26 THE ANCIENT MAYA CANOE PADDLE AND THE CANOE FROM PAYNES CREEK NATIONAL PARK, BELIZE

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The 2004 discovery of the K'ak' Naab' wooden canoe paddle in Paynes Creek National Park, southern Belize, as well as the more recent discovery of a Classic Maya wooden canoe, underscore the infrastructure of ancient Maya canoe transportation and coastal-inland salt trade. Wooden objects and buildings were preserved in mangrove peat that formed the sediment below the seafloor at the underwater Maya Paynes Creek sites. Wooden posts formed the outlines of buildings associated with briquetage—the broken pots used to evaporate brine over fires to make salt. The Paynes Creek Salt Works produced massive quantities of salt, which was a basic biological necessity that was scarce at inland cities where the bulk of the Classic population lived. In this paper we review the story of the discovery of the K'ak' Naab' canoe paddle: from conservation and study, and culminating in the paddle's 2013 return to Belize. We also expand the story to report the first ancient Maya wooden canoe, discovered at the Eleanor Betty Salt Work, in Paynes Creek National Park, Belize.

Introduction

A search for ancient Maya salt works in a shallow lagoon in Paynes Creek National Park in southern Belize led to the unexpected discovery of wooden architecture and a canoe paddle found below the seafloor (McKillop 2005a; Figure 1). Preserved in mangrove peat that formed the sediment below the seafloor, the discovery of the wooden artifacts broadens our understanding of the Maya past, previously known mainly by stone architecture, pottery, and stone tools. The Paynes Creek Salt Works include wooden buildings with massive amounts of briquetage—the broken pottery vessels and their supports used to evaporate brine in pots over fires to make salt. The amount of salt produced was beyond the needs of the local coastal and island population—even the nearby major trading port of Wild Cane Cay (McKillop 2005b).

Discovery of the K'ak' Naab' Canoe Paddle

A search for ancient Maya sites submerged by sea-level rise in the coastal waters of southern Belize revealed three underwater sites in Punta Ycacos Lagoon (Stingray, Orlando's, David Westby sites), and another site in the nearby mangroves (McKillop 1995, 2002) in Paynes Creek National Park (Figure 1). Ethnographic analogy to modern and historic salt works (eg. Reina and Monaghen 1981), as well as comparison of the briquetage from sites in China, Europe, and North America (Li and Von Falkenhausen 2010) indicate the Maya sites were salt works. Analysis of artifacts from the

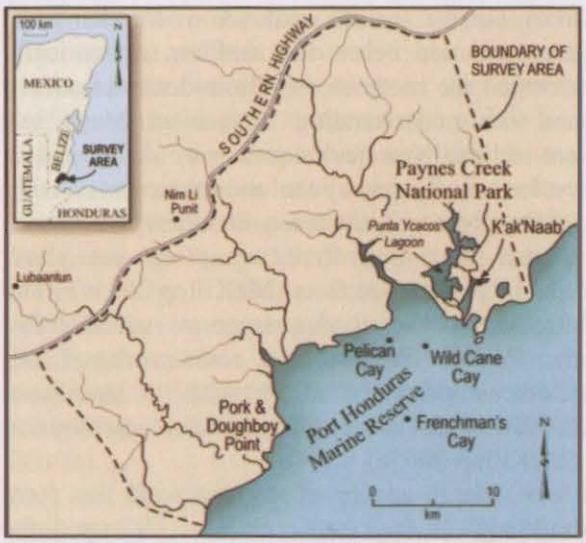

Figure 1. Map of Southern Belize showing location of Paynes Creek National Park (by Mary Lee Eggart, LSU).

Paynes Creek Salt Works showed that salt production was specialized, since the salt pots were standardized in their dimensions for mass-production of salt (McKillop 2002). Moreover, the overwhelming majority of artifacts at the sites were used in salt production, with little evidence of habitation.

Since four salt works could not have produced enough salt to meet the biological needs of the Maya at nearby inland cities, a comprehensive search for additional salt works was initiated in 2004. Systematic pedestrian survey in the shallow Punta Ycacos lagoon system indicated there were more salt works, as evidenced by briquetage on the seafloor. The discovery at Site 15 of wood embedded in the seafloor that was neither stray limbs nor old

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Figure 2. Jaguar Paddler god and Stingray Paddler god carved in bone from Burial 116, Temple 1, Tikal. (drawing by Mary Lee Eggart, LSU).

trees, but the surface evidence of wooden posts deeply buried below the seafloor, dramatically changed the methods for the underwater survey and our understanding of ancient Maya salt production: New techniques were developed to systematically survey the underwater sites using RFDs (Research Flotation Devices) in order to protect the sites from trampling yet allow visibility of the sea floor (McKillop 2005a). The discovery of the wooden structures indicated that the Paynes Creek Maya mass-produced salt inside wooden buildings with a significant infrastructure of production and distribution (McKillop 2005a).

