

**EAST-CENTRAL FLORIDA PRE-COLUMBIAN WOOD SCULPTURE:
RADIOCARBON DATING, WOOD IDENTIFICATION AND STRONTIUM ISOTOPE
STUDIES**

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Introduction

Florida's wetlands have yielded a wealth of prehistoric wood sculpture, from the remarkable site of Key Marco, excavated in 1896 by Frank Hamilton Cushing and yielding some of the finest wood carvings known from the Americas, to over 100 carvings recovered from Fort Center, to the bird effigies at Belle Glade, among many others (Purdy 1991; Sears 1982; Schwehm 1983; Wheeler 1996). Most of these sites are concentrated in the eastern and southern part of the state, with a chronology spanning from as early as AD 400 through the earliest era of European contact, and encompassing various archaeological cultures (e.g. St. Johns, Glades, and Belle Glade). But the largest examples – indeed the largest known wood sculptures in pre-Columbian North America – come from the vicinity of Hontoon Island in east-central Florida (Purdy 2007). Here, three carvings were dredged from the same location on the St. Johns River in 1955 and 1977. All are zoomorphic figures, representing an owl, pelican and otter, with the largest, the Owl 'totem', measuring nearly four metres in height. This figure was subject to radiocarbon dating in the late 1950s (650 ± 200 BP, U of Michigan M-464; calibrating to AD 962-1666 at 94.7% probability; Bullen 1958) and has frequently been used as an icon of Florida's prehistory, most recently for the 81st meeting of the Society for American Archaeology held in Orlando in 2016. Less well known and studied are the Pelican and Otter carvings from the same location, as well as the state's only finished anthropomorphic wooden carving known outside of southern Florida, from Tomoka State Park on the east coast.

The three Hontoon carvings seem to be part of the same artistic tradition, and it has been suggested that they are contemporary, perhaps even carved by the same individual or workshop (Purdy 2007:61). Given the wide range of the abovementioned radiocarbon date for the Owl, this would place them within St Johns II, an archaeological period seeing Mississippian influences in northeastern Florida, and raises the possibility that the carvings were part of the elaboration of mortuary

rites found at this time (Ashley 2012; Ashley and Rolland 2014; Milanich 1994:269-272). But it is also possible that they have a far greater time depth, and are instead related to the Late Woodland tradition of moundbuilding and the erection of wooden effigies seen at Fort Center in southern Florida (Sears 1982). Crucial to evaluating these matters, and placing the figures within their cultural context, is a firm chronology, which is currently lacking.

The central questions regarding the smaller Tomoka figure are rather different. Stylistically it appears distinct from the Hontoon carvings, so the question arises whether it belongs to a different contemporary carving tradition, or to a different time period. More importantly, a previous study identified the wood from which it is carved as *Peltophorum* cf. *adnatum* (sometimes mistakenly referred to as ‘brazilwood’, which belongs to a different genus in the same family, Fabaceae [legumes]). *P. adnatum*, or ‘horse bush’, is not listed in floristic records for Florida (Wunderlin *et al.* 2016), leading to the suggestion that the sculpture may have originated in the Caribbean (Morrell 1974; Purdy 1988:642), where the species does occur. Here, we approach these questions through a programme of radiocarbon dating, wood identification and strontium isotope analysis, and discuss the significance of the results for our understanding of the prehistory of this region. Specifically, these pieces can inform on the contexts in which monumental wood sculptures were erected by Florida’s sedentary fisher-foragers in the case of the Hontoon carvings, and on potential and long-controversial Caribbean connections in the case of the Tomoka carving.

East-central Florida’s prehistoric wood sculpture in context: Hontoon and Tomoka

Hontoon Island

Hontoon Island in Volusia County is formed by the main channel of the St. Johns River and its tributary the Hontoon Dead River. Although it is now heavily modified by early- to mid-twentieth century shell dredging and cattle ranching, the island documents Amerindian occupation spanning several millennia, with the earliest radiocarbon dates at 5200-4760 cal. BC (Randall and Sassaman 2005:iii, 206; 2009). Excavations in the 1980s by Barbara Purdy at site 8VO202 on the island's north shore yielded large quantities of waterlogged wood (both artefacts and wood debitage) and plant remains, as well as a rich assemblage of ceramics and other artefacts, including non-local stone, and, in the upper levels, early European trade goods. Bottlegourd (*Lagenaria siceraria*) and gourd/squash (*Cucuribita pepo* ssp. *ovifera*) were at least casually cultivated throughout the record of human occupation at the site (Decker and Newsom 1988; Newsom 1987). Maize cobs and pumpkin (*Cucuribita pepo* ssp. *pepo*) seeds and peduncles were recovered in levels dating ca. AD 1260-1678 (Purdy 1991). Nevertheless, the mainstay of the diet was still fishing, hunting and gathering until the colonial period (Purdy 1987b; 1991; Newsom 1987).

On the southern shore of the Beresford peninsula – separated from Hontoon Island by the winding St. Johns River – are the neighboring sites of Thursby Mound (8VO36) and Thursby Midden (8VO35). Northern Hontoon Island and southern Beresford peninsula undoubtedly shared a common history at various points and might be considered as part of the same site complex, especially as waterways were not impediments to travel in Florida, but rather facilitated it (Purdy 1991:280). Thursby Mound was, in excavator C.B. Moore's own words, "demolished" over the course of 9 days in January 1894 (Moore 1999:268). Its impressive 91m length and 3.5m height yielded a minimum of 132 burials, close to 800 ceramics, numerous worked stone implements and several rare silver and gold ornaments (Moore 1999:188; 93; 268). The metal ornaments, together with the ceramic styles, suggest activity spanning a long period from at least ca. 500 BC to AD 1565 (Goggin

1952:90). Some 60km to the north is another large burial mound, Mt. Royal, from which Moore recovered artefacts clearly linked with the Mississippian cultures of the wider southeast region, including a copper breastplate displaying classic Mississippian iconography (Moore 1999; Milanich 1994: 269-272). Thursby was at least partly coeval with Mt. Royal, and so may have been within the same sphere of influence.

The first of the 'Hontoon' carvings to be recovered was the Owl sculpture (**Figure 1**), found during dredging operations in the river in June 1955 (Bullen 1955). Originally nearly four metres in height (372cm), it likely stood in front of the Thursby Mound/Midden (dredging was on the Beresford side of the river, rather than the Hontoon side), before slope erosion or natural deterioration to the base resulted in its falling forward into the river, where the anaerobic sediments and waterlogged environment helped to preserve it until its discovery (Bullen 1955; Purdy 2007). The figure is a stylised representation of a great horned owl (*Bubo virginianus*), while also suggesting transformative aspects (e.g., five digits on each foot, whereas owls have four; a morphing of an owl's characteristically large round eyes with a human eye and rectilinear guilloche designs down the bird's back suggesting of both feathers and a textile) (Bullen 1955; Wheeler 1996; Ostapkowicz *et al.* forthcoming). The Owl's body alone extends nearly two metres in height, its claws clutching a perch that exceeds another metre; an additional 76cm section of base was originally present, but was removed prior to the sculpture going on display in 1955 (see discussion below).

The Otter (**Figure 2**) and Pelican (**Figure 3**) carvings were dredged from the Beresford side of the river in 1978, near channel marker 55, directly adjacent to the outbound ferry and loading dock for Hontoon Island State Park. Designated site 8VO238, it is believed that this is the same location from which the Owl was

recovered 23 years earlier, though less precise information is available for the 1950s work. At 88cm in height, the Otter is the smallest of the three carvings. It clutches a fish to its belly, a feature that, together with the erect ears and tail distinguish it as an otter (a frog has also been suggested previously – Kenner and Russo n.d.; Florida Master Site File, Division of Historical Resources). Apart from the fish, no further designs can be distinguished on its eroded surface. The bird figure, measuring 194cm in height, retains only a small area of incised semi-circular designs on its surviving right wing. All that remains of the head is a long beak resting on the chest, a posture suggestive of a pelican: while this identification is tentative, it will be referred to here as the Pelican carving.

