ARRRCHAEOLOGICAL CONSERVATION: PRESERVING THE *QUEEN ANNE'S REVENGE* AND OTHER ARTIFACTS

By

Daniel Lowery

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Director of Thesis: Dr. Charles R. Ewen

Major Department: Anthropology

As partial fulfillment of a master's degree, the Anthropology Department as East Carolina University offers an internship option. After choosing to pursue this option, a graduate assistantship was made possible through the *Queen Anne's Revenge* Conservation Lab on ECU's West Research Campus. Though archaeology and conservation are separate disciplines the two complement each other well, with each providing a foundation in the proper identification and care of artifacts. The *QAR* conservation lab is the primary location for the conservation of artifacts recovered from the wreck of the *Queen Anne's Revenge*, and as such an internship at this lab provides students with an opportunity to handle and care for a variety of marine artifacts and witness the daily tasks necessary for their conservation. The student is tasked with daily and weekly conservation duties, as well as a personal project to oversee to completion. The skills imparted by this internship will prove invaluable in both a field and lab setting in any future career as an archaeologist, conservator, or museum worker.

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In Partial Fulfillment of the Requirements for the Degree

Master of Arts in Anthropology

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APPROVED BY:

DIRECTOR OF INTERNSHIP: Dr. Charles R. Ewen, MA Adviser

COMMITTEE MEMBER: Dr. I. Randolph Daniel, Jr., MA Committee Member

COMMITTEE MEMBER: Dr. Benjamin Saidel, MA Committee Member

COMMITTEE MEMBER: Kimberly Kenyon, MA Committee Member

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Chapter 1 – The Importance of Conservation

Many people are familiar with the concepts of archaeology and museums: recovering an important historical object from a site and displaying it for public knowledge. However, an often overlooked step is what happens in between when an artifact is recovered, and when it is displayed; that is where the field of conservation is utilized. Conservation in this context is defined as the "the profession devoted to the preservation of objects, structures, and sites that constitute the archaeological record" (Archaeological Heritage Network 2022). Conservation aims to prevent the further degradation of objects after they have been recovered from a burial context and to preserve them so that future generations can observe and study them. According to author and conservator Chris Caple, conservation treats objects as historic documents that can further humanity's understanding of the past and reveal the importance of the objects themselves (Caple 2000).

Conservation has numerous aims; one is to practice "first aid" for artifacts. When an artifact is recovered it could be considered to be analogous to a wounded person, and must be treated quickly and skillfully to ensure no further damage occurs. Conservation also seeks to understand how and why materials decay in various burial environments. By knowing what burial environments cause what reactions in certain materials, conservators can better understand the processes of decay and counteract them more efficiently. Conservators must also aim to analyze the material they are conserving and conduct investigative cleaning. This often means undertaking experimental conservation on small samples of artifacts to determine how materials react to new treatments and chemicals. This can allow conservators to create new methods of conservation that are cheaper, more efficient, more effective, and safer for the artifacts themselves. Lastly, conservators must of course stabilize artifacts to ensure they do not degrade further and prepare them for display at museums. The overarching goal of archaeology and conservation should always be the preservation, cultivation, and sharing of knowledge with others; archaeologists recover artifacts, conservators preserve them, and museums exhibit them so that people can learn more about humanity's past.

<u>The History of Conservation</u>

The beginnings of the field of conservation are similar to that of archaeology; it did not have a basis in science, only a veneration for the past and an obsession with artifacts, comparable to antiquarianism in archaeological theory. Collectors might acquire artifacts and "clean" or "repair" them, but they did not do so following any scientific principles or basic conservation guidelines. In fact, the fields of archaeology, conservation, and museum practice all have similar origins that while not scientific did derive from the same guiding principles: appreciation of artifacts both for their aesthetic beauty and value as well as their historic importance as documents from which information about the past could be gathered. As one of these fields progressed so too did the others, sharing knowledge about the preservation and interpretation of artifacts and developing further appreciation for them.

Perhaps the first example of an early form of museum being established was the Greek temple of Delphi. After the Greeks triumphed over King Darius I and his Persian army in 490 B.C., they collected weapons and artifacts related to the battle and stored them inside the temple to be preserved and appreciated. This compulsion to collect and display artifacts related to historic events and prominent leaders seems to be a natural human instinct, one that would continue and evolve over the centuries into the intensive conservation and carefully curated museums that can be seen all over the world today. Another historic example of the beginning of museums is the Medici family of Florence, Italy. Rising to prominence in the 13th century, these wealthy merchants and bankers were patrons of the arts and sciences and amassed a large private collection of art pieces and artifacts (Caple 2000: 46). Though they were likely partly inspired to collect these pieces out of an interest in history and preservation, it is fair to guess they were equally inspired by the privilege and status conferred just by owning said artifacts.

Over the next few centuries, artifact collections would become less concentrated in the hands of a few wealthy families and instead would become a point of interest for national governments. With the establishment of the British Museum in 1759 and the Louvre in 1793, it became evident that political leaders had developed an interest in preserving cultural heritage in well-funded facilities that were accessible to the public (Caple 2000: 47). As communication and transportation technologies improved throughout the 20th century, so too did museums and international cooperation between them, starting with the establishment of the International Museum Office in the 1930s and leading to the many museums, conferences, and publications that are available today.

As museums developed over the centuries, the art and science of conservation evolved in tandem. One of the first historic examples of conservation can be found in the writings of Pliny the Elder, a Roman commander, author, and philosopher. He wrote one of the world's first encyclopedias, *Natural History,* which is the largest single work from the Roman Empire that has survived to this day. Published in 77 AD, this work references the care and restoration of monuments and works of art that had deteriorated. Though Pliny does not mention specific conservation methods used, it is clear that a desire to preserve artifacts and revere the past was as common in antiquity as it is today (Sease 1996: 157).

Many centuries later the Renaissance took place, inspiring a newfound respect for classical civilizations and in turn a new interest in conservation of artifacts from that time.

Financed by the Catholic Church and wealthy nobles such as the Medici family, artists such as Michelangelo were hired in the 16th century AD to restore sculptures and other pieces of art from ancient Greek and Roman cultures (Sease 1996: 157). Another example of classical conservation is the discovery of and attempt to preserve the Herculaneum papyri scrolls, excavated in 1752. These scrolls consist of 1800 rolls of papyrus that were carbonized by the eruption of Mount Vesuvius in AD 79. Due to the carbonization process, the scrolls were extremely fragile and the writing would begin to fade once exposed to air. To attempt to unroll the scrolls and transcribe the writing inside, a monk by the name of Antonio Piaggio invented a machine in 1756 that would unroll the scrolls very slowly, at a rate of only millimeters per day. Once unrolled the writing would be transcribed before it faded (Sease 1996: 157). Though not many scrolls were unrolled, this is an example of how early conservationists understood the risks associated with caring for ancient artifacts and the slow, painstaking methods that must often be used to avoid destruction.

In the early 19th century, the field of conservation began to progress from a craft-based skill to a more professional, lab-based discipline. One of the first examples of this can be seen in publications from Christian Jürgensen Thomsen, a Danish antiquarian who originated several archaeological methods as well as the three-age system of European antiquity. In 1831 he published *On Nordic Artifacts and Their Preservation,* one of the first examples of a manuscript detailing conservation techniques for an artifact collection (Stease 1996: 158). Another 18th century example was William Morris, a British poet, activist, and architectural conservationist. While studying at Oxford University he developed a fondness for medieval architecture and was appalled at the “restoration” processes that were being applied to them in the 18th century England. He established the Society for the Protection of Ancient Buildings in 1877 and proposed that ancient buildings be repaired rather than “restored”, with all of their cultural heritage intact (Stansky 2006: 354). This practice follows the principles of conservation today, that an artifact should be conserved rather than changed drastically to completely resemble its original state.

It can be argued that the field of conservation officially became a science with the emergence of Friedrich Rathgen, a German chemist who is considered to be the “father of modern conservation.” In 1888 he was appointed the first director of the Berlin Royal Museum Chemical Laboratory, where he would remain until his retirement in 1927. He was the first chemist to be employed by a museum, and helped significantly shift the profession of conservation towards a more scientific approach. During his time at the Royal Museum he was tasked with discovering new treatment methods for several Egyptian artifacts excavated in the 1830s, and his scientific approach involved determining specific causes of deterioration and cataloguing every step of treatment that was conducted. Many of the techniques he discovered, such as desalination of stone artifacts, are still in use today, and in 1898 he published the first conservation handbook, *The Preservation of Antiquities.* The first part of his handbook was devoted to the decay processes that artifacts undergo, and the second part is dedicated to conservation techniques to preserve said artifacts. This handbook provided a basis for many future conservation methods and would be used as a guide by many conservators in the 20th century (Caple 2000: 53).

As mentioned previously, the International Council of Museums was established in the 1930s as international travel and communication became more prevalent, and this lead to more sharing of research between conservators and the establishment of conservation conferences. Conservation quickly became even more scientific and specialized, culminating in the creation of the American Institute of Conservation in 1972 and the Getty Conservation Institute in 1985. Today, conservation is more scientific and well-informed than ever, with degrees in the field being available at many universities. Conservation is now seen as an essential step in the artifact recovery process and is practiced at many museums and labs around the world, with the *Queen Anne's Revenge* Conservation Lab being a fine example.

Skills and Challenges

As the field of conservation has become highly specialized, there are several skills a conservator must utilize, considerations that must be measured, and challenges that often must be overcome. Conservators need an array of professional skills, starting with the ability to identify what an artifact is and understand the context in which it was found. This is where having an archaeological background is helpful for many conservators, as they are familiar with the excavation of artifacts and interpreting their context. Conservators may also have to identify the composition of an artifact, and will often need to be familiar with many modern conservation handbooks so that they possess a conservator's "toolkit". This means that they are aware of the guiding principles of conservation that should be followed when dealing with all artifacts, as well as specific conservation methods available for different types of artifacts such as metal, glass, rope, wood, and so forth. Conservators also need manual dexterity to perform many conservation techniques, and an aesthetic sense of what a conserved artifact should look like does not hurt. Lastly, the most important trait to possess when conserving artifacts is patience; it is always better to take years to conserve an artifact correctly, than to rush the process and destroy something that can never be replaced.

Conservators have many professional responsibilities in their line of work. When encountering an artifact for the first time, they must first identify all problems facing the artifact;

for example, if the artifact is a waterlogged piece of wood with iron nails embedded in it, the conservator will have to determine a course of action for how to preserve each type of material without harming the other. After several potential treatments have been considered, it is up to the conservator to decide on a solution and carry out the treatment. This can be a weighty decision, as artifacts sometimes do not survive the conservation process no matter how carefully considered the treatment was. There are many other challenges conservators often face as well; one such challenge is that there is not a single conservation "cookbook" with every single answer printed inside. The reason for this is that the discipline is constantly changing, with new methods being discovered each year, and there is often no single solution to a conservation challenge; multiple conservation techniques exist for every material type. Every artifact is also unique and must be considered in the context of its situation, which often requires judgement and collaboration between several skilled conservators, and success is not guaranteed even with the most tried and true techniques depending on the stability of the artifact.

