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The Magnificent Seven: Marine Submerged Precontact Sites Found by Systematic Geoarchaeology in the Americas

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ABSTRACT

There are significant challenges to answering questions of Native American precontact history with data from sites in marine submerged continental shelf settings. We find seven published examples of projects in the Americas that encountered archaeological sites through systematic and phased geoarchaeological research. These seven projects share similar characteristics: recognition of archaeological potential, mapping and learning paleolandscape configurations, modeling where past human behaviors should be expected and, importantly, testing those places underwater. We summarize the approaches and outcomes of each project, discuss similar characteristics, and recommend additional strategies for future discoveries.

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Introduction

In the Americas there is a short list of projects using systematic, phased geoarchaeological research methods to find precontact sites in marine submerged continental shelf settings. We compiled data on seven published research projects that followed similar trajectories to success (Table 1). First, recognition of archaeological potential and understanding paleolandscapes by mapping and study. Then, modeling site locations from local terrestrial analogs, and, most importantly, testing models by underwater investigation and sampling paleolandscapes directly. The projects are in three regions of North America: Pacific Northwest Coast, Baja California, and Gulf of Mexico (Figure 1). Our goal is to show how the researchers of these seven projects found sites through methodical and phased research, overcoming shared challenges of obtaining resources to map and study marine submerged landscapes, getting out to sea, and working underwater. Regardless of the geographic and environmental differences of these projects, note that each begins with the premise that submerged precontact sites are found and sampled as methodically as those terrestrially, given that the field work is technologically and logistically constrained. Each of these seven projects focused on two genres of information: past landscape configurations and past human behaviors expected in those settings.

In this paper we describe each project with regard to mapping and modeling paleolandscapes, modeling human behaviors, and testing and analyzing sediments to find or

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Table 1. Summary details of seven sites found by systematic phased geoarchaeological methods.

Project	Funding	Time on site	Setting	Depths	Methodology	Age	Site type
Gulf of Mexico: PaleoSabine	MMS, US Parks Service, BOEM	2 Field seasons	Buried in marine sediments	12 m water depth ~5.5 m into substrate	Model site location with terrestrial analogs. Remote sense for buried features. Core paleochannel margins, levees	Early Holocene by radiocarbon	Possible camp and midden
Belize: Wild Cane Cay, Punta Ycacos Lagoon	NSF, EarthWatch	Annual field seasons 1985–present	Shallowly buried structures and ceramic vessels in younger mangrove peat	2 m water depth 1 m into substrate	Boat survey looking in water, pedestrian, then floating survey, mapping. Excavation along transects, deeper sites with surface supplied air. Core peat to 7m; SONAR from AUV, drone survey.	Late Holocene Classic Maya by radiocarbon, and diagnostics	Pole and thatch salt works
Gulf of Mexico: PaleoAucilla, PaleoEconfina	Private, EarthWatch, NSF, State of Florida	>10 field seasons PaleoAucilla	Exposed landscape, pocketed karst with sediment packages locally	2–5 m water depth 1 to 3 m into substrate	Digitized bathymetry for homemade DEM from navigation charts to find paleochannels. Diver survey and controlled hand-fan collections. Induction dredge excavations, coring in paleochannel.	Late Pleistocene Early Holocene Middle Holocene by diagnostics	Clustered chipped stone tools and debitage, quarries, and shell middens
British Columbia: Montague Harbor	Parks Canada, British Heritage Trust	Four field seasons	Buried, bedded midden deposit with food remains, organic and lithic artifacts	~4 m water depth 2.8 m into substrate	Previous excavations at high waterline, augers show similar strata continue offshore. Excavation of two 2 × 2 m units by air lift 2.8 m.	Middle Holocene Late Holocene by radiocarbon	Intertidal midden
Pacific Northwest Coast: Werner Bay, Hecate Strait	Parks Canada, Canadian Geological Survey, CRM	More than 10 Field seasons	Exposed rocky paleochannel terrace	53 m water depth 0.5 m into substrate	Multibeam used for surface mapping, clam bucket grab samples. Diver surveys.	Late Pleistocene by sea level	Isolated artifact
Gulf of Mexico: Tampa Bay, Hillsborough Bay	CRM	~10 days	Buried in marine seds	3.3 m water depth ~4 m into substrate	Buried Paleochannel margin from subbottom profile data and local site distributions. Monitor material from hydraulic dredge excavations.	Middle Archaic by diagnostics	Possible camp
Baja, México: Isla Espiritu Santo	National Geographic and NOAA	Three field seasons	Exposed rocky landscape	~20 m water depth 0.9 m into substrate	Homemade DEM with echosounder, side scan Sonar mapping. Testing by diving and hand fanning, small air lift.	Unclear early Holocene by sea level very late Holocene by radiocarbon	Probable midden

