

Article 6.21.1.10. UNDERWATER ARCHAEOLOGY

b) Brief addresses of authors

James P. Delgado, Vancouver Maritime Museum, 1905 Ogden Avenue, Vancouver, B.C. V6J 1A3, Canada
Dr. Mark Staniforth, Department of Archaeology, Flinders University, GPO Box 2100, Adelaide, 5001, Australia

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d) Short contents list

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AIMA: Australian Institute for Maritime Archaeology.

ACUA: Advisory Council on Underwater Archaeology.

Assemblage:

CAMM: Council of American Maritime Museums.

Conservation: the scientific process of preserving cultural material; in the case of artifacts from underwater archaeological sites conservation usually involves waterlogged material often with high chloride concentrations.

Conservator: person qualified and experienced in the treatment and preservation of cultural material - in this case, cultural material from underwater archaeological sites.

Curator: person qualified and experienced in the storage, interpretation and exhibition of cultural material – in this case, cultural material from underwater archaeological sites.

EEZ: Exclusive Economic Zone.

ICMM: International Congress of Maritime Museums is the main international body representing maritime museums.

ICOM: International Council of Museums

ICOMOS: International Council on Monuments and Sites was established in 1964 and is the main international non-governmental organization concerned with the preservation of monuments and sites including underwater archaeological sites.

ILA: International Law Association.

Internal waters: includes all naturally occurring and artificially created water bodies within the jurisdictional boundaries of a nation or state/province including lakes, rivers, streams, swamps, marshes, caves, sinkholes, cenotes, reservoirs, dams, canals and wells as well as certain marine coastal waters such as enclosed bays and estuaries.

International waters: those areas of the world's oceans and seas that lie beyond the jurisdiction of any national or state/provincial government.

Material culture: consists of objects (or artifacts) made, altered, or used by humans.

NAS: Nautical Archaeology Society.

ROV: Remotely Operated Vehicle, a submersible robotic device fitted with a camera and/or other instruments

SHA: Society for Historical Archaeology.

SHARPS: Sonic High Accuracy Ranging and Positioning System.

Territorial seas: normally taken to mean those marine waters from the coastline and offshore islands of a nation or state/province out to the 12-mile limit.

Trilateration: two-dimensional recording system using tapes to measure the distances from two or more known points on an underwater archaeological site.

UNCLOS: United Nations Convention of the Law of the Sea is an international treaty that provides a structure for the governance and protection of the world's oceans and seas.

Underwater cultural heritage: includes the direct and indirect physical evidence of the human past that survives underwater.

UNESCO: United Nations Educational, Scientific and Cultural Organization.

f) Body of the Contribution

1. Introduction

Underwater archaeology is the systematic study of past human life, behaviors, activities and cultures using the physical (or material) remains (including sites, structures and artifacts) as well as other evidence found in the underwater (or submerged) environment. Such evidence may exist beneath fresh (or inland) waters or beneath salt (or marine) waters. It may be visible on the bed of the water body (i.e. seabed) or buried beneath sediment.

Underwater archaeological sites may consist of the remains of ships (shipwrecks), boats (boat finds), other watercraft or vessels and aircraft as well as cultural material that was accidentally dropped, lost overboard or deliberately deposited into the water body. It also includes the remains of structures that were originally built wholly or partly underwater (such as fish traps, crannogs, bridges, piers, jetties and wharves) as well as the remains of human activity that originally took place on dry or marshy land that has subsequently been inundated, either by rising water levels or by marine (or fluvial) erosion.

The term underwater archaeology simply refers to the environment in which the practice of archaeology is undertaken. Contemporary definitions of underwater archaeology overlap with definitions of:

Maritime archaeology - is the archaeological study of humans and their interactions with the sea and can include sites that are not underwater but that are related to maritime activities such as lighthouses, port constructions or shore-based whaling stations.

Marine archaeology – is the archaeological study of material remains created by humans that are submerged in the marine (or saltwater) environment such as submerged aircraft.

Nautical archaeology - is the archaeological study of ships and shipbuilding. Like maritime archaeology it can include sites that are not underwater but that are related to ships and shipbuilding including ship burials, shipwreck remains in the terrestrial environment or shipbuilding yards.

In order to practice a suitable standard of underwater archaeology requires appropriate academic qualifications, training and experience. Training in archaeological technique alone will not suffice. Tertiary (preferably postgraduate) education in anthropological, historical and archaeological theory, methodology and research practice need to be combined with suitable qualifications and experience in working underwater. Advanced level training in technical diving is also advantageous, specifically in working on underwater sites at depth, in surf, in poor or limited visibility, or other conditions that may be hazardous. When conducting archaeology in the underwater environment, an underwater archaeologist will often have one or more geographical, temporal, thematic or cultural specialties or interests such as European wooden ship-building of the Medieval period, Bronze Age sea-borne trade in the Mediterranean or Confederate blockade-runner Paddle steamers. Other archaeologists may focus on themes such as ship symbols, site formation processes, or computer modeling. Technically oriented archaeologists may focus their efforts in areas such as remote sensing, survey methodology, or conservation.

Underwater archaeological activity must conform to all of the legislative and administrative requirements of the nation or state/province within whose internal waters, territorial seas or Exclusive Economic Zone (EEZ) the work is being conducted. It should also take into consideration international conventions and guidelines for the protection and management of the underwater cultural heritage including the United Nations *Convention on the Law of the Sea* (UNCLOS) and the UNESCO *Draft Convention on the Protection of Underwater Cultural Heritage*. Furthermore underwater archaeologists should be guided by codes of practice and codes of ethics such as the ICOM *Code of Professional Ethics* and the Australian Institute for Maritime Archaeology (AIMA) *Code of Ethics*.

