

31 SEA-LEVEL RISE AND SETTLEMENT AT EK WAY NAL: CORING THE PAST

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Excavations in the spring and summer of 2022 were carried out at the underwater ancient Maya salt work of Ek Way Nal in Punta Ycacos Lagoon, Paynes Creek National Park, Belize. Ek Way Nal provided salt to the ancient Maya during the Late and Terminal Classic periods (600-900 C.E.). In addition to excavations in buildings at the site, a 1 X 2 m unit was excavated to extract a sediment column for examining the relationship between the ancient Maya settlement at Ek Way Nal and sea-level rise. In this article, the excavations, extraction of the sediment column, and processing it for laboratory analyses are described. Field observations are discussed. Fine red mangrove root (*Rhizophora mangle*) and charcoal samples were extracted from the sediment column for radiocarbon dating. The results from the datum core excavation indicate that sea-level rise occurred before, during, and after the ancient Maya occupation at Ek Way Nal.

Introduction

Excavations in mangrove peat at the site of Ek Way Nal were carried out in order to extract a sediment column to investigate the relationship between the ancient Maya at the site and sea-level rise. The underwater site of Ek Way Nal is one of 110 sites that make up the Paynes Creek Salt Works in Punta Ycacos Lagoon in southern Belize that were used by the ancient Maya during the Late to Terminal Classic period (A.D. 600-900 C.E.; Figure 1; McKillop 2019). The salt works were built on dry land that was mangrove peat. The peat preserved the wooden posts that were driven into the ground during building construction (McKillop et al. 2010).

At some point, the sites were flooded by rising seas. The timing and rate of sea-level rise can be determined by radiocarbon dating red mangrove peat, which is a proxy for sea-level rise. As sea levels rise, red mangroves grow upwards to keep their leaves above water, trapping detritus in the root systems that becomes mangrove peat. In the inshore lagoon system between the coast and the Belize barrier reef there is 12 m of red mangrove peat accumulation during the Holocene (Toscano et al. 2018).

The submerged site of Ek Way Nal has ten pole and thatch buildings, constructed with over 200 hardwood posts (McKillop and Aoyama 2019; McKillop et al. 2019; McKillop and Sills 2021:4). A modified pedestrian survey was used at Ek Way Nal to locate and map the site and the artifacts and posts. The survey team floated on Research Flotation Devices (RFDs) in a line, feeling the sea floor for posts and artifacts.



Figure 1. (Left) Map of Maya area with box highlighting location of Paynes Creek Salt Works (McKillop 2017b:702).

This method of survey reduces the risk that the posts and artifacts on the seafloor are damaged by walking across the site.

The underwater site of Ek Way Nal is bisected by a strip of land (Figure 2). A 1 m x 2 m unit was excavated to a depth of 170 cm on this strip of land (Figure 3).

