Journal of Archaeological Science: Reports 49 (2023) 103884

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Geo-archaeology and Haíɫzaqv oral history: Long-term human investment and resource use at EkTb-9, Triquet Island, N̓úláw̓itx̌v Tribal Area, Central Coast, British Columbia, Canada

Alisha Gauvreau [a,b,*], Daryl Fedje [a,b], Angela Dyck [a,f], Quentin Mackie [b], Christopher F. G. Hebda [a], Keith Holmes [a], Qˇíxˇitasu Yímˇázalas Elroy White [c], Dúqva̓ísḷa William Housty [d], Ĝvuí Rory Housty [e], Duncan McLaren [a,f]

[a] *Hakai Institute, Heriot Bay, British Columbia, Canada*
[b] *University of Victoria, Victoria, British Columbia, Canada*
[c] *Central Coast Archaeology (CCA), Bella Bella, British Columbia, Canada*
[d] *Haíɫzaqv Integrated Resource Management Department (HIRMD), Bella Bella, British Columbia, Canada*
[e] *Haíɫzaqv Language Program, Bella Bella, British Columbia, Canada*
[f] *Cordillera Archaeology, Victoria, British Columbia, Canada*

ARTICLE INFO

Keywords:
Northwest Coast
British Columbia
Haíɫzaqv (Heiltsuk) Nation territory
Geoarchaeology
Site Formation Processes
Oral History
Persistent Places

ABSTRACT

Archaeological site EkTb-9 is located on Triquet Island in the N̓úláw̓itx̌v Tribal area of Haíɫzaqv (Heiltsuk) Nation territory, on the Central Coast of British Columbia, Canada. The results of radiometric dating and the analysis of palaeoenvironmental correlates indicate that the site was a persistent place of repeated human occupation spanning the early post-glacial period to the present day. This paper focuses on the paleogeographic and geomorphic setting of EkTb-9. Stratigraphic records show a complex array of site formation processes. Marine beach sediments are elevated above modern sea level, an extensive sand sheet consistent with a possible palaeotsunami event is present, as well as organic soils and peat deposits. Cultural strata are interbedded with these and include both shell-less and preserved shell accumulations. Results from our geo-archaeological and palaeoenvironmental assessments indicate that the outer coastal island changed from what was likely an open landscape during the early post-glacial period to the hypermaritime coastal temperate rainforest environs of the present day. Our interpretations are combined with Haíɫzaqv oral history and discussions are organized by Haíɫzaqv temporal phases identified for the N̓úláw̓itx̌v Tribal area. Combining Indigenous knowledge with our archaeological interpretations enhances our collective understanding of the long-term record of human occupation and investment at EkTb-9.

1. Introduction

The early post-glacial record of human occupation on the outer Pacific coast of British Columbia (BC), Canada represents an integral component of the evolving narrative for the peopling of the Americas and the coastal corridor hypothesized to have permitted human expansion from Asia along the western margin of the Cordilleran Ice Sheet (Erlandson et al., 2007; Fladmark, 1983; McLaren et al., 2019; Potter et al., 2018). While debates surrounding the occupation of the Americas prior to the Last Glacial Maximum continue (Bennett et al., 2021), robust archaeological and genetic evidence indicate it is more likely that the peopling of the Americas occurred as ice began to retreat (Madsen et al., 2022). The coastal corridor is supported by evidence of non-glacial conditions on the Northwest Coast of BC as early as ca. 18,000 – 16,000 years ago (Al-Suwaidi et al., 2006; Blaise et al., 1990; Darvill et al., 2018; Hebda, 2019; Hebda, et al., 2022; Lesnek et al., 2020; Misarti et al., 2012; Oviatt et al., 2022; Shaw et al., 2020) and documented human presence on the landscape by ca. 14,000 – 13,000 years ago, as well as archaeological and other palaeoenvironmental evidence from elsewhere in the Americas (Davis et al., 2019; Davis et al., 2022; Dillehay et al., 2015; Halligan et al., 2016; McLaren et al., 2019; Waters et al., 2018; Waters et al., 2023; Williams et al., 2018). However,

* Corresponding author.
E-mail address: alishag@uvic.ca (A. Gauvreau).

https://doi.org/10.1016/j.jasrep.2023.103884
Received 12 February 2022; Received in revised form 23 January 2023; Accepted 7 February 2023
Available online 28 April 2023

our understanding of this crucial period remains limited as many near-coastal archaeological sites were submerged or high-stranded following changes in sea level during and after the Last Glacial Maximum (Mackie et al., 2018; McLaren, 2008; McLaren et al., 2014). Archaeological sites on Triquet Island and a few other outer-coastal islands along the north and central coast of BC[1] are rare exceptions as the relative sea level has remained similar in these areas since the late Pleistocene (Mackie et al., 2018; McLaren et al., 2015).

Triquet Island is situated approximately 25 km west of the Pacific mainland coast of BC within Haíłzaqv (Heiltsuk) Nation territory. It is a small island (144 ha in size) in a larger archipelago north of Hakai Passage, located at the entrance to Kildidt Sound within the Hakai Lúxvbálís Conservancy (Fig. 1). Today, the island is in the Coastal Western Hemlock biogeoclimatic zone, Very Wet Hypermaritime subzone, Central Variant (CWHvh2)[2] (Banner et al., 1993; Pojar et al., 1991). Triquet Island's hypermaritime environment is characterized by high levels of precipitation (fog, drizzle, rain) during mild wet winters and generally cool summers, subtle variation in slope, excess soil water, and a maximum elevation of 49 m above modern sea level (Banner et al., 2005). Average yearly precipitation on Triquet Island ranges from approximately 120–500 mm a month with the highest levels generally occuring from October through February. Average temperatures fluctuate between approximately −12 °C and 9 °C from October to March and between approximately −1 °C and 20 °C from April to September. Throughout the year, average windspeeds vary between 2 and 40 km/h.

Despite the small size of the island, seven archeological sites (EkTb-3, 8, 9 and 11–14) have been recorded there (Fig. 2). The sites are primarily distributed across the northern and protected coastal extent of the island. Inventoried features include intertidal fish traps and petroforms (circular stone alignments), extensive intertidal surface lithic scatters, culturally modified trees, shell-midden and shell-less midden accumulations, and a house platform. Estuarian root gardens[3], well established berry patches, and a Haíłzaqv registered trapline[4] and trapper's cabin are also known on Triquet Island (Stafford et al., 2009). While most of the outer coastal islands in the area of Hakai Passage and Kildidt Sound are rocky and steep sided, Triquet Island has gently sloped and protected beaches. With its desirable topographical features and outer coastal positioning allowing unimpaired visibility of the Pacific Ocean and adjacent inner waterways, the island is a logical choice for repeated human occupation and investment in place (Letham et al., 2020).

EkTb-9, comprising both intertidal and terrestrial deposits, is the largest archaeological site currently recorded on Triquet Island (Fig. 2). The site is centrally located along a protected northeastern bay, facilitating access to resources in the surrounding productive intertidal and estuarine areas, coastal forests, deep-sea and near shore marine environments, and sea-mammal rookeries. An extensive tidal flat on the lee side provides an excellent place for landing watercraft and harvesting intertidal resources. EkTb-9 is a multi-component site containing a rich assemblage of stratified natural and cultural deposits bearing stone tools, hearth features, fauna, preserved organics, perishable wooden artifacts, and fire-altered rock.

This paper focuses on the terrestrial component of our fieldwork (above the intertidal zone), presenting the main stratigraphic and archaeological results with a discussion of site formation processes. The results of radiometric dating[5] coupled with the analysis of sediments and biological proxies demonstrate landscape change since the late Pleistocene. Geospatial modelling enables reconstructed visualisations of these processes. We provide detailed results of the lithic analyses and preliminary summaries of the faunal and waterlogged artifact assemblages recovered. EkTb-9 offers a unique opportunity to learn more about site formation processes, terraforming, and the theoretical and political importance of observed continuity at a single place of repeated human occupation and investment. This study contributes to discussions surrounding the hypothesized coastal dispersal route for the peopling of the Americas. This study also represents a novel collaboration with descendent community members from Haíłzaqv Nation to bridge Indigenous knowledge with archaeological methods of investigation.

2. Background

EkTb-9 was first recorded during a one-day archaeological impact assessment; part of a larger study of select recreation sites within the Hakai Lúxvbálís and Outer Coastal Islands Conservancies (Stafford et al., 2009). The site was selected for further investigation during the Hakai Ancient Landscapes Archaeology Project (HALAP)[6] due to its outer coastal position and promising stratigraphy (McLaren, 2013; McLaren, 2014). The primary goal of the HALAP was to investigate the early post-glacial environmental and human history within the Hakai Passage region of the Central Coast. In 2011 the HALAP team conducted a preliminary core and auger testing program at EkTb-9 to sample and date cultural deposits (McLaren, 2013). Land-based excavation at the site began in 2012, continued in the spring of 2015 and 2016, and culminated with a minimally invasive Vibracore sampling program in 2017 (Gauvreau and Dyck, 2018; McLaren, 2013; McLaren, 2016; McLaren, 2018). Intertidal excavations at the site began in 2016 and concluded in 2017 (Dyck et al., 2020).

2.1. Regional setting

Among outer coastal islands situated along the Northwest Coast of North America there are hundreds of recorded archaeological sites that pre-date ca. 7,000 Cal BP located within 300 m of the current shoreline, and a handful that pre-date ca. 12,000 Cal BP (Fedje et al., 2021; Gustas and Supernant, 2019; Lausanne et al., 2019; Vogelaar, 2017). Early post-glacial occupation sites such as Far West Point (GcTr-6) (Martindale et al., 2009; McLaren, 2008); Kilgii Gwaay (1325T) (Cohen, 2014; Fedje et al., 2001, 2005; Mackie et al., 2011; Wigen, 2002, 2005); and Richardson Island (1127T) (Fedje et al., 2005; Magne, 2004; Smith, 2004; Steffen, 2006; Storey, 2008; Waber, 2011) indicate site inhabitants practiced maritime-based subsistence with a focus on near-shore and bottom fish species such as pelagic herring, rockfish and greenling, whereas karst cave sites K1, Gaadu Din 1, and Gaadu Din 2 on southern Haida Gwaii demonstrate early post-glacial presence of black and brown bear, ungulates, domesticated dog, and salmon, with an archaeological record up to ca. 13,100 – 12,600 Cal BP (Fedje et al., 2021).

Early post-glacial sites EjTa-4 and EjTa-15 on Calvert Island (Wuíga;

[1] Hereafter referred to as the Central Coast.

[2] The Coastal Western Hemlock Zone, Very Wet Hypermaritime subzone, Central Variant includes all coastal islands and a mainland fringe along the central and north coast of BC from Smith Inlet in the south to the Alaska border in the north (Banner et al., 1993).

[3] Estuarian root gardens identified in coastal BC are cultivated landscapes that have been managed and maintained by coastal Indigenous Nations across generations (Deur, 2002; Turner and Deur, 2005; Turner et al., 2013). Estuarian root gardens often comprise a mix of springbank clover (*Trifolium wormskioldii*), Pacific silverweed (*Potentilla egedii*), northern riceroot lily (*Fritillaria camschatcensis*) and Nootka lupine (*Lupinus nootkatensis*) (Turner et al., 2013). These root gardens are typically situated on "estuarian salt marshes and gravel beds where the mouths of rivers and streams meet saltwater" [29:11].

[4] Haíłzaqv traplines were integral sources of income during the fur trade and the rights to the traplines have been passed down across generations (Stafford et al., 2009).

[5] For consistency, we report all radiocarbon dates herein as "Cal BP" (calendar years before present; AD [anno domini] 1950). Calibration details are described in the Methods – Radiometric Dating Section.

[6] The HALAP was conducted under the terms and conditions of Heritage Conservation Act (HCA) Permit 2011–0171.

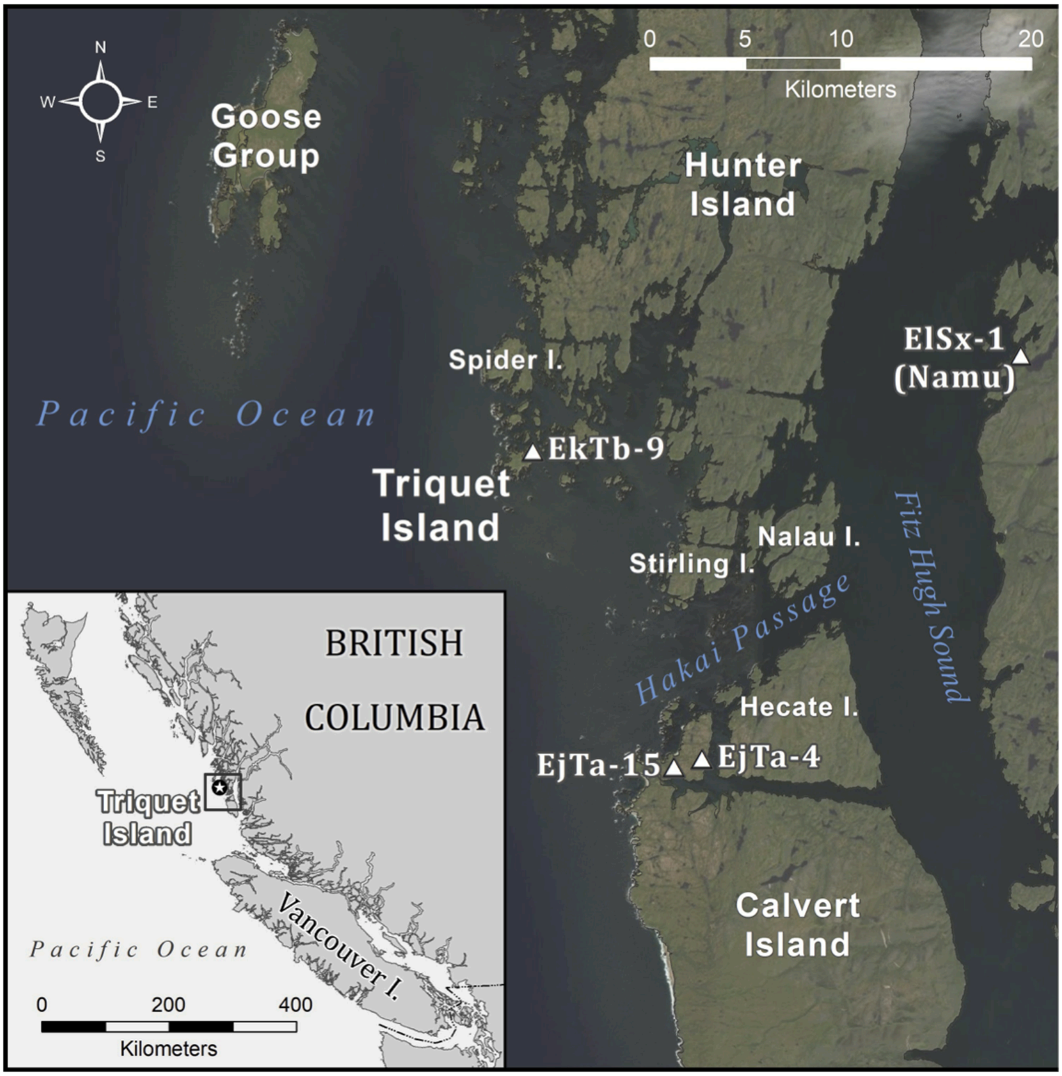

Fig. 1. Study area map showing location of EkTb-9 on Triquet Island and other nearby archaeological sites (ElSx-1, EjTa-15, EjTa-4) on the Central Coast. Archaeological sites EkTb-9, ElSx-1, EjTa-4, and EjTa-15 exhibit similar patterns of long-term human occupation and investment beginning during the late Pleistocene /early Holocene. The inset shows the location of Triquet Island along the coast of British Columbia, Canada. Prepared by K Holmes.

approximately 18 km southeast of EkTb-9) demonstrate long-term records of human occupation (Fig. 1) (McLaren et al., 2015; McLaren et al., 2018). Archaeological sites GcTr-6, EjTa-15, and EjTa-4 indicate a pattern of population and site expansion that point to persistent outer coastal settlement during the early post-glacial period and early Holocene (Martindale et al., 2009; McLaren, 2008; McLaren et al., 2015; McLaren et al., 2018). Like EkTb-9, accessing these other island sites over the last 14,000 years would have required the use of watercraft[7] (Fig. 1). A nearby mainland coastal site of regional significance within Haíłzaqv Territory is Namu (ElSx-1) (Fig. 1). Archaeological investigations at Namu also demonstrate a long-term record of repeated human occupation, beginning ca. 11,500 years Cal BP (Cannon, 1991; Carlson et al., 1996; Luebbers et al., 1978; McLaren et al., 2015; Rahemtulla, 2006). Due to the extensive field and laboratory investigations conducted at Namu, the settlement and subsistence history of this mainland site has served as the primary comparative record for all other sites on the Central Coast.

Past archaeological research on the Central Coast has demonstrated long-term cultural continuity in the absence of sustained political conflict, environmental upheavals, group migrations, and cultural replacement (McLaren et al., 2015). Few village sites were permanently abandoned, implying that people were choosing to stay in places where they had millennia-old settlements rather than finding alternative locations. The option to remain and repeatedly reoccupy settlements over millennia was possible, in part, as a result of the stable relative sea level in the region (McLaren et al., 2015). Results from the HALAP have demonstrated that mainland coastal and outer coastal adaptation systems were locally specific, exhibiting variation in resource procurement strategies (Duffield, 2017; McLaren, 2013; McLaren et al., 2015; McLaren et al., 2019). These varied systems coalesced through established trade routes and kinship ties and were perpetuated for millennia through culturally specific prerogatives[8] and long-term connections to place, creating a legacy of persistent places of repeated human occupation and investment (Letham et al., 2020; McLaren et al., 2015).

[7] See section 2.3 History of glaciation and sea level change for additional context.

[8] Culturally specific prerogatives are exclusive rights and privileges held and inherited by a person, class, or village (McLaren et al., 2015).

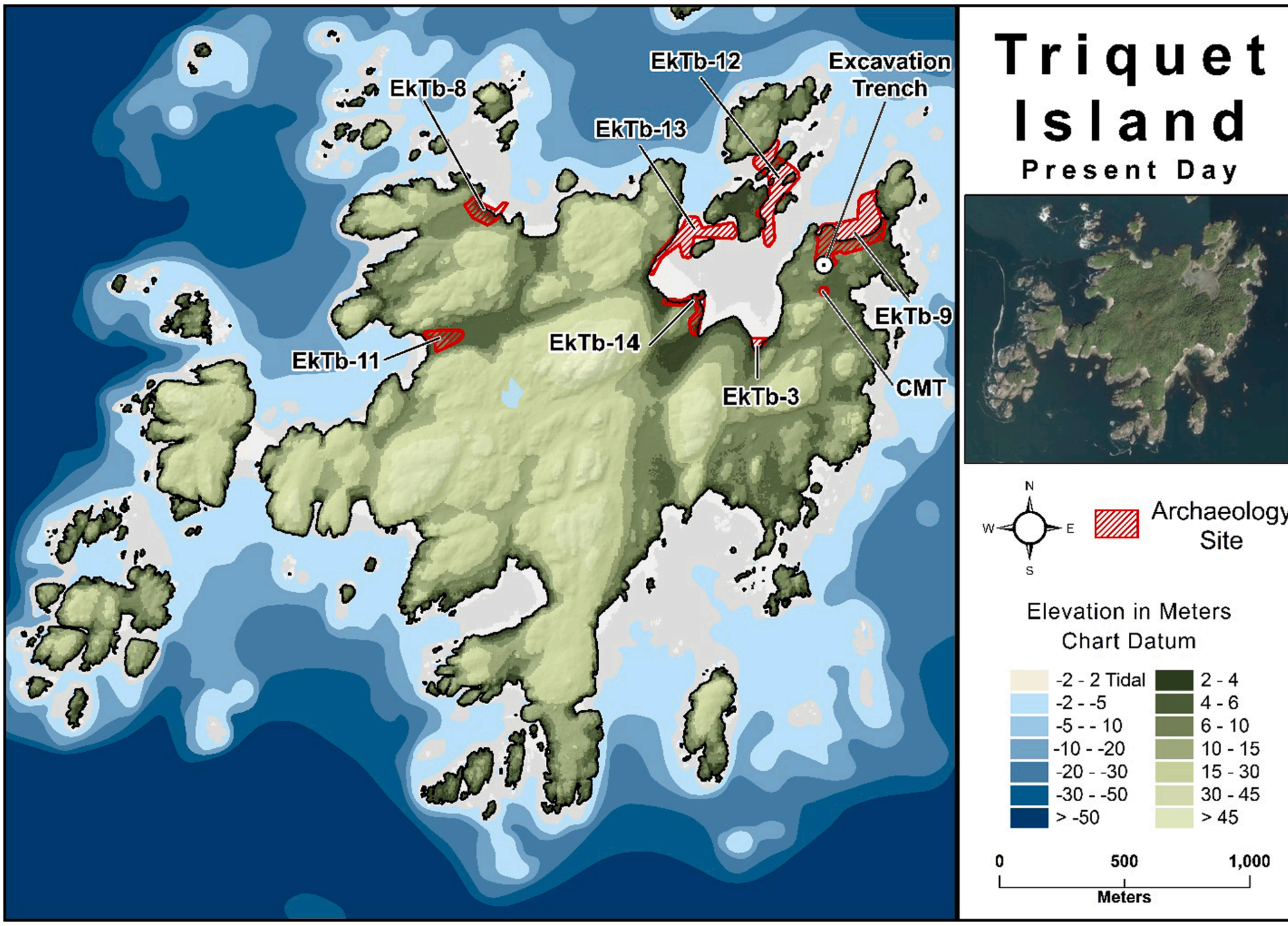

Fig. 2. Mid-Range map showing the location of archaeological sites EkTb-3, -8, -9 and -11 to -14 on Triquet Island. The modern day sea level at Triquet Island is shown with elevation in meters from chart datum. Image derived from data obtained through drone imagery and LiDAR. EkTb-9 archeological site boundary shown in red with small polygon showing location of a culturally modified tree (CMT) associated with the site and a white circle showing the location of the excavation trench. Prepared by K. Holmes.

2.2. *Terraforming and intentional investment in place*

Early outer coastal island inhabitants engaged in the material process of terraforming, a practice involving the alteration and construction of components of the landscape through repeated human occupation and investment over millennia (Grier and Schwadron, 2017). Although large shell accumulations (shell middens) have long been regarded as refuse heaps revealing the subsistence, seasonality, and resource exploitation practices of the site's inhabitants, increasing attention has been given to the relationship between these types of terraformed landscapes and human social memory and identity (Gamble, 2017; Grier et al., 2017; Randall and Sassaman, 2018).

At outer coastal sites GcTr-6, EjTa-15, and EjTa-4 (Letham et al., 2020; Martindale et al., 2009; McLaren, 2008; McLaren et al., 2018) and other large shell midden sites on the Northwest Coast (Grier et al., 2017; Mackie, 2003) where patterns of population and site expansion are revealed, terraforming has occurred through labor-intensive movement of available materials such as shell, rock, fire-altered rock, and sediments. Terraforming was undertaken at diverse spatial and temporal scales at these sites, and they all eventually became more suitable for human habitation and resource harvesting over time (Grier and Schwadron, 2017; Trant et al., 2016). Large-scale resource production features connected with the inhabitants' management systems, such as clam gardens (Caldwell et al., 2012; Holmes et al., 2022; Jackley, 2014; Jackley et al., 2016; Lepofsky et al., 2015), fish traps and weirs (Caldwell et al., 2012; Moss, 2012; White, 2006), and plant gardens (Hoffmann et al., 2016; Turner and Deur, 2005) are often associated with the labor-intensive feats of terraforming. These landscape modifications are deemed to be of monumental scale in relation to their impact on social practice, as the implications of terraforming extend beyond simply making a landscape more habitable (Gamble, 2017; Grier et al., 2017; Randall and Sassaman, 2018). Places that become persistently occupied and invested in are generally understood to have been incorporated into cultural spheres, informed by the ecology of the area as well as the traditions, behaviours, and worldview of the inhabitants (Randall and Sassaman, 2018). Conceptually, terraforming is not simply the creation of new livable surfaces, but rather, the production of "new topologies" manifest through the rearrangement of histories and relations to the land guided by a vision for the future (Randall and Sassaman, 2018: 11). It is important to note that while many acts of terraforming on the Northwest Coast were intentional, the modification of the landscape was nevertheless gradual, and may have been somewhat unintentional at the onset. In this paper we explore how the natural and cultural deposits at EkTb-9 and the oral histories of Haíɫzaqv Nation indicate that the site is a persistent place that has been subject to terraforming through continued investment and intentional landscape modification.

2.3. *History of glaciation and sea level change*

Ice from the late Wisconsin glacial maximum (locally known at the Fraser glaciation) had retreated from the outer islands of the Central Coast, including Triquet Island, by ca. 18,000 years ago (Darvill et al., 2018; Shaw et al., 2020). By ca. 13,800 Cal BP, ice had retreated well into the fjords of the mainland to the east (Darvill et al., 2018; Shaw et al., 2020). The local and global diminishment of ice during this time had significant effects on the regional sea level history. Sea levels in the area of Triquet Island prior to ca. 15,000 years ago are not well constrained (Fig. 3). At ca. 15,000 years ago, relative sea level was below 1.5 m above higher high tide (hht). At ca. 14,500 years ago, coincident with a local ice advance, sea level was 6 m above modern levels (McLaren et al., 2014). This rise may have resulted from the increased isostatic depression of the earth's crust or the effects of a global meltwater pulse event (Abdul et al., 2016). By ca. 14,000 years ago sea level had fallen to a position near modern and was slightly lower than modern for the next three millennia (McLaren et al., 2014). After ca. 10,500 years ago, relative sea level began to rise and has remained within 1 to 2 m of modern until the present day. Radiometric dates on samples collected from a paleosol identified below beach sand (2.2 m below hht) on the west side of Triquet Island provide localized evidence of a lowstand with ages of ca. 10,600 Cal BP (UCIAMS 102764, 102763) (Walker and McLaren, 2013).

The relative stability of the local sea level in the vicinity of the Central Coast continued until late Holocene times. This phenomenon is referred to as a "sea level hinge"; that is, a fortuitous offsetting of isostatic, eustatic, and tectonic forces resulting in the general stability of the local sea level (McLaren et al., 2014). This consistent sea level has contributed to the abundance of archaeological sites that have records of repeated long-term use, as the same protected beaches would have been accessible along the shoreline for over 15,000 years. The stable relative early post-glacial sea level history of the Hakai Passage region contrasts with inner coastal fjord shorelines that were, concomitantly, up to 200 m above modern sea level, and with outer coastal shorelines of Haida Gwaii to the west which had late glacial sea levels as low as 150 m below modern shorelines (Mackie et al., 2018; Shugar et al., 2014) (Fig. 3).

2.4. Palaeoenvironmental setting

Following the retreat of Cordilleran ice from the outer coast ca. 18,000 years ago (Barrie and Conway, 2002; Clague, 2000; Clague et al., 2004; Shaw et al., 2020), the region experienced dynamic climatic fluctuations including the temperate Bølling–Allerød interstadial (ca. 14,700 – 12,900 Cal BP) and the cooler Younger Dryas (ca. 12,900 – 11,700 Cal BP) (Lacourse et al., 2005; Mathewes, 1993); both of which affected the growth and spread of post-glacial vegetation along the coast.

Pollen studies provide a ca. 14,500-year-old vegetation history from the Hakai region, revealing a succession of plant species from open conditions during the late Pleistocene, to the climax coastal rainforests and bog ecosystems in the region today (Eamer, 2015; Lucas, 2013). Older post-glacial plant communities have been documented from at least ca. 17,500 years ago on northern Vancouver Island (Hebda, 2019; Hebda et al., 2022), and from ca. 18,000 (Blaise et al., 1990) to ca. 14,500 years ago in comparably situated coastal contexts on the Haida Gwaii archipelago (Lacourse et al., 2003; Lacourse et al., 2012; Lucas, 2013; Mathewes and Clague, 2017). These data suggest the outer coast environment from ca. 18,000 – 16,000 years ago was cool and dry with tundra-like herb and shrub-dominated vegetation communities, followed by a transitional period between ca. 16,000 – 14,500 Cal BP when a mosaic of tundra-like environments and early arboreal communities existed across the outer coast.

By ca. 14,500 Cal BP the record from Calvert Island (W̓uíga), located approximately 15 km southeast of Triquet Island, indicates that a shore pine (*Pinus contorta*) dominated parkland was established (Eamer, 2015). By ca. 13,500 years Cal BP the canopy became more closed with the addition of Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and some alder (*Alnus* sp.). Soon after ca. 13,000 years Cal BP a slight expansion of mountain hemlock (*Tsuga mertensiana*) is noted, possibly the result of the onset of the Younger Dryas cooling event (Mathewes, 1993). By the early Holocene, climatic conditions ameliorated with forests dominated by alder and mixed conifers. Sphagnum bogs expanded in flatter, more poorly drained areas of the outer coast. Cedar (Cupressaceae) pollen — likely belonging to western redcedar (*Thuja plicata)* — appears in the record on Calvert Island (W̓uíga) between ca. 8,300 – 7,500 Cal BP (Eamer, 2015). On Triquet Island, pollen analyzed from archaeological sediments reveal that cedar appears between ca. 6,700 – 5,700 Cal BP at lesser relative amounts than on Calvert Island (W̓uíga) (Hebda, 2020; Lucas, 2013). This later signal could be the result of hypermaritime moisture-laden conditions which slowed evapotranspiration and may have limited the initial growth of cedar as it spread to smaller outer islands (Banner et al., 2005; Hebda et al., 1997).