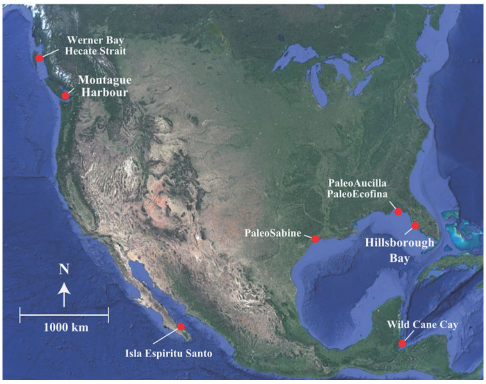

Figure 1. Locations of seven projects that found submerged precontact sites by methodical, phased research.

perceive "sites" (i.e. material evidence of human behavior). We discuss avenues of funding and different aspects of the projects and then appraise the evidence from each project, evaluating whether unequivocal artifacts are present, whether the geologic context is secure, and if there are radiometric ages associated to frame both (Haynes 1969). We conclude by discussing promising projects in development and observe that evidence for first people's early coastal migration in the Pacific Northwest Coast is absent. We order the projects as they occurred.

PaleoSabine 1977–1986

The earliest example of systematic, phased research set a precedent for submerged precontact studies in the Americas. Between 1976 and 1986, Coastal Environments, Inc. (CEI) was contracted to develop survey and testing guidelines for precontact cultural resources. These guidelines were intended for Gulf of Mexico cultural resource management (CRM) surveys using petroleum industry remote sensing data. The CEI team designed and carried out a research project with three phases in the PaleoSabine channel, offshore between Texas and Louisiana (Figure 1). The approach was to model, based on terrestrial analogs, localities where Native Americans likely lived, such as river channel terraces and levees. Next, they remotely sensed for such locations offshore, and last, they tested those identified locations by vibracoring specific targets (CEI 1977, 393; Gagliano et al. 1982; Pearson et al. 1986, 2014)

CEI geoarchaeologists collectedsub-bottom profiler data from widely spaced (600 m) sub- track lines offshore and then plotted reflector positions and depths to construct contour maps of buried surfaces. CEI then collected 20 vibracores in a crisscrossing fashion over a buried paleochannel with levee and terrace features to test the paleolandscape models inferred from these data (Pearson et al. 2014, 61). The seafloor depths were ∼12 m and cores, dropped from a 120 ft research vessel, penetrated sediments between 5.5 and 10.6 m.

CEI geoarchaeologists employed analytic methods developed by Gagliano et al. (1982, 94–109) to process small-volume sediment samples from the cores. The methods include particle size and geochemical analyses, as well as "point counting" particle type studies. There were two important findings from this 1982 study about the recognition of submerged precontact sites. The first is the low probability of encountering artifacts from a core, even when collected within the bounds of a known archaeological site. The second finding is that sites are indicated from point counting by particle types and diversity (Gagliano et al. 1982, 99–107).

Evidence for past human presence along the PaleoSabine came between 6 and 7 m below marine sediments from multiple cores. The evidence included a bed of disarticulated shell from the paleochannel margins and "charred wood and vegetation, nut hulls, seeds, fish scales, and bone from fish, reptiles, birds, and small mammals" from the paleolevee. Geochemical analysis indicated increased phosphorous content in the levee sediments, also consistent with human presence. *Rangia* shell from the shell bed produced an age of ~9000 cal BP (Pearson et al. 2014, 63). This near-coastal setting is consistent with eustatic sea-level estimates of marine transgression at the location soon thereafter (Siddall et al. 2003). Evans (2020) continues this research around the PaleoSabine with forays to test by coring targets identified from CRM projects and data from petroleum industry surveys.

Belize 1985–Present

In Belize, in the mid-1980s at Wild Cane Cay, McKillop (1995, 2002, 2005a) recognized late Classic period Maya materials (AD 600–900) were flooded by groundwater and she reasoned that sea levels rose and sites of that age, and possibly earlier, should continue offshore (Figure 1). The sites McKillop found offshore are massive salt production facilities (McKillop 2019, 2002; McKillop et al. 2019). To map features and reach tests units, researchers floated on air mattresses, with masks and snorkels in ~1 m water to avoid damage to the peat substrate and structures (McKillop 2005b). Thousands of mapped posts defined submerged pole and thatch building outlines. Posts and associated briquetage (ceramic vessels used for salt production) were marked and mapped with a total station. Three-dimensional projections of structures and past landscapes are made from these data. Through-water drone photography is used to identify features and places for testing operations (McKillop 2002). Other remote mapping methods include side-scan sonar remote sensing by autonomous underwater vehicle (AUV).

