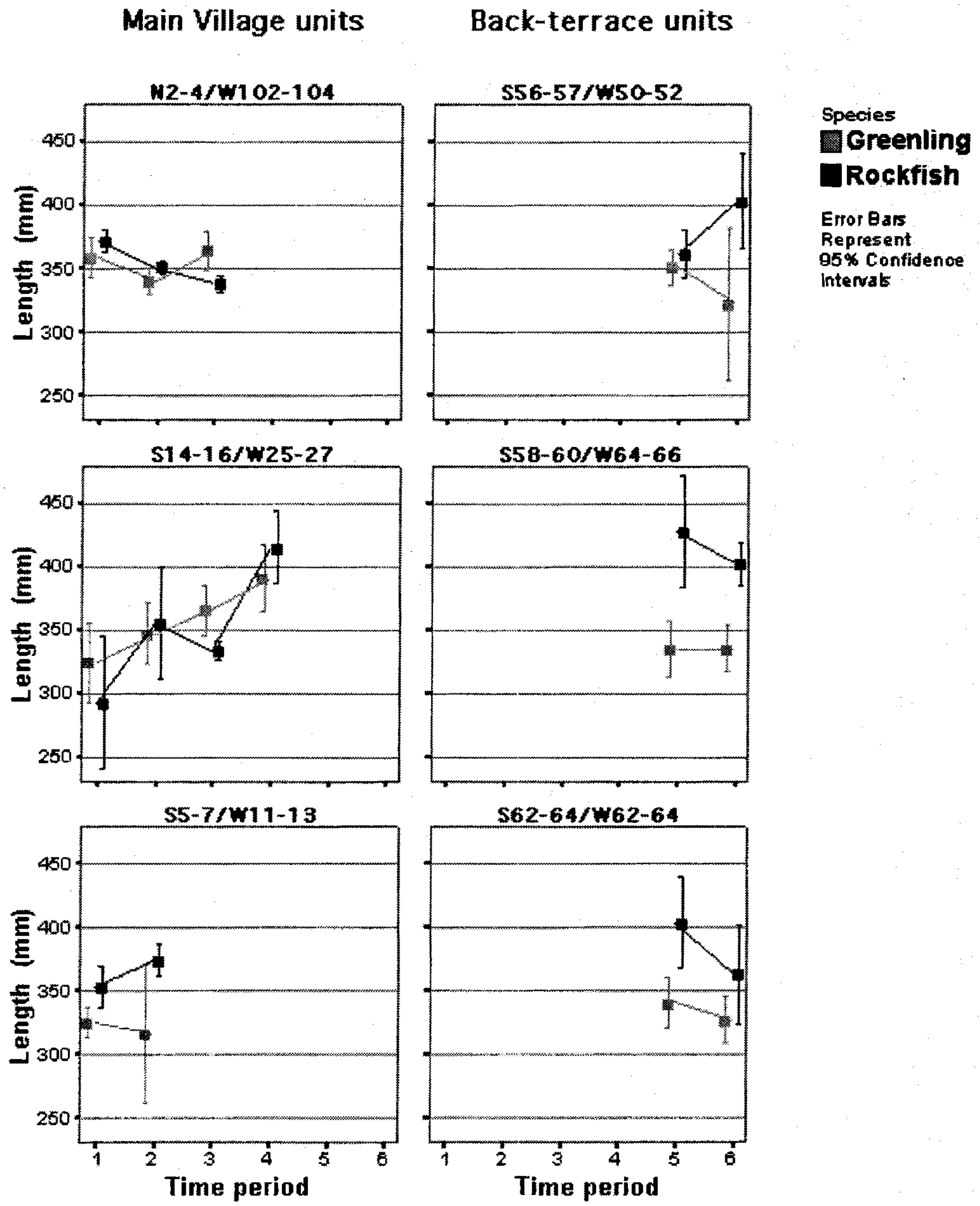
Analysis 9. Linking trends in the size and abundance of rockfish and greenling by individual deposit

While intriguing trends emerge from the site-wide temporal analysis of rockfish and greenling length discussed above, the previous analysis does not reveal if similar trends in length occur among individual deposits in different areas of the site. In this respect, the analysis of the mean length of rockfish and greenling in each of the six excavation units shows that there is not a strong coherence between trends in fish length among contemporaneous deposits (Figure 24). Instead, significant trends are present within specific deposits but are absent in others (Figure 24). Specifically, the increase in rockfish size between periods 3 and 1 appears to be limited to unit N2-4/W102-104, whereas the progressive decrease in greenling size over the same periods appears limited to unit S14-16/W25-27 (Figure 23 and Figure 24). In the discussion below, I focus on how temporal trends in size and abundance are expressed in each of these deposits and how this appears to relate to rockfish and greenling abundance overall.

Unit and column S14-16/W25-27

There is a progressive and significant decrease in the size of both rockfish and greenling over the four periods represented in unit S14-16/W25-27 (Tamhane's T2 ANOVA, p=.010-.003) (Figure 24). This provides evidence to suggest that the people who were depositing fish remains in this part of the site were consistently catching smaller rockfish and greenling between ca. 1800-250 cal yr BP. Mean rockfish relative abundance also decreases precipitously over this interval (Figure 22) and is significantly correlated with the decrease in rockfish length (Pearson's R = .965, p=.035, n=4). Meanwhile, the mean relative abundance of greenling remains relatively stable over time (Figure 22) in contrast to the stepwise decrease in greenling length (Figure 24). In this instance therefore, the significant decrease in rockfish and greenling length and rockfish abundance is consistent with the expectations of resource depression (cf. Butler 2000), suggesting that residents in this part of the site were exhibiting a size-selective harvest pressure upon rockfish and perhaps greenling as well.

Figure 24. Mean total lengths of rockfish (black) and greenling (grey) by temporal period among each of the six excavation units (n=3040 elements, 6mm mesh). Error bars represent 95% confidence intervals of mean length.



Unit and column N2-4/W102-104

This unit is approximately 80 metres to the west of unit S14-16/W25-27 (discussed above, Figure 14). In contrast to the pattern observed in unit S14-16/W25-27, the length of rockfish in this unit N2-4/W102-104 increases significantly and progressively between periods 3 and 1 (Tamhane's T2 ANOVA, p=.000-.003, Figure 21) and this pattern is not matched by a consistently positive or negative change in rockfish mean relative abundance values (Figure 22). Nonetheless, this area of the site contains the highest number of rockfish specimens per litre (e.g., NISP/litre= 8.45 ±4.1 S.E) suggesting that rockfish use was more intensive in this part of the site than anywhere else. Considering the higher overall density (NISP/litre) and the progressive increase in rockfish length over time, this appears to reflect an intensified strategy of procuring rockfish relative to other areas through the increased targeting of rockfish in deeper waters (cf. Leach and Davidson 2001). Intentional targeting of smaller individuals (who produce fewer and lower quality offspring, Berkeley et al. 2004) may further reflect a way to increase the overall level of rockfish harvesting by minimizing the population-level effects of depletion.

Unit and column S5-7/W11-13

In this area of the site, there are not significant differences in rockfish and greenling size between the two time periods represented in this deposit (greenling ANOVA, p=.725; rockfish ANOVA, p=.110). The relative abundance of rockfish matches the precipitous declines observed in other areas of the site (Figure 21), but the slight decrease in rockfish size between ca. 1000-250 cal yr BP is not significant. Combined, these results suggests that the residents of this part of the village were not adversely impacting rockfish and greenling populations.

Back terrace units

Among the three deposits from the back terrace, the only significant change in fish size over time is the decrease in rockfish size between period 6 and 5 in unit S56-57/W50-52 (ANOVA *F*=4.981, p=.029). Overall, this suggests that temporal trends in abundance are not related to the size of rockfish and greenling.

Discussion

This chapter identified long-term expressions of [short-term] fishing practices in contemporaneous areas of a large coastal shell midden. Focusing on those taxa which are the most ubiquitous and abundant in the site as a whole, I explored how aspects of this important subsistence practice differed over time and space at the household and community level. In the following discussion, I review multiple interpretations for the results of my analyses. First, I evaluate whether taphonomic and methodological factors account for the patterning I observe in my results. I then move on to discuss some of the cultural factors that I believe are responsible for the patterned use of fish resources at Ts'ishaa.

Do methodological factors account for patterning in the assemblage?

Taphonomy

In spite of the potential for taphonomic factors (dogs, preservation, bone density, etc.) to influence patterning in the assemblage, I interpret the similarity in the temporal deposition of fish remains to reflect strong continuity in cultural practices. First, there is not a significant difference between the total number of identified fish specimens per litre between the main village and back terrace deposits (MWU, p=.644). This demonstrates that differences in the density and preservation of fish remains cannot directly account for differences between the older and younger deposits. Second, while it is possible that the high abundance of greenling in the back terrace may be due to the differential survivorship of this taxon's relatively robust skeletal elements (personal observation), the distinct lack of change in the abundance of herring (a fish with fairly delicate bones) between these two periods provides evidence to suggest that this was not the case (Figure 18). Likewise, while rockfish also contain robust skeletal elements (personal observation), these are less abundant in the older back terrace deposits but are more abundant in the younger main village deposits (Figure 18). Finally, if taphonomic factors negatively affected the taxonomic composition of species, such factors would need to exert an equal influence among the multiple individual level assemblages used to characterize abundance (e.g., abundance, density, columns, and units).

Quantification

Although the analyses presented in this chapter utilized individual level assemblages containing small numbers of identified specimens (mean NISP =243, range=3-2663) which represent small volumes of archaeological matrix (i.e., 1-400 litres), this is not a factor that appears to be responsible for the patterning in the assemblage. Rather, change in abundance was only characterized for the six most abundant and frequently occurring fish taxa, thereby increasing the probability that those specific taxa were adequately sampled (chapter 2). Moreover, consistent differences in abundance were observed between temporally distinct deposits using three independently derived abundance measures. In order to further assess whether the use of these small assemblages was responsible for the significant differences observed, I again compared the main village and back terrace column samples but I eliminated all assemblages containing less than 50 specimens (cf. Barrett et al. 2004). Even though this considerably reduced the number of individual level assemblages available for comparison (i.e., 52 to 28), similarly significant differences were observed between the back terrace and main village deposits. This provides reason to suggest that the use of these small assemblages did not produce erroneous results.

