A BASELINE INVENTORY OF MULTIBEAM ACOUSTIC TARGETS FROM THE HUDSON RIVER BETWEEN NEW YORK HARBOR AND WAPPINGERS FALLS

A Final Report of the Tibor T. Polgar Fellowship Program

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ABSTRACT

The Hudson River has served as a focal point for human activity for more than 10,000 years. Use of the river has taken many different forms, resulting in a rich and diverse archaeological record. Study of this record preserved beneath the Hudson will have much to contribute to our understanding of the past in New York.

In 1998 five organizations teamed up to map the bottom of the Hudson River to learn the nature and extent of benthic habitats. Techniques used included multibeam swath bathymetry, side-scan sonar, sub-bottom profiling, and analysis of bottom samples. A detailed record of the Hudson floor from the Verrazzano Narrows to Troy was produced using multibeam swath bathymetry. In the process of mapping, hundreds of targets of possible anthropogenic origin were revealed, including many shipwrecks. The State has not yet permitted publication of the bathymetry data in detail because in doing so, the exact coordinates of these shipwrecks would be revealed, thus making them vulnerable to looting.

A first step to assessing and protecting the archaeological value of the Hudson River is to create a baseline inventory of the acoustic targets. An inventory was created for the seven sections mapped through 2001 and the images were compared with local history records to try to match acoustic targets with known past events. Thus far, 179 targets have been classified as shipwrecks in the multibeam data. Many of these targets appear to be canal boats. Other targets were classified as barges, steam ships, and possibly two Revolutionary War frigates. Eventually, steps need to be taken to improve the legislation in New York to better protect these resources.

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INTRODUCTION

The purpose of this project was two-tiered: first to construct a baseline inventory of the acoustic targets identified during sonar mapping in seven sections of the Hudson River and, second, to correlate the acoustic data with events documented in the local history of the Hudson River. By doing this, we hoped that some of the numerous shipwrecks revealed on the river bottom by sonar mapping could be positively identified, or at least classified by vessel type.

The acoustic targets were mapped as part of the Benthic Mapping Program, which began in 1998. The Benthic Mapping Program is a collaborative effort of five organizations: the New York State Department of Environmental Conservation (NYSDEC), Columbia University's Lamont-Doherty Earth Observatory (LDEO), the Marine Science Research Center (MSRC) at Stony Brook University, the Hudson River Estuary Program and the Hudson River Natural Estuarine Research Reserve (Bell et al. 2000). Mapping the bottom of the Hudson River with multibeam swath bathymetry has revealed the specific locations of hundreds of targets of likely anthropogenic origin, almost two hundred of which are shipwrecks and one which is a possible prehistoric feature.

The New York State Office of Parks, Recreation, and Historic Preservation (OPRHP) has not yet allowed release of the high-resolution multibeam bathymetry data collected because publication of the exact locations of shipwrecks could put them at risk for looting. New York State fears that scavenging will destroy any historical or archaeological value these targets could offer. Under the 1987 Abandoned Shipwreck Act the wrecks remain property of the state (National Park Service 1987). These resources are also protected by the 1980 New York State Historic Preservation Act (New York State Parks 1980). Therefore even as this project continues, the exact locations of shipwrecks remain confidential.

In the inventory constructed in the first part of the project, the targets' location and dimensions were recorded. Any morphological features that might help identify the ship were noted. The second part was to compare the historical record with the multibeam data in the hope that shipwrecks might positively identified.

There are several benefits to positively identifying a shipwreck. For example, in terms of marine geology, identifying a wreck (and its associated age) could help understand sediment processes on the river bottom. It also would yield invaluable archaeological knowledge to the community. Since these sites are currently at risk, proper steps could be taken for their protection. Ways of protecting these sites could include nomination of significant wrecks to the National Register of Historic Places, or perhaps updating the existing New York State legislation to better protect the state's archaeological resources.

