THE American Surveyor

A FOOT IN THE PAST... AN EYE TO THE FUTURE

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National Treasures

Along Came a Spider

From crosshairs to clothing—a fascinating look at the versatility of spider silk.

Emergency Management

Streamlined data delivery for first responders is put to the test.

New Instrument Technology

A centuries-old problem for surveyors is solved.

Surveying California

Smoothing boundary "wrinkles" in the Golden State is no small challenge for today's California surveyors.

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Mapping the

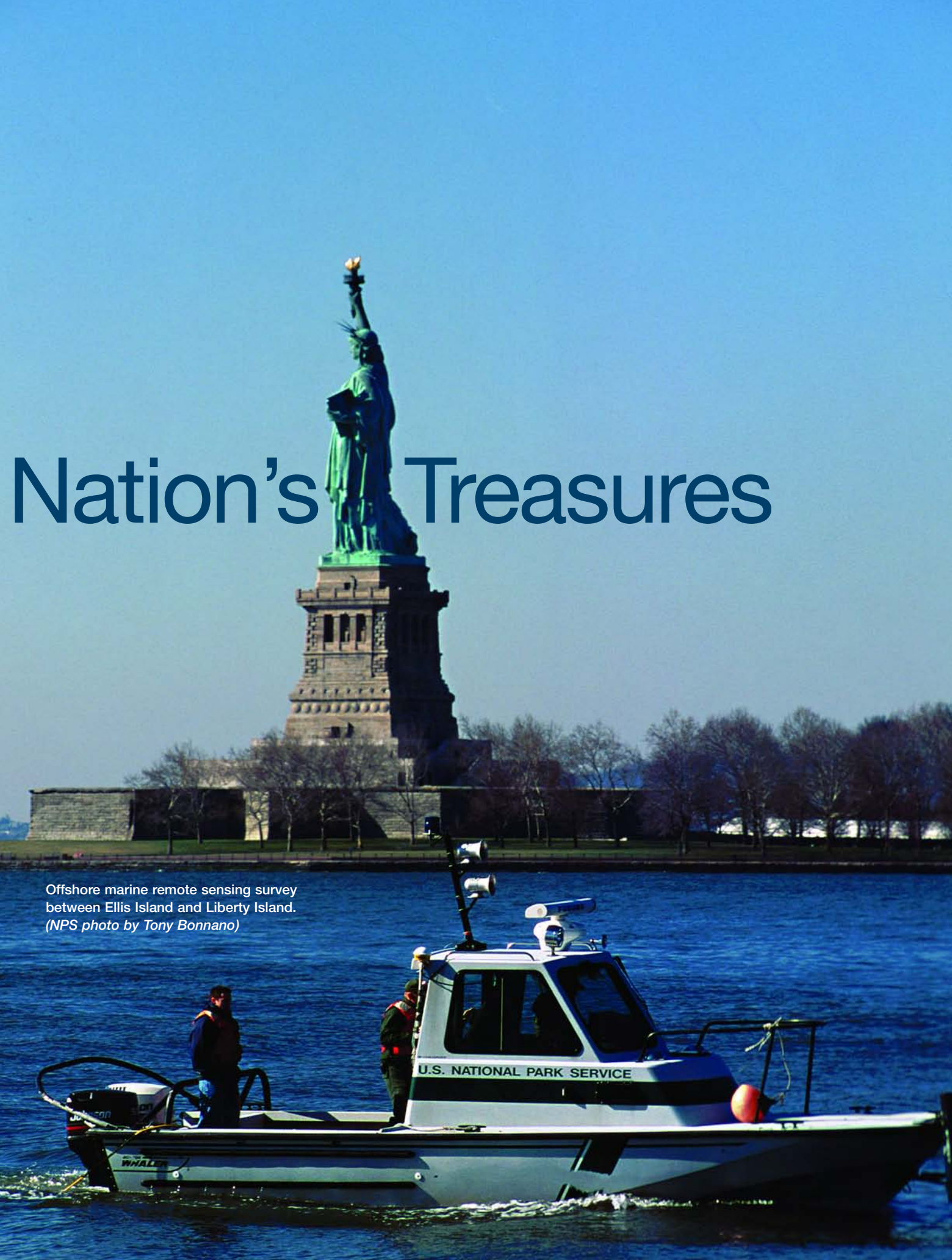
>> By Tim Smith, Dave Conlin and Art Ireland, National Park Service

There are few icons in the world that represent such a migration of human beings as Ellis Island does for the United States. For almost sixty years, Ellis Island represented the beginning of a new life, hope and a bright future for their children to those who hungered for freedom. Ellis Island is representative of what was envisioned by the Founding Fathers for their new country, the United States of America.