Conservators often encounter challenges from forces that are out of their control as well. Unfortunately, they often have to work with facilities that might not have the equipment needed for certain treatments, or they might have to work with a budget that cannot afford supplies for other treatments. There is no simple answer for any artifact, and success is never guaranteed. Despite these potential setbacks, conservators all strive to do their best and follow certain guiding principles. The first of these is to do no harm to the artifact; this is essential to make sure irreplaceable historic objects are not destroyed, but unfortunately damage may sometimes occur even with the most careful of treatments. This is a risk that every conservator accepts when they begin treatment of an artifact, and any damage that occurs should be seen as a learning opportunity to avoid in the future. Conservators should also seek to reveal and preserve the "true nature" of the object, rather than try to make it look new or more aesthetically pleasing. Every step conducted should also be reversible whenever possible, to ensure that if a mistake is made it can be undone, or if a new conservation method is discovered the previous one can be reversed. Lastly, conservators should practice minimal intervention; this means only the steps necessary to conserve the artifact should be taken, as any unnecessary steps could risk harm to the artifact with no added benefit (Cronyn 1990; Caple 2000).

Case Studies

To further emphasize the importance of conservation for the preservation of historical artifacts, it is necessary to provide case studies that highlight times where conservation was successful, as well as times when it was not. One such example is the drawing *Orpheus Being Attacked by the Furies* by Leonardo da Vinci. Discovered in 2001 in a private collection, this drawing was taken to a museum to be treated, but conservators utilized a water and alcohol treatment on the entire drawing without first testing a miniscule section for solubility. As a result, the entire image disappeared, and the damage was irreversible (Bonsanti 2001). Had the conservators considered the principles of reversibility and testing small samples, this priceless drawing would still be present today.

Another recent example of questionable conservation was the restoration of the painting *Ecce Homo.* This fresco depicting Jesus wearing a crown of thorns was painted in 1930 and was displayed at the Sanctuary of Mercy Church in Borja, Spain. In 2012, an elderly parishioner began to restore the painting after becoming upset that parts of it had flaked off. However, she had not received any prior conservation or painting restoration training, and the subsequent result was less than ideal (Figure 1). Had an expert with restoration experience been consulted, the painting would not have been altered in a clear and irreversible manner (Handler 2016).


Figure 1. *Ecce Homo* before and after restoration attempt. Taken from Handler 2016.

One last example of successful and continuing conservation is the *Vasa,* a Swedish warship that sank in 1628 and was recovered in 1961. When the wreck was first excavated, conservators faced an unprecedented conservation challenge: the preservation of over 21,000 cubic feet of waterlogged oak timbers. They eventually decided to impregnate the wood with polyethylene glycol (PEG), a method that has become the standard conservation method for waterlogged wood today. The hull of the ship was sprayed with PEG for 17 years and then underwent a slow drying process that is still ongoing. A museum dedicated to preserving and displaying the hull of the ship was established in 1990 in Stockholm, Sweden (Figure 2). However, the ship soon presented another problem: in the late 1990s, yellow and white spots began to appear on the surface of the ship. It was discovered that the corrosion products from the iron bolts that once held the ship together had sulfides that interacted with oxygen in the air, producing sulfuric acid that continues to damage the wooden hull. As a result, organic artifacts now undergo the process of chelation to remove any traces of iron remaining in the artifact.

Another potential problem is that when artifacts are treated with PEG in an acidic environment formic acid can form, which would also be damaging to the wooden hull. Steps to further preserve the wreck of the *Vasa* are ongoing and are still being tested, and this case study highlights how conservation is a constant process that can present new problems long after the artifact is first considered to be conserved (Hocker et al. 2012).

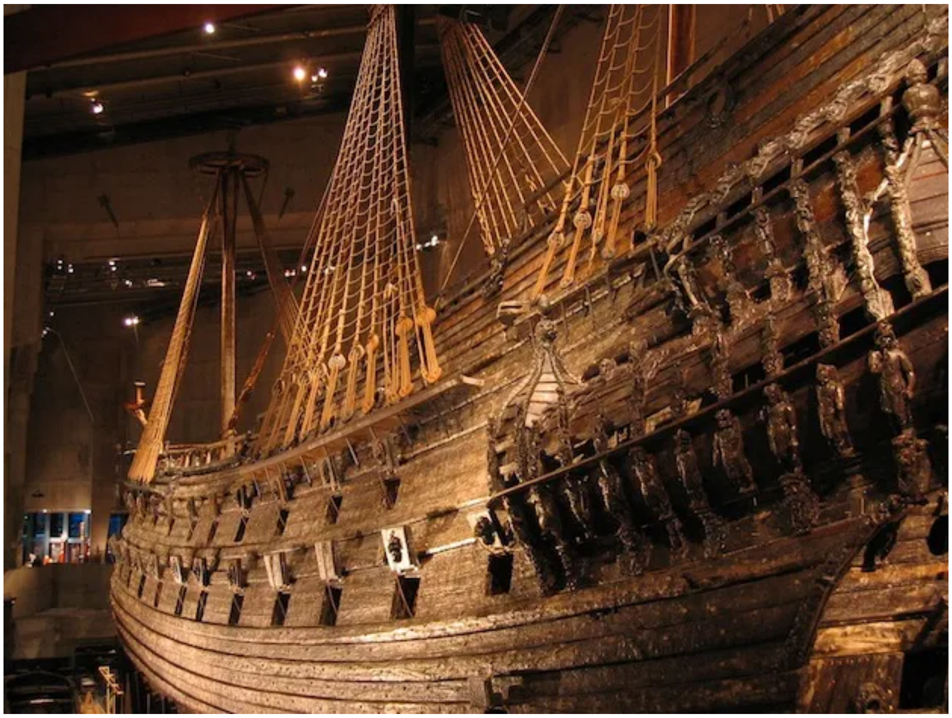

Figure 2. The *Vasa* on display at the *Vasa* Museum in Stockholm, Sweden. Taken from Hocker et al. 2012.

Conclusion

In conclusion, conservation is a complex field with a storied history, and conservators must have a variety of skills and expect to face many potential challenges. Humanity's desire to preserve and revere the past can be traced back to many centuries ago, and the evolution of museums and conservation can be tracked throughout human history, progressing from antiquarian collecting to a rigorous scientific process to preserve the past. Many case studies exist that provide insight into how conservation helps prevent artifacts from deteriorating, and the consequences that arise when the principles of conservation are not applied. The next chapter will provide an in-depth look at the history of one particular case study, the *Queen Anne's Revenge*, and explain how the QAR Lab, where my graduate assistantship took place, came to be.

Chapter 2 – Background of the Ship, Site, and Lab

To understand the significance of the *Queen Anne's Revenge* and the work that is conducted at the QAR lab, a brief history of Blackbeard, his ship, and the founding of the lab itself should be provided. The ship that would come to be known as *Queen Anne's Revenge* was originally named *La Concorde*, and is believed to have been constructed in 1710 (Ducoin 2001: 13). The ship weighed 200 tons and sailed the seas for a period of 8 years, only 6 months of which were under Blackbeard's command. The vessel was first owned by a French naval officer and slave trader by the name of René Duguay-Trouin, who converted the ship into a slaving vessel that was operated by the slave trader René Montaudin (Wilde-Ramsing 2009: 4). The ship was sold and exchanged hands a few times over the course of the next 7 years but was primarily used for transporting slaves until Blackbeard and his crew captured the ship on November 28th, 1717 in the West Indies (Ducoin 2001; Wilde-Ramsing 2009). A majority of the French crew were gravely ill and surrendered the ship to Blackbeard with little resistance (Watkins-Kenney 2018: 199). Blackbeard recruited some of the crew and kept *La Concorde* for himself, renaming it *Queen Anne's Revenge,* and left a small sloop behind for the remaining French crew and enslaved Africans (Ernaut 1718).

Once he had acquired his flagship vessel Blackbeard began his short but tyrannical reign as a pirate, sailing the Caribbean and attacking vessels near the Grenadines, St. Lucia, Antigua, and the Dominican Republic (Wilde-Ramsing 2009: 9-10). He then acquired an additional sloop, *Adventure,* in the Bay of Honduras, and another sloop off the coast of Cuba. With this flotilla assembled Blackbeard conducted the most daring and famous act of his career: the blockade of Charleston, South Carolina. In May of 1718 Blackbeard detained several ships attempting to leave the port and took crew members as hostages, insisting that they would only be released in exchange for a chest of medicine. Blackbeard's demands were met and he kept his word, releasing the hostages and sailing further up the eastern coast (Lee 1995).

Only a month later the *Queen Anne's Revenge* would be lost, just six months into its time as a pirate vessel. In June of 1718 Blackbeard tried to enter Beaufort Inlet off the coast of North Carolina and ran the vessel aground on a sandbar. The sloop *Adventure* also ran aground attempting to free the *Queen Anne's Revenge.* Several different historical accounts describe this incident, and one from David Herriot (the former captain of *Adventure*) claims that Blackbeard ran his ship aground on purpose to break up his company of pirates so that he could escape with most of their valuable loot himself (Bonnet 1730). Archaeological evidence potentially supports this, as there are indicators that the ship had suffered a large amount of wear and tear and required repairs, though the exact reason why the ship ran aground may never be known for certain. Even so, Blackbeard did indeed maroon many of his pirates, leaving with a handpicked crew and most of the plunder his flotilla had acquired. Blackbeard accepted a royal pardon and settled in the town of Bath, North Carolina for a short time, but it did not take long for him to resort back to piracy. After attracting the attention of the Governor of Virginia, he was ambushed by Lieutenant Robert Maynard on the 22nd of November, 1718 and was beheaded after a vicious battle. Ironically, the most famous pirate in history was only a pirate for a period of about two years, and the most famous pirate ship was used for piracy for an even shorter time.

In 1996, almost 300 years later, a private salvaging firm called Intersal Inc. discovered a ship wreck off the coast of Beaufort, which they believed to be the remains of *Queen Anne's Revenge* (Figure 1). Realizing the significance of their discovery, Intersal Inc. reached an agreement with the North Carolina Department of Natural and Cultural Resources (NCDNCR) and the Maritime Research Institute: Intersal would give up any rights to artifacts recovered from the wreck so that the collection could stay intact, and in exchange would receive all media and replica rights. The wreck was assigned the site number 0003BUI, as it was the third site discovered in Beaufort Inlet (BUI) by the NCDNCR's Underwater Archaeology unit. In 1997 the NC Office of State Archaeology's Underwater Archaeology Branch was assigned management of the site and preliminary surveys took place. A site plan was drawn and material evidence that the wreck was indeed the *Queen Anne's Revenge* began to be discovered, and it was determined that the entire wreck should be recovered from the ocean floor (Figure 2). Over the course of the next 20 years, thousands of artifacts would be brought up to the surface by underwater archaeologists for preservation. Many of these artifacts provided supporting evidence that the wreck was indeed the *Queen Anne's Revenge*; the ship had a large number of cannons, many of which were still loaded and of varying countries of origin, and there is evidence that langrage (various bits of bolts and scrap metal) was used as shot, a common pirate trick. Depth markings on the surviving stern post also align with a French foot rather than an English foot, indicating that the ship was constructed by the French (Hampton, 2018).

