1 Introduction: Archaeology Underwater

Underwater archaeology is not a new practice, although it is important to distinguish the systematic investigation and analysis of cultural material found underwater, from shipwreck hunting, looting, treasure collecting, and marine salvage. Archaeology underwater is seen as dramatic, often fueled by harrowing stories of storms and shipwrecks, warfare, and plane crashes, while diving itself still has an adventurous allure. But beyond this perception of the field, what truly is underwater archaeology? Simply – archaeology underwater – the study of the human past through material remains in or adjacent to underwater environments. While we often think of underwater archaeology taking place in the oceans, submerged environments containing archaeological remains also include lakes, rivers, reservoirs, cenotes, swamps, and other drowned sites. While archaeology is the study of the past, we use the latest technology, and this is especially true given the challenges of working underwater and caring for waterlogged materials. Despite taking place underwater – it is still archaeology and as such can be rooted in anthropological theory. Situating archaeology underwater within archaeological practices and anthropological approaches in general is a main theme of this Element as well as introducing the vast array of submerged sites all over the world. Theoretical orientations, research frameworks, and methods will be discussed in Sections 2 and 4, but it is critical to note from the outset that underwater archaeology combines ideas and approaches from many disciplines, (anthropology and archaeology of course) but also history, geology, geophysics, geomorphology, paleoenvironmental research, paleoecology, seafloor and subsea technologies, robotics, SCUBA (self-contained underwater breathing apparatus) diving, and engineering. Due to the similarities between archaeology on land and archaeology below water, this Element will often use "archaeology underwater" rather than underwater archaeology (following Bass 1966).

Why are some archaeological sites submerged? How do they form? There are a range of different site types underwater, along a spectrum from some catastrophic event that sank a ship, or submerged an airplane, to those that were once terrestrial sites and have been drowned. Archaeological sites become inundated due to slower geological processes such as sea level rise, or faster geological processes, such as earthquakes and resulting land subsidence. Working in underwater environments can be challenging and may be expensive, so why do underwater archaeology at all? Beyond the fact that underwater or offshore settings are just an extension of the archaeological record, one that deserves to be investigated and protected in its own right, submerged environments offer some of the best preservation in the world, where limited oxygen and other factors often leave organic materials more intact than they would be

on land. The waterlogged, anaerobic (the absence of free oxygen), and often anoxic (the absence of any oxygen) context of underwater settings preserves stone, ceramics, and other durable materials similar to terrestrial sites but also organic materials often missing on land, resulting in higher resolution archaeological data (Maarleveld 2020). Furthermore, some of the most important questions facing anthropology and archaeology today rely on data that are now underwater. Questions as far-ranging and diverse as human evolution, global human expansion, early seafaring, the origins of coastal adaptations, the movement of enslaved peoples, societal responses to climate change, and many others can be addressed by underwater archaeologists (e.g., Dunnavant 2021; Lemke 2021). Equally, the types of sites and data preserved underwater range from historical and prehistoric shipwrecks and canoes to sunken cites, submerged landscapes, human remains, and ritual or votive offerings. Essentially the full range of site types we know of from terrestrial contexts are also preserved below water, usually with higher data quality. Beyond that, underwater settings preserve some types of sites that do not survive on land at all – as underwater environments, especially those that are largely inaccessible, far offshore, and/or in deep water, are protected from postdepositional disturbances and subsequent human occupation. Types of sites and types of data are further detailed in Sections 3 and 5.

Overall, underwater sites offer significant contributions to our knowledge of the past. Individual ship and plane wrecks offer historical insights into technological development and provide accidental time capsules and details considering the circumstances of the event and the magnitude of loss of life. Submerged sites offer evidence that often does not exist on land, representing time periods and data that are not preserved in terrestrial settings, giving us additional insights into environmental adaptations and problem solving, the world's first mariners, and coastal use and colonization. For these reasons and others, the archaeological record underwater is an important part of our global shared history, which is protected by the UNESCO 2001 Convention on the Protection of the Underwater Cultural Heritage (hereafter, the UNESCO 2001 Convention, see Evans et al. 2010).

It is important that we first understand the history of archaeologists working underwater, to separate it from non-science on underwater sites, to outline various research trajectories, and finally to demonstrate the range of underwater archaeological projects. While a short review follows, underwater archaeology is often thought to be synonymous with nautical, or shipwreck archaeology, which is often conducted from a historical perspective with different research questions, scales of inquiry, and ultimate goals; after reviewing the history of underwater archaeology, this Element will focus primarily on submerged sites and landscapes and their investigation through an anthropological lens.