In 2002, the Submerged Resources Center (SRC) of the National Park Service (NPS) began a survey project to help with a stabilization project for Ellis Island. The project included an archeological survey of the immigration ferry, a seawall condition assessment, a hydrographic survey of surrounding waters and production of geographic data for the park's Geographic Information System (GIS).

As immigration to the United States boomed during the end of the 19th and beginning of the 20th century, the country was forced to develop infrastructure to usher the flood of humanity through the portals of Ellis Island. Part of that infrastructure was the double-ended steam ferryboat *Ellis Island*. For fifty years, from May 1904 until November 1954, *Ellis Island* carried more than 12,000,000 immigrants on the final leg of their journey to a new home in America, logging an estimated nine million miles during daily trips between the Ellis Island Immigration Station and Manhattan Island. The ferry *Ellis Island* was the last taste of immigration bureaucracy that the freshly minted citizens of America had before starting new lives in a new world.

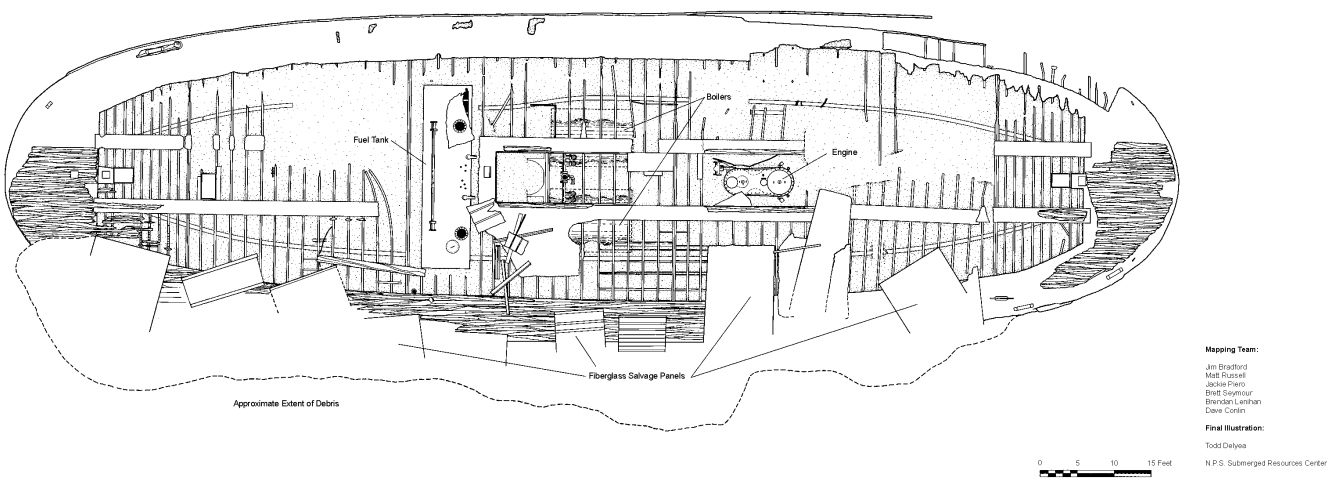
Nation's Treasures



Offshore marine remote sensing survey between Ellis Island and Liberty Island. *(NPS photo by Tony Bonnano)*