2. Aims

The aims of underwater archaeology (including marine, maritime and nautical archaeology) are to integrate archaeological data and interpretation into the broader study of the human past, emphasizing not only materials from submerged sites, but also from maritime activities, arguably one of the more universal human endeavors. Inasmuch as two-thirds of the earth is covered by water, many human civilizations have turned to the sea, lakes, and rivers for

sustenance, transportation, and war. To obtain as complete an understanding of the past, archaeological reconstructions of the past, as well as anthropological interpretations of human behavior, must include information from submerged or underwater sites.

Archaeology underwater is a relatively new sub-discipline of archaeology, and is just now passing from a pioneering period that spanned the last half of the 20th century. The aims of archaeologists working in this field, over the next century, will focus on better integration of their data and interpretation with the wider professional community, better dissemination of their research to the public, combating treasure hunting and commercial salvage of archaeologically significant shipwrecks, and adapting to the late 20th century development of new technologies that have unlocked the potential to discover, examine, excavate or plunder sites at any depth in the ocean.

3. The Environment

Underwater archaeology is conducted in naturally occurring bodies of fresh or salt water such as oceans, seas, lakes, rivers, streams, swamps, marshes, caves, sinkholes and cenotes as well as bodies of water constructed by human beings such as reservoirs, dams, canals and wells. The underwater environment provides the underwater archaeologist with both opportunities and challenges, which can result in the long-term preservation of some cultural materials but also the rapid deterioration of certain cultural materials when the environmental conditions are changed.

The work of maritime archaeologists can be accomplished on sites that are now buried but were formerly underwater, including bogs, former riverbeds, or urban settings along reclaimed waterfronts. Shipwreck work occasionally takes place on beaches as well as underwater. In all these cases, however, the material studied is almost always still in a wet environment, be it mud, wet sand, or bog.

3.1 Preservation

The underwater environment can preserve complex associations of cultural material in better condition than they may be preserved on a terrestrial archaeological site. After a period of time an underwater archaeological site may reach an approximate state of equilibrium with its environment. As a result certain types of cultural material may remain in a remarkably good state of preservation of considerable periods of time (hundreds or even thousands of years).

3.2 Deterioration

It has been suggested that shipwrecks are like time capsules and to a very limited extent this may be true in that the majority of the site's structure and artifact assemblage were deposited on one particular day in the past. Nevertheless taphonomic or site formation (post-depositional) processes will affect the site over time resulting in the deterioration or destruction of certain materials or parts of the site as well as the addition of cultural material to the site

By definition cultural material removed from any underwater archaeological site will be waterlogged and depending upon the type of water (fresh or salt water) and the type of material, it may be saturated with chloride ions. Physical and chemical processes as well as biological organisms cause deterioration to, and in some cases the eventual destruction of, underwater archaeological sites, structures and artifacts. The rate of deterioration for certain materials may slow after a period of time particularly in anaerobic conditions (without oxygen) and when buried by sediment.

There are two principle processes affecting, and potentially threatening, underwater archaeological sites. These arise from:

- Environmental processes
- Human activities

Naturally occurring environmental processes such as changes in sea level and marine (or fluvial) erosion may affect, and potentially threaten, underwater archaeological sites. Changes in sediment levels or current patterns over a site may result in the damage to the site. Such changes may be cyclical and can only be assessed by observation of the site over a period of time. Recent research on the wreck of RMS *Titanic* (1912) has identified a metal-eating species of bacteria that may also pose a threat to submerged iron and steel shipwrecks.

By far the greatest threat to underwater archaeological sites is deliberate or inadvertent damage or destruction of the site and/or its associated artifacts caused by human activity. This includes dredging and other forms of harbor maintenance and clearing, damage from deep trawling and other fishing activity, anchoring, and deliberate salvage, souvenir hunting, or looting.

4. Methodology, techniques and equipment

In order for human beings to remain submerged in the underwater environment for any length of time at virtually any depth below the water surface requires the use of special equipment. In relatively shallow water (usually less than 40 meters water depth) one option is 'diving' where a 'diver' is supplied with a compressed gas supply such as SCUBA or surface-supplied air. Recent advances in diving technology, termed 'technical' or mixed gas diving involving the use of Nitrox and Trimix, have extended the water depths achieved by divers to beyond 80 meters. Technical diving uses tethered diving systems, gas mixtures other than air, and training specific to diving at depth. Nevertheless at the present time, the vast majority of the oceans of the world are too deep for diving activity and human beings can only physically reach and work in relatively shallow water depths. To work in the underwater environment at depths beyond about 100 meters involves using a submersible (or submarine) or the adoption of a technical diving regime.

Submersibles offer increasing opportunities for underwater archaeology without exposing the relatively unprotected human body to the inherent dangers of diving at depth. Submersibles also allow for a human presence on sites at depths where diving is impossible with current technologies, such as deep ocean wreck sites like *Titanic*. The first submersible used for archaeological research was the 1960s-built *Asherah*. Built for the University of Pennsylvania for the then-infant Institute of Nautical Archaeology, *Asherah* worked on Mediterranean shipwreck sites under the direction of Dr. George F. Bass.

The research submersible *Alcoa Seaprobe* was the next to be used for archaeological work. *Seaprobe* carried divers to the wreck of USS *Monitor* in 1979. The US submersible *Alvin*, developed for the US Navy in 1964 has conducted many military and scientific missions, including the exploration of RMS *Titanic*. Other deep ocean submersibles – the Russian *Mir 1* and *Mir 2*, and the French *Nautile*, have also dived on *Titanic*. These commercial uses have not been archaeological, but they demonstrated that archaeological work was possible. Work by *Mir 1* and *Mir 2* to document and encapsulate portions of the sunken Soviet nuclear submarine *Komsomolets* in 1989 was a further demonstration of the ability of deep ocean submersibles, operated by skilled pilots, to conduct intricate work like archaeology, in this case at a depth of 1,700 metres. This potential has since been explored and proved with projects such as Dr. Robert Ballard and Dr. Anna Marguerite McCann's surveys of the Mediterranean, Black Sea, and the survey and excavation of shipwrecks at Skerki Bank in the Mediterranean.