1.1 A History of Archaeology Underwater

Underwater archaeology as a discipline or subfield or specialty (it has been called all of these, see Section 2), had what can be characterized as a rocky start. It struggled to establish itself as bona fide archaeological research for several reasons. First, there are access and methodological difficulties in researching sites underwater, but second and more critically, some of the tools and skills used early on were developed by shipwreck salvagers. It is therefore critical to distinguish between what is and what is *not* archaeology underwater. Salvage, or the removal of materials for their monetary value, is not archaeology. Similar to looting on land, salvage is a notable issue in underwater archaeology, specifically for shipwrecks as many vessels were often carrying items of great value. After wrecking/sinking, depending on the context of the wreck (Were there eyewitnesses? Is the location of the wreck known? Is it in shallow water, areas of slow-moving currents, etc.?), materials may have been salvaged very quickly, similar to tombs being robbed in antiquity. Other wrecks are salvaged much later as they are discovered, or technology becomes available to access them. In all these cases, salvaged materials range from valuables including gold and jewels to warfare equipment such as cannons, and memorabilia such as bells, nameplates, or other items. Souvenir collecting is also not archaeology, the casual removable of materials for personal use, treasure hunting, or fortune and glory is also not archaeology. Lastly, snorkeling or SCUBA diving on shipwrecks is not scientific archaeology; divers sometimes collect souvenirs from wrecks and/or they impact a site and its archaeological integrity by moving objects to different places or by modifying the vessel itself, occasionally inscribing their names on it, like graffiti over rock art. While SCUBA diving on a wreck site is not archaeology, many SCUBA divers and their communities have worked closely with archaeologists to share site locations and conduct scientific investigations of sites (Scott-Ireton et al. 2023).

To trace the route from salvage to science, the history of underwater archaeology can be broken down into four phases: (1) 1600s–1960 Salvaged Treasure, (2) 1960–Present, Shipwrecks, (3) 1970s–1990s, Submerged Sites, (4), 1990s–Present, Deep Prehistory. The history of underwater archaeology has been covered elsewhere (see Broadwater 2002; Ford et al. 2020; Garrison and Cook Hale 2021), here the focus is to provide background as context for understanding the growth of the field, the various types of sites that exist underwater, the introduction of different methods for investigating such sites, and the origin of disciplinary divergences in underwater archaeology, which will be discussed in Section 2. These are chronological and developmental stages and within each, significant methodological leaps will be outlined and

notable sites will be introduced. The history of archaeology underwater is the history of ideas and theories, the development of methods, and the history of actual discoveries.

The first period marks the earliest examples of salvage from shipwrecks and other artifacts recovered from underwater contexts. The second phase marks the first systematic archaeological research underwater by George Bass, and subsequently the birth of both nautical and maritime archaeologies (Bass 1966, 1971, 1988; Muckelroy 1978, see Section 1.1.2). During the third phase, submerged prehistoric sites were systematically excavated for the first time, and lastly, the fourth phase marks the deepest and earliest known artifacts to have been recovered from underwater contexts. Within each developmental stage, it will be clear that the history of underwater archaeology is intimately connected with the history of subsea research and technology in general (Broadwater 2002:17). It parallels trends in diving, bathymetric mapping, SONAR (sound navigation and ranging) technologies, and other improvements and draws extensively from them. Beginning with breath holding and then the use of diving bells in the seventeenth and eighteenth centuries, it wasn't until the twentieth century that the most well-known and common underwater breathing technique, SCUBA with self-contained gas, was used extensively. While vessel salvage using breath holding, diving bells, and surface-supplied air dates back centuries, the invention of the Aqualung in 1943, the first SCUBA system by Jacques-Yves Cousteau and Emile Gagnon, revolutionized research underwater. Indeed, the emergence of systematic underwater archaeology coincides with SCUBA becoming generally affordable in the 1960s and 1970s. Additionally, the large-scale commercial development of SONAR and other subsea equipment for accurate mapping led to the incorporation of these technologies into archaeological research (e.g., side-scan SONAR, magnetometer, sub-bottom profiler, multibeam SONAR, fathometer, global positioning systems, etc. see Section 4). Both the history of diving and subsea mapping technologies greatly influenced the development of underwater archaeology, and the gradual incorporation of these techniques is discussed below.