Sampling

I utilized a considerable number of individual level assemblages to evaluate small-scale differences among the deposits (e.g., 52 column and 70 unit assemblages). However, the statistical strength of the comparisons was reduced as more refined analyses were attempted (i.e., among the six temporal periods, Figure 21). Nevertheless, statistically significant differences were successfully detected, suggesting the occurrence of widespread shifts in abundance between adjacent temporal periods (Figure 21). Moreover, these shifts in abundance were observed among three independently derived measures of abundance (%NISP, NISP/litre, and excavation unit %NISP). The most prominent of these is the high abundance of anchovy during period 2 (ca. 750-1000 cal yr BP) and the near absence of rockfish in Period 1 (ca. 250-750 BP). For future analyses, the use of a greater number of individual level assemblages would enhance the explanatory power of these techniques in a way that would better demonstrate their effectiveness.

Do cultural factors account for the patterning in the assemblage?

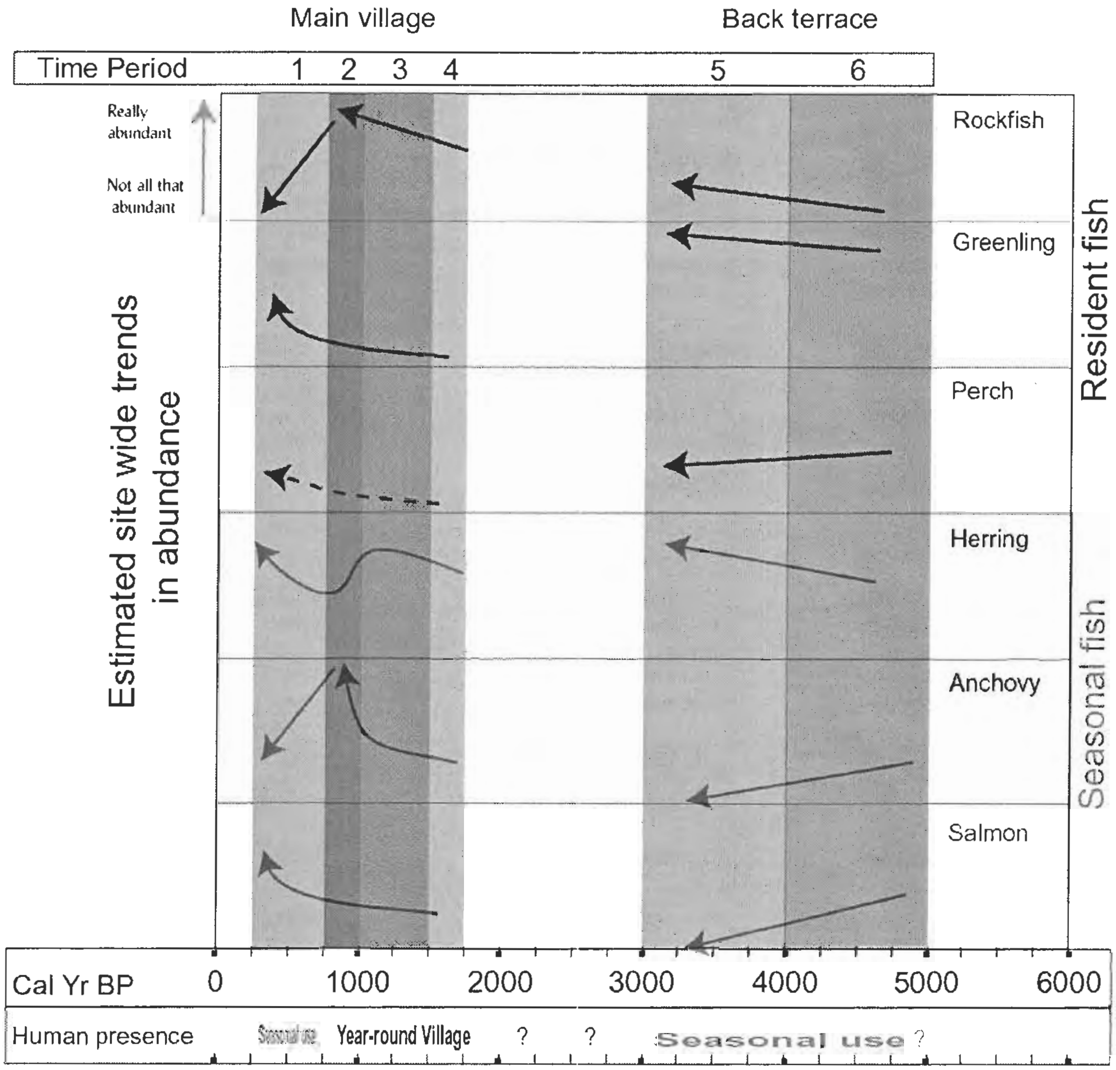
Seasonality and settlement patterns

One of the more straightforward questions to ask of the differences in the composition of fish remains is whether the people responsible for creating the deposits were using this site seasonally or were occupying the site on a year-round basis. However, this is often a much more complicated question than it appears because the measurement of seasonality is commonly defined on the basis of the relative presence or absence of seasonal indicator species even though these assessments are highly subject to sample size and lumping effects, past climate conditions, and variability in animal ecology and biogeography (e.g., Ford 1989; Monks 1981). Moreover, developing predictions about the faunal signature of human settlement patterns commonly requires making assumptions about the consistency of human behaviour and settlement and applying this pattern to millennial time-scales. Compared to conventionally 'lumped' assemblages, however, the analyses conducted in this chapter provide a more representative way to measure the patterned use of seasonal indicator species and to show how the use of these taxa may have changed over time. In particular, three of the top six fish taxa (herring, salmon, and anchovy) exhibit seasonal periods of abundance which constrain their availability to specific seasons of the year (Table 2, in chapter 1). In contrast, the other three taxa (rockfish, greenling, and perch) are non-migratory taxa and could have been locally procured on a year-round basis (Table 2).

For the back terrace deposits, fishing activity appears to have been heavily focused on greenling and herring, with comparatively small number of rockfish, salmon, and anchovy recovered from this area relative to the main village (Figure 18). Overall, this suggests that fishing in the back terrace deposits reflects a more specialized and perhaps more seasonal activity relative to the main village deposits. However, within this broad temporal interval (ca. 3000-5000 cal yr BP), subtle but distinct temporal trends during periods 6 and 5 illustrate a coherent change in the relative abundance of all six species (Figure 22). Specifically, period 6 contains a greater abundance of anchovy and salmon relative to period 5, an interval when these taxa are virtually absent (Figure 21). In contrast, rockfish, herring, and greenling increase in abundance in period 5, suggesting an increased focus on these specific species between ca. 3000-4000 cal yr BP. Thus, if this range of taxa provide a reliable measure of the seasonal use of this site, it would seem that the duration of seasonal occupation was more extensive between ca. 4000-5000 cal yr BP than between ca. 4000-3000 cal yr BP (Figure 25).

In the main village deposits, the generally increased use of rockfish, anchovy, and salmon relative to the back terrace midden suggests that fishing was practiced on a year-round basis. This is also the period of rapid and widespread midden accumulation (chapter 2 accumulation rates), presumably resulting from the expansion of the village to accommodate 'an increased population' (Sapir and Swadesh 1955:386, 413). This prolonged period of full-time occupation appears to falter during period 1, however, when rockfish use drops off precipitously throughout the site and salmon, herring, and greenling use increases (Figure 21). Rockfish are clearly an important resource during the occupation of the main village and their dramatic drop in abundance provides a strong indication of an abrupt return to a seasonal use of the site (similar to patterns observed in the back terrace). The use of salmon also increases in two parts of the site (N2-4/W102-104 and S5-7/W11-13) during the final period of occupation (Figure 22). This evidence suggests that sometime after ca. 750 cal yr BP, Ts'ishaa village became a less intensively occupied locale, and was used as a seasonal hunting and fishing station until occupation became more and more infrequent around ca. 250 yr BP. This interpretation corresponds to the ethnohistorically documented expansion of Tseshaht territory eastwards into Barkley Sound during the historic era (Golla 2000; St. Claire 1991). However, the evidence of decreased use of the site during the final period of occupation (ca. 750-250 cal yr BP) extends the archaeological evidence for the beginning of this expansion much further into the past than previously thought (i.e., McMillan and St. Claire 2005).

Figure 25. Interpretative schematic of temporal changes in the use of fish throughout the site and a speculative summary of how those changes correspond to the settlement pattern at Ts'ishaa.



Community-level fishing practices

The fact that archaeological evidence of fishing is highly similar in dispersed but contemporaneous areas of the site indicates that this aspect of subsistence was conducted in a similar way by the people who lived here over extended periods of space and time. The subtle but widespread change occurring at multiple scales within these broad temporal periods suggests a level of continuity and coherence to longer term changes, at least among the six most abundant fish taxa. This in turn provides an opportunity to explore some of the cultural implications of the way in which resources were used and distributed and how this changed over time.