All three sculptures feature a long base or 'perch' for a single animal, in keeping with other large-scale animal figures predominantly from southern Florida, and similarly indicating their vertical placement into the ground (e.g., Fort Center [Sears 1982; Purdy 1991: 82-102]; Belle Glade [Wheeler 1996:Figure 5-17d]). The east-central Florida carvings, however, are considered to be part of a distinct tradition, with more stylised, geometric conventions (Schwehm 1983:93). The chronological relationship between the traditions is also unclear, with the single available date on the Owl suggesting that the Hontoon carvings may be later than the southern Florida examples (Thompson and Pluckhahn 2012).

Tomoka State Park

Tomoka State Park is also located in Volusia County, on Florida's east coast. As with Hontoon Island, the Tomoka peninsula has a long history of Amerindian occupation, extending back into the pre-ceramic Late Archaic period at the Tomoka Mound and midden site (8VO81) (Piatek 1992). Of more immediate relevance here is the site of Nocoroco (8VO82), occupied from at least AD 1000 and continuing into the historic period, with the presence of a village being noted here in 1605 by Alvaro Mexia

(Piatek 1992). Nocoroco is identified as a Timucuan settlement, but was located in close proximity to the Ais people of the Indian River Lagoon, who are typically recognised as having more in common with their neighbours in southern Florida. This southern connection is potentially relevant in terms of the proposed tropical origins of the wood used in the carving of the Tomoka figure.

The Tomoka carving was reportedly found in 1960 during dredging operations at Ormond Beach, in the north end of Tomoka State Park (Purdy 1979:106; Johnson 1971) near the location of Nocoroco (Piatek 1992, Figure 1). The small carving (22 cm in height) depicts a seated human figure, with hands raised to the chest, the body conforming to the rounded surface of the bole (**Figure 4**). The head carries the most diagnostic features, including sharply arched brows connected to the nose, small eyes, fleshy lips, crested headdress and a large hair bundle cascading down the back.

Previous research

The Owl and Tomoka figures have undergone previous analyses, including radiocarbon dating and wood identification. A 76cm long section of the deteriorated base of the Owl carving was removed when it went on display at the Florida State Museum (now Florida Museum of Natural History) shortly after its discovery. Wood identification at the time initially suggested bald cypress, *Taxodium distichum* (Smith in Grobman 1955, letter on file, Florida Museum of Natural History [Ruhl 2016]), but eventually settled on 'southern pine' (Bullen 1955), an umbrella term for various *Pinus* species in the southeastern US. It is understood that the radiocarbon sample taken in 1958 was from this basal section, though from exactly where is not clear in archival records. Its current length of 61.5cm suggests that a section of ca. 15cm was removed at some point in its history, and in all likelihood this was the sample submitted by Ripley Bullen to James Griffin at the University of Michigan's

radiocarbon laboratory (**Figure 5, left**). Such large samples were standard in the early days of the technique, before the introduction of accelerator mass spectrometry (AMS) radiocarbon dating in the 1980s and 90s.

The remaining basal section's cleanly cut cross-section exhibits ca. 35 growth rings, though this is a minor issue given the large error terms in radiocarbon dating at the time. More important is that it is not clear whether the sample was taken prior to the conservation treatment of the carving, which included an initial application of alvar (a polyvinyl acetaldehyde acetal resin), followed by yearly coatings of turpentine and linseed oil for the displayed portion of the carving over the course of 25 years (Lewellen, pers com. 2014).¹ These contaminants need to be removed from radiocarbon samples through various solvent washes, and it is unlikely that the original 1950s radiocarbon date was done with solvent extraction. But the large sample sizes routinely used then would have been less affected by the presence of low levels of contamination from conservation treatments; the much smaller sample sizes required for AMS dating result in samples that are more susceptible to producing erroneous dates due to low levels of contamination. The 1958 radiocarbon measurement returned a result of 650 ± 200 BP (M-464) (Crane and Griffin 1959). It is repeatedly cited using its intercept of AD 1300 (Milanich 1994:273; Purdy 2007), although the calibrated range actually spans AD 962-1666 (94.7% probability, calibrated in OxCal 4.2 using IntCal 2013; Bronk Ramsey 2013; Reimer et al. 2013).

¹ Archival records indicate that requests to remove the basal portion were made by Arnold B. Grobman, Florida State Museum Director to the owner, Mr. Victor Roepke, in 07 July 1955, and roughly a week later museum personnel were "busily engaged putting preservatives on the owl totem" (Ripley Bullen to Roepke, 15 July 1955 [Ruhl 2016]). By 16 September, Grobman wrote Roepke that "It has taken us a good deal longer to treat and preserve your totem pole than we had anticipated. It was necessary to dry it out slowly so that it would not crack". It may be that even though the basal portion was removed, it also underwent the initial Alvar treatment, particularly as Grobman's 07 July letter indicated that it was to be kept for 'any future needs', and so needed to be preserved (Ruhl 2016).

Shortly after its donation to Tomoka State Park in 1971, the Tomoka figure also underwent radiocarbon dating and wood identification. The figure was initially thought to be carved of oak or a cypress 'knee' (Johnson 1971), but a sample must have been taken in the early 70s and was sent to the USDA Forest Products Laboratory in Madison, Wisconsin, where it was reportedly identified as "*Peltophorum* sp., probably *P. adnatum*" (Peterson 1973; Purdy 1991:238-9; Morrell 1974 lists this as *Peltophorum* cf. *P. adnatum*); we have been unable to locate the original report on the wood assignment to verify the details). Since this tree was not native to Florida, it was suggested that it probably came from Central America or the Antilles (e.g., Morrell 1974), either as a finished object or as a piece of driftwood, although the possibility that *Peltophorum* was once present in Florida has also been raised (Purdy 1979:106). In fact, two species of *Peltophorum* do occur in Florida - *P. dubium* and *P. pterocarpum* – however, they are considered exotic (Fox *et al.* 2005; Wunderlin *et al.* 2016) and may represent recent introductions. In any event, and working on the assumption that the genus assignment is correct, it is important to understand that individual species within the genus are inseparable by wood anatomy. This includes the above three mentioned species as well as additional neo- and paleotropical species. The wood anatomist with the Forest Products Laboratory would simply have been making the observation that the archaeological wood matches well with the species of *P. adnatum*, but this should not be interpreted as precluding other species. The issue is important because of the tenuous nature of the claimed connections between Florida and the Caribbean in prehistory, despite their proximity, and clear contacts in the early historic period (Fewkes 1904; Rouse 1949; Sears 1977).

It appears that little in the way of conservation treatments were applied to the Tomoka carving, making the original ¹⁴C measurement less problematic than that on the Hontoon Owl. A wood sample from the Tomoka figure returned a date of 470 ±

90 BP (no lab. number) (Kenner 1974; 1991:239), calibrating to AD 1300-1638 (95.4% probability). As with the Owl, it is not clear from the archival records where the ^{14}C sample was taken. Upon inspection of the piece as part of the current project, the sample location appears to have centered on the pith of the bole (**Figure 5, right**), implying that the radiocarbon date refers to the early growth years of the tree, rather than to its felling date and subsequent carving. However, given the relatively low precision of this measurement (± 90 years), the additional offset of some decades introduced by sampling the centre of the bole will not have significantly affect the final result.

The need for new radiocarbon determinations on the Owl and Tomoka carvings arises from the large error terms on the existing dates (particularly for the Owl), the sampling locations not reflecting the felling date, or at least terminal growth, and, in the case of the Owl, uncertainty over the pre-treatment protocols employed to remove conservation materials. Given the possibilities presented by the use of a potentially exotic wood for the Tomoka carving, it is important to revisit the species identification made in the 1970s. Neither the Otter and Pelican have been previously dated nor were they subject to wood identification. We also employ strontium isotope analysis in an exploratory fashion to investigate the provenance of the wood used for these carvings. Specifically, we aim to assess whether the three Hontoon carvings all show a signal consistent with the immediate environs of the site, and whether the Tomoka figure presents a signal suggesting a source outside of Florida.

Materials and Methods

Wood identification

Small samples (ca. 2cm x 1cm x 2mm) were removed from the least conspicuous areas of each carving, using the growth increments as a guide to sample the outermost rings. The wood samples were then prepared for analysis by removing

thin sections of the cross, radial and tangential dimensions using stainless steel microtome blades. The sections were mounted on glass microscope slides in glycerine solution under glass coverslips. The wood from the Pelican was very dry and in an advance state of deterioration, thus sectioning was very limited. Nevertheless, sufficient material was mounted to observe and record several critical details to complete the identification.