Initially, McKillop (2005a, 2002, 1995) excavated shovel test pits into peat around Wild Cane Cay by wading, confirming the model that *in situ* deposits continued offshore. Survey by boat in Punta Ycacos Lagoon confirmed additional submerged features identified from aerial photos (McKillop 1995). Surface supplied diving excavations at Punta Ycacos occurred along transects, with rope tethered to the seafloor, PVC pipes placed at 1 m intervals, and 1 × 1 m metal frames to control excavations. A large steel knife was used to cut the anaerobic peat matrix surrounding structures and artifacts into 10 cm level blocks. These blocks are placed on floats tied to a pulley system and conveyed off-site for water screening through 0.635 cm mesh. Column and sediment samples from each unit are collected for geochemical and loss-on ignition (LOI) analyses. Plant parts are identified by microscopy and pottery and wood are kept in bags of water and desalinated in a wet lab. Select specimens are photographed for 3 D imaging. Samples of wood posts are cut for species identification and ^{14}C dating. An asymmetrical Mayan canoe paddle found at Punta Ycacos Lagoon is the only such artifact known, as well as an example of the preservation potentials of anaerobic conditions (McKillop 2005b). McKillop, Sills, and Harrison (2010) were also able to construct a late Holocene sea-level record from sediment coring and radiocarbon dating.

PaleoAucilla/PaleoEconfina 1986–Present

CEI's 1977 Gulf of Mexico study described the Apalachee Bay of Florida as highly likely to contain offshore precontact sites (Figure 1; CEI 1977). This potential was identified from the abundance of terrestrial Paleoindian and Archaic sites that should continue offshore. The marine environment of Apalachee Bay is relatively low energy and the seafloor geology is exposed and shallowly buried karst with a very low slope. These facts are advantageous for site abundance, preservation, and research.

For these reasons, Faught began research in this region in 1986, diving and snorkeling offshore with then Florida State Underwater Archaeologist Jim Dunbar and several avocationals. Artifacts were found at several rock outcrops mapped on local NOAA navigation charts. These outcrops, in depths of 2 m or less, were demonstrated to be outcrops of chert with evidence of quarry knapping. Bathymetric data from NOAA charts were used to estimate the depressions of the PaleoEconfina and PaleoAucilla drainage basins. The karst topography has subtle bathymetric changes that become distinct when digitized, gridded for 3-D mesh illustration, and exaggerated to enhance topographic detail. These maps were used during subsequent diver surveys offshore from 1988 to 1989 (Faught 1988). Sub-bottom profiling in 1991 mapped the PaleoAucilla thalweg and stratigraphy. These data were added to the previously digitized navigation data for more precise depictions of bottom morphology (illustrated in Faught and Gusick 2011, 150, figure 12.3). This remote sensing revealed a series of linear sinkholes and shoals forming the paleochannel. In a second phase of research operations from Florida State University from 1998 to 2003, side-scan sonar was effective at identifying rocky areas where divers often found clusters of *ex-situ*, surface lithic artifacts (Faught 2002, 2004, 2019). Found in 1989 by diver survey, J&J Hunt (8 Je 740) is the most studied of the deflated, channel margin, rocky area sites of the PaleoAucilla (Arbuthnot 2002; Faught 2004).

Vibracores were driven into one of the remotely sensed sinkholes in the paleochannel near J&J Hunt during the 1991 foray. In 1992, divers sampled J&J Hunt by hand fanning 0.25 m^2 square, 10 cm deep test units, collecting artifacts and sediment samples in depths of 4–5 m. Hydraulic dredges (10 and 15 cm) were used to probe 3 m into the sinkhole, near one of the cores taken the year before. This sondage aimed to find a sediment bed like the one at Page-Ladson; the stratified, pre-Clovis through early Holocene aged, freshwater submerged archaeological site located inland a short 10 km away (Dunbar 2006; Faught 1996, 388–393; Halligan et al. 2016; Webb 2006). In total, divers dug 34, 1 meter-square test units at J&J Hunt, with 10 cm hydraulic dredges (Faught 2004, 282). The fluidized sediments from the test units were pumped topsides to floating screen decks and through 0.635 cm mesh (Faught 2002, 282, figure 7).