The costs of sending a manned submersible into the deep are high but the costs are dropping. Once the domain of the military and government-funded bodies like Woods Hole Oceanographic Institute, deep-sea exploration has extended to the commercial world, as the employment of *Nautile*, and the *Mirs* in *Titanic* projects demonstrates. For shallower work, tethered diving suits are becoming less expensive and allow people to descend into the depths without fear of decompression sickness. They include the most recent update of the armoured diving suit, in this case a one-atmosphere body fitting "Newtsuit." Developed between 1979 and 1987 by International Hardsuits, a Canadian firm, the Newtsuit dives to 1,000 feet with the diver safely inside. Foot pedals control a thruster pack, and while tethered to the surface, the Newtsuit diver can spend 48 hours submerged without surface air. While employed in military and commercial salvage operations, the Newtsuit has yet to be employed on an archaeological project.

The alternative to actually placing people on an underwater archaeological site involves the use of a Remote Operated Vehicle (ROV) or remote sensing equipment (underwater geophysical) equipment such as Side Scan Sonar, Magnetometers, Metal Detectors, Sub-Bottom profilers or CHIRP systems. Remote Operated Vehicles are robotic devices, tethered to a support ship on the surface that carries still or video cameras. ROVs can also carry manipulating devices for excavation or recovery of materials ranging from geological samples or artifacts.

4.1 Regional or site inventory

In order to assess and manage underwater archaeological sites it is necessary to undertake a process of regional or site inventory to establish information about what sites and cultural material actually exists underwater. Information about the location, nature, extent and significance of underwater archaeological sites needs to be compiled into a database for each nation and/or state/province.

A regional survey may take one of two forms – a random sample or a stratified sample. A random sample regional survey would take the form of conducting an intensive visual and/or remote sensing survey of a selected percentage (say 10%) of an area for archaeological sites, structures or artifacts. Such a survey methodology may be more suitable for area surveys of anchorages or jetty sites. A stratified sample regional survey distinguishes areas within the total survey area on the basis of differences in environmental factors such as topography and water depth and cultural factors such as shipping routes and the location of ports. Increased levels of coverage (or over sampling) in areas with a higher probability of sites, structures or artifacts may be more suitable for area surveys for shipwrecks.

States, museums, cultural resource managers and professional and avocational organizations have undertaken numerous regional surveys, some of extensive areas, throughout the world. Notable examples include the work of the Institute of Nautical Archaeology in the eastern Mediterranean, the U.S. National Park Service in the national parks and marine protected areas of the United States, the Western Australian Maritime Museum in western Australia, GRAN in France, and Parks Canada's surveys of Canadian national parks areas.

4.2 Site survey and recording

Site survey is the process of measuring and recording the site features, spatial arrangements, distributions and relationships between cultural materials on an underwater archaeological site. Site survey requires that the accurate location of any item of cultural material must be measured and recorded before it is moved or raised. Site survey recording may take the form of the use of physical measurements such as trilateration or a three-dimensional grid frame system and/or electronic systems such as the Sonic High-Frequency Archaeological Ranging System (SHARPS) or similar system. In addition to physical and/or electronic measurements, a site survey should include the use of underwater photographic recording such as site photographs, a photomosaic, stereo-photogrammetry and/or video recording. Site survey methodology may also employ remote sensing equipment such as metal detectors, magnetometers and/or sub-bottom profilers.

A predisturbance survey of every underwater archaeological site must be undertaken before any cultural material is moved or raised.

4.3 Excavation

Excavation is the process of uncovering all or part of an underwater archaeological site by removing the sediment, recording the location, type, size and amount of cultural material and then removing or recovering all or part of that material. Excavation is a destructive process and will radically change or destroy the archaeological record.

Excavation of an underwater archaeological site should only be undertaken when:

- * the site and/or artifacts is threatened with disturbance or destruction as a result of human activity or through environmental processes
- * previous research and a written research design has demonstrated that only through excavation can answers be found to specific research questions.

5. Sites and structures

5.1 Submerged or inundated terrestrial sites

Terrestrial prehistoric archaeological sites throughout the world have become submerged as a result of naturally occurring rising sea level or inundated in human created water storage such as reservoirs and dams. Submerged prehistoric sites with material including lithic artifacts, human remains and organic cultural material have been found at underwater archaeological sites such as Little Salt Spring (Florida, USA), Warm Mineral Springs (Florida,

USA) and Montague Harbor (British Columbia, Canada). Other prehistoric and protohistoric sites with submerged remains include Iron Age villages covered by rising water levels in Swiss lakes, as well as crannogs in Ireland and Scotland.