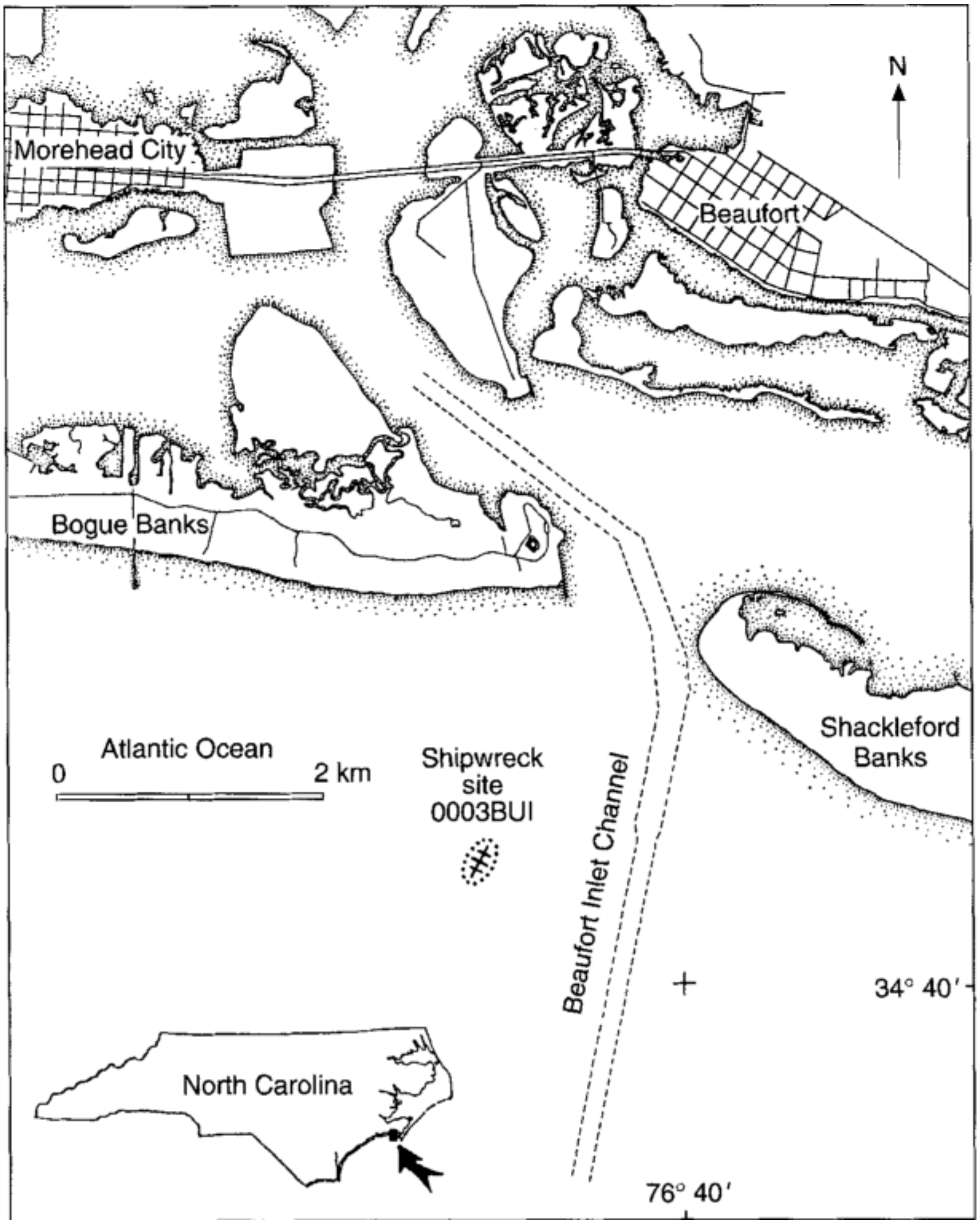

Figure 1. The location of the wreck of the *Queen Anne's Revenge.* Drawing by David Moore. Taken from Lusardi (2000).

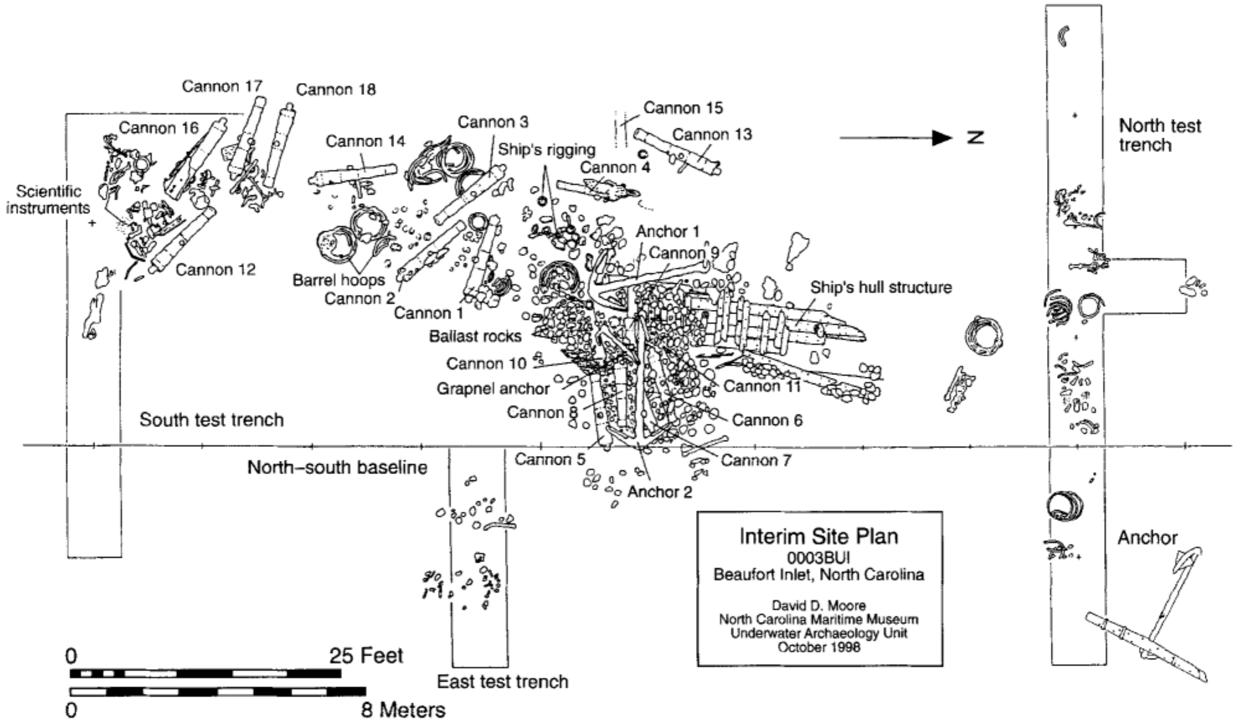

Figure 2. The site plan from the 1997 survey and field season. Drawing by David Moore. Taken from Lusardi (2000).

After determining that a full-scale excavation of the site was the best course of action to preserve the remains of the wreck, the NCDNCR realized that the large number of artifacts recovered would need to undergo conservation before being displayed at a museum. "The conservation facility for the *QAR* finds moved several times between 1997 and 2003 between facilities in Fort Fisher, Beaufort and Morehead City, before finally coming to rest at East Carolina University's (ECU) West Research Campus following a Memorandum of Agreement between ECU and NCDCR" (Watkins-Kenney 2010: 5). The *Queen Anne's Revenge* Conservation Lab was officially dedicated in 2004, and there employees help to conserve the artifacts from the wreck and prepare them for display before they are sent to the North Carolina Maritime Museum in Beaufort. To date, over 400,000 individual artifacts have been recovered from the wreck site and have been sent to the lab, ranging from glass beads and wood fragments to firearms, cannons, and an anchor. 30 cannons have been identified, and 24 have been recovered and sent to the lab. Additionally, only about sixty percent of the wreck has been brought to the surface, meaning that the QAR lab will still have artifacts to conserve for years to come (Watkins-Kenney et al. 2015: 6).

The work that the QAR lab does is incredibly important because Blackbeard and the *Queen Anne's Revenge* are extremely significant parts of both North Carolina's history and the history of piracy. Without the QAR lab, artifacts recovered from the wreck would sit untreated in warehouses or even out in the elements and would crack and degrade due to the large amount of salts inside them. The hard-working staff at the lab ensure that artifacts are not only retrieved but are properly treated and cared for so that the public can view and learn about the history of this ship for decades to come.

Chapter 3 – Internship Duties and Skills Acquired

As partial fulfillment for the degree Master of Arts in anthropology, I was afforded the extraordinary opportunity to have been a graduate assistant at the Queen Anne's Revenge Conservation Lab from August of 2021 to April of 2022. The full requirements of this position include the construction and presentation of a research proposal in the first Spring semester, 180 hours of supervised labor at the lab, a personal project conducted by the student with some guidance from staff, and finally an internship report detailing research conducted and skills acquired to be defended by the student at the conclusion of their time as an intern. While working at the QAR Lab, I was assigned or assisted with numerous conservation steps, some of which were conducted on a weekly basis while others were done more infrequently. This chapter will examine in detail each conservation skill that I acquired during my time at the QAR Lab and their importance to the fields of conservation and archaeology to show how they will prove invaluable to a future career in said fields.

Artifact Documentation and Data Entry

In the field of conservation, it is essential that every step done to an artifact be recorded; a common saying is that if the step was not written down, then it did not happen at all. This guarantees that the person conserving an artifact is transparent about every process they put an artifact through and that a guide exists for those who conserve similar artifacts in the future. It also ensures that a detailed record of the artifact exists so that if it begins to degrade in the future or a step needs to be reversed, a conservator can identify what was done to it and what the problem might be (Caple 2000: 70). This is done by writing steps down on artifact record sheets, known as "blue sheets" at the QAR Lab due to the color of the paper.

The first piece of information recorded on an artifact record sheet is the unique number assigned to the artifact. At the lab these are known as QAR numbers and they ascend in the order in which an artifact was pulled up and recorded, with a sub number when items such as concretions break down into multiple artifacts. For example, a large concretion may be recovered from the site and labeled with the QAR number 2300.000. When that concretion is broken down and the first artifact is removed from it, that artifact will be assigned the number 2300.001. This ensures that each artifact from the site has a unique number that all the steps it goes through can be recorded under.

The next piece of information on an artifact record sheet is the date that a step occurs, so that conservation progress can be tracked over time and future conservators know when an artifact underwent any certain process. After that the conservation step itself is recorded, so that every process and change an artifact undergoes is clearly conveyed. These steps are first labeled categorically, with a detailed description of what exactly was done following afterwards. Examples of step categories can include handling, examination/analysis, photography, desalination, soak/bath, protectant/sealant, storage, and many more. Therefore, a common step may say something such as “photography: pre-treatment photos were taken on a black background with a 10 centimeter scale.” Finally, the conservator then records the room in which the step occurred as well as their own initials so that if any questions about a step occur in the future they may be consulted.

After conservation steps have been recorded on an artifact record sheet, they are then entered into an online database as well. This ensures that at least two copies exist of all steps that an artifact has undergone and provides a useful tool for conservators so that they can quickly and easily look up an artifact via its QAR number and recall what steps were taken previously. The database is also used to keep track of where an artifact is located in the QAR lab, so that no artifacts are ever misplaced or lost. Because every conservation process done at the QAR Lab has to be recorded on an artifact record sheet and entered into the database, a conservator may often spend a large part of their time devoted to artifact documentation and data entry. However, that highlights just how essential this part of the process is to conservation; nothing is more important than making sure conservators in the future know where an artifact is and what has been done to it.

