

Sea Urchin and Indigenous Marine Resource Management in the Archaeological Record:  
Implications for Sea Otter Conservation in Coastal British Columbia

by

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### Abstract

[Ancient remains of sea urchins are frequently encountered in archaeological contexts along the Northwest Coast of North America, yet they have not been the focus of synergetic archaeological study. However, these important marine species are important for providing new insights into the deep time of Indigenous marine resource management systems. Motivated in part by current ecological research identifying the importance of sea urchin body size for influencing the range and productivity of kelp forests on the Pacific coast and the importance of urchins as a size selective preferred prey for sea otters (*Enhydra lutris*) this project involved developing a quantitative methodology to evaluate red sea urchin (*Mesocentrotus franciscanus*) size variation in the archaeological record based on linear regression. This method was developed to investigate the prevalence of sea otters in the Barkley Sound region from archaeological data to inform contemporary sea otter conservation in coastal British Columbia – a widespread concern across several First Nations’ traditional territories today. Specifically, this paper investigates whether urchins of large size are regularly present in archaeological samples from the Broken Group and Deer Group Islands to lend support to the hypothesis that Coastal First Nations actively managed sea otters by excluding them from urchin harvesting areas. This research contributes to the greater socio-cultural context of Coastal First Nations interaction with their marine environments as active participants rather than passive foragers.]

### Keywords

[Archaeology, Historical Ecology, Red Sea Urchin, Sea Otters, Linear Regression, Marine Conservation, Indigenous Rights and Title, Collaboration]

## **Introduction**

Despite a common presence across temporal scales, regions, and cultures, archaeological remains of sea urchins along the Northwest Coast of North America have not been a subject of concerted archaeological research (Campbell 2008a, 16). Nonetheless, they have the potential to provide new insights into the deep time of Indigenous marine resource management systems, and the complexities of pre-contact First Nations' ecological roles in their marine landscapes.

Motivated in part by current ecological research identifying the importance of sea urchin body size for influencing the range and productivity of kelp forests on the Pacific coast (Stevenson et al. 2016) and the importance of urchins as a size selective preferred prey for sea otters (*Enhydra lutris*) (Salomon et al. 2015), this paper examines the importance of red sea urchin (*Mesocentrotus franciscanus*) size variation in the archaeological record of Barkley Sound, on the west coast of Vancouver Island.



Figure (1). Sea otter (*Enhydra lutris*) in Barkley Sound in 2014, eating large red urchins (*Mesocentrotus franciscanus*). Photo taken by Butch Neilson.

Specifically, this paper explores whether urchins of large size are regularly present in archaeological samples from the territories of the Tseshah and Huu-ay-aht First Nations. I argue this may be significant for investigating the prevalence of sea otters in the Barkley Sound region prior to the onset of the Pacific Maritime Fur Trade (1780's-1850's A.D.) to inform contemporary sea otter conservation in coastal British Columbia – a widespread concern across several First Nations' traditional territories today (Salomon et al. 2015). Alongside their ecological significance, sea urchins are a highly valued food resource among Indigenous Peoples of the Northwest Coast and have been for millennia, as is evidenced in oral tradition and archaeological assemblages (Ellis and Swan 1981; Campbell 2008a; Sumpter 2005, 2012). This paper aims to explore archaeological insight into the nuances of past Indigenous management of sea otters by investigating urchin harvest profiles where they can be reconstructed in archaeofaunal assemblages. This research project asks how size variation may be important for lending support to the conjecture that Coastal First Nations purposefully managed sea otters by excluding them from urchin harvesting areas to allow for increased shellfish productivity (Salomon et al. 2015; Szpak et al. 2012). This research contributes to the greater socio-cultural context of Coastal First Nations interaction with their marine environments as active participants rather than passive foragers (Lepofsky et al. 2017; Lepofsky and Caldwell 2013; Szpak et al. 2012; Moss 2011).

This paper involved building a quantitative methodology based on linear regression to evaluate red sea urchin (*Mesocentrotus franciscanus*) size variation in the archaeological record specific to British Columbia. Regression analysis was chosen to confidently predict original *test* sizes of sea urchins based on the greatest length of urchin hemipyramids (an element in urchin jaw structure) (Campbell 2008a, 18, Figure 2: (h)). This B.C. specific method was created using

modern red urchin samples, collected from natural mortalities on Quadra and Calvert Islands, and along western Vancouver Island in 2016 and 2017 (Barkley Sound). The resulting formula can be applied to human harvested urchin remains found in archaeological sites along the Northwest Coast to further archaeological investigations into, and understandings of, urchins as a valued food resource for pre-contact (and post-contact) Indigenous Nations.

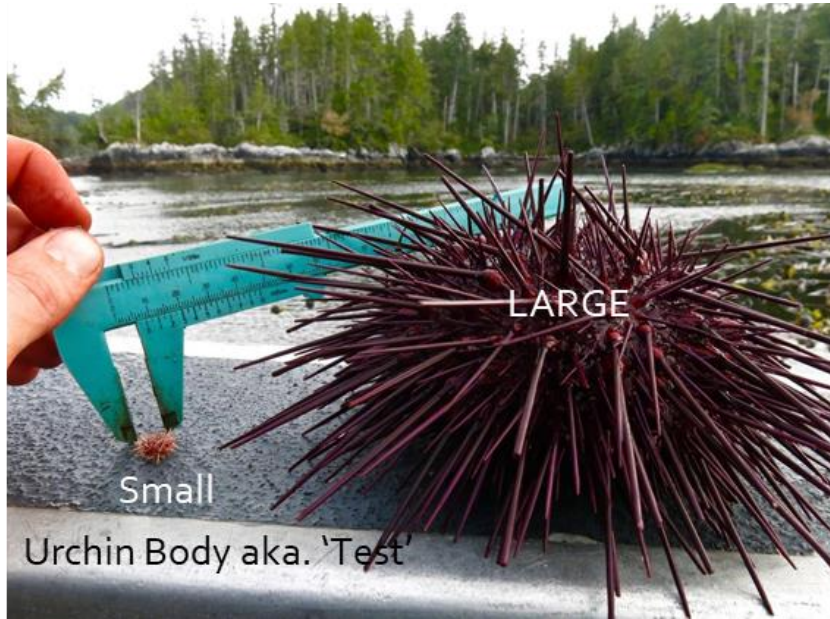


Figure (2): Red sea urchin of variation in size. Large red urchins are prized food items by both humans and sea otters (cf. Ellis and Swan 1981, 68-69; Steveson et al. 2016; Szpak et al. 2012). Photo by Jenn Burt.

### ***Sea Urchin Ecology and Contemporary Marine Conservation***

Across time and globally, sea urchins of many varieties, have been harvested by humans as an important marine food item (Campbell 2008a, 16). Urchin remains are commonly present in archaeological assemblages in many coastal sites around the world (Campbell 2008a, 16). Today, urchins continue to be a highly sought-after resource and are commercially fished worldwide (Ebert and Southon 2003, 915). In the Pacific Northwest, sea urchins have been a delicacy for millennia, and on the west coast of Vancouver Island urchin remains are frequently present in excavated archaeofaunal assemblages (Campbell 2008a, 16; Ellis and Swan 1981;

Sumpter 2012 and 2005). However, following the Pacific Maritime Fur Trade the primary predator of sea urchins, sea otters, were hunted to local extinction in what is now British Columbia (Salomon et al. 2015). The removal of sea otters from these waters has allowed urchin populations to increase exponentially triggering a cascade effect “on the ecosystems, social systems, and management systems of the Northwest Coast” (Salomon et al. 2015, 303-305; Stevenson et al. 2016, 1042). Beginning with the transformative shift from kelp dominated reefs to shellfish barrens all along the coast where sea otters were exterminated (Salomon et al. 2015, 303-304), this devastation of kelp forests from the over grazing of increased densities of sea urchins has resulted in significant direct and indirect effects on other important species that rely on temperate macroalgae reef systems (Fisheries and Oceans Canada 2017; Lee et al. 2016). In turn, the proliferation of shellfish, including sea urchin, brought about the sizable growth of a commercial shellfish fisheries industry in the early 20<sup>th</sup> century (Salomon et al. 2015, 305). With the commodification of shellfish for a global market, Indigenous peoples of the Northwest Coast were increasingly prevented from harvesting and accessing marine foods well into the mid and late 1900’s (Salomon et al. 2015, 305). In British Columbia, as recently as the 1990’s, fishery policies regarding commercial boat licenses instigated and controlled by the Canadian Government, have “indirectly excluded indigenous participation” (Salomon et al. 2015, 305). The results of which have negatively impacted the reassertion of Aboriginal harvesting rights, security and accessibility to food, and economic opportunity within many First Nations (Salomon et al. 2015, 305).