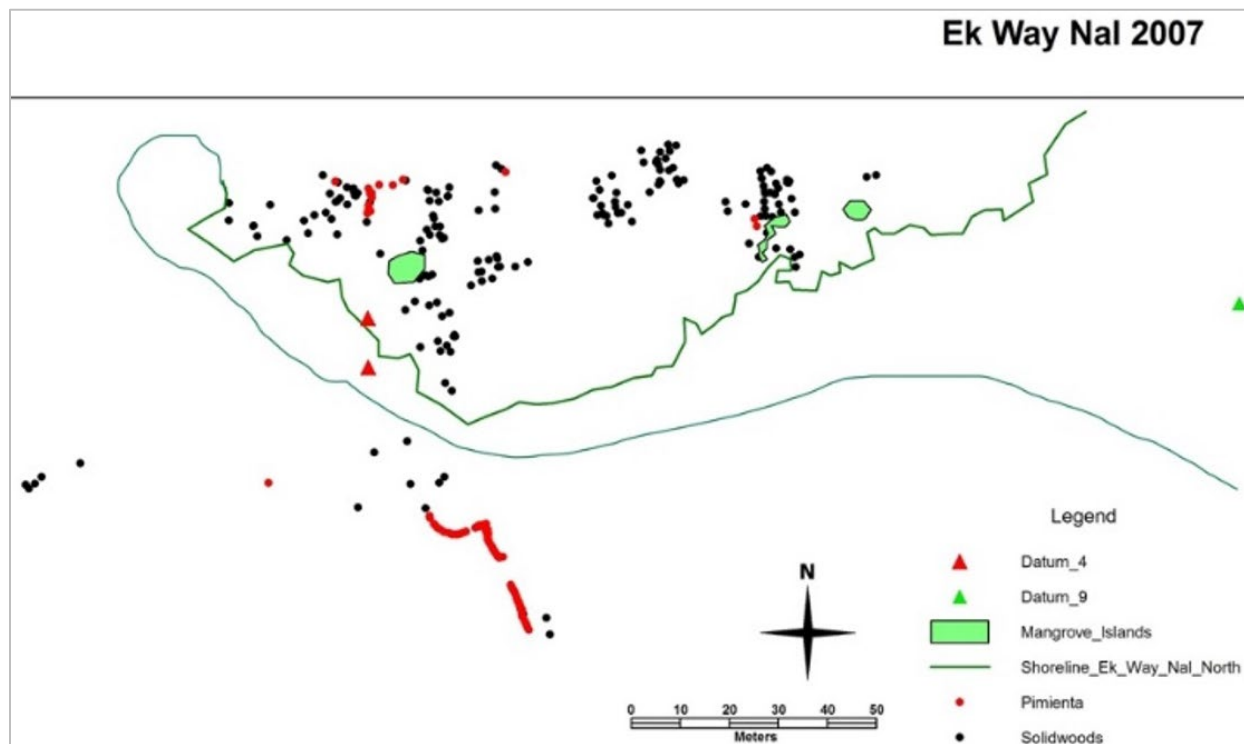


Figure 2. Map of Ek Way Nal with box indicating location of core excavation and arrow indicating location of sediment column within excavation. Map from H. McKillop, modified by C. Foster).

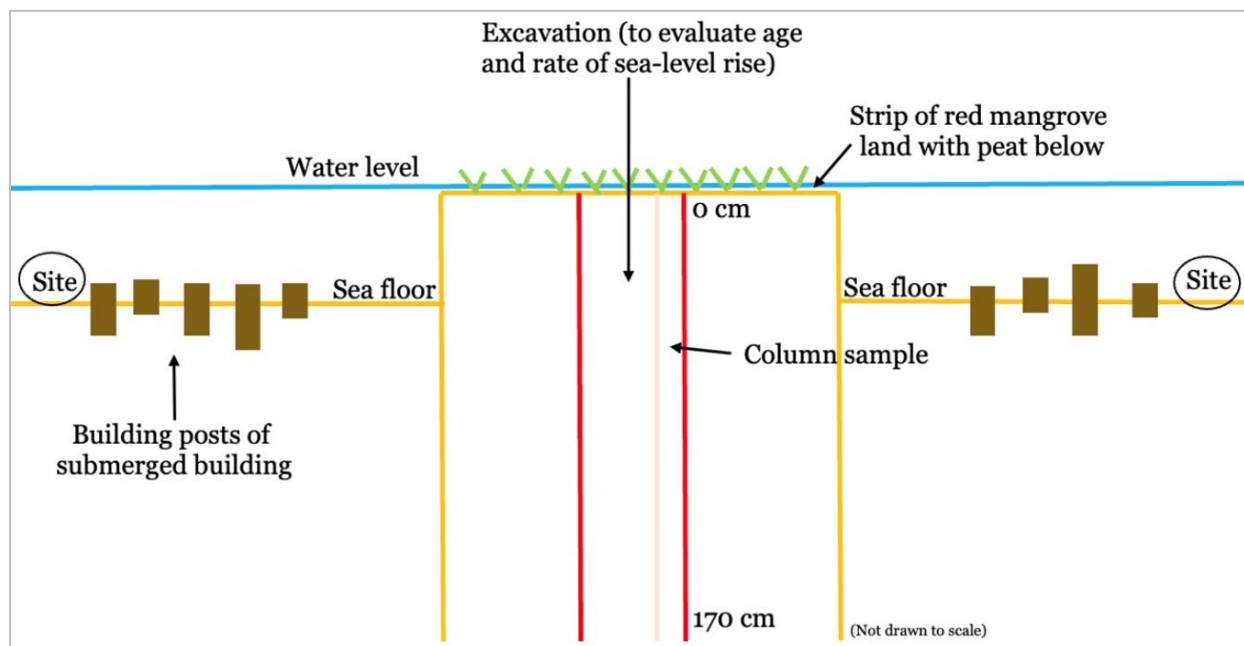


Figure 3. Schematic drawing of core excavation in relation to submerged buildings at Ek Way Nal. Drawing by C. Foster.

The main goal of the excavation was to extract a sediment column from an excavation wall to address sea-level rise, to determine if the

site continued through the land, and to recover any temporal or diagnostic pottery. If the strip of land is a natural formation, formed prior to the

ancient Maya occupation at the site, the sediment column sample and peat excavations would show a continuous record of mangrove deposits from the surface to the base of the excavation. Alternatively, the site may have been continuous, with red mangrove peat deposited over the site as a result of sea-level rise. Cutting a sediment column from an excavation wall in the unit placed on the strip of land was undertaken to select peat samples and any diagnostic artifacts.