Ferryboat *Ellis Island*

Condition as of July 2002



Final plan of Ferry *Ellis Island*

When the immigration station closed in 1954, the ferry, like the rest of the island, fell into ruin and disrepair. In 1962, when NPS took over administering Ellis Island, the ferry was still tied up at the dock, slowly rusting into New York Harbor. In August 1968, after sitting at the dock for 16 years, *Ellis Island* sank in its present position at the head of the Ellis Island ferry slip. At the time NPS did not have the funds available to refloat or restore the ferry. Over the years pieces of this once-proud vessel were carried away by decay, storms and unsuccessful salvage attempts until only the lower hull remained. When the northern half of Ellis Island was restored in the late 1980's, the ferry, as well as the south side of the island, remained untouched. With the opening of the Ellis Island Museum in 1990 came new demands on the infrastructure and resources of the park. Silting, a perennial problem in the ferry slip, accumulated to the point that the Circle Line ferries carrying visitors to the park were having difficulty getting in and out. Dredging operations scheduled for 2002 to remove accumulated silt in the slip posed a potential threat to the sunken vessel and prompted Park Superintendent Diane Dayson to request the services of underwater archeologists and survey specialists from SRC.

Ellis Island has a conveniently located National Geodetic Survey (NGS) first-

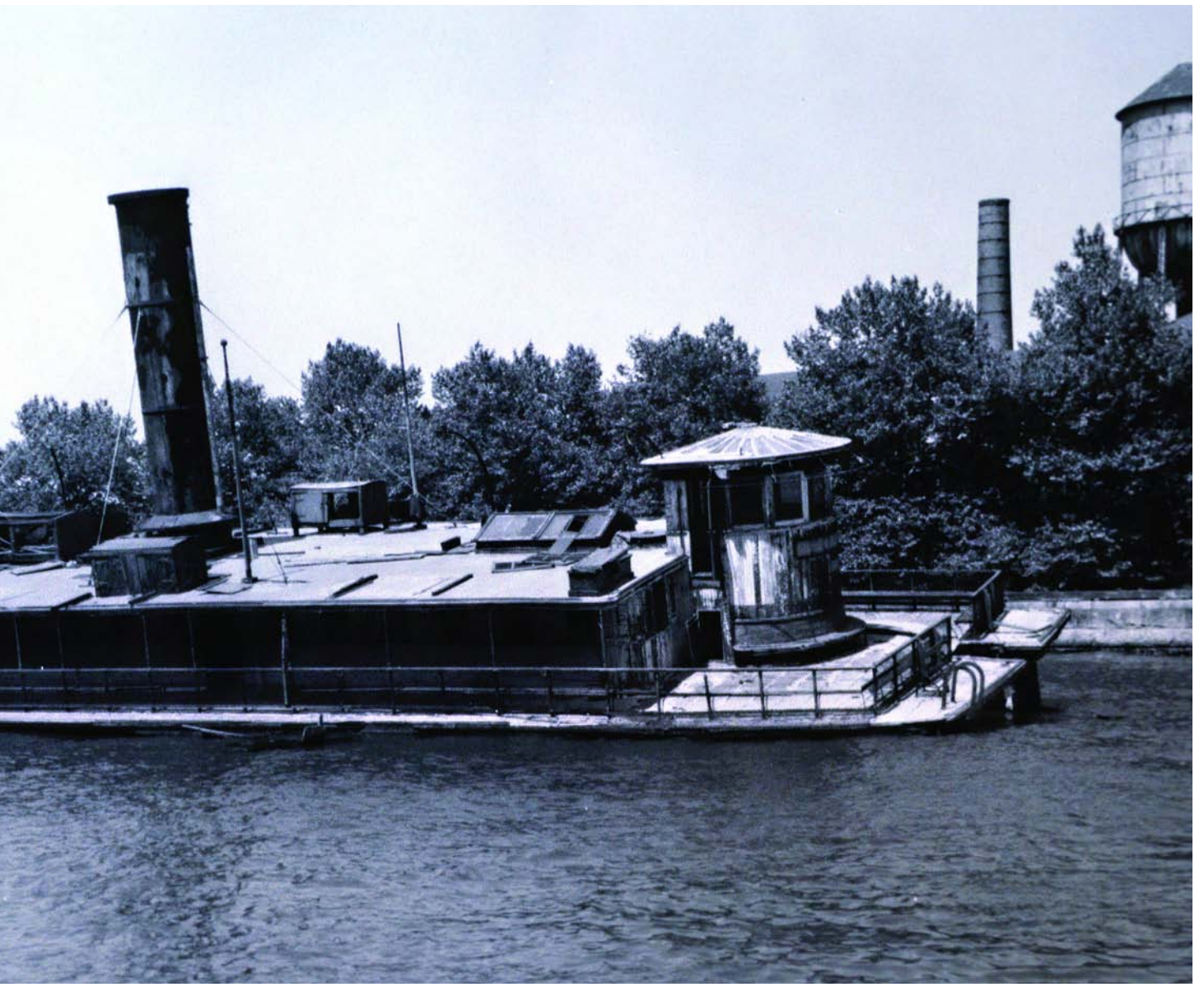
SRC Team member Brendan Lenihan and SRC Photographer Brett Seymour document the remains of the ferry at low tide. *(NPS photo by Tony Bonnano)*