The discovery of wooden posts that form buildings at Paynes Creek Site 15 raised the question of whether there were wooden buildings at Sites 1-14 or even at the salt works previously discovered and excavated in another arm of the lagoon (McKillop 2002). A return to Site 14 led to the discovery of wooden posts and a wooden canoe paddle leading to the renaming of the site as K'ak' Naab' (translated as Fiery Water Place; McKillop 2005a). A systematic flotation survey of the previously discovered and excavated underwater salt works, Stingray Lagoon, Orlando's, and the David Westby site (McKillop 1995, 2002), found that all had abundant wooden posts (McKillop 2011).

Acquiring Evidence for the Antiquity of the Maya Canoe Paddle

The context of the K'ak' Naab' canoe paddle at a site with Late Classic Maya pottery suggested a similar age for the paddle (McKillop 2007). The similarity in shape of the blade and shaft to those in artistic depictions of the Maya paddler gods carved on bone objects from Tikal's Late Classic Temple 1, Burial 116 (Trik 1963) also supported a Late Classic age, by the similar date and shape of the paddles (Figure 2). In order to avoid any uncertainty of the Late Classic age of the paddle, a sample of wood from the shaft was submitted for radiocarbon dating. The radiocarbon date of A.D. 660-880 meant that the paddle dated to the Late Classic period (McKillop 2005a).

Figure 3. Packaging the K'ak' Naab' canoe paddle for temporary export for conservation under supervision of the Belize Institute of Archaeology (photo by Wallace Young).

Conservation of Waterlogged Wooden Artifacts

The K'ak' Naab' canoe paddle was conserved in the United States with a temporary export permit from the Belize Institute of Archaeology (Figure 3). After the initial discovery of the K'ak' Naab' canoe paddle, it was photographed, sampled for C14 dating, returned to the sea, and buried under mangrove peat in order to protect the paddle, which began to dry and deteriorate upon exposure to the air. Once a temporary export permit was granted, the paddle was removed from the mangrove peat and wrapped and sealed in plastic with water, for preservation. Instead of the traditional conservation method of preserving wood in propylene glycol, a new polymer method (Smith 2003) was selected for a variety of reasons. The polymer process results in a dry object that does not require humidity or temperature control (Smith 2003), making the process more suitable for curation and exhibitions in Belize.

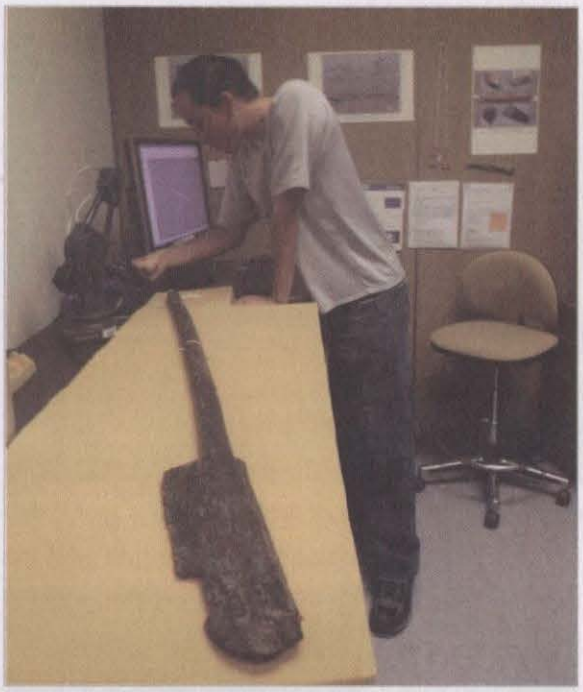

Figure 4. The K'ak' Naab' canoe paddle in the LSU Digital Imaging and Visualization in Archaeology (DIVA) Lab for 3D surface scanning by Roberto Rosado (photo by H. McKillop).

Figure 5. Dimension Elite 3D printer in the LSU DIVA Lab (photo by H. McKillop).