Figure (3): “Old growth” kelp forest in Haida Gwaii where urchin densities have been kept low, from Salomon et al. 2015. Photo taken by Brittany Keeling.

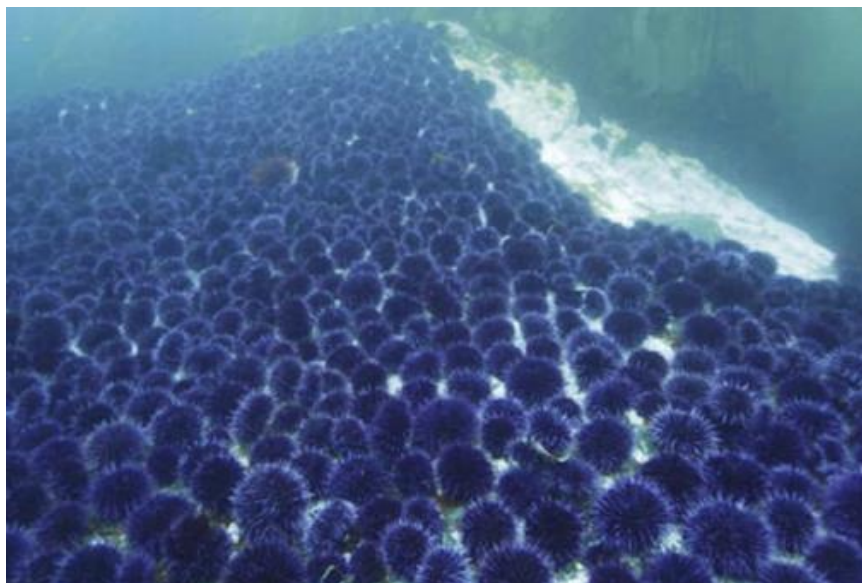


Figure (4): Urchin barren in Haida Gwaii resulting from absence of sea otter predation in these subtidal reefs, from Salomon et al. 2015. Photo taken by Lynn Lee.

Presently, the commercial red sea urchin fishery in British Columbia is regulated by DFO and operates largely in the winter months (October – May) expending only 110 harvesting licenses annually (Fisheries and Oceans Canada 2017). The edible and desirable portion of sea urchin is its roe, which is largely procured in B.C. to be sold to Asian and European markets

(Fisheries and Oceans Canada 2017). The reintroduction of sea otters into areas where sea urchins and other shellfish have flourished in their absence has caused contemporary conflicts between human harvests of shellfish and marine conservation (Coastal Voices, n.d., Salomon et al 2018; Salomon et al. 2015) After nearly 200 years without sea otter predation, there is concern in communities about the impact this predator will have on urchin and other shellfish fisheries, livelihoods, and continued access to culturally important foods (Coastalvoices.net 2016, Salomon et al. 2015).

Red sea urchins are an essential species within nearshore marine ecosystems (Stevenson et al. 2016). Living in both shallow and deep inter-tidal zones, these marine invertebrates inhabit rocky shore environments and are the key grazers of large macroalgae (Campbell 2008a, 16; Stevenson et al. 2016, 1042-1043; Estes and Steinberg 1988). Red sea urchins are members of the Echinodermata phylum and are easily identified by their compressed rotund exoskeleton (the *test*) which is covered in numerous long spines (Campbell 2008a, 16-17). The *test* is a hollow structure made up of *plates* which articulate in ambulacral zones defined by paired rows of pores (Campbell 2008a, 17). Lining the inner *plates* of the *test* are the edible roe (Campbell 2008a, 18). Located at the base of the *test* is the mouth, where the internal structure of the jaw is situated (the *Aristotle's Lantern*) (Campbell 2008a, 17). The jaw structure in red sea urchins is made up of five sets of articulated elements: the *hemipyramid*, *rotula*, *compass*, *epiphysis*, and *teeth* (Campbell 2008a, 18).



Figure (5): A broken open sea urchin, showing the internal structure of the *Aristotle's Lantern* as situated in life. The white plates are where the edible roe would be. Image provided by Iain McKechnie.

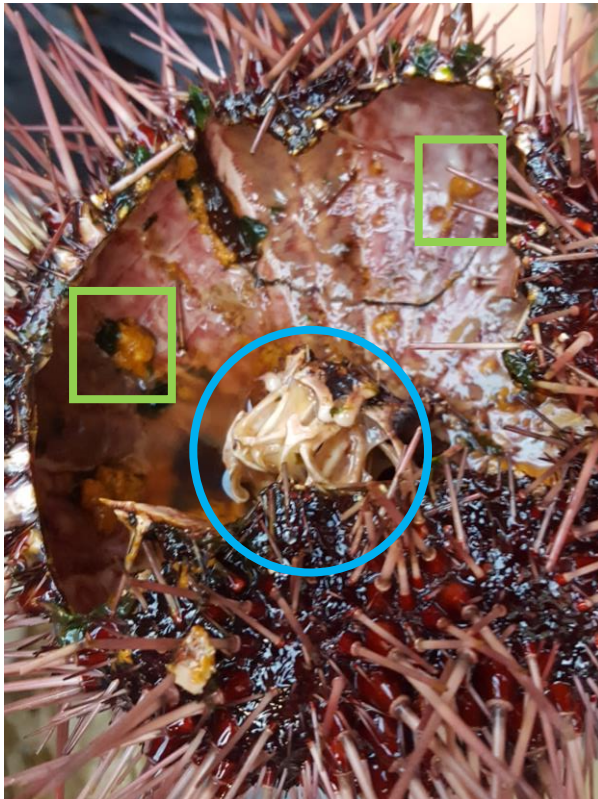


Figure (6): Red sea urchin eaten by myself and harvested with permission near Bamfield in Huu-ay-aht territory. Circle: *Aristotle's Lantern*. Rectangles: Remnants of the edible orange roe. Photo by Arianna Nagle.

Ecologists and archaeologists have both noted urchin jaws as an important structure for study because of the proportional relationship between sea urchin *test* size to jaw size (Campbell 2008a; Ebert and Southon 2003). The relationship between *hemipyramid* length and average *test* size between red urchin (*Mesocentrotus franciscanus*) purple urchin (*Strongylocentrotus purpuratus*) and green urchin (*Strongylocentrotus droebachiensis*) has been defined by Campbell in his 2008(a) paper: “A Preliminary Study of Methods for Identifying Archaeological Sea Urchin Remains in the Pacific Northwest”. In 2003, Ebert and Southon investigated incremental growth in red urchin hemipyramids to determine overall growth and age parameters of this species. Their study resulted in consequential new data that outlines large red urchins as having lifespans upwards of 100 years (Ebert and Southon 2003, 917). According to Ebert and Southon (2003, 918), urchin age (and subsequently size) is related to successful reproductive capacity where the longer-lived a red urchin is, the greater the likelihood it has to produce successful offspring. Therefore, the relationship between urchin age and their *test* size has consequence for management policy regarding contemporary fisheries (Ebert and Southon 2003, 919). An in-depth description of hemipyramid appearance can be found in Campbell (2008b, 82-83). For a morphological description of Northwest Coast urchin *Aristotle’s Lantern* elements for identifying species of urchin remains in archaeological contexts, see Campbell (2008a).