The artifacts from J&J Hunt are reworked, but within a clear and confined area. Excavations revealed artifacts constrained to the upper marine sands and brackish organic deposits. These unconformably overlay the ravinement surface of a truncated, subaerially indurated, silty-clay soil on bedrock. Juvenile mastodon teeth and cranial elements were embedded in this soil, but no artifacts were recovered, and these fossils contained insufficient collagen for radiocarbon. In general, artifacts were stained but not water-worn by their extended marine submergence. This context is analogous to a plow-zone terrestrially. The stratigraphic sequence of transgression, from freshwater to brackish to marine conditions, was confirmed by foraminifera and ostracod analyses from sediments within the 3 m sondage (Faught 1996, 385–386).

The earliest ages from freshwater deposits and *in situ* stumps are just slightly older than 8,000 cal BP, a bracketing age for sea-level at that time. Radiocarbon control from *in-situ* cypress tree stumps and oyster shell were used to reconstruct local sea-level history (Faught and Donoghue 1997; Joy 2019). Hundreds of chipped stone artifacts collected at J&J Hunt, and other sites found by this research, include diagnostic projectile points, tools, and debitage (Faught 1996, 401–455, 2004). The diagnostics indicate late Pleistocene and early Holocene occupants experienced an inland, upland, riverine landscape. These diagnostics were comingled with those of middle Holocene age, along with middens of disarticulated *Crassostrea* shell from the coastal landscape experienced by later, Middle Archaic culture groups. Research in the PaleoEconfina continues by others (Garrison and Cook Hale 2019; Cook Hale, Hale, and Garrison 2019), and coauthor Smith is conducting research west of the PaleoAucilla drainage described more in the discussion.

Montague Harbour 1989–1992

Montague Harbour, British Columbia, contains an intertidal shell midden that extends offshore. Researchers recognized offshore potentials from excavations that exposed a deep, stratigraphic record of midden deposits flooded by groundwater (Easton 1993; Easton and Moore 1991, 2007; Easton, Moore, and Mason 2020). This context is analogous to that at Wild Cane Cay, Belize, described above, but Montague Harbour is much earlier, with inundated deposits dating to ~7,000 cal BP. Underwater excavations were conducted 90 m offshore in 5 m of water. Divers used a 15 cm dredge to dig 2.8 m into the sediment beds (Easton, Moore, and Mason 2020, 11). Easton, Moore, and Mason (2020, 11–15) illustrate and describe the excavations and details of the findings in detail.

By observation, and using foraminifera and radiocarbon analyses, they mapped a stratigraphic sequence for transgression from terrestrial, to brackish, to marine sediments, as with the example from the PaleoAucilla above. Changes in mollusk species also demonstrated a terrestrial-brackish-marine sequence (Easton 1993; Easton and Moore 2007; Easton, Moore, and Mason 2020). Food remains of terrestrial fauna and mollusks, and fragments of organic and inorganic artifacts, were well-preserved by the buried anaerobic sedimentary environment. Easton, Moore, and Mason (2020) describe this research in detail.

Werner Bay and Pacific Northwest Coast 1995–Present

There is currently a groundswell of interest in the role that submerged landscapes played in the peopling of the Americas. If the initial peopling of the Western

Hemisphere was by the Pacific Northwest Coast, that place should exhibit very early sites (~16,000–14,000 cal BP; see Easton 1992, Braje et al. 2017, Braje et al. 2020, Davis et al. 2019). Along this rocky coast and seafloor, Canadian researchers are mapping with side-scan sonar, sub-bottom profiler, and multibeam echosounder, showing a seafloor made up of exposed and shallowly buried, rocky paleolandscapes with paleochannels and terraces (Fedje and Josenhans 2000, 100; Mackie, Fedje, and McClaren 2018; Josenhans et al. 1997). Multibeam echosounder post-processing produces sun-illuminated and color-ramped digital terrain images that are immediately informative of exposed, paleolandscape morphologies.

In one 10 km^2 study area in Werner Bay, Hecate Strait, British Columbia, Fedje and Josenhans (2000) targeted remotely sensed paleoterraces for testing. Terraces are analogs of places where Native Americans live along the Pacific Northwest coast terrestrially. Fedje et al. used a large clamshell grab sampler able to penetrate 50 cm into the gravelly substrate. The sampler is dropped and retrieved from a large research vessel. With one of several grab samples, researchers recovered a single, unequivocal chipped stone artifact (Fedje and Josenhans 2000, 102; Mackie, Fedje, and McClaren 2018). The terrace is estimated to have been subaerially exposed at ~12,600 cal BP based on sea-level curves of the region and the depth of the paleoterrace (Fedje and Josenhans 2000, 99).