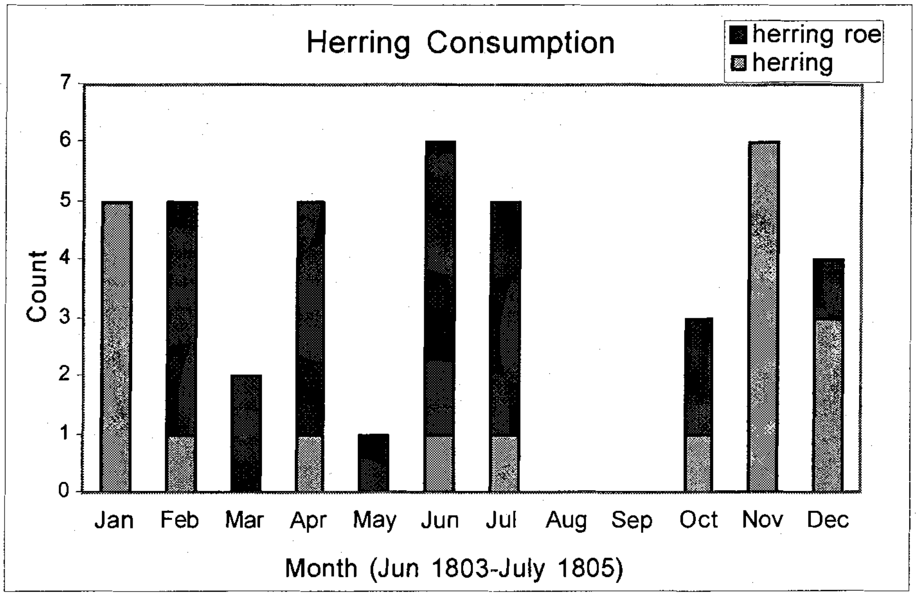
In the historic era, Nuu-chah-nulth fishing was an important subsistence practice and one in which everyone in the community could participate (Donald 1997:276; Drucker 1951; Folan 1984; Jewitt 1807; Koppert 1930; Sapir and Swadesh 1955; Sproat 1987). Aside from the collection of shellfish, fishing represented one of the most basic ways for individuals to regularly obtain food in a village setting (e.g., Jewitt 1807). However, Nuu-chah-nulth fishing (as with other subsistence pursuits) was an activity that required permission from the 'owners' of the rights to harvest resources in that territory (Drucker, 1951; Sproat 1987). Territories encompassed offshore reefs as well as intertidal habitat.

Fishing for rockfish, greenling and perch in the nearshore environment was an activity which could be conducted relatively quickly and without a high degree of logistical preparation. In this regard, these taxa represent a highly predictable source of food that could be procured on a year-round basis. The common occurrence of these taxa in the midden deposits likely reflects the frequent use of areas in the nearshore environment that were within the defined territory of particular lineage households. Rockfish and greenling, due to their habitat and behaviour, were probably caught on an individual but highly regular basis, making this activity distinct from the use of aggregate schooling fish such as herring and anchovy, which were only available seasonally.

The logistical requirements of these two harvesting strategies (fishing for seasonal schooling fish vs. year round resident fish) differs greatly. To take full advantage of the predictable seasonal occurrence of large numbers of herring, anchovy, and salmon, a community would need to devote considerable time to preparing for a period that would be devoted to the collection and processing of large numbers of fish (days, weeks). In the historic era, these fish were dried or smoked and could be stored for long periods

(Figure 26). Participation in this collective activity would be an important way to demonstrate one's contribution to the sustenance of the community, which could help to fulfil one's political and social obligations while also being an important way to obtain a share of a large quantity of nutritious and storable food. This could also be achieved at the scale of an individual bout of fishing (e.g., an afternoon) and over the course of a 'season' (e.g., the month of March). The high overall quantity of food, the subsequent redistribution and extended use-life of these stored resources would also leave an archaeological signature of high abundance and ubiquity. These factors undoubtedly contributed to the widespread distribution of fish such as herring, anchovy, and salmon throughout the deposits.

Figure 26. Monthly occurrences of herring consumption in Mowchaht-Muchalaht territory (June 1803-July 1805) as recorded in the journal of John Jewitt (data compiled from Jewitt [1807]). Note the extended period of consumption, indicating prolonged availability or storage of herring and herring roe. Note also that the peak period of 'fish' consumption is during in early winter (Nov-Jan) suggesting that procurement is occurring prior to springtime spawning.



What are the cultural and ecological consequences underlying widespread trends in fishing?

Each of the three examined main village deposits is in a separately named location of a household lineage (*ushtak̲imilh)*. Tseshaht oral tradition recounts that known historical figures from the distant past established each of these households and obtained the privilege to harvest resources in particular territories (McMillan and St. Claire 2005; Golla 2000; Sapir n.d.). Although the membership and leadership of these households changed over time, the rights associated with the lineages of the household did not change as readily and the physical location of lineage households was even less likely to change over time (St. Claire 1991; Marshall 2000). Thus, leaders, and by extension members of each *ushtak̲imilh*, held hereditary rights to harvest resources in these socially defined territories and these rights were passed on to subsequent generations (Golla 2000; St. Claire 1991; Sapir and Swadesh 1955). Therefore, one way to understand the cultural significance of the fish deposited in these physically separate but contemporaneous deposits is to assume that they reflect the long-term use of the nearshore reef habitats occurring within these socially defined territories. In the following discussion, I examine how the abundance and length of greenling and rockfish changes over time in separate areas of the main village deposits. I do this because these taxa are available on a year round basis and likely reflect the use of the territory of particular household groups.

Ts'ishaa7at̲h̲, unit and column S14-16/W25-27

The location of this particular *ushtak̲imilh* is in the immediate vicinity of the highest ranking of the four ethnographically identified subgroup households at Ts'ishaa (McMillan and St. Claire 2005). In this deposit, there is a significant decrease in rockfish and greenling length and rockfish abundance that is consistent with the expectations for over-harvesting (analysis 9). This suggests that residents in this part of the site were exhibiting considerable harvest pressure upon rockfish and greenling. This particular *ushtak̲imilh* is considered to be the most closely related to the original founding ancestor of the village and is therefore the oldest established household subgroup at the site (Golla 2000; Sapir n.d.). It is perhaps not such a coincidence, therefore, that this excavation unit happens to contain the earliest radiocarbon date from the excavated areas in the main village (ca. 1870-1560 cal yr BP). Moreover, considering that leaders, and by extension members of each *ushtak̲imilh*, held hereditary rights to harvest resources in these markedly defined territories (St. Claire 1991; Sapir, n.d.), the decline in rockfish and greenling length may reflect the repetitive (over)use of the territory specific to this household.

Lha7ash7ath̲, unit and column N2-4/W102-104

In this area of the site, it appears the people responsible for creating the deposits had rights to harvest rockfish in a territory that was not over-harvested but that expanded over time (analysis 9). This intensive use of rockfish and the increase in rockfish size over time suggests that residents expanded their use of this fish by targeting deeper offshore areas where larger rockfish are more prevalent (cf. Leach and Davidson 2001). Coincidentally, this deposit is in an area of the site that has the most direct access to the offshore environment to the west of the island, as opposed to unit S14-16/W25-27 which faces into the more protected waters to the east (Figure 14).

H̲imayisath̲, unit and column S5-7/W11-13

The third location in the main village that is identified with an *ushtak̲imilh* is roughly 150m south of unit S14-16/W25-27 (Figure 14). This location is considered to be the youngest and lowest ranking of the four household societies in the village, becoming established only after there was overcrowding in the rest of the village (Golla 2000; Sapir n.d.). This oral history is supported in so far as the earliest radiocarbon age of these deposits (970-740 cal yr BP) indicates that intensive human occupation of this area did not begin until after 1000 yr BP (McMillan and St. Claire 2005). The lack of a significant difference in the size of rockfish and greenling suggests that residents of this part of the site did not negatively affect rockfish and greenling populations.

Summary

The differing trends in the use of rockfish and greenling in the separate areas of the main village provides insight into the possible strategies and consequences of foraging in a social landscape, one where access to resources was constrained by the presence of others. In the oldest examined deposit in the main village (S14-16/W25-27), harvest pressure on rockfish and greenling suggests that people in this area were negatively impacting the nearshore fish populations in a particular territory. Conversely, in the contemporaneous deposit ~80 metres to the west (N2-4/W102-104), the use of rockfish appears to have intensified and expanded over time without similar consequences. Meanwhile, greenling and rockfish use in *H̱imayisatẖ* (unit and column S5-7/W11-13) does not appear to differ over time. In spite of these different outcomes, there are broad similarities in the temporal trends in fish abundance throughout the site and in the main village deposit in particular. I interpret this to mean that at the community level, fishing practices reflect the overall use of the landscape while the differences among particular deposits provide an indication of the variable consequences of sustaining the repetitive use of that landscape.

Conclusion

Fishing at Ts'ishaa was a frequently practiced activity that reflects the broad-scale efforts of a community's long-term use of the marine environment. At a community level, important aspects of resource use changed over time, but also showed considerable stability over broad temporal and spatial scales. These analyses demonstrate that the temporal and spatial scale of everyday depositional activity can be used to better understand the practice of fishing at a village on the outer Northwest Coast.

Chapter Four: Conclusions

This thesis identified long-term expressions of [short-term] fishing practices in contemporaneous deposits of a large coastal shell midden. Focusing on those taxa which are the most ubiquitous and abundant in the site as a whole, I explored how aspects of this important subsistence practice differed over time and space at the household and community level (i.e., individual level assemblages within deposits and deposits from throughout the site). I discovered that archaeological evidence of fishing is highly similar in dispersed but contemporaneous areas of this large human settlement. Collectively, this implies a level of continuity in resource use at a community level, whereby the most commonly utilized resources are also the most similarly deposited throughout contemporaneous areas of the site. In this chapter, I briefly review how these issues relate to the central objectives of my research and discuss some of the ways in which this adds knowledge to the study of Tseshaht prehistory and Nuu-chah-nulth fishing practices in general.

How is evidence of fishing expressed at a large shell midden on the outer Northwest Coast?

A central goal of the zooarchaeological research in this thesis was to determine how resource use by stratified maritime hunter-gatherers is expressed in the archaeological record. In the pursuit of this objective, I undertook detailed analyses of fine-screened faunal remains recovered from spatially and temporally dispersed deposits throughout the site and employed quantitative techniques that examined the taxonomic composition, taphonomic history, and sampling distribution of this assemblage from a variety of analytical perspectives (Chapter 2). I discovered that fish remains represent the overwhelming majority of vertebrate specimens throughout the site and just six taxa appear to constitute the bulk of the assemblage at all times and places during this 5000 year period. These analyses provide strong evidence showing that fishing for these particular taxa was a vitally important aspect of resource use at this site.