Conservation of the paddle required removing the salt water and replacing it with polymer, a process that took almost three years. Desalination of the wood was initiated at Louisiana State University by immersion in fresh water. The desalination was continued at the Preservation Lab at Texas A & Am University by Dr. C. Wayne Smith and Dr. Helen Devereux. Once desalinated, the paddle was soaked in a bath of acetate to remove the water. Then the paddle was immersed in solutions of polymer, a liquid plastic, under a process developed and patented (but freely available for others to use; Smith 2003). Acetate is replaced more quickly by polymers than water. The resulting conserved canoe paddle was a dry object that was stable, since the polymer had penetrated throughout the wood structure. The paddle was not a solid plasticized object. The polymer adhered to the inner cell walls of the wood, resulting in an exterior surface of dry wood. However, the paddle was preserved to the condition in which it was discovered, which included hairline cracks from being in an alternating wet and dry environment. Imagine a wooden paddle lost or set down at the water's edge, sinking out of sight and periodically being exposed to the air and cracking. After conservation, the paddle continued to deteriorate, with the original cracks expanding (McKillop, Sills, and Harrison 2010a, 2010b).

A 3D digital scan of the K'ak' Naab' canoe paddle was carried out in the LSU Digital Imaging and Visualization In Archaeology (DIVA) lab using a Skiron laser scanner attached to a movable Microscribe arm (Figure 4; McKillop and Sills 2013a and 2013b). The 3D digital paddle is a permanent record suitable for study. A 3D printed replica of the paddle was created using the DIVA lab's Dimension Elite 3D printer (Figure 5). The 3D printed replica became a permanent record for viewing. A 3D print is only as good as the 3D scan, which at 80,000 points per second, provides an accurate record.

Exhibiting the 3D Printed Replica and the Original K'ak' Naab' Canoe Paddle

A permanent exhibit of a full-sized 3D printed replica of the K'ak' Naab' canoe paddle was opened at the Toledo Information Center in Punta Gorda, Belize, on 11 May 2013. The 3D print was exhibited inside a wooden display cabinet with a glass lid (Figure 6).

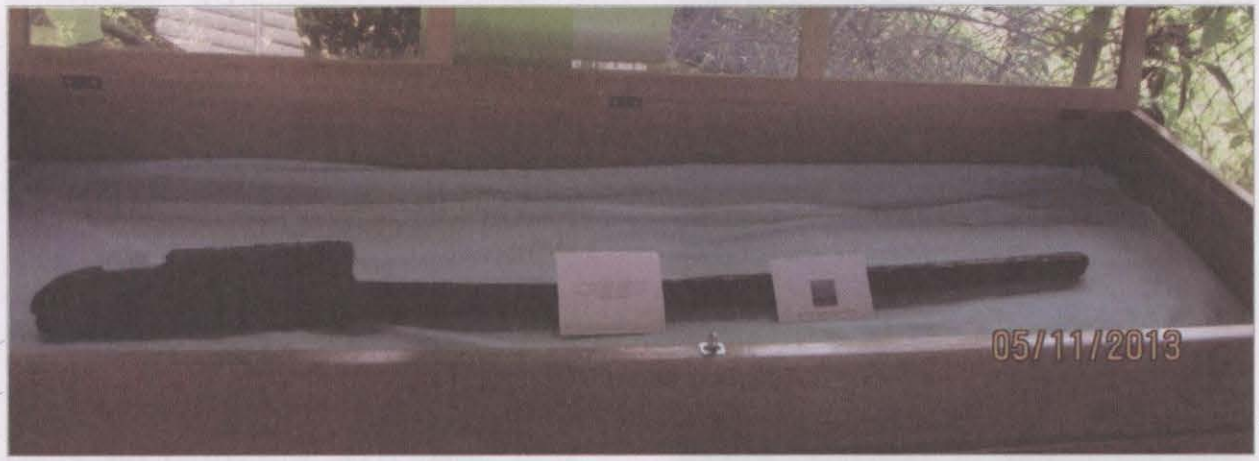

Figure 6. Permanent Exhibit at the Toledo Information Center featuring a 3D printed replica of the K'ak' Naab' Canoe Paddle (photo by H. McKillop).