History of Mangrove Coring in the Maya Area

Mangrove cores in coastal areas can provide information on sedimentation rates, vegetation variation, sea-level rise, and marine and coastal landscapes (Jaijel et al. 2018; McKee et al. 2007; McKillop et al. 2010a, 2010b; Monacci et al. 2009; Torrescano and Islebe 2006). Toscano and Macintyre (2003) used *Rhizophora mangle* (red mangrove) peat and *Acropora palmata* (Elkhorn coral) to construct a western Atlantic Holocene sea-level curve. The researchers used 145 dates from samples collected in Belize, the Florida Keys, and elsewhere in the Caribbean. The depths of the coral and the peat allowed the researchers to revise an earlier sea-level curve (Lighty et al. 1982). The segment of the curve corresponding to 2,000–400 years ago indicates a rate of sea-level rise half that of the past 100 years. Archaeologists can relate calibrated radiocarbon dates to this corrected western Atlantic Holocene sea-level curve.

A study by Karen McKee and colleagues (2007) examines the rates of elevation change and the accumulation of mangrove root matter from Twin Cays and Cat Cay in Belize to understand mangrove peat formation. Some of the mangrove peat in this study dates to more than 7000 years. The researchers also compared the modern elevation changes to past peat development, using geological rates of peat accumulation calculated by radiocarbon dating of peat cores from Belize, Panama, and Honduras. These elevation changes were compared to the corrected sea-level curve for the western Atlantic area. Results indicate that, in response to sea-level rise, mangroves may move vertically and laterally and act as an integral natural defense for coastal ecosystems against sea-level rise.

A study of the settlement and sea-level rise at Marco Gonzales, Ambergris Cay, Belize used sediment cores and probes to reconstruct the landscape (Mazzullo et al. 1987; Mazzullo and Reid 1988; Graham and Pendergast 1989). The researchers reconstructed past sea levels. Starting at 3,500 B.P., sea levels rose from a depth of 1 m below present, to 30 cm below present at 2,000 B.P., to 15 cm below present at 750 B.P. The depth at 2,000 B.P. correlates to the first occupation at the site. Mangrove accretion at the site is a recent occurrence, meaning that the landscape was an open marine environment from 3,500 B.P. to 750 B.P.

Monacci et al. (2009) studied an 8 m-long mangrove peat core from Spanish Lookout Cay, Belize to investigate mangrove ecosystem changes during the Holocene. The peat from Spanish Lookout Cay is younger than that at Twin Cays and Cat Cay, starting at approximately 8,000 cal. years BP. The mangrove peat at Spanish Lookout Cay decreased at approximately 4,000 B.C. In another study, researchers investigated a 2.5 m long sediment core from El Palmar, Mexico using a Dachnovsky corer (Torrescano and Islebe 2006). Fossil pollen grains extracted from the core showed a distinct change from tropical forest dominated by *Moraceae* and *Fabaceae* to a mangrove system comprised of *Conocarpus erecta* and *R. mangle* around 4,600 YBP. The researchers attribute the change in vegetation to changes in sea level, which rose approximately 2–3 m between 6,000 and 4,000 cal. BP.

Jaijel et al. (2018) analyzed sediment from six cores to reconstruct the environmental changes during the past 3,000 years at the ancient Maya site of Vista Alegre on the north coast of the Yucatán, Mexico. The research suggested that the ancient coastal landscape was more suitable for settlement in the past. The abandonment of the site was identified by a decrease in shell content and overall foraminifera numbers in the sediment cores followed by an increase in organic content due to sea-level rise.

Previous Sea-level Research at the Paynes Creek Salt Works

In 2008, a column of sediment was cut from a vertical face of a hole dug into the sea floor between Sites 14 and 15 (K'ak' Naab' and Sak

Nuk Naj, respectively) in Punta Ycacos Lagoon (McKillop et al. 2010a, 2010b). This K'ak' Naab' sediment core was used as a template for the Ek Way Nal methodology. The 1.5 m long K'ak' Naab' sediment column was cut in 10 cm increments, wrapped in cling wrap, placed in Ziploc bags with arrows indicating orientation, and exported to Louisiana State University. Several analyses were carried out on the mangrove sediment, including loss-on ignition, microscopic sorting and identification of organic material, and AMS radiocarbon dating. For the loss-on ignition, small samples of each of the 15, 10 cm sections were weighed, dried in an oven to burn away the organic matter, then weighed again. The difference in weight is the percentage of organic matter present in the sample. The average organic matter in the column sample was 65%, which is high and consistent with red mangrove from coastal Belize (McKillop et al. 2010a, 2010b).