Historical Context

Henry Hudson "discovered" the river that bears his name in 1609, although archaeological evidence suggests Native Americans have lived along its banks for more than 10,000 years. Soon after Hudson's voyage, the Dutch set up a fur trading post on what would later become Manhattan Island. By the end of seventeenth century the Dutch sold their colonized area to the British who named the area New York.

Over the next 75 years, trade colonies would grow, as would the number of settlers in New York. The Hudson River was routinely traveled. By the end of the eighteenth century, the colonists had fought and won their independence from the British and in doing so, dramatically altered New York. The Hudson River valley was host to many pivotal battles both on land and water. One of those battles is the Battle of Fort Montgomery. The battle will be discussed in detail below as one example of historical events that contribute to the archaeological potential of the Hudson River.

During the Revolutionary War, the Hudson River was one of the most strategic and sought after locations for both the British and American armies. To each, the river served as the essential connection from the mid-Atlantic colonies to New England and Canada. To strangle the colonies and their revolution, the British schemed to capture the Hudson and isolate General George Washington in the north (Conley 2002). As the British planned to move into the Highlands from New York City, the Patriots made plans to construct fortifications at specific locations along the Hudson.

In 1775, the Continental Congress ordered the construction of two forts on the Hudson that would "most effectively prevent any vessels passing that may be sent to harass inhabitants on the borders of said river" (Journals of Continental Congress II 1775 cited in Carr and Koke 1937:8). The two forts were initially to be built in the vicinity of what would later be known as Constitution Island, on either side of the river. Later, the location was moved south, immediately north of Popolopen Creek and opposite Anthony's Nose. The name of the installation was Fort Montgomery, in honor of

General Richard Montgomery who died in battle the previous year in Quebec (Conley 2002).

After construction of Fort Montgomery was well underway, General James Clinton wrote to Washington explaining that while Fort Montgomery was situated advantageously due to the elevation, Popolopen Creek provided a natural division that would prevent any Patriot attempts at retaliation should the British attack Fort Montgomery. Therefore, with the advice of Clinton, Washington and the Continental Congress approved the building of a twin fort in 1776, on the south side of Popolopen Creek. George Clinton's brother, Colonel James Clinton was named the commander of the fort, named Fort Clinton. There is some disagreement as to which Clinton it was named after (Carr and Koke 1937, Conley 2002, Diamant 1989).

Meanwhile, in December of 1775, a resolution passed by the Continental Congress approved the construction of two Continental frigates, the first commissioned naval vessels. Built in Poughkeepsie, the first of the frigates, the *Congress,* was built as a 28-gun ship (Figure 1). It measured 38.4 meters in length, 10.4 meters in beam, and 3.2 meters in depth (122 x 33 x 10 feet). The second frigate was named the *Montgomery* and was slightly smaller. The *Montgomery* was a 24-gun ship with dimensions measuring 36.3 meters in length, 9.8 meters in beam, and 3.2 meters in depth (116 x 31 x 10 feet) (OPRHP 2003). Construction on the ships continued into mid-1777 however they were never fully outfitted before participating in naval activities on the Hudson River.