The wood taxonomic work was conducted using an Olympus BX51 compound microscope, recording observations at magnifications ranging from 40x to 1000x and collecting metric data with an eyepiece micrometer. The anatomical data were analysed using published keys to wood identification (Panshin and de Zeeuw 1980; Phillips 1941), the Insidewood database (Insidewood 2004-onwards; E. A. Wheeler 2011), and by direct comparison with thin sections from wood reference collections. In addition, the sample from the Tomoka figure was placed in a black-light box to check for fluorescence under ultraviolet light, which is a characteristic of some wood taxa (Hoadley 1990; Meier 2008-2017), including the genus *Peltophorum* sp.

Radiocarbon dating

Six samples were taken from the sculptures for radiocarbon dating, providing a total of eight dates: one each from the Otter, Pelican and Tomoka figures, and five from the Owl (Table 1; all bracketed numbers, e.g., [1.3], in the text cross-reference with Table 1, where more detailed information on the ¹⁴C dates is provided). Our methodology specifically targeted issues arising from contamination and in-built wood age. The ¹⁴C sample sites on the Otter, Pelican and Tomoka figures were carefully selected from the outermost edges of the carvings, thereby securing a date as close as possible to the felling time of the tree, and so the presumed carving period. It is also quite likely that these woods, which are relatively easy to work, were carved fresh, harvested when the need arose, particularly for such large sculptures.

The Owl underwent multiple sampling due to its size and its long history of conservation (alvar, turpentine and linseed oil, the latter two being added yearly over 25 years to the displayed portion of the sculpture). Two samples (both run in duplicate) were extracted from the cut basal portion – one from the outermost rings for a terminus date and another from the innermost to better understand the age and the growth rate of the tree used to carve the sculpture. The third sample was from the hind leg of the displayed sculpture, serving to confirm the results obtained on the basal fragment, which, based on archival records, had undergone only an initial alvar treatment.

All samples were processed using solvent washes specifically catered to their conservation histories. The Otter, Pelican and Tomoka figures were subjected to sequential washes with petroleum ether (35°C, 75 min), acetone (45°C, 75 min), methanol (45°C, 75 min) and chloroform (room temperature, 75 min). The three samples from the Owl were treated as follows: water (45°C, 5 hr, then freeze-dried), acetone (3 × 45-50°C, 60-80 min each, then air dried overnight), water (45°C, 6.25 hr, then freeze-dried), methanol (2 × 45°C, 85-155 min) and chloroform (room temperature, 60 min). Two of the Owl samples were dated a second time with the acetone treatment replaced with a 5-hour soxhlet extraction with acetone. All samples were thoroughly air dried for a minimum of overnight before undergoing the routine wood pretreatment at ORAU (lab code UW: Brock et al., 2010) as follows: 1 M HCl (80°C, 20 min), 0.2 M NaOH (80°C, 20 min), 1 M HCl (80°C, 60 min), with thorough washing with ultrapure MilliQ™ water between each step. All samples except the Tomoka figure (which was too fragile) were then subjected to a bleach wash (5.0 wt% NaO₂CL, pH3, 80°C, up to 30 min) before a final water wash and freeze-drying. Samples were then combusted, graphitised and AMS dated as described by Brock et al. (2010).

All dates are calibrated in OxCal 4.2 using the IntCal13 calibration curve (Bronk Ramsey 2013; Reimer et al 2013).

Py-GC/MS

Py-GC/MS was performed using a Chemical Data Systems (CDS) 5200 series pyroprobe pyrolysis unit attached to an Agilent 6890A gas chromatograph (GC) fitted with an CPSil-5CB fused column (Varian 100% dimethylpolysiloxane; 50 m, 0.32 mm i.d.; 0.45 μ m film thickness) and a ThermoElectron MAT95 double focussing mass spectrometer (ThermoElectron, Bremen) operated in electron ionization (EI) mode (EI source temperature 200°C, interface 310°C) with helium as a carrier gas (2 mL/min). Samples were pyrolysed in a quartz tube at 610°C for 20 s, transferred to the GC using a pyrolysis transfer line (310°C) and injected onto the GC using a split ratio of 10:1; the injector port temperature was maintained at 310°C. The oven was programmed to heat at 4°C/min from 50°C (held for 4 min) to 300°C (held for 15 min). The MS scanned the range m/z 50–650 at a rate of one scan per second and there was a solvent delay of 7 min. Data were collected using MAT95InstCtrl v1.3.2 and viewed using QualBrowser v1.3 (ThermoFinnigan, Bremen). Compounds were identified using the National Institute of Standards and Technology (NIST) database and by comparison with spectra from the literature.

Strontium isotope analysis

In order to investigate the provenance of the Hontoon and Tomoka carvings, small wood samples were subjected to strontium isotope analysis. Strontium occurs as a trace element in soils, originating from a combination of weathered bedrock, surficial sediments (if different from bedrock) and atmospheric deposition (airborne dust, precipitation). An isotope of strontium, ^{87}Sr , is a product of the radioactive decay of rubidium (^{87}Rb), with the amount of ^{87}Sr dependent on the initial amount of rubidium present in the rock and the passage of time (Faure 1986). As a result, the ratio of

^{87}Sr to another isotope of strontium, ^{86}Sr , varies in different geological formations. When in solution in groundwater, strontium is taken up by plants in lieu of calcium, and the $^{87}\text{Sr}/^{86}\text{Sr}$ value can be measured using isotope ratio mass spectrometry, providing information on the geology on which the plant grew (Capo et al. 1998). In archaeological contexts, the success with which the resulting $^{87}\text{Sr}/^{86}\text{Sr}$ value can be used to assess provenance depends on: 1) obtaining a reliable *in vivo* signal; 2) the presence of sufficient geological variability in the study region; and 3) knowledge of the range of values for biologically available strontium (see below).

The bedrock limestone geology of Florida varies in age from Quaternary to Palaeogene (Lower Tertiary), with relatively small but distinct differences in $^{87}\text{Sr}/^{86}\text{Sr}$ values (Hess et al. 1986; Hodell et al. 1989). However, across much of the state this bedrock is overlain by later surficial sediments of varying depth and composition (Scott et al. 2001). Only in a few places does it come near enough to the surface to directly affect the biosphere. Springs along fault lines also provide a means of bringing waters to the surface that have taken up strontium from the limestone bedrock. Most of the available strontium isotope research in Florida – as in other parts of the world – has focussed on bedrock geology, often commencing many metres below the surface (Edwards et al. 1998; Katz and Bullen 1986; Katz et al. 1987; Phelps 2001; Toth 2003). Thus, the use of bedrock geology maps in the interpretation of either modern or archaeological materials originating in the biosphere must be done with caution, and in many instances will be inadvisable.

Highlighting the need for the measurement of biologically available strontium is the fact that, even where weathered bedrock is the main source of surficial soils, geological $^{87}\text{Sr}/^{86}\text{Sr}$ values will not necessarily translate directly into biological values in plants (Sillen et al. 1998). This is because the various rocks and minerals in the bedrock can weather differentially, and so not contribute equally to strontium in

solution. Soil and plant values will also be affected by flowing surface and groundwaters potentially originating from regions and/or depths with different geologies, as well as by atmospheric inputs (Bataille et al. 2012; Capo et al. 1998; Muhs et al. 1990; Prospero 1999). Constructing a relevant baseline for the study area thus typically relies on direct measurement of strontium isotope values in modern or archaeological flora/fauna. For this study, we sampled 24 modern trees (small branches of pine, live oak and Florida maple) from various locations in east-central Florida, focussing firstly on Hontoon Island itself, but including samples from Seminole and Lower Wekiva State Parks to the west (Cypresshead Formation, Pliocene), and Tiger Bay and Tomoka State Parks to the east (Quaternary sediments)(**Figure 6**). To confirm the stability of the local $^{87}\text{Sr}/^{86}\text{Sr}$ signal over time (e.g., to assess the possibility of anthropogenic changes), we also sampled two waterlogged hickory nutshells excavated from the Hontoon Island midden in the 1980s (Purdy 1987a), from levels approximately contemporary with the Hontoon carvings.

Finally, archaeological materials are potentially subject to contamination by exogenous strontium, either from the depositional environment or from conservation media applied to the artefact. In the present context, this includes strontium present in the waters of the St. Johns River, as well as a long history of conservation treatment in the case of the Owl. Removal of such materials is crucial to the analysis. The wood samples were from the same locations as those used for ^{14}C dating. Exceptions to this are the Owl figure, with an additional sample being taken from the interior of the clean cut basal section, which exhibited no evidence for any conservation treatments, and the Otter figure, which was re-sampled to confirm the initial result (see below).