Pre-Treatment and Post-Treatment Measurements

One of the first and last steps that an artifact undergoes is the recording of its length, width, thickness, count, and weight. If the object is circular or spherical then the diameter and weight are recorded instead. This is done to record how an artifact changes dimensionally after undergoing conservation or to ensure that at least some measurements of the artifact exist in case it does not survive conservation. Measurements are taken using digital calipers and scales with varying weight capacities, with the smallest able to weigh the tiniest of glass beads and the largest capable of weighing cannons that are several hundred pounds.

An important aspect of weighing artifacts is that it can let a conservator know when an artifact has finished an essential conservation step. After an artifact has undergone desalination, it is kept in desiccated storage to dry out. No moisture can be left inside the artifact or it may have adverse reactions in the future. To ensure that an artifact has completed this process, drying weights are conducted. Once an artifact records the same weight three times in a row over a period of several days, the conservator can be sure that the artifact has fully dried and is ready for the next conservation step.

Photography

Photography is another first and last step that an artifact undergoes and it is essential to the process of conservation. Just as artifact record sheets and the online database provide a written record of all the steps an artifact is put through, photography provides a visual record of an artifact's journey through the conservation process. Before any mechanical or chemical cleaning is attempted, an artifact is photographed in its original state. This is done so that in the unfortunate case where an artifact does not survive conservation, images of it still exist. Pre-treatment photos also help provide a stark contrast with post-treatment photos to show how much conservation can help improve the appearance and condition of an artifact.

The camera, lens, and backgrounds that are needed for photography will often vary based on what stage of photography one is doing or what stage the artifact is in. For objects that have just been removed from concretions, photos will often be taken on a relatively dirty black background with a small point-and-shoot camera and then those photos will be uploaded to a computer. If pre-treatment or post-treatment photos are being taken, then much more effort and staging is required to achieve a high-quality photograph. These photos are taken on black backgrounds that must be kept relatively clean, especially post-treatment photos that are often used for publications. A conservator can use a piece of tape to pat the background, removing excess dust and debris that may accumulate. Pre-treatment photos are taken on a black canvas background, which may sometimes become especially dirty if a wet object is being photographed and will require washing. Post-treatment photos, however, are taken on a black velvet background, and these should rarely if ever become dirty as all artifacts are dried out during conservation.

The camera utilized by the lab is a high-quality Nikon D3500 that is screwed into a camera stand, suspended facing down towards the object. The lens that is selected depends on the size of the object being photographed; one is a 105 mm lens for extremely small to medium sized artifacts, a second is a 16-80 mm lens that zooms outwards for medium to large sized objects, and an 8 mm fish-eye lens is used to photograph very large objects such as cannons, which requires a much more elaborate set-up. A majority of artifacts are photographed in room VOA 110, where the overhead lights are turned off and a studio light is placed on either side of a table holding the object. Half of each of these lights are covered using black reflectors, and the lights are also passed through diffusers so that too much light is not picked up by the camera (Figure 1). The camera is then hooked up to a device called a CamRanger, which connects to a computer via a wireless signal. Using the CamRanger program on the computer, a conservator can then take photographs of artifacts without even touching the camera.

The CamRanger program allows a conservator to control several settings on the camera to achieve the best quality photos of artifacts. One such setting is the f-stop number, which determines how wide the aperture of the camera will be when the shutter is open. The most important setting, however, is the shutter speed, which determines how long the shutter will be open and therefore how much light will be let in. This affects how dark or bright a photograph will appear once taken. A fast shutter speed lets in only a small amount of light, resulting in a darker picture, and conversely a slow shutter speed lets in more light resulting in a brighter picture. Therefore, conservators run a sequence of nine to eleven photographs from faster to slower shutter speeds, resulting in a series of pictures ranging from darker to brighter. This ensures that at least one picture of the artifact in the middle of that sequence will be at the perfect brightness level. This sequence must be done multiple times for most artifacts to ensure all angles are captured; if the artifact is flat then two series of photos may suffice, but if the artifact is more three dimensional with six faces then photographs of all six sides are necessary.

Artifact photography is a meticulous process that requires a great deal of patience and an eye for detail. Even after a conservator has learned how to set up the camera and use the CamRanger program, they must also learn how to properly stage artifacts and put them into focus. Fragile objects must often have supports built up under the black background to ensure the artifact does not rest on any breakable areas. In addition, artifacts are photographed with scales so that their sizes are evident, and the scale must often be raised to be on the same plane as the artifact so that both the scale and artifact are in focus. Then the camera itself must be focused by rotating a dial on the lens, a process that often takes several test shots before a truly satisfactory result is achieved.

Figure 1. The photography studio arranged to photograph cannonballs. Courtesy of NCDNCR.

Photo Cleaning

After artifacts are photographed, the pictures are uploaded to online folders accessible by the QAR staff to be cleaned, resized, labeled, and entered into the artifact image database. This is done using Adobe Photoshop. As mentioned previously, series of photographs are taken ranging from dark to bright. Conservators select one from each angle of the artifact that best depicts its natural color, and then upload those photos to Adobe Photoshop. Those photos are then cropped to eliminate excess black space and the image size is reduced. A QAR number is then placed in the top left corner of the picture to identify the artifact, and then the cleaned pictures are labeled to be transferred to the QAR online image database as well as burned onto CDs so that physical copies of the photographs also exist.

X-Rays (XRF and Concretions)

The QAR lab has two x-ray machines that it uses to analyze and assist with the conservation of artifacts: a large industrial x-ray machine, and a Bruker XRF. The industrial x-ray machine is used to scan concretions to determine what objects are hidden beneath the dense, concrete surface. To operate this machine a conservator must be extensively trained, take extreme precaution, and where a radiation tracking badge to minimize exposure. Taking x-rays of concretions greatly assists conservators with the process of airscribing, or breaking down concretions, which is explained further on in this chapter.

The other x-ray machine, a Bruker XRF (X-Ray Fluorescence), aesthetically resembles a phaser from Star Trek and is used to determine the elemental composition of artifacts (Figure 2). An XRF is a highly useful tool to have because it can let a conservator know if an artifact contains any harmful elements and helps the conservator know how best to conserve an artifact based on its elemental composition. XRFs are also highly portable, making them easy to bring into the field or to a highly fragile object that can't be moved to a lab. Some conservators might not have access to larger, more expensive x-ray machines, so XRFs are also useful based on cost and availability factors. However, XRFs do have limitations as well. They cannot distinguish between minerals; they only reveal an object's elemental composition. They are also superficial, meaning they only reveal elements at the surface level of an object. Lastly, they are semi-quantitative, and cannot tell you the exact percentage of every element that an object contains. The program utilized by XRFs can also be difficult to use and understand for someone who is not extensively trained.

Figure 2. A Bruker XRF being used to x-ray an object. Courtesy of NCDNCR.

<u>Sorting for Lead Shot</u>

One common method that pirates utilized to create ammunition was pouring molten lead through a sieve from the top of a tower down into water, which would then harden and produce small spherical pellets known as Rupert shot. This type of ammunition is named after Prince Rupert of the Rhine, who designed the method of creating it. So far the QAR Lab has found over 200,000 pieces of lead shot from the wreck site, making it by far the most numerous item recovered, and it seems that there is still much more to be found. Because Rupert shot is so small it can often be overlooked, and therefore bags of debitage (small broken up pieces of concretion) are often x-rayed to make sure there is none inside before they are declared to be void of artifacts. If lead is detected by x-rays, the bag of debitage is poured through a sieve and a conservator will examine it closely to pick out the lead shot from the debitage.

Air Scribing and Aroscribing

A particularly time-consuming, meticulous, and highly important task at the QAR Lab is that of air scribing. An air scribe is a small pneumatic tool with a metal tip that vibrates rapidly. This tool is used to break down concretions of varying sizes that can contain anything from glass beads to cannonballs and even massive cannons. Concretions are hard, cement-like surface layers on artifacts that result from the corrosion of iron under water, consisting of sediment, marine life, and iron corrosion product (Hamilton 1999b: 293). They only form in the presence of iron, but often surround other non-iron objects that lay nearby on the ocean floor.

Because breaking down concretions sends dirt and dust particles into the air, several safety precautions must be taken by conservators before they can begin airscribing. Lab coats, gloves, N-95 masks, face shields, and ear protection all must be worn when operating an airscribe. This ensures that no harmful particles are inhaled and no hearing damage occurs. A dust collector is also turned on to capture most of the particles that accumulate in the air.

Once a conservator is properly equipped and their station is set up, they can begin the airscribing process. To turn on the airscribe a metal ring on the shaft is turned clockwise. The conservator then slowly moves the tip of the airscribe along the surface of the concretion to remove layers of sediment and reveal the objects hidden underneath (Figure 3). In many situations objects inside concretions can be fully concealed, so the conservator must airscribe carefully and precisely to ensure that no artifacts are damaged (Hamilton 1999b: 296). Instances such as these are where x-rays can be quite beneficial. Oftentimes concretions will be x-rayed beforehand to determine what objects might be hidden inside. Conservators study these x-rays before airscribing to get an idea of where in the concretion objects are located, what the objects might be, and where might be the best area on the concretion to begin.

Depending on the size of the concretion, the density of the material, and the schedule of the conservator, airscribing can take anywhere from a few hours to weeks or even months. A single concretion can also contain many different objects. To ensure proper record keeping, a concretion may for example be assigned the number 800.000. The first object to be removed from that concretion would then be assigned 800.001, the next object would be 800.002, and that would continue for each object removed until the concretion is fully broken down and labeled as debitage in the online database. Each object removed is photographed, stored, and eventually conserved using the methods appropriate for the material it consists of.

Sometimes a concretion or even an artifact itself may require cleaning, but it is too small or fragile to survive regular airscribing. This is where an aroscribe can be used. Aroscribes are smaller airscribes with more precise tips, for when a gentler approach is needed. I used an aroscribe to help remove corrosion particles from several Brunswick Town artifacts that were conserved during the course of my internship. In addition to the Brunswick Town artifacts, I also airscribed several concretions. One concretion contained the head of a bar shot, which I was able to remove completely and then place into a passive sodium carbonate solution. Many smaller concretions that were airscribed contained no artifacts, but had to be broken down to confirm that they were empty. Lastly, I began work on concretion 909.000 that contained three cannonballs, an iron sprue, and a fastener void (Figure 4). I was able to remove the sprue and two cannonballs before the end of my internship, and the remaining objects will be removed by another conservator in the future (Figure 5).

Figure 3. Conservators using airscribes to clean artifacts. Courtesy of NCDNCR.

Figure 4. A concretion that is partially airscribed, revealing an iron sprue and cannonball. Courtesy of NCDNCR.

Figure 5. A cannonball that has been removed from its concretion via airscribe. Courtesy of NCDNCR.

<u>Casting Voids</u>

When airscribing a concretion, conservators will often come across voids where iron objects have partially or completely degraded. When this occurs, the conservator will use an airscribe to expose one end of the void, and then use a thin metal rod and running water to clear the void of any sediment or remaining corroded metal. Acetone is then applied to the void under a fume hood to evaporate any excess water left inside. Once the void has dried, it is placed in a bucket of sand and any additional openings are dammed with clay to avoid leaks. Then, Hysol epoxy resin is mixed with 30% epoxy hardener and poured into the void opening. The epoxy must sit for 24 to 48 hours to ensure that it hardens completely. Once this occurs, an airscribe is used to remove the remaining concretion from around the cast object (Hamilton 1999b: 296). Now a model exists of the artifact even though the original degraded completely, and it can be painted to resemble the original artifact for display purposes. During my time as an intern I was able to assist with the casting of several voids, such as ones from iron fasteners.