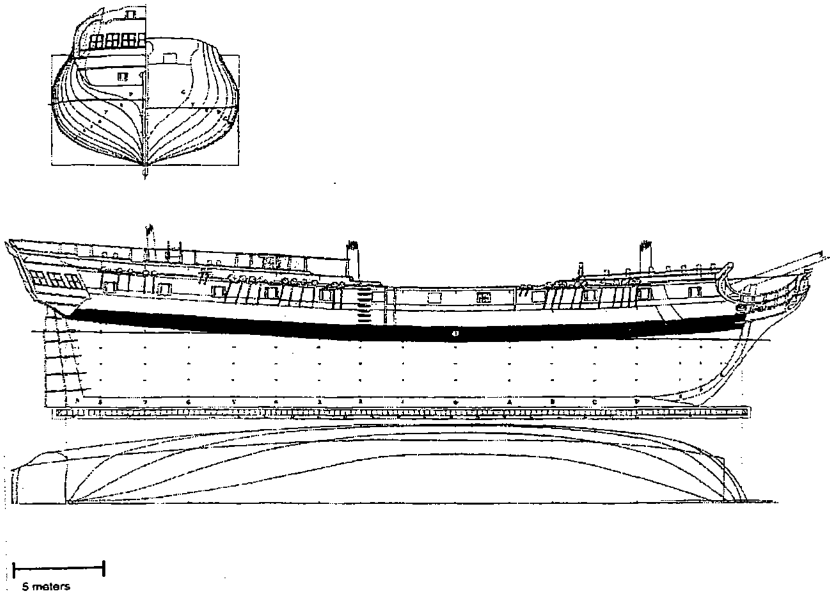

Figure 1. This is a scale drawing of the 28-gun Continental frigate *Congress*. The ship was run aground and scuttled on Constitution Island during the Battle of Fort Montgomery.

In 1776, the Secret Committee of the Continental Congress began making plans to further obstruct the Hudson River from the British (Diamant 1989, Cole 2002). The Committee was forewarned that two British fifth-rate warships the *Phoenix* and *Rose* were sailing into Haverstraw Bay and preparing to move north and attack. In response to this, the Great Iron Chain was stretched across from Fort Montgomery to Anthony's Nose. The Great Iron Chain was a series of oversized metal links, a large investment of specialized skill and labor. Attached to the links were floats. The chain was to prevent ships from passing or at the very least cause the ships some delay during which they would be situated directly in front of either Fort Montgomery or Fort Clinton. Conveniently, this area is also one of the Hudson's narrowest sections thus minimizing the effort of getting the chain from one side to the other. In November of that year, the chain was secured on either side of the river.

In October of 1777 Forts Montgomery and Clinton were attacked by British forces. The forces of the Patriots were no match for the British. With approximately 3,100 men and a fleet consisting of six ships, the British descended upon the twin forts. The patriots had only 900 men at both forts and with a naval fleet of the frigates *Montgomery* and *Congress*, two rowed galleys, and a privateer sloop, all located just north of the Great Iron Chain (Conley 2002). Within two days the British gained control of both forts after attacking by land rather than water. The two Continental frigates under the command of a fresh crew were no match for the strong ebb of the Hudson and the maneuvers of the British fleet. The *Congress* sailed north to escape impending British capture. Captain Daniel Shaw ran the ship aground at Fort Constitution, where Constitution Island is today. Shaw scuttled the ship, burning it to prevent enemy capture, in the evening of October 7, 1777. At the time of loss, it was said that the *Congress* was armed with nine or more 9-pound cannons (OPRHP 2003).

The *Montgomery* suffered a similar fate. During the Battle of Fort Montgomery, the ship was forced south by the tide and was too close to the Great Iron Chain. With no way to safely save the ship or its crew, Captain Hodge also scuttled the ship, with all of his crew safely off the vessel. The ship was armed with eight 12-pound cannons at the time of scuttling. As Carr and Koke (1937: 405-406) quote from Charles Stedman (1794), "…flames suddenly broke forth; and, as every sail was set, the vessels soon became magnificent pyramids of fire. The whole was sublimely terminated by the explosions [of the fire reaching the cannons], which again left all to darkness."

Following the battle, the British fleet sailed north to Kingston to burn the city to the ground. However, they were unable to join up with British General Burgoyne coming south along the Hudson from Canada. General Burgoyne had surrendered to Continental troops at Saratoga (Conley 2002).

Some surviving maps from the late 18th century and later depict the locations of the forts and the battle both on land and on the Hudson. Figure 2 is a reprint of "Plan of the Attack on the Forts Clinton and Montgomery upon Hudsons River," by John Hills (Diamant 1989; Conley 2002). The map dates to 1784 and clearly shows the twin forts and the frigates *Montgomery* and *Congress* as well as the privateer sloop and their general relation to the Iron Chain.