How is temporal change in fishing expressed at a large shell midden on the outer Northwest Coast?

Because just six fish taxa were discovered to represent such a significant aspect of resource use at Ts'ishaa, I focused my efforts on describing the use of these commonly occurring taxa by exploring how this use may have changed over the course of 5000 years. To do this, I investigated alternative ways of characterizing and quantifying change using faunal remains. In particular, I examined the extent to which broad-scale trends in resource use are similarly expressed on a small depositional scale *and* in dispersed areas of a large human settlement (Chapter 3). Through the use of individual level assemblages and the temporal categorization of discrete deposits, I discovered that the taxonomic composition of the assemblage exhibits strikingly similar temporal patterns even among vastly different areas of the site (~300m apart). This is manifest at multiple temporal and spatial scales as well as being similarly represented among three independently derived measures of abundance (%NISP, NISP/litre, excavation unit %NISP).

Collectively, the results of these analyses strongly demonstrate that temporal trends in resource use at a large shell midden can be expressed and detected on a broad spatial scale. This is not meant to be a conclusive statement about all aspects of resource use at this site; it merely points out that the most commonly utilized resources also appear to be the most similarly distributed throughout contemporaneous areas of the site. The fact that this was illustrated using individual level assemblages provides even stronger evidence as these analytical units more closely approximate the depositional scale of short-term subsistence practices.

What is the cultural significance of widespread changes in fishing?

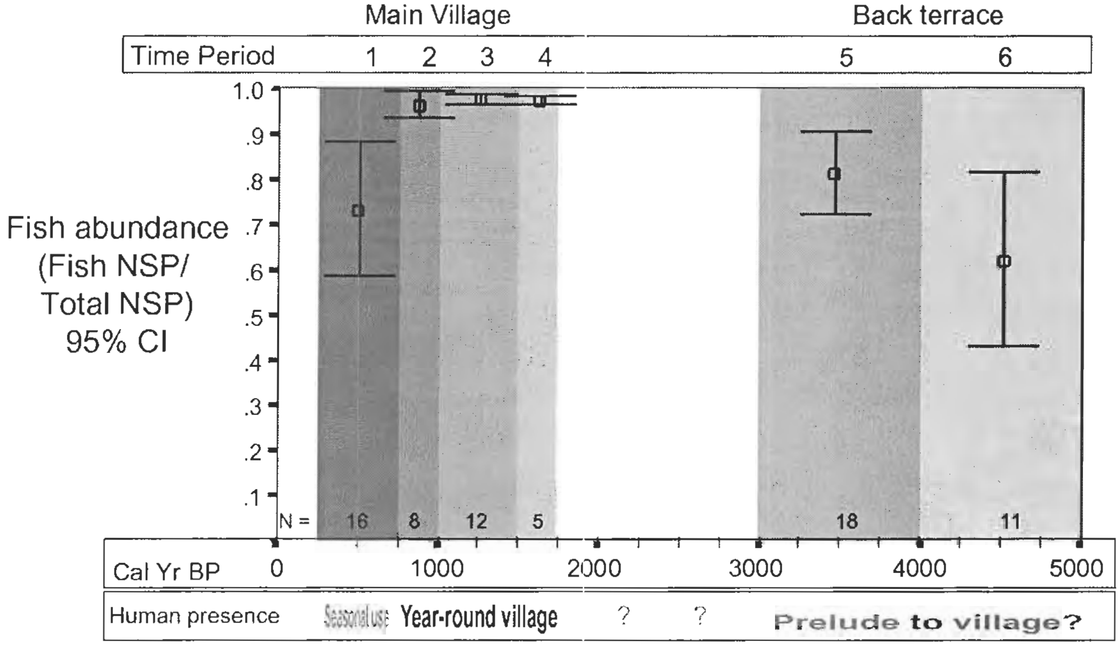
Ethnohistoric accounts describing Ts'ishaa as a major Nuu-chah-nulth village provide a well documented link between the ethnographic and prehistoric use of the site (McMillan and St. Claire 2005). Pushing this record backwards in time, it appears that the practice of obtaining and consuming particular fish taxa encompassed two distinct fishing strategies that variously persisted throughout the occupation of this large human settlement: (*I*) the intensive use of the nearshore environment to target rockfish, greenling, and perch (available year-round) and (*II*) the seasonal harvest and processing of schooling or aggregate spawning fish, namely herring, anchovy, and to a lesser extent, salmon. Together, these activities appear to have played a major role in the human subsistence strategies in all areas of the site.

Over the course of the 5000 years, widespread changes in the abundance of these six fish taxa indicate that people approached the use of fish resources in fundamentally different ways at separate points in time. That is, generations of people appear to have harvested resources from this landscape in a particular way and this changed subtly but comprehensively over broad temporal periods. For instance, during the first two millennia of occupation (ca. 3000-5000 cal yr BP), fishing appears to have been focused on the use of herring and greenling relative to the deposits during later periods (ca. 250-1800 cal yr BP), in which rockfish, salmon, and anchovy constitute a much greater portion of the total fish assemblage. Likewise–but at a finer temporal scale–the precipitous site-wide decline in the abundance of rockfish and the synchronous rise in the abundance of salmon, greenling, and herring during period 1 (ca. 250-750 cal yr BP) provides reason to believe that the abrupt absence of this previously focal aspect of fishing activity signifies a critical shift in the use of resources throughout the site.

Widespread temporal shifts in the use of these fundamentally important taxa indicate that the collective outcome of human activity changed throughout the site. These temporal changes appear to reflect differences in the way the site was occupied over extended periods. One explanation for this may be that the long-term patterns of resource use implied by the consistent abundance of particular fish taxa correspond to two distinct regional settlement patterns, one being the seasonal movement of village locations and the other being the permanent (year-round) occupation of the site (i.e., seasonal camp - year-round village - seasonal camp). This scenario is analogous to the differences between the well-documented seasonal movement of village communities during the historic era (e.g., Drucker 1951; Jewitt 1807; Sproat 1987) and the permanent settlement of small local-group territories noted for certain regions in prehistoric times (e.g., Calvert 1980; Inglis and Haggarty 2000; Marshall 1993; McMillan 1999; St. Claire 1991). This transition is further suggested by examination of the temporal relationship between fish and other vertebrate remains (birds and mammals), showing that the relative intensity of fish use at Ts'ishaa is lowest during the initial and final stages of human occupation at the site (Figure 27).

Alternative (but not mutually exclusive) explanations for these broad scale changes may also be found by examining the correspondence between millennial scale climatic or sea level changes and patterning in fish use throughout the site (e.g., Anderson et al. 2005; Cannon 1991, 1998; Finney et al. 2001; Graham et al. 2003). Regardless, any particular interpretation will ultimately depend upon how these patterns can be related to other sources of archaeological evidence from the site.

Figure 27. Site-wide abundance of fish specimens (NSP) from 6mm excavation units relative to all other vertebrate specimens (fish/birds + mammals + fish) during the six temporal periods (95% confidence intervals). Number of individual level assemblages per time period indicated just above the x axis.



What are the cultural and ecological consequences underlying widespread trends in fishing?

The combination of ethnographic and archaeological data suggest there is a strong association between the main village deposits (ca. 1800-250 cal yr BP) and the named locations of lineage households (McMillan and St. Claire 2005). Given the emphasis on lineage-based resource ownership among the Nuu-chah-nulth, one way to understand the significance of the fish deposited in these physically separate but contemporaneous locations is to assume they reflect the long-term use of the nearshore habitats occurring within socially defined territories. Thus, examining the record of fishing in these three contemporaneous deposits presents an opportunity to potentially observe the different strategies and consequences of fishing in a highly circumscribed social landscape seemingly prone to over-harvesting. Rockfish and greenling–taxa that could be readily obtained in the nearshore environment–were likely a highly predictable source of food that could be procured on a year-round basis but are also vulnerable to over-exploitation (e.g., Love et al. 2002; Yamanaka and Lacko 2001). Thus, a predictable consequence of regularly fishing in particular territories may be a decline in abundance and body size of these taxa in the immediate vicinity of the site (cf. Butler 2000).

The harvest profiles of rockfish and greenling discussed in chapter 3 (analysis 9) demonstrate that, in the oldest and highest ranking part of the main village (S14-16/W25-27), people appear to be negatively impacting the nearshore rockfish and greenling populations. Conversely, in the contemporaneous deposit ~80 metres to the west (N2-4/W102-104), the use of rockfish appears to have intensified and expanded over the same time period without similar consequences. Meanwhile, in unit and column S5-7/W11-13 (the location of the H̲imayisath̲ household lineage), neither greenling or rockfish size differs significantly over time. Thus, while different deposits have divergent trends in rockfish and greenling size, temporal trends in fish use throughout the site exhibit broad similarities. This provides reason to believe that even though people throughout the community were engaged in similar subsistence activities, they appear to have conducted those activities in socially defined but ecologically similar territories (analyses 6 and 7 in chapter 3).

The strategies and consequences of sustaining the repetitive and intensive use of prehistoric environments by native peoples has long been a focus of debate in archaeology and anthropology (reviewed in Smith and Wishnie 2000; Grayson 1980, 2001) as well as recently on the Northwest Coast (Butler 2000; Hunn et al. 2003). In this respect, the five thousand year record of fishing from Ts'ishaa shows that an important aspect of human resource use was sustained over the 'long term' without widespread negative impacts to the 'natural' environment. For the site as a whole, there is no clear evidence of a progressive decrease in the size or abundance of these important taxa (analysis 8, chapter 3). Rather, nearshore fishing was a fundamental component of subsistence that was intensively sustained throughout the human occupation at the site. Considering the emphasis on controlling access to resources in Northwest Coast societies as a whole, this archaeological evidence suggests that this aspect of human resource use (nearshore fishing) was implicitly or explicitly 'managed' in the past (perhaps more effectively in some households than in others). This is to say, the restrictions placed on the use of territories 'belonging' to a chiefly lineage in a Nuu-chah-nulth local group may have facilitated and been informed by management principles, namely the moderated use of vulnerable and limited resources (e.g., rockfish and greenling, cf. Berkeley et al. 2004).