The microscopic sorting and identification of the sediment column included selecting sediment from 0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm, 70-80 cm, 10-11 cm, and 11-12 cm depth. The samples were rinsed through a 1 mm sieve, and placed in water in a Petrie dish. They were sorted according to root size and other organic matter. Results show that the column sample is comprised largely from *R. mangle* (McKillop et al. 2010a, 2010b). The top, bottom, and several intermediate layers of the column sample were radiocarbon dated. The column sample shows a 4,000-year record of continuous and gradual sea-level rise in the Paynes Creek Salt Works.

In 2012, excavations at Witz Naab' and Killer Bee investigated the origins of earthen mounds found at the sites (Watson and McKillop 2019; Watson et al. 2013). The mounds were similar to those found at other salt making sites in the Maya area, notably the Guzman mounds (Nance 1992) and mounds in the Placencia lagoon area (MacKinnon and Kepecs 1989). The Guzman mound contained leached soils, dense areas of charcoal, and remains of salt-making pottery (Nance 1992). The mounds in the Placencia lagoon area were low-lying, ranging from one to one and a half meters in height. The mounds at Witz Naab' and Killer Bee were both low-lying and covered with modern vegetation.

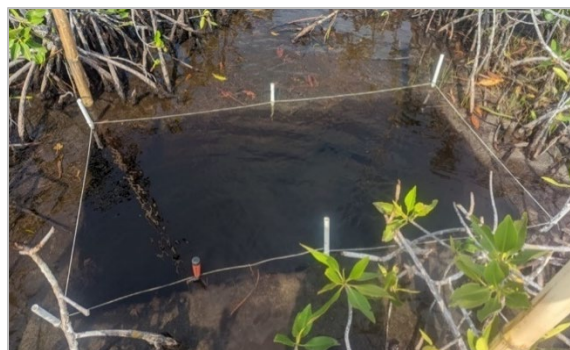


Figure 4. Picture of Ek Way Nal sediment column excavation unit. Trowel marks location of column sample in bottom left corner. Photo by Hollie Lincoln, Louisiana State University.

The mounds at both sites produced briquetage. Results of the excavations indicate that the mounds were created as part of the brine enrichment process.

In 2019, two sediment columns were cut at the Ta'ab Nuk Na underwater site, including one beside post 145 in Building B, a residence (McKillop and Sills 2022). The other column was cut beside a large beam, termed Nunavut, at the western periphery of the site.

The Ek Way Nal Sediment Core

Set-up and Excavation

The Ek Way Nal core excavation was located on the strip of land that bifurcates the site and that is covered in living red mangroves. The excavation measured 1 m x 2 m and was set up 3 m southeast of the Ek Way Nal datum in an area void of vegetation (Figure 4). The core excavation was divided into two units, with unit 1 being the unit closest to the site datum (farther north) and unit 2 being the southern unit. The excavation was dug with shovels for the first 20 cm. The presence of a few small sherds and charcoal below 20 cm depth prompted the switch to trowels and hand-sorting of the sediment. Wooden box screens with ¼" wire mesh were used to screen sediment after endocarps from native palm fruits were found in the 30-40 cm level. The artifacts were bagged by 10 cm excavation level. Unit 1 was excavated to 70 cm depth. Unit 2 was excavated to 170 cm depth. Unit 1 was used to access the deeper unit 2 in the excavation. Shovels were used in unit 2 below 100 cm where little cultural material was found.

The sediment continued to be water-screened, with all the artifacts collected.

The excavation unit was below the water surface. Once the water level was over a meter deep in the excavation, the team wore dive masks and snorkels to excavate. Below 100 cm, the excavators held their breath while digging, which increased the time to excavate each level. Loose silt and sediment accumulated at the bottom of the excavation. Before beginning to excavate each day, this loose accumulation layer was removed.

Mangrove branches and thick roots in the lower depths made excavation difficult. A large mangrove root, at 170 cm depth extended across the unit, precluding deeper excavation.

Excavating the Sediment Column

Once unit 2 reached 170 cm depth, preparations were made to extract a sediment column from the eastern wall, which was the best sediment devoid of large roots. A 2.4 m-long, ½ inch diameter PVC pipe was sunk into the bottom of the excavation at 1.5 m from the northwest corner of the unit along the eastern wall of the excavation. A cut was made in the pipe at the sea floor to mark 0 m. Small cuts were made in the pipe every 10 cm to act as a tactile guide while cutting sediment samples underwater.

A trowel was stuck into the wall at the 10cm notch in the PVC pipe, marking the bottom of the first 10 cm sample of the sediment column. A tape measure was used to measure 10 cm into the wall face from the PVC pipe, marking the back of the first sample. Then, the tape measure was used to measure 10 cm to the left of the pipe, marking the side of the sample. A stainless-steel kitchen knife with an 18" blade was used to slice the 10 cm³ sample from the excavation wall face (Figure 5). The 10 cm³ sample was wrapped in plastic cling wrap with arrows drawn on the wrapping to indicate the top of the sample and the word "FACE" was written on the front of the wrapping to indicate which side was exposed to the open excavation. Additionally, "0 m" was written on the top of the sample face and "10 cm" was written on the bottom of the sample face to indicate the depth of the sample. The labeled and wrapped sediment sample was placed in a plastic box for transport and storage. This process was repeated for each 10 cm depth, for a total of 17 samples.