Different pre-treatments were carried out according to the known history of preservative applications (see Snoeck *et al.* in prep for more details). Modern plant samples as well as the two nutshells recovered from Hontoon Island (site 8VO202) during Purdy's excavations were ashed in porcelain crucibles and a muffle furnace by step heating to 650°C prior to digestion (see Snoeck *et al.* 2015 for more details).

The purified strontium samples were then evaporated, and dried residues were dissolved in 100µl of concentrated HNO₃, evaporated and finally dissolved in 1.5mL of 0.05M HNO₃. Strontium isotope compositions were measured on a Nu Plasma MC-ICP Mass Spectrometer (Nu015 from Nu Instruments, Wrexham, UK) at the Université libre de Bruxelles. Particular attention was paid to the purity of the Ar gas used inside the spectrometer in order to avoid any interference (from Kr for instance) on Sr isotope masses. All Sr isotopes (84, 86, 87, 88) were measured, while the masses 85 (Rb) and 83 (Kr) were simultaneously monitored, allowing for interference corrections on masses 84, 86 (Kr) and 87 (Rb). All the data were corrected for mass fractionation by internal normalization to $^{86}\text{Sr}/^{88}\text{Sr} = 0.1194$. In addition, after the measurements all the raw data were normalised using a standard-sample bracketing method with the recommended value of $^{87}\text{Sr}/^{86}\text{Sr} = 0.710248$ (Weis *et al.* 2006). For each sample the $^{87}\text{Sr}/^{86}\text{Sr}$ value is reported with a 2σ error (absolute error value of the individual sample analysis minus internal error).

Results

Wood Taxonomic Assignments

The Owl, Otter and Pelican carvings all proved to be *Pinus* sp., specifically of the *taeda* anatomical group, the most definitive traits for which are the presence of pinoid cross-field pitting in the ray parenchyma and strongly dentate-reticulate ray tracheid wall thickenings (**Figure 7a**). This group encompasses some thirteen species native to the Southeastern Coastal Plain; these are indistinguishable as separate species

based on wood anatomical traits, which are shared across this group (Panshin and de Zeeuw 1980:44-446; Phillips 1941). In the timber industry, the *taeda* pines are collectively termed “yellow” or “southern hard pine”.

The material recovered from the Tomoka figure was insufficient for observation of all cellular traits in a three-dimensional perspective. It was possible, however, to compare the limited information gleaned from the thin sections (**Figure 7b-e**) with the anatomical structure of *Peltophorum* to corroborate or refute the original assignment to that genus. Placement to the family Fabaceae, particularly the Caesalpinoid legume subgroup, of which the genus *Peltophorum* is a member, is fairly secure. *Peltophorum* is a reasonably good match for most, but not all, anatomical details; some of the discrepancies may relate to taphonomic effects, if not simply the limitations of the material available for analysis. The sample fluoresced under ultraviolet light, further supporting this identification. We have thus provisionally assigned the wood to cf. *Peltophorum*, essentially in agreement with the earlier identification.

Radiocarbon dating

The five determinations on the Owl carving document the selected tree’s growth, from the innermost sampled growth rings, at AD 1161-1250 (Table 1 [1.7]²), through to the two combined terminus dates of AD 1281-1389 [1.3] on the outermost rings of the sculpture, with the greater probability (68.5%) suggesting AD 1281-1319 [1.3] for the felling date, which in turn is assumed to be close to its carving date. Though the sequence of determinations is consistent with the tree’s growth, there is a surprisingly large gap between the results for the basal portion, taken at only 10 cm apart (**Figure 5, left**). This cannot be reconciled in a Bayesian model with the ca. 35

² Bracketed numbers cross-reference with Table 1, where more detailed information about each of the artefact’s radiocarbon dates can be found.

growth rings evident in the section, which requires a minimum of 70 years growth in order for the dates to be successfully modelled in OxCal 4.2 (**Figure 8**). Currently, we cannot explain this discrepancy, though we are confident that it does not relate to contamination: the Py-GC/MS results clearly showed that the samples taken from the base, and pre-treated for the radiocarbon dating, were free from the historic conservation contaminants (**Figure 9**; see further discussion below). It is possible that the visible growth rings underestimate those present, with the analysis being impeded by the lack of proper preparation and polishing of the section.

Further complicating the issue is the difficulty of estimating general growth rates for 'southern pine' species. These may be quite fast growing, in the region of less than 1.2 rings/cm, at least under management (Haygreen and Bowyer 1996:286), although much depends on individual species, life stage, growing location and climatic conditions. The longleaf pine (*P. palustris*) is a good candidate for the Owl's source wood given the characteristic tall, straight, large-diameter boles of mature trees. This species has a very slow growing early "grass stage" (typically 6 years; range 3-12 years) during which no annual rings are formed (all energy being invested in the root system), which is followed by a "broom stage" (juvenile wood) when rapid height and thus also radial growth (i.e., increase in girth, stem-wood production) resumes (Barnes *et al* 1998; Meldahl *et al* 1999). This may be followed by a slower, mature growth rate, depending on moisture conditions and local stand dynamics (Fritts 2001; Meldahl *et al* 1999). Growth trends in slash pine (*P. elliotii*) and loblolly (*P. taeda*) are somewhat similar. Turning to the carvings specifically, Bullen gave the minimum thickness of the Owl carving as 45cm wide by 28 cm in depth: keeping in mind that sapwood was likely removed during the carving phase, this suggests a pine of at least 50cm in diameter (assuming at least 5cm of sapwood) – though some species can be upwards of 100cm in diameter at maturity. The cross-section of the removed basal end shows a minimum of 35 growth rings within 10cm; assuming a

constant growth rate, a tree with a minimum 50cm diameter would be over 175 years old when felled. This age estimate is in accordance with longevity records for longleaf and other southern pines (www.longleafalliance.org), and highlights the importance of targeting the outermost growth rings for dating.

The Otter [2] returned a date of AD 1456-1635, with a comparable result for the Pelican [3] at AD 1487-1644. Both are thus significantly later than the Owl. At some 15cm in diameter, and assuming a similar growth rate as that identified above for the Owl, the bole used to carve the Otter may have been in the region of ca. 50 years old. For the more substantial Pelican, at ca. 32cm in diameter, we could estimate a tree age of ca. 100 years. Given our sampling of the outer edges of the carvings, however, neither of these age estimates significantly affects the radiocarbon results.

The Tomoka figure yielded a calibrated age range of AD 1440-1620 (95%) [4], with the greatest likelihood falling within the period AD 1440-1521 (80%). Our result is not inconsistent with the previously obtained date of AD 1300-1638, but provides greater precision due to the targeted sampling (**Figure 5, right**), placing the carving just prior to, or at the cusp of earliest European contact.

Py-GC/MS

All three of the Py-GC/MS chromatograms exhibit a range of characteristic lignin degradation products based on identifications made previously by Galletti and Bocchini (1995). These compounds dominate the two chromatograms (**Figures 9a-b**) derived from wood sampled from the owl carving but are more minor components in the alvar consolidant-wood composite (**Figure 9c**) which is dominated by a later eluting series of unidentified isoprenoidal compounds. The lignin-derived compounds observed in all three samples primarily comprise components derived from vanillyl (guaiacyl) subunits.

From the Py-GC/MS results it is clear that all three samples contain lignified tissue. Moreover, the dominant occurrence of compounds derived from vanillyl (guaiacyl) moieties of the lignin macromolecular structure indicates a woody gymnosperm origin for the tissue, which is concordant with an origin from the genus *Pinus* (Hedges and Mann, 1979). The later eluting mixture of unidentified isoprenoidal compounds observed in the alvar consolidant-wood composite may well occur as a result of turpentine and linseed oil applied as part of previous conservation efforts associated with this carving. Importantly, the two wood samples (OxA-31563 and OxA-31564) taken from the base of the owl carving do not exhibit a similar distribution of later eluting compounds thereby supporting the proposition that they are free from any contamination conferred by the conservation history of this item.