1.1.1 1600s–1960 Salvaged Treasure

Pioneering efforts to recover archaeological artifacts from underwater happened at least as early as the seventeenth century when divers using a bell recovered a cannon from the *Vasa* (or *Wasa*) warship in Sweden in 34 m of water (1663). Built between 1626 and 1628 *Vasa* foundered (or filled with water and sank) after sailing just 1300 m on its maiden voyage. Thirty-five years after its sinking, the first salvage operation took place. Other salvage operations also

used open diving bells to salvage wreck sites in the Caribbean Sea (1685) (Broadwater 2002: 23). A Spanish ship the *Concepción*, grounded on a reef in 1641. Given the nature of the wrecking event, which included storms, drownings, starvation, and sharks, the remaining survivors could not report the location of the wreck accurately. After its discovery in 1685, Sir William Phips salvaged treasure from the wreck using an open bell at what was called Silver Shoals. Similar operations during the eighteenth century in England and Italy using diving bells and metal helmets met with minimal success but included the first underwater excavation (Broadwater 2002). In 1716, in England, William Tracey dove in a leather dress with a metal helmet while trying unsuccessfully to raise the wreck of the *Royal George*, a British ship, sunk near Portsmouth in 19 m of water. In 1775 Italy, the first underwater "dig" took place when English antiquarians sponsored an expedition to recover artifacts from the Tiber River using an open bell. In the nineteenth century, between 1839 and 1843 the *Royal George* was finally removed using Augustus Siebe's diving equipment. The enclosed suit and helmet system was developed in 1837 and is the forebear of hard hat diving systems. This dive was the first recorded use of the "buddy system" in diving and the wreck was blown up and salvaged. In 1854, the first archaeological diving team investigated the remains of prehistoric pile dwellings in Lake Zurich, these were the remains of stilt houses built on marshy land, raised to protect the houses against occasional flooding (Delgado 1997: 236–237). In the 1860s divers investigated the submerged remains of crannogs (artificial islands with dwellings) in Scotland (Morrison 1985: 4–6) and numerous Mesolithic artifacts were recovered and reported off the coast of Denmark in the Baltic Sea (Müller 1897: 18–23).

Throughout the twentieth century, there was rapid change and improvements in discovering and recovering materials from underwater archaeological sites. Many famous shipwrecks such as the *Antikythera* were discovered in the early 1900s by sponge divers in the Mediterranean (Muckelroy 1978: 12) and in 1900 in Greece surface-supplied helmet divers worked at 55 m to recover statuary from a Roman wreck carrying Greek art and were under the supervision of an archaeologist. Just 100 years later MIT's *Odyssey* autonomous underwater vehicle (AUV) was deployed in Greece to search for shipwrecks in the Mediterranean. Other notable events during the early twentieth century include 1909 in México when Edward Thompson recovered over 30,000 Mayan artifacts from the cenote at Chichén Itzá by lowering a bucket attached to a pulley system into the water. This was the first major underwater artifact recovery in the western hemisphere resulting in the discovery of gold, jade, and wooden figures, which were ritually deposited into the cenote (Coggins and Shane 1984; Lenihan et al. 2017). In 1927, Neolithic and Bronze Age pile dwellings in the

Swiss Lakes/Alps were seen on early aerial photographs (Stickel and Garrison 1988: 71). In 1931, the fishing boat *Colinda* recovered a mass of peat with a barbed antler harpoon point embedded in it off of Norfolk, among the first evidence of Doggerland, a submerged landscape that was dry land until ~6,000–7,000 years ago, which connected the United Kingdom to continental Europe (Martin 2020). In 1935, Jim the "Iron Man" Jarratt used a one-atmosphere diving suit to locate the *Lusitania* at 90 m. Between 1957 and 1961 in Sweden, after the cannon was raised in 1663, the *Vasa* itself was raised from 34 m of water and is regarded as one of the most significant and successful shipwreck recoveries of all time.