Towards developing better methods of measuring and describing change and continuity in Northwest Coast Archaeology

Similarities and discontinuities in the archaeological record are central to explanations of historical and evolutionary phenomena in Northwest Coast archaeology (Cannon 2002, 2003). Using faunal data obtained from separate areas of one site, this thesis has sought to refine ways to *identify and measure periods of change and continuity* using multiple scales of analysis and multiple measures of abundance. This approach has yielded specific examples showing how small-scale depositional events collectively relate to the production of broad-scale spatial and temporal patterns within a site. This in turn provides a more refined perspective on the human activity responsible for the creation of these deposits while also characterizing the routine use of resources in a way that is more appropriately scaled to the outcome of everyday depositional activity. Collectively, these analyses provide new insight into the context and practice of everyday life at a village on the Northwest Coast.

Conclusion

Fishing at Ts'ishaa was a frequently practiced activity that reflects the broad-scale efforts of a community's long-term use of the marine environment. While my results strongly demonstrate that important aspects of resource use changed over time, they also show that there was considerable stability in the archaeological expression of important taxa over broad temporal and spatial scales. The level of analytical resolution provided by the use of individual level assemblages most closely approximates the temporal and spatial scale of everyday depositional activity and allows me to describe change and continuity in human resource use in a way that helps to reconcile the complex palimpsest of archaeological deposits and everyday life in prehistory.

Appendices

Appendix A: Stratigraphic profiles and excavation photographs

Profile of unit and column S14-16/W25-27 (main village) showing the designation of temporal periods. Black squares are calibrated radiocarbon ages (2 sigma range). Shaded boxes in column samples are examined levels containing identified bones.

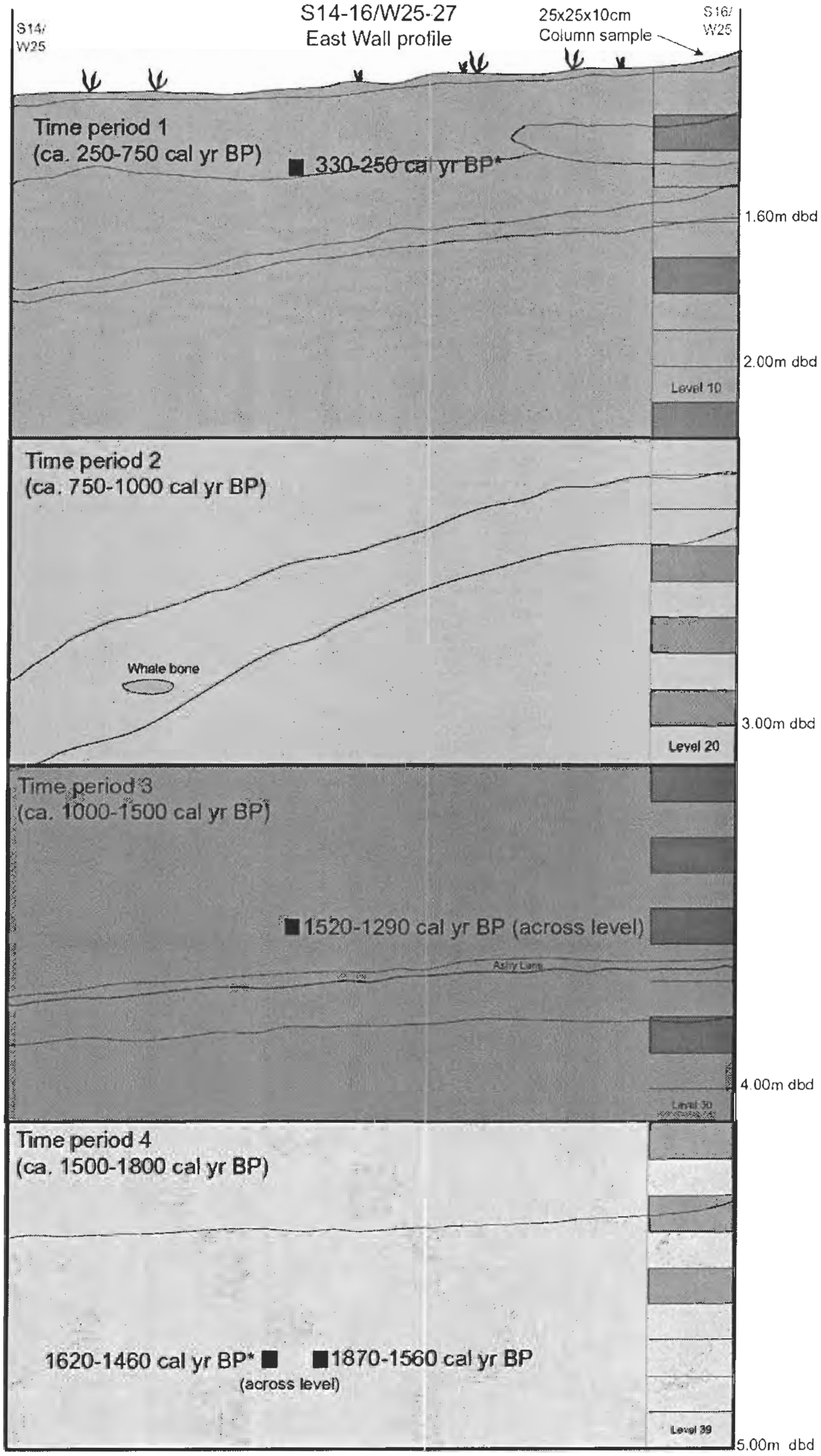


Photo of trench excavation in the main village showing general location of unit and column S14-16/W25-27 (S14-16/W25-27 in the middle of the trench on the left). Photo courtesy of Alan McMillan. Used with permission.

West wall profile of unit and column N2-4/W102-104 and unit N4-6/W102-104 (main village) showing the designation of temporal periods. Black squares are radiocarbon dates shown with ages presented at the 2 sigma calibrated range. Shaded boxes in column sample represent examined levels containing identified bones.