Easton, Moore, and Mason (2020, 17) describe additional Parks Canada forays in 2005 and 2007, as well as recent CRM projects diving remotely sensed landscapes up to 30 m deep. Testing methods include grab sampling, hand fanning, coring, and hydraulic dredge excavating but no additional cultural materials have been reported. Easton, Moore, and Mason (2020, 17) note that working at the depths modeled for earliest sites (older than 14,000 cal BP) will require technical diving operations for longer stays and excavation methods better able to penetrate compacted seabed sediments.

Hillsborough Bay, Florida–2007

Excavations proposed in 2007 for freighter-size docking berths in Hillsborough Bay, Florida, triggered a CRM survey for submerged precontact resources. Panamerican Consultants, Inc. (PCI) was contracted to conduct the survey. Hillsborough Bay is a marine submerged setting within Tampa Bay where twentieth and twenty-first century dredging for navigation channels and "made land" constructions altered the configuration of the bay bottom considerably (Figure 1; Faught 2014; Faught and Ambrosino 2007). The precontact bay bottom was estimated by georeferencing digitized navigation charts made by US Army surveyors between 1859 and 1879. The original bay bottom was mapped as ~3–4 m deep at the project location. Sub-bottom profiling revealed the PaleoHillsborough thalweg and terrace buried under 3.6 to 4 m of marine sediments. This terraced, channel margin location represented a place where a site (if present) would be eligible for the National Register of Historic Places (NRHP) and a need, therefore, to mitigate.

This channel margin sub-bottom target was "tested" by monitoring large-scale hydraulic dredge effluent. The project was approved as experimental mitigation by the Florida Division of Historical Resources (FDHR). Dredge effluent was pumped 8.5 km through 0.9 m diameter piping from the excavation site to the sediment dumping basin

(Faught 2014, 40, figure 3.1; Faught and Ambrosino 2007). Field crews observed flow at all times and recovered cut-marked faunal bone and chipped stone artifacts, including a diagnostic Middle Archaic projectile point. The fluidized matrix surrounding these materials was brown, contrasting the gray marine sediments coming before and after, indicating terrestrial deposits were encountered.

The position of artifacts and faunal bone was calculated using time-stamped, three-dimensional positioning from the dredge cutter head and transit time through the dredge to the made-land dump. The archaeological site is recorded in the Florida Master Site File (FMSF) as 8Hi11393. No additional analyses other than projectile point and faunal bone identifications were done, while an inventory of associated chipped stone debitage was conducted using standard CRM procedures. The elevation of artifacts with regard to estimates of sea-level rise in Tampa Bay are consistent with the age of the diagnostic point (middle Holocene). In addition to the unequivocal artifacts encountered, there were “dredge-facts:” chert nodules flaked by the dredge impellors (Faught 2014; Faught and Ambrosino 2007). By-passing the effluent from the impellors would avoid damage such as this, and screening from a sluice-like ramp should be mandatory if attempting this method again.

Espiritu Santo, Baja 2008–2011

Gusick reasoned that a cluster of early and middle Holocene shell middens, known and studied terrestrially on Isla Espiritu Santo, in Baja California, indicated that more sites of those ages would be underwater (Figure 1; Faught and Gusick 2011; Gusick and Davis 2010; Gusick and Faught 2011). Initially, Gusick used a small boat echosounder and hand-held GPS to record depth measurements between Isla Espiritu Santo and Isla Ballena. These data were combined with terrestrial topographic data to construct a digital elevation model (DEM) that included terrestrial and submerged morphology. This method was similar to mapping the PaleoAucilla. Gusick targeted several areas for diving and testing in 2008, and one of those places was interpreted as a shell midden (Faught and Gusick 2011; Gusick and Davis 2010; Gusick and Faught 2011).