Strontium isotope analysis

Eight $^{87}\text{Sr}/^{86}\text{Sr}$ measurements on modern trees growing immediately adjacent to the St. Johns River average 0.7083 ± 0.0002 (**Figure 6; Table 2**). The river valley's surficial sediments date to the Quaternary and are a mix of marine and windblown deposits, with unknown but presumably variable $^{87}\text{Sr}/^{86}\text{Sr}$ values. As it happens, the value obtained for the modern trees lies at the upper end of the range expected for the area's underlying Upper Tertiary limestone bedrock. Three samples from the dry, sandy interior part of Hontoon Island (pine flatwoods ecosystem, ca. 400 m from the river) are significantly higher, averaging $0.7085 \pm \leq 0.0001$ (Mann-Whitney U-test, $p = 0.025$). This is likely the result of the input of surficial Quaternary sediments within the river's catchment as well as atmospheric deposition. The combined six measurements from Tiger Bay and Tomoka State Parks average 0.7092 ± 0.0003 , consistent with the Quaternary beach ridge and dune sediments here, as well as with possible sea spray effects (modern ocean $^{87}\text{Sr}/^{86}\text{Sr} = 0.7092$). Two of these samples were taken from the inner and outer wood of a Florida red cedar (*Juniperus*

virginiana) tree stump in Tomoka State Park, in order to assess any changes over time due to modern contaminants. The stump was from a tree of approximately 30 cm diameter, so that the inner part was on the order of 60-100 years older than the outer part, which reflects the last few years, as the tree had been recently felled. The results are very similar to one another, suggesting no significant changes to the strontium isotope values in the groundwater due to recent activity here, including the extensive drainage that will have affected the water table.

Five samples from Seminole and Lower Wekiva parks to the west of Hontoon Island average 0.7094 ± 0.0006 . While the basement bedrock consists of Upper Tertiary limestone with $^{87}\text{Sr}/^{86}\text{Sr}$ values of < 0.7080 (Quinn et al. 2008: Fig, 2), these trees grew on Pleistocene sands and the sands and clays of the Pliocene Cypresshead Formation, which comes near to the surface here and forms part of Florida's surficial aquifer (Fountain 2009). To our knowledge, no strontium isotopic studies have been undertaken specifically on this formation, but clay minerals are usually relatively elevated in ^{87}Sr (certainly higher than the values for Pliocene limestone). In addition, there is the influence of atmospheric dust of Saharan origin ($^{87}\text{Sr}/^{86}\text{Sr} = \text{ca. } 0.71788 \pm 0.00068$ (2SE); Pett-Ridge et al. 2009), known to make a significant contribution to Florida's soils (Muhs et al. 2007; Prospero 1999), with trees trapping windblown dust and then contributing it to the soil via throughfall (Åberg et al. 1990). Confirmation of high $^{87}\text{Sr}/^{86}\text{Sr}$ values in the surficial aquifer is seen in measurements of water and sediment leachates taken from various depths in bore holes at two north Florida lakes (**Figure 10a**). Values from waters in the upper 7m average 0.7105 ± 0.0004 ($n = 12$), completely at odds with those of the Upper Floridian aquifer at ca. 0.7080 to 0.7085 obtained at depths greater than ca. 30m (Katz and Bullen 1986; Katz et al. 1987). One of these sites, Lake Barco, is within the same Cypresshead Formation as found in Seminole and Lower Wekiva parks.

While not statistically significant (due to small sample size), the results for the two parks differ: 0.7098 ± 0.0001 for Seminole and 0.7086 ± 0.0002 for Lower Wekiva (**Table 3**). This forms a clear spatial trend with increasing values moving away from the St. Johns River (**Figure 10b**). Those nearest to the river come closest to the expected limestone bedrock values. This is probably because: 1) the river itself is closer to bedrock, following the lowest-lying land and having eroded surficial deposits; and 2) the contribution of aquifers through the numerous springs feeding into the river, bringing $^{87}\text{Sr}/^{86}\text{Sr}$ values that are in equilibrium (or nearly so) with the underlying Tertiary limestone bedrock of the Floridian aquifer (Phelps 2001; Swarzenski et al. 2001; Toth 2003). The difference in elevation is confirmed by the GPS readings taken in the field (**Table 2**), and indeed a nearly identical correlation to that observed with distance from the river can be seen plotting elevation instead.

Turning to the Hontoon carvings, the $^{87}\text{Sr}/^{86}\text{Sr}$ measurements of five samples from the Owl average $0.70821 \pm <0.0001$, while five samples (out of six) from the Pelican average 0.7083 ± 0.0001 (**Figure 10c; Tables 4 and 5**). An untreated sample from the latter shows a much higher value (0.7091) and is treated as an outlier, highlighting that contamination can be an issue even though not necessarily affecting all parts of the carving. Indeed, two untreated samples show identical values to those of the pre-treated samples. This unpredictability nevertheless warrants the need for pre-treatment.

Both the Owl and Pelican are thus consistent with the 'local' signal of 0.7083 ± 0.0002 , derived from trees growing near the water at Hontoon Island and along the St. Johns River. Similar values to that of the Owl were also obtained on two hickory nutshells ($0.7081 \pm \leq 0.0001$) from a waterlogged archaeological site on Hontoon Island itself. In addition, published measurements on modern blueback herring (*Alosa aestivalis*) otoliths from the St. Johns River average $0.7081 \pm <0.0001$ (n =

20) (Turner et al. 2015). Broadly similar values of 0.7083 ± 0.0004 ($n = 8$) were obtained on human dental enamel from the Archaic period Harris Creek (8VO24) site on Tick Island, located ca. 16.5km to the north of Hontoon (Quinn et al. 2008). Taken together, these measurements on a range of materials from the St. Johns River provide a clear baseline of 0.7081–0.7083 for biologically available $^{87}\text{Sr}/^{86}\text{Sr}$ values, which in turn is broadly comparable to results on water from a series of springs in the St. Johns River catchment (0.7080 ± 0.0001 , $n = 7$) (Hoppe et al. 1999; Toth 2003).

Three measurements on the Otter, however, average significantly higher at 0.7089 ± 0.0001 . The wood from which this carving was made cannot have come from the immediate vicinity of the St. Johns River at Hontoon Island, nor is it consistent with the slightly higher values from the island's interior. The nearest values in this range in the present study derive from Lower Wekiva Park, ca. 4.6km to the west (possibly closer, since no samples were taken between 400m and 4.6km). This is still within the 5-10km Hontoon catchment area noted by Newsom (1987:48). While the Otter is the smallest of the Hontoon carvings (H: 88cm; W: 17cm), the pine trunk from which it was carved would still have been sizeable and unlikely to be transported any great distance overland, given the ubiquity of pine in the area, combined with its abundant waterways. Higher $^{87}\text{Sr}/^{86}\text{Sr}$ values are found to the east at Tiger Bay Park, which, as noted above and in contrast to the region to the west of Hontoon Island, is consistent with that area's Quaternary marine sediments. Waterways flowing through, or fed by springs from both Tertiary and Quaternary sediments will have intermediate values, imparting them to the trees growing along their shores. Any such location may be the source of the wood used for the Otter carving. The distance involved need not be great and it is not possible to be specific about its origins, but nevertheless, it can be said that – unlike the Owl and Pelican – the Otter is not from the immediate vicinity of Hontoon Island. The consistency of the three measurements made on untreated and pre-treated fragments of the Otter demonstrate that any contamination with strontium

in the water of the St. Johns River – in which the carving sat for some five centuries – and preservatives did not significantly alter the results (see Snoeck *et al.* in prep).

Finally, three measurements on the Tomoka carving average 0.7089 ± 0.0001 . This falls within two standard deviations of the modern tree values from Tomoka State Park and Tiger Bay obtained in this study, and so is consistent with an origin in the area in which it was found. However, this value is expected to be common along much of coastal Florida (Scott *et al.* 2001), and likely extending considerable distances inland in certain areas – the Tiger Bay samples, for example, were taken from trees growing ca. 21km from the coast.