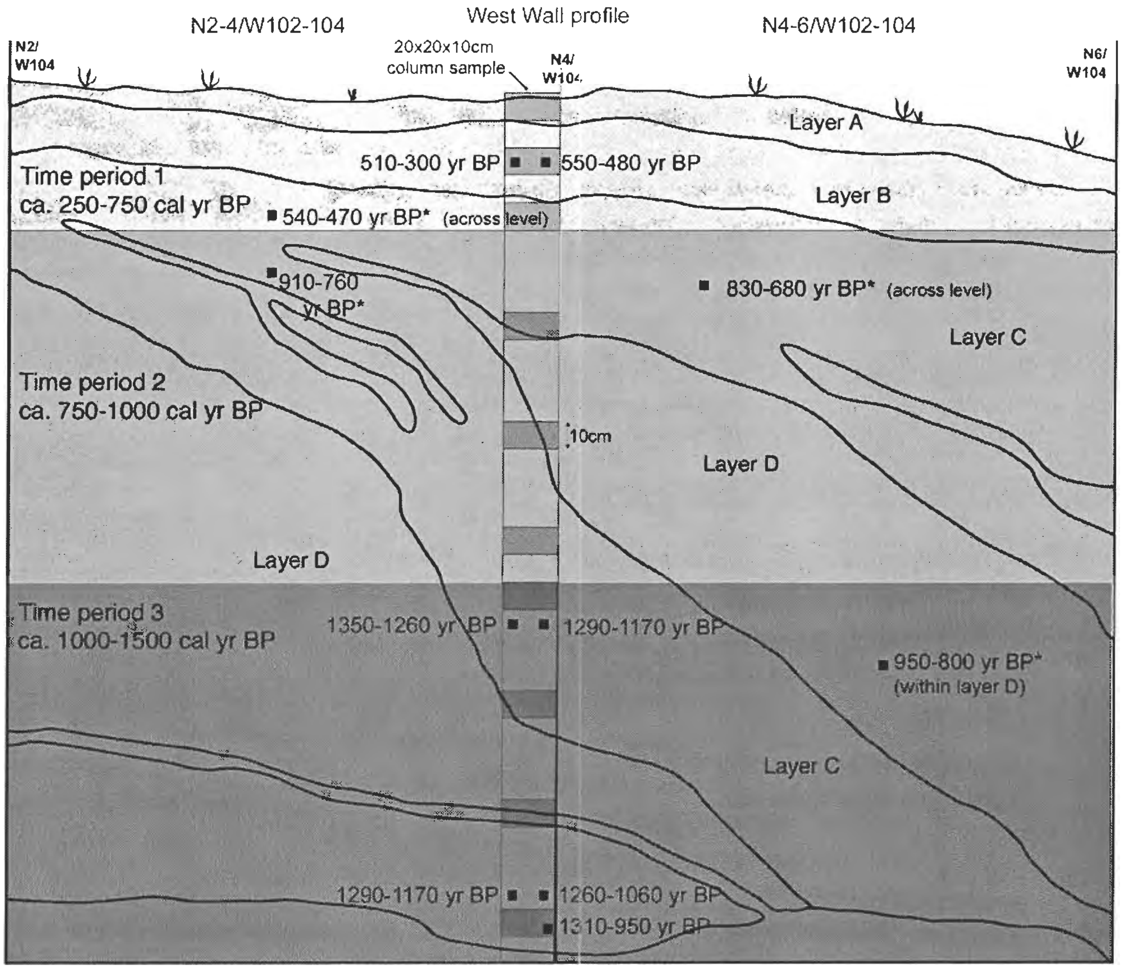
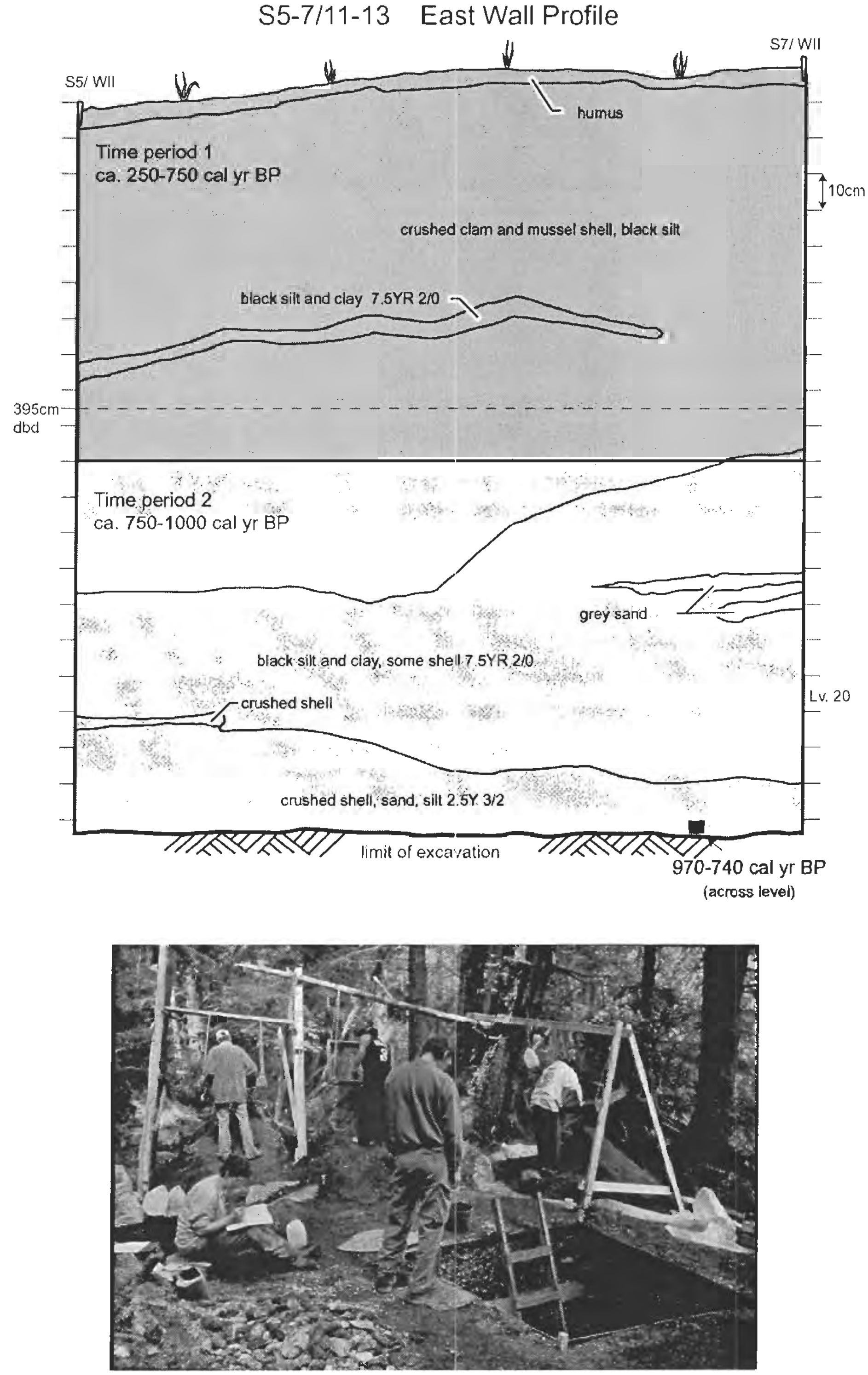


Photo of trench excavations in the main village showing unit and column N2-4/W102-104 and unit N4-6/W102-104 (the two 2x2m units n the foreground) showing the view from the south end of the trench, west wall profile is exposed on the near left. Photo courtesy of Alan McMillan. Used with permission.

Profile of unit and column S5-7/W11-13 (main village) showing the designation of temporal periods. Black square is the radiocarbon date shown at 2 sigma calibrated range. Stratigraphic designations are those designated in the field. Photo courtesy of Alan McMillan. Used with permission.



Profile of unit and column S56-57/W50-52 (back terrace) showing the designation of temporal periods. Black squares are radiocarbon dates presented as 2 sigma calibrated range. Shaded boxes in column samples are examined levels containing identified bones.

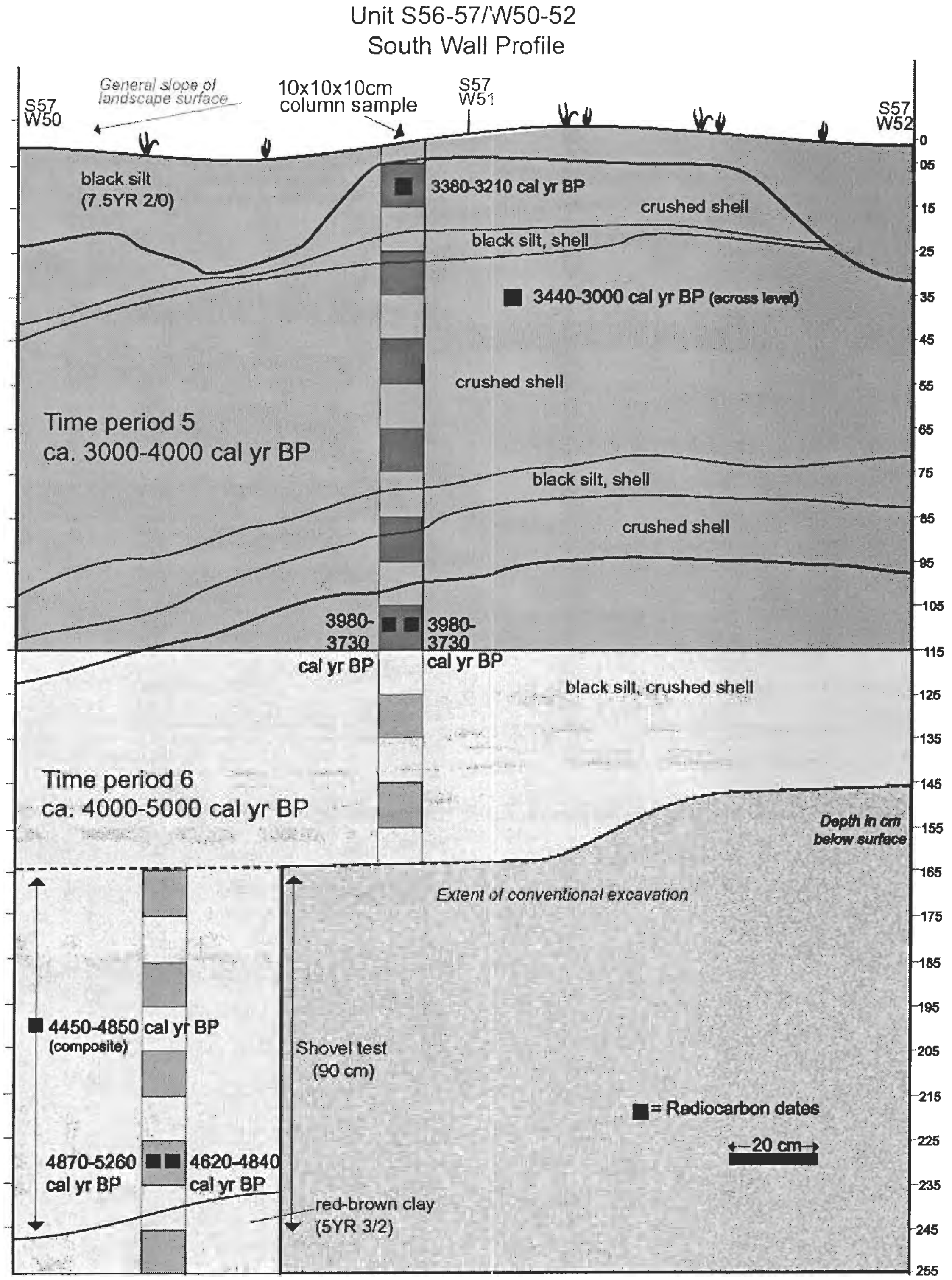
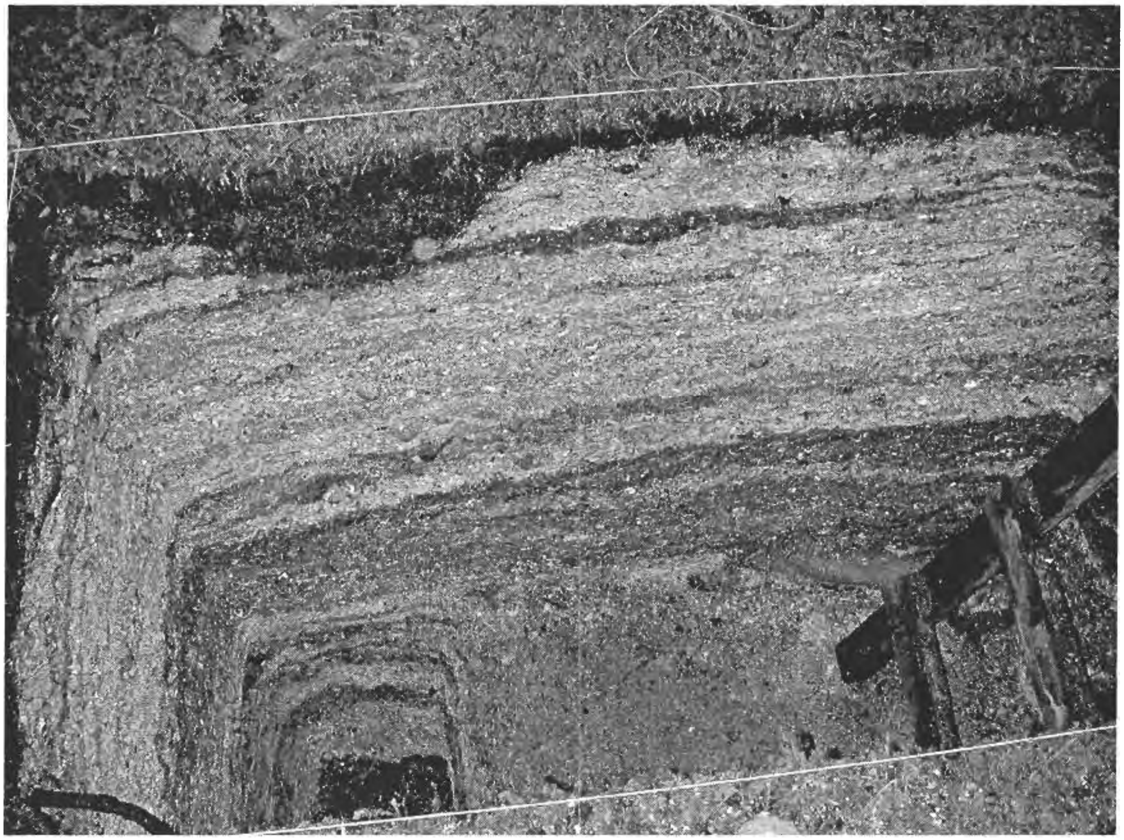
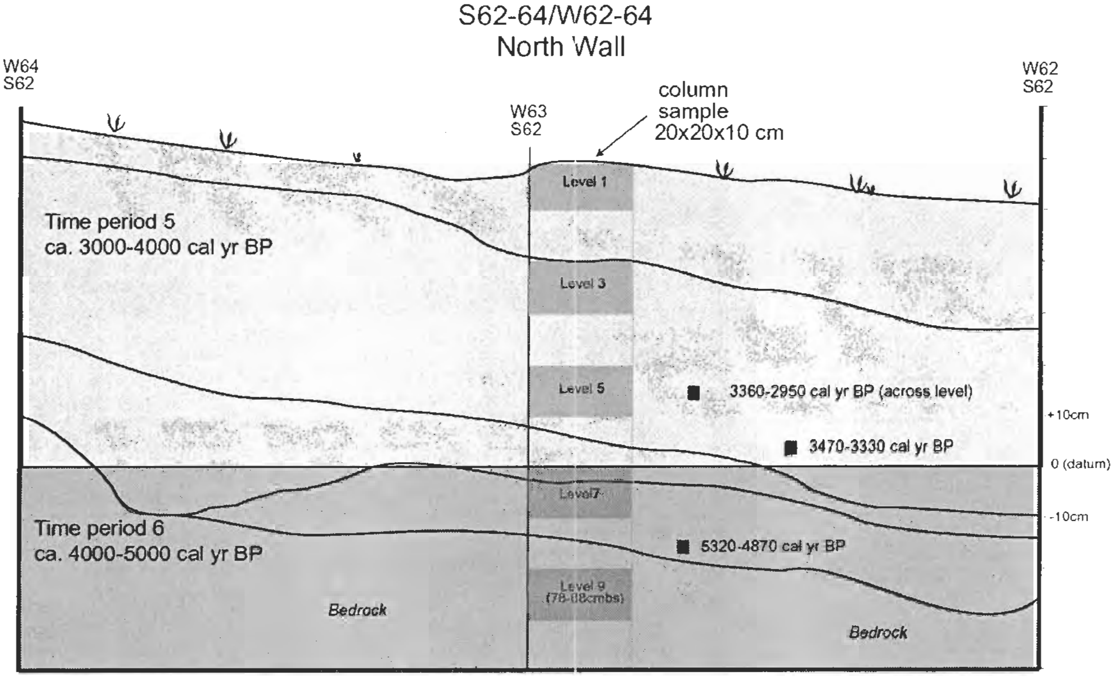