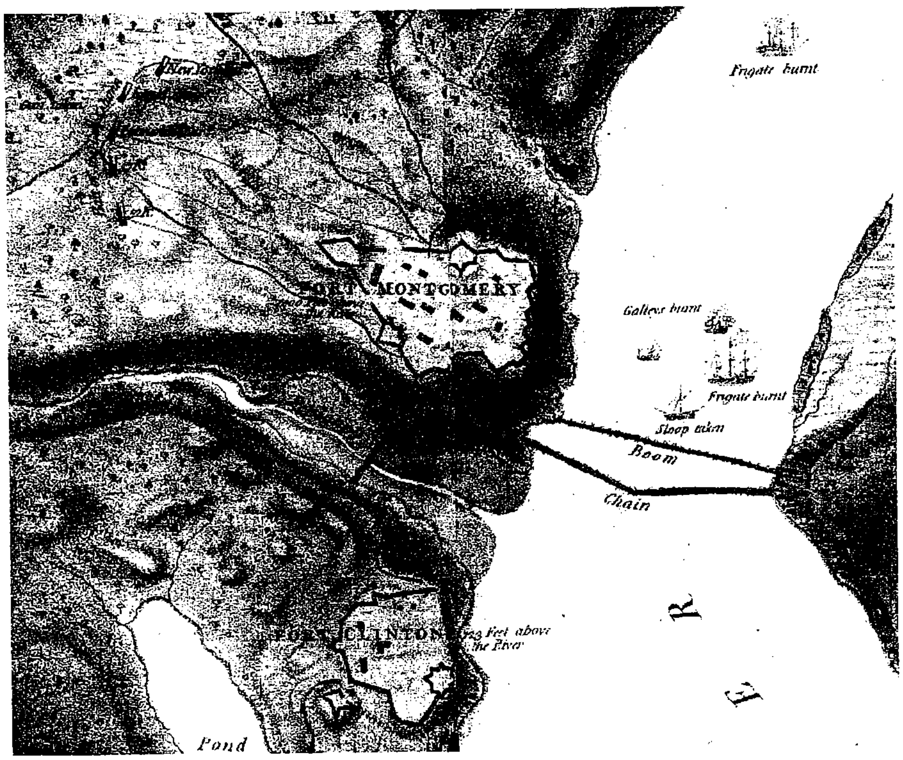

Figure 2. The John Hills map from 1784 shows the general locations of where the ships of the American naval fleet were burned or sunk.

Another map titled, "View near Fort Montgomery" (Figure 3) is part of *The Pictorial Field-Book of the Revolution*, Volume I (1855) by Benson J. Lossing. Since it was published some time after John Hills' map, it is possible that Lossing used Hills' map for information but there are details not included on Hills' map that are part of the Lossing map. Both of these maps show two frigates (presumably the *Montgomery* and *Congress*) being burned, one just north of the Great Iron Chain and another west of Anthony's Nose and one further north, perhaps as far north as Constitution Island. Also included on the map are the galleys and the sloop. The locations all coincide with the Hills map.