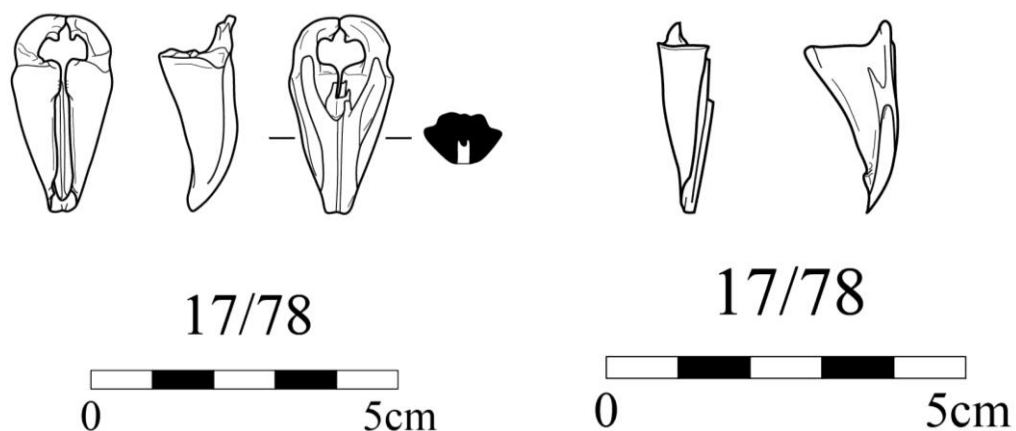


Figure (7): Archaeological illustrations of red sea urchin *hemipyramid* elements. Right: Paired *hemipyramids* as articulated in life. Left: Individual *hemipyramid*. Illustration by Alicia Walsh.

Alongside their value as an important resource, urchins are also a key intertidal species that have a critical ecological role as “the principal grazers of coastal kelp forests” (Campbell 2008a: 16). After more than a century of absence, the reintroduction of sea otters on western Vancouver Island has had significant effects on both urchin abundance (Markel and Shurin 2015) and urchin body (*test*) size, as is indicated by Stevenson et al. (2016, 1047, Figure 3). In turn, this has had “important implications for the grazing potential of urchins on kelp in the absence of behavioural shifts or density dependence” (Stevenson et al. 2016, 1049). A high abundance of red urchins with large body sizes has a substantially greater impact on kelp and algae abundance than ecosystems with fewer, small urchins (Stevenson et al. 2016, 1050). Given that large urchins were also human food items and were likely harvested along with sea otters, humans have a significant role in these ecosystems (Ellis and Swan 1981; Szpak et al 2012). By seeking out ways to determine the sizes of urchins in faunal records, archaeologists and others may be able to make more confident inferences about whether (or to what extent) people were

excluding and managing sea otters and their shared prey in specific regions.

### *Significance*

Marine wildlife conservation efforts in Coastal British Columbia have, historically, largely excluded Indigenous consultation, collaboration, and perspectives resulting in “social-ecological conflicts among coastal communities” for decades (Salomon et al. 2015, 306). The local elimination of sea otters from their coastal ecosystems after the fur trade drastically shifted the structure of these marine environments, and in turn contributed to long-term issues of food security, aboriginal harvesting rights and title, and indigenous well-being (Salomon et al., 2015). How humans harvested sea urchins may lend further insight into what is currently understood about sea otter abundance prior to the onset of the historic Pacific Maritime Fur Trade (ca. 1778-1850). This will add to the contemporary understandings of Aboriginal rights and title, harvesting use rights, and marine ecosystem management both in the past and present.

The regression developed in this paper is intended to be useful in “reconstructing prehistoric and historic kelp forest baselines” (Salomon et al. 2015, 325). This will be significant for collaborative efforts between indigenous communities and researchers in “co-establish[ing] appropriate and regionally specific reference points and recovery targets [for sea otter restoration] based on both empirical data and human values” (Salomon et al. 2015, 325). As Salomon et al. (2015, 325; 2018) discuss, collaboration and co-management of conservation efforts are essential for “equitable governance” over important marine resources, wildlife, and seascapes. Analyses of urchin elements found in archaeological assemblages have the potential to address or contribute to studies being undertaken concerning sea otter recovery in the Pacific Northwest, as well as to larger contexts of past and present human ecological roles (and cultural

influencers that impact this) in this part of the world (Boivin et al. 2016; Szpak et al 2012).

### *Positionality Statement*

This project is firmly situated in the growing body of interdisciplinary research between anthropology, archaeology, and historical ecology. This research recognizes and acknowledges millennia-old traditional practices of marine management by Indigenous peoples and its continuity and on-going relevance in contemporary complexities of human-environment relationships and connections to place (Armstrong et al. 2017; Lepofsky and Caldwell 2013, 1-3; Lepofsky et al. 2017). I approached this project with reflexivity, acknowledging that as a researcher, it is my responsibility to recognize my biases, opinions, theoretical perspectives, and world views. It is my understanding that having an awareness of my own personal situation and perspectives on the world, and of the problematic elements and ethical considerations raised in my discipline, is crucial for conducting meaningful, respectful, and collaborative work.

I situate myself in this research through my identity as a settler Canadian person. My mother is first-generation settler-Canadian, born to Italian immigrants who settled on the west coast of Vancouver Island in the 1950s. My father comes from a multigenerational family of settler-Canadians, from which I trace my heritage back to England and Ireland. I acknowledge fully that I have an inherited privilege through my family's European ancestry and a subsequent connection to the colonial settling of what is now British Columbia. I was very fortunate to be raised in the shared territories of the Skwxwú7mesh and Lílwat Peoples. While I hold generational ties to Vancouver Island and mainland British Columbia, I also firmly recognize that this land that I love and that I know as my home, is not my land but that of the First Peoples who have been here since time immemorial. I feel a deep gratitude to the First Nation

communities that have housed my privilege on their traditional territories, and I endeavour in all aspects of my life to be a good guest by respecting their continued connections to place and by supporting the reassertion of Aboriginal Rights and Title.

Presently, I have lived much of my adult life on the traditional territories of the Songhees, Esquimalt, and WSÁNEĆ Nations as I've been pursuing my undergraduate education in Anthropology at the University of Victoria. I chose this institution because of my familiarity with Vancouver Island and to be near to kin. My focus in Anthropology has been centred on Archaeology of the Pacific Northwest, which I have found to be profoundly humbling. However, I am conscientious of archaeology as a Western way of knowing. As a non-indigenous person who comes from this Western epistemology and who's interests lie in a historically contentious discipline, I am mindful of the ways in which First Peoples have their own knowledge and ways of knowing their past. To this end, I strive to decolonize my research, my mindset, and my life – recognizing that I am in the process of un-learning and re-learning.

My investment in this project stems from both my own rooted connections to the Northwest Coast landscapes in which I live and find meaning, but also from a deep responsibility I feel to support First Nations by doing good anthropological and archaeological work that is critical of my own self-location and that works with communities in a way that is respectful, informed, ethical, mutually beneficial, and always in collaboration with. This research, as it pertains to Tseshahat archaeological material, was conducted under the umbrella of the 2017-2022 Collaboration Agreement between Tseshahat Nation, Pacific Rim National Park, the Bamfield Marine Sciences Centre, and UVic Faculty of Social Sciences – Department of Anthropology (Collaboration Plan 2017). This collaborative plan outlines where I, as an Honours student at the University of Victoria, have permission and access to Tseshahat cultural material. The research

conducted for this paper is in accordance with the mutual interests of the Partners and contributes to “fostering awareness and celebration of Tseshah̓t ecological and cultural history”

(Collaboration Plan 2017). Through my participation in the Historical Ecology and Coastal Archaeology field school in 2016 which was conducted at the Bamfield Marine Sciences Centre in H̓u-u-ay-aht territories, I was extended permission to analyse H̓u-u-ay-aht archaeological samples excavated from the important site of H̓u-u-7̓ii. It is my intent with this research that my findings may lend support to the reassertion of Aboriginal rights and title, harvesting rights, and Indigenous marine ecosystem stewardship.