Discussion

The results obtained here provide new insights into east-central Florida's surviving pre-Columbian wood carvings. Multiple radiocarbon determinations on the Hontoon Owl provide a date range of AD 1281-1389 [1.3]. It has previously been suggested that not only were the Pelican and Otter carvings contemporary with the Owl, but "...based on the craftsmanship, there seems little doubt that all three were manufactured by the same artist... or an apprentice" (Purdy 2007:61; 1991:119). However, there is no overlap in the radiocarbon results between the two groups: while the Owl most likely dates to AD 1281-1389 [1.3], the Pelican and Otter both date to nearly a century or more later, post-AD 1456 [2-3]. This suggests that the Hontoon carvings span several generations, and they were not erected as a group, nor carved by the same artist, despite being found in the same location. As recognised by both Purdy (1991; 2007) and Schwehm (1983), however, they still do appear to belong to the same artistic tradition, with distinctive, stylised depictions of animals, enhanced with two-dimensional designs of circles, semi-circles, guilloche and secondary animals (i.e., the otter's fish). It is also possible that they stood together, though the wet and humid conditions make it unlikely that a pine pole would

survive in the condition of the Owl for over a century. However, it is of course highly improbable that these were the only three ‘totems’ erected at the Hontoon-Thursby site group. Far from it, and in contrast to artistic reconstructions featuring the Owl carving in isolation (e.g., backdrop mural to the Owl display at the Timucuan Ecological and Historic Preserve; large-scale diorama in the Florida Museum of History’s First People exhibit; cover art in Hann 1996), there may have been many monumental carvings at the site, both standing at the same time and erected sequentially. The site may in this respect have had something in common with Fort Center (Sears 1982; Purdy 1991).

What is not held in common with Fort Center, however, is the date of the Hontoon carvings, all of which can now be confirmed as significantly later. The wooden effigies at Fort Center appear to have been erected entirely within the Middle to Late Woodland (Belle Glade II, AD 200-1000), with one carving directly radiocarbon dated to cal. AD 540-650 (Beta-244803: 1450 ± 50 BP)(Thomson and Pluckhahn 2012:55). Together with the stylistic differences between the Hontoon and Fort Center carvings, this suggests that these were completely independent traditions, though future findings may extend their chronologies. On present evidence, the origins of the monumental wood sculptures at Hontoon/Thursby, beginning with the Owl, may indeed be related, even if indirectly, to the impact of Mississippian influences, well documented not far to the north (Ashley 2012; Ashley and Rolland 2014; Milanich 1994; Moore 1999).

The strontium isotope results for the Owl and Pelican are consistent with trees growing in the immediate vicinity of Hontoon Island. The Otter, however, is not ‘local’ but derives from a location with slightly but significantly higher $^{87}\text{Sr}/^{86}\text{Sr}$ values. This need not be any great distance: we suspect that comparable values can be found within a few kilometres of the site, though additional sampling of modern trees will be

required to confirm this. The main point here, however, is that the wood used to carve this particular sculpture came from some distance, which itself suggests that the carving was an organised event (involving the labour of transport, carving, and erection at the site, most likely the participation of the wider community), from the specific harvesting of the appropriately sized material, to the depicted subject matter, to its eventual placement near Thursby Midden/Mound. Further, there is a rich ethnographic literature on the various criteria by which timber is selected, particularly for the carving of ceremonial artefacts, and particular considerations of distance might be overshadowed by more esoteric concerns. In the Caribbean, for example, trees animated by spiritual forces would articulate their desire to be carved into important *cemís* (depictions of spirits and ancestors) to shamans under the influence of the hallucinogen cohoba (see Pané 1999:25-26), while in Siberia, only trees from specific locations were carved into spirit figures (Jordan 2003).

The Hontoon corpus also provides a window onto the final centuries of activity at a location with a history spanning several millennia. The dates for the carvings correspond to a period that marked a transition in faunal, floral and artefactual remains, including the first presence of European trade items (Purdy 1987a-b).³ Historian John Hann attributes some of these changes to occupation and reoccupation of the site by various groups, including the Mayaca during the late pre-Contact period, followed by resettlement of a mix of peoples, including the Mayaca, their Timucuan neighbours, and the more far-flung Yamassee, during the Mission period (Hann 2003:69-70; Milanich 1996:15). The site also yielded salt-water shells and exotic flints suggesting links to the coast, and to this can be added the possibility

³ For example, a shift from emphasis on freshwater snails to freshwater mussels, as well as to more use of terrestrial fauna over time (Wing and McKean 1987); the *in situ* domestication of a scallop-like squash (Decker and Newsom 1988) and the appearance of maize at the site (Newsom 1987).

of sourcing woods from neighboring regions, as the strontium values for the Otter suggest.

It remains unclear how these various factors relate to one another, and what it implies about the people who erected and maintained the carvings, though it is hoped that with further investigation these aspects will converge. What is clear from the scale of the Hontoon carvings is that they had importance and purpose. The context of the finds, dredged as they were from the immediate vicinity of Thursby Mound, where Moore excavated numerous burials, implies their function as grave markers and in mortuary ceremonies. There is a long tradition of mortuary monumentality in Florida, from Fort Center and Weeden Island to accounts from southern Florida well into the early 18th century, where ceremonies were held in front of large-scale bird sculptures at cemeteries, with frequent gifts of offerings and food provided for the deceased. But were they solely grave markers/focal points for the appeasement of spirits, or did they have broader meaning? Some have also suggested that they carried clan significance – Bullen proposed that the owl marked Thursby as the Owl Clan village, functioning as a type of territorial marker. Indeed, Hontoon's position – on the frontier between Timucua and Mayaca peoples – may also suggest their role of cultural or boundary markers. Their unique, highly stylised conventions might lend some support to this scenario: Alice Schwehm (1983:93; 95) noted that the angular St. John's carving style marks a radically different approach to the fluid naturalism seen in the wood carving of more southern sites.

The date of the Tomoka figure has been refined from the previously available determination to AD 1440-1521 (80% confidence). While its strontium value is consistent with the east-central Florida coast where it was found, a local origin is seemingly precluded by the confirmation that the figure was carved from the wood of a tropical tree species in the genus *Peltophorum*. While two species presently occur

in the state, they are not considered to be native (Wunderlin *et al.*, 2016). A Caribbean link has previously been proposed (Morrell 1974; Purdy 1988), given that the genus occurs naturally in the islands – particularly Cuba and the Bahamas (Fern 2012; Barreto *et al.* 1985) – but this is problematic on a number of grounds. Cultural contacts between the Caribbean and Florida have been proposed over the last century (e.g. Fewkes 1904; Rouse 1949; Sears 1977), though these have been based mainly on perceived stylistic parallels and unrefined chronologies (Knight and Worth 2007; Marquardt 1990). In terms of Euclidean distance, the closest known source of *Peltophorum* is the Bahamian archipelago. However, this can be excluded because the strontium isotope range for trees growing on the Bahamas has been extremely well characterized as $0.7092 \pm \leq 0.0001$ ($n = 91$) (Ostapkowicz *et al.* 2012). The northwards flow of the Florida Current (Gulf Stream) raises the possibility that the piece could have arrived from Cuba, and its geology suggests that strontium isotope values consistent with that of the Tomoka figure occur there. However, its arrival as a carved figure can be excluded because its iconography is atypical of the well-documented wood carving traditions of the late pre-Columbian Caribbean (Ostapkowicz 1998). This leaves the option of the wood bole being transported to Florida – either by people traveling from Cuba, or of its washing up as a piece of driftwood rather than as a finished carving, but here we have to question whether a woodcarver would choose hardened and potentially internally damaged driftwood over easily available local woods.

A far more probable scenario is that the Tomoka figure derives from Florida itself, and to this point we proffer two hypotheses. The first is that the figure originated in southern Florida, where the tropical flora is well developed and relatively enduring below the 23°C isotherm (Myers 2000a). This assumes that *Peltophorum* (*P. adnatum*) was previously present as a natural component of the tropical hammock flora (Long and Lakela 1976; Myers 2000b). The second possibility is that the figure

came from the immediate area, i.e., the Tomoka river environs (Volusia, Brevard counties), assuming a northward extension of the flora along the coasts, much as has occurred in recent years, with the range expansion of tropical mangrove species, among others (see Mayers 2000b). With regard to either hypothesis, natural, unassisted (by humans), dispersal of at least *P. adnatum* by rafting or via bird mutualisms from either Cuba or the Bahamas archipelago is tenable, even if only ephemerally established in either area (the southern peninsula and/or the central east coastal area). Moreover, as first suggested by Wheeler (1996:281), the carving exhibits parallels with the anthropomorphic carvings of the southern Florida Glades tradition. The clearest comparandum is an undated carving from Palm Hammock, Glades County – over 270km south of Tomoka State Park – featuring similar chevron-shaped eyebrows connected to a rectangular nose, small, round eyes, tight fitting cap or headdress and an elaborate hair bundle at back (Wheeler R 2011:143-144). The compact Tomoka figure is clearly a portable object, unlike the more monumental Hontoon Island carvings. While we have no biologically available baseline strontium isotope values from southern Florida, we expect similar values to those found on the Quaternary sediments of east-central Florida, which extend for considerable distances to the south.