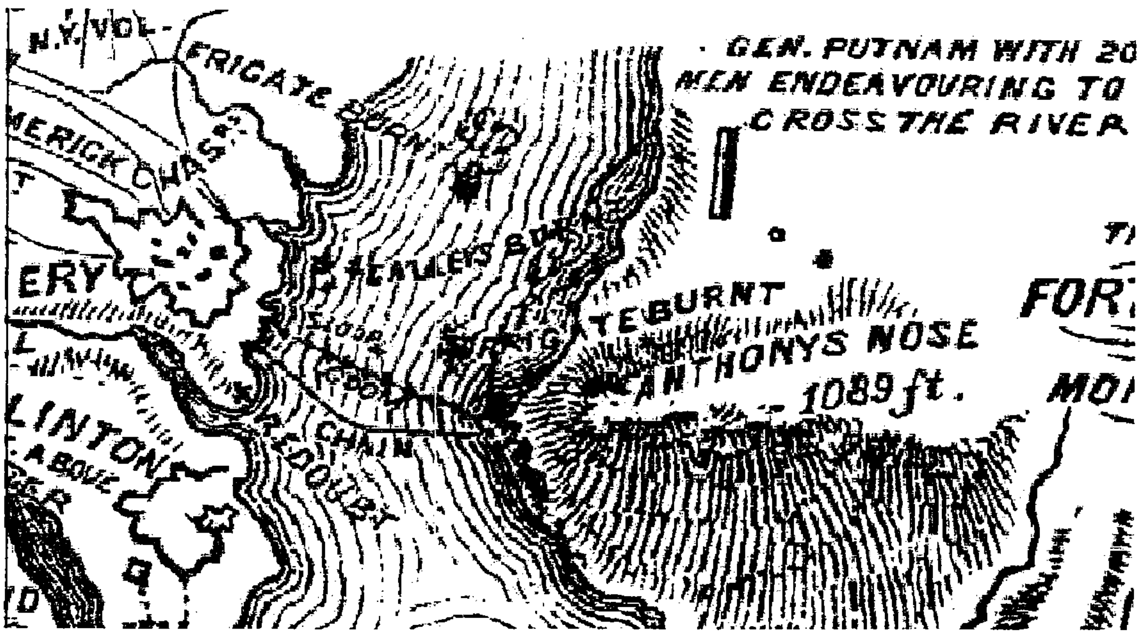

Figure 3. This map entitled "The View near Fort Montgomery" also shows the same general location of the American naval fleet during the Battle of Fort Montgomery.

As any the local records regarding recovery and salvage of the ships, there is nothing concerning the cannons, or the ships themselves (Millar 1978). By all accounts, the remains of these ships, as well as their guns, should still be at the bottom of the Hudson River. While the exact location of shipwrecks identified by the multibeam mapping is confidential, obviously maps such as the Hills and Lossing maps are available to anyone and they do show the general location of possible remains.

Not thirty years later, the Hudson River would again host a pivotal point in history when, in 1807, Robert Fulton successfully ferried passengers from New York to Albany in record time. While he was not the first to experiment with steam as a propulsion device, Fulton was the first to operate ferries from New York to Albany at a rate of faster than four miles per hour (Simmons 1996). This began a new era for the Hudson River-the Age of Steam. Interestingly, the innovative steam engine did not extinguish the heavy reliance on the sail (van Gemert 1972). Sailing was still seen as a dependable way to travel on the river and above all, was cheaper. The steam engine did bring more vessels to the Hudson with numerous ferry services competing with each other once Fulton's monopoly was ended by court order in 1823.

Another type of vessel commonly used on the Hudson River during the nineteenth century was the canal boat. The Champlain Canal was opened in 1823 after six years of construction. It connected the Hudson River to the south end of Lake Champlain (Cohn 2003). This linked lower New York to the rest of the state, and it also opened a direct route to Canada. It was built with a lock system to adjust for elevation increase and decrease. The original locks in the Champlain Canal were 28 meters (90 feet) long by 4.6 meters (15 feet) wide. The opening of the canal was met with wide public approval (Cohn 2003).

In 1825, the Erie Canal was completed from Albany to Buffalo. This opened up a passageway to western New York agricultural lands as well as the American mid-West via the Great Lakes. The canal also facilitated the westward movement of European immigrants. Over the following twenty years canal travel exploded with popularity.

The canal itself is a 575 kilometer (360 mile) long waterway. Traveling from Albany to Buffalo, there is a 188 meter (600 feet) difference in elevation and so, like the Champlain Canal, a lock system was utilized to account for topographic changes. The locks were the same dimensions as the Champlain Canal. Since the canals were man made, they canals posed less of a threat than some natural waterways because there were fewer navigation hazards. In 1825, 19,000 vessels were logged to sail or steam their way on the Erie Canal (Merwin 2003).