Silicone Molds

In the same vein as casting voids, silicone molds can be made of objects that allow further casts to be made in the future. This involves surrounding an artifact with a clay dam and pouring a liquid silicone mixture over the upwards facing half of the artifact and allowing the mixture to harden. Once that occurs, additional silicone is poured over the other half and left to harden (Figure 6). Once both halves have solidified, they can be separated, leaving a perfect impression of the artifact in between the two halves. In the future, epoxy resin can be poured into this silicone mold to create further copies of the artifact and the mold can be used an unlimited number of times (Figure 7). Creating molds and casts of artifacts is useful when a copy of an artifact is needed for public outreach and educational purposes or when it is feared that an original artifact will not survive conservation.

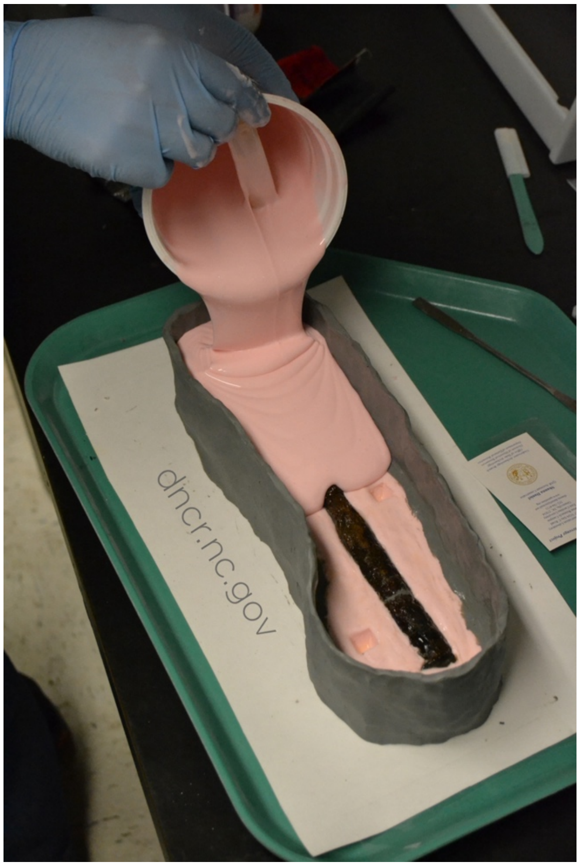

Figure 6. Silicone is poured over an object to create a mold. Courtesy of NCDNCR.

Figure 7. Epoxy resin is poured into a silicone mold to cast an object. Courtesy of NCDNCR.

Iron – Electrolytic Reduction

For larger iron artifacts that need desalination, a process known as electrolytic reduction (ER) is commonly used for conservation. This process involves placing an iron artifact in a solution of either 1% sodium hydroxide or 2.5% sodium carbonate along with stainless steel sacrificial plates, both of which are attached to a DC power supply using copper wires (Watkins-Kenney et al. 2015: 18). A negative charge is supplied to the iron artifact (the cathode), which forces the negatively charged salt ions out of the artifact and into the solution. A positive charge is supplied to the steel plates (the anodes), which then attract the negatively charged salt ions and begin to sacrificially corrode (Figure 8)(Hamilton 1999b: 298).

It is important to note that this process must be done carefully and slowly, and can take several years to complete for large artifacts such as cannons. A very low current must be supplied, or else the artifact could be damaged. The solution that the artifact is in must also be monitored for its chloride levels, and should be emptied until it no longer registers as containing chlorides. A decrease in chloride levels with each changeout lets the conservator know that the process is working and that the artifact is desalinated once very few chlorides are detected (Watkins-Kenney 2015: 18). I assisted with setting up several electrolytic reduction tanks over the course of my internship, containing various cannonballs, eyebolts, crow bars, and other iron artifacts.

Figure 8. An iron artifact undergoes electrolytic reduction. Courtesy of NCDNCR.

Iron – ER Solution Testing/Chloride Testing

To test the chloride levels of electrolyte solutions in electrolytic reduction tanks, a process known as chloride testing is used. This method is similar to TDS testing used to monitor chloride levels for organic artifact solutions, but it is more complex and time-consuming. It is done to measure the level of chlorides in the solutions inside ER tanks, and lets a conservator know when a solution has become saturated and should be changed out. Conservators also know when an artifact is close to being desalinated based on the amount of chlorides still leaving the artifact. The first step is the collection of samples from every ER tank into mason jars, which must be done carefully as they contain caustic solutions of sodium hydroxide or sodium carbonate. Every jar is labeled with the date the sample was collected, the tank from which the solution was retrieved, and what the solution in the jar is. This step is done the day before testing occurs to ensure the samples reach room temperature by the following day.

After the samples have been collected and are ready for testing, the necessary equipment for this process is gathered. To conduct ER solution testing a conservator needs an Accumet AP63 pH/mV/Ion meter, a chloride measuring electrode with a digital display, chloride ionic strength adjustment (ISA) solution, 1000 ppm Chloride Standard solution, and several 250 mL beakers. Once the equipment is assembled, 100 mL from every jar are measured out into individual beakers, which are then tested for their pH using pH paper strips (Figure 9). This allows the conservator to know how basic the solution is and therefore how much it needs to be neutralized. A solution that is not neutral will damage the chloride electrode, so 30 to 40 drops of nitric acid are added to the sample until it reaches a neutral pH of 7 (Figure 10). 2 mL of chloride ISA solution are also added to each neutralized sample so that the solution will react with the chloride electrode. After these steps, five chloride standard solutions are created in 250 mL beakers to calibrate the chloride electrode. Using 100 mL of the Chloride Standard solution, five concentrations of it are created: 1000 ppm, 100 ppm, 10 ppm, and two 1 ppm concentrations. This is done by increasing the ratio of RO water to Chloride Standard in each successive beaker. 2 mL of chloride ISA are also added to these standards so that the electrode will interact with them.

Once the standards and ER tank samples are prepared, the Accumet meter is attached to the chloride electrode and it is calibrated. The electrode is placed in the 1000 ppm solution first to establish a baseline, and is then placed in each successive beaker (100 ppm, 10 ppm, and 1 ppm) so that a baseline is created for each ppm sample (Watkins-Kenney 2015: 86-87). Now that the Accumet meter and electrode are calibrated, the equipment can be used to measure the chloride content of each ER tank sample. When the electrode is placed in a sample, the chloride reading will steadily rise on the digital display until it reaches a stable reading for five seconds.

This reading is recorded onto a Solution Testing Record Sheet, and the electrode is rinsed with RO water before being used to test the next sample (Figure 11). This is done until every sample has been tested and recorded. Once samples indicate three consecutive stable measurements, the solution in the ER tank may be changed out for fresh solution. Throughout the course of my internship I assisted with the collection of samples, the neutralization and testing of them, the calibration of chloride electrode, and the changeout of ER tank solutions.

Figure 9. 100 mL of each tank sample are measured into beakers. Courtesy of NCDNCR.

Figure 10. Nitric acid is added to the samples to neutralize them. Courtesy of NCDNCR.

Figure 11. The Accumet meter and electrode measure the chloride levels of the sample. Courtesy of NCDNCR.

Iron – Passive Solution

For iron objects that are smaller or more fragile, ER may not be the best course of action and artifacts may be placed into a passive solution instead. This is usually a 1% sodium hydroxide solution, and chloride ions will naturally leach out of the artifact into the solution even without an electrical charge such as in ER. For this method, the same chloride testing detailed before is used to monitor the chloride levels in the solution so that conservators know when to change out the sodium hydroxide for a fresh solution. Once the solution consistently registers as having few chlorides, conservators know that the iron artifact can be taken out of the sodium hydroxide and placed into reverse osmosis (RO) water.

Iron – Metals Testing

Once iron artifacts are placed into RO water, they may remain there for several months until residual chlorides exit the artifact and they reach a more neutral pH (Hamilton 1999a: 70). To test this, conservators will take Hydrion paper pH strips that change color based on the pH of what they are exposed to. Conservators use pH strips to test both the RO water and the artifact itself to see if they have reached a neutral pH close to a 7 or an 8, which would manifest as a yellow or light green color on the orange test strip. If the strip shows darker blue colors, then the artifact is still basic and must soak in the RO water for a longer period of time. In this case the RO water is drained from the plastic tub and new RO water is added along with the artifact. If the artifact is close to neutral, then it can be removed from the solution and be moved to the next step of iron conservation. During my time as an intern at the QAR Lab I performed this task every Monday morning and therefore became skilled at quickly testing iron artifacts and changing out their solutions.

Iron – Protectant and Sealant

Once an iron artifact has completed a soak/bath step in RO water, it is taken to a fume hood where it can receive a protectant and sealant step. A protective coating is applied to iron objects so that they are defended from harmful moisture that could lead to further degradation (Hamilton 1999b: 299). At the QAR lab, the protectant that is most often used is tannic acid. Conservators start by applying two coats of tannic acid to an artifact with a toothbrush or other small brush under a fume hood. The artifact is then placed in an airtight desiccator to dry for 24 to 48 hours, before a third coat of tannic acid is applied and the artifact is returned to the desiccator (Figure 12). Lastly, a final sealant is applied to further protect against any moisture or corrosion. This sealant should be impervious to water vapor, able to be removed if needed, and translucent so that it does not impact the appearance of the artifact (Hamilton 1999b: 300). The sealant of choice at the QAR lab is acryloid B-72 resin. Acryloid B-72 can be applied to an iron artifact one week after the third coat of tannic acid was applied. This is the final step for iron conservation, as once marine iron has had all harmful salts removed and has received the needed protectants/sealants, it will no longer degrade and is ready for storage or display.

Figure 12. Tannic acid is applied to two cannons using toothbrushes. Courtesy of NCDNCR.

Solution Change Outs

As mentioned before, solutions used for both ER and passive desalination must have their chloride levels monitored on a regular basis to determine when an iron artifact has completed the desalination step. When a solution becomes saturated with chlorides or an artifact completes desalination, the solution must be changed out. To do this at the QAR lab, conservators place pumps connected to hoses into the tanks. These pumps suck the solution into the hose, which deposits it into a waste tank or an artifact tank that needs more solution. Conservators may also mix new solutions of sodium hydroxide or sodium chloride in large barrels by depositing the powder form of the chemical into RO water and stirring. It can take a while for tanks to fill and for solution to be transferred, and conservators must be careful to monitor the process closely so that caustic solutions such as sodium hydroxide do not spill anywhere. Conservators must also make sure that no solutions are deposited into the wrong tanks and that any solutions transferred to waste tanks are properly recorded.

Organics – TDS

Like marine iron artifacts, organic artifacts such as plant fibers, leather, and wood must also undergo passive desalination to remove any soluble salts that remain in them. This is done by placing the artifacts in containers with RO water and refrigerating the containers to ensure no bacterial growth occurs. Immersing artifacts in RO water which has extremely low salinity results in the salts inside of the artifact draining out into the solution (Hamilton 1996: 16). To monitor the increase of salts in the solution, conservators use a total dissolved solids (TDS) meter (Figure 13). This device gives two readings: the number of dissolved solid particles in the solution in parts per million, and the conductivity of the solution in microsiemens (uS). Both of these values will go up as salts exit the artifact. As the RO water becomes saturated with chlorides, no more chlorides will be able to leave the artifact and these values will begin to plateau (Cronyn 1990: 81). After three stable readings, the conservator will decide to change the saturated solution. This involves removing the artifacts from the RO water, pouring the old solution down a drain, and filling the container with fresh RO water. Once the TDS meter no longer shows salts being deposited into the solution, a conservator can be sure that the artifacts have completed the desalination process.