2.5. Surficial geology

The surficial geology of EkTb-9 comprises a mix of undivided rock complexes consisting of Mesozoic and Late Jurassic to Early Cretaceous granodioritic intrusive rock. Quaternary deposits include glacial till and colluvial deposits consisting of blocks and rubble with sand and silt derived from the crystalline bedrock, medium-grade metamorphic substrate, and cemented sandstone (Bellafontaine et al., 2019; Fulton, 1995). Sandy duric (McKeague and Sprout, 1975) sediment with cobble to boulder-size clasts overlies this bedrock and likely represents a combination of deglacial and early post-glacial beach deposits. These deposits are overlain by Ferro-Humic Podzols (Pennock et al., 2015; Sanborn et al., 2011) with clastic sediment to gravel size material, organic soil, peat accumulations, woody debris, and stratified anthropogenic sediment (D Horizons) (Naeth et al., 2012; Valentin, 2019).

2.6. Community collaboration

This project was conducted from the onset through direct collaboration with Haíɫzaqv Nation, the Hakai Institute, the University of Victoria, and the Royal British Columbia Museum (RBCM). Our collaborative work operates under the authority of the Haíɫzaqv Tribal Council (HTC) and Yím̓ás Council (Hereditary Chiefs), with input and direction from the Haíɫzaqv Integrated Resource Management Department (HIRMD) and the Haíɫzaqv Language Program. This collaboration is fundamental to the democratization of the discipline of archaeology and represents a positive step towards acknowledging the legal and ethical need to consult, co-create, and re-envision how western science and Indigenous knowledge can be combined to improve social-ecological systems today and enrich our understanding of the past (Salomon et al., 2018). Through our collaboration, we combine Haíɫzaqv oral historical and linguistic data with our archaeological results (and vice-versa) to enhance our mutual understanding and interpretations of the site (Gauvreau and McLaren, 2016). Our approach acknowledges that oral history and archaeological chronologies are diachronic systems of knowing the past and that not all aspects of oral history can be tested using empirical methods (Gauvreau and McLaren, 2016). We have collaborated closely with the HIRMD to explore the overlapping edges of Haíɫzaqv oral histories and the archaeological record for the N̓úláw̓itx̌v Tribal area (Hakai Passage/South Hunter Island area) where the EkTb-9 site is located. Available oral historical information shared with us by the HIRMD is not specific enough to allow direct spatial anchoring to the EkTb-9 site, however, it highlights the enduring cultural significance of archaeological sites in the immediate region to members of Haíɫzaqv Nation.

2.7. Haíɫzaqv Nation oral historical records

Haíɫzaqv Nation members descend from marine-based people who acquired their primary subsistence from the Pacific Ocean and coastal river systems (White, 2006). Haíɫzaqv Nation recognize five ancestral local groups (tribes) that held and continue to hold rights and title to the lands and waters of their territory. The five local groups include the

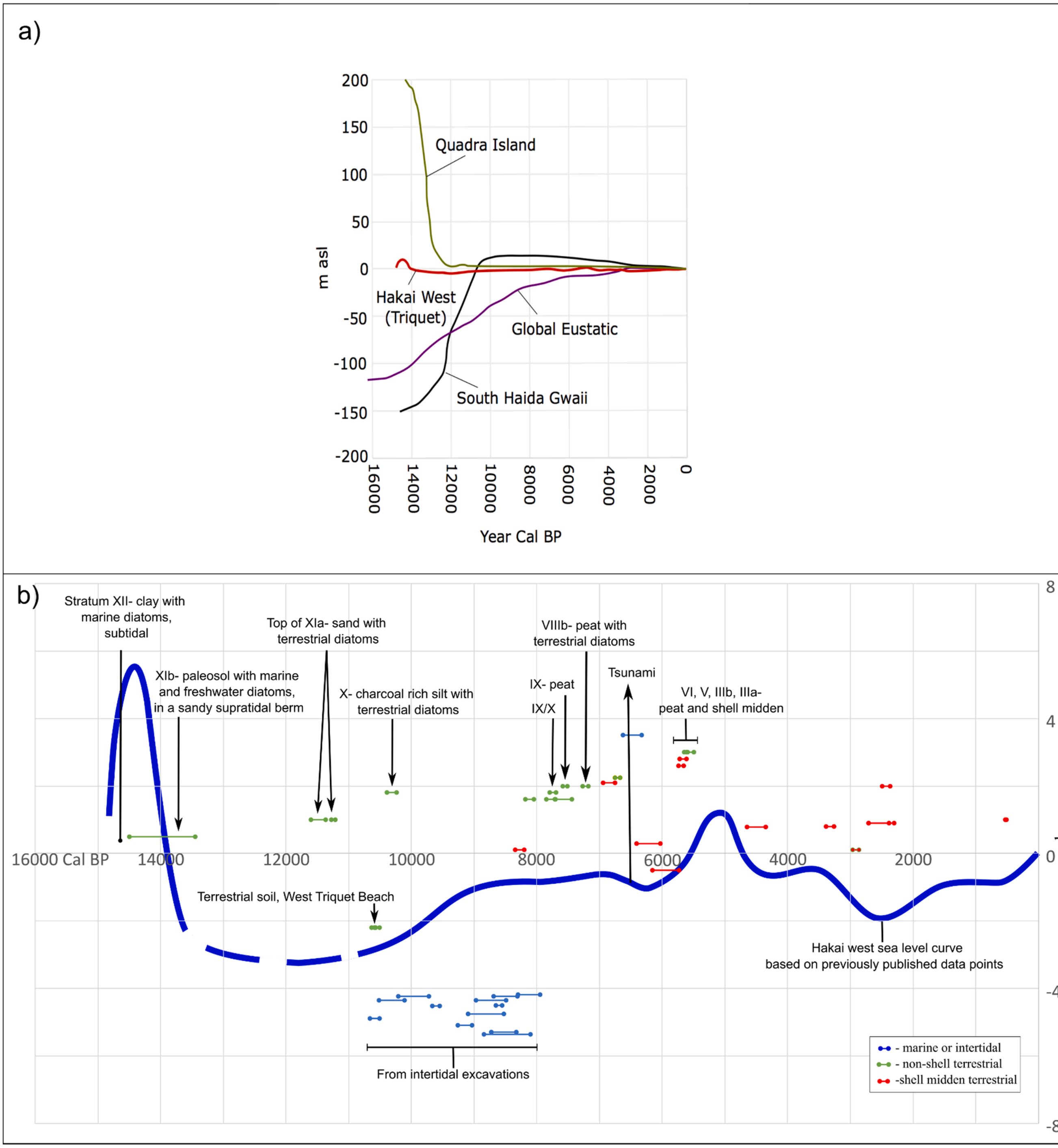

Fig. 3. Sea level Curve for the study area within the Hakai West region. a) Selection of regional sea level curves including Quadra Island (Fedje et al., 2018), Hakai West (including Triquet Island) (McLaren et al., 2014) and southern Haida Gwaii (Fedje et al., 2005). The global eustatic sea level curve is approximated from Barbados sea level research (Peltier and Fairbanks, 2006). (b) Detailed view of the Hakai West sea level curve published in 2014 (McLaren et al., 2014) which includes Triquet Island and the broader outer Central Coast region. Radiocarbon/elevation data points from Triquet Island (McLaren et al., 2014; McLaren, 2014; Dyck et al., 2020) and this paper are plotted on either side of the curve with details concerning the stratigraphic associations of the data points. Prepared by D McLaren.

Q̓vúqvaỷáitx̌v (People of the calm water), the W̓úyalitx̌v (People of the outside), the W̓uíƛitx̌v (People of the inlet; inside water People), the Xíx̌ís (down river People), and the Ýísdáitx̌v (People of Ýísdá – where mountains meet the sea) (HTC, 2018). The names of the Haíɫzaqv local groups demonstrate the significance of coastal freshwater and marine environments to Haíɫzaqv people and how they continue to shape Haíɫzaqv cultural identity today (HTC, 2018). Prior to European contact, Haíɫzaqv Nation also recognized the N̓úláw̓itx̌v Tribal group; a local sub-group who later amalgamated with the W̓úyalitxv sub-group when relocating to the village of Q̓ḷc (Old Bella Bella) and then to the present day site of Wáglísla (Bella Bella) on Campbell Island (Boas, 1932; Olson, 1955). In Haíɫzaqvla, the language of Haíɫzaqv people, N̓úláw̓ítx̌v means “People of the oldest place in the world”.

Haíɫzaqv Nation have núym̓as laỷax̌sx̌v gaḷglis n̓álayax̌v (story about the beginning of time when the world was created), or origin stories, that are held by the different local groups. These origin stories are tied specifically to the regions that each local group inhabited, and differ between groups (HTC, 2018; McLaren et al., 2015; White, 2006). Origin stories are continuously reaffirmed through oral sharing (and written transcription) by Haíłzaqv knowledge keepers during potlatches and other ceremonies, as well as more casually, such as around the dinner table, or more formally for legal cases and academic research (White, 2006). Núyṃ́as lay̓ax̌sx̌v gaḷ́glis n̓álayax̌v and other ancestral origin stories tying local groups to place are how Yím̓ás (Hereditary Chiefs) and their families affirm their rights, privileges, cultural practices and connections to their specific regions of the broader Haíłzaqv territory (HTC, 2018; White, 2006). One núyṃ́as lay̓ax̌sx̌v gaḷ́glis n̓álayax̌v shared with anthropologist Livingston Farrand in 1897 by a member of the Killer Whale clan (who originates from the N̓úláw̓itx̌v Tribal area; now W̓úyalitxv) parallels the available archaeological and palaeoenvironmental data for the region (Boas, 1932; Farrand, 1916; Olson, 1955):

In the beginning there was nothing but water and ice, and a narrow strip of shoreline.

This excerpt is spatially anchored to the Hakai Passage/South Hunter Island area that the Killer Whale clan inhabited (McLaren et al., 2015). Following glacial-retreat and subsiding sea levels during the early post-glacial period, the N̓úláwitx̌v Tribal area would have revealed newly exposed shorelines, tombolos and steeply sided rocky outcrops, as well as narrow strips of shoreline and increasingly productive tidal flats (McLaren et al., 2015). In 1968, Haíłzaqv historian Q̓áq̓utíláy̓u (Hoffman Harris) reaffirmed this origin story excerpt during an interview conducted by the Haíłzaqv Cultural Education Center (HCEC). During our excavations at EkTb-9, archaeologist Q̓íx̌itasu Yím̓ázalas/Elroy White (Central Coast Archaeology) and Haíłzaqv field technician Guvi'ba/Josh Vickers generously shared Haíłzaqv histories and songs of the outer islands (Núláw̓itx̌v/ W̓úyalitxv Tribal areas) with us when we gathered around the campfire, the screening stations, and the excavation unit. Haíłzaqv people, generation after generation, have repeatedly transmitted the environmental history of the Hakai Passage region, and continue to be active managers of their terrestrial and marine landscapes.

The N̓úláw̓itx̌v tribal area encompasses a sizable portion of the outer Central Coast, capturing sites such as EjTa-4, EjTa-15, as well as EkTb-9, and many other sites in the general area. The place name N̓úlú, meaning 'the eldest,' is mentioned in several oral narratives (Boas, 1932; Olson, 1955) and is believed to be associated with an important village at archaeological site ElTb-1, within the N̓úláw̓itx̌v Tribal Area (Kildit Sound) (Hobler, 1988). However, N̓úlú was never plotted on a map by Haíłzaqv knowledge keepers, and it has been suggested that N̓úlú may have been the name for the geographic area used by the N̓úláw̓itx̌v, rather than a specific village site (Olson, 1955; Pomeroy, 1980). The cultural identities of several Haíłzaqv community members continues to be derived from this ancestral location (Stafford et al., 2009). The following translated origin story from N̓úlú, told by Ai'wageł (alternate spelling: K̓áwázíł)/ Ellen Anderson (née Douglas), a Núláw̓itx̌v descendant, was transcribed by anthropologist Franz Boas in *Bella Bella Tales* (Boas, 1932):

In N̓úlú lived a Killer Whale with a human face. Y̓ágis, who had also the name Haíłṃlisa, came down from the sky and arrived in Núlú. He said to the Killer Whale, "Who is older in this world, you or I?" The Killer Whale replied, "When we came into life there were no place names. We were the first ones to come into this world". Then Y̓ágis said, "You must be the first of men, and therefore this place shall be called N̓úlú.
Then the Killer Whales became men. They were the ancestors of the No'loidexu (N̓úláw̓itx̌v). They always had plenty of food at W̓uíga (Calvert Island) and at the W̓uígaxstú River. And they also had plenty of food which they obtained at the Sea Otter Rocks, Sisiumt or w̓áwís.

This origin story from N̓úlú re-affirms the name of the N̓úláw̓itx̌v Tribal Area and explains the origins of the ancestors of the N̓úláw̓itx̌v. An interesting connection to Calvert Island (W̓uíga) is highlighted in Ai'wageł's narrative, hinting at the longstanding connection among outer coastal islands for subsistence and other purposes. Intertidal archaeological investigations conducted at EjTa-4 on Calvert Island (W̓uíga) uncovered ca. 13,000 Cal BP human footprints impressed in clay-rich soils, providing an additional line of evidence supporting the early post-glacial occupation of the N̓úláw̓itx̌v Tribal area (McLaren et al., 2018).

3. Methods

This section provides a description of field, laboratory, radiometric dating, and geospatial modelling methods applied during our research program.

3.1. Field methods

Preliminary subsurface testing at EkTb-9 was conducted with core and auger devices. Six tests were conducted in 2011 using a JMC Environmentalist's Sub-Soil Probe (ESP; 2 cm diameter) to refine site boundaries and obtain samples suitable for radiometric dating (McLaren, 2013) (Fig. 4). Two of these ESP tests (ESP-2011-E and ESP-2011-F) were selected for dating (McLaren, 2013) (Fig. 4). Three shovel tests (50 × 50 cm) and 13 Dutch auger tests (7 cm diameter) were also conducted between 2011 and 2017 at various locations across the site to further refine our understanding of terrestrial site stratigraphy and boundaries (Fig. 4). Only one sample from an auger test (AT-2017-DJJ1) was selected for dating (Fig. 4).

The excavation trench at EkTb-9 was established at the southern extent of the site where auger testing revealed peaty deposits below relatively thin shell midden accumulations. The excavation trench is located approximately 70 m inland from the shore of the protected northeastern bay at the "front" of the site where intertidal components have been identified (Dyck et al., 2020; Gauvreau and Dyck, 2018) (Fig. 4 and Fig. 5). This peripheral excavation unit location was chosen with the aim of attaining the oldest cultural deposits and due to the presence of peat deposits with potential to contain preserved wooden artifacts and macrobotanical remains. The trench is composed of three contiguous 1 × 1 m units (EU2012, EU2015, EU2016). The units were excavated in 5 cm levels within the identified stratigraphic layers. All material recovered from the excavation trench was screened using 3 mm mesh. Due to the presence of human remains identified in the early Holocene deposits at the site,[9] the excavation trench was not reopened or expanded in 2017.

Four Vibracore tests (VC-2017–1 through VC-2017–4) were conducted in 2017 with a Wink Vibracore 'H' Series model to sample the deepest shell-midden layers while causing the least amount of impact to terrestrial cultural deposits (Fig. 4).[10] VC-2017-1, -2 and -4 were oriented east to west in a transect across the northern extent of the site and VC-2017-3 was conducted at the southwestern extent of the site, approximately 1 m northwest of the northwestern corner of the excavation trench (Fig. 4). Each Vibracore test began with a shovel test and/or Dutch auger test to remove the organic overburden (culturally sterile organic LFH horizon down to the Ah horizon soil). The LFH/Ah ranged from 20 to 100 cm depth below the forest soil surface. Once the interface with the mineral soil (B horizon) or cultural strata (D horizon) was uncovered, the Vibracore drill bit was positioned at the base of the

[9] Stratum IX; subsequently reinterred as per Haíłzaqv Human Remains Policy.
[10] We conducted the Vibracore tests in previously cleared areas to minimize disturbance to the forest understory.

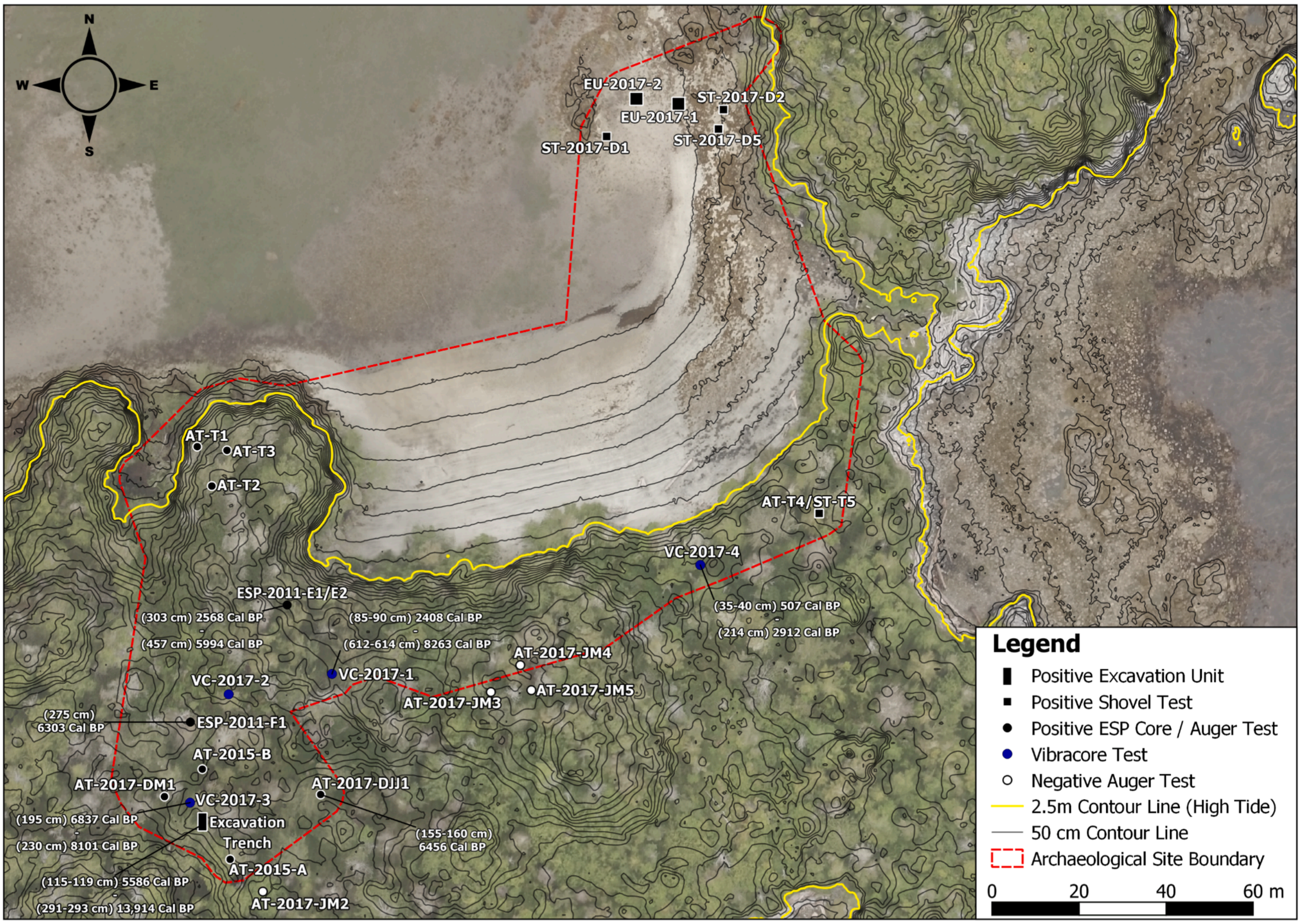

Fig. 4. Map of EkTb-9 showing locations of select subsurface tests and the excavation trench with callouts for relevant median radiometric dates (Cal BP) obtained. Subsurface tests comprise: Auger Tests (AT), JMC Environmentalist's Sub-Soil Probe (ESP) Tests, Vibracore Tests (VC), Excavation Units (EU) and the Excavation Trench (comprised of EU2012, EU2015, and EU2016); positive subsurface tests conducted in the intertidal area are also shown (Dyck et al., 2020). Symbols used to denote the location of the subsurface tests are not to scale. Median radiocarbon ages shown where relevant. Prepared by A Dyck.

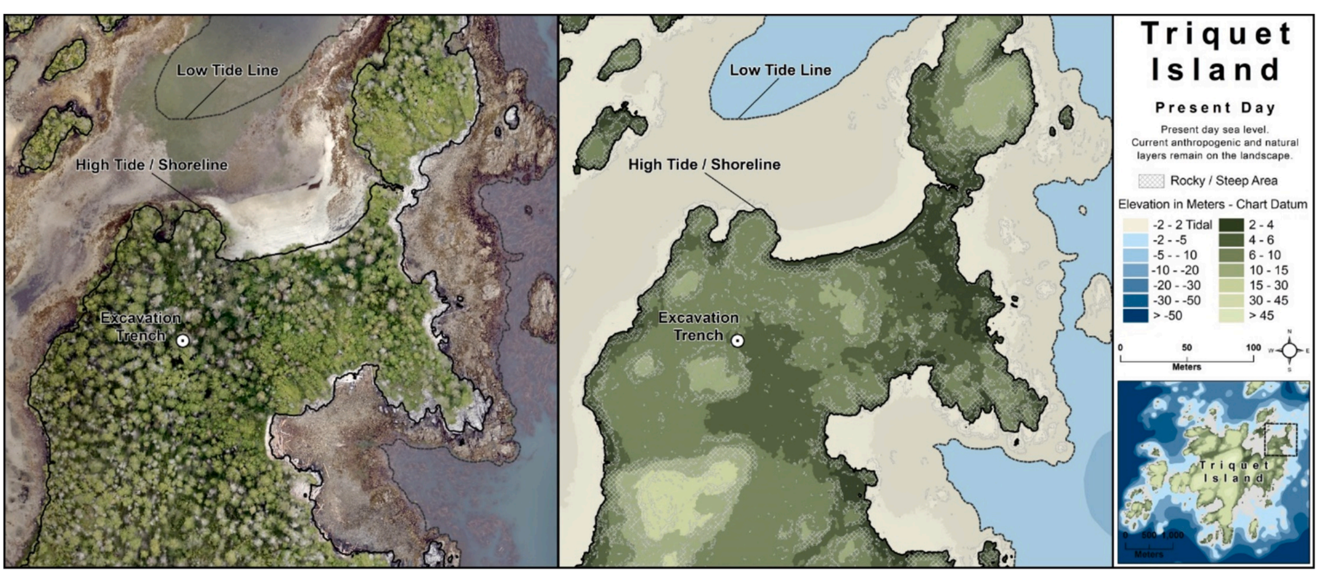

Fig. 5. Present day sea level at the northeastern extent of Triquet Island, encompassing the EkTb-9 site area and location of the excavation trench. Elevation in meters from chart datum. Current anthropogenic (e.g., shell-midden) and natural layers remain on the landscape. Image derived from data obtained through drone imagery and LiDAR. Prepared by K Holmes.

shovel/auger test to commence drilling. The Vibracore tests measured 7.5 cm in diameter[11] (Duffield, 2017; Duffield et al., 2022).

3.2. Laboratory methods

Description of laboratory procedures in this manuscript are limited to radiocarbon analyses and geospatial modelling. Methods employed for lithic, faunal, sediment, pollen, macrofloral, perishable artifact, and silicious microfossil analyses are described in S1 Supplementary Material.

3.3. Radiometric dating

The Keck Carbon Cycle AMS Facility at the University of California Irvine (UCIAMS) processed 28 radiocarbon samples for this research program between 2012 and 2019. The A.E. Lalonde AMS Laboratory at the Canadian Centre for AMS and Environmental Radionuclide Research at the University of Ottawa (UOC) processed a single sample in 2019. The 29 radiocarbon samples (17 charcoal, 8 wood and plant material, 4 marine shell) were calibrated using Calib Rev8.2 (Stuiver et al., 2021); the charcoal, wood and plant samples were calibrated with the IntCal20.14C dataset (Reimer et al., 2020) and the marine shell samples were calibrated with the Marine20.14C dataset (Heaton et al., 2020). Marine shell samples were assigned an 84.0 ± 132.0 Delta R correction (Schmuck et al., 2021).[12] All dates are reported with a two-sigma error range. Uncalibrated ages are included in Tables 1 and 2.

3.4. Geospatial modelling

This research program was enhanced through high-density digital elevation modelling and spatial mapping of past shorelines and landscape transformation through time. Data were obtained through drone imagery[13] and LiDAR[14] (Light Detection and Ranging). Drone and LiDAR based digital elevation models were merged and converted to chart datum. The elevation models are based on field sampling data listed above using Esri ArcGIS software. Geospatial modelling provides a visualization of geomorphic features of the site and adjacent areas. Radiometric dates obtained for discrete stratigraphic layers coupled with the regional sea level curve enabled us to reconstruct landscape evolution through time.

4. Results

The results of our multi-proxy research program are described below. Radiometric dating results are followed by a discussion of surficial geology, site stratigraphy (sedimentology) and formation processes uncovered at the site. Summaries of the siliceous microfossil, pollen, macrobotanical, faunal, perishable wood, and lithic assemblages are also provided. Common names, scientific names (Latin), and Haíɫzaqv terminology are provided for identified floral and faunal specimens.

4.1. Dating

Twenty-nine accelerator mass spectrometric (AMS) dates were obtained for the terrestrial component of the EkTb-9 site (Tables 1 and 2). These include dates on charcoal (n = 17), sclerotia (n = 1), shell fragments (n = 4), seeds (n = 5), a western hemlock (*T. heterophylla*) needle (n = 1), and a carved western yew (*Taxus brevifolia*) wood artifact (n = 1). A date of 14,802 – 13,478 Cal BP (12,010 ± 180 14CBP; UCIAMS 179732) was obtained from dispersed charcoal collected from a deeply buried paleosol (Stratum XIb) associated with a cluster of quartzite lithics (cores and flakes) found resting on a boulder (Table 1). This date provides an approximate age for the earliest occupation of the site. An attempt was made to duplicate this date through external assessment of sub-sampled sediments collected above, below, and within the paleosol (Stratum XIb) by the Paleoscapes Archaeobotanical Services Team. Only uncharred unidentifiable material was recovered from the sub-sampled deposits, none of which were substantial enough for accurate dating (Puseman and Briles, 2019). Further efforts to identify charcoal within existing sediment samples has not yielded enough identifiable material for accurate radiocarbon dating (1 mg).

The next record of occupation at EkTb-9 is associated with an age of 11,606 – 11,262 Cal BP (9,960 ± 25 14CBP; UCIAMS 118001; charcoal), which was obtained from the top of Stratum XIa (Table 1). The latest radiometric date obtained from the site is 519 – 494 Cal BP (450 ± 15 14CBP; UCIAMS 210955; charcoal) between 45 and 50 cm below the modern soil surface (Table 2). All twenty-nine dates occur sequentially; no reversals were found within the samples collected from the terrestrial component of the site. This radiocarbon chronology indicates that the site was repeatedly occupied between ca. 11,606 and 494 Cal BP and that earlier human activity occured at the site between ca. 14,802 – 13,478 Cal BP (Table 1). Bark-stripped western redcedar culturally modified trees (CMTs) at EkTb-9 provide direct evidence of more recent occupation and resource use over the last 300 years.

4.2. Site stratigraphy

For this analysis, the stratigraphy of the site is primarily derived from the excavation trench where thirteen strata were identified. Individual strata were recorded in the field based on their lithological and pedological characteristics (Stein, 1992; Stein, 2008). Complex stratigraphy identified in the Vibracore and ESP tests are collapsed into primary stratigraphic units consistent with (and/or post-dating) those found in the trench. Stratigraphy is variable across EkTb-9 due to the uneven nature of the parent substrate on the island and a combination of natural and cultural site formation processes. Tests undertaken across the site (Figs. 4 and 6) provide information on the accumulation of cultural layers during the Holocene.

Shell midden deposits at the site are extensive and preserved shell accumulation began as early as ca. 8,000 years ago (Figs. 4 and 6; Table 2). In the north-central area of the site, the basal shell midden deposits in VC-2017–1 have an associated radiometric date of 8,335 – 8,191 Cal BP (7,445 ± 20 14CBP; UCIAMS 210954; charcoal) (Figs. 4 and 6; Table 2). The upper deposits of this sample have an associated radiometric date of 2,489 – 2,354 Cal BP (2,405 ± 15 14CBP; UCIAMS 210952; charcoal) (Fig. 6; Table 2). A date of 2,705 – 2,366 Cal BP (2,460 ± 25 14CBP; UCIAMS 151820; charcoal) was obtained from basal shell midden deposits in ESP-2011-E1 (conducted at the northwestern extent of the site) (Fig. 4; Table 2). Results from dating VC-2017–4 indicate that the formation of the shell midden deposits at the northeastern extent of the site did not commence until ca. 2,961 – 2,854 Cal BP (2,810 ± 20 14CBP: UCIAMS 210956; charcoal) and terminated ca. 519 – 494 Cal BP (450 ± 15 14CBP; UCIAMS 210955; charcoal), indicating that the eastern extent of the site was a horizontal expansion of the earlier (western) area of occupation (Figs. 4 and 6; Table 2). Shell midden deposits (Strata IV/ V) are considerably thinner in the excavation trench (averaging 40 cm in thickness) at the southern side of the site (Figs. 4 and 7), when compared to the deeper shell midden deposits at the northern side of the site, which have a maximum measured vertical span of 5.29 m (Figs. 4 and 6). At the northern edge, shell and other material were used (Strata IV/ V) to fill in low lying areas, including between exposed bedrock and rocky promontories, thereby expanding the site footprint (Figs. 4 and 6). At the southern extent of the site, Stratum X in the excavation trench and VC-2017–3 consist of charcoal-

[11] The tests measure the width of the drill rods; see Duffield MA thesis for a detailed description of the mechanisms involved in Vibracore testing with a Wink Vibracore 'H' model (Duffield, 2017).