Photo of unit and column S56-57/W50-52 (back terrace) showing the south wall profile. Photo courtesy of Ian Sumpter, Parks Canada, Victoria (image #204T11E). Used with permission.



Profile of unit and column S62-64/W62-64 (back terrace) showing the designation of temporal periods. Black squares are radiocarbon dates shown at 2 sigma calibrated range. Shaded boxes in column samples are examined levels containing identified bones. Photo shows Ken Watts excavating near the west wall of the same unit (north wall is on the right). Photo courtesy of Ian Sumpter, Parks Canada, Victoria (image #204T15E). Used with permission.



Appendix B: Primary faunal data

Appendix B1. Identified fish taxa from the fine-screened (3mm) column samples (see Tables 5 and 7). NISP= number of identified specimens. NIT= number of identified taxa. For formal species designations refer to Table 7.

			Fish taxa																						
Column sample	Time period	Level	Pacific herring	Anchovy	Rockfish sp.	Greenling sp.	Salmon sp.	Perch sp.	Dogfish shark	Lingcod	Hake	Plainfin midshipman	Halibut	Sablefish	Irish lord sp.	Cabezon	Ratfish	Starry flounder	Petrale sole	Skate sp.	Sculpin sp. Not Cabezon or	Rock sole	Pacific cod	Flatfish spp*	NISP fish per level	NIT fish per level
N2-4/W102-104	1	01	51	3		2	2	4																	62	5
N2-4/W102-104	1	03	169	1	1	9	3	6																	189	6
N2-4/W102-104	1	05/6	22		1	18	11	1	2	4															59	7
N2-4/W102-104	2	09	48	26	25	12	7	1	1		1	1		2	1	1		1							127	13
N2-4/W102-104	2	13	40	309	124	37	23	15	5	8	16	2	4	2	1	1	1	1	1					1	591	17
N2-4/W102-104	2	17	48	393	152	9	5	24	16		8			1			1					1		6	664	11
N2-4/W102-104	3	19	541	6	10	22	2	3		1						3									588	8
N2-4/W102-104	3	23	298	26	10	6	2	5							1	1									349	8
N2-4/W102-104	3	27	183	4	14	5	2	7	1	1				3			1								221	10
N2-4/W102-104	3	31	4	1	1	1																			7	4
S14-16/W25-27	1	03	110	22	1	16	1	1	2	1	1	1	1												157	11
S14-16/W25-27	1	07	31	1						1															33	3
S14-16/W25-27	1	11	4	1		1		4																	10	4
S14-16/W25-27	2	15	53	102	8	5	4	3																	175	6
S14-16/W25-27	2	17	40	10	18	2	7	1	2				1		1										82	9
S14-16/W25-27	2	19	112		49	22	4	2	5		1		1						1						197	9
S14-16/W25-27	3	21	192		70	18		19	8				11			1	1								320	8
S14-16/W25-27	3	25	259	4	29	13	3	1	2	2				13	2									1	329	10
S14-16/W25-27	3	28	81	24	45	12	2					16			4		1		1	1				1	188	10
S14-16/W25-27	4	31	74	4	42	21	10	1		1		1		1		1	2							1	159	11
S14-16/W25-27	4	33	139	7	59	16	12	10	1	1	1						1								247	10
S14-16/W25-27	4	35	1		14	3		3		5	3										1		1		31	8
S56-57/W50-52	5	01	76			2		4					1												83	4
S56-57/W50-52	5	03	47		1	13	1																		62	4
S56-57/W50-52	5	05	32		3	36		4		1															76	5
S56-57/W50-52	5	07	16		4	14		4																	38	4
S56-57/W50-52	5	09			3	10																			13	2
S56-57/W50-52	5	11	14	4	2	14	5	3	4																46	7
S56-57/W50-52	6	13	15	3	1	20	1	3		8															51	7
S56-57/W50-52	6	15	6	1	1	19	5	3	2								1								38	8
S56-57/W50-52	6	17	18			8	1		9																36	4
S56-57/W50-52	6	19	55		2			2					1												60	4
S56-57/W50-52	6	21	6	11		6																			23	3
S56-57/W50-52	6	23	2		1	6		1		2			1					1							14	7
S56-57/W50-52	6	25	13			1	2	2																	18	4
S5-7/W11-13	1	01	19	18																					37	2
S5-7/W11-13	1	03	150	8	6	13	14		1	1															193	7
S5-7/W11-13	1	05	22	2		9	30																		63	4
S5-7/W11-13	1	07	80	2	1	35	5			1						2									126	7
S5-7/W11-13	1	09	67		5	12	1	1													1				87	6
S5-7/W11-13	2	11	3	5	3	5	1		1																18	6
S5-7/W11-13	2	13	14	19	10	7	1						1												52	6
S5-7/W11-13	2	15	5	2	4	1									2										14	5
S5-7/W11-13	2	17	2	27	13		6	2					1											1	52	6
S5-7/W11-13	2	19	13	15	12	2	7	2			5					1									57	8
S5-7/W11-13	2	21	9	143	6	3					1														162	5
S5-7/W11-13	2	23	65	5	4	1		4	1																80	6
S62-64/W62-64	5	01	3		1	7																			11	3
S62-64/W62-64	5	03	220	4	6	53		12		1			1	1											298	8
S62-64/W62-64	5	05	112			19		4				1												1	137	4
S62-64/W62-64	6	07	113	20	8	47	1	6		2		3								1					201	9
S62-64/W62-64	6	09	25	10		11		2																	48	4
Grand Total			3722	1243	770	624	181	170	63	41	37	25	24	23	12	11	9	3	3	2	2	1	1	12	6979	21

*Flatfish are not included in NIT per level calculation.

Appendix B2. Identified fish taxa from the excavation units (6mm). NISP= number of identified specimens. NIT= number of identified taxa.

