Submerged Archaeological Landscapes

From Ancient Myth to New Frontier

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The idea of ancient settlements preserved in the darkest depths of the ocean may have originated in ancient myths. The medieval legend of Lyonesse, for example, involves a once thriving kingdom located between Land's End and the Isles of Scilly, off southwest England, that sank beneath the sea. Although many of these legends were created in medieval times to teach moral lessons, including the power of the sea, there is little doubt that they were in part inspired by local evidence of drowned land features. At low tide or from a boat on a calm day it is possible to see drowned forests, the remains of field boundaries and trackways, and ancient structures along the Atlantic coast of Europe, including near Land's End and the Isles of Scilly (Figure 1).

That these myths of sunken cities persist in popular culture today is largely a reflection of society's fascination with 'lost civilizations' and our inadequate knowledge of the ocean floor. Unfortunately, prehistoric underwater archaeology has suffered from this public notion of myth-busting, and also from skeptical professional archaeologists who have disregarded its potential, reasoning that inundation has either destroyed the relevant evidence or rendered it totally inaccessible. Nevertheless, there is now growing consensus among archaeologists that ancient sites are preserved on the modern seabed, can be studied effectively and may hold the key to some of the most important developments in world prehistory. Coincidentally, recent progress in seabed mapping is providing archaeologists with new opportunities to explore these ancient landscapes beneath the sea.

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In this essay, we explain why these landscapes are now submerged,

Figure 1: Bronze Age trackway preserved in the intertidal mudflats of the Shannon Estuary, W Ireland. This trackway would have been situated above high tide when it was originally constructed.

describe their archaeological importance and outline how we use new technologies to locate and investigate archaeological landscapes on the seafloor. Our regional focus is Newfoundland in eastern Canada, and although the archaeological context may differ, the rationale and investigative approaches are broadly applicable to many submerged coastal regions of the world.

Submerged Landscapes – Rippling Effects of the Last Ice Age

On a geological timescale, global sea level is constantly changing. The growth and decay of ice sheets and fluctuations in seawater temperature have led to changes in ocean volume, which together with vertical movements of Earth's land surface have altered the relative sea level (RSL) along coastlines, by up to several hundred metres in places. On an archaeological timescale, RSL variations have created land bridges between continents (e.g. the Beringian land bridge between Asia and North America), connected offshore islands to adjacent continents (e.g. Doggerland which connected the island of Great Britain to mainland Europe) and exposed large areas of shallow continental shelf (e.g. the Scotian Shelf off Atlantic Canada).

The reconstruction of past RSL movements demands a sophisticated understanding of the complex interplay of changing ocean and land levels, which resulted in both rising and falling sea levels at different times and places. Of particular complexity are those RSL records from regions that were once located near the margins of the last ice sheets, such as the North Atlantic rim, including most of Newfoundland with the exception of its Northern Peninsula. In these regions, RSL reached short-lived highstands of several tens of metres above present sea-level upon ice retreat, in places inundating the land far inland of the modern coast. Thereafter, the removal of ice load caused the land to rebound, in turn resulting in a RSL fall, by as much as 5 m or more per century, to depths below modern sea-level (down to 30 m water depth around Newfoundland) exposing the continental shelf. In due course, RSL fall tapered off as the rebound of the land slowed and was ultimately overwhelmed by the volume of glacial meltwater returning to the oceans. Thus, following a short-lived lowstand, the subsequent rise in RSL re-submerged the exposed coastal environments. RSL continued to rise to its modern level, although other factors resulted in local short-lived oscillations. Conversely, in areas closer to the centre of the ice sheet where the ice was thicker, such as Newfoundland's Northern Peninsula and neighbouring Labrador, the magnitude of land rebound was such that a trend of falling RSL has continued to the present day.

The implications of the complex RSL history characteristic of ice-marginal areas for formerly coastal archaeological sites are threefold. First, the earliest postglacial sites should now be raised above present sea level on emerging shorelines and detectable by traditional land-based archaeological techniques; second, later postglacial sites should be located on or below the seabed on submerged coastal landscapes and in the first instance detectable only by underwater survey techniques; and third, the most recent postglacial sites should be located in the intertidal zone or above present sea-level.