Methods for testing included hand fanning and collecting samples from 1 m diameter test units excavated down 90 cm. Divers hand-picked samples from stratigraphic exposures while hand fanning and sorted through collected sediment samples post-dive. From one of these units in 2008, at 20 m deep, divers recovered manuported cobbles and possible chipped stone artifacts imbricated with disarticulated *Ostrea pamula* shell buried beneath approximately 30 cm of substrate (Gusick and Davis 2010; Gusick and Faught 2011). By eustatic sea level estimates this landscape would have been transgressed by ~9000 cal BP (Siddall et al. 2003). Gusick returned in 2010 to map a large area with side-scan sonar around both islands and to dive to targets generated from those data (Gusick and Glasow 2011). Divers surveyed and tested side-scan targets to depths of 30 m and experimented with a 7.6 cm diameter PVC device to core and air lift dredge sediments. While there was no discovery of additional, unequivocal, submerged precontact archaeological materials in 2010, the paleolandscape is mapped for future researchers to continue. The radiocarbon age of a single *Ostrea* shell from the unit with artifacts was much younger than the estimated age of the deposit by depth, or by the sites onshore, facts compounding the need for additional research there.

Discussion

These seven submerged precontact geoarchaeology projects followed similar systematic, phased trajectories to find submerged precontact sites: recognition of potential, mapping and understanding paleolandscapes, modeling where sites should be based on local terrestrial analogs, and testing underwater. Each project worked from the terrestrially known, to the submerged unknown. The projects are listed chronologically (Table 1), and it is noteworthy that three projects, PaleoSabine, Belize, and PaleoAucilla/PaleoEconfina, began between the late 1970s and mid-1980s, around the same time as continental shelf precontact archaeology in the Americas was being published (Flemming 1983; Masters and Flemming 1983). Three of the seven projects currently continue: Pacific Northwest Coast, Belize, and PaleoAucilla/Econfina.

The researchers of these seven projects found sites in marine continental shelf settings by methodical and phased research strategies, but funding was the first challenge for each. Most of the funding sources for these projects were, and are, from governmental agencies, such as the Canadian Geological Survey and Parks Canada, National Oceanic and Atmospheric Administration (NOAA) and the Bureau of Ocean and Energy Management (BOEM, formerly Minerals Management Service [MMS]). These resources are offered as requests for proposals, and they are often related to recommending cultural resource management (CRM) policies for submerged precontact sites. The National Science Foundation (NSF) funded two of the seven projects for academic research (Belize and PaleoAucilla projects). National Geographic funded Gusick's first diving foray, and NOAA her second (Gusick and Glasow 2011; Faught and Gusick 2011). EarthWatch funding and volunteers were effective resources for Belize and PaleoAucilla projects (Faught 1996; McKillop 1995). Private donations funded much of Faught's dissertation research in the PaleoEconfina and PaleoAucilla (Faught 1988, 1996). The Florida Division of Historical Resources (FDHR) supported much PaleoAucilla research through Florida State University (FSU), and they continue to be a significant source of funding for submerged precontact archaeology in Florida.

The different approaches of these seven projects show diverse and clever mapping and modeling strategies, as well as myriad underwater testing methods to identify "sites" (i.e. evidence of human behaviors). Each approach is devised for the local marine geological and terrestrial culture historical environment. In most cases, local terrestrial landscape analogs, such as river channels, midden deposits, ponds, sinkholes, springs, and any prominent features are targeted. Additionally, specific culture historical behaviors are used to model whether particular submerged paleolandscape features will exhibit sites at certain depths. In two cases, sites were simply traced into the water from known terrestrial and intertidal sites.

All of the seven projects in this summary used local and eustatic sea-level curves to estimate the extents and evolution of submerged landscapes. Three projects yielded data for more precise controls locally after radiocarbon analysis of environmental samples (Faught and Donoghue 1997; Fedje and Josenhans 2000; Mackie, Fedje, and McClaren

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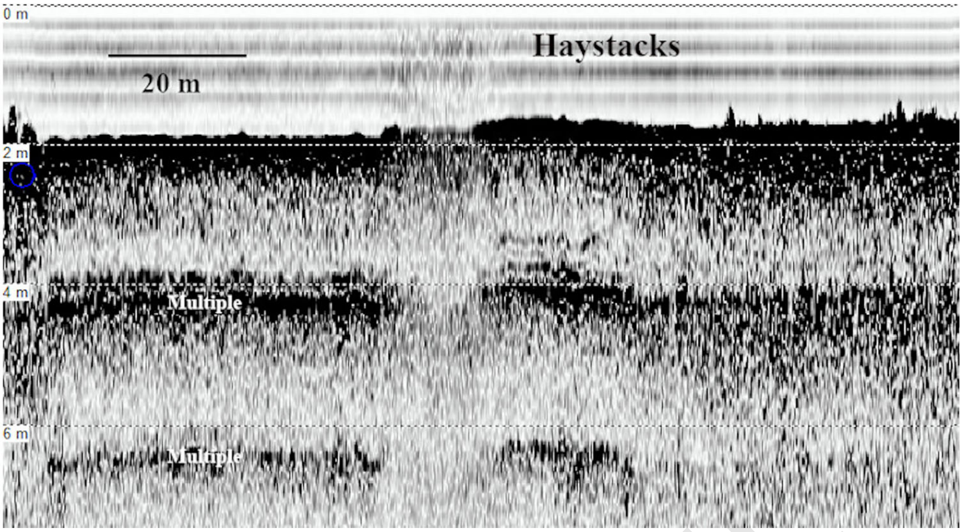