### ***Historical Ecology Framework***

*“I think the way our people did in the past, is that they kept [sea otters] away from where we were, close by, like all around the islands out here. They hunted them there and kept them off the sea urchin beds so they didn’t take everything. It could be done again.”* - Waakitaam, Peter Hanson, Legislative Chief, Kyuquot/Cheklesah̓t Nation, Hereditary Chief, Kyuquot (Coastal Voices, 2017)

Historical ecology has become increasingly utilized in multiple disciplines since the late 1990’s and has been impactful in both anthropological and ecological studies regarding human interaction and relationships to environment (Armstrong et al. 2017; Isendahl 2016, 128-129). Historical Ecology in its anthropological emergence in North America is often noted as a “reaction against” cultural ecology and processual archaeology frameworks that were dominating the discipline’s attempts at studying human-environmental experience in the 1980’s and 1990’s (Isendahl 2016, 129). Specifically, historical ecology diverged from these trends by its emphasis on human agency and decision making regarding human-environment interaction, rather than cultural ecology’s stance on culture as environmentally determined (ibid.). Historical Ecology in

anthropology engages with ecological discourse around restoration and conservation but situates itself in an “anthropocentric perspective” that understands “humans and their activities [as] integrated constituents of long-term ecosystem development, rather than simply disturbance factors in ecosystem development” (ibid). A historical ecology framework for interpreting how people shape and are shaped by their environments recognizes the continuity and fluidity of “combined cultural-natural processes that [construct] contemporary landscapes” (Lepofsky et al. 2017, 449).

The term “management” and its use by colonizers for describing Indigenous relationships to place and environment has been discussed by several scholars (Fowler and Lepofsky 2011, 286-287; Lepofsky and Caldwell 2013, 2; Thornton et al. 2015, 189-191; Turner and Lepofsky 2013, 108-109). As it is used in this paper, it aligns most with Turner and Lepofsky’s (2013, 108) definition, where they understand “management” to be an adaptable term “that incorporates a continuum of practices, from light-handed caretaking to more intensive forms of resource manipulation”. Recognizing, also, that by appropriating “management” to describe Indigenous stewardship and caretaking of their biophysical worlds does not fully encompass the relationships and responsibilities First Peoples have with the plant and animal communities on which they rely (Turner and Lepofsky 2013, 108).

People have deep connections to the landscapes and seascapes in which they live and make meaning (Lepofsky et al. 2017). Relationships to place and environment are rooted “not only [in] physical interactions but also social, spiritual, cognitive, and emotional experiences” (Lepofsky et al. 2017). As is discussed by Lepofsky et al. (2017, 449), anthropological conceptualizing of human-environment relationships and their nuanced complexities is no easy task. It is critically important that where anthropologists and archaeologists make efforts to understand these

connections, the conveying of such interpretations must be done in a way that is respectful of descendant communities and their on-going engagement to, and within, salient places (Lepofsky et al. 2017). There is a growing appreciation and acknowledgement within Western academic perception for the deep-time of human interaction within their ecologies and the human agency that is embedded in landscapes from generations of lived experience in, and encounters of, place (Lepofsky et al. 2017). These landscapes are salient and often embody language, memory, management systems and interaction with non-human communities, and they are often integral to “a specific cultural group’s identity and well-being” (Lepofsky et al. 2017, 449).



Figure (11): View from the 5000 year-old village site of *HuuZii*, a culturally salient place to the Huu-ay-aht People. It is the place from which they take their name (McMillan and St. Claire 2012). Photo by Arianna Nagle.

In British Columbia, First Nations have always had diverse protocols, governance systems, and tools for sustainably managing their important resources (e.g., ancient clam gardens) (Salomon et al. 2015, 312). With the onset of European colonization, approximately 240 years ago, these systems were destructively impeded by colonial interests in resource extraction from the marine and terrestrial ecosystems in this part of the world (Salomon et al.

2018). However, most First Nations in British Columbia have never ceded rights or title to the territories they have held from time immemorial, and in several cases ancient Indigenous governance systems “have been recently reaffirmed” (Salomon et al. 2018, 1). As efforts and relationships continue to be renewed, and to emerge, between First Nations and the Provincial and Federal governments regarding marine conservation and environmental restoration, there is a call for the coproduction of knowledge in response to ecological concern (Salomon et al 2018). This in turn, must find its foundations in equitably shared power between distinct knowledge systems (ibid.). Indigenous resource management systems are imbued with well-established conservation protocols for sustainable and productive care-taking of important species (Salomon et al. 2018; Salomon et al. 2015). Notably, concepts of reciprocity within most First Nations governance systems (including the Nuu-chah-nulth) “were used to conserve and manage most marine species, including sea otters” (Salomon et al. 2015, 315).

### **Nuu-chah-nulth Territories**

The landscape and environment of Nuu-chah-nulth peoples, along Vancouver Island’s west coast, is marked by striking rugged islets, long fine-sand beaches, and sheltered misty inlets and by its exposure to the Pacific Ocean (McMillan and McKechnie 2015, 3; McMillan 1999). Thick, blanketing fogs and full-force storms are often frequent, with high precipitation occurring as warm Pacific air meets cooler currents running down from more northern coasts. The Island Range mountains that back this coastline produce much of the moisture and rainfall (300cm per annum on average) in the area (Arima and Hoover 2011, 14; Moss 2011, 10). Ocean temperatures are cold throughout the year, serving to keep the climate generally mild, as it meets with warmer currents from Japan (Arima and Hoover 2011, 14). The resulting weather supports a

dense temperate rainforest, where the presence of Western Redcedar is notably important (ibid). The western coastline of Vancouver Island is rich in biodiversity, with an abundance of flora and fauna (Arima and Hoover 2011, 14-15). Marine species found along this outer coastline includes significant sea mammals such as sea otters, whales, and sea lions (ibid). Numerous shellfish, kelp, and fish are also important to these waters (ibid). These landscapes and seascapes along Vancouver Island's west coast are also the homelands of several diverse First Nations, who have navigated and thrived in this beautiful and variable environment since time immemorial (McMillan 1999)

The Nuu-chah-nulth, and their closely related neighbours, the Ditidaht and Makah, have territories that extend over much of the west coast of Vancouver Island (Arima and Hoover 2011). The Nuu-chah-nulth, historically, lived in politically autonomous communities, with social structure situated around local hereditary chiefs (*Ha'wiih*) and their families (Arima and Hoover 2011, 16; McMillan and St. Claire 2005, 9). Nuu-chah-nulth *Ha'wiih* maintained their power through their inherited title and rights, notably over important resource locations such as salmon streams, clam gardens, houses, and ceremony (McMillan 1999, 16). However, the arrival of European explorers to Nuu-chah-nulth shores in the late 1700s followed in destructive colonization, resulting in part, to large scale amalgamation of previously politically separate groups as the local populations declined from intensified violence and disease (McMillan 1999, 13). The sea otter fur trade, beginning between the Nuu-chah-nulth and European visitors during the initial contact years (ca. 1770s-1810s AD), contributed to the tensions and increased violence among Indigenous Peoples and European traders as sea otters became scarce from severe over-hunting to accommodate the global demand for their pelts (McKechnie and Wigen 2011).

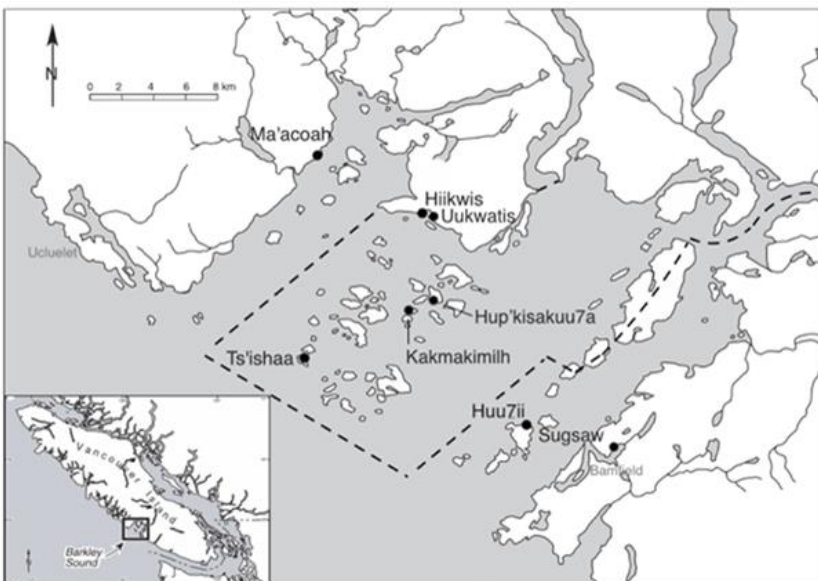


Figure (8): Map of Barkley Sound, indicating Tseshah and Huu-ay-aht archaeological sites (Adapted by Iain McKechnie from McMillan 2009; McMillan and St. Claire 2012).