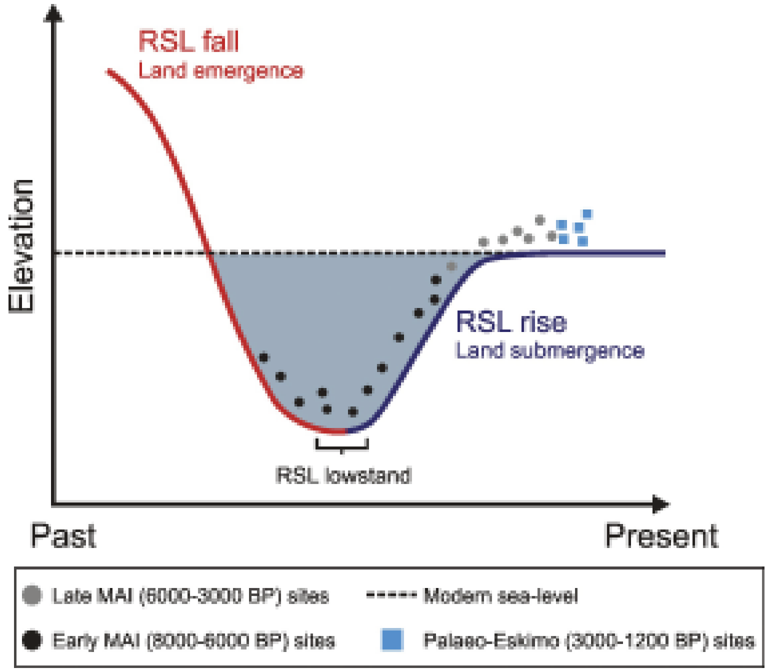

Figure 2: Generalized relative sea level (RSL) curve and archaeological site distribution for Newfoundland, with the exception of the Northern Peninsula, where RSL fell without subsequent rise. The earliest part of the record is characterized by RSL fall, such that early Maritime Archaic Indian (MAI) sites were situated at elevations now below sea-level. RSL rose during the MAI period, reaching near present levels during the late MAI period. Most late MAI sites are therefore located above present sea-level, at similar elevations to later Palaeo-Eskimo sites. Note however that some late MAI sites may still be submerged in shallow water or the intertidal zone.

The prehistoric site distribution for the island of Newfoundland illustrates this complex pattern. Its earliest known occupants were a maritime-adapted group referred to as the Maritime Archaic Indians (MAI) who were part of the wider Archaic Indian hunter-gatherer society that occupied the North American Atlantic seaboard between 10,000 and 3,000 years before present (BP). The extant terrestrial (i.e. above the modern shoreline) archaeological record shows that the MAI occupied the island of Newfoundland between 6,000 and 3,000 BP, after which they were replaced by Palaeo-Eskimo groups migrating down from the Arctic. However, earlier MAI sites, dating back to at least 8,000 BP, coincide with the sea-level lowstand and are therefore located on the seabed. In this case, the earliest sites are not emerged above present sea-level because incoming migrants did not arrive until the RSL fall was well underway (Figure 2).

Submerged Landscapes Provide New Perspectives on an Ancient World

At present, the extant archaeological record is overwhelmingly biased towards sites located on land, above modern sea-level. However, given that global sea-level has been, on average, lower than present for much of the last three million years, this implies that a vast component of the archaeological record is missing, equivalent to a continent the size of Africa. This is not just a theoretical observation; evidence of submerged prehistoric sites has been uncovered on continental shelves across the world ranging from South Africa to Japan, but is best exemplified by Denmark where intensive survey and research over the last three decades has uncovered over 2,000 sites and findspots, in some cases, containing *in situ* material that is better preserved than it would be on land.