order, horizontal control monument on it. Originally set in 1991 by the Army Corps of Engineers, the monument (*Ellis*) is located on the east side of the island, near the flagpole in wide-open sky with a beautiful view of lower Manhattan Island across the Hudson River. *Ellis* was used to establish control positions for conducting a conventional survey of the immigration ferry wreck, *Ellis Island*. The GPS control survey was conducted to optimize conventional survey operations during the SRC ferry survey operations. Control points 1, 2, 3 and 4 were laid out. In 2002, NPS was using single-frequency geodetic GPS equipment from Trimble. The Trimble equipment has been used by the NPS for many successful cultural and natural resource control survey operations over the last fifteen years. This project would prove to be the same. Once the control points were laid out around the ferry slip, a conventional total station was used for continuing survey operations on the ferry itself. What this provided was a map of the ferry remains in "real-world" coordinates for incorporating in the park's GIS.

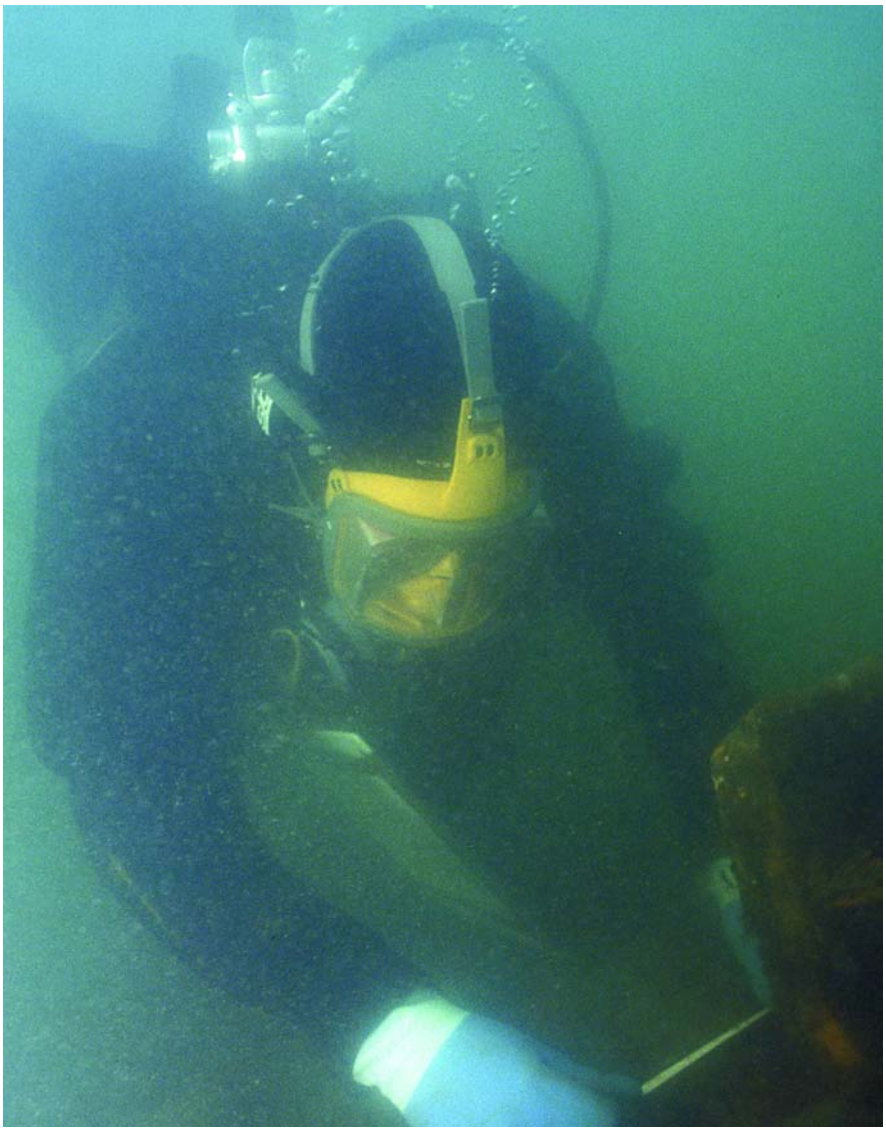
As part of the SRC survey and mapping operations, the control points (1, 2, 3, 4 and *Ellis* NGS monument location), seawall mapping, and various other spatial information documents were used to geographically rectify previous survey maps, historic maps, aerial imagery and as-builts (buildings, infrastructure, etc.), so that they would all be in a common "real-world" coordinate system. This approach resulted in an electronic GIS product that can be combined with project-specific results and analytically manipulated to examine relationships that would otherwise be extremely difficult to observe. The Ellis Island project GIS data set was generated to provide a standardized, permanent, cumulative, computer-accessible database for multiple applications by managers involved in project planning and future assessments. This approach also provides a comprehensive reference against which future changes can be measured such as building and seawall restoration.