This paper examines the significance of ancient sea urchin remains found within the archaeological contexts of the asserted territories and living landscapes of the present-day Tseshah and Huu-ay-aht Nations, two of fourteen Nuuchahnulth Nations. Excavations in Barkley Sound have been occurring periodically since the 1960's (Buxton 1969), with larger scale projects having taken place in the last few decades (McMillan and St. Claire 2012) The Ohiaht Ethnoarchaeology and Pacific Rim Projects in the 1980s (Haggarty and Inglis 1985; Mackie and Williamson 1985), and the Toquaht Archaeological Project in the 1990s are notable (McMillan and St. Claire 1996). Culturally salient sites such as *Ts'ishaa* (DfSi-16), *Macoah* (DgSi 22), *Ch'uumat'a* (DfSi 4), *Huu7ii* (DfSh 7) and *Hiikwis* (DfSh 16) have been excavated in more recent years (McMillan et al. 2008). Investigations into the presence of sea otter remains in zooarchaeological assemblages on the southern coasts of British Columbia, including the west coast of Vancouver Island, have been conducted in recent years (McKechnie and Wigen 2011).

The results of which provide evidence for the temporal depth of sea otter hunting by Tseshaht and Huu-ay-aht ancestors (McKechnie and Wigen 2011, 141-142 [Table 7.1-7.2]).

Oral histories, as told by Tom Saayach'apis' (a Tseshaht elder and respected knowledge holder) and translated by Edward Sapir in 1922 provide insight into the significance of the sea otter to the Tseshaht People (McMillan and St. Claire 2005, 8; McMillan 2009). In the Tseshaht creation story, Saayach'apis' discusses the presence of the sea otter in Tseshaht territory from the very beginning of time when the first Tseshaht man and women were created by Day Chief, who according to Saayach'apis', lives in the sky (McMillan and St. Claire 2005, 8). In this narrative, Saayach'apis' stated that "there were many sea otters all over the passes... they hunted sea otter. They clothed themselves in sea otter skins" (Sapir and Swadesh 1955, 53 cited in McMillan and St. Claire 2005, 8). Until the arrival of Europeans and the subsequent eradication of this important sea mammal, sea otters had since the beginning of time always been in Tseshaht worlds, as is evidenced in their Creation story. Further accounts of Sapir's informants document that sea otters were hunted in November, which coincides with the season when sea urchins are nearing, or are at, their best quality for human consumption (Fisheries and Oceans Canada 2017; McMillan and St. Claire 2005, 27).



Figure (9): A portion of TseshahT Territory in the Broken Group Islands. Photo Hakai Institute.



Figure (10): Huu-ay-aht Territory. Photo taken by Arianna Nagle.

## **Methods and Materials**

### ***Quantitative Analysis of Modern Samples***

To evaluate size distributions of urchins in archaeological contexts in Barkley Sound, collections of modern specimens from the BC coast were required to generate a linear regression model. The dataset consists of 28 modern red sea urchins collected on Quadra, Calvert, and

Vancouver Island in 2016-2017. Twenty-three of these urchins were collected courtesy of Hakai Institute researcher and UVic PhD candidate Erin Rechsteiner from beaches and were not harvested or taken from their natural environments for this project. The remaining five were generously collected by Siobhan Gray, the Bamfield Marine Science Centre's dive and safety officer in Scott's Bay (near 'Ohiat Islet' in the Deer Group Islands) at depths of 10-15 metres in 2016. All 28 urchins have *tests* complete enough to measure their full diameter and with jaws still attached or that remained within the *tests*. This ensured that each jaw structure was associated with its original *test* without question. The 28 modern *tests* (urchin bodies) were labelled, measured, and then processed for their individual *Aristotle's Lantern*. These were removed from the *tests* by a careful breaking of the ambulacral zones (cf. Campbell 2008a: 17, Figure 1(C.)), near to the mouth, making sure *test* diameter extents remained intact. The diameters of the tests were then measured with digital calipers to the nearest hundredth of a millimetre. The modern *test* size diameters range from 46.90 mm to 142.70 mm.



Figure (12): Individual *hemipyramid* half showing inner profile. Photo by Arianna Nagle.

The samples were cleaned, and the jaw structures disarticulated to allow for measurements of the hemipyramid at the Zooarchaeology Lab at the University of Victoria, following recommendation by lab manager Rebecca Wigen (personal communication, 2018). Cleaning for disarticulation was done by placing each specimen in a pot of tap water over a hot plate, allowing this to reach a low boil for several minutes. Once the *Aristotle's Lanterns* were sufficiently disarticulated, drained and dried, measurements of all 10 *hemipyramids* from each urchin jaw were taken. This was done with digital calipers to the nearest hundredth of a millimetre to find the greatest lengths. The average greatest length of all ten *hemipyramids* for each specimen was then calculated. The average lengths, alongside their corresponding *test* diameters, were input into an Excel scatterplot and a linear regression analysis was run to determine predictability of *test* diameters based on *hemipyramid* greatest length. This resulted in a formula that can be applied to future archaeological studies where urchin jaws are present in the faunal record to determine original urchin size at the time of harvest.

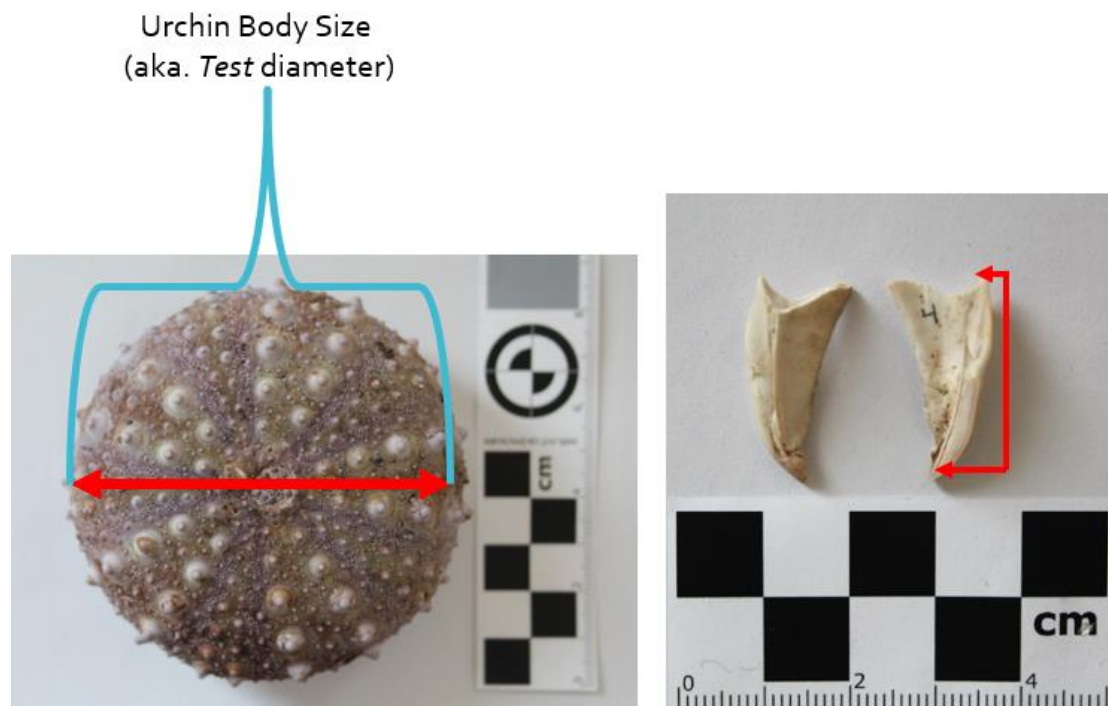


Figure (13). Left: Modern red urchin *test* with diameter measurements (mm) indicated (partially adapted by Iain McKechnie). Right: Modern red urchin *hemipyramid* pair with greatest length measurements (mm) indicated. Photos by Arianna Nagle.