Harbor constructions including wharves, moles, quays, jetties, piers, fortifications, canals or artificial docks that have become submerged by rising sea-level, caused by catastrophic events such as earthquakes or simply as a result of natural site-formation and deterioration processes. Examples of sites studied and/or excavated within the last few decades are:

Caesarea Maritima
Cosa,
Dvaraka
Hoff's Store
Kencherai
Pontia
Port Royal

5.2 Shipwrecks

Archaeologists, aided by chance or deliberate discoveries by fishermen, divers, the military, dredging, construction, or salvage, have inventoried and studied thousands of shipwrecks, ranging from 5,000 BP to the 20th century. These include ships deliberately buried on land as part of a grave – such the Khufu or Cheops ships buried in boat pits at the Great Pyramid of Giza (Egypt), Viking ship burials, such as the Gokstad, Oseberg, or Tune ships (Norway), or the Saxon ship at Sutton Hoo (England) to ships in reclaimed land. The latter includes numerous finds in the polders of Holland, as well as ships discovered in landfill in Pisa, London, Marseille, Quebec City, Dublin, New York, and San Francisco. Other examples include ships excavated from former river courses, such as *Bertrand* and *Arabia*, two mid-19th century river steamers discovered in the central United States, and the Butuan boats, eight boats ranging from AD 320 to AD 990 discovered near Ambangan in the southern Philippines. Shipwrecks on beaches or in the littoral zone have yielded significant archaeological results, including *Amsterdam* (1749) at Hastings (England), *LaBelle* (1686) at Matagorda Bay, Texas (USA), or the Quanzhou ship (circa 1270) at Hou-Zhou, Fujian (China). Other significant finds include the Nydam boat, buried in a bog as a deliberate sacrifice in the 4th century AD.

The majority of shipwreck work undertaken in the last half century has been devoted to non-disturbance survey or limited (test) excavation. This is largely due to the prohibitively high costs of excavation and conservation. An emphasis on resource protection, particularly in the United States, has also played a role. Among the most significant shipwreck excavations of the last half of the 20th century are:

CSS *Alabama* (1865), a composite-built, American Civil War Confederate naval raider sunk off Cherbourg, France, and to date the only detailed archaeological examination of a wooden-hulled, steam-powered warship;

The Athlit Ram (circa 200 BC) the only ancient warship bronze ram recovered archaeologically from the sea, with well-preserved bow timbers inside the ram's socket, discovered near Haifa, Israel;

Batavia (1629), the second oldest known shipwreck in Australia, with well-preserved hull remains from the vessel's stern and a rich assemblage of artifacts;

HMS *Betsy* (1788) a well-preserved naval transport deliberately scuttled after the British surrender at Yorktown during the American Revolution, yielding well-preserved interior furnishing and fittings as well as other artifacts;

Blackfriars I (2nd century AD), the earliest known indigenous seagoing sailing ship yet discovered in northern Europe, excavated after riverbank construction revealed the hull on the shores of the Thames River in London;

Bremen Cog (circa AD 1378) the best preserved remains of a cog, until then archaeologically undocumented but the typical medieval cargo carrier and warship in northern Europe, excavated from the banks of the River Weser, Germany;

Brown's Ferry Vessel (18th century AD), a well-preserved indigenous flat-bottomed inland transport vessel excavated from the Black River near Georgetown, South Carolina (USA);

The Butuan Boats (AD 320 to AD 1250), indigenous, plank-built wooden boats excavated by the National Museum of the Philippines, well-preserved examples of a hitherto little documented seafaring technology in protohistoric southeast Asia;

The Cape Gelidonya Wreck (circa 1200 BC) excavated off the south coast of Turkey, at the time the oldest known shipwreck, this site yielded detailed information about the nature and materials of Late Bronze Age international trade in the Mediterranean;

The Cattewater Wreck (early 16th century AD) an armed merchantman excavated near Plymouth, England, with well-preserved hull remains that have helped define the development of 16th century European ship design;

Dartmouth (1690) a fifth-rate English warship, Dartmouth's wreck site was subjected to detailed spatial analysis in one of the first archaeological examinations of site formation process;

Defence (1779) an American privateer scuttled after defeat by a British naval force, this wreck yielded a detailed look at shipboard life and provisions as well as the hull;

The Duart Wreck (1653) a scattered shipwreck site with exceptionally well preserved remains, including human bone and decorative carvings, probably the pinnace *Swan*, lost off the west coast of Scotland;

El Gran Grifon (1588), one of three Spanish Armada wrecks scientifically excavated by the Scottish Institute of Maritime Studies, this wreck off the Scottish coast provided the first detailed look at the ordnance of the Armada;

The Emanuel Point Ship (mid 16th century AD), possibly a ship of exploration lost during a 1559 Spanish voyage of colonization to Florida (USA) and one of the earliest wrecks yet discovered in North America;

The Ferriby Boats (13th century BC), three prehistoric, late Bronze Age sewn plank boats discovered on the banks of the Humber River in England;

Fredensborg (1768), a Danish-Norwegian frigate lost off the coast of Norway and the only ship involved in the Atlantic slave trade to be scientifically excavated, yielding African and Caribbean trade goods as the ship was lost on the return home from a lucrative slaving expedition;

The Gedesby Ship (late 13th century AD) a well-preserved merchant vessel discovered off Denmark with sufficient (90%) remains of the hull and some of the rigging, which allowed archaeologists to build a replica for experimental trials at sea;

Girona (1588) a Spanish Armada loss off the coast of Ireland, this Mediterranean galleass's remains were largely destroyed by sea, but excavation of the site yielded ordnance and an amazing array of Renaissance jewelry and knightly orders, some of it associated with drowned officers of the ill-fated Armada;

The Graveney Boat (circa AD 900) a late Saxon clinker-built seagoing ship discovered in an English marsh, the wreck evidenced an indigenous shipbuilding tradition as yet not influenced by Scandinavian techniques;

The Guernsey Wreck (late 3rd century AD), a Romano-Celtic merchant ship wrecked in the English Channel islands with construction that shows a merging of Mediterranean and native Celtic techniques;

Halsenoy Boat (350 AD) a small sewn boat discovered in a bog near Bergen, Norway, and the earliest indisputable evidence of the clinker-built tradition in a vessel;