[12] Marine shell samples are only included in Table 2.

[13] Keith Holmes, Hakai Institute.

[14] Dr. Brian Menounos, University of Northern BC; Hakai Institute.

Table 1
Radiocarbon dates obtained from the excavation trench (EU2012, EU2015, EU2016), EkTb-9. Dates have been calibrated with a 2-sigma error. Dates have been organized by stratum and depth. Calibration data set: IntCal20.14C (Reimer et al., 2020). Prepared by A Gauvreau.

Laboratory ID#	Test Designation	Stratum and Field depth (~cm below surface)	14CBP	±	Older Cal BP range	Younger Cal BP Range	Median Probability	Material for dating	Sample elevation above or below high-high tide (m)
UCIAMS 163731	EU2015	Stratum IIIa; 115–119	4840	20	5599	5483	5586	Charcoal	3
UCIAMS 179730	EU2016	Stratum IIIb; 130–131	4865	15	5647	5583	5593	Charcoal	3
UCIAMS 117999	EU2012	Stratum V; 155–160	4930	20	5714	5595	5637	Charcoal	2.8
UCIAMS 118002	EU2012	Stratum VI; 180–185	4965	15	5732	5604	5681	*Sambucus racemosa* seeds	2.6
UCIAMS 118003	EU2012	Basal Stratum VII; 215–220	5885	20	6777	6658	6705	*Tsuga heterophylla* needle	2.25
UCIAMS 118000	EU2012	Stratum VIIIb; 220	6300	20	7264	7165	7208	*Taxus brevifolia* wood atlatl artifact	2.04
UCIAMS 118004	EU2012	Stratum IX; 230–235	6840	20	7713	7612	7670	*Sambucus racemosa* seeds	1.8
UCIAMS 184918	EU2016	Stratum IX/X; 254–259	6915	15	7788	7682	7732	Unidentified seeds	1.8
UCIAMS 112263	EU2012	Stratum X; 255–260	9140	25	10402	10232	10275	Charcoal	1.8
UCIAMS 163730	EU2015	Stratum XIa; 268–270	9845	25	11311	11201	11242	Charcoal	1
UCIAMS 118001	EU2012	Stratum XIa; 270–275	9960	25	11606	11262	11357	Charcoal	1
UCIAMS 179732	EU2016	Stratum XIb; 291–293	12010	180	14802	13478	13914	Disperse Charcoal	0.5

Table 2
Radiocarbon dates obtained from Auger, ESP, and Vibracore tests conducted between 2011 and 2017 at EkTb-9. Dates have been calibrated with a 2-sigma error. Dates have been organized by subsurface test. Calibration data sets: IntCal20.14C (Reimer et al., 2020) and Marine20.14C (Heaton et al., 2020). Marine samples calibrated with DeltaR 84.0 ± 132.0 (Schmuck et al., 2021). Prepared by A Gauvreau.

Laboratory ID#	Test Designation	Stratum and Field depth (~cm below surface)	14CBP	±	Older Cal BP range	Younger Cal BP Range	Median Probability	Material for dating	Sample elevation above or below high-high tide (m)
UOC-8927	AT-2017-DJJ1	Stratum VIIIa; 155–160	5674	48	6620	6314	6456	Charcoal	3.5
UCIAMS 151820	ESP-2011-E1	Basal Shell Midden; 303	2460	25	2705	2366	2568	Charcoal	0.9
UCIAMS 151837	ESP-2011-E1	Basal Shell Midden; 303	3075	25	2946	2238	2587	Shell fragment	0.9
UCIAMS 102751	ESP-2011-E2	Shell Midden; 334	4775	20	5129	4355	4729	Clam shell fragments	0.8
UCIAMS 102750	ESP-2011-E2	Basal Shell Midden; 457	5865	20	6291	5658	5994	Mussel shell fragments	−0.5
UCIAMS 102752	ESP-2011-F1	Basal Shell Midden; 275	6155	20	6629	5976	6303	Clam, mussel, and barnacle fragments	0.3
UCIAMS 210952	VC-2017–1	Upper Shell Midden; 160–165	2405	15	2489	2354	2408	Charcoal	2
UCIAMS 210953	VC-2017–1	Central Shell Midden; 350	3110	20	3382	3249	3337	Charcoal	0.8
UCIAMS 210954	VC-2017–1	Basal Shell Midden; 610–612	7445	20	8335	8191	8263	Charcoal	0.1
UCIAMS 206012	VC-2017–3	Stratum VIIIa; 195–196	6000	35	6931	6748	6837	Unidentified Seeds,.083mgC	2.25
UCIAMS 206011	VC-2017–3	Stratum VIIIb; 200	6670	20	7582	7489	7533	Charcoal	2
UCIAMS 206010	VC-2017–3	Upper Stratum IX; 205	6730	20	7660	7518	7593	Charcoal	1.6
UCIAMS 206013	VC-2017–3	Upper Stratum IX; 210	6950	20	7838	7694	7771	Unidentified Seeds	1.6
UCIAMS 206014	VC-2017–3	Upper Stratum IX; 210	7060	110	8163	7668	7876	0.25mgC Sclerotia	1.6
UCIAMS 206015	VC-2017–3	Upper Stratum X; 230	7320	20	8177	8035	8101	Charcoal	1.6
UCIAMS 210955	VC-2017–4	Upper Shell Midden; 45–50	450	15	519	494	507	Charcoal	1
UCIAMS 210956	VC-2017–4	Basal Shell Midden; 211	2810	20	2961	2854	2912	Charcoal	0.1

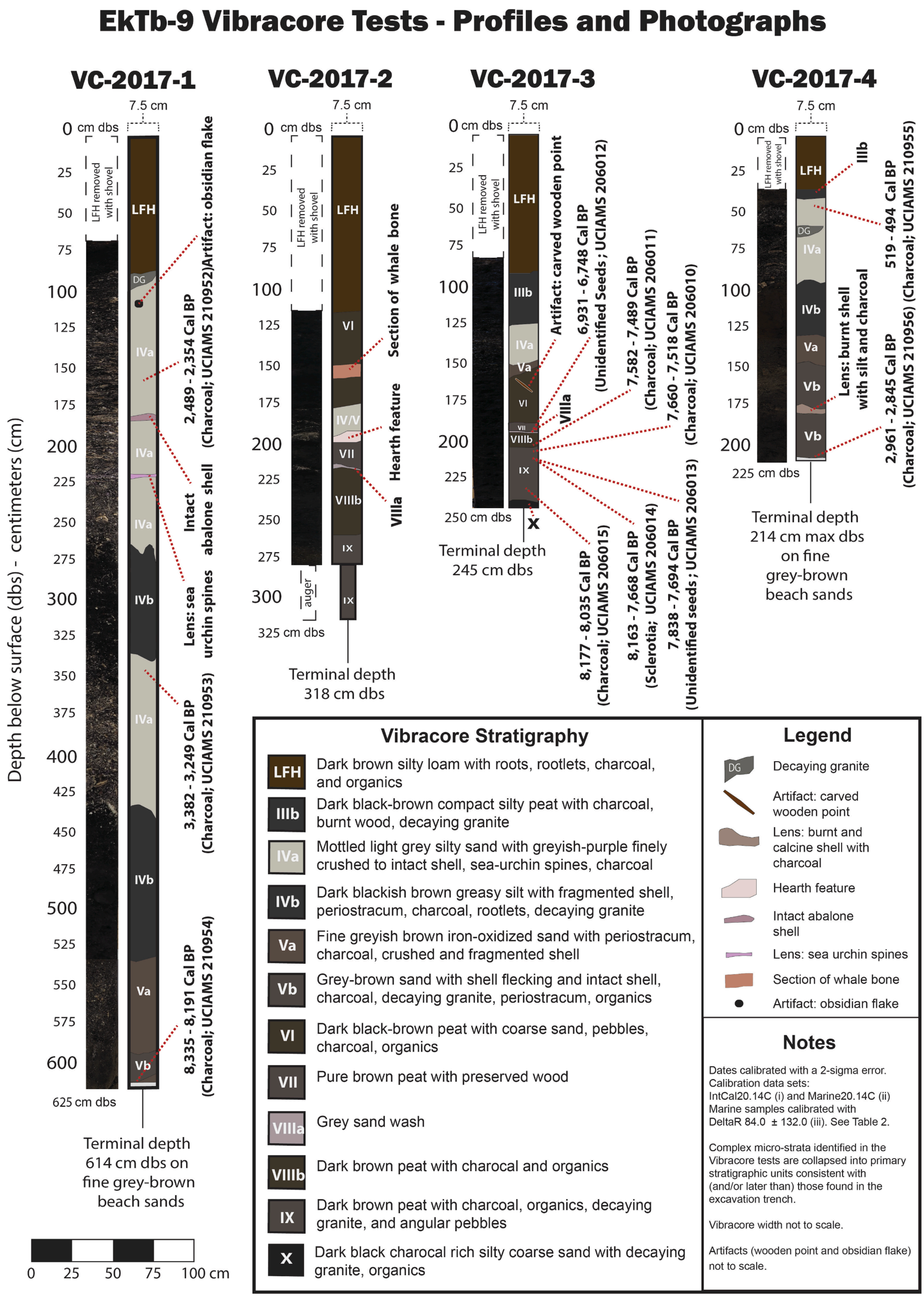

Fig. 6. Stratigraphic profiles and photographs of the four Vibracore tests (VC-2017–1, VC-2017–2, VC-2071–3, VC-2017–4) conducted at EkTb-9. Vibracore tests conducted across the central extent of the site. Radiometric dates (Cal BP; 2-sigma error; see Table 2) obtained from discrete strata within each core are listed along the vertical axis. Complex strata collapsed into primary stratigraphic units consistent with those found in the excavation trench (see Fig. 7). Calibration data: (i) (Reimer et al., 2020), (ii) (Heaton et al., 2020), and (iii) (Schmuck et al., 2021) Prepared by A Gauvreau.

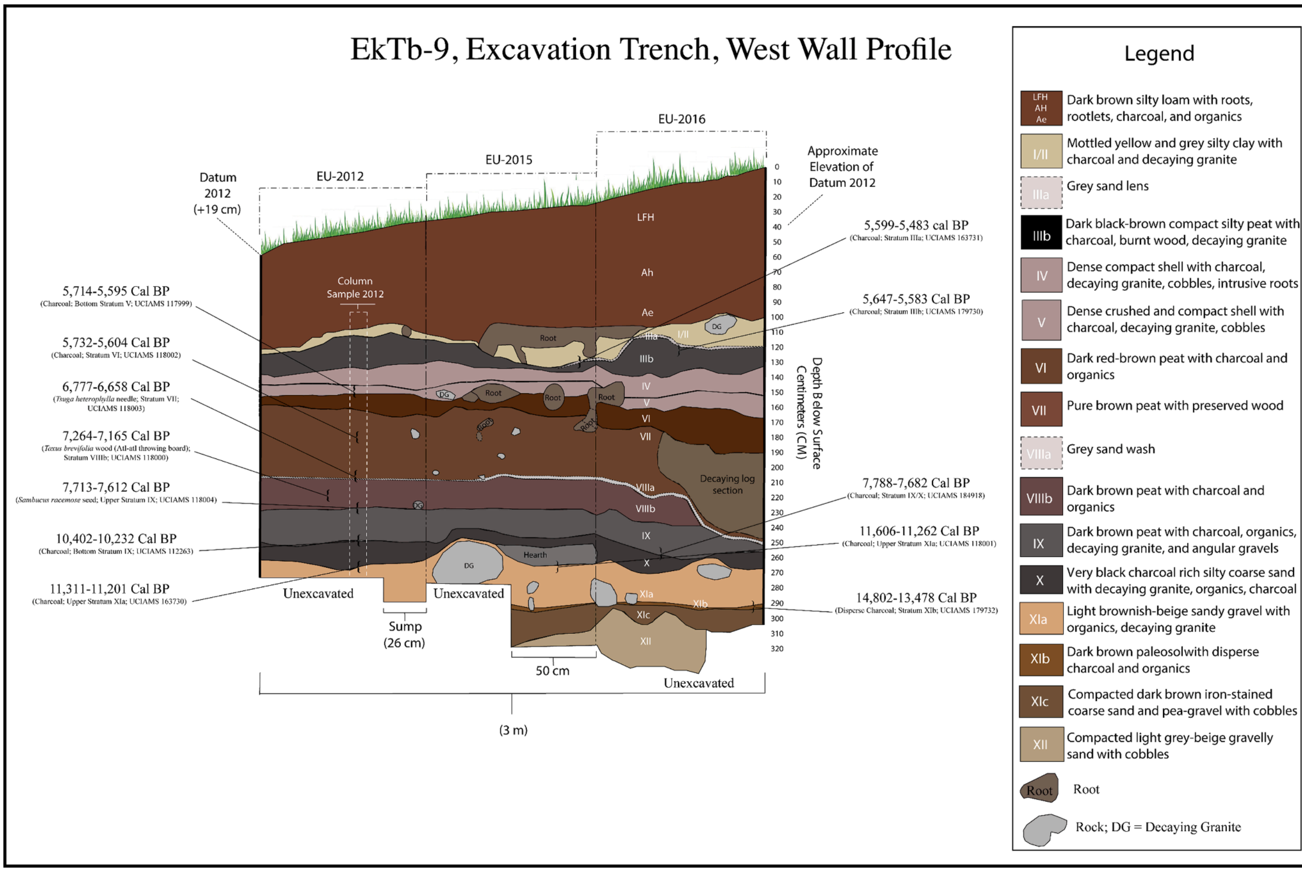

Fig. 7. Stratigraphic profile of the west wall of the excavation trench comprised of EU2012, EU2015, and EU2016; the excavation trench is located at the southwestern extent of the site. Trench measured 3 m in length, oriented north–south, and we attained approximately 3 m depth below surface. Radiometric dates (Cal BP; 2-sigma error; see Table 1) obtained from discrete strata within each excavation unit (EU) are listed along the vertical axis. Calibration data: (Reimer et al., 2020). Prepared by A Gauvreau.

rich greasy black organic shell-less (carbonate-free) midden deposits with abundant periostracum suggesting the same approach was intially taken to fill in these rocky areas as well (Figs. 4, 6 and 7). A date of 8,177 – 8,035 Cal BP (7,320 ± 20 14CBP; UCIAMS 206015) was obtained from upper Stratum X in VC-2017–3 (Fig. 6; Table 2). Within the excavation trench, a date of 11,606 – 11,262 Cal BP (9,960 ± 25 14CBP; UCIAMS 118001) was obtained from the interface of Strata XI/X and a date of 7,788 – 7,682 Cal BP (6,915 ± 15 14CBP; UCIAMS 184918) was obtained from the interface of Strata X/IX (Table 1; Fig. 7). The stratigraphy of the excavation trench is described in detail below.

4.3. *Excavation trench: stratigraphy, sedimentology, and formation processes*

Strata identified in the excavation trench are designated "Stratum XII" through "LFH horizon" (Fig. 7). Horizon labels and soil classifications assigned to each stratum are derived from the Canadian System of Soil Classification (Soil Classification Working Group, 1998) and other published resources (Naeth et al., 2012; Pennock et al., 2015; Valentin, 2019). Site strata are described from bottom to top.

Stratum XII (the deepest deposit encountered in the trench) is composed of water rounded light-beige-grey compact gravelly sand and clasts up to cobble size (Table 3). In the upper part (upper 20 cm) these sediments are cobble-rich and highly cemented (duric) (Fulton, 1995). Gravel clasts were largely granitic with rare pieces of other mineral origin, exhibiting moderate to heavy rounding. Sand and silt clasts were also rounded but largely limited to quartz and feldspar.

The water rounded character of the mineral component and the presence of marine microfossils, including diatoms and very abundant fragmentary sponge spicules (Table 3), suggests this is marine sediment (C Horizon). Cultural material and organic remains are absent. Stratum XII extends to at least 395 cm depth based upon auger testing. The marine microfossils indicate sea level was higher than today when this stratum was deposited (Figs. 3 and 10; Table 3). We have not been able to obtain a sample large enough for radiocarbon dating within this layer. Due to its stratigraphic location, we assume that the formation of Stratum XII dates to the late Pleistocene, sometime around ca. 14,500 Cal BP when relative sea level was higher than today (McLaren et al., 2014). Triquet Island's landscape would have had low topographic relief during this time, with gravel beaches, slightly raised berms, and exposed rocky outcrops (Fig. 8).

Stratum XI overlies Stratum XII. It is a DOm horizon comprised of sandy gravel and varying proportions of organics, including plant macrofossils (Table 3). The sandy gravel was composed of both heavily rounded clasts, likely marine sediment, and angular degraded granite. The latter included gravel clasts and sand, deposited by slope-wash from weathered granite bedrock. The sand was comprised of quartz, feldspar and mica clasts. The combination of rounded and weathered rock, along with terrestrial and marine macrofossils would be consistent with deposition on a supratidal berm (Fig. 3). Stratum XI is comprised of three sub-strata: XIc, XIb, and XIa.

The lower part of the berm is Stratum XIc which overlies Stratum XII; it is a compact dark brown coarse sand with pea gravels overlain by slightly lighter brownish-beige fine sand with gravel, flakes, a core, and debitage (Compact DOfc Horizon). This layer has the first indication of human presence. Stratum XIc demonstrates restricted drainage, as well as cool, wet, and acidic conditions. Sediments are iron stained and cemented, and close to the water table which is between approximately

Table 3
Sediment components from lower Strata X through XII (263–317 cm dbs).

Stratum	Median Cal BP Date	Depth below surface (cm)	% Gravel fraction	% Mineral fraction exotic	% Mineral fraction rounded	Mica clasts	% Organic fraction	Fish bone	Small mammal bone	Marine plants	Terrestrial plants	Charcoal
X	10,275	263–265	–	–	<5	present	>95	–	–	present	common	abundant
XIa	11,242	265–270	10–15	<1	<5	abundant	5–10	–	–	absent	present	present
XIa	11,357	279–284	15–20	<1	<5	abundant	5–10	–	–	absent	absent	absent
XIb	13,914	288–291	15–20	2–5	>75	abundant	40–50	–	–	common	present	almost nil
XIb	13,914	289–290	15–20	2–5	>75	abundant	40–50	–	–	common	present	almost nil
XIc	N/A	291–293	15–20	5–10	>75	abundant	5–10	–	–	present	absent	absent
XIc	N/A	294–297	30–40	5–10	>75	abundant	5–10	–	–	present	absent	absent
XII	N/A	307–312	50–60	5–10	–	rare	<1	1	–	absent	absent	absent
XII	N/A	312–317	50–60	5–10	–	rare	<1	1	2	present?	present?	almost nil

Mineral and organic component percentages are estimates from 10x binocular evaluation. Sand fraction from Stratum XII (307–317 cm dbs) is approximately > 90 % quartz, whereas the sand fraction from overlying Strata XIc through X is approximately 50 % quartz. Prepared by D Fedje.

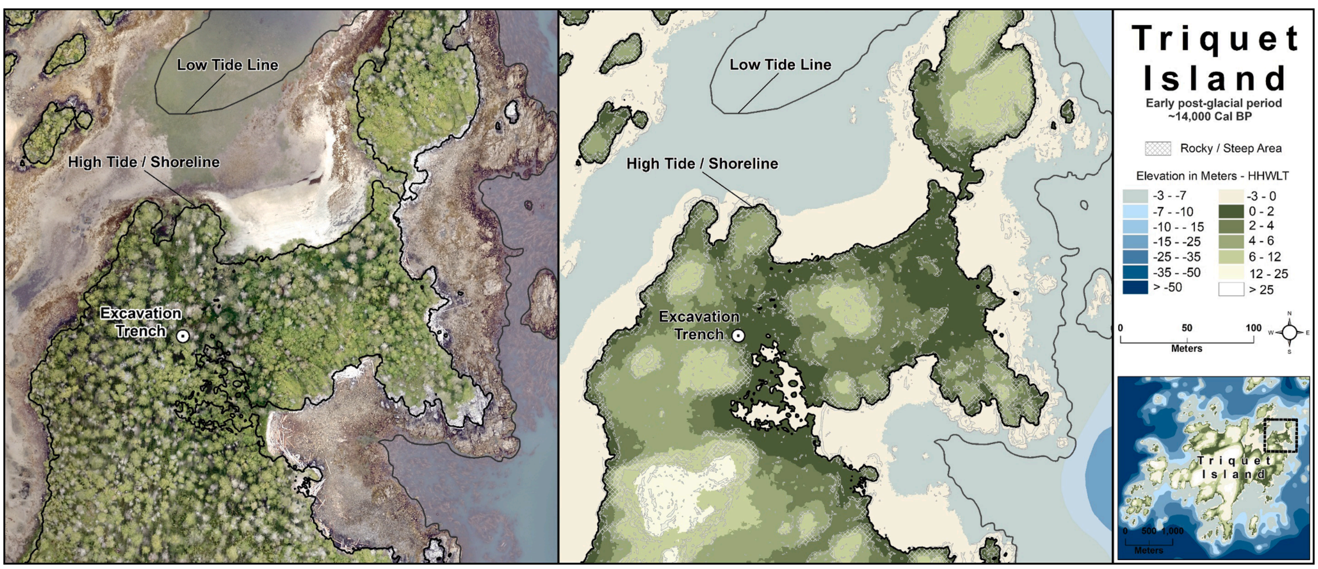

Fig. 8. Reconstructed sea level at Triquet Island during the Early post-glacial period (ca. 14,000 Cal BP). Reconstruction of shoreline ca. 14,000 years ago with sea level at modern levels and the LFH/Ae and Strata I-X stripped away from the landscape. Elevation in meters from Higher High Water Large Tide (HHWLT). Data obtained through drone imagery, LiDAR, and radiometric dates from discrete strata coupled with the regional sea level curve. Prepared by K Holmes.

3 to 3.5 m below surface at this area of the site. Groups of boulders were present in the stratum floor, like those visible today in the upper intertidal beach area at the northeastern extent of the site. Fauna are absent in Stratum XIc; it is possible they were once present but did not preserve due to the acidic nature of this stratum and/or exposure to the elements at the time of deposition.

Stratum XIb overlies Stratum XIc; it is a thin dark brown paleosol within the berm deposit. A cluster of flakes and cores were recovered from the surface of a boulder in the stratum floor of XIb; the boulder was likely deposited by natural processes in Stratum XII, but the surface of the boulder (within XIb) appears to have been used as an anvil stone to produce the flakes (evidenced by pitting on the boulder) (Fig. 9). There are no indications of substantial disturbance in Stratum XIb, therefore the position of the flakes on the boulder surface likely represents an intact context (Fig. 9). Miniscule flecks of charcoal from Stratum XIb were recovered using a microscope and pipette from a sample taken from the north wall at the same elevation as the lithic cluster and boulder surface, yielding a radiocarbon date of ca. 14,802 – 13,478 Cal BP (Table 1). Stratum XIb consists of sediment derived from erosion of granite cobbles and bedrock; significant amounts of pea-gravel were present. As with Stratum XIc, fauna are absent from this stratum (Fig. 7).

Stratum XIa overlies Stratum XIb and is the top of the berm deposit; it is a light brownish-beige fine sand with decaying granite. Preserved macrobotanical specimens were collected from the interface of Stratum XIa and overlying Stratum X. Enough charcoal was present in the very top of Stratum XIa for two radiocarbon ages: 11,311 – 11,201 Cal BP (9,845 ± 25 14CBP; UCIAMS 163730) and 11,606 – 11,262 Cal BP (Table 1).

Stratum X overlies Stratum XIa; it is a Compact DOf Horizon, comprised of a very black charcoal-rich silt layer with decaying granite (resulting in pockets of coarse sand/gravel), preserved faunal remains, lithics, and some preserved organics (Table 3). Preserved wood chips, macrobotanicals (conifer cones, needles, seeds), and burnt wood, as well as chunks of charcoal, abundant shellfish periostracum (most likely California mussel *[Mytilus californianus]),* and other organics (seaweeds and algae) were collected from Stratum X, indicating that the layer was subject to infiltration by water. Stratum X averages approximately 10 – 25 cm in thickness. Charcoal collected from the lower level of Stratum X yielded a radiocarbon date of 10,402 – 10,232 Cal BP (9,140 ± 25 14CBP; UCIAMS 112263l; Table 1).

Stratum IX is interbedded with Stratum X; unidentified seeds collected from the interface of Strata IX/X yielded a radiocarbon date of

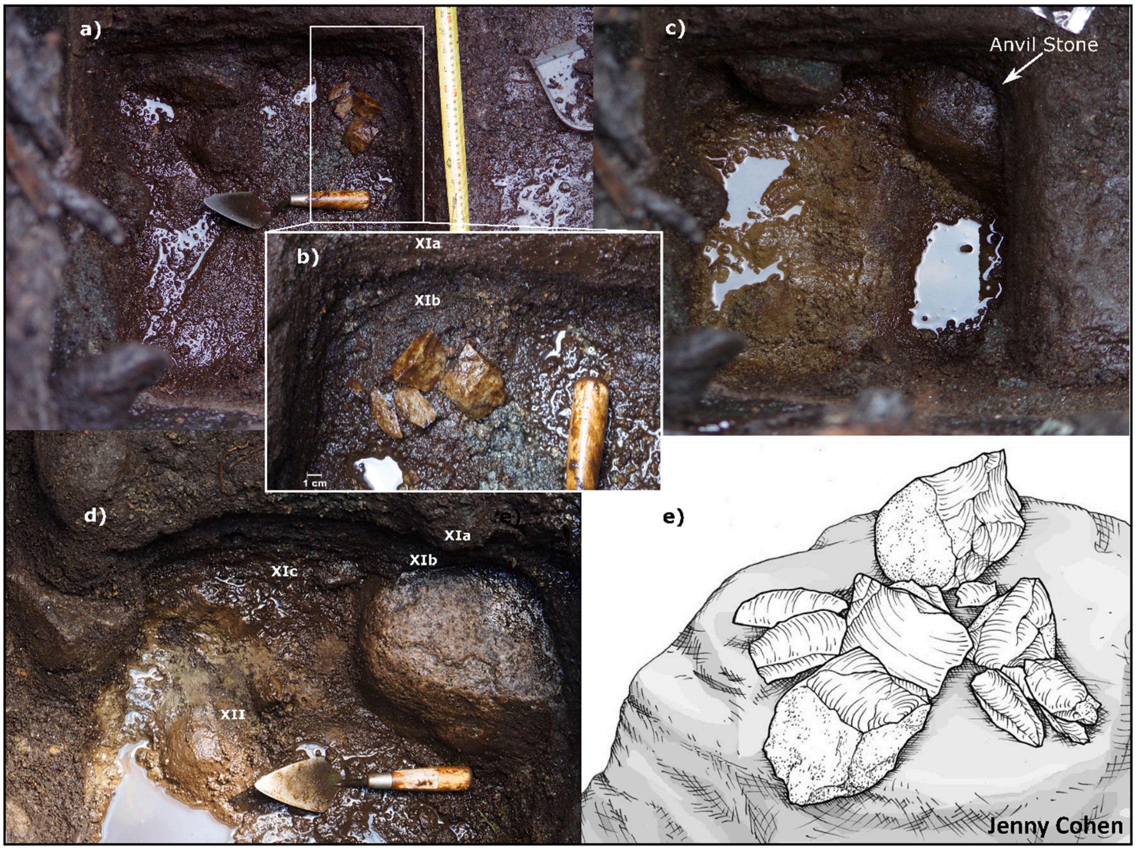

Fig. 9. Lithic cluster and anvil stone (boulder) in the excavation trench. (a) Portion of lithic cluster in-situ on anvil stone (boulder), resting in paleosol (Stratum XIb). (b) Close-up of lithic cluster being exposed in Stratum XIb with transition from XIa to XIb shown. (c) Anvil stone after excavation in 2015. (d) Plan view of portion of anvil stone (boulder) exposed in the northwestern quadrant of EU 2015 during the 2016 field season. (e) Idealized drawing of lithic cluster resting on anvil stone (boulder) prepared by Jenny Cohen. Photos a) to d) taken by D McLaren.

7,788 – 7,682 Cal BP (Table 1). Stratum IX is an acidic, mostly anaerobic, water-logged DOf Horizon comprised of dark brown peat with medium-hard soil consistency. Red elderberry seeds (*S. racemosa*) collected from upper Strata IX were radiocarbon dated to 7,713 – 7,612 Cal BP (6,840 ± 20 14CBP; UCIAMS 118004) (Table 1). Preserved organics, faunal remains, lithics, as well as decaying granite and sandstone cobbles, including angular pebbles, were also present in Stratum IX.