Conclusions

This multi-disciplinary project has established a foundation for investigating the chronology, materials and provenance of four key east-central Florida carvings of the last centuries leading up to European contact. The study has refined the dating of one of the most iconic examples of pre-Columbian Florida wood carving: the series of radiocarbon dates on the Owl provides a precision of ca. 100 years (AD 1281-1389). This is constrained even further to some 40 years if the greatest probability range is considered (AD 1281-1319; 68.5%). The dating results also indicate that the three Hontoon/Thursby sculptures were not carved and erected at the same time,

which speaks to a continuation of distinctive carving and symbolic traditions over several generations as well as the need for periodic placement of sculptures at the Thursby Mound. The Tomoka figure chronology has been refined from the over 300 year date range established in 1978 (AD 1300-1638; 95.4% probability) to a much tighter range of 60 years at AD 1440-1521 (80.1%), placing it in the late prehistoric/early protohistoric period.

The modern strontium isotope results above all emphasise the importance of establishing local baselines. Of the Hontoon/Thursby carvings, the Owl and Pelican are consistent with the immediate environs of the site, while the Otter differs significantly, though the distance from which the timber came is at present unclear: it may have been within the 10km catchment of the site or it could have been from further away. While cultural links to the Caribbean cannot be confirmed for the Tomoka figure, its style clearly reflects regional/supra-regional influences (southern Glades/Mississippian respectively). This type of chronological, as well as stylistic and cultural (Ostapkowicz et al. forthcoming) detail, being entirely based on perishable materials, is rarely available in the archaeological record unless conditions are conducive to organic preservation, yet in the Hontoon Island vicinity, and indeed, across much of Florida, organic artefacts are relatively abundant and rich in interpretive potential. Despite several decades of study and increasingly sophisticated analytical methods, we have barely scratched the surface of the wide and varied wood carving repertoire of this region. There is scope for greater chronological, material and provenance resolution, and through these inroads, deeper insights into people's lives, beliefs and traditions.

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Figure captions

Fig 1. Three views of the Owl carving; *Pinus* sp., AD 1281-1319 (68.5%; calibrated and modelled), $^{87}\text{Sr}/^{86}\text{Sr}$: $0.70821 \pm <0.0001$ (average of five samples); Hontoon-Thursby site group; H: 366cm (cut down to 282 cm); W: 43cm Depth: 28cm; Circumference: 129cm (max). Images courtesy Florida Museum of Natural History, combined in Adobe Photoshop by Ostapkowicz. The carving is owned by the Timucuan Ecological and Historic Preserve, and is currently on display at the Fort Caroline National Memorial (FOCA 493).

Fig 2. Three views of the Otter carving; *Pinus* sp., AD 1456-1635 (95.4%), $^{87}\text{Sr}/^{86}\text{Sr}$: 0.7089 ± 0.0001 (average of 3 values); Hontoon-Thursby site group; H: 88cm; W: 17cm Depth: max 15cm. Image: Ostapkowicz, courtesy of the Florida Department of State, Division of Historical Resources, catalog #81A.37.2.1.

Fig 3. The Pelican carving; *Pinus* sp., AD 1487-1644 (95.4%), $^{87}\text{Sr}/^{86}\text{Sr}$: 0.7083 ± 0.0001 (average of 5 samples); Hontoon-Thursby site group; H: 194cm; W: 31cm Depth: max 32cm. Image: Ostapkowicz, courtesy of the Florida Department of State, Division of Historical Resources, catalog #81A.37.2.2

Fig 4. Four views of the Tomoka carving; *Peltophorum* sp., cf. *adnatum*, AD 1440-1521 (80.1%), $^{87}\text{Sr}/^{86}\text{Sr}$: 0.7089 ± 0.0001 (average of 3 samples); Tomoka State Park, Flagler County; H: 22cm; W: 7cm D: 6cm. Image: Ostapkowicz, courtesy, Tomoka State Park and Bureau of Natural and Cultural Resources, Florida Park Service, TMST.11.1.

Fig 5. Left: Cross section (W: ca. 10cm) of the removed portion of the Owl's base, the length of which measured 76cm in 1955. Only 61.5cm currently remains,

suggesting that the 15cm was removed for the radiocarbon dated run in 1958. The cross section clearly shows ca. 35 growth rings within the 10cm width. The drill holes were made at some point in its history; their purpose currently remains unclear.

Right: original ^{14}C sampling location on the Tomoka figurine, positioned at the pith of the bole and stretching roughly 3cm across the 6.7cm base. The locations of this study's sample sites, and the radiocarbon results, are superimposed in white (combined ranges for Owl [1.3; 1.7], and single date for Tomoka [4]).

Fig 6. Geological map of east-central Florida (based on Scott et al. 2001), with modern sampling locations and archaeological site locations (black circles; springs: white circles). Qh: Holocene sediments; Qbd: Quaternary beach ridge and dune; Qu: Quaternary undifferentiated; Qa: Anastasia Formation (Pleistocene); TQsu: Plio-Pleistocene shelly sediments; TQu: Plio-Pleistocene undifferentiated sediments; TQd: Plio-Pleistocene dunes; Tc: Cypresshead Formation (Pliocene); Thc: Hawthorn Group, Coosawhatchie Formation (Miocene); To: Ocala Limestone (Eocene). Drawn by Schulting and Ostapkowicz.

Fig 7. Wood sections (a): Otter figure: radial longitudinal section showing xylem ray with diagnostic dentate-reticulate ray tracheids, *Pinus* sp., *Taeda* section (southern hard pines) (400x). (b-e): Tomoka figure: some diagnostic wood anatomical traits observed in tangential longitudinal section during analysis of samples of the tropical hardwood, Caesalpinioideae, cf. *Peltophorum* sp.; **(b)** and **(c)** polygonal medium-sized intervessel pitting and sectional view of simple perforation plate (400x, 600x); **(d)** and **(e)** storied uni- and biseriate rays, 7-12 cells high (200x, 400x). Images: Newsom.

Fig 8. Bayesian model (OxCal 4.2) showing sequence from interior to exterior sample locations of the Hontoon Owl, separated by ca 10cm. This is required to represent at least 70 years of growth in order for the model to be accepted.

Fig 9. Partial Py-GC/MS chromatograms of samples taken from the Hontoon owl carving: (a) OxA-31563 (growth, basal fragment, 10cm interior to edge), (b) OxA-31564 (terminus, basal fragment), and (c) Alvar consolidant-wood composite scraped from the base of the carving.

Fig 10. a. $^{87}\text{Sr}/^{86}\text{Sr}$ values for water and sediments plotted against depth from bore holes at Lakes Bradford and Barco, northern Florida (data from Katz and Bullen 1986; Katz et al. 1987). **b.** Plot of modern plant $^{87}\text{Sr}/^{86}\text{Sr}$ values at increasing distances from the St. Johns River (based on data in Table 2). **c.** Average $^{87}\text{Sr}/^{86}\text{Sr}$ results on the archaeological wood carvings (error bars are within the size of the symbols). The light green and blue bands show the range of biologically available strontium on trees growing alongside the St. Johns River and in Tiger Bay and Tomoka State Parks, respectively.

Table 1.

Summary of ¹⁴C and wood ID results for the east-central Florida corpus. Eight AMS radiocarbon results (excluding combined dates listed in 1.3 and 1.7) are given from the four carvings from the vicinity of Hontoon Island and northern Tomoka State Park. The Oxford Radiocarbon Accelerator Unit lab numbers (OxA) are provided alongside the material and sample site (e.g., terminus: sapwood or outer growth rings, to indicate when tree was felled and likely carved; growth: selected areas within the bole marking growth rates). Multiple dates are listed sequentially, with terminus dates listed first, followed by growth rates with. Dates BP and calibrations at 95.4% are listed, the most likely calibration ranges highlighted in bold. All dates are calibrated using the IntCal13 dataset (Reimer et al., 2013) and OxCal v4.2.2 (Bronk Ramsey, 2013).