Accompanying documentation included a 2D photo of the paddle at actual size, 1.43 meters (4' 7") in length, as well as a poster providing information about the canoe paddle. Brochures, book marks, and stickers were available at the exhibit. The opening was covered by local media, with Toledo District LoveFM correspondent Paul Mahung acting as emcee of the opening. The opening included a lecture about the canoe paddle. The exhibit added to the permanent exhibit of 3D printed replicas of artifacts opened in 2012 at the Toledo Information Center and at the Paynes Creek Ranger Station (McKillop and Sills 2013 a, 2013b).

The world premier viewing of the original K'ak' Naab' canoe paddle occurred on 28 June 2013 at the Toledo Information Center in Punta Gorda, with an opening ceremony and visitation over the course of one day of some 300 individuals. The event was covered by local media, including LoveFm, LoveTV, and PGTV. Many people were encouraged and took up the offer to have their photo taken with the canoe paddle (Figure 7).

The second public viewing of the K'ak' Naab' canoe paddle occurred at the Belize Archaeology and Anthropology Symposium in San Ignacio, following a presentation on the canoe paddle (Figure 8). The canoe paddle was on view for the duration of the symposium, along with a full-size photo of the paddle, a descriptive poster about the canoe paddle, and a

Figure 7. World Premier Viewing of the K'ak' Naab' Canoe Paddle at the Toledo Information Center, Punta Gorda, 28 June 2013 (photo by Dilma "Yoli" Cano, Toledo BTIA).

Figure 8. The K'ak' Naab' canoe paddle on display at the Belize Archaeology and Anthropology Symposium, July 2013, featuring members of the Cayo Tour Guide Association (photo by Lyra Spang).

poster about the Underwater Maya project, all laminated. The conserved original paddle was returned to the Institute of Archaeology staff, along with a 3D printed replica and posters, at the BAAS symposium. The original paddle was subsequently curated in the Museum of Belize for exhibition. The 3D printed replica is durable ABS+ plastic, so is suitable for local exhibits by the IA staff. The 3D print is an accurate replica that also is suitable for study.

Paddling the Coastal Waters versus the Maya Universe

Upon discovery of the K'ak' Naab' canoe paddle, its similarity with the shape of paddles in use by the Maya paddler gods depicted in Maya art, was immediately apparent (Figures 2, 4, 6). The paddler gods are shown in carvings on bones from Tikal's Burial 116 in Temple 1 (Trik 1963). The paddles have a straight shaft without a grip, as well as a blade on one side only. The Jaguar Paddler god and the Stingray Paddler god are shown each holding a paddle in an awkward position for paddling: The right arm is bent and the right hand holds the shaft, well above the blade (Figure 2). The left hand holds the shaft below the top. In order to get leverage to move a paddle in the water, the right hand needs to be close to the blade and the left hand closer to the top of the shaft. In addition, the artistic depiction of the blade on one side of the shaft, would not work paddling in the water, since the blade would turn. Perhaps one could suggest that the one-sided paddles were used as rudders, but the artistic depiction of paddling from the bow and middle of the canoe, indicates the paddles were intended to be shown as moving water. The depiction suggests either that the artist was not familiar with canoeing or that it was not important to depict actual paddling. Clearly the paddler gods depicted in the Burial 116 bone carvings were not travelling in the water.

A close examination of the K'ak' Naab' canoe paddle did not occur until after it was conserved and stabilized, indicating that the shape of the blade differed from the artistic depictions on the Tikal Burial 116 paddles. The blade of the K'ak' Naab' canoe paddle was broken along one side, forming a continuous line from the shaft. The original canoe paddle had a blade that extended on both sides from the shaft. A demonstration of a modern version of the K'ak' Naab' canoe paddle took place at the conference hotel pool, indicating a good working paddle (Figure 9).

Figure 9. Demonstration of the K'ak' Naab' canoe paddle using a modern version in the conference hotel pool at the Belize Archaeology and Anthropology Symposium, 3 July 2013, with Cynthia Ellis-Topsey and Anabel Ford in the canoe held by Paul Healy and H. McKillop (photo by Jessica Harrison).

Canoe Models from the Paynes Creek Salt Works

Artistic depictions of canoes and boat models have been reported from several ancient Maya sites (McKillop 1985, 2002, 2010). Artistic depictions of Maya canoes on bone carvings from Tikal's Burial 116 and from a Postclassic painted mural from the Temple of the Warriors at Chichen Itza, show flattened bow and stern and low walls. The shape is similar to boat models carved from manatee rib bones from Altun Ha (Pendergast 1979: Figure 46b) and Moho Cay (McKillop 1985: Figure 4), two fragmentary pottery boat models from the Paynes Creek salt works (McKillop 2002), and a pottery boat model discovered by William D. Strong (1935) from the Bay Islands of Honduras.