To summarize this first stage, from the 1600s to 1960, underwater investigations of archaeological sites primarily focused on salvaging treasure and/or valuables, in addition to locating wrecks of historical significance in deep waters. From a methodological perspective, it is clear that the history of underwater archaeology is connected to the history of diving. The incorporation and evolution of different diving techniques – from bells to one-atmosphere suits – were tied into both underwater salvage and archaeological discovery. Prior to the invention of the Aqualung and large-scale and affordable SCUBA gear, these incidental discoveries of underwater finds remained the extent of underwater archaeological research until 1960. Significantly these early finds already indicated that different types of archaeological sites were underwater, including shipwrecks where some catastrophe sank a vessel but also ritual deposits where artifacts were intentionally sunk, such as the figures in the Chichén Itzá cenote (Coggins and Shane 1984) and the river offerings in the Tiber, as well as evidence of architecture including pile dwellings and crannogs.

1.1.2 1960–Present, Shipwrecks

The break between the first and second stages in underwater archaeology as defined here is 1960. 1960 represents a significant shift in underwater interactions with archaeological sites going from discovering them, salvagers taking artifacts or entire ships to the surface, to systematic archaeological investigations. This stage is primarily focused on shipwrecks and systematic underwater archaeology emerged with a nautical focus on identifying, mapping, photographing, and excavating shipwrecks in the Mediterranean (Bass 1966; Bass et al. 1967; Bass and Van Doorninck 1982; Throckmorton 1970). Earlier campaigns include Cousteau's efforts to excavate the *Mahdia* shipwreck off the coast of Tunisia in 1948 where the Aqualung and airlifts were first used (Broadwater 2002), but it was in 1960 in Turkey that the first professional underwater archaeological excavation was conducted by Bass and colleagues in

29 m of water on a wreck dating to 1300 BC. This team would establish high standards for future underwater archaeological projects.

Bass' investigation of a fourth century Byzantine shipwreck at Yassi Ada, Turkey, is considered the first controlled excavation of an underwater site, with careful mapping of each artifact in situ and excavations in controlled layers, first recording and removing the cargo and then proceeding down to the hull planking. Underwater excavation techniques were invented throughout the course of this project, as the crew had to deal with some unforeseen challenges of working in an underwater environment. For example, each wooden piece of the vessel had to be secured to the sea floor using bicycle spokes so that each plank could be mapped before floating away. This early work established that controlled excavation was possible in underwater contexts using SCUBA gear that allowed archaeologists the flexibility they needed, and that intact shipwrecks as well as scattered wreck sites could yield valuable data to historians, classicists, and archaeologists (Bass 1966; Gould 2000; Muckelroy 1978, 1980). Their research demonstrated that shipwreck construction and trade routes could be reconstructed in amazing detail by examining wreck sites. It also showed that virtually everything from tiny stone blades to huge temple columns were carried on the sea and much was lost in wrecking events, providing time capsules of the movement of goods. Archaeological research underwater could therefore gain unique knowledge of technology, art, and history from ancient cargoes. These early efforts were crucial for demonstrating that the systematic investigation of wrecks could provide details about the past we would otherwise never see.

From 1960 to the present, shipwreck investigations have offered a venue for technological development. Just as the history of diving is tied to the development of underwater archaeology, so is the evolution of subsea technology, including remote sensing cabled and towed instrumentation, submarines, remotely operated vehicles (ROVs), AUVs, and most recently unmanned, autonomous surface vessels (ASVs). 1963 was the first use of side-scan SONAR to find a shipwreck, developed by Harold Edgerton of MIT. 1964 was the first use of a submersible to map a shipwreck when Bass mapped an ancient wreck in the Mediterranean using the special-purpose submarine *Asherah* (named after the Semitic goddess "she who treads on the sea"). Submarines in archaeology have multiple uses including exploration and discovery of sites, documentation, and sampling, and can act as an aid for SCUBA divers. Specific wrecks were often the target of evolving methods as each site presented its own methodological hurdles. For example, the United States Ship (USS) *Monitor* and *Hunley* are famous American Civil War vessels. The *Monitor* was built in 1862 and was the first ironclad of the Union Navy. The

Hunley was built the following year in 1863 and was a Confederate submarine, the first to sink an enemy ship. The *Monitor* was discovered off Cape Hatteras in 1973, it was mapped in 1974, artifacts were recovered by divers in 1977, and in 1979 the deepest "hands-on" investigations by professional archaeologists to date took place in 73 m of water. Archaeologists also began incorporating subsea technologies such as ROVs into their expeditions. The first deepwater excavation with an ROV took place in 1990 for the Tortugas Project, where ROV *Merlin* worked on a Spanish shipwreck from 1622 in 457 m. The following year, ROV *Nemo* raised gold from the 1857 wreck *Central America* from 2,438 m.