Seawall and Hydrographic Surveys

The goal of the Ellis Island project was to document and prevent any potential adverse effect dredging operations might



Ferry Ellis Island shortly after sinking in 1968. *(NPS photo)*



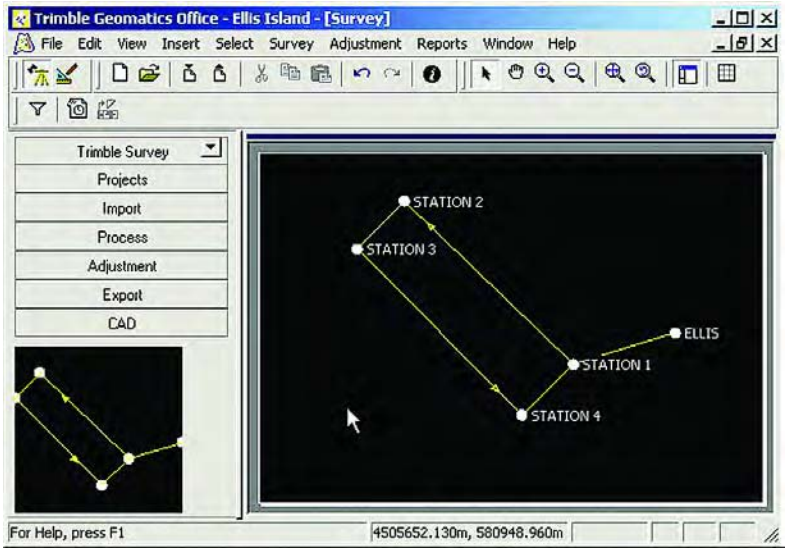
have on cultural resources (including the sunken ferry) in the ferry slip. Attaining this goal required a fully rigged, marine survey vessel incorporating magnetometry, side scan sonar, sub-bottom profiler and precision bathymetry. The vessel was also used to survey all of the waters surrounding Ellis Island, those surrounding Liberty Island as well as portions of Gateway National Recreation Area, specifically Millers Field and Sandy Hook. The instruments were used to locate any underwater cultural material, such as shipwrecks, old barges or even trash piles, that had lay on the bottom around the island. If cultural materials were located in the potential area of effect for dredging operations, they would be removed after documentation. Cultural materials located outside the potential area of effect were included in the GIS database but not investigated. Overall the marine survey helped NPS gain a broader understanding of the geological and cultural environment around the island.