Sediments in Strata IX through VI are distinctively peaty in character with variable degree of organic preservation (DOf/DOm Horizons); these deposits are limited to the southwestern extent of the site. Peat deposits are typically formed in wetland conditions, suggesting that this area was subjected to significant freshwater inundation or flooding in anoxic conditions which slowed the rate of decomposition of the organic matter contained therein (Keddy, 2010). These types of podzols are typical of hypermaritime island environs with flat topography (Lacourse et al., 2012; Sanborn et al., 2011). The developing peat deposits started to retain freshwater and by ca. 7,000 Cal BP these water-saturated areas created the conditions for the peatland to expand (Lacourse et al., 2012).

Stratum VIIIb overlies Stratum IX; it is a permanently waterlogged DOf Horizon with medium-dense soil consistency. Strata IX and VIIIb contain clumps of seaweed (*Ulva intestinalis*) and *Sphagnum* that are typical of former upper intertidal seepage areas (Of/LFH Horizons). A sample collected from a yew (*T. brevifolia*) wood atlatl recovered from Stratum VIIIb yielded a radiocarbon date of 7,264 – 7,165 Cal BP (6,300 ± 20 14CBP; UCIAMS 118000) (Table 1) (McLaren et al., 2019).

A distinct and extensive thin sheet of moderately sorted grey sand and silty sand (Stratum VIIIa) with abundant wood and other plant detritus is wedged between peaty Strata VII and VIIIb (with sharp upper and lower contacts with these strata). The composition and orientation of the sand grains in Stratum VIIIa is similar to palaeotsunami deposits recorded at archaeological sites in northern Japan (Shinkai et al., 2015) and palaeotsunami deposits identified beneath tidal marshes on the west coast of Vancouver Island (Clague and Bobrowsky, 1994). In the west wall profile (Fig. 7), Stratum VIIIa appears to exhibit landward fining and thinning. Interestingly, a large section of a decaying log was uncovered in the excavation trench that was resting atop of the sand sheet, with other detritus that had been preserved in the peat (Fig. 7). A very fine wash of sand was similarly observed on the northern side and upper surface of the log section; it is possible that this log was deposited during a palaeotsunami event or big storm event. Stratum VIIIa is distributed across the entirety of the excavation trench (Fig. 7) as well as all nearby subsurface tests (Figs. 4 and 6). Stratum VIIIa is also expressed upslope approximately 23 m east of the excavation trench in test AT-2017-DJJ1 between 155 and 160 cm below surface (approximately 3.5 m above hht) (Fig. 4). Charcoal collected from AT-2017-DJJ1 Stratum VIIIa sand yielded a radiocarbon date of 6,620 – 6,314 Cal BP (5,674 ± 48 14CBP; UOC-8927) (Table 2). Stratum VIIIa is expressed in test VC-2017–3 between approximately 195–196 cm dbs; VC-2017–3 is located approximately 1 m northwest and slightly upslope of the excavation trench (Fig. 4). Unidentified seeds collected from VC-2017–3 Stratum VIIIa sand yielded a radiocarbon date of 6,931 – 6,748 Cal BP (6,000 ± 35 14CBP; UCIAMS 206012) (Table 2). These radiocarbon ages indicate Stratum VIIIa was deposited sometime between ca. 6,900 and 6,300 Cal BP.

The possible palaeotsunami deposit (Stratum VIIIa) is overlain by peaty Stratum VII (DOf Horizon) with preserved organics. A single lithic (hammerstone) was collected from this stratum; preserved wooden artifacts and faunal remains are absent. A western hemlock

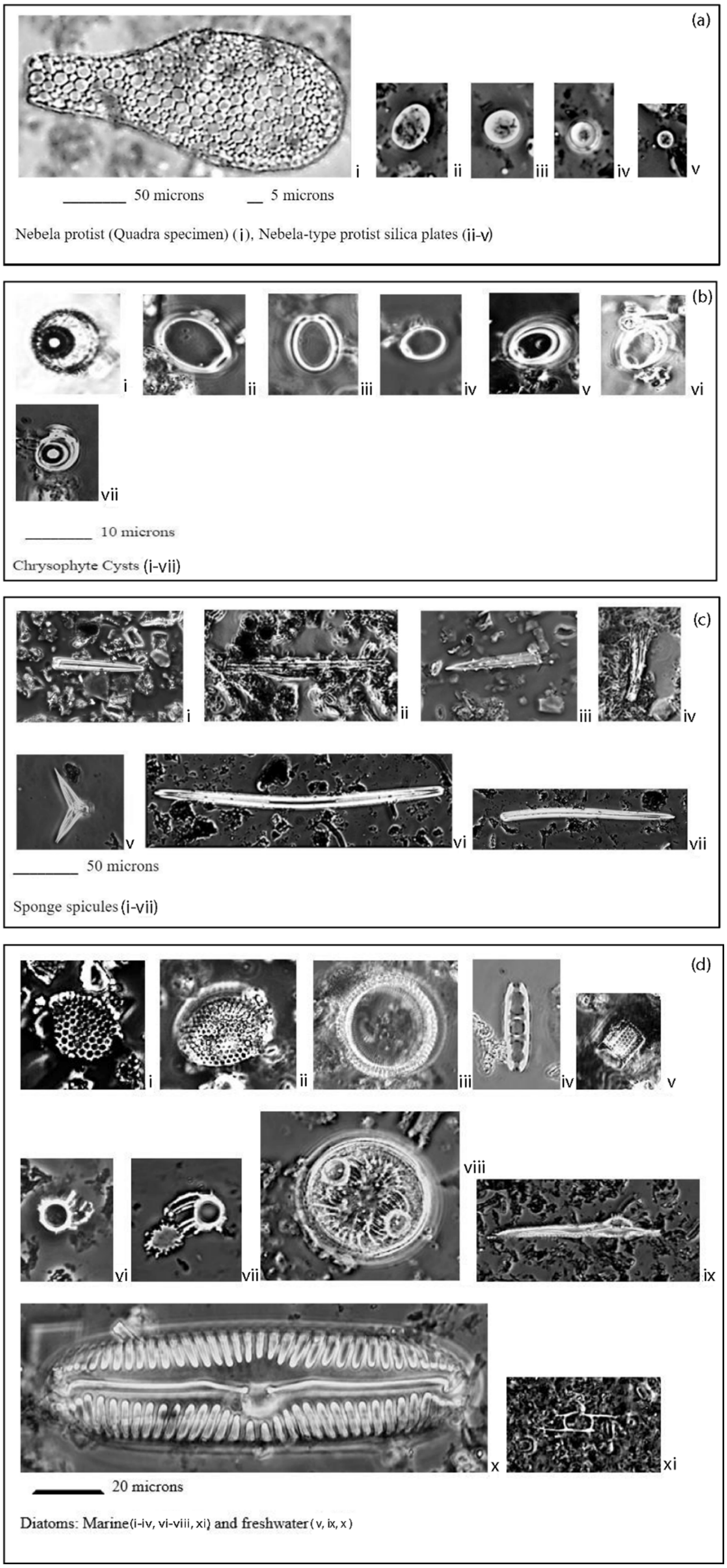

Fig. 10. Magnified photographs of microfossils from Triquet Island and Quadra Island (shown for comparative purposes), BC. *Nebela* protists and *Nebela*-type specimens: (i) microfossil *Nebela* protist from a sediment sample collected from Quadra Island, BC (Fedje et al., 2018), and (ii-v) *Nebela*-type silica plates identified in sediment samples collected from upper Strata IIIa, VIIIa, and VIIIb, and basal Strata X through XII in the excavation trench at the southwestern extent of EkTb-9. (b) Chrysophyte cyst specimens: (i) chrysophyte cysts identified in sediment samples collected from peaty Strata VIIIa, and VIIIb, and basal Strata X through XII, in the excavation trench at the southwestern extent of EkTb-9. (c) microfossil sponge spicule specimens: (i-vii) Sponge spicules identified in sediment samples collected from upper Strata IIIa and VIIIa, and basal Strata X through XII, in the excavation trench at the southwestern extent of EkTb-9. (d) microfossil marine and freshwater diatom specimens: (i-iv, vi-viii, xi) marine diatom and (v, ix, x) freshwater diatom species identified in sediment samples collected from upper Strata IIIa, VIIIa and VIIIb, and basal Strata X through XII, in the excavation trench at the southwestern extent of EkTb-9. Prepared by D Fedje. Comparative marine diatom specimen from Quadra Island (viii) (Fedje et al., 2018).

(*T. heterophylla*) needle collected from the base of Stratum VII yielded a date of 6,777 – 6,658 Cal BP (5,885 ± 20 14CBP; UCIAMS 118003) (Table 1).

Stratum VI (DOf Horizon) overlies Stratum VII and has an associated radiocarbon date of 5,732 – 5,604 Cal BP (4,965 ± 15 14CBP; UCIAMS 118002) yielded from red elderberry (*S. racemosa)* seeds (Table 1); wooden artifacts, lithics, and faunal remains are present. Combined, the peat associated with Strata VII/VI averages about 50 cm in thickness and

Table 4
Microfossils from basal Strata XII through X (263–317 cm dbs).

	Diatoms						
Layer and Depth Below Surface (cm dbs)	**Marine *Thalassiosira* sp.** [a]	***Arachnoidiscus ehrenbergii***	***Cocconeis costata***	***Ehrenbergii granulosa***	***Grammatophora serpentina***	***Hyalodiscus scoticus***	***Paralia sulcata***
X 263–265	(2)	–	–	–	–	–	–
XIa 265–270	(4)	–	–	–	–	–	–
XIa 279–284	(17)	1	–	–	–	1	1
XIb 288–291	1, (15)	–	–	–	3	–	1
XIb 289–290	4, (11)	–	1	–	–	–	1
XIb 291–293	1, (9)	–	–	–	–	–	–
XIc 294–297	(3)	–	–	–	–	–	–
XII 307–312	(3)	–	–	1	–	–	–
XII 312–317	(3)	–	–	–	–	–	–

[a]25-100 % complete, (x) = small fragment.
Prepared by D Fedje.

accumulated over approximately 1,500 years (Hugron et al., 2013).

Strata V/IV (shell midden deposits; DOm Horizon) were similar in composition and averaged about 40 cm in thickness in the excavation trench; they had medium-dense soil consistency and were damp. Strata V/IV consists of alternating layers of dense compact shell and silty crushed shell with charcoal and lithics, as well as intact hearth features (domestic fire features retaining their original structure with charred organics, burnt or calcine fauna and overlying ash) and combustion features (degraded hearths and burned materials in secondary positions due to human or natural process) (Mentzer, 2014). The calcium carbonate (shell) present in the strata enabled the preservation of faunal remains. Basal Stratum V has an associated radiocarbon date of 5,714 – 5,595 Cal BP (4,930 ± 20 14CBP; UCIAMS 117999; charcoal).

Stratum IIIb (DO Horizon) overlies Stratum IV and averages 15 – 20 cm in thickness. It is characterized by a medium to very hard and compact charcoal-bearing silty peat with intrusive roots and contains worked bone and stone artifacts. Charcoal collected from basal Stratum IIIb date to 5,647 – 5,583 Cal BP (4865 ± 15 14CBP; UCIAMS 179730). Stratum IIIb is overlain by Stratum IIIa; a 1 to 3 cm-thick lens of fine grey sand identified in the excavation trench. Charcoal collected from this thin sand lens dates to 5,599 – 5,483 Cal BP (4,840 ± 20 14CBP; UCIAMS 163731).

Strata I/II overlie Stratum IIIa and consist of an undulating veneer of mottled yellow-grey silty clay (Bg Horizon) of variable thickness (1 – 10 cm). Strata I/II underlays the organic horizons, coloured by leached sediments and minerals with interspersed charcoal and decaying granite. Cultural deposits lie under roughly 20 to 100 cm of relatively well-drained sterile humic organic sediment (the LFH, AH, and Ae horizons) across the site.

4.4. Siliceous microfossils

Siliceous microfossils recovered from Strata XII, XIc-XIa, X, VIIIb, VIIIa, and IIIa in the excavation trench include the siliceous elements of diatoms, testate protists, chrysophyte cysts and sponges, which can help correlate these strata to changes in relative sea level. Preservation of fine silica structures in the peaty and seasonally groundwater-saturated sediments was generally poor, with only highly silicified specimens preserved (Bennett et al., 1991; Ryves et al., 2009). Sponge spicules, the siliceous plates and spines of some protists, and chrysophyte cysts were preserved moderately well in these strata (Fig. 10). However, only robust diatom taxa were preserved (Fig. 10). Use of multiple proxies helped mitigate the effect of differential preservation of these microfossils. Overall, taxa identified were quite limited due to sampling issues (separating microfossils from mineral sediment) and preservation (high pH or silica-undersaturated bogs or groundwater).

Protist plates and spines, and chrysophyte cysts in these deposits derive from freshwater or terrestrial environments (Rühland et al., 2000), whereas sponge spicules are likely marine in origin as there are no clear freshwater bodies (ponds, streams, etc.) in the vicinity of the excavation trench and they do not grow in peat or on wet soils (Nortrup and Watts, 2010). Sponge spicules recovered from deposits at EkTb-9 are mostly smooth curvate oxeae that compare well to those of the intertidal glass sponge *Halichondria panicea* which is present on the rocky shores of Triquet Island today.

Basal Stratum XII produced abundant small fragments of sponge spicules, some marine diatoms and a few protist silica plates (Table 4). Sponge spicules and diatoms, except for specimens of *Grammatophora* and *Ehrenbergii*, ranged from fragmented to sand size. No freshwater diatoms or chrysophyte cysts were observed. These data are consistent with interpretation of the stratum as a beach or subtidal deposit. Strata XIc through XIa produced both terrestrial and marine diatoms (Table 5). The terrestrial diatom species observed in these strata are mostly poorly preserved but those identified to species inhabit ponds, wet soil, peat, and groundwater seeps (Bahls et al., 2018). The marine diatoms are largely littoral planktonic types. A number of these are complete which suggests deposition on top of, rather than within, the high-energy deposited coarse sand and gravel. Sponge spicules are common in Stratum XIb and include many complete or nearly complete specimens, also suggesting deposition on a terrestrial surface rather than in an active wave zone. This stratum, especially in that part identified as a paleosol (288 and 291 cm below surface), also produced relatively large numbers of chrysophyte cysts and testate protist silica plates and spines, indicative of a vegetated wet terrestrial environment. These data are consistent with a very wet hypermaritime terrestrial nearshore setting with occasional inundation by extreme tides or storm surges (Pennock and Sanborn, 2016).

The base of Stratum XIa has a strong marine signature (diatoms and sponge spicules) with relatively few terrestrial microfossils whereas the upper part of the stratum is strongly terrestrial. This may indicate that a paleosol developed upon the berm (storm surge) of marine sediment.

Stratum X produced relatively abundant terrestrial or freshwater diatoms, a few small fragments of a marine planktonic diatom and large numbers of protist silica plates and spines as well as several chrysophyte cysts (Table 4). Only two small sponge spicule fragments were observed. This suggest that, at the time of deposition, sea level had fallen sufficiently to stop marine waters from reaching the landform during extreme tides and storm surges.

Strata VIIIa and IIIa (fine grey sand layers) and Stratum VIIIb (peat deposit) were examined for microfossils to determine their origin (tsunamis or storm surges). Results of microfossil analysis of Strata VIIIa and IIIa are presented in Table 5. Diatom preservation was poor as compared to the preservation of sponge spicules, *Nebela*-type silica plates, and crhysophyte cysts. Strata VIIIa contained both well-preserved and fragmentary marine diatoms. Terrestrial diatoms were common in samples from VIIIb and IIIa but rare in the Stratum VIIIa sample. Sponge

Diatoms							Protists		
Marine *Plagiogramma stauroforum*	Freshwater *Rhabdonema minutum*	*Aulacoseira* sp.	*Cyclotella meneghiniana*	*Pinnularia* sp.	*Stephanodiscus medius*	*Navicula antonii*	*Chrysophyte cyst*	*Nebela-like silica plates*	*Testate amoeba siliceous spines*
–	–	12	–	13	–	–	4	>300	>650
–	–	1	1	7	–	–	8	91	193
–	–	–	–	3	–	1	32	7	–
–	–	–	–	5	–	–	146	75	59
–	1	1	–	7	1	–	151	30	15
–	–	–	–	1	–	–	7	6	–
–	–	–	–	–	–	–	1	4	–
2	1	–	–	–	–	–	–	2	–
–	–	–	–	–	–	–	–	3	–

Table 5
Microfossils from VIIIa (212–219 cm dbs) and Strata IIIa (131–132 cm dbs), representing possible palaeotsunami deposits.

Depth below surface (cm dbs)	Diatoms						Cysts	Protists	Sponge spicules[a]
	Thalassiosira sp. (small fragments)	*Auliscus sculptus fragment (ocellus)*	*Cocconeis pseudomarginata*	*Paralia sulcata*	*Pinnularia* cf. *P. lata*	*Pinnularia* sp.	Chrysophyte cysts	Nebela-like silica plates	
IIIa 131–132	1	–	–	1	–	1	–	1	58
VIIIa 212–217	3	8	1	–	2	16	2	45	24
VIIIa 214–219	–	1	–	–	–	46	24	40	–

[a] Sponge spicules are well preserved. Most are long fragments or complete. Prepared by D Fedje.

spicules were relatively common in both sandy layers (VIIIa and IIIa); most being complete specimens or long fragments. In the peaty layer (VIIIb) fresh water or terrestrial microfossils were abundant and sponge spicules absent. Sedimentological analysis of Stratum VIIIa revealed water-rounded fine sand clasts of consistent size class, and relatively abundant marine diatoms and spicules sandwiched between peat deposits, therefore demonstrating the signatures of a tsunami deposit or big storm. Stratum IIIa, in contrast, likely represents a cultural surface as mineral clasts (silt to fine gravel) are largely angular and unsorted.

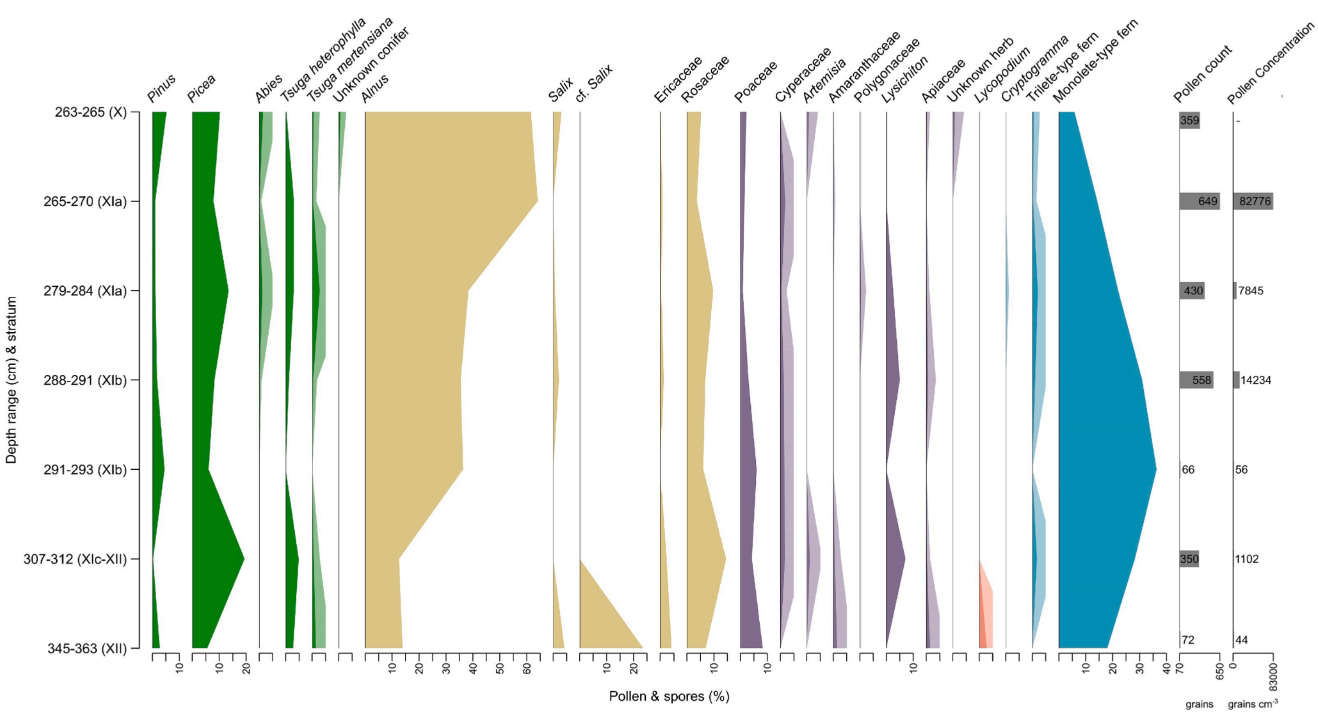

Fig 11. Pollen Taxa observed in EkTb-9 Strata XII to X (ca. 14,802 – 10,232 Cal BP) of the excavation trench (EU2012, EU2015, EU2016). Results of pollen analysis of Strata XII to X from EkTb-9 plotted as a percentage of the total pollen and spores counted for each sample. A 5x exaggeration has been applied to select infrequent taxa. Pollen and spore count totals and pollen concentrations (grains cm^{-3}) are presented to the right of the main panel for each sample. Key to colour fill: trees (green), shrubs (beige), herbs (purple), bryophytes (orange), pteridophytes (blue). Prepared by C. Hebda and N. Hebda.

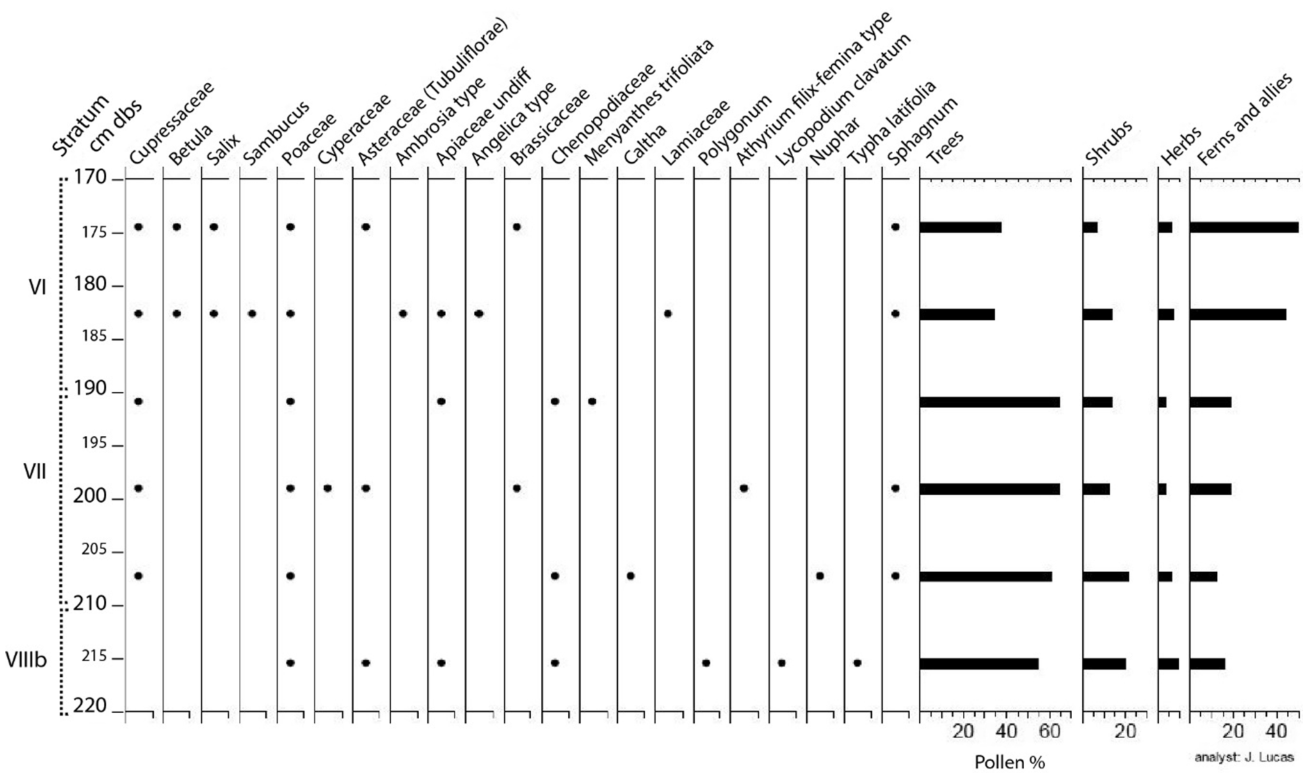

Fig 12. Presence diagram of pollen taxa observed in EkTb-9 Strata VIIIb to VI (ca. 7,263 – 5,604 Cal BP) of the excavation trench (EU2012). Results of pollen analysis of Strata VIIIb to VI from EkTb-9. Dots indicative of presence in a sample, with summary columns for total. Prepared by J Eamer (Lucas), figure used with permission (Lucas, 2013; McLaren, 2013).

4.5. Pollen

Fossil pollen and spores (hereafter pollen) were recovered and analyzed from lower sandy and silty Strata XII, XIc, and XIb (ca. 14,802 – 13,478 Cal BP), XIa and X (ca. 11,606 – 10,232 Cal BP) (Hebda, 2020) (Fig. 11; Table 1) and peaty upper Strata VIIIb to VI (ca. 7,263 – 5,604 Cal BP) (Lucas, 2013) (Fig. 12; Table 1). Pollen yields from samples in the Strata XII/XIc transition and Strata XIb, XIa, and X were high, with assemblages characterized by a largely non-arboreal, shrubby component consisting of green alder and leptosporangiate ferns (monolete and trilete types) with other herbaceous taxa and some conifers (Fig. 11). Samples associated with Strata XII, XIc and the lower portion of XIb are also characterized by shrubby and herbaceous taxa but yielded less pollen (72, 27, and 66 grains, respectively). In particular, the low-count sample from Stratum XIc has been omitted from Fig. 11 and is not described in the text, but the count is included in S1 Supplementary Material.

In the deepest sample analyzed from Stratum XII, the arboreal assemblage is a minor component of the total pollen, consisting of a small amount of spruce (*Picea* 6 %), pine (*Pinus* 3 %), western hemlock (*T. heterophylla* 3 %), and mountain hemlock (*T. mertensiana* 1.4 %). Most of the assemblage consists of shrub, herb, and fern taxa including alder (*Alnus* 14 %, predominantly shrubby *A. viridis*-type) and willows (*Salix* 4 % and cf. *Salix* 24 %) with monolete-type fern spores (18 %) as well as grass (Poaceae 8 %), rose (Rosaceae 7 %), heather (Ericaceae 4 %), and minor components of club-mosses (Lycopodium 3 %), umbellifer (Apiaceae 1.4 %) and amaranth (Amaranthaceae 1.4 %). At the transition between Strata XII and XIc, arboreal taxa comprise a somewhat larger percentage than in the XII sample, including spruce (*Picea* 19 %) with a smaller amount of western hemlock (*T. heterophylla* 5 %) and trace amounts of mountain hemlock (*T. mertensiana*) and pine (*Pinus*). The non-arboreal component of this sample is dominated by shrubby alder (*Alnus* 13 %, mostly green alder [A. viridis-type]), monolete-type fern spores (28 %), and rose pollen (Rosaceae 15 %) along with skunk cabbage (*Lysichiton* 7 %), grass (Poaceae 4 %), heather (Ericaceae 2 %), sedge (Cyperaceae 1.7 %), trilete-type fern spores (1.7 %), sagebrush (*Artemisia* 1.1 %), and trace amounts of umbellifer (Apiaceae) and amaranth (Amaranthaceae).

The assemblages in the two samples from Stratum XIb are largely similar, with the arboreal fraction of the upper XIb sample containing a modest proportion of conifers including spruce (*Picea* 8 %), pine (*Pinus* 1.8 %), western hemlock (*T. heterophylla* 1.3 %), and trace amounts of fir (*Abies*) and cedar (Cupressaceae) pollen. The non-arboreal portion of the upper XIb assemblage is again dominated by shrubby alder (*Alnus* 35 %; primarily *A. viridis*-type) with monolete-type fern spores (31 %) and other herb and shrub constituents including rose (Rosaceae 7 %), grass (Poaceae 3 %), willow (*Salix* 2 %), sedge (Cyperaceae 1.3 %), and heather (Ericaceae 1.3 %) as well as skunk cabbage (*Lysichiton* 5 %) and trace amounts of umbellifer (Apiaceae) pollen.

Stratum XIa is characterized by a notable increase in mountain hemlock (*T. mertensiana*) in the lower sample as well as increasing alder (*Alnus*). The lower sample from Stratum XIa is composed of alder (*Alnus* 38 %) and conifers including spruce (*Picea* 14 %), mountain hemlock (*T. mertensiana* 3 %), western hemlock (*T. heterophylla* 3 %), and smaller amounts of pine (*Pinus* 1.2 %) and fir (*Abies* 1.2 %). The non-arboreal fraction of the lower XIa sample includes monolete-type fern spores (22 %) and pollen derived from rose (Rosaceae 10 %) and skunk cabbage (*Lysichiton* 3 %), trilete-type fern spores (2 %), and trace amounts of numerous taxa including grass (Poaceae), willows (*Salix*), heather (Ericaceae), sedge (Cyperaceae), knotweed (Polygonaceae), umbellifer (Apiaceae), and parsley ferns (Cryptogramma). The upper sample from XIa contains an even greater preponderance of alder (*Alnus* 64 %) and a concomitant reduction in monolete-type fern spores (14 %), spruce (*Picea* 8 %), and mountain hemlock (*T. mertensiana* 0.3 %) among other small shifts. Non-arboreal taxa including rose (Rosaceae 4 %), grass (Poaceae 1.5 %), sedge (Cyperaceae 1.8 %), and heather (Ericaceae 1 %)

Table 6
List of plant species identified in the archaeological deposits at EkTb-9.