			Fish taxa																							
Excavation Unit	Time period	Level	Rockfish sp.	Greenling sp.	Lingcod	Perch sp.	Petrale sole	Hake	Dogfish	Herring	Salmon sp.	Anchovy	Cabezon	Ratfish	Halibut	Irish Lord sp.	Plainfin midshipman	Rock sole	Bluefin tuna	Pacific cod	Sculpin sp.	English sole	Skate sp.	Flatfish sp.*	**NISP per level**	**NIT per level**
N2-4/W102-104	1	1	2							1	2		2												7	4
N2-4/W102-104	1	3	112	35	31	5	21	2	5	2	35		4	3		7	1		3					4	270	14
N2-4/W102-104	1	5	178	47	50	14	13	28	5	3	4		6	8											356	11
N2-4/W102-104	1	7	499	36	45	13	29	155	28	3	9		11	13	10	1	1		4						857	15
N2-4/W102-104	2	9	628	43	22	44	31	26	7	1	10		15	6	3	8	2	1		1	1				849	17
N2-4/W102-104	2	11	684	114	18	52	80	23	9	5	4		22	14	6	5	1					2			1039	15
N2-4/W102-104	2	13	987	203	30	8	25	1	11	28		1	7	3		8								2	1312	12
N2-4/W102-104	2	15	1919	64	18	86	52	8	19	14	14		11	19	6	7		5							2242	14
N2-4/W102-104	2	17	2424	64	20	64	21	9	6	8	5		10	9	8	1	2	10		2					2663	16
N2-4/W102-104	3	19	207	41	21	39	9		10	12	10		43	3	13	3					4				415	13
N2-4/W102-104	3	23	227	105	14	15	23		8	39	6		4	18	2	2	1	5		3					472	15
N2-4/W102-104	3	25								3															3	1
N2-4/W102-104	3	29	153	19	18	3	8	1			20		9	4		2	2								239	11
N2-4/W102-104	3	31	94	9	9		2	1	1		3			2	1									1	123	9
N2-4/W102-104d	2	13	174			70	95	6	2		20			9											378	7
N4-6/W102-104	1	3	1	2	4						33														40	4
N4-6/W102-104	1	5	24	32	11	3	2	2	3	17	28		7	1		1									131	12
N4-6/W102-104	1	7	52	48	20	5		1	1	1	10		6	1		5			3						153	12
N4-6/W102-104	2	9	347	24	22	8		1	5	1	10		5	1	1	3			3					1	432	13
N4-6/W102-104	2	13	642	74	43	11	10	22	5		3		8	8		3	5	1						4	839	13
N4-6/W102-104	3	19	852	35	18	23	31	34	37		12		7	10	1	6	7							22	1095	13
N4-6/W102-104	3	21	1166	16	20	11	94	25	5		2		2	6	1	7	1								1356	13
N4-6/W102-104	3	23	491	33	31	10	33	49	7		4		3	15	2	4	5	1		1				10	699	15
S14-16/W25-W27	1	2	2	1		4			5																12	4
S14-16/W25-W27	1	4	4	15	8	2			5	1	2				1										38	8
S14-16/W25-W27	1	5	1	52	10	7			1	50	5	40				1									167	9
S14-16/W25-W27	1	6	4	5		3			2	9	4	26													53	7
S14-16/W25-W27	1	8	2	4	4	5				77		113			4										209	7
S14-16/W25-W27	1	9	3	9	1	46				3				2	1	1									66	8
S14-16/W25-W27	1	10	9	17	5	33			1	35			2												102	7
S14-16/W25-W27	1	11	4	1	3	19							5			1									33	6
S14-16/W25-W27	1	12		7		10				21	2		8												48	5
S14-16/W25-W27	2	18	73	12		2					4		1	2	5										99	7
S14-16/W25-W27	3	25	664	30	19	21	5	5	3	1	2		3	22	3	1	4						1	2	786	15
S14-16/W25-W27	3	26	156	11		3	8	37	2	2	1			4	1		2				1			2	230	12
S14-16/W25-W27	3	27	143	1	4					1	3			4										2	158	6
S14-16/W25-W27	3	30	224	6	14	3				1	21		2	10					1					1	283	9
S14-16/W25-W27	4	31	54	5	11	3			14		4		5	6	5				1						108	10
S14-16/W25-W27	4	33	74	7	108	15			8		1		1	2	18										234	9
S14-16/W25-W27	4	35	107	18	165	2			11			11	4	4	13				1	1					337	11
S14-16/W25-W27	4	37	325	71	290	4			4	1	5		7		39		1		3	8					758	12
S14-16/W25-W27	4	39	21	34	74	1			6	3	4		11	1	17					1					173	11
S56-57/W50-52	5	1		1	1	1																			3	3
S56-57/W50-52	5	3	23	17	4	8				1			2		3										58	7
S56-57/W50-52	5	5	32	62	7	8			4		1		4	1	6		1								126	10
S56-57/W50-52	5	7	28	39	1				2				1		4										75	6
S56-57/W50-52	5	9	123	109	13	13			6		2		3	5		1					4			5	279	10
S56-57/W50-52	6	11	91	30	26	37			11				4	6							1				206	8
S56-57/W50-52	6	13	36	43	1	3			7		4		3	1		1					1				100	10
S56-57/W50-52	6	15	11	13	1	1			60		8		5												99	7
S58-60/W64-66	5	1	4	1										1											6	3
S58-60/W64-66	5	2	3	2	1									1											7	4
S58-60/W64-66	5	3	101	21	11	5						137		4										2	281	6
S58-60/W64-66	5	4	34	13	8	1			2		1		1												60	7
S58-60/W64-66	5	5	11	17	1	1			1				2	2	1										36	8
S58-60/W64-66	5	6	20	16	7				2		1		2	1		2									51	8
S58-60/W64-66	6	7	127	99	12	3			34	34	39		10	2										1	361	9
S58-60/W64-66	6	8	24	29	2	11			17		1		4	1											89	8
S58-60/W64-66	6	9	8	41		56	5		25	14			2		1						1				153	9
S58-60/W64-66	6	10	18	20	5	13			94	2	2		1		1									5	161	9
S58-60/W64-66	6	11		4		3			11	8															26	4
S62-64/W62-64	5	1	6	2	2											1									11	4
S62-64/W62-64	5	2	18	7	15	1							2	2	1										46	7
S62-64/W62-64	5	3	73	42	29	7			4		1		4		2										162	8
S62-64/W62-64	5	4	114	103	108	3			1		5		15		6	1					2				358	10
S62-64/W62-64	5	5	51	42	35	12			2		10		7	6	6	1	1								173	11
S62-64/W62-64	5	6	25	18	17	12					1		6	5		1									85	8
S62-64/W62-64	6	7	9	9	11						2		1	4	1		2								39	8
S62-64/W62-64	6	8	3	3	1									1											8	4
S62-64/W62-64	6	9	2	1																					3	2
Grand Total			14728	2154	1500	866	597	436	519	402	380	328	310	253	193	85	39	23	19	17	15	2	1	64	22926	21

*Flatfish are not included in NIT per level calculation.

Appendix B3. Identified fish taxa recovered exclusively from 6mm screens in the column samples (see Figure 7). NISP= number of identified specimens. NIT= number of identified taxa. For formal species designations refer to Table 7.

			Fish taxa																				
Column sample	Time period	Level	Rockfish sp.	Herring	Greenling sp.	Perch sp.	Lingcod	Salmon sp.	Hake	Anchovy	Halibut	Dogfish	Cabezon	Irish lord sp.	Ratfish	Sablefish	Plainfin midshipman	Petrale sole	Starry flounder	Rock sole	Pacific cod	Sculpin sp.	Flatfish spp.*	NISP per level	NIT per level
N2-4/W102-104	1	01						2																2	1
N2-4/W102-104	1	03	1	24	4	4		1																34	5
N2-4/W102-104	1	05/6			1			1																2	2
N2-4/W102-104	2	09	16	2	3			3	1				1	1					1					28	8
N2-4/W102-104	2	13	49	1	12	7	2	2	6	1	4		1	1	1			1						88	13
N2-4/W102-104	2	17	112		2	6			8	14		2			1	1				1			5	152	9
N2-4/W102-104	3	19	5	59	8		1	1					3											77	6
N2-4/W102-104	3	23	5	11	3	3							1	1										24	6
N2-4/W102-104	3	27	12	14	3	4	1								1	1								36	7
S14-16/W25-27	1	03	1		1	1	1																	4	4
S14-16/W25-27	1	07					1																	1	1
S14-16/W25-27	1	11				1																		1	1
S14-16/W25-27	2	15	3		1	1		1		3														9	5
S14-16/W25-27	2	17	8			1		4			1													14	4
S14-16/W25-27	2	19	25	1	5			1	1		1							1						35	7
S14-16/W25-27	3	21	46	4	5	6					7		1											69	6
S14-16/W25-27	3	25	22	3	3		2							2		2							1	35	6
S14-16/W25-27	3	28	27	3	7					1				2			4	1					1	46	7
S14-16/W25-27	4	31	16	1	5		1	2							2									27	6
S14-16/W25-27	4	33	23		4		1	1							1									30	5
S14-16/W25-27	4	35	14	1	3	3	5		3												1	1		31	8
S56-57/W50-52	5	03	1	2																				3	2
S56-57/W50-52	5	05			8		1																	9	2
S56-57/W50-52	5	07	1		3																			4	2
S56-57/W50-52	5	11	1									4												5	2
S56-57/W50-52	6	13			1		1																	2	2
S56-57/W50-52	6	15			1										1									2	2
S56-57/W50-52	6	17			2							2												4	2
S56-57/W50-52	6	21			1																			1	1
S56-57/W50-52	6	23	1		1		2				1								1					6	5
S56-57/W50-52	6	25				1																		1	1
S62-64/W62-64	5	01	1																					1	1
S62-64/W62-64	5	03	3		5	1	1																	10	4
S62-64/W62-64	5	05		2	6	2																	1	11	3
S62-64/W62-64	6	07	2		9																			11	2
S62-64/W62-64	6	09			2																			2	1
Grand Total			395	128	109	41	20	19	19	19	14	8	7	7	7	4	4	3	2	1	1	1		817	20

*Flatfish are not included in NIT per level calculation.

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