The importance of the missing record is enhanced by the fact that it contains the vast majority of evidence for the

Figure 3: Intertidal zone at Back Harbour, NE Newfoundland, exposed at low tide. Inset shows a MAI plummet that was recovered from the intertidal zone, a strong indication that archaeological material exists on the modern seabed.

prehistoric use of coastlines. This is reflected by a long-standing debate in archaeology regarding the timing and rationale for exploitation of marine resources. For many years, it was believed that the lack of evidence for coastal occupation indicated that past humans were unable or unwilling to exploit the sea until relatively late (within the last 10,000-15,000 years) in prehistory. However, in recent years, fragmentary 'early' evidence (such as ancient shell middens dated up to 160,000 years ago) for the occupation of past coastlines has come to light, making it much more plausible that the lack of palaeo-coastal evidence relates more to its submergence than its non-existence in the first place. Evidence from presently submerged coastal landscapes is therefore crucial to addressing questions of how, when and why prehistoric humans adopted marine settlement and subsistence strategies.

Finally, submerged landscapes played an important role in facilitating the dispersal of prehistoric humans across the world. As described earlier, lowered sea-levels created landbridges and terrestrial connections across areas now divided by marine passages, opening up the world to people that may not have had the ability or technology to traverse the open ocean. Recent hypotheses also suggest that coastlines were significant components of global dispersal by providing delineated resource-rich 'corridors' along which past people could easily travel.

Newfoundland prehistory can be seen as a microcosm of these global issues. The terrestrial archaeological record dates the MAI occupation of Newfoundland to between 6,000 and 3,000 BP. By contrast, the neighbouring mainland of Labrador, separated from Newfoundland only by the narrow Strait of Belle Isle, which is iced over in winter and only 18 km wide at its narrowest point, has MAI sites that date as early as 8,000 BP. The proximity of Labrador to Newfoundland and the fact that the MAI were a coast-dwelling maritime-adapted society making extensive use of marine resources make it almost inconceivable that they ignored, or were incapable of reaching, the productive shores of Newfoundland for thousands of years after they first arrived in Labrador. A more plausible explanation can be found in the pattern of RSL change between 8,000 and 6,000 BP. Simply put, this period was typified by low and high sea-levels around Newfoundland and Labrador respectively (see previous section). As a consequence, the earliest archaeological record in Newfoundland presently lies on the seabed, whereas that of Labrador has been uplifted above the modern shoreline. Evidence from submerged coastal landscapes around Newfoundland therefore holds the key not only to understanding when the MAI arrived, but also how they utilized and traversed its coastal zones on their way to colonizing the island, and were able to contend with dramatic environmental changes taking place at the time, notably rapidly changing sea-levels (Figure 3).

New Technologies to Map Old Landscapes

We approach the investigation of submerged archaeological landscapes in two distinct stages. In the first stage, we attempt to map the configuration and identify the elements of the landscape while in the second, we classify the archaeological potential of the landscape and focus on local site survey and testing. It is our belief that this landscape-based approach will ultimately be more successful than one that aims explicitly to survey for and excavate a discrete archaeological site. By reconstructing the landscape first we can identify areas where it has been preserved rather than eroded by marine processes and also where features preferred by past humans for settlement, such as river valleys, lake basins and sheltered lagoons, are situated. This will facilitate future underwater prospection efforts by pinpointing areas of the highest archaeological potential. Moreover, accurate interpretation of existing archaeological sites, as well as ones that may be discovered in the future, requires them to be placed in an accurate palaeo-landscape context. Thus, understanding the nature of the past landscape in the first stage gives us a head start in this regard. Our investigations to date have concentrated on the first stage, but for completeness we also include a brief outline of stage two.

Stage I: Mapping the palaeo-geography of submerged landscapes

The main goals of this research stage are to delimit the extent of former dryland through identification of the RSL lowstand, map the palaeo-geographic evolution of the submerging coastline, and identify key elements of the former land surface that elucidate its character or preserve an environmental record. The depth of the RSL lowstand and rates of RSL rise are at first approximated using a combination of field-based evidence and computer-modeled simulations which incorporate ice sheet history and the Earth's uplift/subsidence in response to the removal/addition of ice. In northeast Newfoundland the lowstand is predicted to be between 17 and 20 m below sea level.

Once RSL position for a given time interval is known, high-resolution multibeam sonar imagery of the seabed can be contoured or colour-coded to provide a reasonable approximation of palaeo-shoreline location and configuration. Traditional bathymetric chart data in the region have insufficient resolution to permit this level of analysis (Figure 4). Through the use of various illumination angles, shaded relief effects and vertical stretching of the multibeam imagery, submerged landscape features are identified and mapped; for example, river channels and valleys, barrier beaches, wave-cut platforms, sea cliffs, lake basins and lagoons.