Common Name (English)	Scientific Name (Latin)	Haíłzaqv Name (Haíłzaqvla)
Amaranth family	Amaranthaceae	–
Aster family	Asteraceae	–
Burnets	*Sanguisorba* sp.	–
Club-mosses	*Lycopodium* sp.	*plṃ́s* (moss)
Common cattail	*Typha latifolia*	–
Douglas-fir	*Pseudotsuga menziesii*	*ṃáwál̓as*
Ferns	Leptosporangiate ferns/ Polypodiidae	*k̓áláx* (fern)
Grass family	Poaceae	g̓ḷíƛlá
Green alder	*Alnus viridis*	ƛ̓áq̓vt̓ás (alder)
Heather family	Ericaceae	*Nk̓vł*
Knotweed family	Polygonaceae	–
Mountain hemlock	*Tsuga mertensiana*	–
Western yew	*Taxus brevifolia*	*ƛ̓ṃ́q̓ás*
Parsley ferns	*Cryptogramma* sp.	–
Peat mosses	*Sphagnum* sp.	*p̓lṃ́s* (moss)
Red alder	*Alnus rubra*	ƛ̓áq̓vt̓ás
Red elderberry	*Sambucus racemosa*	*K̓íbát*
Rose family	Rosaceae	*Ĝúláḷi or L̓qáx̌ḷ̓ás*
Sagebrush	*Artemisia* sp.	–
Sedge family	Cyperaceae	–
Shore pine	*Pinus contorta*	*ƛ̓íń̓a*
Sitka spruce	*Picea sitchensis*	*h̓ṇíw̓as*
Skunk cabbage	*Lysichiton americanus*	*K̓vk̓vúk̓v*
Subalpine fir	*Abies lasiocarpa*	–
Umbellifer family	Apiaceae	*Ĝísdṃ*
Water lilies	*Nuphar* sp.	*ĝḷ́wát*
Western hemlock	*Tsuga heterophylla*	*lúq̓vás*
Western redcedar	*Thuja plicata*	*dṇ́y̓ás*
Willows	*Salix* sp.	*Qváqvll̓ay̓as*
Yellow cedar	*Xanthocyparis nootkatensis*	*díw̓ás*

The common name (English), scientific name (Latin), and Haíłzaqv Name (Haíłzaqvla) is provided for all recovered floral specimens that were identifiable to family or species level. Prepared by A Gauvreau with support from C Hebda, W Housty, R Housty, M Humchitt, and members of the Haíłzaqv Language Program.

continue to contribute a smaller but notable percent of the total pollen counts in XIa.

In Stratum X, conifers continue to represent a modest proportion of the total, including spruce (*Picea* 10 %), pine (*Pinus* 5 %), and an increase in fir (*Abies* 1.4 %) pollen above trace amounts. Alder (*Alnus* 60 %) remains the major taxa in Stratum X and is comparable with XIa below. Non-arboreal taxa persist in the assemblage at small amounts including rose (Rosaceae 5 %), willow (*Salix* 3 %), grass (Poaceae 2 %), and trace amounts of others including heather (Ericaceae), sagebrush (*Artemisia*), umbellifer (Apiaceae), and burnets (*Sanguisorba*). The increases in conifers and other taxa in Stratum X is accompanied by a further reduction in monolete-type fern spores (6 %).

Previous analysis indicates that the assemblage from peaty Strata VIIIb to VI consists primarily of pollen from arboreal taxa (Fig. 12), including spruce (*Picea)* and western hemlock (*T. heterophylla)*, as well as abundant fern spores and small amounts of Cupressaceae pollen representing either western redcedar (*T. plicata*) or yellow cedar (*Xanthocyparis nootkatensis*) (Lucas, 2013). Some herbaceous taxa including grasses (Poaceae), sedges (Cyperaceae), asters (Asteraceae), umbellifers (Apiaceae), and others were observed in this assemblage along with aquatic plants including pond-lily (*Nuphar* sp.), cattail (*Typha latifolia*), and peat mosses (*Sphagnum sp.*) (Lucas, 2013). The presence of these aquatic taxa and *Sphagnum* are indicative of standing/slow moving freshwater and acidic peat-forming environments. Arboreal taxa identified in these upper strata are consistent with a cool, wet, rainforest climate.

4.6. Macrobotanicals

Pollen evidence in the basal cultural strata is augmented by the recovery and identification of numerous macrobotanical remains from these deposits. A rounded tip fragment from a flat conifer needle was identified from Stratum XIa (ca. 11,606 – 11,201 Cal BP; Table 1) that could represent either subalpine fir (*Abies lasiocarpa*), western hemlock (*T. heterophylla*), or Douglas-fir (*Pseudotsuga menziesii*) (Puseman and Briles, 2019). Conifers and other taxa may have been propagated among outer coastal islands during the early post-glacial period by aeolian and flotsam transport. Clumps of seaweed (*Ulva intestinalis*) were also preserved (Strata X and IX; ca. 10,402 – 7,612 Cal BP; Table 1); these species thrive in tidepools (high upper intertidal seepage areas) and protected brackish waters (Lindberg and Lindstrom, 2010). A variety of additional preserved macrofossil remains have been identified in Strata XIa through IV. Preserved macrobotanicals include red elderberry seeds *(S. racemosa),* spruce (*Picea* sp.*)* roots and cones, and western hemlock (*T. heterophylla*) cones and needles (Strata IX and IV; ca. 7,713 – 5,604 Cal BP; Table 1) – species which thrive in moist riparian or nearshore environments (Hawes et al., 2014; Puseman and Briles, 2019). Haíłzaqv words for identified macrobotanical specimens are listed in Table 6.

4.7. Perishable artifacts

A modest assemblage of 850 perishable wooden artifacts has been recovered from EkTb-9 deposits spanning ca. 7,788 – 5,604 Cal BP (Strata IX through VI; Table 1) (McLaren et al., 2019). These include 504 woodchips, 136 pieces of split wood, 84 split sticks, 40 pieces of chopped wood, 15 pieces of worked wood, 13 split roots, 10 points, eight strips of bark, five bi-points, four board fragments, four tool tips, three fish-hook barbs/fishhook preforms, two wedges, two tools, two carved wooden balls (or knobs), one piece of carved wood, one worked root, one atlatl throwing board, one fragmented bark-wrapped cedar tool handle, one harpoon foreshaft, and seven possible pieces of worked wood, four possible tools, and two possibly carved pieces of wood. All but one of the perishable wooden artifacts recovered from EkTb-9 were collected from the excavation trench. One of the 10 carved wooden points was collected from VC-2017–3 (Fig. 6); the coring process damaged the point (cutting off one end), and it is possible that it represents a bipoint.

4.8. Fauna

The vertebrate faunal assemblage comprises 14,246 specimens from deposits spanning ca. 10,402 – 450 Cal BP (Strata X through IIIb; Table 1); 8,752 of these specimens were recovered from the excavation trench (Table 7). A few worked bone tools (biconically drilled needle, possible bird-bone straw), fragments of cut bone (domestic dog and stellar sea-lion), and unidentifiable fragments of worked mammalian bone were identified during laboratory analyses.

Thirty-six vertebrate taxa are represented within the excavated assemblages at EkTb-9, including eleven taxa of birds, fourteen taxa of fish, six taxa of land mammals, and five taxa of sea-mammals. Nearshore fish species such as Pacific herring (*Clupea pallasii*), greenling (*Hexagrammos* sp.), and rockfish (*Sebastes* sp.) dominate the faunal assemblage. Cormorants constitute the bulk of the bird remains (though albatross [*Phoebastria sp.*] is also present), and stellar sea lion (*Eumetopias jubatus),* fur seal *(Callorhinus ursinus),* and harbour seal (*Phoca vitulina*) dominate the assemblage of mammals. An unidentified section of a whale bone was also recovered from VC-2017-2 (Fig. 6). Domesticated dog (*Canis familiaris*) and wolf (*Canis lupus*) remains were also collected. Recovered shellfish include California mussel (*M. californianus*), butter clam (*Saxidomus gigantea*), cockle (*Clinocardium nuttalli*), sea urchin (*Strongylocentrotus* sp.*),* abalone (*Haliotis kamtschatkana*), chiton (Polyplacophora), acorn barnacle (*Balanus glandula*), limpets (*Tectura* sp.*),* and various snails. Haíłzaqv terms for identified faunal species are listed in Table 7.

Table 7
Vertebrate faunal remains (NISP) per stratum recovered from the excavation trench (EU2012, EU2015, EU2016).

	Taxon	Scientific Name (Latin)	Haíłzaqv Name	Approximate Cal BP Range / Stratum														EU Total	% of identified
				450 - 5,500 Cal BP						5,500 - 8,000 Cal BP					8,000 - 10,000 Cal BP				
			(Haíłzaqvla)	I/II	III	IV	IV/V	V	V/VI	VI	VI/VII	VII	VIII	IX	X	XI	XII		
FISH	Arrowtooth flounder*	*Atheresthes stomias*	*páis*	0	2	0	0	1	0	2	0	0	0	1	0	0	0	**6**	**0.06**
	Capelin	*Mallotus villosus*		0	0	0	0	15	0	0	0	0	0	0	0	0	0	**15**	**0.10**
	Great Sculpin	*Myoxocephalus* sp.		0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**	**0.01**
	Greenling	*Hexagrammous* sp.	*Máglís (bottom fish)*	2	78	18	22	23	0	28	0	0	3	18	6	0	0	**198**	**2.30**
	Ling cod	*Ophiodon elongatus*	*náłṃ*	1	57	56	21	18	2	31	2	0	0	2	6	0	0	**196**	**2.20**
	Pacific Halibut	*Hippoglossus stenoleps*	*p uái*	0	5	2	0	1	0	4	0	0	0	2	0	0	0	**14**	**0.20**
	Pacific Herring	*Clupea pallasii*	*wán ái*	0	14	6	24	113	4	608	84	0	1	5	124	0	0	**983**	**11.20**
	Perch	Embioticidae	*ƛ́ámú*	0	0	0	1	0	0	3	0	0	0	0	0	0	0	**4**	**0.05**
	Ratfish	*Hydrolagus colliei*	*Gvúmá*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**	**0.01**
	Red Irish Lord	*Hemilepidotus*		0	1	0	0	0	0	2	0	0	0	0	0	0	0	**3**	**0.03**
	Rockfish	*Sebastes* sp.	*λák álá*	4	158	145	56	179	113	307	1	0	2	20	10	0	0	**995**	**11.40**
	Salmon	*Oncorhynchus* sp.	*miá*	0	0	1	5	0	0	5	0	0	0	0	2	0	0	**13**	**0.14**
	Spiny dogfish	*Squalus acathias*	q vágvíná	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**	**0.01**
	Starry flounder	*Platicthys stellatus*	*Páis*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**	**0.01**
	Ray-finned fish			16	1346	506	290	918	6	1245	105	0	2	63	71	0	0	**4568**	**52.20**
Total Fish				**23**	**1661**	**735**	**419**	**1269**	**125**	**2236**	**192**	**0**	**8**	**111**	**220**	**0**	**0**	6999	80.00
MAMMAL	Deer	*Odocoileus* sp.	*qám ílá*	0	1	0	0	0	0	2	0	0	0	1	1	0	0	**5**	**0.06**
	Domestic Dog	*Canis familiaris*	*w áċ̓*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**	**0.01**
	Harbor Seal	*Phoca vitulina*	*ságvṃ*	0	0	0	0	0	0	0	0	0	0	1	7	0	0	**8**	**0.09**
	Mink	*Neovision vision*	*kvṇ̓ á*	0	0	0	1	0	0	1	1	0	0	0	0	0	0	**3**	**0.03**
	Mustelid	*Mustela* sp.	*Glṃ́ (weasel); Msƛ̓ gṇ́ (marten);*	0	0	0	0	0	0	0	1	0	0	6	0	0	0	**7**	**0.08**
	Northern Fur Seal	*Callorhinus ursinus*	*Núkví*	0	0	0	0	0	0	0	0	0	0	0	9	0	0	**9**	**0.1**
	Porpoise	*Phocoena* sp.	*ƛ̓ áłlá*	0	0	0	1	0	0	1	0	0	0	0	0	0	0	**2**	**0.02**
	Sea lion	*Eumetopias jubatus*	*máwák̓*	0	0	0	0	0	0	0	0	0	1	4	5	0	0	**10**	**0.1**
	Sea otter	*Enhydra lutris*	*q asá*	0	0	0	0	0	0	0	0	0	0	2	0	0	0	**2**	**0.02**
	Sitka deer	*Odocoileus hemionus*	*qám ílá*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**	**0.01**
	Wolf / (Dog?)	*Canis lupus*	*k vsls*	0	1	1	1	0	0	1	0	0	0	1	0	0	0	**5**	**0.06**
	Sea Mammal			0	0	0	0	0	0	0	0	0	0	48	461	0	0	**509**	**5.8**
	Medium Land Mammal			0	0	0	0	1	0	0	0	0	0	8	6	0	0	**15**	**0.2**
	Small/ Medium Land Mammal			0	0	0	0	0	0	0	0	0	1	7	12	0	0	**20**	**0.3**
	Mammal			0	12	10	1	13	1	9	0	0	25	735	311	0	0	**1117**	**12.8**
Total Mammal				**0**	**14**	**11**	**4**	**14**	**1**	**15**	**2**	**0**	**27**	**813**	**813**	**0**	**0**	**1714**	**19.6**
BIRD	Albatross	*Phoebastria* sp.	Báƛ̓a	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**	**0.01**
	Canada Goose	*Branta canadensis*	*hṇ́gáx̌ or hṇ́gaq*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**	**0.01**
	Cassin's auckle t	*Ptychoramphus aleuticus*		0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**	**0.01**
	Cormorant	*Phalacrocorax pelagicus*	*c ítáw í*	0	1	1	0	0	1	1	0	0	0	0	0	0	0	**4**	**0.05**
	Goose	*Branta* sp.	*hṇ́ gáx̌ or hṇ́gaq*	0	0	1	0	0	0	0	0	0	1	0	0	0	0	**2**	**0.02**
	Large Alcid	*Uria* sp.		0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**	**0.01**
	Loon	*Gavia immers*	*x̌ áwí*	0	0	0	3	0	0	0	0	0	0	0	0	0	0	**3**	**0.03**
	Shore bird	*Larus* sp.	*Ċ̓ígíláĝa*	0	0	0	4	0	0	1	0	0	0	0	0	0	0	**5**	**0.06**
	Murre	*Uria* sp.		0	0	1	0	0	0	1	0	0	0	0	0	0	0	**2**	**0.02**
	Waterfowl	*Anserinae* sp.	*Hṇ́gáx̌ (goose) qvgvúqv (swan)*	0	0	0	1	0	0	1	3	0	0	0	0	0	0	**5**	**0.06**
	Western Grebe	*Aechmophorus occidentalis*		0	1	0	0	0	0	1	0	0	0	0	0	0	0	**2**	**0.02**
	Unidentifiable Bird			0	1	0	0	3	1	1	2	0	0	0	4	0	0	**12**	**0.1**
Total Bird				**0**	**3**	**4**	**9**	**3**	**2**	**8**	**5**	**0**	**1**	**0**	**4**	**0**	**0**	39	0.4
Grand total				**23**	**1678**	**750**	**432**	**1286**	**128**	**2259**	**199**	**0**	**36**	**924**	**1037**	**0**	**0**	8752	100.00

The common name (English), scientific name (Latin), and Haíłzaqv Name (Haíłzaqvla) is provided for vertebrate faunal remains recovered from the excavation trench that were identifiable to family or species level. Prepared by A Gauvreau, with support from W Housty, R Housty, M Humchitt, and members of the Haíłzaqv Language Program.

Table 8
Description of the terrestrial lithic assemblage from EkTb-9.

Type	EkTb-9 Excavation Trench (EU 2012, EU 2015, EU 2016)																		EkTb-9 VC-2017–1		Total
	IIIb	IIIb/ IV	IV	IV/V	V	V/VI	VI	VII	VIIb	VIIIb/IX	IX	IX/X	X	X/XIa	XIa	XIb	XIc	XII	Tube A (Upper IV)	Tube B(Mid IV)	
Abrader/Abrader Fragment	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Biface Reduction Flake	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
ASP Core	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	4	–	–	–	–	5
ASP Flake	4	–	1	–	1	–	1	–	–	–	6	–	5	–	2	18	1	–	–	–	39
Bipolar Split Cobble	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Bipolar Split Pebble	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	3
Core Tool	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	2
Core	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	–	–	–	–	3
Debitage	4	–	–	1	–	–	–	–	–	–	4	2	6	–	–	–	–	–	–	1	18
Flake	22	1	4	2	3	–	–	–	–	–	4	2	10	1	1	1	1	–	–	–	52
Flake Tool	–	–	–	3	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	5
Graver	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Hammerstone	–	–	1	–	–	–	1	1	–	–	–	–	2	–	–	1	1	–	–	–	7
Manuport	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	2
Multidirectional Core	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Obsidian Flake	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	2
Obsidian Flake Tool (utilized)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Obsidian Microblade	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Obsidian Microblade (utilized)	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	2
Pebble Tool	1	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	1	–	–	–	5
Pigment stone	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Unidirectional Core	1	1	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	4
Total	34	2	8	9	6	1	2	1	0	2	16	6	32	2	5	25	6	0	1	1	159

The table is arranged by artifact type and stratum. The assemblage includes lithics from the excavation trench (EU2012, EU2015, EU2016) and a Vibracore test (VC-2017–1). Prepared by A Gauvreau and A Dyck.

Interestingly, periostracum – the thin quinone-tanned protein layer or coating on the outermost layer of shell (Taylor and Kennedy, 1969) – were abundantly present in the peat and basal water-saturated strata (Strata XIa, X, IX; coarse sand and gravel layers) where the rest of the shell did not preserve well due to soil acidity and other taphonomic processes. The periostracum is most likely derived from decayed California mussel (*M. californianus)* shells, as there are indentations in the fragmented and complete pieces of periostracum created by the radiating rib lines along the shell that are consistent with (and specific to) the morphology of California mussel shell (Gosling, 1992). The periostracum is a dark brown to heavy blue-black color (Jones and Richman, 1995), slightly altered through oxidization upon excavation. Periostracum preserved where shell did not as it is more akin to keratin-based horn, hair, or fingernails and composed of fibrous cysteine-rich proteins that can withstand humic acids (Tanzi et al., 2019).

The faunal assemblage indicates a specialized marine-based subsistence that spanned the early to late Holocene. Sea-mammal remains are the most relatively abundant component of the faunal assemblage in the early-mid Holocene from ca. 10,402 – 5,604 Cal BP (Strata X through VI; Table 1). In the mid-late Holocene from ca. 5,604 – 450 Cal BP (Strata VI through III; Tables 1 and 2), there is a shift towards outer coastal fish species; greenling, rockfish, and Pacific herring are the most relatively abundant species preserved in the sediments at EkTb-9 during this time. Harvesting of invertebrates is demonstrated in Strata XIa through IX (ca. 11,606 – 7,612 Cal BP; Table 1) and peaty strata VIIIb through VI (ca. 7,264 – 5,604 Cal BP) by an abundance of preserved periostracum, and in Strata V through IV (ca. 8,335 – 450 Cal BP; Tables 1 and 2) by preserved shell, mussel, abalone, chiton, and sea urchin spine accumulations.

4.9. *Lithic artifacts*

Terrestrial excavations at EkTb-9 recovered a modest assemblage of 159 lithic artifacts, 82% of which consisted of flakes of variable size and material type (n = 94), debitage (n = 18), and tools (n = 19) (Table 8). 157 lithics were recovered from the excavation trench, and two flakes were recovered from VC-2017–1 (Table 8; Fig. 6). Both ground stone and chipped stone technology are present, with the latter being dominant (only two ground stone artifacts were found in later Holocene-aged deposits). Percussive methods utilized include hard hammer, soft hammer, and anvil supported percussion (ASP) consisting of anvil-rested percussion (ARP) and bipolar reduction.[15] A wide range of medium to coarse grained material types (with a few fine-grained volcanics) were utilized by island inhabitants through time, with milky quartz, andesite, basalt, dacite, and metamorphic materials occurring with the most frequency.

Nearly half of the total lithics collected from the excavation trench come from the basal-most cultural layers (Strata XIc to X) (Table 8). Late Pleistocene and early Holocene cultural layers with an associated radiocarbon date range of ca. 14,802 – 10,232 Cal BP (Table 1) yielded 70 lithics, most notably the ASP lithic cluster, 14 freehand percussion flakes, one graver, four hammerstones, and six retouched tools (Tables 1 and 8). From these 70 lithics, six were found within Stratum XIc – the deepest stratum containing cultural materials. Stratum XIc remains undated but is presumably older than Stratum XIb above it. Twenty-five lithics were collected from within Stratum XIb, including 22 lithics produced by ASP, a hammerstone, a bifacial pebble tool, and one early reduction flake produced by freehand percussion.

The most notable lithics recovered from Stratum XIb are the 15 lithics positioned as a cluster on a battered boulder within the excavation trench (Figs. 9 and 14). The cluster was embedded in dark brown sediment (paleosol; Stratum XIb) overlying the surface of the boulder

[15] Refer to the S1 Supplementary Material for references to discussions on variability within bipolar/anvil percussion.

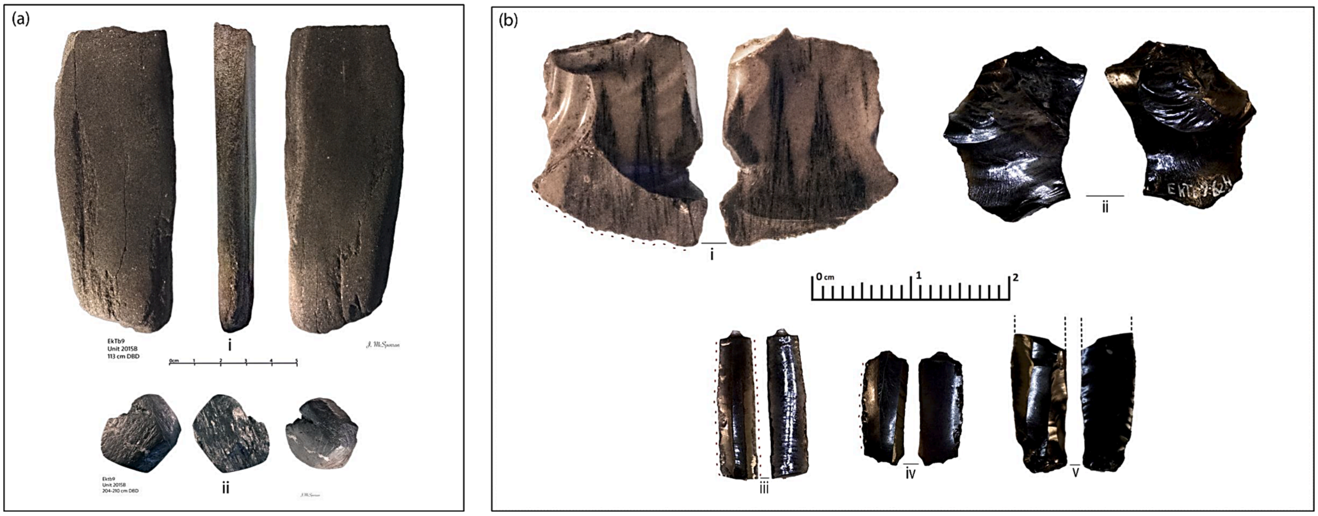

Fig 13. Select lithics from EkTb-9 terrestrial excavations: Strata IX/X, VIIIb/IX, and V. (a) Selection of lithics collected from the upper shell midden accumulations of the excavation trench at EkTb-9 in 2015: (i) sandstone abrader with multiple incisions and grooves resulting from utilization, collected from stratum IV (EkTb-9:499). (ii) Utilized graphite nodule with multiple incisions and grooves for mineral (crystalline carbon) extraction for pigment production, collected from stratum V (EkTb-9:495). Lithics photographed by J McSporran, and layup prepared by A Dyck. (b) Obsidian artifacts collected from the terrestrial excavations at EkTb-9. Dots indicate areas of utilization: (i) Utilized obsidian flake tool collected from interface of strata IX/X in the excavation trench (EkTb-9:583). (ii) Obsidian flake collected from VC-2017–1 stratum IV (EkTb-9:636). (iii) Utilized obsidian microblade collected from interface of strata VIIIb/IX in the excavation trench (EkTb-9:623). (iv) Utilized and intentionally snapped obsidian microblade collected from interface of strata VIIIb/IX in the excavation trench (EkTb-9:621). (v) Distal end of an obsidian microblade collected from interface of stratum IX/X in the excavation trench (EkTb-9:622). Obsidian artifacts (i) and (iii-v) sourced via XRF to Bes But'a (Anahim Peak) by R Reimer. Lithics photographed by J McSporran and A Dyck. Layup prepared by A Dyck and A Gauvreau.

between 289 and 291 cm below surface (Fig. 9). There are no indications of substantial disturbance in Stratum XIb, therefore the position of the flakes on the boulder surface likely represents an intact context (Fig. 9). The base of the boulder sits at 300 cm below surface, resting in Stratum XII. The ASP lithic cluster found on the boulder within XIb consists of 12 flakes and three cores made of quartzite. The three cores in the cluster were produced by ARP (as revealed by the location and position of the flake scars), and the 12 flakes were produced via ARP or bipolar reduction. Two of the three cores exhibit elongated, linear flake removals and five of the flakes are linear and elongated. One core has a pyramidal shape and shows a very controlled reduction sequence with multiple, linear flake scars evident (Fig. 14). The flakes and cores were determined to be cultural in origin for the following reasons: 1) they all variably exhibit morphology that is consistent with ASP (positive to diffuse bulbs of percussion, proximal and distal crushing, bidirectional or multidirectional scarring, and variable presence of multiple platforms), 2) the flake removals are systematic and the crushing/battering is present in anticipated locations (which would be difficult to achieve naturally), 3) their material type is unique and differs noticeably from the surrounding black and white granodioritic cobbles and boulders, and 4) they were found in a cluster that does not refit (indicating selective removal/loss of pieces) upon a boulder that exhibited battering on its top (as an anvil stone would).

Four milky quartz lithics produced from bipolar reduction are also present in Stratum XIb; milky quartz is often reduced using bipolar reduction because it is commonly found as small pebbles and is difficult to freehand knap (Barham, 1987; Kaplan, 1990). Five lithics were recovered from the very top of Stratum XIa, with an associated date of ca. 11,311 – 11,201 Cal BP (Table 1) and two were collected from the transition between Stratum X and XIa (Table 8). The remaining 32 lithics were collected from Stratum X, with an associated date of ca. 10,402–10,232 Cal BP (Tables 1 and 8). Three obsidian lithics were collected from Stratum IX and the interface of X/IX (ca. 7,788 – 7,682 Cal BP; Table 1) (Fig. 13); these consist of one late-stage flake, one utilized flake, and one un-utilized microblade. Other lithics present in Stratum IX and the interface of X/IX include one early-stage flake, two mid-stage flakes, three general reduction flakes, six ASP flakes, one tested core, and six pieces of debitage. Utilized and intentionally snapped obsidian microblades (n = 2) were also collected from the interface of Strata IX/VIIIb (ca. 7,713 – 7,165 Cal BP; Table 1) (Fig. 13). Sixty-two pieces of chipped stone, two ground-stone abrader fragments, and a pigment stone (graphite nodule) were collected from mid-to-late Holocene cultural layers (Strata VII to IIIb) with an associated radiocarbon date range of ca. 6,777 – 5,583 Cal BP (Fig. 13; Table 1). Chipped stone recovered from this later occupation of the site includes 14 early-stage flakes, nine mid-stage flakes, one late-stage flake, nine general reduction flakes, one biface reduction flake, seven ASP flakes, three bipolar split pebbles/cobbles, three unidirectional cores, a water-rolled obsidian flake, two hammerstones, a cobble chopper, a pebble tool, four flake tools, and six pieces of debitage. In addition to this assemblage, comparable early Holocene-aged lithics were found during intertidal excavations conducted at EkTb-9 in 2017 (Dyck et al., 2020).

5. Discussion (w̓áláqvla) and interpretation (λulúyay̓u)

This section is organized around the site chronology (periodization) established for EkTb-9 wherein we discuss the key topical areas of our investigation and focus on λulúyay̓u (a presentation of our key interpretations). The EkTb-9 site chronology was collaboratively developed with co-authors Ĝvu̓í/ Rory Housty, Dúqva̓ísla/ William Housty, and Q̓íx̌itasu Yím̓ăzalas/ Elroy White (Table 9). The table builds on previously established chronologies for the Central Coast that have primarily been derived from work at Namu (ElSx-1) (Carlson, 1993; Carlson and Cannon, 1991; Carlson et al., 1996; Maas, 1990). Three major temporal phases were observed and assigned Haíɫzaqv nomenclature, with the caveat that each temporal phase be named after a primary component of the archaeological assemblage for which a Haíɫzaqv word exists.[16] The inclusion of Haíɫzaqv nomenclature allowed us to co-create the site chronology, thereby enhancing our mutual understanding and interpretation (λulúyay̓u) of the site history.