In 1835 the Erie Canal was widened to over 5 meters (17.5 feet). This allowed the canal boats to transport 200 tons of cargo. Canal boats were refitted to hold the maximum amount of cargo possible. The same year the Champlain Canal followed suit, however the work was not completed until 1862. This time the length and the width of the locks were changed. The canal underwent another expansion from 1864 to 1877. By this time, the length of the locks was roughly 35 meters (110 feet) in length and roughly 6 meters (18 feet) wide. Indeed it appears that the canal expansions could not quite keep up with demand. As soon as one was completed it was only a couple of years before the next expansion began.

These expansions on the canals directly affected boatbuilding. Overall, a wide, flat shape was optimal for carrying cargo; however the main limits on boat morphology are the canal locks. The boats would be outfitted with a sail, used for traveling on the river. When on the canal they would be pulled by animal on a toe path.

As canal locks were expanded, the dimensions of the boats were expanded accordingly (Figure 4) (Cohn 2003). When the Champlain canal opened originally, the canal boats ranged in length from 14 meters (48.5 feet) to 25 meters (81 feet). Their beam was 4 meters (13 feet) and the depth was around 1 meter. In 1841, the first fleet of canal boats was introduced with a more uniform shape ranging from 23 meters (73.5 feet) to 25 meters (81 feet). The width for both these classes stayed at around 4 meters (13 feet) and their depth was around a meter (3.2 feet). From 1662 to 1873 the lengths of the boats ranged from 26 meters (85 feet) to 27.5 meters (88 feet) the size with a width of 4 to 5 meters (13-15 feet) and a depth of 1.5-2.3 meters to (4.5-7.5 feet). The 1873 class of sailing vessels expanded the length to 28-30 meters (91-99 feet). The width expanded up to 6 feet (18 feet) and a depth of 2.5 meters (8 feet) (Cohn 2003).

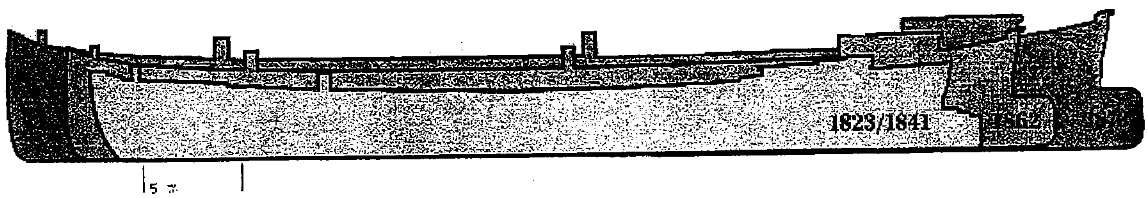

Figure 4. The scale drawing shows how canal boats were lengthened over time.

As a result of their morphology, these boats were poorly suited for river travel. Canal barges, once loaded with cargo, would have to make its way up to the canal. Many barges sank on their way to and from the canal.

An email from Stanley Dickstein to Betsy Blair in January of 2004 brought to light a Supreme Court case involving a shipwreck. This serves as a good example depicting the kind types of accidents on the river that would result in a shipwreck. In October 1845, the steamship *New Jersey* and the sloop *Hamlet* collided, causing the sloop to sink. The court was deciding which boat was struck by whom. Eyewitness accounts of when and where the impact and sinking took place were part of the proceedings. All of the testimony puts the shipwreck in the area of Blue Point. The accident happened at two in the morning and there were four eyewitness accounts from separate vessels in close proximity. Since the testimony gives a fairly precise location of the wreck, it is possible to narrow our search and look at the imagery from that section of the river.

Similarly, the age of steam has given way to modern diesel-powered engines. The Hudson is still used to ferry passengers up and down New York, and is still heavily traveled and used for recreation and transportation of goods. Dredging, especially north of the city of Hudson, allows ocean going boats to reach Albany. Now, high-speed ferries are a common site on the river.