Herculaneum Boat (79 AD) the carbonized remains of a small Roman boat, found preserved the volcanic mud at Herculaneum after it was tossed ashore and buried by the mud during the eruption of Vesuvius;

Highborn Cay Wreck (early 16th century) one of the earliest shipwreck sites in the New World, a probable Iberian ship lost during the early years of European exploration and conquest in the Caribbean, this Bahamian wreck yielded important information on the hull construction of Europe's first "ships of discovery";

H.L. Hunley (1864), an American Civil War, Confederate submarine, the first submersible to sink another vessel in combat, recovered near Charleston, South Carolina (USA);

Ijsselmeerpolders wrecks (various) an incredibly well-preserved collection of wooden wrecks of the medieval and post medieval period, buried in the reclaimed polders of Holland, these wrecks are one of the world's great repositories of maritime archaeological knowledge, with a dedicated program by the Netherlands Institute of Ship and Underwater Archaeology constantly excavating and analyzing the discoveries;

Isis Wreck (4th century AD) the deepest shipwreck subjected to archaeological excavation, this late Roman ship lies in 800 meters of water off the southern tip of Sicily;

James Matthews (1841) a former Portuguese slave ship, captured by the British and then lost on a trading voyage to Australia, this wreck provided details of construction for a mid-19th century illegal slaver as well as a variety of artifacts for trade to Colonial Australia;

Kalmar Harbor Wrecks (various) a collection of medieval and post-medieval wrecks (25 in all) recovered from the reclaimed harbor of Kalmar, Sweden, excavated and studied to provide a detailed look at northern European shipbuilding;

Kennemerland (1664) a Dutch East Indiaman excavated off the Shetlands, north of Scotland, this wreck was instrumental, along with *Dartmouth*, in establishing an archaeological approach and ascertaining site formation processes with scattered wreck sites;

Khufu Ships (2600 BC) the oldest ships yet discovered, these elaborate royal ships were buried in pits adjacent to the Great Pyramid in Egypt. One of them was left in place, while the other was excavated and reconstructed;

Kyrenia Ship (late 4th century BC) a Greek merchant vessel excavated off Cyprus, with well preserved hull remains, this wreck provided the first detailed look at ancient ship construction. Iron spear point embedded in the hull are the earliest direct archaeological evidence of piracy, making this site even more fascinating;

LaBelle (1686), the well-preserved remains of a vessel lost on a French voyage of colonization, the complete excavation of the site off the Texas coast (USA) yielded numerous artifacts, including trade goods, cordage, personal items, and human remains;

La Trinidad Valencera (1588) an Spanish Armada victim on the Irish coast, this transport's excavation yielded invasion supplies, substantial organic deposits, guns and carriages, all providing a detailed look at Armada preparations and tactics;

Lomellina (1516), a Genoese nave lost near Nice, France, the remains of the ship provide the earliest archaeological evidence of gun ports. The guns and weapons aboard offer a rare look at an armed vessel during the time navies were adapting to the introduction of guns at sea;

Madrague de Giens Wreck (1st century BC) the largest and best studied Roman amphora carrier, discovered near Toulon, France;

Mainz Boats (4th century AD), the remains of several Roman boats found near a frontier legion's camp in Germany, four of them hitherto undocumented shallow draft riverine warships;

Marsala Punic Warships (circa 250 BC) Discovered off the coast of Sicily, these two wrecks appear to be Carthaginian warships – the only ancient ships of war yet discovered;

Mary Rose (1545) Roughly half of this Tudor warship was excavated by archaeologists off Portsmouth, England. The hull, and the thousands of artifacts recovered from it offer a time capsule of the period and the earliest detailed look at a ship of war;

Molasses Reef Wreck (early 15th century AD) the earliest shipwreck discovered in the western hemisphere, this Iberian wreck was excavated in the Turks and Caicos Islands, yielding little in hull remains but extensive ordnance and evidence that the ship was engaged in slaving;

Niantic (1851) The bottom of the hull of this 1835 merchant ship was excavated from the mud in the heart of downtown San Francisco (USA) to reveal well-preserved cargo and goods stored aboard the ship during the California Gold Rush. The goods demonstrated the tremendous buying power of California gold and the global supply of goods to that inflated market;

Padre Island Wrecks (1554) Three Spanish shipwrecks from an ill-fated flota (treasure fleet) lost on the Texas (USA) coast. Excavation of the wrecks provided a rare look at Spain's transatlantic shipping in the first century of its New World empire;

HMS *Pandora* (1791) Well-preserved wreck of a British warship sent into the Pacific to capture the mutineers from the famous *Bounty*, *Pandora* lies off Australia's Great Barrier Reef. Excavation has revealed not only a great deal of the ship's structure and fittings but also recovered native Polynesian artifacts collected by the crew as "curiosities";

Quanzhou Ship (circa 1270 AD) A Sung dynasty Chinese shipwreck, and the earliest example of an Asian ship yet discovered, this ship was built with a rudder and watertight bulkheads at least a century before these features were introduced to Europe;

Rapid (1811) An American merchant ship involved in the China Trade and lost on the coast of Western Australia. The excavation of the ship revealed much about the fast built ships of the trade and life aboard them;

San Juan (1565) One of the earliest New World wrecks yet excavated, this Basque whaler was discovered off the coast of Labrador (Canada). Excavation of the well-preserved remains revealed much about 16th century shipbuilding. The work on the wreck was linked to archaeological work on the whaler's settlement on the nearby shore, documenting a site, ships and early maritime activities in North America that had been lost to history;

Santa Maria de la Rosa (1588) Vice-flagship of a Spanish Armada squadron, this Irish coast wreck is one of a handful of Armada losses discovered and archaeologically documented. The remains provide, along with the wreck of *San Juan* in Canada, a good look at 16th century shipbuilding;