[16] i.e., not necessarily an "exclusive" component of that phase, nor a wholly "summative" or "representative" term.

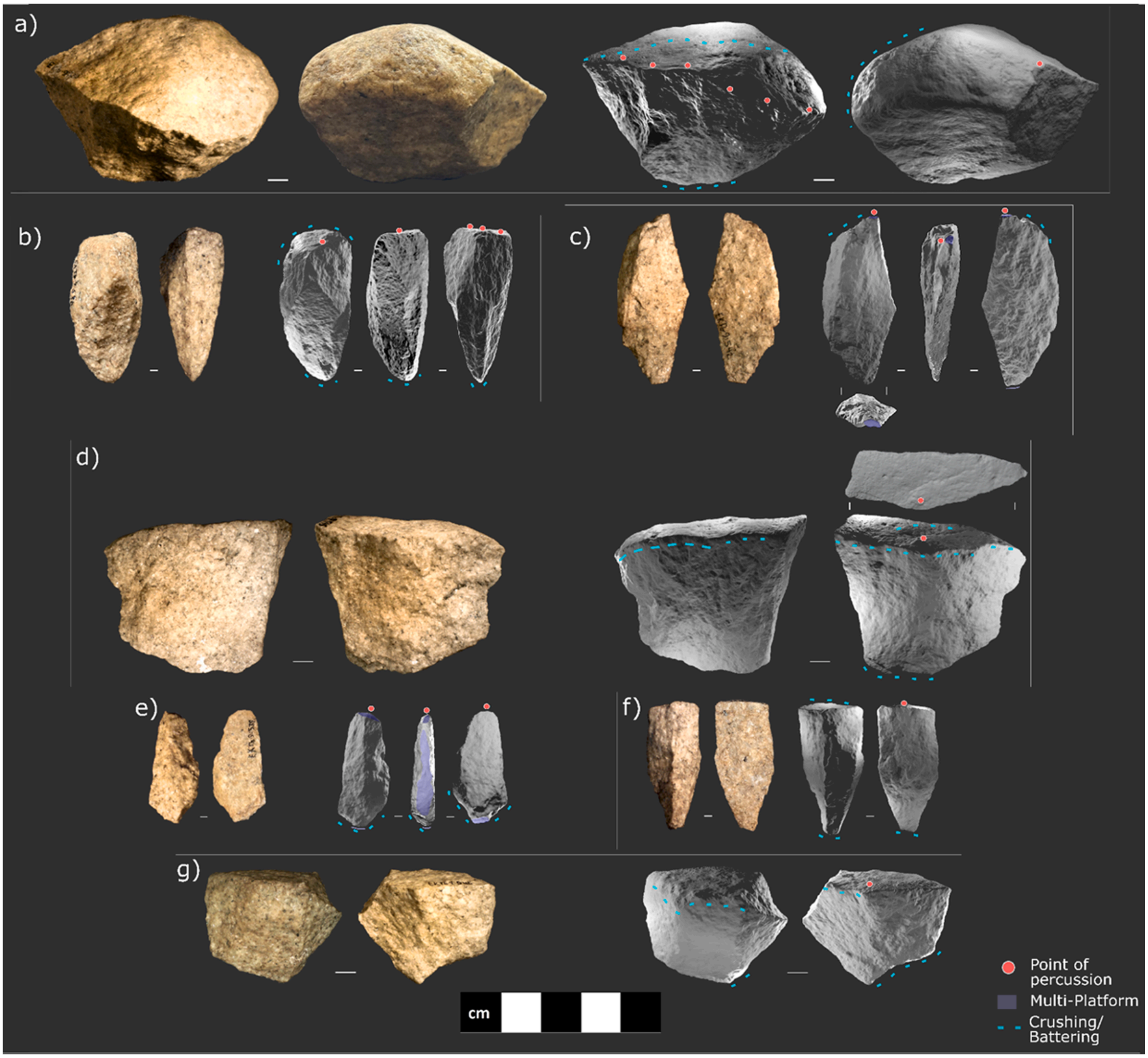

Fig 14. Select lithics from EkTb-9 terrestrial excavations: Stratum XIb. Photographs (colour) and 3D scans (grey scale) of a selection of quartzite artifacts from the anvil supported percussion (ASP) lithic cluster collected from the excavation trench in 2016: (a) Anvil-rested percussion (ARP) core (EkTb-9:535). Note the oblique angle of the flake removals. (b) ARP core with pyramidal profile. Note the elongated linear flake scars (EkTb-9:536). (c) ASP flake with intact platforms on proximal and distal ends (EkTb-9:542). (d) ASP flake with positive bulb of percussion and proximal/distal crushing (EkTb-9:545). (e) ASP flake with three intact platforms (EkTb-9:539). (f) ASP flake with proximal and distal crushing (EkTb-9:538). (g) ASP flake with proximal and distal crushing (EkTb-9:546). Lithics photographed by A Dyck, layup prepared by A Dyck. 3D scans created by Camosun Innovates.

Periodization is discussed in reverse chronological order, beginning at the earliest period with evidence of archaeological materials and features. The late Pleistocene-early Holocene period is called the **Gálgla**[17] (arrive on the beach) **Phase** (ca. 14,000 – 8,000 Cal BP), or "*laỷasi gálgla*" the time when the first People arrived at the island (Table 9). The early to mid-Holocene period is called the **Ćíc̓xvp̓át**[18](layers of shells) **Phase** (ca. 8,000 – 5,500 Cal BP); a time where shell is better preserved in the strata (Table 9). The mid to late Holocene period is called the **Dṇ́ỷás**[19] (cedar) **Phase** (ca. 5,500 – 450 Cal BP), or "*laỷasi q̓váx̌ʔit dṇ́ỷásax̌i*" the time when the western redcedar became more abundant at Triquet Island (Table 9).

5.1. Gálgla Phase (ca. 14,000 – 8,000 Cal BP)

This section reviews the evidence of human occupation during the Gálgla Phase and includes a discussion of palaeoenvironmental conditions, artifacts, and faunal assemblages for this time period.

5.1.1. Evidence of human occupation during the Gálgla Phase

The earliest evidence of human occupation at EkTb-9 occurs during the Gálgla Phase and is revealed in Strata XIc and XIb in the excavation trench (Figs. 4, 7, 9, and 14). The occurrence of lower stratigraphic units with lithics in an intact context, palaeoenvironmental correlates, and a single radiocarbon date (ca. 14,802 – 13,478 Cal BP; Table 1) indicates a late Pleistocene occupation is likely. Our interpretations are consistent with the relative sea level history of the area that shows that relative sea level was ca. 6 m above modern about 14,500 years ago (McLaren, 2013) (Fig. 3). Once sea level dropped 2 to 3 m from its position of 6 m above modern (sometime between ca. 14,500 – 14,300 years ago), the area encompassing the EkTb-9 trench and Stratum XIc and XIb became

[17] Pronounced: Gal-gell-ah.
[18] Pronounced: Zi-zix-bot.
[19] Pronounced: Den-yass.

Table 9
Haíɫzaqv temporal phases for terrestrial deposits identified at EkTb-9.

Haíɫzaqv Temporal Phases for EkTb-9	**The Gálgḷ̓a Phase**	**The C̓íc̓xvp̓át Phase**	**The Dṇ̓ýás Phase**
Haíɫzaqv Description and English Translation of Temporal Phases	*Lay̓ṇtxv gálgla* (when we arrived on the beach) or *lay̓asi gálgla* (when they arrived on the beach) *"In the beginning there was nothing but water and ice, and a narrow strip of shoreline."* (Farrand, 1916)	C̓íc̓xvp̓át: shells of shellfish, layers of barnacle shells on a beach	dṇ̓ýás: lay̓asi q̓váxʔit dṇ̓ýásax̌i (when the western redcedar started to grow)
Geological Era	**Terminal Pleistocene - Early Holocene**	**Early to Mid-Holocene**	**Mid to Late Holocene**
EkTb-9 Cal BP Ranges	**ca. 14,000 – 8,000 Cal BP**	**ca. 8,000–5,500 Cal BP**	**ca. 5,500–450 Cal BP**
EkTb-9 Strata	**XII - X**	**IX-VI**	**V-IIIa**
Central Coast Periodization (Carlson and Cannon, 1991; Maas, 1990)	The Early Period, 10,000–5,000 years ago Period II Period III	The Middle Period, 5,500–1,500 years ago Period IV Period V	The Late Period, 1,500 years ago & The Contact Period 1793 CE
Central Coast Stone Tool Traditions (Carlson et al., 1996; Carlson and Cannon, 1991)	Interface of Pebble Tool Tradition and Microblade Tradition Namu I – Zone IIa Namu I – Zone IIb	Namu II McNaughton I Cathedral Phase Namu III Namu IV McNaughton II	Anutcix Kwatna Phase
EkTb-9 Palaeoenvironmental Reconstruction	Hypermaritime; likely open or parkland; exposed, relatively flat bedrock; shrubby alder, ferns, and rose-family with few conifers; Younger Dryas and early Holocene bring more conifers; gradual sedimentation from erosion and marine deposition; Subsiding sea level	Hypermaritime; cool, wet, temperate; conifer forets form closed stands; western redcedar and yew appear; berry bushes; peat formation; storm surges/tsunamis; periods of higher relative sea level	Hypermaritime; cool, wet, temperate; modern rainforest co-dominated by western hemlock, sitka spruce and western redcedar; berry bushes; peat formation; periods of higher relative sea level
EkTb-9 Subsistence	Specialized marine-based subsistence: sea-mammal are the most relatively abundant species group, followed by fish (Pacific herring, lingcod, greenling, rockfish) and invertebrates (primarily evidenced by periostracum from California mussels)	Specialized marine-based subsistence: Greenling, rockfish and Pacific herring are the most relatively abundant species; Sea-mammal also present in assemblage; Shellfish (abalone, chiton, butter clam, California mussel, littleneck, barnacle, sea urchin) harvesting and propagation; Traditional plant management: estuarian root gardens, eelgrass beds, berry bush patches	Specialized marine-based subsistence: Greenling, rockfish, and Pacific herring most relatively abundant species; Shellfish (abalone, chiton, butter clam, California mussel, littleneck, barnacle, sea urchin) harvesting and propagation; Traditional plant management: estuarian root gardens, eelgrass beds, berry bush patches, CMTs; Domesticated dogs
EkTb-9 Settlement Type	Temporary structures (tents/lean-tos; inferred) Stratum X: water saturated shell-less midden accumulations with abundant periostracum and charcoal	Accumulations of preserved shell (intentional midden terraforming); settlement expansion (plank houses; inferred)	Continuation of shell midden terraforming; plank houses (inferred)
Haíɫzaqv Stone Tool Traditions at EkTb-9	**The t̓ssi̓á Tradition** *t̓ssiá*: to break, smash a stone in half *Lay̓ṇtxv tssiá* (when we smashed rocks to make stone tools)		**The diák̓a tradition** *diák̓as:* whetstone, grindstone; *láy̓ṇtxv diáka diák̓asax̌* (when we sharpened tools on whetstones and grindstones)
EkTb-9 Stone Tool and Maritime-Adapted Organic (Composite Wooden Tool) Technology	Boats (inferred); Cobble reduction industry with bipolar technology; Locally available raw material (basalt, quartzite and granite); Composite tools (stone, wood)	Boats (inferred); Composite tool technology (Carved harpoon foreshafts, bentwood fishhooks, bark wrapped-stick, bi-points); Chipped and flaked stone tools; Locally available and imported raw material; Imported obsidian from Anahim Peak (microblades, flake tools) Imported Graphite: Pigment stone (art, personal adornment, spiritual, ritual)	Boats (inferred); Flaked and Chipped stone tools; Ground stone tools; Worked bone tools; (Textile production; Inferred)

Prepared by A Gauvreau, R Housty, W Housty, and E White, with contributions from J Carpenter (Haíɫzaqv Cultural Education Center), the Haíɫzaqv Integrated Resource Management Department, and M Humchitt (Haíɫzaqv Language Program).

suitable for vegetation development and human occupation (Figs. 3 and 8).

5.1.2. Environment during the Gálgla Phase

When the first people arrived in the sheltered bays at what is now called "EkTb-9" during the Gálgla Phase, the landscape would have looked very different than it does today, though nevertheless welcoming compared to some of the more steeply sided islands in the region. Pollen in basal cultural strata suggests that the island had pioneering vegetation dominated by shrubby alder and rose-family taxa alongside ferns, herbs, and few conifers, with soil surfaces that were repeatedly exposed to the elements. Pollen spectra from lower Strata XII to X suggest few trees were present on Triquet Island in the late Pleistocene and earliest Holocene, potentially the result of the island's hypermaritime isolation in the post-glacial period (Fig. 12). The early co-occurrence of ferns with alder and herbaceous taxa seen here has also been documented in post-glacial deposits at Hippa Island, another hypermaritime site off the west coast of Haida Gwaii (Lacourse et al., 2012). Similar non-arboreal assemblages — though without the prevalence of alder — have also been described from elsewhere in coastal BC (Barrie et al., 1993; Lacourse et al., 2003; Lacourse et al., 2005; Mathewes et al., 2020; Warner, 1984) and are often interpreted to represent cool and dry climatic conditions prior to ca. 14,700 Cal BP.

The notable presence of taxa associated with wet to mesic soils including alder, rose-family taxa, and skunk cabbage amongst other non-arboreal indicators, especially in Strata XII, XIc, and XIb, may indicate warmer, moister conditions on the island coincident with global climatic amelioration during the Bølling-Allerød interstadial (ca. 14,700 – 12,900 Cal BP). These conditions are also supported by paleosol formation in the top of Stratum XIb, which would have required the presence of sufficient moisture and vegetation to undergo such marked soil formation processes. At most sites in coastal BC, the pollen records for the period from ca. 14,700 – 12,900 Cal BP demonstrate the presence of a pine and/or mixed conifer woodland (Hebda, 1995). There is, however, no indication of substantial pine growth on the island in any of the sediments examined at EkTb-9, including Stratum XIb. Rather, the island's distance from potential refugia for arboreal species off northern Vancouver Island (Lacourse et al., 2003) and Haida Gwaii (Godbout et al., 2008) coupled with its hypermaritime character may have prevented pine trees from establishing an early foothold, despite having done so on nearby Calvert Island (Ŵuíga) by ca. 14,500 Cal BP (Eamer, 2015).

Modest incidence of conifer pollen in the early period assemblages from Triquet Island may have resulted from aeolian transport of pollen[20] (Hebda and Allen, 1993) or from oceanic waves and currents transporting coniferous cone-bearing flotsam. A notable increase in pollen from mountain hemlock in the lower sample from Stratum XIa likely corresponds with the onset of the Younger Dryas at the site (ca. 12,900 – 11,700 Cal BP) (Mathewes, 1993), which is concordant with outer constraining dates on Stratum X above (ca. 11,311 – 11,201 Cal BP; Table 1) and Stratum XIb below (ca. 14,802 – 13,478 Cal BP; Table 1). Overall, conifer pollen remains low in both Stratum XIa and Stratum X, suggesting slow forest development on the island into the early Holocene.

5.1.3. Artifact and faunal assemblages of the Gálgla Phase

The stone tool technology during the Gálgla Phase comprise the ***t̓ssiá***[21] Tradition; the Haíłzaqv term *"t̓ssiá"* means to break or smash a stone in half. This is demonstrated in the lithic assemblage through production by ASP and hard-hammer freehand percussion. Cultural activities are evidenced as early as Stratum XIc and XIb with the presence of lithics in these layers (n = 31; Table 8). Early island inhabitants produced stone tools using a wide range of locally available, medium to coarse grained material types (with a few fine-grained volcanics), as well as quartzite, fine-grained milky quartz, volcanic andesite/basalt, and metamorphic materials. Stone tools recovered from basal cultural strata have practical application for woodworking, processing mammalian, avian, fish, and invertebrate resources, and other ecological management applications. Towards the end of the Gálgla Phase, and continuing into the Ćíćxvp̓át Phase, the perishable tools and faunal remains recovered from the site demonstrate a well-developed maritime-adaptation (atlatls, carved wooden bi-points, composite tools, fish-hooks). Part of this maritime adaptation likely involved extensive knowledge and awareness of outer coastal floral and faunal resources, as faunal evidence suggests that island inhabitants were primarily reliant upon sea-mammals, bottom feeding fish, and shellfish.

Within the assemblage, the lithics recovered from Stratum XIb (the oldest dated layer) are of particular interest. The five elongated linear flakes and the flake scars on two cores produced by ARP may indicate that elongated flakes were a desired outcome. Recent studies have shown that ASP is particularly efficient at producing small elongated flakes (Pargeter et al., 2019; Pargeter and de la Peña, 2017; Pargeter and Eren, 2017). Interestingly, the early Holocene lithic assemblage in the intertidal zone of EkTb-9 also contains a sizable bipolar component (Dyck et al., 2020). The relatively common presence of lithics resulting from ASP in various areas of the site suggests that this reduction method may have been a preferred strategy for inhabitants during earlier periods of occupation on the island. The early date obtained from Stratum XIb and the associated lithic cluster indicates that an occupation may have occurred ca. 2,700 years prior to the occupation associated with Stratum XIa and X. However, the radiocarbon ages from XIa are from its interface with Stratum X above, and the lower deposit in XIa remain undated. The lower deposit in XIa could comprise sediments dating to this observed 2,700-year gap.

5.1.4. Terraforming during the Gálgla Phase

The cultural remains in Stratum X closely resemble the components in shell midden strata, except that all the shell has degraded. The presence of abundant periostracum in Stratum X is likely representative of a process of decay (not a change in diet or resource availability), indicating that shellfish was a staple of ancestral diets and actively discarded at the site during at least the latter part of the Gálgla Phase. Charcoal-rich water saturated shell-less midden deposits with abundant periostracum are also documented at nearby sites EjTa-4 (Calvert Island) and EjTa-15 (North Pruth Bay) (McLaren et al., 2015). Like the shell-less midden deposits encountered at EjTa-4 and EjTa-15, shell discarded at the southern extent of EkTb-9 (Stratum X; Figs. 4, 6 and 7) may represent the early onset of intentional terraforming activities.

5.2. Ćíćxvp̓át Phase (ca. 8,000 – 5,500 Cal BP)

This section reviews the evidence of human occupation during the Ćíćxvp̓át Phase and includes a discussion of terraforming activities, palaeotsunamis, intentional investment in place, and the artifact and faunal assemblages for this time period.

5.2.1. Terraforming during the Ćíćxvp̓át Phase

Terraforming activities are more concretely expressed during the Ćíćxvp̓át Phase, evidenced vertically across the rocky promontories as well as horizontally along and within the nearby intertidal flats through dense accumulations of preserved shell (See Fig. 8; with terraformed layers removed). Terraforming activities were perpetuated into the late Holocene (Dŋ́yás Phase), resulting in substantial accumulations of altered and unaltered shell across the site (Figs. 4, 6 and 7). Evidence of preserved shell accumulations (calcine, burned, and unaltered) begin ca. 5,732 – 5,604 Cal BP at the southern extent of the site, capping the peat-fringed pond. Shell midden accumulations begin at the northwestern extent of the site ca. 8,163 – 7,668 Cal BP, atop shell-less midden, bedrock, and intertidal beach sand deposits (Tables 1 and 2). This would have been necessary to create more liveable space for an increasing population and would have established well-draining foundations for plank house construction. A single house depression is visible on the landscape at EkTb-9 today[22] (Stafford et al., 2009). A similar pattern of population and site expansion, with permanent outer coastal settlement is revealed at archaeological sites GcTr-6, EjTa-15, and EjTa-4 during this time (Martindale et al., 2009; McLaren, 2008; McLaren et al., 2015).

5.2.2. Palaeotsunamis and intentional investment during the Ćíćxvp̓át Phase

During the Ćíćxvp̓át Phase, stable relative sea level and increasingly thick vegetation likely enabled consistent access to terrestrial and marine resources, however, a possible palaeotsunami event (q̓íkas t̓úwala; large waves/tsunami waves) is recorded in the stratigraphy at EkTb-9 and is discussed further below (Figs. 6 and 7; Stratum VIIIa). During the mid-Holocene, the possible palaeotsunami event (q̓íkas t̓úwala) occurred at EkTb-9 ca. 6,931–6,314 Cal BP, depositing water-rounded fine grey sand clasts of consistent size class and relatively abundant marine diatoms and spicules (Stratum VIIIa) across much of the site within a few meters of the modern southern shoreline (between

[20] Especially common for Pinaceae species (Hebda and Allen, 1993).

[21] Pronounced: Diss-we-yah.

[22] Additional house platforms may be present at EkTb-9, and Triquet Island more broadly, though presently obscured by very tall and very dense vegetation (Stafford et al., 2009).

approximately 2.25–3.5 m above hht; Tables 2 and 5; Figs. 4, 6 and 7). Evidence of between 10 and 22 palaeotsunami events have been documented along the Pacific coast of Canada spanning ca. 4,500 Cal BP to CE 1700 (Goff et al., 2020), however no intensive palaeotsunami investigations have yet focused on the immediate region surrounding Triquet Island. The island is located north of the Cascadia Subduction Zone and east of the Queen Charlotte Fault and Explorer Plate within the active tectonic zone of the broader Pacific-North American plate boundary (Goff et al., 2020). The characteristics of the Pacific-North American plate boundary (side-slip plate) are unlikely to produce large tsunamis (Clague et al., 2003; Goff et al., 2020; Peterson et al., 2013). Localized earthquake-generated tsunamis are however possible, as demonstrated in 2012 when the largest tsunami of the year (worldwide) occurred on a subsidiary thrust fault off the west coast of Moresby Island (southern Haida Gwaii) following Canada's second-largest recorded earthquake (Fine et al., 2015; Leonard and Bednarski, 2014). The tsunami had maximum runup heights of up to 7.6 m in sheltered areas and up to 13 m in a less sheltered area of Moresby Island; waves triggered by the event were recorded throughout the entire Pacific Ocean[23] (Fine et al., 2015; Leonard and Bednarski, 2014).

As Triquet Island has low topographic relief and is exposed to the Pacific Ocean, an earthquake is the most likely tsunamigenic source for the Stratum VIIIa deposit (Figs. 6 and 7) (Goff et al., 2020). Sea level was around 0.5 to 1 m below modern ca. 7,000 – 6,000 Cal BP when the palaeotsunami occurred (Fig. 3). Although we do not know if it occurred at low tide or high tide, nor the length of the wave, nor if there were successive waves, it is possible that the palaeotsunami had a runup height of approximately 3 m as the deposits are presently expressed between 2.25 and 3.5 m above modern sea level. With enough force behind it, a wave of this height would have had implications for anything or anyone in its path.

Palaeotsunami events identified in archaeological contexts along the Cascadia Subduction Zone have been linked to resource fluctuations and displacement of site inhabitants (Hutchinson and Clague, 2017; Hutchinson et al., 2019; Minor and Peterson, 2017; Thrush and Ludwin, 2007), however, archaeological and oral historical evidence indicates that settlements (primarily shell midden sites) that were located in favoured settings were reoccupied (Goff et al., 2020; Hutchinson et al., 2019; McMillan, 2011; McMillan and Hutchinson, 2002; Minor and Peterson, 2017; Thrush and Ludwin, 2007). On the Central Coast, a Haíłzaqv oral historical account shared by Mágaga (Mrs. Charley Windsor) to Ronald Olson in 1955 describes a deluge or palaeotsunami event that occurred at Húy̓at[24] (McMillan and Hutchinson, 2002; Olson, 1955). Húy̓at is the location of several important Haíłzaqv villages (shell midden sites and associated features) located along Fannie Cove on northern Hunter Island (approximately 29 km northeast of Triquet Island) (Jackley, 2014). Haíłzaqv ancestors decided to return and rebuild their villages at Húy̓at after the waters receded and the area remains a cultural keystone place for Haíłzaqv Nation today (Lepofsky et al., 2017; Olson, 1955). EkTb-9 was similarly reoccupied following the palaeotsunami event that occurred in the mid-Holocene. Reoccupation of village sites following tsunami events highlights the importance of these places for the inhabitants and their descendants and signals the inhabitants continued intentional investment in these terraformed landscapes.

5.2.3. Artifact and faunal assemblages of the C̓íc̓xvp̓át Phase

The terrestrial lithic assemblage of the C̓íc̓xvp̓át Phase primarily reveals a cobble reduction industry useful for woodworking, processing mammalian, avian, fish, and invertebrate resources, and other ecological management applications, such as pruning/coppicing (see Turner et al., 2013). The majority of the lithics appear to be produced from locally available materials except for the obsidian, quartz crystal, and graphite that are exotic to the area. Obsidian artifacts were sourced[25] to Bes But'a (Anahim Peak), located approximately 206 linear km northeast of Triquet Island (Reimer, 2018). The origin of the graphite nodule (bearing distinct incisions from repeated modification and use as a pigment stone) remains unknown; however, a lump vein is located near Bella Coola, approximately 110 km east of the island (Simandl et al., 2016).

Faunal remains associated with the C̓íc̓xvp̓át Phase demonstrate specialized marine-based subsistence that included fish, shellfish (including mussel, abalone, sea urchin), and sea-mammal; most of which were accessible year-round. Perishable artifacts associated with this phase demonstrate that the island inhabitants were skilled woodworkers and carvers, producing a range of carved wooden tools used for land and sea-mammal hunting, deep-sea fishing, textile and other production, including composite tool technology.

5.3. Dṇ̓y̓ás Phase (ca. 5,500 – 450 Cal BP)

This section reviews the evidence of human occupation during the Dṇ̓y̓ás Phase and includes a discussion of environmental conditions, artifacts, and faunal assemblages for this time period.

5.3.1. Environment during the Dṇ̓y̓ás Phase

Preserved pollen and macrobotanicals from upper cultural layers reveal a hypermaritime rainforest environ was fully established by the Dṇ̓y̓ás Phase. During this time, parts of Triquet Island were densely vegetated, like conditions found on the island today (Lucas, 2013). Western redcedar slowly entered the ecosystem, joining Sitka spruce, western hemlock, and a rapidly developing understory with dense stands of salal, ferns, and berry bushes.

5.3.2. Artifact and faunal assemblages of the Dṇ̓y̓ás Phase

During the Dṇ̓y̓ás Phase, rockfish and Pacific herring are the most relatively abundant species encountered in the deposits at EkTb-9 signaling a shift in species targeted, but a continuation of a marine based subsistence. Flaked and chipped stone tools persist, and ground stone tools appear, as well as worked bone for weaving and sewing (Carlson et al., 1996). A shift in stone tool technologies therefore occurred and is referred to as the **Diáka**[26] (whetstone or grindstone) tradition. "*Láy̓ṇtxv diáka diák̓asax̌*" refers to the time when Haíłzaqv people sharpened and formed organic and lithic tools (e.g., knives, needles) on whetstones and grindstones as an addition to the already established chipped and flaked stone tool tradition. These technologies are well suited for harvesting bark from the thriving western redcedar trees for textile and other production (woven cedar hats, mats, blankets) as well as large planks for the construction of plank houses necessary to accommodate an expanding population.

[23] Waves associated with the event measuring between 5 and 50 cm were recorded on tidal gauges in the United States, Canada, Japan, New Zealand, and the Pacific Islands. The tidal gauge at the Haíłzaqv village of Bella Bella registered a small wave height of 24 cm (Fine et al., 2015).

[24] The paleotsunami event at Húy̓at remains undated, however, through interpretation of Mágaga's account (Olson, 1955) and identification of a large slope failure scarp on the western shore of a lake located southwest of Fannie Cove, it has been hypothesized that this narrative speaks of a potential earthquake generated slope failure which would have had localized effects (Goff et al., 2020).

[25] See S1 Supplementary Material. Obsidian artifacts were sourced using X-ray Fluorescence (XRF), a non-destructive technique whereby trace elements of lithic material can be identified; in this case, using a Bruker Tracer III-V+ portable XRF spectrometer (Reimer, 2018).

[26] Pronounced: Dee-ah-gas.

5.4. Oral history, persistent places and the coastal route into the Americas

The deep-time palaeoenvironmental and archaeological record for EkTb-9, layered with the available oral historical records for the broader Ṅúláw̓itx̌v Tribal area, demonstrate a pattern that is suggestive of long-term cultural continuity. Collectively, these data support the contention that the EkTb-9 site — and Triquet Island more broadly — is a persistent place of repeated human occupation (McLaren et al., 2015). The stable relative sea level in the region coupled with the long-term assertion of Haíɫzaqv tenure and proprietorship and the lack of historic era development on the island are factors that have contributed to the preservation of the archaeological deposits at EkTb-9. The substantial size, depth, and integrity of the terrestrial deposits and nearby intertidal features reveal that the site was a terraformed landscape, that is, a *built environment* with substantial *human investment in place* (Grier and Schwadron, 2017; Letham et al., 2020); it is a major outer-coastal occupation site with inferred intentional landscape modification. The abundance of shellfish and fish remains recovered from EkTb-9 and the presence of nearby intertidal features (petroforms and stone fishtraps) demonstrate evidence of deliberate investment and enhancement of marine resource harvesting technologies on and around the island. Haíɫzaqv Elders interviewed for the traditional use studies undertaken between 1996 and 2009 identified important fishing locations (notably flat fish), as well as shellfish and seaweed harvesting locations within a 1 km radius of Triquet Island, highlighting the continued importance of the island and nearby marine resources for Haíɫzaqv Nation today (Stafford et al., 2009).