Figure 5. Photo of a 10cm³ sediment sample being removed from the excavation wall. Photo by H. McKillop.



Figure 6. A section of the mangrove sediment column after being selectively cut. Photo by C. Foster.

In an effort to reduce the size and weight of the column sample as a whole, each 10 cm³ sample was later cut to a standard size. Each sample was unwrapped and photographed. The height of each sample was kept the same to ensure the entire depth was represented in the column sample.



Figure 7. Fine red mangrove roots, charcoal, quartz, and other materials under magnification from the 48-50cm depth of column sample. Photo by C. Foster.

However, the depth and width of the samples were cut for storage and shipment. Each sample was examined for large roots and overall stability, and the best portion was selected (Figure 6). The sample was re-wrapped in new cling wrap with the same information on the outside. The samples were placed in plastic boxes and exported under permit by the Government of Belize to the Louisiana State University Archaeology Lab, where they were placed in refrigerated storage.

Sampling the Sediment Column for Radiocarbon Dating

The sediment column was laid out in stratigraphic order on a counter in the Archaeology Lab at Louisiana State University next to a measuring tape, with 0 cm at the top of the sediment column (indicating the sea floor). A small sample (approximately 1 teaspoon) was taken from the sediment column at the 48-50 cm depth using a stainless-steel paring knife. The sample was rinsed using a No. 25 geologic sieve to remove the sediment. The remaining material was placed into a Petrie dish with water (Figure 7). The material was sorted using a microscope

and needle-nose tweezers. Each material (fine mangrove roots, coarse mangrove roots, pottery, charcoal, quartz) was placed into a separate glass vial with water. The fine mangrove roots were placed in distilled water for the radiocarbon dating process.

The wet fine mangrove roots and charcoal were weighed before being placed in a drying oven at 60°C for 18 hours. The samples were removed, weighed again, and placed in dry, labeled glass vials, ready to be sent for Accelerated Mass Spectrometer (AMS) dating. The fine mangrove roots and charcoal were selected from the 48-50 cm depth to provide absolute dates for both the environmental (roots) and cultural (charcoal) activities.

Results

Mangrove peat extended from the sea floor to 170 cm depth. Cultural material was recovered between 20-80 cm depth, with the highest density at 40-50 cm depth. The presence of the mangrove peat deposits throughout the entire sequence of the column sample (170 cm) signifies that the strip of dry land with living red mangroves is a natural formation, formed prior to the ancient Maya occupation at the site and continuing during and after their occupation and subsequent abandonment. The mangrove sediment column provides a continuous record before, during, and after the site was in use.

The consistency of the mangrove peat differed by depth. The peat in 0-40 cm of the excavation was dense and thick with both fine and coarse mangrove roots and other detritus. The peat could easily be picked up in chunks and handed to a team member for screening. Pockets of sandy sediment were found periodically throughout these levels as well. The mangrove peat decreased in density from 40-100 cm depth. Coarse red mangrove roots were less frequent with increased depth. The 100-170 cm depth consisted of loose, silty sediment with few large mangrove roots or other detritus. The sediment was not solid peat, so it was removed by hand. Areas of light gray clay were found associated with the charcoal deposit around the 40-50 cm depth.