Santo Antonio de Tanna (1697) This 42-gun Portuguese frigate, lost off Mombasa (Kenya) provided a significant look not just at the ship and its fittings, but also the richness of items bound for Portugal from the country's far-flung overseas trade;

Sea of Galilee Wreck (1st century AD) A well-preserved small boat, possibly a fishing vessel, discovered in Israel and the only indigenous craft associated with Biblical times;

Serce Limani Wrecks (3rd century BC and the 11th century AD) Two wrecks on the Turkish coast, the first yielding trade items only. The second wreck, a Byzantine loss, allowed archaeologists to reconstruct the ship, but just as significant was the recovery of an exceptional cargo of Islamic glass and a variety of other artifacts that documented life aboard and trade relations between Constantinople and the Moslem Caliphate of the Fatimids;

Shinan Gun Wreck (circa 1323 AD) A Chinese merchant vessel lost off the Korean coast during the Mongol (Yuan) dynasty, loaded with ceramics, the Shinan Gun wreck is a rare archaeological look at Asian seafaring technology and trade;

Skuldelev Ships (11th century AD) Five Scandinavian ships deliberately sunk to block the harbor of Roskilde, Denmark, these wrecks provided the first detailed look at "Viking" ships. Excavation revealed various types of ships, built for both trade and war, and revised the popular view of Viking craft and seafaring;

Studland Bay Wreck (early 16th century) A Spanish merchant ship, lightly armed and lost off Poole, England, this wreck yielded trade ceramics and hull remains that join those of *San Juan*, *Mary Rose* and the Armada wrecks to provide a better, more detailed look at 16th century ships just as Europe was expanding throughout the world;

Sutton Hoo (7th century AD) Buried in the sand overlooking the River Deben in Suffolk, England, the excavation of this ship revealed the traces of the original vessel in the sand and an exceptional array of grave goods, including a jeweled purse, a helmet and shield, silver tableware from the eastern Mediterranean, and other treasures. Painsstaking attention to detail with the wreck's outlines in the sand allowed archaeologists to reconstruct the ship;

Ulburun (14th century BC) A late Bronze Age shipwreck lying off the south coast of Turkey, this site yielded one of the largest assemblages of ancient trade goods yet excavated, including Caananite, Cypriote, Egyptian, and Mycenaean artifacts. The Uluburun wreck is perhaps the most significant ancient shipwreck yet discovered;

Vasa (1628) The completely intact Swedish galleon, raised from Stockholm (Sweden) harbor in 1961, is one of the world's great archaeological treasures. *Vasa* yielded incredible artifacts, including ship's stores, a spare set of sails, armament, and the remains of 25 of her crew;

Yassiada Wrecks (various) Over a dozen shipwrecks lie off the island of Yassiada in the Aegean near Turkey. Three of the wrecks have been excavated by the Institute of Nautical Archaeology, a 4th century AD Byzantine wreck, a 7th century AD Byzantine wreck, and a 16th century AD Ottoman wreck. The wreck from the 7th century yielded much information about Byzantine shipbuilding. The study of the Yassiada wrecks, along with others excavated by INA, is providing a detailed physical look at Mediterranean shipbuilding, century by century from antiquity through the medieval period.

Thematic studies of shipwrecks collectively analyze and compare sites having the same attribute. While shipwreck archaeology began with work focused on individual sites, thematic studies over the past few decades have made invaluable contributions. These include work on Scandinavian ships and boats, the wrecks of the Spanish Armada, East Indiamen, the California Gold Rush, the American Civil War, whaling, and ships of war, to name a few.

6. Artifacts

The raising of material including artifacts, samples and ecofacts from an underwater archaeological site creates an artifact assemblage that requires conservation, curation and display. Artifact assemblages from underwater sites can, and often do, include not only any item expected in a land excavation, but also include items often not preserved on land, such as organic materials such as wood, foodstuffs, leather, and paper.

Shipwreck sites contain specialized artifacts associated with seafaring, beginning with the ship, its fittings, equipment and rigging, but also include ordnance, cargo, and the personal possessions of crew and passengers. In the case of shipwreck sites like those at Uluburun or *Mary Rose*, artifactual finds from underwater are often not replicated on land; hence the best evidence for a widespread Late Bronze Age maritime trade in the Mediterranean comes from the sea, and the most detailed look at Tudor life and warfare also comes from the mud encapsulated remains of a wreck.

6.1 Conservation.

Virtually every artifact that is removed from the underwater environment will require some form of conservation. Conservation of maritime archaeological material can be complex, expensive and time-consuming and is best carried out by a qualified and experienced conservator. Each type of material (wood, copper, ceramics etc) will require a different conservation treatment and composite artifacts (made from two or more different types of material) may prove difficult, or even impossible, to conserve. It is important that the underwater archaeologist and the conservator work closely together in order to ensure satisfactory raising, transportation, conservation, documentation, analysis, cleaning, stabilization, storage and long-term preservation of the artifact assemblage.

The first key conservation issue that arises from the removal of artifacts from the underwater environment is that certain types of material (particularly organic materials such as wood, rope, textiles and leather) are waterlogged.

Waterlogged organic material cannot simply be allowed to dry instead it must be treated using polyethylene glycol, sucrose, acetone/rosin, freeze-drying or some combination of these treatments.

The second key conservation issue is that some materials (particularly some metals such as iron as well as organic materials) are saturated with salts in particular chloride ions. Conservation treatment to remove the chlorides and stabilize the artifact is a critical step that must begin immediately upon removal from a salt water environment. Complicating matters is contraindication between treatments for metal and wood, in which certain treatments for one material will prove destructive to the other.