The higher general marine productivity of the Central Coast (as compared to inland waters) (Barrie and Conway, 2002; Breivik, 2014; Mackie et al., 2011) coupled with a long-standing system of prerogatives (McLaren et al., 2015), and marine adaptation enabled ancestral populations to settle and thrive in these outer coastal environs for thousands of years. Oral historical, ethnographic, and recent accounts demonstrate a long-standing system of community-specific prerogatives that have been reasserted and transmitted over millennia (McLaren et al., 2015). These long-standing prerogatives comprise exclusive rights and privileges for occupation of the island and access to available resources. Like other persistent places on the Northwest Coast, EkTb-9 is a manifestation of deep-time human connection to place, long-term place making, expression of socio-political complexity, and dynamic geomorphological processes (Letham et al., 2020).

Persistent and early places of human occupation on the outer Central Coast have implications for the peopling of the Americas (McLaren et al., 2015; McLaren et al., 2019). Triquet Island is located along the proposed coastal corridor which may have permitted human expansion southward from Asia into the Americas along the western margin of the Cordilleran Ice Sheet (Erlandson et al., 2007; Fladmark and Shulter, 1983; McLaren et al., 2019; Potter et al., 2018). Despite ongoing debates (Bennett et al., 2021), robust archaeological and genetic evidence suggest that the peopling of the Americas occurred as ice began to retreat (Madsen et al., 2022). Results from EkTb-9 contribute to this growing body of evidence and suggest that some of the remote islands on the outer Central Coast were not only desirable places to stop along the proposed coastal route, but also places capable of supporting human population settlement and expansion (Gauvreau and Dyck, 2018; Mackie et al., 2018; McLaren et al., 2015; McLaren et al., 2019), therefore challenging long-held hypotheses (Borden, 1951; Kroeber, 1939; Pirazzoli, 1996) that people may have been unable to inhabit the outer coast during the late Pleistocene. Archaeological and oral historical evidence demonstrate that people were not only capable of arriving in the area during the late Pleistocene but were also sufficiently experienced in such environs to both survive and thrive using available marine and terrestrial resources. Over time, people repeatedly inhabited the outer coast, investing and modifying the landscape through terraforming, thereby establishing persistent places of human occupation.

Ames and Martindale correctly identified that "the distance between the archaeological record and the peoples whose lives we seek to describe and explain is great" (Ames and Martindale, 2014). Collaborating with descendent community members to bridge Indigenous oral histories with archaeological methods of investigation can help us span this chasm, providing a better understanding of site formation processes, resource use, and material culture on the Northwest Coast (Gauvreau and McLaren, 2016). Although our geo-archaeological data align with some Haíɫzaqv oral historical descriptions of the environment during the early post-glacial period (Farrand, 1916; White, 2006), our interpretations of *how* people arrived on the Central Coast express an imperfect alignment.

The contemporary archaeological and oceanographic hypothesis is that travel along the Pacific Rim and southward from Beringia would have required marine vessels (skin-boats, rafts, and vessels made with materials of local origin) to transport people and goods (Barrie and Conway, 2002; Cannon et al., 1999; Erlandson and Braje, 2011; Heusser, 1960; Letham et al., 2020). Vessels are therefore assumed to be the primary mode of transportation utilized along the proposed coastal route (Barrie and Conway, 2002; Cannon et al., 1999; Erlandson and Braje, 2011; Heusser, 1960; Letham et al., 2020). Due to the relative stability of the regional sea level, Triquet Island has been an island since at least 15,000 years ago, which means settlement would have necessitated paddling between the mainland and other islands in between (approximately 25 km). This is similarly assumed for the settlement of other locations along the Pacific Rim, including the Kuril Islands ca. 17,000 Cal BP, as the islands are spaced between 26 km and 66 km apart (Erlandson and Braje, 2011).

When the first people arrived on Triquet Island during the late Pleistocene, they must have done so by boat, and archaeological evidence of a well-established maritime adaptation with long distance trade and/or material point-sourcing (obsidian, graphite; mainland, deep-water and pelagic faunal resources) suggests that boat use continued throughout the period of human occupation. In the Haíɫzaqv Núym̓ told by Ai'wageɫ (Ḱáwázíɫ), the supernatural being/ Haíɫzaqv ancestor Y̓ágis descended from the sky and met an anthropomorphized being — a killer whale with the face of a man — at Ṅúlú, and through their conversation, determined that they were the first people in this outer coastal world, *a "place with no names"* (Boas, 1932). Although boat travel is not mentioned in the transcribed oral historical account told by Ai'wageɫ (Ḱáwázíɫ), there is a clear distinction of a time *before settlement* and *a time when people settled* and attributed a *name to a place*, and thus, attributed an identity to a people, and an identity for all descendants thereafter. The environmental description transcribed by Farrand (Farrand, 1916); "*In the beginning there was nothing but water and ice, and a narrow strip of shoreline*" suggests that the events described by Ai'wageɫ (Ḱáwázíɫ) may be temporally anchored to the late Pleistocene (McLaren et al., 2015). The place name Ṅúlú, meaning 'the eldest', aligns with our understanding of the archaeological and palaeoenvironmental evidence. Further to this, a reflection of the long-term patterns of repeated use at Triquet Island is affirmed through Haíɫzaqv people living in Bella Bella (Wáglísla) and elsewhere today, including co-authors Q̓íx̌itasu Yím̓ázalas/ Elroy White and Ĝvu̓í/ Rory Housty, who trace descent from common ancestors that once inhabited the area around Ṅúlú.

6. Conclusion

Our multi-proxy analysis of the archaeological deposits of EkTb-9 indicate repeated human occupation and long-term intentional human-environment interactions on a hypermaritime island on the Central Coast of BC, spanning the late Pleistocene to the present day. Stratigraphic records at EkTb-9 show a complex array of natural site formation processes. Marine beach sediments (Strata XII, XIc and XIb) are elevated above modern sea level, consistent with the stable relative sea level history of the Hakai West Region (<5 m elevation change over the last 14,500 years) (McLaren et al., 2014). Peat accumulations (Strata IX – VI) are limited to the southwestern extent of the site and suggest that this area was subject to persistent water saturation, consistent with hypermaritime islands with flat topography. A possible palaeotsunami event occurred during the mid-Holocene and distributed fine grey sand deposits across much of the site within a few meters of the modern shoreline. Cultural strata include both shell-less deposits with abundant periostracum (the shell has decayed) and deep (5 m +) preserved shell accumulations consistent with sites where shell terraforming has been observed elsewhere in coastal BC (Grier et al., 2017). The results of radiometric dating and the analysis of sediments, pollen, macro-botanicals, and diatoms combined with geospatial modelling demonstrate that this outer coastal island gradually changed from what was likely an open shrubby landscape during the late Pleistocene to the productive very wet hypermaritime coastal temperate rainforest environs of the present day. Early pioneering vegetation is characterized by largely non-arboreal taxa such as alder, ferns, and other shrubby and herbaceous species developing on otherwise exposed soil surfaces. Present-day island vegetation is dominated by culturally important species including western redcedar and yellow cedar, shore pine, Sitka spruce, western hemlock, yew, and dense stands of salal, ferns, and berry bushes.

The stratified archive of natural and cultural deposits at EkTb-9 broadens our archaeological understanding of early maritime technological developments and the viability of early post-glacial settlement and population expansion on outer coastal islands on the Northwest Coast. The site chronology for EkTb-9 established through radiometric dating demonstrates that people lived on and invested in Triquet Island from the late Pleistocene until at least 450 years ago and culturally modified trees reveal continued use of the island over the last 300 years. Additionally, ethnographic accounts reveal the island was inhabited until the late CE 1800s at which time island inhabitants relocated approximately 40 km northeast of Triquet Island to the village of Wáglísla (Bella Bella Indigenous Reserve No.1), located on the eastern coast of Campbell Island (Olson, 1955).

Triquet Island remains an important part of the cultural landscape for Haíłzaqv Nation. The island's natural and cultural resources are safeguarded for future generations through the Hakai Lúxvbálís Conservancy Program, and the island is regularly monitored by members of the Haíłzaqv Guardian Watchmen Program. Through ongoing collaboration, our archaeological data may help inform local resource management efforts including sensitive species such as rockfish, abalone, and Pacific herring. Following the completion of our work at EkTb-9 in 2017, restoration efforts were conducted in accordance with the HIRMD and BC Parks requirements, and the site was inspected during a final visit in 2019 to confirm site protections were in place. Like the hundreds of other sites in Haíłzaqv Nation territory, Triquet Island is a repository enriched through thousands of years of prerogatives, oral historical transmission, deliberate human investment in the landscape, and ongoing intimate connection to place. In the spirit of the Hakai Lúxvbálís Conservancy Program, there are no current plans or active archaeological investigation permits to return to Triquet Island for additional archaeological work; rather, it has been decided that the site be conserved for the future.

6.1. Limitations and future directions

This section identifies possible future directions for: (1) analysis using existing samples, (2) work at the site should Haíłzaqv Nation decide that additional archaeological investigations may occur, (3) work at other sites on Triquet island, and (4) future work for the broader Central Coast region.

6.2. Future work with existing samples

Fruitful avenues for study include grain analysis, micromorphology, OSL dating of sediments with poor organic preservation, ancient DNA analysis, residue analysis, and isotopic analysis. Isotopic work on the domesticated dog remains would help establish the canids' diet with implications for ancient human diet at the site, and aDNA analyses could establish the canid's haplotype (Cannon et al., 1999; Fedje et al., 2021). Ancient DNA or ZooMS work could be performed on the fortuitously retrieved sea-mammal remains obtained from the Vibracore test (VC-2017–2) as well as the degraded sea-mammal remains obtained from the basal cultural strata in the excavation trench to allow species level identifications.

6.3. Future work at EkTb-9

Should Haíłzaqv Nation decide that additional archaeological investigations be conducted at the site, the following future directions for research have been identified. Although a chronology has been established for the terrestrial component of EkTb-9, these results have been primarily derived from the excavation trench and auger and vibracore tests and could be enhanced through additional subsurface testing at the site (e.g., excavation units or additional vibracoring). The site boundaries have also not been fully defined. Although preservation in basal cultural strata is generally poor, it is possible that additional excavation and exploration of the earliest cultural deposits at EkTb-9 could yield more dateable material that would further support the early record of occupation on the Central Coast. Additional testing along the north-western extent of the site would permit the assessment of basal shell midden and other deposits in that area, aiding in the refinement of our understanding of site formation processes and terraforming activities.

Additional place name studies conducted by Haíłzaqv community members, as well as the preparation of teaching materials for Haíłzaqv youth, and Haíłzaqv-led eco-tourism or camps/field-schools represent additional beneficial future research and education directions for EkTb-9.

6.4. Future work on Triquet Island outside of EkTb-9

An auger/coring program coupled with radiometric dating conducted at nearby sites on Triquet Island (EkTb-3, -8, and -11 to -14) would help to establish a chronology of settlement and expansion on the island. Collecting additional sediment samples for pollen analysis from Triquet Island and comparable hypermaritime sites would permit a refinement of the post-glacial vegetation history for the area. Additional testing on Triquet Island should also focus on palaeotsunami investigations.

6.5. Future work in the Central Coast region

Palaeoenvironmental evidence and GIS modelling suggest coastal environments and resources were available for human occupation and use earlier than the earliest archaeological evidence currently available (Fedje et al., 2021; Gustas and Supernant, 2019; Lausanne et al., 2019; Mackie et al., 2018; Matson et al., 2003; Vogelaar, 2017); therefore, more collaborative archaeological research at previously recorded archaeological sites as well as additional investigations to find new sites on the Central Coast remains a promising and worthwhile pursuit. Additional collaborative palaeotsunami investigations should also be considered for the Central Coast region.

Credit authorship contribution statement

Alisha Gauvreau: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Daryl Fedje:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Angela Dyck:** Investigation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Quentin Mackie:** Investigation, Writing – original draft, Writing – review & editing. **Christopher F.**

G. Hebda: Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Keith Holmes:** Visualization, Writing – review & editing. **Q̓íx̌itasu Yím̓ázalas Elroy White:** Investigation, Resources, Writing – original draft, Writing – review & editing. **Dúqva̓ísḷa William Housty:** Resources, Writing – original draft, Writing – review & editing. **Ĝvuí Rory Housty:** Resources, Writing – original draft, Writing – review & editing. **Duncan McLaren:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

The authors are sincerely appreciative of the collaborative engagement, support, and involvement of the Haíłzaqv Integrated Resource Management Department (HIRMD) and the HIRMD working group, Jennifer Carpenter and the Haíłzaqv Cultural Education Center (HCEC), Marina Humchitt and other members of the Haíłzaqv Language Program, Central Coast Archaeology (CCA), and the Haíłzaqv Coastal Guardian Watchmen. Our collaboration with the HIRMD and CCA enabled the coordination and participation of Haíłzaqv field assistants during every field season and site visit conducted at Triquet Island from 2011 to 2019. Haíłzaqv field workers include Brodie Lawson, Danny Windsor, Kelly Windsor, Andrea Walkus, Josh Vickers, Jordan Sandy, and Maxwell Johnson Jr.; Larissa Dixon is thanked for her assistance with lab work and for joining on the final site visit in 2019. We are also appreciative for Johnny Johnson's dedication to the project and thank him for providing daily transport and supporting the team with fieldwork and camping logistics. Thank you to Haíłzaqv Coastal Guardian Watchmen and the HIRMD for faciliating the final site visit at Triquet Island in 2019 and for continuing to monitor the island and archaeological site. Ongoing communications and coordination with the HIRMD enabled Haíłzaqv cultural protocols to be followed and fostered a truly collaborative arrangement whereby opportunities for publication and other content review were possible, and consensus reached for dissemination of results. We also wish to thank the HCEC for acting as the approved local repository for cultural materials collected through the project. The authors have utmost appreciation for Eric Peterson and Christina Munck for coordinating the generous financial and logistical support through the Tula Foundation and the Hakai Research Station. Fieldwork conducted between 2011-2017 was based out of the Hakai Institute located on Calvert Island (W̓uíga), and laboratory activities were occasionally based out of Hakai's archaeology lab at the Quadra Island Ecological Observatory; many thanks are owed to the Hakai staff that contributed tirelessly to the coordination of field and lab activities, offering assistance with transportation, support with meals and accommodation, as well as for sharing local insights, observations, and great company. Deep gratitude and appreciation are owed to our core field team members, John Maxwell (Ethos Archaeology and Cultural Heritage Services), Jim Stafford (Coast Interior Archaeology), Joanne McSporran, and Seonaid Duffield. Several other researchers are thanked for their participation and support with various aspects of this research including Dr. Darcy Matthews, Dr. Rudy Reimer, Dr. John Southon, Rebecca Wigen, Dr. Gay Frederick, Dan Stueber, Dr. Brian Menounos, David Fargo, Jenny Eamer (Lucas), Kathleen Hawes, Dr. Dale Croes, Jenny Cohen, Callum Abbott, Cecilia Porter, Jess Barton, Aurora Skala, and Al Mackie. Additional thanks are due to Jenny Cohen for her idealized illustration of the EkTb-9 lithic cluster in panel (e) of Fig. 9. We wish to thank Dr. Ken Marr, Dr. Genevieve Hill, and Grant Keddie of the RBCM, as well as Kathryn Puseman and Christy Briles of Paleoscapes Archaeobotanical Services Team. We also wish to express thanks to Dr. Junko Habu, and the delegation of Japanese wet site archaeologists that joined our crew for the 2015 excavations on Triquet Island: Dr. Naoto Yamamoto, Dr. Tomonori Kanno, and Rika Shinkai. Many thanks to Cathy Rzeplinski, Jindra Belanger, Dr. Iain McKechnie, Dr. April Nowell and Dr. Anne Stahl for their support at the University of Victoria.

Financial Disclosure

Funded by the Tula Foundation, HALAP 2012-2017. https://tula.org/ to D McLaren. The Tula Foundation provided funding for research expenses. The funders participated in meetings concerning the overall scope of this project. 'In kind' support was provided for transportation and accommodations while in the field. The funders encouraged us to pursue this line of investigation but had no role in the preparation of this manuscript.

Funded by Social Sciences and Humanities Research Council (SSHRC) of Canada (Scholarship #752-2017-1022) to A Gauvreau. SSHRC provided funding for fieldwork, laboratory analyses, dissertation obligations, community collaboration, public outreach, and manuscript preparations. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

***Ethics** Statement*

Archaeological study conducted per the terms and conditions of Heritage Conservation Act Permit 2011-0171, held by Dr. D McLaren, Cordillera Archaeology. Permit issued by the Archaeology Branch of British Columbia, Ministry of Forests, Canada.

University of Victoria, Human Research Ethics, Community Engaged Research Project Registration Protocol Approval Number: 19-0104-01 (Renewed Annually).

Heiltsuk Tribal Council c/o Heiltsuk Cultural Education Center, approved of this research per the conditions of the Heiltsuk Band Research Registration (2016-ongoing). Bella Bella, British Columbia.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2023.103884.

References

Abdul, N.A., Mortlock, R.A., Wright, J.D., Fairbanks, R.G., 2016. Younger Dryas sea level and meltwater pulse 1B recorded in Barbados reef crest coral Acropora palmata. Paleoceanography 31 (2), 330–344.

Al-Suwaidi, M., Ward, B.C., Wilson, M.C., Hebda, R.J., Nagorsen, D.W., Marshall, D., et al., 2006. Late Wisconsinan Port Eliza cave deposits and their implications for human coastal migration, Vancouver Island. Canada. Geoarchaeol. 21 (4), 307–332.

Ames, K.M., Martindale, A., 2014. Rope bridges and cables : a synthesis of prince rupert harbour archaeology. can J. Archaeol. 38 (1) 140–178 [Internet]. Available from: https://www.jstor.org/stable/43967081?seq=1.

Bahls, L., Boynton, B., Johnston, B., 2018. Atlas of diatoms (Bacillariophyta) from diverse habitats in remote regions of western Canada. PhytoKeys. 105, 1–186.

Banner, A., Mackenzie, W., Haeussler, S., Thomson, S., Pojar, J., Trowbridge, R., 1993. A field guide to site identification and interpretation for the Prince Rupert Forest Region, Part 1, Land Management Handbook No.[Internet]. Vol. B.C. Min., B.C. Min. Forests. Land Management Handbook No. 28. Ministry of Forests and Research Program; 285 p. Available from: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:A+Field+Guide+for+Site+Identification+and+Interpretation+for+the+Vancouver+Forest+Region#0.

Banner, A., Lepage, P., Moran, J., de Groot, A., 2005. The HyP3 project: pattern, process, and productivity in hypermaritime forests of coastal british columbia - synthesis of 7-Year Results. Special Re. Ministry of Forests Forest Science Program. Victoria, British Columbia.

Barham, L.C., 1987. The bipolar technique in southern africa: a replication experiment. South African Archaeol. Bull. 42 (145), 45–50.

Barrie, J.V., Conway, K.W., 2002. Rapid sea-level change and coastal evolution on the Pacific margin of Canada. Sediment Geol. 150 (1–2), 171–183.
Barrie, J.V., Conway, K.W., Mathews, R.W., Josenhans, H.W., Johns, M.J., 1993. Submerged Late Quaternary terrestrial deposits and paleoenvironment of northern Hecate Strait, British Columbia continental shelf. Canada. Quat. Int. 123–129.
Bellafontaine, K., Alldrick, D., Desjardin, PJ., 2019. British Columbia Digital Bedrock Geology [Internet]. BC Geological Survey, Ministry of Energy, Mines and Petroleum Resources. Available from: https://catalogue.data.gov.bc.ca/dataset/bedrock-geology.
Bennett, M.R., Bustos, D., Pigati, J.S., Springer, K.B., Urban, T.M., Holliday, V.T., et al., 2021. Evidence of humans in North America during the Last Glacial Maximum. Science 373 (6562), 1528–1531.
Bennett, P.C., Siegel, D.I., Hill, B.M., Glaser, P.H., 1991. Fate of silicate minerals in a peat bog. Geology 19 (4), 328–331.
Blaise, B., Clague, J., Mathewes, R., 1990. Time of Maximum Late Wisconsin Glaciation. West Coast of Canada. Quat. Res. 34, 282–295.
Boas, F., 1932. Bella Bella Tales. Memoires of the American Folklore Society, 25.
Borden, C., 1951. Facts and problems on northwest coast prehistory. Anthropol. Br. Columbia. 1, 13–26.
Breivik, H.M., 2014. Palaeo-oceanographic development and human adaptive strategies in the pleistocene-holocene transition: a study from the norwegian coast. Holocene 24, 1478–1490.
Caldwell, M.E., Lepofsky, D., Combes, G., Washington, M., Welch, J.R., Harper, J.R., 2012. A Bird's Eye View of Northern Coast Salish Intertidal Resource Management Features, Southern British Columbia. Canada. J. Isl Coast Archaeol. 7 (2), 219–233.
Cannon, A., 1991. The Economic Prehistory of Namu: Patterns in Vertebrate Fauna. Archaeology Press: Simon Fraser University. Burnaby, British Columbia.
Cannon, A., Schwarcz, H.P., Knyf, M., 1999. Marine-based subsistence trends and the stable isotope analysis of dog bones from namu. British Columbia. J Archaeol Sci. 26, 399–407.
Carlson, R.L., 1991. Appendix B: namu periodization and C-14 Chronology. In: Cannon, A. (Ed.), The Economic Prehistory of Namu. Archaeology Press, Simon Fraser University, Burnaby, British Columbia, pp. 85–95.
Carlson, R.L., 1993. The pender canal excavations and the development of coast salish culture. Pender Canal Excav Dev Coast Salish Cult. 99, 25–52.
Carlson, R.L., 1996. Early Namu. In: Carlson, R., Dalla Bona, L. (Eds.), Early Human Occupation in British Columbia. UBC Press, Vancouver, British Columbia, pp. 83–102.
Clague, J.J., 2000. Recognizing order in chaotic sequences of Quaternary sediments in the Canadian Cordillera. Quat. Int. 67–71, 29–38.
Clague, J.J., Bobrowsky, P.T., 1994. Tsunami deposits beneath tidal marshes on Vancouver Island. British Columbia. Geol. Soc. Am. Bull. 106 (10), 1293–1303.
Clague, J., Mathewes, R., Ager, T., 2004. Environments of the northwestern North America before the Last Glacial Maximum. In: Madsen, D. (Ed.), Entering America: Northeast Asia and Beringia Before the Last Glacial Maximum. The University of Utah Press, Salt Lake City, pp. 63–96.
Clague, J.J., Munro, A., Murty, T., 2003. Tsunami hazard and risk in South. Nat. Hazards. 28 (June), 433–461.
Cohen, J.M., 2014. Paleoethnobotany of Kilgii Gwaay: a 10,700 year old Ancestral Haida Archaeological Wet Site. Master's Thesis, Department of Anthropology, University of Victoria. Victoria, British Columbia.
Darvill, C.M., Menounos, B., Goehring, B.M., Lian, O.B., Caffee, M.W., 2018. Retreat of the Western Cordilleran Ice Sheet Margin During the Last Deglaciation. Geophys. Res. Lett. 45 (18), 9710–9720.
Davis, L.G., Madsen, D.B., Becerra-valdivia, L., Higham, T., Sisson, D.A., Skinner, S.M., et al., 2019. Late Upper Paleolithic occupation at Cooper's Ferry, Idaho, USA, ~16,000 years ago. Science 80, 891–897.
Davis, L.G., Madsen, D.B., Sisson, D.A., Valdivia-Becerra, L., Higham, T., Stueber, D., et al., 2022. Dating of a large tool assemblage at the Cooper's Ferry site (Idaho, USA) to ~15,785 cal yr B.P. extends the age of stemmed points in the Americas. Sci Adv. 8 (51), eade1248.
Deur, D., 2002. Plant cultivation on the Northwest Coast: a reconsideration. J. Cult. Geogr. 19 (2), 9–35.
Dillehay, T.D., Ocampo, C., Saavedra, J., Sawakuchi, A.O., Vega, R.M., Pino, M., et al., 2015. New Archaeological Evidence for an Early Human Presence at Monte Verde, Chile. PLoS One [Internet]. 10(11):1–27. Available from: https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0141923&type=printable.
Duffield, S., Walkus, J., White, E., McKechnie, I., Mackie, Q., McLaren, D., 2022. Documenting 6,000 Years of Indigenous Fisheries and Settlement as Seen through Vibracore Sampling on the Central Coast of British Columbia. Canada. Am. Antiq. 87 (1), 168–183.
Duffield, S., 2017. Long-Term Use of Fish and Shellfish Resources Revealed through Vibracore Sampling at EjTa-13, Hecate Island, Central Coast, BC. Master's Thesis, Department of Athropology, University of Victoria. Victoria, British Columbia.
Dyck, A., Fedje, D., Gauvreau, A., Stafford, J., Yím̓ázalas (White, E.), Mackie, Q., et al., 2020. Intertidal investigations of early Holocene archaeological deposits from the Ńúláw̓ìt̓v tribal area, British Columbia, Canada. Quat Sci Rev. 244 (2020) 106415.
Eamer, J.L., 2015. Late quaternary vegetation dynamics on calvert island, british columbia. In: McLaren, D. (Ed.), Hakai Ancient Landscapes Archaeology Project, 2014 Field Season (Permit 2011–171). Archaeology Branch, Ministry of Forests, Lands and Natural Resource Operations, Victoria, British Columbia, pp. 139–158.
Erlandson, J.M., Braje, T.J., 2011. From Asia to the Americas by boat? Paleogeography, paleoecology, and stemmed points of the northwest Pacific. Quat Int [Internet]. 239 (1–2), 28–37. Available from: https://doi.org/10.1016/j.quaint.2011.02.030.
Erlandson, J.M., Graham, M.H., Bourque, B.J., Corbett, D., Estes, J.A., Steneck, R.S., 2007. The kelp highway hypothesis: Marine ecology, the coastal migration theory, and the peopling of the Americas. J Isl Coast Archaeol. 2 (2), 161–174.
Fedje, D.W., Josenhans, H., Clague, J.J., Barrie, J.V., Archer, D., Southon, J., 2005. Hecate Strait paleoshorelines. In: Fedje, D., Mathewes, R.W. (Eds.), Haida Gwaii, Human History and Environment from the Time of Loon to the Time of the Iron People. UBC Press, Vancouver, British Columbia, pp. 21–37.
Fedje, D., Wigen, R., Mackie, Q., Lake, C., Sumpter, I., 2001. Preliminary results from investigations at Kilgii Gwaay: an early holocene archaeological site on Ellen Island, Haida Gwaii. British Columbia. Can J Archaeol. 25 (1), 98–120.
Fedje, D., Magne, M.P.R., Christensen, T., 2005. An early maritime site in the South of Haida Gwaii. In: Fedje, D., Mathewes, R.W. (Eds.), Haida Gwaii: Human History and EnvIronment From the Time of the Loon to the Time of the Iron People. UBC Press, Vancouver, British Columbia, pp. 121–139.
Fedje, D., McLaren, D., James, T.S., Mackie, Q., Smith, N.F., Southon, J.R., et al., 2018. A revised sea level history for the northern Strait of Georgia, British Columbia, Canada. Quat. Sci. Rev. [Internet]. 192, 300–316. Available from: https://doi.org/10.1016/j.quascirev.2018.05.018.
Farrand, L., 1916. Appendix I -Bellabella and Nootka Tales. In: Boas, F. (Ed.), Tsimshian Mythology. Thirty-First Annual Report of the. Bureau of American Ethnology. Washington: Smithsonian Institution, pp. 883–935.
Fedje, D., Mackie, Q., McLaren, D., Wigen, B., Southon, J., 2021. Karst caves in Haida Gwaii: Archaeology and paleontology at the Pleistocene-Holocene transition. Quat. Sci. Rev. [Internet]. 272, 107221. Available from: https://doi.org/10.1016/j.quascirev.2021.107221.
Fedje, D.W., Magne, M.P.R., Christensen, T., 2005. Test Excavations at Raised Beach Sites in Southern Haida Gwaii and their Significance to Northwest Coast Archaeology. In: Fedje, D., Mathewes, R. (Eds.), Haida Gwaii: Human History and EnvIronment From the Time of the Loon to the Time of the Iron People. UBC Press, Vancouver, British Columbia, pp. 204–211.
Fine, I.V., Cherniawsky, J.Y., Thomson, R.E., Rabinovich, A.B., Krassovski, M.V., 2015. Observations and Numerical Modeling of the 2012 Haida Gwaii Tsunami off the Coast of British Columbia. Pure Appl. Geophys. 172 (3–4), 699–718.
Fladmark, K., 1983. Times and places: environmental correlates of mid-to-late wisconsinian human population expansion in north america. In: Shulter, S. (Ed.), Early Man in the New World. Sage Publications, Beverly Hills, CA, pp. 13–41.
Fulton, R.J., 1995. Surficial Materials of Canada, Map 1880A, scale 1:5 000 000 [Internet]. Geological Survey of Canada. [cited 2019 Apr 8]. Available from: http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/205/205040/gscmap-a_1880a_b_1995_mn01.pdf.
Gamble, L.H., 2017. Feasting, ritual practices, social memory, and persistent places: new interpretations of shell mounds in southern california. Am. Antiq. 82 (3), 427–451.
Gauvreau, A., Dyck, A., 2018. EkTb-9 Results. In: McLaren, D. (Ed.), Final Report for the Hakai Ancient Landscapes Archaeology Project With the 2016–2017 Field Seasons Permit 2011–171. Provincial Archaeological Report Library, Victoria, British Columbia, pp. 91–119.
Gauvreau, A., McLaren, D., 2016. Stratigraphy and storytelling. Hunt Gatherer Res. 2 (3), 303–325.
Godbout, J., Fazekas, A., Newton, C.H., Yeh, F.C., Bousquet, J., 2008. Glacial vicariance in the Pacific Northwest: evidence from a lodgepole pine mitochondrial DNA minisatellite for multiple genetically distinct and widely separated refugia. Mol. Ecol. 17 (10), 2463–2475.
Goff, J., Bobrowsky, P., Huntley, D., Sawai, Y., Tanagawa, K., 2020. Palaeotsunamis along Canada's Pacific coast. Quat Sci. Rev. 237.
Gosling, E.M., 1992. Systematics and geographic distribution of mytilus. In: Gosling, E. M. (Ed.), The Mussel Mytilus: Ecology, Physiology, Genetics and Culture. Elsevier, Amsterdam, pp. 1–20.
Grier, C., Angelbeck, B., Mclay, E., 2017. Terraforming and monumentality as long-term social practice in the Salish Sea region of the Northwest Coast of North America. Hunt Gatherer Res. 3 (1), 107–132.
Grier, C., Schwadron, M., 2017. Terraforming and monumentality in hunter-gatherer-fisher societies. Hunt Gatherer Res. 3 (1), 3–8.
Gustas, R., Supernant, K., 2019. Coastal migration into the Americas and least cost path analysis. J. Anthropol. Archaeol. [Internet]. 54 (April), 192–206. Available from: https://doi.org/10.1016/j.jaa.2019.04.006.
Halligan, J.J., Waters, M.R., Perrotti, A., Owens, I.J., Feinberg, J.M., Bourne, M.D., et al., 2016. Pre-Clovis occupation 14,550 years ago at the Page-Ladson site, Florida, and the peopling of the Americas. Sci. Adv. 2 (5), 1–9.
Hawes, K.L., Cohen, J.M., 2014. Wood and Macrofossil Identifications from EkTb-9. In: McLaren, D. (Ed.), Report for the Hakai Ancient Landscapes Archaeology Project: 2011 and 2012 Field Seasons Permit 2011–171. Provincial Archaeological Report Library, Victoria, British Columbia.
Heaton, T.J., Köhler, P., Butzin, M., Bard, E., Reimer, R.W., Austin, W.E.N., et al., 2020. Marine20 - the Marine Radiocarbon Age Calibration Curve (0–55,000 cal BP). Radiocarbon 62 (4), 779–820.
Hebda, R.J., 1995. British Columbia vegetation and climate history with focus on 6 ka BP. Géographie Phys. Quat. 49 (1), 55–79.
Hebda, C.F.G., 2019. Late Pleistocene palaeoenvironments, archaeology, and indicators of a glacial refugium on northern Vancouver Island. Master's Thesis, Department of Anthropology. University of Victoria. Victoria, BC.
Hebda, C.F.G., 2020. Preliminary Pollen Analysis : EkTb-9 Layer X and XIb, Triquet Island. BC. Victoria, British Columbia.
Hebda, C.F.G., McLaren, D., Mackie, M., Fedje, D., Winther Pedersen, M., Willerslev, E., Brown, K.J., Hebdam, R.J., 2022. Late Pleistocene palaeoenvironments and a possible glacial refugium on northern Vancouver Island, Canada: Evidene for the viability of early human settlement on the northweset coast of North America.