Beyond the marine survey, the team used the survey assets to document the condition of the seawall surrounding Ellis Island. Utilizing a Trimble XR real-time, differential GPS system integrated with GPS Photolink software, the team also documented the decaying dock structures that were once an integral part of the ferry operation.

The principal focus of the project, the *Ellis Island* ferry, was documented by hand using the as-built plans and noting changes to the remaining structure. Once an archeological site plan had been created, real-world positioning information was obtained by angle and distance measurements from the previously established control points on the island. For the offshore marine survey, the NPS team used a Geometrics G-881 cesium marine magnetometer, which acts as an underwater metal detector; two Marine Sonics side scan sonar sensors, operating at 600 and 1200 kHz respectively, to acoustically scan for materials protruding from the sea floor; an EdgeTech SB-424 sub-bottom profiler to acoustically inves-

Top: NPS Archeologist Jim Bradford mapping remains of the sunken ferry. *(NPS photo by Brett Seymour)*

Bottom: NPS GPS Coordinator, Tim Smith using a 3D Marketing's, realtime differential, backpack system with ESRI's ArcPad. *(NPS photo by Tony Bonnano)*



Screen capture from Trimble's Geomatics Office during post-processing of control survey data.

Trimble 4000SE single frequency geodetic receiver. *(NPS photo by Tony Bonnano)*

tigate the sediment layers on the sea floor, and a Navitronics Navisound 50 echo sounder to record precision bathymetric data. Positioning of the vessel was provided by a Trimble AG132 real-time differential GPS receiver. Data were collected on a Cyber Research NBG 311 ruggedized laptop computer running Coastal Oceanographic's Hypack Max software. Side scan sonar data were collected on a Marine Sonics Sea Scan PC system utilizing Marine Sonics proprietary software, with positions supplied by the AG132. Sub-bottom data were recorded on a Triton Elic Delph Seismic acquisition system in SEG-Y integer Motorola format on a separate computer, also supplied with the same real-time positioning information.

For both external and in-water assessment of the seawall, the SRC team utilized differential GPS positioning. The U.S. Coast Guard differential broadcast beacon at Sandy Hook, New Jersey, supplied real-time differential corrections.

The in-water and underwater portions of the Ellis Island Seawall Survey relied exclusively on GPS Photolink software developed by Geospatial Experts LLC of Fort Collins, Colorado. GIS Photolink software linked GPS positions from the differentially corrected GPS receiver to digital images taken with a Nikon Coolpix 995 digital still camera. An initial digital image of the GPS receiver was taken at the beginning of each recording session and then the internal time from the digital camera synched with the time displayed on the GPS receiver. By matching the time of the image with the time and location of the GPS unit, a real-world position for each digital image can be determined. These images were then imported as hotlinks using the supplied GPS Photolink ArcView extension into the cumulative Ellis Island ArcView GIS database.

One mapping team member walked along the seawall carrying the GPS unit, while two other members dove with the digital camera. Communication between the divers and the surface was via Ocean Technology System full-face communication dive masks and a wireless through-water communication transducer. As divers located problem areas on the seawall, they took a digital still image of the area and then described the type of problem to the team member on the surface who recorded comments and position information on a form developed for the assessment. Later, these comments were added to the digital image as annotations on the image and imported into the ArcView database.

Due to the extremely poor visibility (6-12 inches typically) most of the digital images were only useful for their locational information and the annotations that were imported into the GIS database. Digital images taken on the surface and during documentation of the above-water damage to the seawall were more able to take full advantage of the capabilities of the software.

Keeping the Balance

As of February 2005 the ferry slip has been successfully dredged, the seawall assessed and recommendations made for rehabilitation, the now dilapidated ferry dock recorded and the ferry documented to nationally recognized standards. With the current multi-million dollar restoration of the southern half of Ellis Island underway, the future of the once-proud ferry is a topic of discussion for NPS managers. As visitors increase at Ellis Island, so too will the ferries carrying them. Some difficult decisions will be made balancing the NPS's dual mandates of preserving historical and natural resources unimpaired for future generations and providing for public access and enjoyment of these resources. The ferry may be removed or left in place. Whatever the final decision, precision surveying of the ferry and its associated structures will ensure that managers have the best possible information available to make their decisions.

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