Scale of the conservation effort is another challenge particular to underwater finds, such as shipwrecks. In some cases, conservation efforts will extend beyond a number of small artifacts to larger ones, such as cannon, steam engines, or complete ships, such as the 20+ year efforts to conserve the hulls of *Vasa* and *Mary Rose*.

6.2 Curation.

One of the key issues in underwater archaeology is that the artifact assemblage from any underwater archaeological site must be kept together and it needs to be curated by qualified and experienced museum curators in a (maritime) museum or other suitable keeping place. This will allow the assemblage to be examined by future generations of archaeologists using more sophisticated analytical techniques and equipment.

The International Council of Museums (ICOM) *Code of Professional Ethics* as well as the recommendations made by the Committee for Underwater Archaeology and adopted by the International Congress of Maritime Museums (ICMM) in 1993 should be seen as the minimum standard for the responsible acquisition and curation of material from underwater archaeological sites. The ICMM recommendations are:

1. That in regard to collecting policy, ICMM member museums should follow the provisions of the ICOM *Code of Professional Ethics*, the ICOMOS Charter, and the *UNESCO Convention*.
2. That ICMM member museums should follow sections 3.1 and 3.2 of the ICOM *Code of Professional Ethics* and that in particular, 'each museum authority should adopt and publish a written statement of its collecting policy ... (and) ... museum(s) should not acquire by purchase (or donation) objects ... where ... their recovery involved the recent unscientific or intentional destruction or damage of ... archaeological sites'. Museums (and other keeping places) with collections from underwater sites should each adopt and publish either a written statement of their general collecting policy or a written policy relating specifically to collections from underwater archaeological sites.
3. That ICMM member museums should follow Council of American Maritime Museums (CAMM) policy and 'not knowingly acquire or exhibit artifacts which have been stolen, illegally exported from their country of origin, illegally salvaged or removed from commercially exploited archaeological or historic sites in recent times.
4. That ICMM members should report to the responsible authorities any illegal activities at underwater sites or auction or sale of artifacts from illegally excavated underwater sites in their countries.
5. That ICMM members should recognize that artifacts from underwater archaeological sites are integral parts of archaeological assemblages, which should remain intact for research and display.
6. That ICMM members should explore ways for more member institutions to involve students from academic institutions in the study of their underwater archaeological collections.

6.3 Display

The display or exhibition of the results of underwater archaeological research including artifacts (ranging from entire ships and boats to smaller finds) raised from underwater archaeological sites should be a priority for any archaeological project that raises cultural material from the underwater environment. The vast majority of underwater archaeological work is conducted using funds obtained from the general public either directly or indirectly and yet the majority of the general public cannot easily visit or observe underwater archaeological sites. As a result it is important that cultural material raised during underwater archaeological work is made available to as

large a part of the general public as possible through suitable display or exhibition in museums or other publicly accessible venues.

7. Publications, Organizations and Conferences

The Advisory Council on Underwater Archaeology (ACUA) forms part of the Society for Historical Archaeology (SHA) which is a primarily North American based scholarly group concerned with the archaeology of the modern world (AD. 1400 – present). SHA and ACUA jointly host an annual Conference on Historical and Underwater Archaeology usually in a North American location and selected underwater archaeology proceedings are published as *Underwater Archaeology*. SHA maintains a website at <http://www.sha.org/>

The Australian Institute for Maritime Archaeology (AIMA) is an Australian non-profit organization dedicated to the promotion of maritime archaeology established in 1982. While based primarily in Australia, it has supported underwater archaeological work in Australia, Asia and the Pacific. AIMA hosts an annual conference in a different Australian city each year sometimes in co-operation with other organizations such as the Australasian Society for Historical Archaeology (ASHA). AIMA publishes *The Bulletin of the Australian Institute for Maritime Archaeology* annually as well as a twice yearly newsletter and has a website at <http://www.aima.iinet.net.au/>

The Nautical Archaeology Society (NAS) is an international voluntary organization established in 1981 to promote interest in and to provide education, training and information about nautical archaeology. NAS conducts training through the internationally recognized four part NAS Training courses. NAS publishes the quarterly *International Journal of Nautical Archaeology (IJNA)* as well as a quarterly newsletter and has a website at <http://www.nasportsmouth.org.uk>

The Institute of Nautical Archaeology (INA) is an international non-profit scientific and educational organization established in 1972. INA has been affiliated with the Nautical Archaeology Program at Texas A & M University, College Station, Texas since 1976. INA has supported underwater archaeological fieldwork primarily in the Mediterranean (particularly in Turkey) as well as in North America, Central America and the Caribbean. INA publishes *The INA Quarterly* and has a website at <http://nautarch.tamu.edu/ina/>

7.1 Other publications

Publication is an important way in which the results of underwater archaeological research are communicated to other underwater archaeologists, underwater cultural heritage managers and the public at large. As well as the journals and newsletters mentioned above there are a number of other publications that regularly publish articles relating to underwater archaeology and underwater cultural heritage including:

The American Neptune

The Journal of Field Archaeology

The Mariner's Mirror

Bermuda Journal of Archaeology and Maritime History

Maritime Archaeology Newsletter from Roskilde, Denmark

The Journal of Marine Archaeology (India)

7.2 Universities involved in teaching underwater archaeology

The following universities are involved in the teaching of underwater archaeology at the undergraduate and/or postgraduate level.