Quaternary Science Reviews 278 (107388), 1–21. Available from: https://doi.org/10.1016/j.quascirev.2022.107388.

Hebda, R.J., Allen, G.B., 1993. Modern pollen spectra from west central British Columbia. Can J. Bot. 71 (11), 1486–1495.

Hebda, R.J., Ogilvie, R.T., Roemer, H., Banner, A., 1997. Vegetation of Brooks Peninsula. In: Hebda RJ, Haggarty JC, editors. Brooks Peninsula An Ice Age Refugium on Vancouver Island [Internet]. Victoria, British Columbia: BC Parks, Ministry of Environment, Lands and Parks and Royal British Columbia Museum. p. 8.1-8.66. Available from: https://www.for.gov.bc.ca/hfd/library/documents/Bib42003.pdf.

Heusser, C.J., 1960. Late-Pleistocene environments of North Pacific North America : an elaboration of late-glacial and postglacial climatic, physiographic, and biotic changes. American Geographical Society, New York.

Hobler, P.M., 1988. Archaeological Survey in the Hakai Recreation Area. Victoria, British Columbia.

Hoffmann, T., Lyons, N., Miller, D., Diaz, A., Homan, A., Huddlestan, S., et al., 2016. Engineered feature used to enhance gardening at a 3800-year-old site on the pacific Northwest coast. Sci Adv. 2 (12), 1–8.

Heiltsuk Tribal Council (HTC), 2018. Dáduqvlá qṇtxv Gvi̓lásax̌ To look at Our traditional laws. Decision of the Heiltsuk (Haíłzaqv) Dáduqvlá Committee Regarding the October 13, 2016 Nathan E. Stewart Spill. [Internet]. Bella Bella, British Columbia. Available from: http://www.heiltsuknation.ca/wp-content/uploads/2018/10/Heiltsuk_Adjudication_Report.pdf.

Holmes, K., Lepofsky, D., Smith, N.F., Crowell, T.D., Salomon, A.K., 2022. Ancestral sea gardens supported human settlements for at least 3 , 800 years on the Northwest Coast of North America. Front. Earth Sci. 10, 1–16.

Hugron, S., Bussieres, J., Rochefort, L., 2013. Tree Plantations within the context of ecological restoration of peatlands: practical guide. Peatland Ecology Research Group (PERG), Laval, Quebec.

Hutchinson, I., Butler, V.L., Campbell, S.K., Sterling, S.L., Etnier, M.A., Bovy, K.M., 2019. Impacts of resource fluctuations and recurrent tsunamis on the occupational history of ̓Cix w icen, a Salishan village on the southern shore of the Strait of Juan de Fuca, Washington State, U.S.A. J. Archaeol. Sci. Reports [Internet]. 23, 1131–1142. Available from: https://doi.org/10.1016/j.jasrep.2018.04.001.

Hutchinson, I., Clague, J., 2017. Were they all giants? Perspectives on late Holocene plate-boundary earthquakes at the northern end of the Cascadia subduction zone. Quat Sci Rev [Internet]. 169, 29–49. Available from: http://dx.doi.org/10.1016/j.quascirev.2017.05.015.

Jackley, J., 2014. Report on Survey and Limited Testing of North Hunter Island Central Coast, British Columbia Heritage Conservation Act Investigation Permit 2013-0171. Report on file with the BC Archaeology Branch. Minitry of Forests.

Jackley, J., Gardner, L., Djunaedi, A.F., Salomon, A.K., 2016. Ancient clam gardens, traditional management portfolios, and the resilience of coupled human-ocean systems. Ecol. Soc. 21 (4).

Jones, T., Richman, J.R., 1995. On mussels: mytilus californianus as a prehistoric resource. North Am. Archaeol. 16, 33–58.

Kaplan, J., 1990. The umhlatuzana rock shelter sequence: 100 000 years of Stone Age history. South African Humanit. 2021 (2), 1–94.

Keddy, P.A., 2010. Wetland ecology: principles and conservation. Second Edition. Cambridge University Press.

Kroeber, A.L., 1939. Cultural and natural areas of native north america. Univ. Calif. Publ. Am. Archaeol. Ethnol. 38, 1–250.

Lacourse, T., Mathewes, R., Fedje, D., 2003. Paleoecology of late-glacial terrestrial deposits with in situ conifers from the submerged continental shelf of western Canada. Quat. Res. 60 (2).

Lacourse, T., Delepine, J.M., Hoffman, E.H., Mathewes, R.W., 2012. A 14,000year vegetation history of a hypermaritime island on the outer Pacific coast of Canada based on fossil pollen, spores and conifer stomata. Quat. Res. (United States). 78 (3), 572–582.

Lacourse, T., Mathewes, R.W., 2005. Terrestrial paleoecology of Haida Gwaii and continental shelf: vegetation, climate, and plant resources of the coastal migration route. In: Fedje, D.W., Mathewes, R.W. (Eds.), Haida Gwaii: Human History and EnvIronment From the Time of Loon to the Time of the Iron People. University of British Columbia Press, Vancouver, British Columbia, pp. 38–58.

Lacourse, T., Mathewes, R.W., Fedje, D.W., 2005. Late-glacial vegetation dynamics of the Queen Charlotte Islands and adjacent continental shelf, British Columbia. Canada. Palaeogeogr. Palaeoclimatol. Palaeoecol. 226 (1–2), 36–57.

Lausanne, A.L., Fedje, D.W., Mackie, Q., Walker, I.J., 2019. Using aerial LIDAR imaging and GIS on Quadra Island, Canada. J. Isl Coast Archaeol. [Internet]. 1–27. Available from: https://doi.org/10.1080/15564894.2019.1659884.

Leonard, L.J., Bednarski, J.M., 2014. Field Survey Following the 28 October 2012 Haida Gwaii Tsunami. Pure Appl. Geophys. 171 (12), 3467–3482.

Lepofsky, D., Armstrong, C.G., Greening, S., Jackley, J., Carpenter, J., Guernsey, B., et al., 2017. Historical ecology of cultural keystone places of the northwest coast. Am. Anthropol. 119 (3), 448–463.

Lepofsky, D., Smith, N.F., Cardinal, N., Harper, J., Morris, M., White, E., et al., 2015. Ancient Shellfish Mariculture on the Northwest Coast of North America. Am Antiq 80 (2), 236–259.

Lesnek, A.J., Briner, J.P., Baichtal, J.F., Lyles, A.S., 2020. New constraints on the last deglaciation of the Cordilleran Ice Sheet in coastal Southeast Alaska. Quat Resesarch. 96, 140–160.

Letham, B., Martindale, A., Ames, K.M., 2020. Endowment, investment, and the transforming coast: Long-term human-environment interactions and territorial proprietorship in the Prince Rupert Harbour, Canada. J Anthropol Archaeol [Internet]. 59(2020):101179. Available from: https://doi.org/10.1016/j.jaa.2020.101179.

Lindberg, M., Lindstrom, S., 2010. Ulva Intestinalis. [Internet]. Seaweeds of Alaska. Available from: http://www.seaweedsofalaska.com/species.asp?SeaweedID=12.

Lucas, J., 2013. Palynology Report from EkTb-9. In: McLaren, D. (Ed.), Report for the Hakai Ancient Landscapes Archaeology Project: 2011 and 2012 Field Seasons Permit 2011 171. Provincial Archaeological Report Library, Victoria, British Columbia, pp. 274–302.

Luebbers, R., 1978. Excavations: Stratigraphy and Artifacts. In: Hester, J., Nelson, S. (Eds.), Studies in Bella Bella Prehistory, 5th ed. Archaeology Press, Burnaby, British Columbia, pp. 11–66.

Maas, A., 1990. The adoption and use of 19th Century Ceramics at Old Bella Bella. Simon Fraser University, British Columbia.

Mackie, Q., 2003. Location-allocation modeling of shell midden distribution on the west coast of Vancouver Island. Emerg. from Mist. Stud. Northwest Coast Cult. Hist. 932, 260–288.

Mackie, Q., Fedje, D.W., McLaren, D., Smith, N., McKechnie, I., 2011. Early Environments and Archaeology of Coastal British Columbia. In: Bicho, N., Haws, J., Davis, L. (Eds.), Trekking the Shore: Changing Coastlines and the Antiquity of Coastal Settlement. Springer, US, New York, pp. 51–103.

Mackie, Q., Fedje, D., McLaren, D., 2018. Archaeology and sea level change on the british columbia coast. Can J Archaeol. 42, 74–91.

Madsen, D.B., Davis, L.G., Rhode, D., Oviatt, C.G., 2022. Comment on "evidence of humans in north america during the last glacial maximum". Science 375 (6577), 1–2.

Magne, M., 2004. Technological Correlates of Gwaii Haanaas Microblades. Lithic Technol. Lithic Technol. 29 (2), 91–118.

Martindale, A., Letham, B., McLaren, D., Archer, D., Burchell, M., Schöne, B.R., 2009. Mapping of subsurface shell midden components through percussion coring: examples from the Dundas Islands. J. Archaeol. Sci. 36 (7), 1565–1575.

Mathewes, R.W., 1993. Evidence for younger dryas-age cooling on the north pacific coast of america. Quat. Sci. Rev. 12 (5), 321–331.

Mathewes, R., Clague, J., 2017. Paleoecology and ice limits of the early Fraser glaciation (Marine Isotope Stage 2) on Haida Gwaii, British Columbia. Canada. Quat Res. 88 (2), 277–292.

Mathewes, R.W., Lacourse, T., Helmer, E.F., Howarth, C.R., Fedje, D.F., 2020. Late Pleistocene vegetation and sedimentary charcoal at Kilgii Gwaay archaeological site in coastal British Columbia, Canada, with possible proxy evidence for human presence by 13,000 ca BP. Veg Hist Archaeobot [Internet]. 29:297–307. Available from: https://doi.org/10.1007/s00334-019-00743-4.

Matson, R.G., Coupland, G., Mackie, Q. (Eds.), 2003. Emerging From the Mist: Studies in Northwest Coast Culture History. UBC Press, Vancouver, British Columbia.

McKeague, J.A., Sprout, P.N., 1975. Cemented subsoils (duric horizons) in some soils of British Columbia. Can J Soil Sci. 55, 189–203.

McLaren, D., 2008. Sea level change and archaeological site locations on dundas island archipelago of north coastal british columbia. University of Victoria.

McLaren, D., 2013. Report for the Hakai Ancient Landscapes Archaeology Project 2011 and 2012 Field Seasons (Permit 2011–171). Victoria, British Columbia.

McLaren, D., 2014. Report for the hakai ancient landscapes archaeology project 2013 field season (Permit 2011–171). Victoria, British Columbia.

McLaren, D., 2016. Report for the Hakai Ancient Landscapes Archaeology Project 2015 Field Season (Permit 2011-171). Victoria, British Columbia.

McLaren, D., 2018. Final Report for the Hakai Ancient Landscapes Archaeology Project including results for the 2016–2017 Field Seasons and a Project Summary (Permit 2011–171). Victoria, British Columbia.

McLaren, D., Fedje, D., Hay, M.B., Mackie, Q., Walker, I.J., Shugar, D.H., et al. 2014. A post-glacial sea level hinge on the central Pacific coast of Canada. Quat Sci Rev [Internet]. 97:148–69. Available from: http://dx.doi.org/10.1016/j.quascirev.2014.05.023.

McLaren, D., Rahemtulla, F., White, E., Fedje, D., 2015. Prerogatives, sea level, and the strength of persistent places: archaeological evidence for long-term occupation of the central coast of british columbia. BC Stud. Br. Columbian Q. 187, 1–18.

McLaren, D., Fedje, D., Dyck, A., Mackie, Q., Gauvreau, A., Cohen, J., 2018. Terminal Pleistocene epoch human footprints from the Pacific coast of Canada. PLoS One 13 (3).

McLaren, D., Hawes, K.L., Graham, T., Gauvreau, A., Cohen, J.M., Croes, D.R., 2019. Early and Middle Holocene Waterlogged Materials from Archaeological Sites on Central Coast of British Columbia. In: Bernick, K. (Ed.), Waterlogged: Examples and Procedures for Northwest Coast Archaeologists. Washington State University Press, Pullman, Washington, pp. 169–192.

McLaren, D., Fedje, D., Mackie, Q., Davis, L.G., Erlandson, J., Gauvreau, A., et al., 2019. Late pleistocene archaeological discovery models on the pacific coast of north america. PaleoAmerica [Internet]. 6 (1), 43–63. Available from: https://doi.org/10.1080/20555563.2019.1670512.

McMillan, A.D., Hutchinson, I., 2002. When the mountain dwarfs danced: Aboriginal traditions of paleoseismic events along the Cascadia subduction zone of Western North America. Ethnohistory 49 (1), 41–68.

McMillan, A., 2011. The Emergence of the West Coast Culture Type. In: Since the time of the Transformers: The Ancient Heritage of the Nuu-chah-nulth, Dididaht and Makah 104–125.

Mentzer, S.M., 2014. Microarchaeological approaches to the identification and interpretation of combustion features in prehistoric archaeological sites. J. Archaeol. Method Theory. 21 (3), 616–668.

Minor, R., Peterson, C.D., 2017. Multiple Reoccupations after Four Paleotsunami Inundations (0.3–1.3 ka) at a Prehistoric Site in the Netarts Littoral Cell 32, 248–266.

Misarti, N., Finney, B.P., Jordan, J.W., Maschner, H.D.G., Addison, J.A., Shapley, M.D., Krumhardt, A., Beget, J.E., 2012. Early retreat of the Alaska Peninsula Glacier Complex and the implications for coastal migrations of First Americans. Quat Sci Rev

[Internet] 48:1–6. Available from: http://dx.doi.org/10.1016/j.quascirev.2012.05.014.
Moss, M.L., 2012. Fishing traps and weirs on the northwest coast of north america: new approaches and new insights. Oxford Handb Wetl Archaeol. 2012, 323–337.
Naeth, A., Archibald, H.A., Nemirsky, C.L., Leskiw, L.A., Brierley, A.J., Bock, M.D., et al., 2012. Proposed classification for human modified soils in Canada: Anthroposolic order. Can J Soil Sci. 92, 7–18.
Nortrup, M., Watts, T., 2010. Freshwater Sponges. National Capital Region Network Resource Brief, Integrated Resource Management, U.S. National Parks Service.
Olson, R.L., 1955. Notes on the Bella Bella Kwakiutl. Univ Calif Anthropol Rec. 14 (5), 319–348.
Oviatt, C.G., Madsen, D.B., Rhode, D., Davis, L.G., 2022. A critical assessment of claims that human footprints in the Lake Otero basin, New Mexico date to the Last Glacial Maximum. Quat Res [Internet]. 1–10. Available from: https://www.cambridge.org/core/product/identifier/S0033589422000382/type/journal_article.
Pargeter, J., de la Peña, P., 2017. Milky quartz bipolar reduction and lithic miniaturization: experimental results and archaeological implications. J. F Archaeol. [Internet]. 42 (6), 551–565. Available from: https://doi.org/10.1080/00934690.2017.1391649.
Pargeter, J., de la Peña, P., Eren, M.I., 2019. Assessing raw material's role in bipolar and freehand miniaturized flake shape, technological structure, and fragmentation rates. Archaeol. Anthropol. Sci. 11 (11), 5893–5907.
Pargeter, J., Eren, M.I., 2017. Quantifying and comparing bipolar versus freehand flake morphologies, production currencies, and reduction energetics during lithic miniaturization. Lithic Technol. [Internet]. 42 (2–3), 90–108. Available from: https://doi.org/10.1080/01977261.2017.1345442.
Peltier, W.R., Fairbanks, R.G., 2006. Global glacial ice volume and Last Glacial Maximum duration from an extended Barbados sea level record. Quat Sci. Rev. 25 (23–24), 3322–3337.
Pennock, D., Sanborn, P., 2016. Field Handbook for the Soils of Western Canada [Internet]. Edition, 3. Pennock D, Sanborn P, editors. Canadian Society of Soil Science. 1–49 p. Available from: http://sis.agr.gc.ca/cansis/taxa/cssc3/index.html.
Pennock, D., Watson, K., Sanborn, P., 2015. Section 4: Horizon Identification [Internet]. Pennock D, Watson K, Sanborn P, editors. Field Handbook for the Soils of Western Canada. Canadian Society of Soil Science. Available from: http://sis.agr.gc.ca/cansis/taxa/cssc3/index.html.
Peterson, C.D., Clague, J.J., Carver, G.A., Cruikshank, K.M., 2013. Recurrence intervals of major paleotsunamis as calibrated by historic tsunami deposits in three localities: Port Alberni, Cannon Beach, and Crescent City, along the Cascadia margin. Canada and USA. Nat. Hazards. 68 (2), 321–336.
Pirazzoli, P.A., 1996. Sea-level changes : the last 20,000 years. Wiley, Chichester, New York.
Pojar, J., Klinka, K., Demarchi, D., 1991. Chapter 6: Coastal Western Hemlock Zone. Ecosyst Br Columbia. p. 95–111.
Pomeroy, J., 1980. Bella Bella Settlement and Subsistence. PhD Thesis, Department of Archaeology. Simon Fraser University. Burnaby, BC.
Potter, B.A., Baichtal, J.F., Beaudoin, A.B., Fehren-Schmitz, L., Haynes, C.V., Holliday, V.T., et al., 2018. Current evidence allows multiple models for the peopling of the Americas. Sci Adv. 4 (8), 1–9.
Puseman, K., Briles, C., 2019. Pollen and Macrofloral Analysis of Samples from Site EkTb-9. In: Technical report 19006. Bailey, Colorado.
Rahemtulla, F., 2006. Design of Stone Tool Technology during the Early Period (ca. 10,000–5,000 B.P.) at Namu, Central Coast of British Columbia. PhD Thesis, Department of Archaeology, Simon Fraser University. Burnaby, British Columbia.
Randall, A., Sassaman, K., 2018. Terraforming the middle ground in ancient Florida. Hunt Gatherer Res. 3 (1), 9–29.
Reimer, P.J., Austin, W.E.N., Bard, E., Bayliss, A., Blackwell, P.G., Bronk Ramsey, C., et al., 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). Radiocarbon 62 (4), 725–757.
Reimer, R., 2018. Simon Fraser University Department of Archaeology X-Ray Fluorescence Report 2018-11. 2018.
Rühland, K., Smol, J.P., Jasinski, J.P.P., Warner, B.G., 2000. Response of diatoms and other siliceous indicators to the developmental history of a peatland in the tiksi forest, siberia, russia. Arctic, Antarct Alp Res. 32 (2), 167–178.
Ryves, D.B., Battarbee, R.W., Fritz, S.C., 2009. The dilemma of disappearing diatoms: Incorporating diatom dissolution data into palaeoenvironmental modelling and reconstruction. Quat Sci Rev [Internet]. 28(1–2):120–36. Available from: https://doi.org/10.1016/j.quascirev.2008.08.021.
Salomon, A.K., Lertzman, K., Brown, K., Wilson, K.B., Secord, D., McKechnie, I., 2018. Democratizing conservation science and practice. Ecol Soc [Internet]. 23 1 s44. Available from: https://doi.org/10.5751/ES-09980-230144.
Sanborn, P., Lamontagne, L., Hendershot, W., 2011. Podzolic soils of Canada: Genesis, distribution, and classification. Can. J Soil Sci. 91, 843–880.
Schmuck, N., Reuther, J., Baichtal, J.F., Carlson, R.J., 2021. Quantifying marine reservoir effect variability along the Northwest Coast of North America. Quat. Res. 1–22.
Shaw, J., Barrie, J.V., Conway, K.W., Lintern, D.G., Kung, R., 2020. Glaciation of the northern British Columbia continental shelf: the geomorphic evidence derived from multibeam bathymetric data. Boreas 49 (1), 17–37.
Shinkai, R., Kanno, T., Yamamoto, N., Habu, J., Matsui, A., McLaren, D., et al., 2015. Excavation of a prehistoric wet site on Triquet Island in British Columbia. Canada. Soc. Archaeol. Stud. Japan Report, News Appeals. 62 (3).
Shugar, D.H., Walker, I.J., Lian, O.B., Eamer, J.B.R., Neudorf, C., McLaren, D., et al., 2014. Post-glacial sea-level change along the Pacific coast of North America. Quat Sci Rev [Internet]. 97, 170–192. Available from: https://doi.org/10.1016/j.quascirev.2014.05.022.
Simandl, G.J. Paradis, S., Neetz, M., Akam, C., 2016. Graphite deposits: Origin and economic significance. Poster. Available from: http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/GeoFiles/Documents/GF2016-06.pdf.
Smith, N.F., 2004. A Geochemical Approach to Understanding Raw Material Use and Stone Tool Production at the Richardson Island Archaeological Site, Haida Gwaii. Master's Thesis, Department of Anthropology,University of Victoria. Victoria, British Columbia.
Soil Classification Working Group, 1998. The Canadian System of Soil Classification. Research Branch, Agriculture and Agrifood Canada. Publication #1646, 3rd Edition. NRC Press, Ottawa, Ontario.
Stafford, J., Maxwell, J., Christensen, T., 2009. Hakai Luxvbalis and outer central coast islands conservancies, archaeological impact assessment of 11 selected recretion sites, HCA Permit 2008–372. Victoria, British Columbia.
Steffen, M.L., 2006. Early Holocene hearth features and burnt faunal assemblages at the Richardson Island Archaeological Site, Haida Gwaii. University of Victoria, British Columbia.
Stein, J.K., 1992. Interpreting Stratification of a Shell Midden. In: Stein, J.K. (Ed.), Deciphering a Shell Midden. Academic Press, San Diego, California, pp. 71–93.
Stein, J.K., 2008. Geoarchaeology and Archaeostratigraphy: View from a Northwest Coast Shell Midden. In 61–80.
Storey, J., 2008. An Analysis of the Unifacial Tool Assemblage from the Richardson Island Site, Haida Gwaii, British Columbia. Radiocarbon.
Stuiver, M., Reimer, P.J., Reimer, R., 2021. CALIB 8.2 [WWW program] at http://calib.org [Internet]. Available from: http://calib.org/calib/.
Tanzi, M.C., Farè, S., Candiani, G., 2019. Biomaterials and Applications. In: Tanzi, M.C., Farè, S., Candiani, G., editors. Foundations of Biomaterials Engineering [Internet]. First Edition. Academic Press; p. 199–287. Available from: https://doi.org/10.1016/B978-0-08-101034-1.00004-9.
Taylor, J.D., Kennedy, W.J., 1969. The influence of the periostracum on the shell structure of bivalve molluscs. Calcif. Tissue Res. 3, 274–283.
Thrush, C., Ludwin, R.S., 2007. Finding fault: Indigenous seismology, colonial science, and the rediscovery of earthquakes and tsunamis in cascadia. Am. Indian Cult. Res. J. 31 (4), 1–24.
Trant, A.J., Nijland, W., Hoffman, K.M., Mathews, D.L., McLaren, D., Nelson, T.A., et al., 2016. Intertidal resource use over millennia enhances forest productivity. Nat. Commun. 7, 1–8.
Turner, N.J., Deur, D., 2005. Keeping It Living: traditions of plant use and cultivation on the northwest coast of north america. University of Washington Press, Seattle, Washington, p. 384.
Turner, N.J., Deur, D., Lepofsky, D., 2013. Plant management systems of british columbia's first peoples. Plant Manag. Syst. Br. Columbia's First Peoples. 179, 107–133.
Valentin, C., 2019. In: Soils as a Key Component of the Critical Zone 5: Degradation and Rehabilitation. Wiley ISTE, France, p. 264..
Vogelaar, C., 2017. Using GIS modelling as a tool to search for late Pleistocene and early Holocene archaeology on Quadra Island, British Columbia. Master's Thesis, Department of Anthroplogy, University of Victoria. Victoria, British Columbia.
Waber, N., 2011. The Development of the Microblade Industry at the Richardson Island Site, Haida Gwaii. Master's Thesis, Department of Anthropology, University of Victoria. Victoria, British Columbia.
Warner, B.G., 1984. Late Quaternary Paleoecology of Eastern Graham Island, Queen Charlotte Islands, British Columbia. Simon Fraser University, Canada.
Waters, M.R., Keene, J.L., Forman, S.L., Prewitt, E.R., Carlson, D.L., Wiederhold, J.E., 2018. Pre-Clovis projectile points at the Debra L. Friedkin site, Texas — Implications for the Late Pleistocene peopling of the Americas. Sci Adv. 4 (4505), 1–13.
White, E., 2006. Heiltsuk Stone Fish Traps: Products of my ancestors' labour. Master's Thesis, Department of Archaeology, Simon Fraser University. Burnaby, British Columbia.
Walker, B., McLaren, D., 2013. Analysis of Environmentalist's Sub-Soil Probe Samples. McLaren. D, editor. Report for the Hakai Ancient Landscapes Archaeology Project: 2011 and 2012 Field Seasons (Permit 2011-171). Report on file with the BC Archaeology Branch, Ministry of Forests.
Waters, M.R., Newell, Z.A., Fisher, D.C., McDonald, H.G., Han, J., Moreno, M., Robbins, A., 2023. Late Pleistocene osseous projectile point from the Manis site, Washington - Mastodon hunting in the Pacific Northwest 13,900 years ago. Sci. Adv. 9 (5), 1–8.
Wigen, R.J., 2002. Fauna from Kilgii Gwaay, 1325T. Victoria, British Columbia.
Wigen, R.J., 2005. History of the Vertebrate Fauna in Haida Gwaii. In: Fedje, D.W., Mathewes, R.W. (Eds.), Haida Gwaii: Human History and EnvIronment From the Time of the Loon to the Time of the Iron People. UBC Press, Vancouver, British Columbia, pp. 96–116.
Williams, T.J., Collins, M.B., Rodrigues, K., Rink, W.J., Velchoff, N., Keen-zebert, A., et al., 2018. Evidence of an early projectile point technology in North America at the Gault Site, Texas, USA. Sci Adv. 4 (5954), 1–7.