Linear regression was chosen for this quantitative method of analysis because it allowed me to predict the relationship between the independent ( $X$ = known *hemipyramid* greatest length) and dependant ( $Y$  = unknown urchin *test* size) variables (Madrigal 2012, 210-211). Linear regression states that if I know  $X$ , I can predict the behavior of  $Y$  (ibid.). This relationship is explained by a resulting mathematical equation once the data has been input into a scatterplot and a trend line has be drawn through the means of both variables (ibid.). The slope of this trend line is critical to determining the degree to which  $X$  explains  $Y$ 's variation (ibid.). While linear regression is critical to this methodology it is important to note that “regression analysis [does] not explain the physical, biological, or cultural mechanisms linking the two variables” (Madrigal 2012, 210; see also Singh et al. 2015).

### ***Archaeological Laboratory Methods***

This research builds off a preliminary 2016 report investigating urchin size prediction in the archaeological record written in partial fulfilment of the requirements of the Historical Ecology and Coastal Archaeology field course at the Bamfield Marine Sciences Centre (Nagle 2016). In July and August 2016, I undertook preliminary research regarding the presence of urchin hemipyramids in the archaeological records of DfSh-7 (Huu7ii on Diana Island) and the 2016 excavations at 93T (Hup'kisakuu7a on Jacques Island) for this project (Nagle 2016). Column sample levels from each site were analyzed for these specimens. The column samples from Huu7ii had previously been processed for small fish remains in 2006 (McKechnie 2012, 155). The Huu7ii column samples were processed further in 2016 for shellfish at the ¼ inch

(6.35 mm) sieve fraction, and for northern abalone (*Haliotis Kamchatskana*) and urchin remains at the 2mm sieve fraction (Nagle 2016). Ten column samples levels were selected from DfSh-7 to examine for urchin hemipyramids at the 2mm sieved fraction. Initial selection of column samples for analysis was based on upper levels where invertebrate material was less likely to be pulverized by deposition and taphonomic processes (Nagle 2016). These were then selected based on if there was urchin (spine) present within a level, and if not, column samples with high invertebrate weights were chosen. DfSh-7 column samples with an urchin presence that were processed for hemipyramids included: levels 6, 7, 10, 11, 12. DfSh-7 column samples without an urchin presence but processed include: levels 8, 9, 14, 18, 19 (Nagle 2016).

Several level column samples from 2016 excavations at 93T were also analyzed for hemipyramids. These column samples were processed in the lab for shellfish, fauna, fire-cracked rock, charcoal, and organics at the ¼ inch (6.85mm) sieved fractions (Nagle 2016). Urchin was processed for at the 2mm sieved fraction. As urchin was not present in any levels of the column samples from 93T, the column samples selected were those which contained the largest weights of invertebrates within 93T2D (Nagle 2016). These included levels CS2-CS6. All possible *Aristotle's Lantern* fragment identifications, from both DfSh-7 and 93T were based on comparisons between the archaeological specimens and the modern Scott's Bay examples, alongside Campbell's (2008a: 18, Figure 2) descriptions of lantern elements (Nagle 2016).

Analyses of faunal assemblages examined in 2018 were focused on material collected from auger tests at the sites of 206T (*MaklZii* on Wouwer Island) and 129T (*Huts'atwilh* on Dicebox Island) in the Broken Group Islands – recognized territories of the present-day Tseshah Nation (McKechnie 2015). The samples selected for analysis were from 206T9E and 129T2E based on known urchin presence (observed spines) from several levels. Twenty-three auger test

levels were analysed from 206T9E and six were analysed from 129T2E. This data was provided by Dr. Iain McKechnie, Assistant Professor at the University of Victoria – Department of Anthropology, based on previously collected samples (McKechnie 2013). Auger test 206T9E has multiple levels that contain a high presence of urchin remains, quantified by number of specimens present (NSP) of 50+ urchin spine fragments, include: levels 10-18, 20. Levels were excavated in 15cm increments with the depth below datum range being 135cm to 300cm between levels 10 and 20. Auger sample levels from 129T2E were less indicative of urchin presence than 206T9E material, but nonetheless were selected for analysis based on previous observations by McKechnie (2013). The auger test levels from 129T2E that were processed for *hemipyramid* and other urchin elements included: levels 1-7. These levels were excavated in 20cm increments, with a depth below datum range of 0-120 cm between levels 1 and 7. Both 206T9E and 129T2E auger test level samples were processed for urchin *hemipyramids* and spines (spines preserve well and are an obvious indicator for urchin presence) at the 2mm sieved fraction. The ¼ inch sieved fractions were previously analyzed by McKechnie (2013). This lab work was conducted with substantial help from the Department of Anthropology (UVic) work study student, Clarice Celeste, and the 2018 ANTH 340 (Archaeology of BC) class. All possible *Aristotle's Lantern* fragment identifications, from both 206T and 129T were based on comparative analysis to the modern specimens. Comparisons between archaeological specimens and the modern dataset were analysed under a microscope for stronger identification confidence.

## Results

### *Successful Progress and Development of a Regression Specific to BC*

The regression formula specific to British Columbia that will generate unknown original *test* diameters from known *hemipyramid* greatest lengths is  $Y=6.0175*X - 26.12$ , where:  $Y$  is the unknown *test* diameter and  $X$  is the known *hemipyramid* length. The  $R^2$  value for this formula is 0.86, indicating a strong correlation between the slope of the trendline and the data points. This supports the formula ( $Y=6.0175*X - 26.12$ ) as successful for estimating accurate *test* diameters.

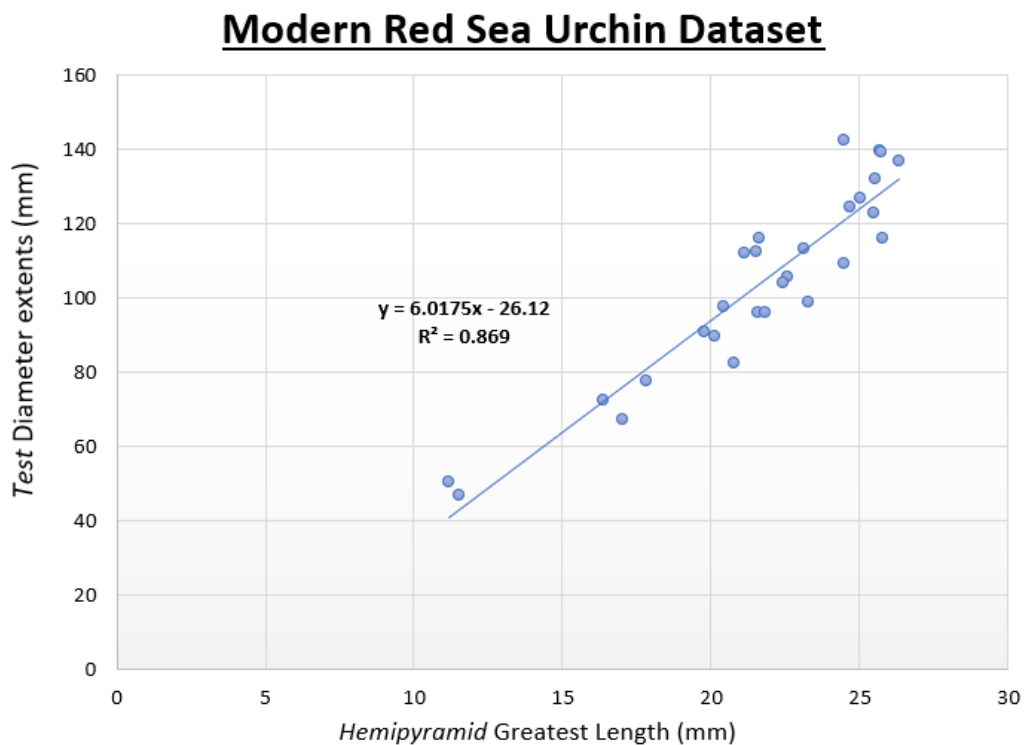


Figure (14): Scatterplot chart depicting known modern red urchin *test* diameters and known *hemipyramid* lengths. The linear regression equation created from this data, is the regression formula that predicts original urchin test sizes from a known hemipyramid greatest length.