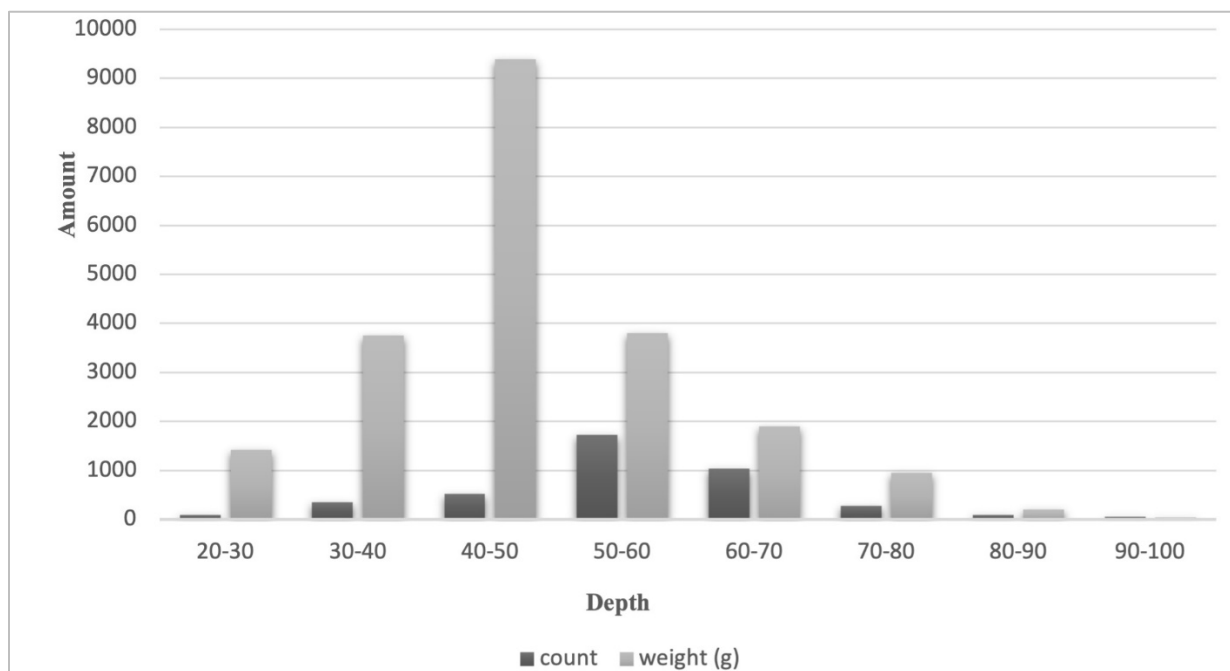


Figure 8. Bar graphs showing Punta Yacocs Ceramic Counts and Weights from Core Excavation.

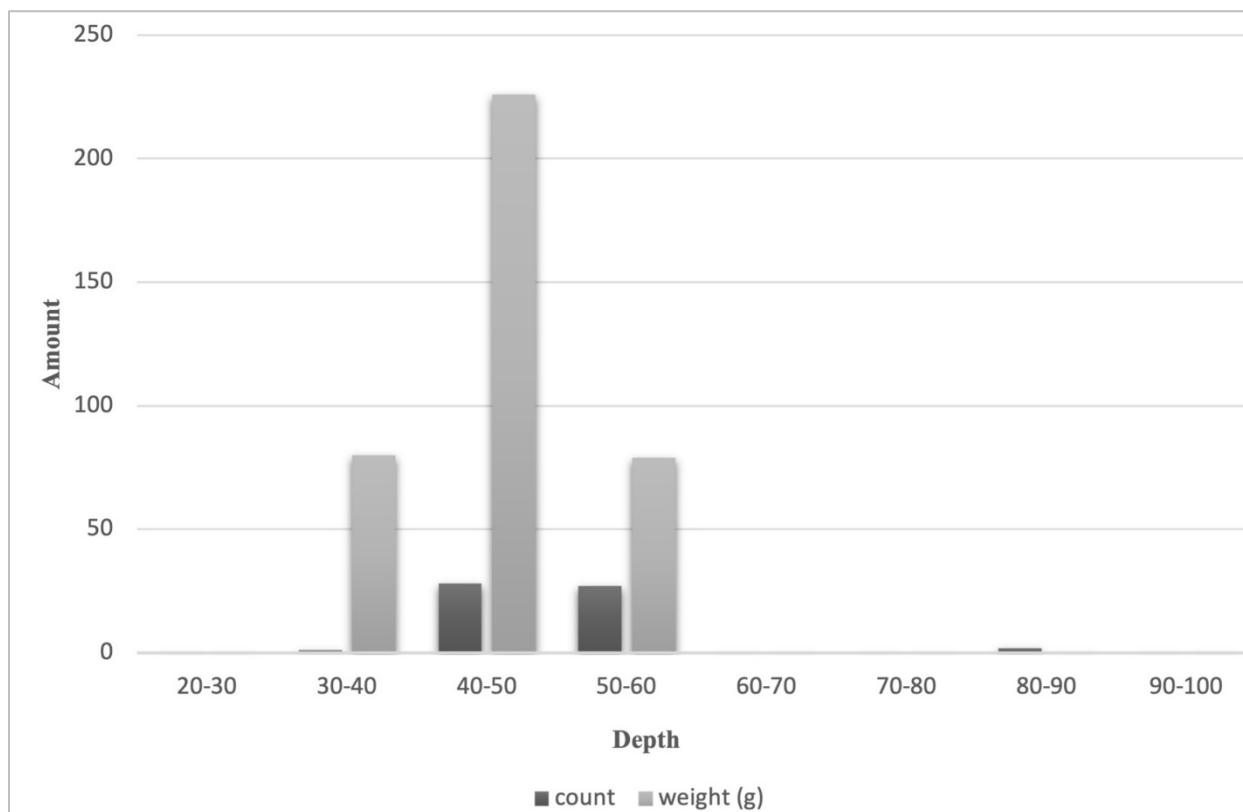


Figure 9. Bar graphs showing Warrie Red Sherd Counts and Weights from Core Excavation.