Figure 13. A TDS meter is used to test a solution. Courtesy of NCDNCR.

<u>Organics – PEG</u>

The QAR lab has a large range of wooden artifacts, varying from large pieces of the hull of the ship to gun stocks, tools, and other assorted bits of wood. After resting on the floor of the ocean for 300 years, they are all extremely waterlogged and require a process known as consolidation, which uses a compound known as polyethylene glycol, or PEG. When wood is exposed to water for extended periods of time, the cellulose that makes up the wood begins to degrade and is replaced by the water. The remaining lignin network and water continue to hold the wood together, but only if it remains wet. If waterlogged wooden artifacts are allowed to dry without proper conservation, the cell walls collapse and the artifact will become extremely shrunken or distorted (Hamilton 1999a: 24).

To avoid the destruction of marine wooden artifacts, PEG treatment is used. Polyethylene glycol is a wax compound that acts as a bulking agent, impregnating marine wood to prevent cellular collapse. To conduct PEG treatment, the first step is to immerse the wooden artifact in an

RO water solution with 5% PEG 400. The artifact is left in this solution for extended periods of time, during which the PEG will penetrate the wood and replace the water inside its cells. As the PEG impregnates the artifact, more PEG will be added to the solution in 5% increments. At the QAR lab, wooden artifacts often complete this process once the solution has reached 25% PEG 400 and 40% PEG 4000. PEG 400 and PEG 4000 are low molecular weight and high molecular weight compounds, respectively, and wooden artifacts require a combination of both to complete the consolidation process.

Once the required amount of PEG has been absorbed into an artifact, it will begin to harden and the artifact will begin to strengthen. The final step for marine wood conservation is for the artifact to undergo a freeze drying process. The artifact is removed from the PEG solution and any excess PEG on the surface is cleaned away, and then it is placed in a freeze dryer between the temperatures of -32 and -40 degrees Celsius. Once the temperature of the artifact reaches -25 degrees Celsius, a vacuum seal is applied to the freeze dryer and any remaining water in the artifact freezes and evaporates. Over the course of the freeze drying process, the amount of water that has been removed is determined by taking consistent weights of the artifacts. Once an artifact shows a consistent weight for three measurements, conservators can be sure that all of the water has left the artifact and it has now completed conservation (Hamilton 1999a: 28).

Organics – Chelation

As mentioned previously in this chapter, marine organic artifacts often must undergo passive desalination in RO water so that the salts in them are removed. However, many organic artifacts require a second treatment as well: a treatment to remove latent iron content within the artifact, often resulting from the artifact's exposure to concretions and iron artifacts such as fasteners. If this latent iron is not removed, it could continue to corrode which would eventually lead to the destruction of the organic artifact as well. For example, marine wooden artifacts are often infused with iron and sulfur mineral salts from iron artifacts in their burial environment. When exposed to oxygen in the air, these iron and sulfur compounds will oxidize and create an acid that damages the structure of the artifact (Almkvist et al. 2013: 4). To remove latent iron and prevent harmful reactions such as these, a process known as chelation is used. Chelating agents such as ethylene diamine tetraacetic acid (EDTA) and ammonium citrate form a soluble bond with metal ions such as iron and copper, removing them from organic artifacts. At the QAR lab, the preferred chelating agent is ammonium citrate.

Fortunately, the chelation process is one that can be done at the same time as passive desalination. The process begins by placing organic artifacts in a 2% ammonium citrate solution in RO water and placing the container in a refrigerator. Like with passive desalination, this helps prevent bacterial and biological growth within the artifact. The artifact must then be left in this ammonium citrate solution for one month before the next step occurs. After a month has passed, the ammonium citrate solution is replaced with RO water and the container is placed back in the refrigerator for 24 to 48 hours. This is done so that the chemical and iron content of the ammonium citrate solution does not affect the chelation test results. Once the artifact has been immersed in RO water for this period, a La Motte Iron Testing Kit is prepared to discern the iron content of an organic artifact in parts per million (ppm)(Figure 14). These kits contain a 30 milliliter bottle of Iron Reagent #1, a 4.5 gram bottle of Iron Reagent #2, two 2.5-10 milliliter test tubes, an Octa-Slide 2 viewer, and an Iron Octa-Slide 2 bar. For this test colorimetric analysis is used, which means that the iron reagents mix with the solution from the artifact container to produce a color reagent indicating how much iron is still within the artifact. The Iron

Octa-Slide 2 bar has a range of colors from light pink to red that correlate with 0.5 ppm to 10 ppm, and the color of the solution after testing is matched with the closest color on the bar to show the solution's iron content.

To conduct this test, 5 mL of solution from the artifact container and 5 drops of Iron Reagent #1 are added to a test tube and shaken. 0.05 grams of Iron Reagent #2 are then added and the test tube is shaken further. Once the mixture dissolves, a three-minute timer is set while the conservator waits for the colorimetric reaction to take place. During this time a conservator will often mix a second test tube to test another organic artifact to hasten the process. After three minutes, the conservator will side the test tube into the Octa-Slide 2 viewer, next to the Iron Octa-Slide 2 bar. The solution in the test tube will have turned a color between pink and red, and will match with a color on the Octa-Slide 2 bar based on its iron content. The darker (redder) the solution is, the higher its iron content. At the QAR lab, an artifact has completed the chelation process when its iron concentration reads lower than 2 ppm. If the artifact registers above 2 ppm, it is placed into a new 2% ammonium citrate solution; if it registers below 2 ppm, it is placed into RO water to continue passive desalination. Over the course of my internship at the QAR lab I assisted Elise with every step of this process several times, and can attest that the smell of ammonium citrate during chelation can often be hard to stomach.

Figure 14. A La Motte Iron Testing Kit and all its contents. Courtesy of NCDNCR.

Boring and Unloading Cannons

Some of the most exciting days at the QAR lab are those when cannons must be bored and unloaded. Because the *Queen Anne's Revenge* was a pirate vessel and also because it ran aground and was abandoned quickly, many of the cannons from the ship were loaded when it sank. Therefore, a number of the cannons at the QAR lab still contain wads and cannon balls at the back of the cannon bore. Removing the cannon balls and wads is a lengthy process that can often take an entire day of work and require a great deal of perseverance and creative problem solving. Because these cannons are made of iron and rested on the ocean floor for 300 years, concretions form not only around them but inside the bore of the cannon as well. Therefore, the first step in this process is using a water-powered drill that is secured into both the floor below it and an A-frame crane above it. The cannon is raised with an A-frame crane and is strapped to two tables in front of the drill, and is carefully measured and leveled so that the drill does not go too far back or go down the bore at an angle (Figure 15). The drill is outfitted with a bit measured to perfectly match the diameter of the bore of the cannon, and is slowly guided down the cannon to remove any concretions in the bore that would block tools used to reach the cannonball (Figure 16). This process can also be quite messy, as the water from the drill and the pitch from the inside of the cannon pour out of the bore and create a black sludge on the floor.

Once the inside of the cannon bore has been cleared, the wads and cannonball at the back of the cannon can be removed. To do this, a hollow iron cylinder measured to fit the bore of the cannon is welded onto the end of a piece of metal rebar and is guided down the bore (Figure 17). Once the tool gets close to the front wad, a piece of wood is secured around the rebar and is hammered carefully and precisely so that the cylinder goes further down the bore and expands around the wad and cannonball. This process can take a couple of hours and is quite physically demanding. Once the cannonball and wads are securely within the cylinder, the tool is hammered backwards out of the cannon bore, and hopefully removes the wads and cannonball with it. Once the tool is removed, it can also be quite difficult to remove the wads and cannonball from the metal cylinder. Pliers and other tools are often needed to expand the cylinder so that the artifacts can be removed. During my internship I assisted with this process twice and can confidently say that while these were some of the most physically exhausting days at the lab, they also became some of my fondest memories.

Figure 15. A cannon is carefully lowered onto two supporting tables. Courtesy of NCDNCR.

Figure 16. A drill is guided down the bore of a cannon. Courtesy of NCDNCR.

Figure 17. A metal tool is hammered down the bore of a cannon to unload it. Courtesy of NCDNCR.

Writing a Blog Post

The QAR lab also operates a blog on which they post artifacts of the month, conservation processes conducted at the lab, historical accounts of famous pirates, and various other informational reports. During my internship at the QAR lab I had the privilege of writing a post for this blog about my journey as an archaeologist and student, starting with a young boy interested in history and leading up to a grad student interning at the Queen Anne’s Revenge Lab. This opportunity not only gave me valuable experience in writing and communicating with the public digitally but also allowed me to share how I got to where I am today, which hopefully may inspire other people with the same interests to follow a similar path and enter the fields of archaeology and conservation.

Public Outreach

The QAR lab frequently gives tours of the lab as part of a public outreach and education initiative. Though the arrival of COVID-19 greatly reduced the number of tours that the lab could give, I was still able to accompany and assist Terry with a few. While Terry would lead the group and give most of the details about the history and operations of the lab, I would follow in the back and answer any side questions that the public might have as well as explain what tasks I performed there. Assisting with this helped me to realize that I have a passion for teaching the public about history, archaeology, and conservation, and I hope that I can utilize that passion in a future career.

While working at the lab I also assisted with the open house event at the QAR Lab in April. For this event stations were set up in the main lab and in the warehouse with each one detailing a different method of conservation or artifact at the QAR lab, such as airscribing, metals testing, firearms, photography, etc. I helped clean the lab and set up many of the stations, and during the event itself I operated a table explaining the history of Brunswick Town and artifacts from that site that I helped conserve. This gave me more experience working with the public and an opportunity to detail my personal project of conserving metal artifacts for my internship.

Summary

During my time as a graduate assistant I became experienced with a variety of conservation techniques, dealing with metal, glass, organics, and various other marine artifacts from the *Queen Anne's Revenge.* Many of these conservation skills such as metals testing, photography, solution change outs, data entry, and air scribing were demonstrated on a regular basis. Other skills such as chelation, PEG treatment, TDS, and chloride testing were done less frequently but still played an important role in my education of conservation. I am confident that after being trained in all of these conservation methods I have left this experience much more knowledgeable in the field of conservation and will be able to apply these skills in any future career I have as a conservator or archaeologist.

Chapter 4 – Conserving Brunswick Town Metal Artifacts

Though this graduate assistantship provided training in a wide variety of conservation skills, one specific, intensive project that I was assigned was the conservation of metal artifacts from the colonial site of Brunswick Town. Brunswick Town was established on the Cape Fear River in colonial North Carolina in 1726 near current day Wilmington. It became an important port, exporting products such as pitch, tar, and turpentine for the Royal Navy. Due to its importance as a port the town grew in political power and interest and was the de facto capital of North Carolina from 1743 to 1770. However, as Wilmington grew Brunswick Town began to decline and the town was raided by British forces in 1776, ending its brief era of prosperity. Centuries later, East Carolina University archaeologists under the supervision of Dr. Charles Ewen conducted excavations at the site and recovered thousands of artifacts, including many made from metals such as copper, lead, and iron. Dr. Ewen entrusted the conservation of several of these metal artifacts to me, and with the assistance of staff members at the QAR lab I put each artifact through proper conservation steps to ensure they no would no longer decay and would be suitable for display in a museum.