Artefact/acc. No./institution	Material	Sample		OxA	δ ¹³ C	Date	Calibrated (95.4%)
Hontoon Owl, Timucuan Ecological and Historic Preserve, FCA 493 Fig 1	<i>Pinus</i> sect. <i>Taeda</i>	terminus (basal fragment)	1.1	OxA-31564	-25.1	633 ± 27	AD 1286-1330 (39.1%) AD 1339-1397 (56.3%)
			1.2	OxA-32983	-24.9	664 ± 26	AD 1277-1319 (50%) AD 1352-1390 (45.4%)
			1.3	Combine		649 ± 19	AD 1281-1319 (68.5%) AD 1354-1389 (26.9%)
		Growth rate, main sculpture, 5cm interior to edge	1.4	OxA-31347	-23.1	750 ± 29	AD 1223-1286 (95.4%)
		Growth, basal fragment, 10cm interior to edge	1.5	OxA-31563	-24.0	844 ± 27	AD 1155-1261 (95.4%)
			1.6	OxA-32982	-24.1	846 ± 28	AD 1059-1064 (0.7%) AD 1154-1261 (94.7%)
			1.7	Combine	-24.1	845 ± 20	AD 1161-1250 (95.4%)
Otter, Museum of Florida History, 81A.37.2.1 Fig 2	<i>Pinus</i> sect. <i>Taeda</i>	Terminus	2	OxA-31998	-24.0	352 ± 24	AD 1456-1635 (95.4%)
Pelican, Museum of Florida History, 81A.37.2.2 Fig 3	<i>Pinus</i> sect. <i>Taeda</i>	Terminus	3	OxA-31999	-24.1	321 ± 25	AD 1487-1644 (95.4%)
Tomoka figure, Tomoka State Park, TMST.11.1 Fig 4	Fabaceae, cf. <i>Peltophorum</i> sp.	Terminus	4	OxA-32000	-27.6	395 ± 24	AD 1440-1521 (80.1%) AD 1591-1620 (15.3%)

Table 2. $^{87}\text{Sr}/^{86}\text{Sr}$ results on modern plants

<i>Location</i>	<i>Bedrock</i>	<i>Id.</i>	<i>Lat</i>	<i>Long</i>	<i>Elev (m)</i>	<i>Material</i>	$^{87}\text{Sr}/^{86}\text{Sr}$	$\pm 2\sigma^*$
Hontoon Is.	Pliocene	H7	c28.9688	c-81.3588	1	pine	0.708500	0.000009
Hontoon Is.	Pliocene	H8	c28.9688	c-81.3588	1	pine	0.708500	0.000009
Hontoon Is.	Pliocene	H2	28.968799	-81.358815	1	pine	0.708563	0.000011
Hontoon Is. carpark	Pliocene	H9	28.976172	-81.356841	2	pine	0.708200	0.000010
St John's River	Pliocene	SJ2	29.008807	-81.380938	2	unid. deciduous	0.708200	0.000009
St John's River	Pliocene	SJ1	29.006143	-81.384045	1	Florida maple	0.708313	0.000009
Hontoon Is.	Pliocene	H1	28.971948	-81.359878	1	unid. deciduous	0.708160	0.000010
Hontoon Is.	Pliocene	H6	28.974484	-81.356504	1	branch from small tree	0.708049	0.000008
Lower Wekiva Park	Pliocene	LW1	28.913151	-81.406733	10	pine (long needle)	0.708716	0.000013
Lower Wekiva Park	Pliocene	LW2	28.913009	-81.406732	10	pine (long needle)	0.708989	0.000009
Seminole State Park	Pliocene	S1	28.889479	-81.461845	19	pine	0.709691	0.000009
Seminole State Park	Pliocene	S2	28.888345	-81.460310	18	pine (long needle)	0.709912	0.000009
Seminole State Park	Pliocene	S3	28.889397	-81.460646	19	pine	0.709896	0.000007
Tiger Bay State Park	Quaternary	TB1	29.112216	-81.188549	12	pine (long needle)	0.709479	0.000008
Tiger Bay State Park	Quaternary	TB2	29.111625	-81.188330	12	pine (long needle)	0.709264	0.000008
Tomoka State Park	Quaternary	T1	29.353499	-81.090065	4	pine (long needle)	0.709260	0.000009
Tomoka State Park	Quaternary	T2a	29.345073	-81.086906	2	Florida cedar (inner)	0.709018	0.000007
Tomoka State Park	Quaternary	T2b	29.345073	-81.086906	2	Florida cedar (outer)	0.708955	0.000009
Tomoka State Park	Quaternary	T4	29.342356	-81.085631	2	live oak	0.709481	0.000010

* 2σ has been calculated following the equation: 2 x mean of 60 Sr ratio measurements x standard error

Table 3. Summary of $^{87}\text{Sr}/^{86}\text{Sr}$ results on modern plants by sampling locations

Group	$^{87}\text{Sr}/^{86}\text{Sr}$	$\pm SD$	n	Comments
Hontoon/St John's River	0.708311	0.000189	8	
Hontoon Is. Interior	0.708521	0.000036	3	Hontoon interior vs. riverside
St John's riverside	0.708184	0.000095	5	Mann-Whitney, p = 0.0253
Quaternary ~coastal	0.709178	0.000241	4	Tomoka & Tiger Bay
Pliocene (Tertiary)	0.709441	0.000552	5	Seminole & Wekiva
Seminole Park	0.709833	0.000123	3	Seminole vs. Lower Wekiva Parks
Lower Wekiva Park	0.708853	0.000193	2	Mann-Whitney, p = 0.0833

Table 4. $^{87}\text{Sr}/^{86}\text{Sr}$ results on archaeological material

Sample	Species	Untreated		Pre-treated	
		$^{87}\text{Sr}/^{86}\text{Sr}$	$\pm 2\sigma^*$	$^{87}\text{Sr}/^{86}\text{Sr}$	$\pm 2\sigma^*$
Hontoon Owl	<i>Pinus</i> sect. <i>taeda</i>	0.708130	0.000020	0.708089	0.000011
Hontoon Owl	<i>Pinus</i> sect. <i>taeda</i>	0.708097	0.000015	0.708114	0.000009
Hontoon Owl	<i>Pinus</i> sect. <i>taeda</i>	/	/	0.708174	0.000017
Hontoon Pelican	<i>Pinus</i> sect. <i>taeda</i>	0.708234	0.000011	0.708334	0.000030
Hontoon Pelican	<i>Pinus</i> sect. <i>taeda</i>	(0.709143	0.000015)	0.708069	0.000010
Hontoon Pelican	<i>Pinus</i> sect. <i>taeda</i>	0.708389	0.000018	0.708318	0.000009
Hontoon Otter	<i>Pinus</i> sect. <i>taeda</i>	0.708866	0.000009	0.708883	0.000015
Hontoon Otter	<i>Pinus</i> sect. <i>taeda</i>	/	/	0.708892	0.000011
Tomoka	Fabaceae, cf. <i>Peltophorum</i>	0.708798	0.000030	0.708870	0.000010
Tomoka	Fabaceae, cf. <i>Peltophorum</i>	/	/	0.708916	0.000026
Hontoon midden, nutshell A	<i>Carya</i> sp.	0.708109	0.000010	/	/
Hontoon midden, nutshell B	<i>Carya</i> sp.	0.708078	0.000009	/	/

* 2σ defined in Table 2

Table 5. Summary of $^{87}\text{Sr}/^{86}\text{Sr}$ results on archaeological materials

<i>Sample</i>	<i>Species</i>	<i>n</i>	$X^{87}\text{Sr}/^{86}\text{Sr}$	$\pm SD$
Owl	<i>Pinus</i> sect. <i>taeda</i>	5	0.70812	0.00003
Pelican	<i>Pinus</i> sect. <i>taeda</i>	5	0.70827	0.00012
Otter	<i>Pinus</i> sect. <i>taeda</i>	3	0.70888	0.00001
Tomoka	<i>Peltophorum</i> sp.	3	0.70886	0.00006
Hontoon midden, nutshells	<i>Carya</i> sp.	2	0.70809	0.00002



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East-central Florida pre-Columbian wood sculpture: Radiocarbon dating, wood identification and strontium isotope studies

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