Of course we do not anticipate that all landscape features will necessarily be preserved on the modern seafloor. Landforms and sediments may be eroded by wave energy during subsequent marine transgression or buried by post-submergence sedimentation. There is little that can be done about eroded landforms, except that there may be evidence for eroded surfaces and lag deposits. Buried landforms, on the other hand, may be mapped using shallow seismic reflection surveys that

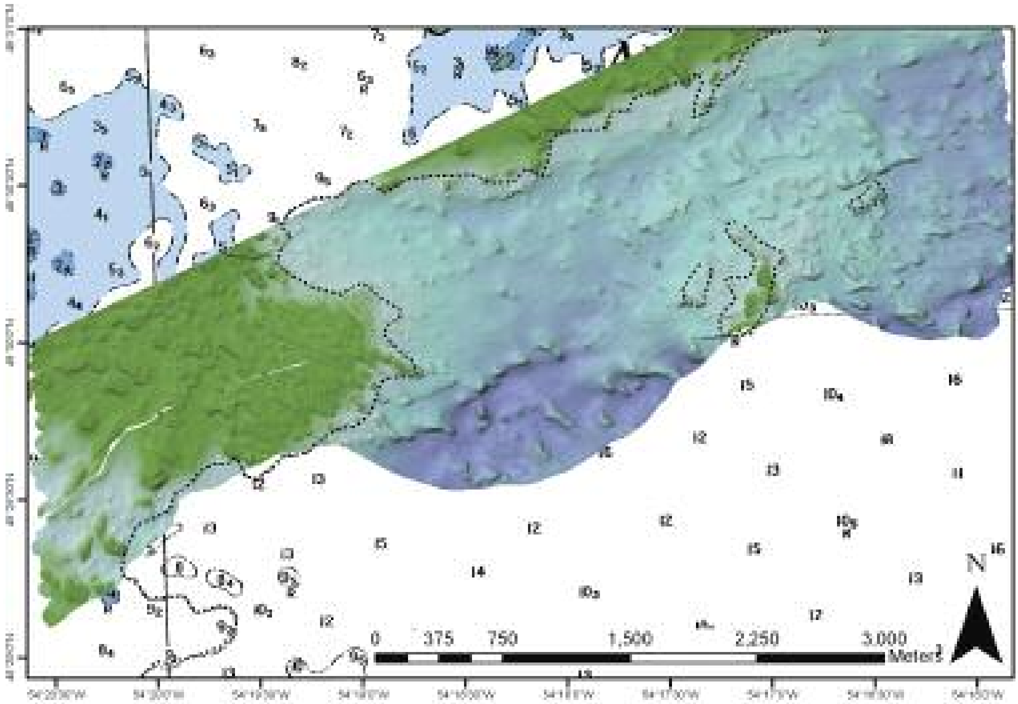

Figure 4: Multibeam bathymetry of Hamilton Sound, NE Newfoundland, coloured to represent the postglacial lowstand of -18m (i.e. green is the land, blue is the sea) overlaid onto a conventional hydrographic chart. The -18m (10 fathom) contour of the bathymetric chart is highlighted by the dashed line. Note how the shoreline reconstructed from the bathymetric chart is less complex than the multibeam reconstruction, and does not resolve a number of features – e.g. the shallow bay/inlet at the southwestern most portion of the multibeam dataset. In addition, the general topography of the palaeo-landscape (e.g. ridges, depressions and channels) is poorly represented by spot heights on the hydrographic chart.