### *Hemipyramid Presence in Column Samples and Auger Samples*

Poor preservation (Campbell 2008a, 19) and natural fragility of urchin jaws generally, appears to have limited the identification of *Aristotle's Lantern* elements and therefore any fragmented remains will only be identified as "potential" specimens within this paper, until such a time when further analyses and studies can be made on identifying urchin jaw material in the archaeological record. Beginning with the material analyzed in 2016 (Nagle 2016), only five column sample levels from Huu7ii rendered any possible remains of urchin hemipyramids. The column sample levels with the number of specimen present (NSP) from DfSh-7 include: level 6 (NSP: 2), level 7 (NSP: 3), level 8 (NSP: 1), level 11 (NSP: 1), and level 14 (NSP: 1) (Nagle 2016). Level 6 specimens are likely to be fragments of *Aristotle's Lantern epiphyses* (following Campbell's 2008a, 18, Figure 2). Level 7 specimens are potential *hemipyramid* and *epiphysis* fragments (following Campbell's 2008a, 18, Figure 2). The level 8 specimen is likely to be a *hemipyramid* fragment (following Campbell's 2008a, 18, Figure 2). Level 11's specimen was identified with more confidence due to better preservation than in other levels, as likely being a *rotula* (following Campbell's 2008a, 18, Figure 2). Finally, level 14's specimen is a possible *hemipyramid* fragment (following Campbell's 2008a, 18, Figure 2). The 93T2D column samples yielded no hemipyramids or other urchin elements (Nagle 2016).

Poor preservation was also apparent in the 2018 analyses of 209T and 129T samples. Much of the material processed at the 2mm fraction for urchin elements in both these deposits was highly pulverized and fragmented. The 206T9E material yielded only three levels containing potential remains of urchin *Aristotle's Lantern* elements. The auger test level samples that have a NSP from 206T are: level 15 (NSP:2), level 16 (NSP:1) and level 17 (NSP: 2). Level 15 specimens may also both be *hemipyramid* fragments. Through comparison to the modern

elements, the level 15 specimen appear to be fragments of *hemipyramid* broad plate (following Campbell's 2008a, 23, Figure 5), with breaks on all outer edges that have been rounded down from deposition. Level 16's specimen could also be a small *hemipyramid* fragment based on its similar appearance and hollowed shape. The level 17 specimens are potential *hemipyramid* fragments as well. After inspection under a microscope alongside a modern intact *hemipyramid* for reference, one level 17 specimen is likely a corner fragment where the base of the *styloid process* is located and has been broken on either end revealing a small triangular hollow. Both the shape and angle of this specimen makes it a strong candidate as a *hemipyramid*. The second level 17 specimen was identified as a possible *hemipyramid* fragment with less confidence. This specimen may likely be a very fragmented portion of an unidentifiable bivalve hinge rather than an urchin element. The tiny size of this specimen likely makes it impossible to identify. The 129T2E auger test level samples yielded no urchin *hemipyramid* remains.

### ***Applying the Modern Regression to Predict Archaeological Urchin Size***

The linear regression model generated from modern red urchin measurements in this paper confidently predicts *test* diameter extents from known *hemipyramid* lengths. There is potential in this method where it may be applied to archaeological specimens encountered in faunal deposits of the Northwest Coast for reconstructing sea urchin harvest profiles. Sea urchin *hemipyramids* have been observed to preserve intact in shell midden deposits across the Northwest Coast (Rebecca Wigen, personal communication, 2018). Due in part to the very fragmentary preservation of examined potential urchin specimens in the DfSh-7 and 93T column samples, as well as the 206T and 129T Auger test samples, no measurements for greatest length of *hemipyramids* could be estimated. Therefore, the modern regression equation for predicting

size could not be applied to the archaeological material from these sites, at this time. Small sample parameters and the time constraints of this honours thesis also contributed to this.

### ***Preliminary Evidence***

To address the absence of *hemipyramids* in the archaeological samples, I conducted preliminary research near the end of this project to examine other ways to investigate urchin size variation in the archaeological record where urchin jaw structures are not present. Urchin spines are the most obvious indicator of urchin presence and often preserve well. Following exploratory research by my colleague Sophie Roth (2016), measurements of urchin spine base diameters were taken on large modern sea urchins (*test* sizes greater than 100mm) and on archaeological urchin spines from 206T (*Maklzi* on Wouwer Island). These measurements were then compared. This preliminary data displays that very large urchins are present at settlement sites in Barkley Sound. Further studies on frequency, preservation, and identification of fragmented sea urchin remains in archaeofaunal assemblages in Coastal British Columbia is recommended, however.

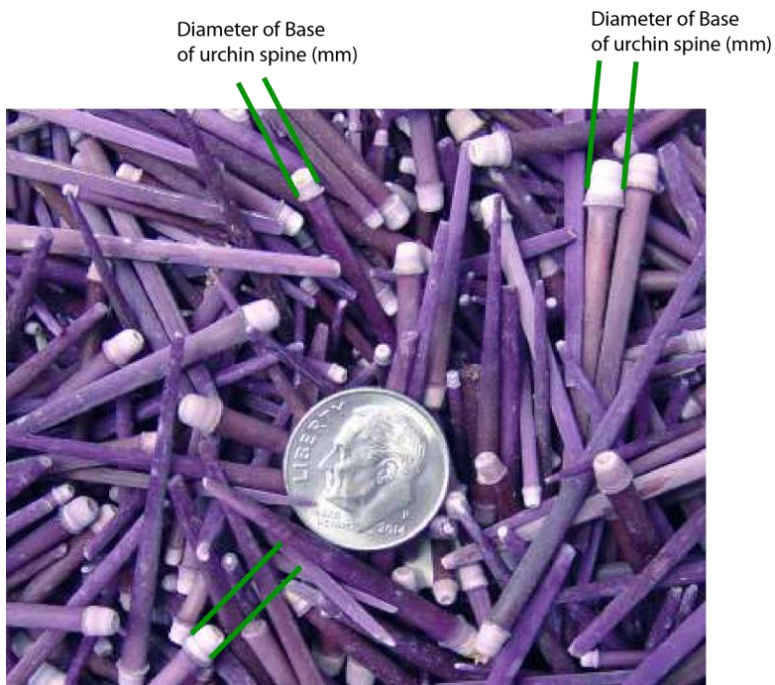


Figure (15). Modern red urchin spines, depicting where measurements for base diameters were taken with a dime for scale. Photo provided by Iain McKechnie.