In 2013, a complete pottery boat model and a fragmentary model were excavated from Paynes Creek Salt Work74 (Figure 10). They are similar in shape to the other reported boat models. The Paynes Creek Site 74 pottery boat models were stored in plastic bags with fresh water and taken to the 3D imaging lab at our base station in Belize for 3D surface scanning. The boat models were then curated in deep silt

Figure 10. Pottery canoe model from Paynes Creek Salt Work 74 (photo by H.McKillop).

Figure 11. Classic Maya boat models, including 3D printed replicas of the Site 74 canoe model actual size and enlarged, and fragments of other Paynes Creek boat models, including the actual artifacts and 3D printed replicas (photo by H. McKillop).

in a storage sack at a marked location in the lagoon at Paynes Creek, along with other artifacts. From previous experience, salt water saturated pottery allowed to dry results in the salt accumulating at the surface and exfoliating the entire surface of the object, so returning the clay boat models to the lagoon environment was a good way to preserve the objects. The 3D scans were post-processed in the LSU Digital Imaging and Visualization in Archaeology (DIVA) lab at LSU, to join the separate 3D scans and remove extraneous data. A 3D printed replica of the complete boat model was made, along with a larger version, suitable for viewing in an exhibit (Figure 11). Painted versions of the 3D printed replicas were given to the Belize Institute of Archaeology (see Figures 7 and 8).

Figure 12. Raising the Wooden Canoe from Paynes Creek Salt Work 67 (the Eleanor Betty Site; photo by Rachel Watson).

Discovery of the First Ancient Maya Wooden Canoe at the Paynes Creek Eleanor Betty Site

The first discovery of an ancient Maya wooden canoe was made at the Eleanor Betty Site, an underwater salt work in Paynes Creek National Park, Belize (Figure 12). The discovery was reported at the Belize Archaeology and Anthropology Symposium in San Ignacio, Belize, July 3, 2013. The Eleanor Betty Salt Work is located in the western arm of Punta Ycacos Lagoon in shallow water beside a point of land. The site is not visible from the water surface. Systematic flotation survey led to the discovery of a line of palmetto palm posts preserved below the seafloor in the mangrove peat. A 10-20 cm layer of thick silt covers the seafloor and further obscures the posts from view. Flagging the posts and total station mapping indicated that the palmetto palm posts form a semi-circle enclosing a large portion of the site, with an opening in the center. The line of palmetto palm posts bifurcates in the middle, forming a long narrow enclosure, a boat slip, where the wooden canoe was discovered, upside down in deep silt and slightly embedded in the mangrove peat below. Upon discovery, the wooden canoe was raised out of the deep silt and above the water to estimate if the heavy, large, wooden object was in fact a canoe, or a hollowed-out log. Sometimes a canoe really is just a hollowed-out log. Logging in Paynes Creek in historic times, as recently as the 1950s, likely brought logs down past the site. The canoe was sunk back into the deep silt. In 2008,

Figure 13. 3D Surface Scanning the Maya Canoe with a Creaform 3D laser scanner at the Field Base (photo by Rachel Watson).

Figure 14. Scanning dots applied to the Eleanor Betty wooden canoe for 3D surface scanning (photo by Rachel Watson).

the canoe was raised again for inspection and to take a wood sample for radiocarbon dating. The canoe was again sunk into the deep silt. Interest was generated by the Early Classic radiocarbon date.

The canoe was raised again from the boat slip in May 2013 (Figure 12). Rene Villanueva and his camera crew from Belize LoveTV collected film footage for an episode of Belize Watch, which aired May 26 on LoveTv and LoveFM radio. Unfortunately, the canoe had broken into several pieces since we had first discovered it. After it was raised again in 2013 for viewing and 3D surface scanning, the canoe was submerged in deep silt in the boat slip at the Eleanor Betty Site and held in place by pvc pipes to keep it from moving (with approval of the Belize Institute of Archaeology).