USA

East Carolina University

Florida State University

Texas A& M University

University of Hawaii

UK

St Andrews University (Scotland)

University of Southampton (England)

University of Ulster (Northern Ireland)

Australia

Curtin University

Flinders University

James Cook University

Other countries

University of Haifa (Israel)

8. Key Issues

8.1 International Conventions and National Legislation

In recent years many countries have enacted cultural heritage legislation for the protection of shipwrecks and other items of underwater cultural heritage in their internal waters and territorial seas. In addition the deep ocean is littered with cultural material, which lies beyond the territorial seas, and therefore the jurisdiction, of individual nation states. Consequently there have been moves through UNESCO, UNCLOS, ILA and ICOMOS to establish international guidelines, charters or conventions, for the protection of underwater cultural heritage.

UNESCO Draft Convention on the Protection of Underwater Cultural Heritage.

UN Convention on the Law of the Sea.

ILA International Convention on the Underwater Cultural Heritage.

ICOMOS Charter

The most common mechanism by which underwater archaeological sites and artifacts throughout the world are protected is underwater cultural heritage legislation. In 1982 the United Nations Convention of the Law of the Sea (UNCLOS) provided that 'States have the duty to protect objects of an archaeological and historical nature found at sea and shall cooperate for this purpose'. All national and/or state/provincial governments have the right to enact legislation and regulations for the protection and preservation of underwater cultural heritage lying in or under their internal waters, territorial seas and EEZ.

Many national governments retain title to (or ownership of) ship and aircraft wrecks that once formed a part of that nation's military forces (Army, Navy or Air force). These property rights are not lost to that government due to the passage of time and apply whether the vessel or aircraft was lost in national, foreign or international waters.

8.2 Ethics, Principals and Guidelines

Establishing national and international standards for the profession, as well as professional regulation and accreditation has occupied considerable attention in the as yet young field of underwater archaeology. The problem has been compounded by treasure hunting activities conducted under the guise of archaeology, unqualified persons presenting themselves as archaeologists, and the collaboration by some professional archaeologists with treasure hunting activities.

The ICOMOS international committee on the underwater cultural heritage has developed professional guidelines, which are incorporated into the proposed Draft Convention on the Protection of the Underwater Cultural Heritage.

In North America, accreditation through the Register of Professional Archaeologists (RPA) joins other national accreditation bodies in establishing a code of standards for professional practice.

8.3 Underwater Cultural Heritage Management

Nations and states/provinces should be responsible for the management of underwater cultural heritage and underwater archaeological sites that lie within their internal waters and territorial seas as well as their EEZ (Exclusive Economic Zone) depending upon circumstances. Underwater Cultural Heritage management includes the enacting of legislation, the establishment of an inventory (database), and a system for the assessment of the significance, of underwater archaeological sites. It involves the declaration of historic shipwrecks and the establishment of protected zones and underwater archaeological preserves. It also involves the enforcement of the provisions of relevant legislation and administrative regulations.

8.4 Guidelines for Divers

Divers and others who are not archaeologists discover the vast majority of the world's underwater archaeological sites. Many have a keen interest in the past and a genuine desire to participate, where possible, in whatever archaeological project ensues. Without the participation of many of these "avocational archaeologists," or committed volunteers, many projects would not happen.

Any person who locates an underwater archaeological site that they believe has not been found before should:

- * Establish an accurate location for the site – using GPS (or Differential GPS) and at least one other technique (visual transits, compass bearings, sextant angles etc.).

- * Take photographs, draw sketches and make a written record of the extent and nature of the site.

- * Do not remove anything from the site.

- * Contact the local (maritime) museum and the state or national government heritage agency responsible for the protection of underwater cultural heritage as soon as possible.

In many places around the world, opportunities for ongoing participation in study, including survey, excavation and analysis, exist once a site is reported. Organizations like the Nautical Archaeology Society in the UK, DEGUWA in Germany, and the Maritime Historical and Archaeological Society (MAHS) in the US are one means of participation, as are volunteer programs with government agencies and museums. Specialized training, particularly through the internationally adopted NAS program, are also available for interested divers.

8.5 Maritime Cultural Landscape

8.6 Extending Technology and Technique to the Deep Ocean

The Cold War inspired development of deep submergence vehicles and survey equipment has opened up the deepest portions of the world's oceans to shipwreck hunters. The highly-publicized late 20th century discovery of modern wrecks such as RMS *Titanic* (1912), KMS *Bismarck* (1941), USS *Yorktown* (1942) and Japanese, US and Australian ships lost at Guadalcanal (1942) as well as the discovery of the *Isis* wreck and several other ancient shipwrecks in the Mediterranean by teams led by American scientist Robert D. Ballard underscore the potential. The ongoing salvage of RMS *Titanic* since 1987 also underscores the problem, as do several other deep ocean salvage projects, including that of SS *Central America* (1857).

To date, archaeological involvement in deep ocean shipwreck projects has been limited. Opportunities extended by Dr. Ballard have been taken up by archaeologists such as Dr. Anna Marguerite McCann and Brendan Foley, but clearly other archaeologists need to become involved in deep ocean projects of their own, including developing research designs and integrating not only deep ocean sites, but also the latest technologies, such as high-resolution digital video mapping, sonar and other equipment used in the deep ocean, to archaeological projects.

g) Summary

The field of underwater archaeology, and its various aspects, has made many excellent contributions not only to our understanding of humanity's interaction with the sea and the maritime environment, but also to our basic understanding of human prehistory and history. Anthropologically-oriented archaeology with shipwreck sites has also developed important interpretations. However, the potential of underwater archaeology to substantially augment our understanding of humanity and the past remains unfulfilled. Unresolved conflict with treasure hunters, a lack of consistent public outreach and hence a lack of public appreciation and support, and the simple relative youth of the discipline, the technical difficulty and high cost of research, the difficulties of access and protection, as well as rapid technological change, are challenges that when met will introduce significant opportunities and results.

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