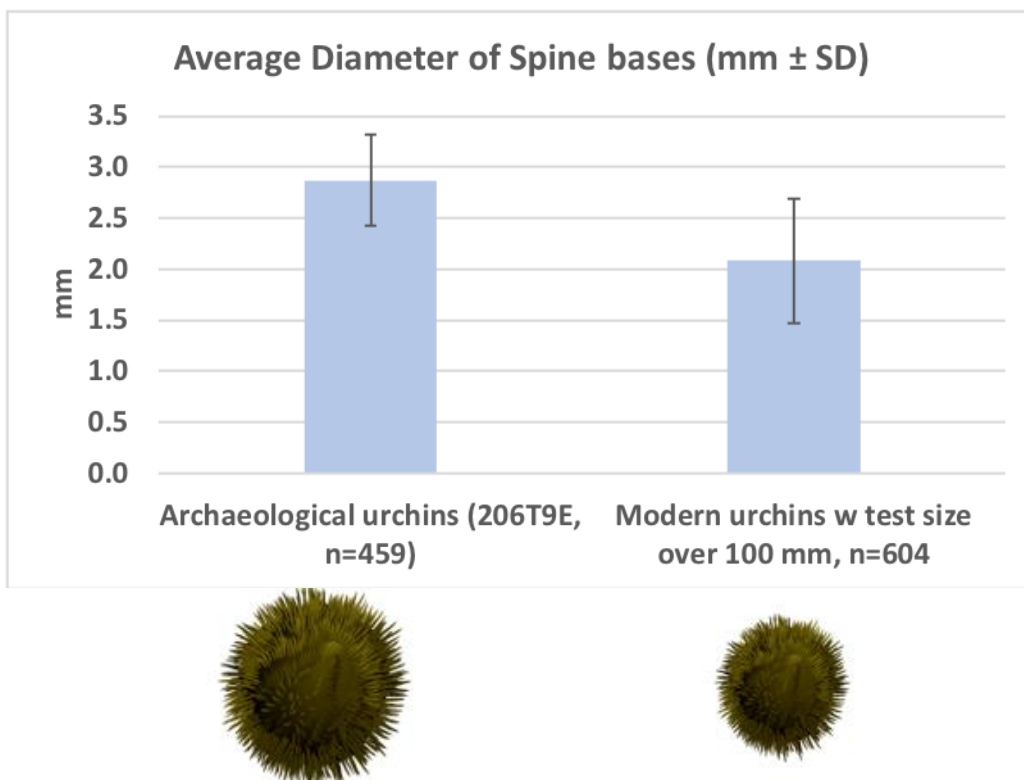


Figure (16). Bar graph depicting average of red urchin spine base diameters among archaeological specimens (n=459) measured from 206T9E and modern red urchin spine measurements (n = 604) taken from six modern urchins with *test* diameters greater than 100mm.

## **Discussion**

The regression formula created for this paper is accurate for generating urchin *test* size estimates specific to British Columbia and can be applicable to the archaeological record for deepening what is currently understood regarding First Peoples' relationships to sea otters and sea urchins prior to contact. This applies not only to the marine ecosystems of Barkley Sound, but also elsewhere along the Northwest Coast. However, it should be noted that my statistical analysis was restricted to natural mortalities, and therefore the sample size of modern dataset and its size range was limited in this regard.

Deposition, taphonomic processes, and abrasive field collection methodologies take their toll on fragile faunal specimens. Knowing what to look for, regarding fragmented or pulverized urchin jaw material proved a challenge, even with the help of images and modern samples for reference. It was also apparent early on in this project that sea urchin jaw elements are particularly fragile structures (Nagle 2016). During the cleaning processes, modern samples had to be handled delicately, and even still, some broke along suture lines easily. This has been observed as normal among *M. franciscanus hemipyramid* structure (Campbell 2008). This fragility is an important characteristic of *Aristotle's Lanterns* when considering the archaeological record (Nagle 2016). If they are a fragile material, preservation upon deposition may be rare or non-existent in most cases. Taphonomic factors are likely very important to understanding how well urchin remains survive in archaeological contexts. Further studies, and further attempts at selecting for *hemipyramids* in the field directly, will be critical for archaeologists to better understand these processes. The prominent absence of easily identifiable *hemipyramids* (or any other jaw elements) within the samples analyzed in 2016 and 2018 from four archaeological sites in Barkley Sound, is suggestive of perhaps the need for a shift in field

collection methodologies regarding the recovery of fragile invertebrate material. It is likely that wet and/or dry screening may be too destructive for collecting *hemipyramid* specimens, and gentler techniques or direct selection during excavation may need to be implemented to better recover such data. Auger tests as well as column samples may also be limiting in their size parameters, and therefore may not be the best method for analyzing urchin representation within level contexts. Auger tests, generally, may also be too pulverizing or ‘traumatic’ to fragile urchin material and therefore other methods of excavation may be better suited to the collection of urchin *hemipyramids*.

Despite possible low preservation rates, archaeological intact urchin *hemipyramid* structures have been observed in recovered Northwest Coast assemblages (Rebecca Wigen, personal communication, 2018). Preliminary urchin spine data presented above also indicated that very large sea urchins are present in the archaeological record of the settlement site of *Maktlzi* (206T) on Wouwer Island in the Broken Group Islands. This suggests that Indigenous Peoples were likely managing sea otter population densities to allow for more productive shellfish in specific harvesting areas, and/or that sea otters were not present in high enough numbers to negatively impact sea urchins in Barkley Sound. Tseshaht oral histories, as recounted by Saayach’apis’ in 1922, also indicate that sea otters were present in large numbers in Barkley Sound for a very long time prior to contact and the Pacific Maritime Fur Trade (McMillan and St. Claire, 2005).

I argue the data potential of *hemipyramids* and spines within archaeological contexts is significant. Sea urchins are an essential species within the marine ecosystems along the Northwest Coast and Stevenson et al. (2016) demonstrate a strong relationship between sea otter urchin consumption and urchin size. Szpak et al. (2012, 1560) suggest that “[a] low abundance of

[sea urchins] *may* also relate to the local presence of sea otters”. Sea urchins are also a culturally salient species and they have been harvested by Coastal First Nations for generations (Ellis and Swan 1981; Campbell 2008; Sumpter 2005 and 2012). Together these processes are significant for a deeper understanding of kelp and algae ecosystems in the Pacific Northwest (Stevenson et al. 2016: 1050), particularly regarding the last century, when sea otter population densities have been very low after near extinction in the late 1800’s (Szpak et al. 2012, 1553; Szpak et al. 2013). Quantifying urchin *hemipyramids* and other elements found in the archaeological record to determine the harvest profiles of red sea urchin is significant for broadening what is currently known not only about past management of sea otters and urchins, but also about larger dynamic processes that fit into the greater span of ecological and cultural activities that have been occurring along the Northwest Coast for thousands of years (Campbell 2008,16).

### **Conclusion:**

*“It’s got to be seen that human beings are a part of the environment, are a part of the ecology, a part of the balance.”* – Guujaaw, former President of the Haida Nation (Coastal Voices, 2015)

In conclusion, this paper investigates the importance of sea urchins in the archaeological record and specifically sea urchin size variation to consider how Coastal First Nations actively managed sea otters prior to contact, for example by purposefully excluding them from urchin harvesting areas (cf. Szpak et al. 2012). Specifically, I asked whether urchins of large size (which would otherwise be preferentially eaten by sea otters) are regularly present in archaeological samples from Tseshaht and Huu-ay-aht territories. To that end, my data suggests that Indigenous communities were capable of excluding sea otters from areas of human

settlement and/or that sea otters were not present on western Vancouver Island in sufficient numbers to have negative impacts on urchins in these study areas in the past.

I argue that addressing how humans harvested urchins and how urchins may have significance for interpreting the abundance of sea otters prior to the onset of the sea otter fur trade will add to the contemporary understanding of Aboriginal rights and title, harvesting use rights, and marine ecosystem management both in the past and present. It is increasingly recognized in academia and environmental sciences that if study is to be made of Holocene environments for restoring modern ecosystems, it cannot be done without also understanding the “long-term human environmental interaction in the past” (Foster et al. 2016, 1). Archaeology, in conjunction with traditional knowledge, can therefore inform “long-term anthropogenic perspectives that are important for conservation and environmental-management policies” of modern ecosystems (Foster et al. 2016, 2).

The regression developed in this paper is intended to be useful for collaborative marine conservation efforts between Indigenous communities and researchers regarding present and future management of sea otters as their populations continue to increase and migrate down the coast (Salomon et al. 2015, 325). This method may be significant for reconstructing more accurate kelp forest baselines to inform regional conservation goals for sea otter restoration that considers the millennia of human agency embedded in the functioning of these ecosystems (Salomon et al. 2015, 325). Therefore, exploring urchin harvest profiles in the archaeological record is useful for gaining a more complex understanding of both the historical ecologies of Barkley Sound, as well as “[providing] a useful line of evidence for interpreting human use of the coast over time” (Campbell 2008a: 16).

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