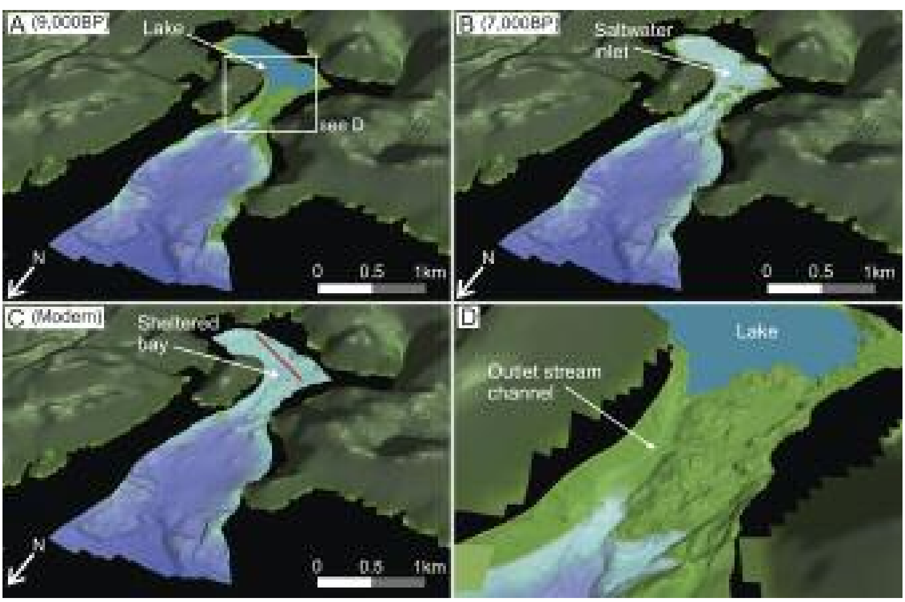

Figure 5: Multibeam bathymetry from Moreton's Harbour, NE Newfoundland, coloured to show RSL change over time. A) Lowstand of -18m, approximately 9,000 BP. This results in the emergence of a rocky sill at the harbour entrance and the creation of a lake within the modern harbour. B) RSL has risen to -12m (c. 7,000 BP), overrunning the sill and converting the lake into a shallow saltwater inlet. C) Modern configuration; the sill is completely flooded creating a sheltered bay. Red line shows position of seismic profile displayed in Figure 6. D) Close-up of the harbour entrance assuming a lowstand of -18m. Note the emerged rocky sill dividing the lake from the sea and an incised outlet stream channel draining the lake basin.

penetrate the seabed at targeted sites to generate a vertical cross-section of sub-bottom stratigraphy. The acoustic character and structure of these sediments permit the identification of buried land-surfaces (e.g. freshwater lake basins, bogs, lagoons, beaches and terraces) (Figure 6).

Grab-sampling of surface sediments and coring of sub-bottom sediments are essential steps in confirming the nature and age of land surfaces and sedimentary horizons (Figure 6). These data also permit re-assessment of RSL model simulations and fine-tuning of model parameters.

The final step in this stage is the integration of all the aforementioned seabed datasets (i.e. sub-bottom seismic, multibeam sonar, cores and grabs) to portray accurate, fully 3-dimensional models of landscape evolution. At this point, post-submergence deposits are digitally removed from the seabed to establish the original landscape surface; the deposits are later added to the seabed to more accurately reflect landscape burial following transgression.

Stage II: Mapping the archaeological potential of submerged coastlines and testing high potential seabed

The application of a predictive model, based on landscape attributes of late MAI sites in Newfoundland, will be used to classify the archaeological potential of reconstructed maritime landscapes. Our model considers site setting at four nested spatial scales. At the two larger scales – regional and coastal settings – site locations were probably related to the distribution of resources, whereas at the smaller scales – shoreline and site settings – site location preferences were likely related to resource access rather than abundance. Consequently, we anticipate that high potential locations for early MAI settlement might include some or all of the following landscape attributes: in the mid-region or heads of nearshore arms or inlets protected from offshore fetch and wave energy; in a sheltered coastal setting such as a cove, the leeward side of a headland or point or the landward side of an island; near a river, stream or pond for access to freshwater; with a view in more than one direction for resource monitoring and access to coastal waters under a range of sea states; and near a promontory which could be used as a resource-monitoring station, especially where site location was chosen for shelter rather than view.