Overall, this period marks many of the most important technological leaps for conducting archaeology underwater including the use of Aqualungs for flexible diving, the airlift for controlled excavations, the development of underwater photography and mapping techniques pioneered by Bass (1964), and lastly, the first use of side-scan SONAR to locate a shipwreck in 1963. Although submerged sites and shipwrecks were known for centuries, it wasn't until the culminating advent of all these tools, that archaeological research could be conducted underwater to the same standards as it was conducted on land.

1.1.3 1970s–1990s, Submerged Sites

Following close on the heels of the pioneering research of shipwrecks, archaeological sites which have been submerged due to changing water levels were known from at least the nineteenth century (e.g., Müller 1897: 18–23) and came to be systematically investigated for the first time in the 1970s. While limited excavations took place in the early 1970s, in the south sea of Funen, Denmark (Skaarup 1983, 1993), the first systematic, large-scale excavation of a submerged prehistoric site occurred from 1978 to 1988 at the site of Tybrind Vig (Andersen 2013). Tybrind Vig is located 300 m off the Danish coast in 3 m of water and is an extensive Late Mesolithic-Ertebølle cultural settlement with a radiocarbon date from a human burial dating the occupation to 6,400 cal yr BP. Mesolithic artifacts near the site (about 500 m south) were first located in 1957 by amateur archaeologists/SCUBA divers (Albrectsen 1959), and in the early 1970s when SCUBA equipment became generally affordable, systematic excavations were carried out in 1 x 1 m squares. Of the material remains excavated, close to 60 percent are organic, including a wickerwork fishing trap, components of fishing weirs, fishhooks made of red deer bone (one with a piece of a line attached), wooden fishing spear tines, textiles, three wooden dugout boats made of limewood, and wooden paddles made of ash, four of which are decorated (Andersen 2013; Malm 1995: 393, Figure 12).

Following Tybrind Vig, in numerous parts of the world, submerged site research emerged. Investigations included systematic survey and excavation of submerged sites in the Baltic, the Mediterranean, and inland Florida. Early survey with the help of a predictive model located additional submerged Mesolithic sites preserved in the slow-moving and shallow waters of the Baltic Sea off the coast of Denmark (Andersen 1980, 1987; Fischer 1995a). Similar to Tybrind Vig, these well-preserved sites have produced a wide array of architecture and artifacts including domestic structures, wooden objects, and textiles (Fischer 1995a, b). In the Mediterranean, underwater site surveys and limited excavation took place off the Carmel Coast of Israel. Sites here are 250 m off the coast in 1–12 m of water and are well preserved under sand. Occasional industrial dredging and intense storms exposed these sites anywhere from a few days to a few months and six were identified early on during these periods of exposure and surveyed (Galili and Wienstein-Evron 1985). These include Late Neolithic-Chalcolithic stone structures such as rectangular house floors, hearths, storage pits, and silos (dated to 6,830 cal yr BP) with lithic artifacts, basalt grinding slabs, ceramic sherds, limestone bowls, and bone fragments (Galili and Wienstein-Evron 1985). In Florida, a karstic landscape of rivers and sinkholes was explored early on by SCUBA divers. In Wakulla Springs divers recovered artifacts and fossils, while Little Salt Spring, Warm Mineral Spring, and the Guest Mammoth site saw excavations of archaeological materials in the 1970s and 1980s (e.g., Hoffman 1983).

The earliest prehistoric site which was found and explored in this period was Fermanville, a Middle Paleolithic occupation discovered in 1968, and excavated periodically during the 1970s–1980s. Originally discovered by petroleum geologists conducting geomorphological surveys, over 2,500 Mousterian lithic artifacts have been recovered near the base of a submerged granite cliff north of Cherbourg, France. This site has preserved stratigraphy and demonstrates that Neanderthals were living 20 m below the present sea level at least 45,000 years ago (the site has been relatively dated based on geological evidence to 40–90,000 cal yr BP). Fermanville seems to present an ideal place for occupation, as Neanderthals living there could take advantage of the proximity to both terrestrial and marine resources, as well as local lithic raw materials (Scuvée and Verague 1988). Fermanville provided additional evidence of the prehistoric occupation of Doggerland. The antiquity of the site was particularly important since it was the first submerged site dating to before the Last Glacial Maximum – demonstrating that archaeological sites and stratigraphy could survive first inundation, then fully glacial conditions, and subsequent transgressions (water level rises) (Scuvée and Verague 1988).