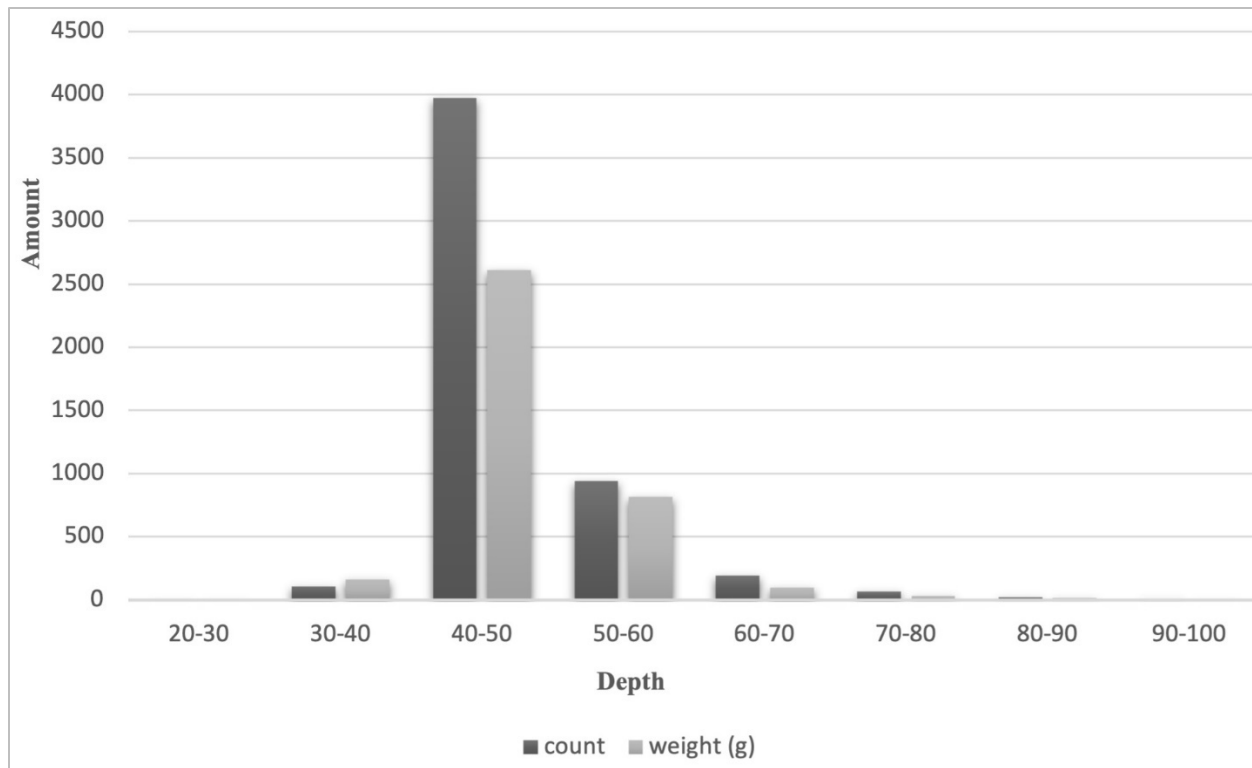


Figure 10. Bar graphs showing charcoal Counts and Weights from Core Excavation.