Once zones or sites of high archaeological potential have been targeted, marine archaeologists can initiate a program of prospection and sampling. A variety of techniques can be employed in this phase, depending in large part on the water depth and environmental conditions of each targeted site. Scuba survey is most effective in calm, shallow waters with good visibility,

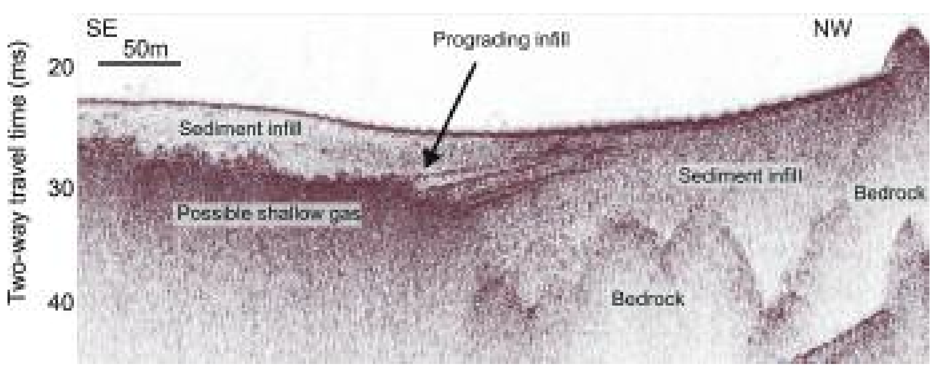

Figure 6: Seismic profile through the inner basin of Moreton's Harbour, NE Newfoundland. See Figure 5C for location. The profile shows complex sediment infill of an eroded bedrock surface relating successively to marine transgression, emergence and formation of a lake basin and finally submergence and resumption of marine sedimentation. Sampling of the freshwater sediments, deposited during the lake basin stage, should provide proxy evidence for environmental and climate conditions during early MAI occupation of this region.

where the archaeology lies on, or just beneath, the seabed surface. In harsher conditions, remote sensing techniques such as seismic profiling or remotely operated vehicles can be employed while sites that are deeply buried beneath the seafloor require imaging by high-resolution sub-bottom seismics and sampling by cores and dredges.

An International Network to Investigate Submerged Landscapes

The investigation of submerged archaeological landscapes requires expertise from archaeology, geography, geology, geophysics and oceanography, together with the support of ocean mapping technology and partnerships with government and industry-led seabed mapping programs. To facilitate and engage such an ambitious collaboration, the Submerged Landscape Archaeological Network (SLAN) was created in 2005. The network represents a consortium of researchers from universities and government agencies in Ireland, Northern Ireland and Newfoundland, and builds on the momentum of previous successful collaborations between Newfoundland and Irish marine industries and institutions.

Our network partnerships have led to some exciting new research activities including: (1) collaboration with the Canadian Hydrographic Service and Fisheries and Oceans Canada on submerged landscapes off northeast Newfoundland which overlap with and may provide the geological context for important demersal capelin spawning habitats; and (2) an assessment of the archaeological applications of the Joint Irish Bathymetric Survey (JIBS) data, which provides 100% multibeam bathymetry coverage within the 3 nm coastal strip between counties Donegal and Antrim and represents a partnership between the Maritime and Coastguard Agency of Northern Ireland and the Marine Institute of Ireland.

The ultimate goal of SLAN is to understand how the submerged coastal environments of the North Atlantic rim facilitated the expansion and growth of its first peoples and how the evolving coastal landscape, marine resources and climate may have stimulated social and cultural change. Perhaps prehistory has important lessons for modern coastal communities in Newfoundland, Ireland and elsewhere who are facing contemporary challenges of sea-level rise, climatic changes and fluctuating marine resources.

Further Reading

SLAN web site: www.science.ulster.ac.uk/cma/slan/
JIBS web site: www.science.ulster.ac.uk/cma/instar/

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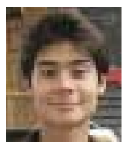

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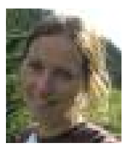
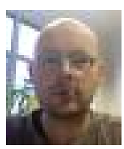


Ruth Plets is a post-doctoral fellow in the Geography Department, Memorial University of Newfoundland. Her current research concentrates on the use of sub-bottom and seabed mapping techniques for the reconstruction of submerged landscapes in the Canadian Arctic and N Atlantic. Her wider interests lie in sedimentology, high-resolution geophysics and marine geoarchaeology.



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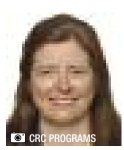

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