Before returning the canoe to the sea, pieces were taken to the 3D imaging lab at our base station in Belize for 3D surface scanning. The aforementioned break of the canoe resulted in three canoe fragments. Using standard transport preservation methods, all three pieces were plastic wrapped in water before being digitally preserved by a high-resolution, color, 3D scanner, the Creaform VIUscan. The handheld, portable scanner was ideal for base station scanning with power from a generator. Scanning took place over three days and consisted of front and back scans of two large canoe fragments and a smaller one (Figure 13). The three fragments were similar in composition, consisting of a flat darkened side that indicated both a slow burnout in addition to tool markings. The opposing side abundantly more-water logged and in contact with organic materials (including plant life and worms); it was therefore perforated and decomposing at a faster rate. To complete the scanning process, wood was temporarily patted dry and dotted using reflective dots in the standard scanning tessellated pattern (Figure 14). Since the scanner uses ultraviolet reflection, more detailed areas were scanned at night. The digital scans were taken to LSU for post-processing. Excavations are planned to further expose the canoe, to excavate below it, and to excavate what appears to be another canoe nearby.

Discussion

The Eleanor Betty wooden canoe, along with the K'ak' Naab' canoe paddle, indicate the Paynes Creek Maya had developed a transportation infrastructure for the distribution of salt produced at over 100 Paynes Creek salt works (McKillop 2005a, 2010, 2011, 2012; Sills and McKillop 2010, 2013). The standardization of the salt production vessels supports a model of mass-production of salt (see McKillop 2002). The overwhelming abundance of briquetage compared to other objects as well as the absence of burials typical of ancient Maya

communities, underscores that focus of activity was the production of salt. Who were the consumers? The presence of Warrie Red water jars with unit-stamped decorations typical of inland cities in southern Belize (such as Lubaantun and Pusilha) and adjacent Guatemala (such as Seibal, Altar de Sacrificios and sites in the Petexbatun region), indicate inland-coastal communication and trade (McKillop 2002). Mold-made figurine whistles typical of inland cities such as Lubaantun also figure in the artifact assemblages at the Paynes Creek salt works, further linking inland consumers of salt—a biological necessity in short supply at nearby inland cities—to the Paynes Creek Salt Works (McKillop 2002).

The context of the Eleanor Betty canoe suggests that it may also contribute to our understanding of the ancient salt industry in terms of the production of salt: Was the canoe used as a container to leach brine or water through salty soil to enrich the salt content prior to evaporating the brine in pots over fires? The archaeological deposits continue below the canoe, but the depth and composition of the archaeological material remains to be identified by excavation. The nearby earthen mounds at Site 50 may be the discard piles of leached soil (Watson et al. 2013). Certainly, ethnographic, historical, and archaeological case studies of salt production using vessels to evaporate brine over fires include enriching the brine prior to evaporation: In some cases, salty water is leached though salty soil; In other cases, solar pans are combined with leaching water through salty soil. The obvious reduction in fuel needs in the evaporation process drives the brine enriching methods.

Conclusions

Ancient Maya sea trade is documented by the occurrence of prehistoric Maya settlements on offshore islands around the Yucatan coasts of Mexico and Belize (Andrews et al. 1989; Graham and Pendergast 1989; Guderjan and Garber 1995; Healy et al. 1984; McKillop 2005b; Sabloff and Rathje 1975), by the presence of marine resources at inland sites (McKillop 1984), by the discovery of a Late Classic wooden canoe paddle from the K'ak' Naab' site (McKillop 2005a), and by the discovery of a wooden canoe from the Eleanor Betty site, a Classic Maya salt work in Paynes Creek National Park, southern Belize. The discovery of the canoe and the paddle were made possible by their preservation in mangrove peat created by red mangroves (*Rhizophora mangle*) that grow in salt water and keep pace with sea-level rise, by extending their prop roots above the water (McKillop, Sills, and Harrison 2010a, 2010b). The mangrove peat created an oxygen-free environment that preserved wood, including the wooden buildings used for salt production, and the wooden canoe and paddle, examples of the transportation infrastructure used to distribute the salt to inland consumers.

The use of 3D surface scanning of wooden artifacts during field research in Belize, as well as selected 3D printing of replicas of artifacts, facilitates research, helps preserve waterlogged objects, and promotes sharing of archaeological finds with the interested public. Salt-water saturated artifacts of wood and pottery from the Paynes Creek underwater sites are kept in plastic bags filled with water so they do not deteriorate in the air. Three-dimensional scanning in the field provides accurate 3D digital replicas of artifacts, while the orginals are stored in caches of deep silt in the lagoon for future study. Exhibitions of 3D printed replicas of artifacts, such as the K'ak' Naab' canoe paddle, bring the ancient past of the Maya to modern communities, thereby helping to protect the past through sustainable archaeological tourism (McKillop and Sills 2013a, 2013b).

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