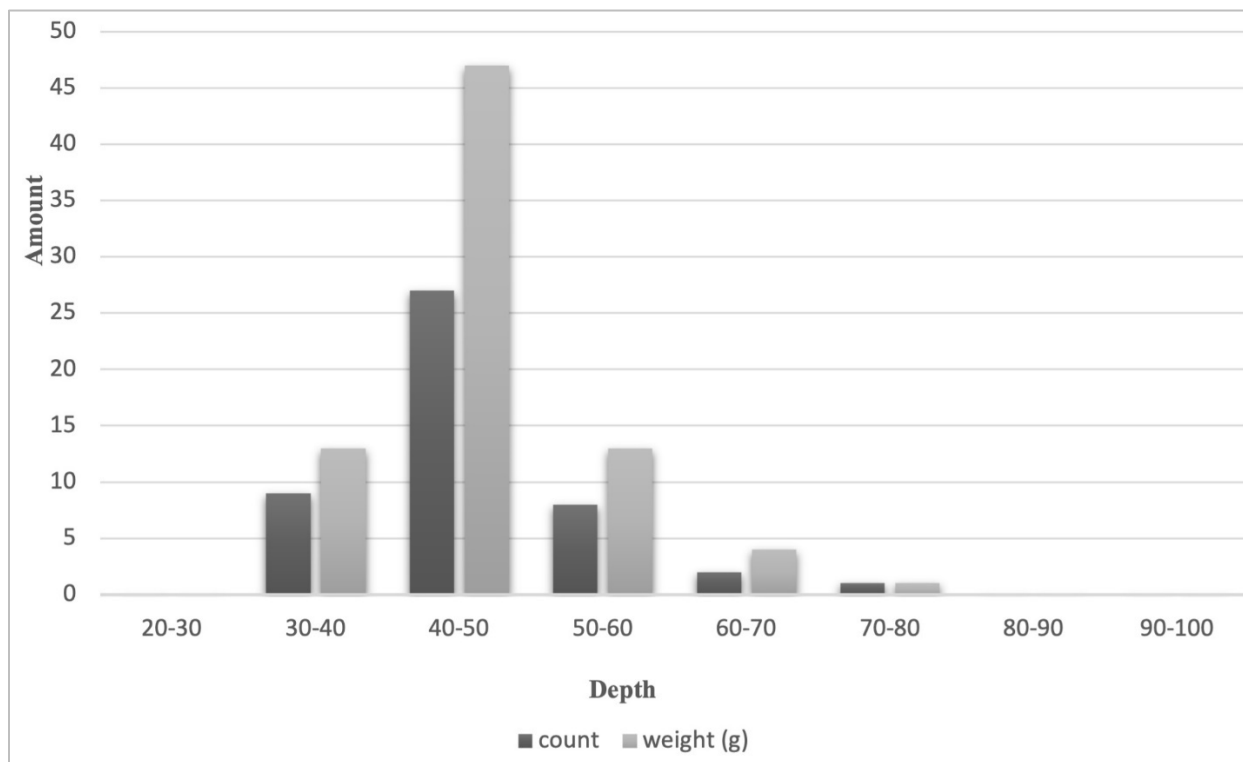


Figure 11. Bar graphs showing seeds and native palm endocarp Counts and Weights from Core Excavation.

Cultural Material

The excavation produced several different artifact types. Excavation levels 0-10 cm, 10-20 cm, and 100-170 cm produced few artifacts. Most of the artifacts are pottery assigned to the Punta Ycacos Unslipped type. They include rim and body sherds, cylinders, vessel supports, and amorphous clay lumps (ACL), which are the unidentifiable remnants of the salt-making pottery, or briquetage. Punta Ycacos ceramics made up much of the weight of all the artifacts combined. There is a minor amount of Late to Terminal Classic Warrie Red sherds, both rims and bodies. Warrie Red ceramics are used at the Paynes Creek Salt Works as storage jars (McKillop 2002:77-86). The other cultural material was charcoal, which was found in excavated levels with artifacts. The highest density of material, by weight and count, was 40-50 cm depth (Figures 8-10). A dense charcoal deposit was found at approximately 47 cm in the excavation. Other botanical material includes native palm endocarps (coyol and cohune) and crabbo seeds (Figure 11). A few other sherds were found in levels 20-80 cm depth of the excavation.

Discussion

The 170 cm sediment core cut from a unit on the strip of land that currently divides the underwater site of Ek Way Nal was not present during the Late to Terminal Classic settlement. The strip of land currently forms a boundary between the East lagoon and the Main Channel areas of the Punta Ycacos Lagoon system.

The presence of artifacts in the sediment column at the same depth as the underwater deposits on both sides of the strip of land indicate the site was continuous during the Late to Terminal Classic periods. At some point after the site was abandoned, sea levels submerged most of the site, except a shallow area where red mangroves took hold, growing taller as sea levels rose, with mangrove peat forming in the root systems. Future radiocarbon dating of the fine red mangrove roots from the Ek Way Nal column will indicate when this occurred.

Similar to the mounds at Witz Naab' and Killer Bee (Watson et al. 2013), the strip of dry land bisecting the Ek Way Nal site has modern vegetation growing on it. Additionally, the

excavation revealed the remains of salt-making pottery and dense areas of charcoal. The presence of briquetage and abundant charcoal in the excavation may indicate it was a leaching area, produced from the brine enrichment process.

Conclusions

Excavations on a strip of land bifurcating the ancient Maya salt works site of Ek Way Nal were done in order to extract a sediment column from the seafloor. This sediment core was cut from a wall of the unit in 10 cm levels to 170 cm depth. The presence of cultural material within the excavation and core indicates that the ancient Maya site continued across the strip of land in antiquity. The presence of mangrove peat throughout the sediment core suggests that sea-level rise was occurring before, during, and after the ancient Maya occupation at the site. Future research includes radiocarbon dating different levels to clarify the timing and rate of sea-level rise in relation to the settlement at Ek Way Nal.

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