Figure 2. One example of haystack reflections in the water column from Clint's Scallop Hole (8Je1759), Apalachee Bay, Florida. There is abundant flintknapping debris present at the site and 13 haystack anomalies are recorded. One has proven positive for chipped stone by diving in August of 2020. More experimentation and diving are planned. Data from Morgan Smith, 2018, post-processing by Faught 2020.

2018; McKillop, Sills, and Harrison 2010). Understanding apparent, local sea level transgression rate and extent is particularly important for Canadian researchers where the isostatic and tectonic readjustments over time are sinusoidal.

Much is written about the destructiveness of seas transgressing terrestrial landscapes. Likewise, much has been written about the phenomenal preservation that can take place with burial in anerobic conditions. Both processes are true, depending on place, but truncation and reworking certainly dominate the results of sea-level rise globally. With systematic approaches and awareness of site formation processes, areas where sediments may be preserved, exposed, or shallowly buried, can be readily identified (see Harris 2018; Harris et al. 2013 for examples). Where targets are buried, seabed overburden can be removed to expose ravinement surfaces from which buried sediments can be excavated with accuracy, the size of excavations being limited to the sizes of the dredges and screen rigs available. Besides depth in the water, limiting factors include matrix stability or coffer buttressing capacity, or both.

We expect the practice and technology of testing sediments underwater will see many improvements in future projects. Some of this already happening, namely the implementation of remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs). Mapping bottom morphology and observing sonar targets with ROVs using videography and photogrammetry makes a record for study and diver bottom time more efficient. ROV's provide accurate GPS locational control when tracked by in-water transponders for photogrammetric mapping. A small ROV is used at ~33 m depths in Lake Huron to observe and map caribou runs and other features of the exposed paleolandscape (Lemke and O'Shea 2019; O'Shea 2015). Experimentation with remote sampling, by ROV grasping, jetting, and dredging are promising avenues for testing in the

Table 2. Project muster scores.

Project	Artifacts unequivocal?	Geologic context secure?	Age by radiometrics?
PaleoSabine	No	Yes	Yes
Wild Cane Cay/Punta Ycacos	Yes	Yes	Yes
PaleoAucilla/Econfina	Yes	Yes	No
Montague Harbor	Yes	Yes	Yes
Hecate Strait	Yes	No	No
Tampa/Hillsborough Bay	Yes	No	No
Isla Espiritu Santo	No	Yes	No

future. AUVs map large areas of submerged landscapes with sonar, seismic, and other instruments before returning to a mother ship, reducing effects of roll, heave and pitch experienced when towing in rough seas.

In addition to remote sensing for landscapes potential for submerged precontact sites, we suggest that two types of physical sites can be remotely sensed. These are shell middens and lithic deposits via sonar "haystacks." Shell middens are formed of interlaced, erosion resistant, compacted materials that produce high backscatter side-scan sonar targets when exposed and, positive-relief sub-bottom reflectors when buried (Gagliano et al. 1982). Two projects we know of in the Americas tested sub-bottom reflectors proposed as middens, with the results showing natural bio herm deposits (Jazwa and Mather 2014; Leach and Belknap 2007). A known midden was remotely sensed in Denmark and is illustrated in Astrup et al. (2020). A positive relief sub-bottom profiler target identified during a CRM survey produced abundant disarticulated shell and avian bone interpreted as a precontact midden when tested in the St. Johns River, Florida (8 DU 1116; Faught 2014; Faught and James 2011).