<u>Copper Alloy Artifacts</u>

A majority of the metal artifacts from Brunswick Town that I conserved were composed of brass, which is a mixture of copper and zinc. They consisted of a variety of buttons, tacks, and buckles, as well as a few more unique artifacts such as a bell, a ramrod thimble, and drawer knobs. For every metal artifact there are certain conservation measures that must be applied depending on the type of metal. All of these artifacts were made with copper alloys, and therefore they were treated accordingly. Additionally, these artifacts came from a terrestrial site rather than a marine one such as the *Queen Anne's Revenge,* and therefore the treatment for them differed from treatments for marine copper alloys. Each conservation step was personally recorded by me onto a blue sheet and then entered into an Excel spreadsheet to ensure that the conservation process for these artifacts was properly conducted and documented.

The first step for these artifacts was to take pre-treatment photographs and measurements. This was primarily done to ensure that images and data existed for all of the artifacts in case any of them did not survive treatment, but it also would provide visual documentation of how the condition of the artifacts improved through conservation. Some of the artifacts such as the buttons only required photographs of each side, but others such as the knobs required six perspectives to properly record the state of each side of the artifact (Figures 1, 3, 5, 7, 9, and 11).

Though these artifacts came from a terrestrial site, they were exposed to moisture in the soil and therefore experienced some corrosion on the surface. Because of this, several of the objects required treatment with an aroscribe to remove the corrosion. An aroscribe was used instead of an air scribe because all of these artifacts were relatively small and fragile compared to an average concretion. Using an aroscribe on a small artifact requires a great deal of patience and precision, as a conservator must make sure they remove corrosion without pressing into the surface of the artifact itself. Even with the most careful hand an artifact may sometimes suffer damage, which was the case with a few of the copper artifacts such as a small tack and a button. In cases such as these, all of the pieces of the artifact were put through the next steps of conservation before being reassembled in the final step.

Another technique for removing corrosion from a metal artifact that can be less damaging than an aroscribe is immersing the artifact in a sonic bath. To do this the artifact is placed in a container filled with tap water which then floats in more tap water inside the sonic bath device. Sound waves are then emitted from the device and travel through the water, vibrating the artifact and slowly removing layers of corrosion from its surface. This was done to some of the artifacts that were more heavily corroded, such as the drawer knobs.

Once a majority of corrosion had been removed, chemical cleaning of the artifacts could begin. Each copper artifact was first placed in a 10% citric acid plus 3% thiourea solution in RO water to remove any encrustation that physical cleaning could not (Hamilton 1999b). Citric acid should be used with caution, as it can sometimes dissolve copper compounds if they are submerged for extended periods of time. The artifacts were therefore monitored regularly and were removed from the citric acid solution and rinsed with RO water once any remaining corrosion had been removed.

One last conservation technique for cleaning copper artifacts is rubbing them with a sodium bicarbonate (baking soda) slurry. This can help remove dirt and corrosion and polishes the artifact for a shinier appearance. To do this, baking soda is placed into a tray and mixed with RO water to form a paste than can then be rubbed onto the surface of artifacts with gloved hands. This method was especially useful for the drawer knobs, buttons, and buckles, which were noticeably cleaner after being scrubbed with this chemical.

After being rinsed with RO water once more, the artifacts had to be dehydrated to remove any excess moisture inside them, preventing any future corrosion. This was done by placing the objects in reagent alcohol and leaving them immersed for 24 to 48 hours. Once the artifacts were dehydrated, they were then immersed in a 3% benzotriazole (BTA) solution dissolved in ethanol. This treatment forms a barrier that prevents any further moisture from penetrating the artifact, as BTA creates an insoluble compound with the copper ions (Hamilton 1999b).

After being immersed in BTA, the final chemical step for the copper artifacts was to apply a coat of 2.5% acryloid B72 with fumed silica. This clear, gluelike coating further protects artifacts from moisture and other harmful outside forces and prepares them for display in a museum (Hamilton 1999b). It is quite adhesive and dries quickly, so conservatives must make sure artifacts are completely coated but do not stick to any surfaces. Once this step was complete the artifacts had completed conservation and were ready for post-treatment photographs and measurements. This step provided final documentation of what the artifacts looked like after completing conservation and highlighted a stark difference between before and after they were conserved (Figures 2, 4, 6, 8, 10, and 12). Once this step was complete the artifacts were placed into a cabinet with other copper alloy artifacts that is monitored to maintain proper relative humidity. For copper artifacts, it is recommended that they be kept at a relative humidity of less than 60%.

Figure 1. A brass buckle from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 2. A brass buckle from Brunswick Town after conservation. Courtesy of NCDNCR.

Figure 3. A brass ramrod thimble from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 4. A brass ramrod thimble from Brunswick Town after conservation. Courtesy of NCDNCR.

Figure 5. A brass bell from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 6. A brass bell from Brunswick Town after conservation. Courtesy of NCDNCR.

Figure 7. A brass buckle from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 8. A brass buckle from Brunswick Town after conservation. Courtesy of NCDNCR.

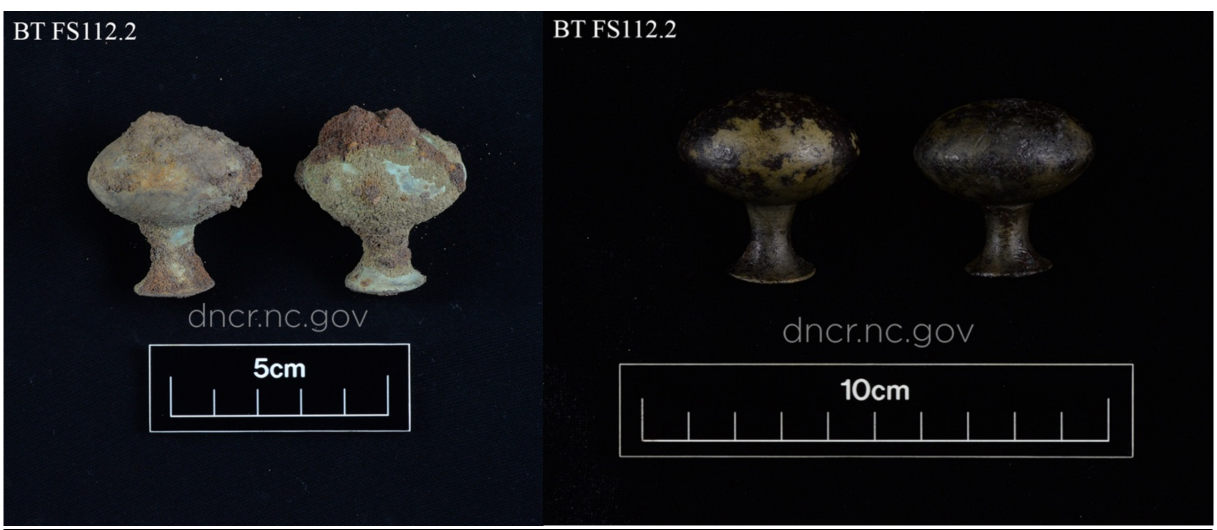

Figure 9. Brass drawer knobs from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 10. Brass drawer knobs from Brunswick Town after conservation. Courtesy of NCDNCR.

Figure 11. A brass button from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 12. A brass button from Brunswick Town after conservation. Courtesy of NCDNCR.

Lead Artifacts

For this project three lead artifacts were conserved: a folded piece of lead, a bale seal, and what was determined to be a trading weight with the initials A.S. carved into it (Figures 13, 15, and 17). This weight would have been placed on the opposite side of a scale from currencies such as gold dust to balance out the scale. Lead artifacts differ from copper artifacts in many ways and therefore these underwent several different conservation steps. For instance, lead is a very soft metal and therefore mechanical cleaning should be kept to a minimum to avoid scarring the surface of the artifact. Lead is also a toxic metal and therefore should be handled with care.

The cleaning of these artifacts was done primarily through chemical means, starting with immersion in a 10% hydrochloric acid solution. This treatment helps to remove any corrosion from the surface of the lead as well as harmful compounds such as lead carbonate and calcium carbonate (Hamilton 1999b: 303). The lead is then thoroughly and carefully rinsed with RO water, as hydrochloric acid is extremely caustic. To completely remove any remaining lead corrosion products the artifacts were then immersed in a 5% ethylenediaminetetraacetic (EDTA) acid solution for 2 to 3 hours. The artifacts were then rinsed with RO water once again.

The final chemical step was to immerse the lead artifacts in a 700 ppm sodium sulfate solution. This solution was necessary to dry out any organic liquids that might have remained in the lead artifacts and caused more corrosion in the future. Unlike other metal artifacts, lead artifacts do not require a protective coating such as B72; once they completed the sodium sulfate treatment the artifacts were ready for post-treatment photographs and measurements (Figures 14, 16, and 18). The artifacts were then stored in a cabinet with other lead objects and monitored for relative humidity; lead should be kept at a relative humidity between 40 and 60%. It is also important to note that lead should never be stored with or near organic artifacts, as organic acids can be extremely harmful and result in corrosion. Other optional treatments for lead artifacts include immersion in a ten percent ammonium acetate solution and electrolytic reduction, though these steps are not necessary in most cases.

Figure 13. A lead trading weight from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 14. A lead trading weight from Brunswick Town after conservation. Courtesy of NCDNCR.

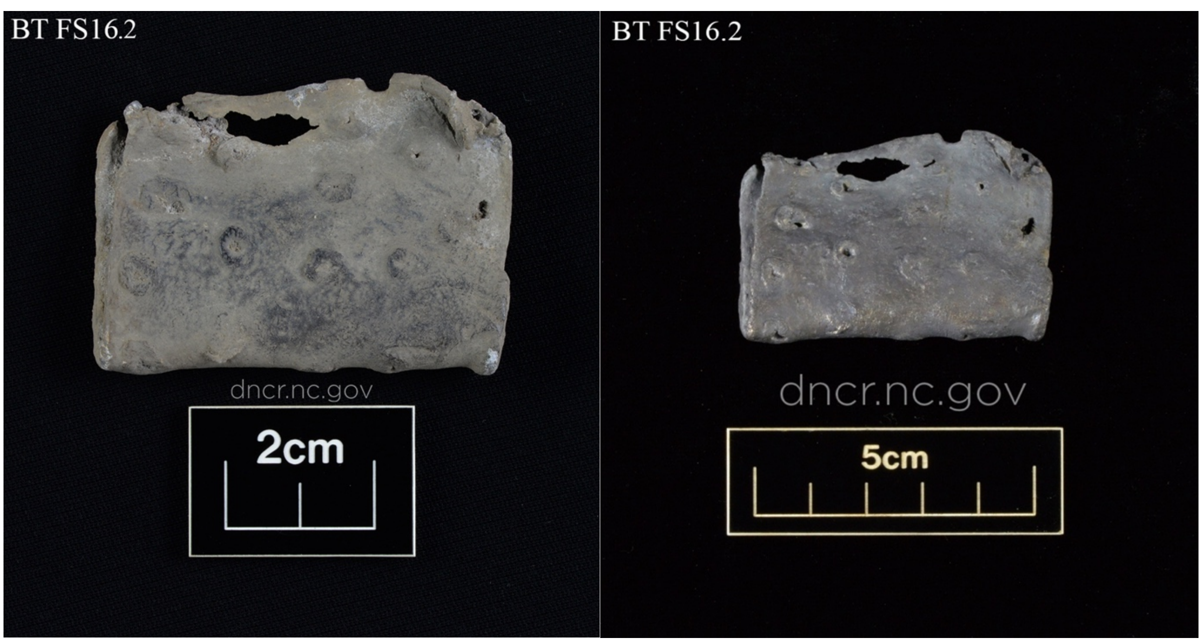

Figure 15. A folded lead piece from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 16. A folded lead piece from Brunswick Town weight after conservation. Courtesy of NCDNCR.