Despite the various innovative techniques and technological advancements, accidents were (and still are) inevitable. During the age of steam, tragic accidents were commonplace. They would often be recorded in local histories if numerous lives were lost, or if the ship was big enough to garner such attention. Sailing vessels would capsize in areas with gusty winds and treacherous currents, and many barges sank laden with cargo. Many canal boats were lost during the canal shipping boom. Many of these ships will theoretically be scattered along the Hudson River floor. This tantalizes the imagination as to what archaeological findings the Hudson River has to offer.

METHODS

One instrument used for the Hudson River Benthic Mapping Program was a multibeam swath echosounder. A multibeam system sends a sound beam perpendicular to the ship track, and then processes the data sent back to determine a number of depths across the ship track (Flood 2003). The multibeam records the time it takes for the sound beam to return, as well as the angle. This provides and x, y, and z set of coordinates, and from these data a three dimensional picture of the river floor is created.

The multibeam swath bathymetry data were collected data in water depths over 4.8 meters (15 feet). The multibeam system used for the Hudson River study is the Simrad EM 3000. The information from this system is gridded at one meter resolution (3.2 feet) (Bell and Flood 2002).

A side-scan sonar was also used to collect data from all water depths along both north-south and east-west lines. Side-scan sonar operates on the same premise as the multibeam except that it only produces a two dimensional pictures because the angle of the return beam is not recorded. The side-scan sonar data was collected using an Edgetech DF-1000 at the frequencies of 100 and 384 kilohertz (kHz). The widths for the 100 kHz and the 384 kHz tracklines are 100 meters (320 feet) and 50 square meters (156 feet) apart, respectively (Bell and Flood 2002, Bell et. al. 2002, Bell et. al. in press). These data and other information collected during the study are presently being assembled into Global Information Systems (GIS) products for DEC. Sites of potential shipwrecks have been identified as part of the data analysis for DEC (Bell and Flood 2002).

The purpose of this project was to build an inventory of all the acoustic targets of possible anthropogenic origin identified in the multibeam data. The target's location was marked as well as its dimensions. Preliminary morphologic identifications were made. These ranged from a possible flat bottom barge to sediment covering a pile of debris. The side-scan data was not evaluated for this inventory because the multibeam data set provided better imagery from which to collect the dimensional information and general morphology of targets.

Computer software used in building the inventory were ESRI ArcView version 3.2 and Microsoft Excel. The data studied for possible shipwrecks were: (1) multibeam depth gridded at one meter (3.2 feet) and (2) images of sun-illuminated bathymetry derived from multibeam depth. Sun-illuminated bathymetry highlights small-scale features by simulating shadows cast by a synthetic sun. It should be noted that Roger Flood converted the data from UNIX to Windows format so that the data could be used in ArcView. To improve the analysis of specific targets, the programs DMagic and Fledermaus were used. These programs digitally create color three-dimensional images of set locations and allow one to "fly" in all directions around a location.

The inventory included the location of the targets, recorded in UTM (NAD 83 coordinate system, zone 18) and their dimensions in meters. Measurements were taken of their presumed length and beam, (width), no matter the orientation of the target. Any characteristic observations were made (e.g. "transom [or flat] stern," "canal barge," "sloop" or simply "wreck"). The inventory was kept on Microsoft Excel spreadsheets.

Once all the targets were inventoried, the next step was to review the local history records, starting with "The New York State Shipwreck Report" (2003), which were compiled by Mark Peckham of OPRHP. Some other resources besides the New York State Shipwreck Report were "Harper's Weekly" and "The Sloops of the Hudson" by William E. Verplanck and Moses W. Collyer (1908). High profile accidents on the Hudson were headline grabbers and well documented. Figure 5 show the top half of the front cover of "Harpers Weekly" from June 25, 1864 illustrating the fire and wreck of the steamship *Berkshire* near Poughkeepsie. The goal was to match up wreck sites from the local historical record to the inventoried locations of acoustic targets.