Another potential for directly remote sensing sites is a recently recognized sonar signature from chipped stone artifacts. It has been observed and theorized that knapped chipped stone materials resonate with low-frequency sound and the disturbance is recorded in the projected water column as "haystacks." Grøn et al. remotely sensed with sub-bottom profiler deposits of Neolithic knapped flint submerged off the coast of Israel. The data produced numerous anomalies, referred to as "haystacks," where the knapped flint was pinged (Grøn et al. 2018; Gron and Boldreel 2014; Hermand et al. 2011). On the other hand, unquarried bedrock exposures of chert did not produce haystack anomalies when remotely sensed, supporting the theory that these signatures reflect knapped material only (Grøn et al. 2018). Smith et al. have remotely sensed with sub-bottom profiler a large chert quarry site known in Apalachee Bay, away from the PaleoAucilla and first reported by a local scalloper (8 JE 1796, Clint's Scallop Hole). The post-processed data resulted in 11 "haystack" targets, five of which have proved positive for chipped stone thus far (Figure 2). More remote sensing and experiments are planned.

Fieldwork by diving underwater is logistically constrained, but excavation and other sampling methods can be as precise, or nearly as precise, as any terrestrial operation, given sufficient time and resources. However, would the evidence from these projects satisfy evaluation criteria as early sites might be evaluated terrestrially? This muster includes demonstration of unequivocal artifacts, secure geologic context, and age estimation by radiometric, or other reliable method (Haynes 1969; Table 2). The weakest examples of a "site" from these projects include the proxy evidence from the

PaleoSabine cores and the single artifact found in Werner Bay. We consider the proxy evidence from the PaleoSabine core samples to be convincing, but additional testing is necessary to confirm this by finding artifacts. The most secure artifact and feature abundances come from the Montague Harbour, Belize, and the PaleoAucilla/PaleoEconfina projects. Montague Harbour and Belize have unequivocal control on strata, chronology, and artifacts. All of the evidence from the PaleoAucilla and PaleoEconfina projects is stratigraphically re-worked and co-mingled. However, these sites are spatially cohesive and temporally accurate via diagnostic artifacts, but they are not precisely dated within intact stratigraphy. The Hillsborough Bay dredge monitoring project lacks acceptable precision of stratigraphic context and chronology, yet the artifacts are unequivocal. The age of the Espiritu Santo midden is in question, but the stratigraphic context and artifacts are not.

Conclusions

We found seven examples of published research projects that encountered precontact Native American sites underwater in marine submerged continental shelf settings by systematic and phased research. We are aware of other projects that are in progress, employing similar strategies (mapping, modeling, testing) that may prove successful in the near future. These include the Canadians in the Pacific Northwest Coast (Easton, Moore, and Mason 2020; Mackie, Fedje, and McClaren 2018), Braje et al. (2019) in the Pacific, and Evans (2020) in the Gulf of Mexico. Current cultural resource management (CRM) projects for wind farms in the Atlantic and Pacific should be adding more continental shelf areas mapped, and more places to make models and conduct search.

Outside of the Americas there is a large library of examples of mapping, modeling, and testing in Scandinavia, Europe, the Mediterranean, and Australia (Bailey et al. 2020; Benjamin and Bailey 2017; Bailey, Harff, and Sakellariou 2017; Tsakanikou, Galanidou, and Sakellariou 2020; Benjamin et al. 2011, 2020; Sturt et al. 2018). We are also aware of past projects that failed their goal (e.g. Hemmings and Adovasio 2014), and we empathize with the efforts that went into that research, from proposal to field work. After all, projects that do not find sites contribute to knowing those places, correcting models, and narrowing the expanses to survey.

More academic and private sector CRM geoarchaeologists are needed to conduct research underwater for submerged sites and Native American precontact histories. This includes the need for administrators of local, state, and federal cultural resources to require more underwater surveys focused on submerged precontact sites, and to distribute more resources for research focused on these sites. In the Americas, graduate programs to do archaeology underwater are dominated by European and American histories and related historic-aged resources, including the Texas A&M Nautical Program, the Maritime Studies track at East Carolina, and the Underwater Archaeology program at the University of Miami. Graduate-level opportunities for underwater archaeology of submerged precontact sites include the Center for the Study of First Americans at Texas A&M University, the University of Michigan, and Florida State University.

Finally, we find it curious, in the case of Northwest Coast research projects, that there remains a dearth of evidence for first people earlier than 12,600 cal BP. And this after mapping and searching in many places, underwater and terrestrially, and with state-of-the-art models and equipment (Fedje and Mathewes 2005; Easton, Moore, and Mason 2020; Mackie, Fedje, and McClaren 2018; Mackie et al. 2013). It may be that this really is evidence of absence of an early coastal migration from Beringia. It may also be that this is simply an absence of that evidence – so far. More submerged precontact geoarchaeology will surely help to clarify the role the NW coast, and other continental shelf areas played in the peopling of the Americas.

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