Figure 17. A lead seal from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 18. A lead seal from Brunswick Town before conservation. Courtesy of NCDNCR.

<u>Iron Artifacts</u>

The final artifacts that I conserved for this project consisted of heavily corroded iron. These artifacts were comprised of a small key, a door lock cover, a buckle, a fastener, and a metal strip. In addition, a larger key was conserved that came not from Brunswick Town but from a colonial tavern in Jackson, North Carolina. While working with these objects I learned a key lesson in the field of conservation: if an artifact is heavily corroded or extremely fragile, it is sometimes better to leave it as is rather than risk its complete destruction. After taking x-rays of the artifacts and consulting with conservators at the QAR lab, it was determined that the small key, door lock cover, and metal strip were so corroded that any attempt to treat them would likely destroy them. These artifacts were therefore stored with other iron objects and ideally kept at a relative humidity of less than 20%, as iron is highly susceptible to oxidation from moisture.

Fortunately, the buckle, fastener, and large key were able to undergo conservation steps and survive. All three of these artifacts were heavily corroded due to water exposure and therefore the first step was to use an aroscribe to remove the encrustation around them. Most of the encrustation was removed from the buckle and fastener without any considerable problems, but aroscribing the large key resulted in a few setbacks (Figures 19-23). While aroscribing the key it was discovered that the metal had corroded and become so weak in some places that it was extremely fragile, and small pieces of the handle and the teeth began to break away (Figure 24). This was not entirely unexpected, as the x-rays of the key indicated that the metal was extremely weak in many places. Fortunately, the rest of the corrosion was able to be removed without completely destroying the artifact and it was still recognizable as a key (Figure 25). This process helped to highlight how artifacts sometimes are damaged during conservation no matter how careful a conservator might be, and conservators often have to make tough decisions about whether conservation attempts will help or harm the artifact.

The last step that the iron artifacts underwent before the end of my graduate assistantship was similar to the treatment for other metal objects at the QAR lab; they were placed in a 1% sodium hydroxide solution in RO water. This solution helps to draw the chlorides out of the heavily corroded artifacts. Though I did not have enough time to see these artifacts complete their conservation journey, the QAR staff assured that they would see the process through. This involves testing the chloride levels of the solution until the chlorides level off, then placing the artifacts in a passive RO water solution and testing them with pH strips until they register as neutral. Lastly, the iron artifacts will receive three coats of tannic acid and then a final coat of acryloid B72. The artifacts will then be stored with other iron artifacts at a relatively humidity between 20 and 40% until they can be displayed at a museum (Cronyn 1990).

Figure 19. An iron fastener from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 20. An iron fastener from Brunswick Town after being airscribed. Courtesy of NCDNCR.

Figure 21. An iron buckle from Brunswick Town before conservation. Courtesy of NCDNCR.

Figure 22. An iron buckle from Brunswick Town after being airscribed. Courtesy of NCDNCR.

Figure 23. An iron key from a colonial Jackson tavern before conservation. Courtesy of NCDNCR.

Figure 24. An iron key from a colonial Jackson tavern during the airscribing process. Courtesy of NCDNCR.

Figure 25. An iron key from a colonial Jackson tavern after being airscribed. Courtesy of NCDNCR.

Conclusion

This project resulted in the conservation of numerous artifacts from the Brunswick Town excavation as well as a key from a colonial Jackson tavern, and provided me with considerable experience in conserving metal objects. I am now quite familiar with the different conservation steps that terrestrial copper, lead, and iron artifacts must go through to ensure they do not degrade further and am confident that I could carry these steps out in a future career as a conservator. The artifacts are now all free from the risk of future degradation and can be displayed in a museum or studied by future archaeologists to gain a better understanding of the site from which they came. This project also helped me to understand the risks that are associated with conserving artifacts and the tough decisions that conservators must make when dealing with highly fragile items.

Chapter 5 – Summary and Conclusion

In conclusion, this graduate assistantship was an extraordinary opportunity that provided great insight into the field of conservation, a wide range of experience with all of the conservation methods utilized at the *Queen Anne's Revenge* Conservation Lab, and a specialized focus on the preservation of metal artifacts from the site of Brunswick Town. To showcase an understanding of conservation as a science, a history of how conservation progressed from a craft-based skill to a professional lab-based discipline was provided. The many skills required by a professional conservator and the challenges one might face were also detailed, and I believe after this assistantship I have many of the skills needed to face said challenges in the future. Case studies of successful as well as less than successful conservation projects provided examples of the important, constant work that conservation does to preserve the past. They also helped to showcase what can happen when proper conservation principles are not followed.

To provide background for the lab at which the graduate assistantship took place, a brief history of the *Queen Anne's Revenge,* its excavation, and the founding of the lab was provided. The ship was active as a pirate vessel for a period of about 6 months before running aground in 1718, and was discovered by a private salvage company called Intersal Inc. in 1996. After an agreement was reached with the state government, excavation of the site began to take place and now over 400,000 individual artifacts and about 60 percent of the wreck have been excavated. These artifacts are put through an intensive conservation process at the QAR lab, which was founded in 2004, before they are displayed at the North Carolina Maritime Museum in Beaufort. This information helps to place the artifacts being worked on in a historical context and to highlight their significance in humanity's records of the past.

A majority of this report is dedicated to documenting the vast array of conservation skills that I received training in during the graduate assistantship. Many of these skills, such as artifact photography, air scribing, metals testing, solution change-outs, and applying protectant/sealant were conducted on a regular basis and I therefore have numerous hours of experience with them. In addition, other conservation methods such as PEG, TDS monitoring, chelation, electrolytic reduction, cannon unloading, and chloride testing needed to be performed on a less regular basis, but I still received a significant amount of training with them and could perform all of the above tasks in the future.

In addition to all of the conservation methods listed above, the personal project that I was assigned was to conserve metal artifacts that were excavated from the colonial site of Brunswick Town. These were terrestrial artifacts and therefore their treatment differed in some ways from methods that would be applied to marine metal. A majority of the artifacts were made of a copper alloy and they therefore required a treatment of citric acid, reagent alcohol, benzotriazole, and acryloid B72. A few of the artifacts were composed of lead, which requires treatment with hydrochloric acid and EDTA before being immersed in a sodium sulfate solution. Lastly, the iron artifacts were heavily corroded and required aroscribing and were then immersed in a 1% sodium hydroxide solution. Throughout this process a few of the artifacts were damaged slightly due to their highly fragile nature, which helped to teach me the sometimes unavoidable risks that are associated with conservation. This project also taught me that certain types of metals require very different conservation treatments, and I am now prepared to identify the composition of metal artifacts and the treatments that would best suit them in the future.

This graduate assistantship was highly educational and extremely rewarding, and provided insight and experience in both conservation theory and practice that will no doubt prove highly useful in any future career as a conservator or archaeologist. This report hopefully highlights the importance of the work done at the QAR lab as well as the skill and helpfulness of the staff there. I am extremely grateful that this graduate assistantship was offered, and believe any anthropology student would be highly successful pursuing this route to gain an essential background in the field of conservation. Additionally, after completing this internship I was hired as the Lab Office Manager at the QAR Lab, which is a testament to the education and experience that is provided by this program, and I am extremely excited to continue working in the field of conservation.

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Appendix: Additional Documents

1.1 *QAR* Online "Archaeology: A Career in Ruins" Blog Text

URL: https://www.qaronline.org/blog/2021-02-15/my-story-daniel-lowery

Author: Daniel Lowery, QAR Lab Intern

My name is Daniel Lowery, and I am a graduate assistant at the QAR Conservation Lab. I am currently pursuing a master's degree in anthropology at East Carolina University. I have always had an interest in history, but it is a bit embarrassing to admit that I was not truly captivated by archaeology until I saw the Indiana Jones movies when I was ten years old. Traveling the world, discovering rare artifacts, and saving them from bad guys – what ten-year-old wouldn't want a career doing that? Of course, I now know that Indiana Jones is not a great archaeologist (he frequently destroys temples and never writes anything down!) and that those movies largely misrepresent what archaeologists actually do. But to their credit, they did inspire a young kid to grow up and become a real archaeologist. Plus, even though archaeology is nothing like the movies, it is still just as exciting!

Movies were not my only inspiration. My parents frequently took me to museums and historic sites like Colonial Williamsburg, and they encouraged me to read history books and learn about other cultures. I owe a lot to my teachers in high school as well, who further nurtured my interest in the past by encouraging me to take classes such as AP United States and European History. I was fortunate to go on two educational trips in high school to England, France, and a few other European countries. One was a World War II trip that began in England and traced the path of the war all the way to Germany. After the extraordinary chance to experience the cultures and witness the histories of these places, I could not wait to go back, and I knew more traveling was in my future.

Despite an early interest in history, it might be surprising to hear that neither history nor anthropology were my first choices for a major. I initially majored in engineering at North Carolina State University. However, after three semesters I realized that my heart was not really in it, and I began to question my choice. Fortunately, it is never too late to change your mind and pursue your passion. I met with several wonderful advisors at NC State, changed my major to anthropology, and I have never regretted that decision.

While at NC State, I had the opportunity to join the Makounta-Voules Archaeological Field School in Cyprus, where we worked to uncover a prehistoric settlement to better understand the shift to urbanization that began in Cyprus during the Middle Bronze Age. We would wake up very early and drive to the site, where we worked until the afternoon to dig trenches, recover artifacts, and carefully map and record our findings. It was tiring yet exhilarating – it is hard to describe the thrill of handling an artifact that has not been touched for a few thousand years! When we weren't working, we took trips around the island, both to bustling cities and other famous archaeological sites. Despite our busy schedules, we even had plenty of time to explore the local town and head to the beach to relax. I made lifelong friends on that trip and some of my fondest memories. I would encourage anyone to take part in a field school, as it was one of the greatest experiences of my life.

Shortly after graduating, I realized there was still a lot I wanted to learn about archaeology, so I decided to stay in North Carolina and pursue a degree at ECU. I have made many wonderful friends here, and it led to this once in a lifetime opportunity to intern at the QAR Lab. I assist with the conservation of materials and artifacts from Queen Anne's Revenge as well as metal artifacts from Brunswick Town, a colonial site on the coast of North Carolina that has been excavated by my advisor, Dr. Charles Ewen. I am currently compiling an internship report describing my duties and newly acquired lab skills, which I will defend in the Spring of 2022.

Though I look forward to graduating and beginning my career as an archaeologist, I am going to miss ECU dearly, especially the new friends I have made and of course the QAR Lab. It is a privilege to work here, and I would do it for the rest of my life if I could. Every day I get to help conserve artifacts that Blackbeard may have actually touched, and I cannot fully describe the thrill and honor of that experience. I am eternally grateful to the QAR staff and to every person that has encouraged me along the way. I hope to make them all proud after I graduate and enter a new and exciting phase of my life.