

**UNDERSEA DRONES: EXPLORATIONS OF THE S.S. TAHOE (1896-1940)
BY MINI-ROV WITH CITIZEN SCIENCE, ENGINEERING AND ARCHAEOLOGY**

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In June 2016 the authors participated in an expedition by OpenROV to test their mini-Remotely Operated Vehicle (ROV) in Lake Tahoe at extreme depth and to capture images of the S.S. Tahoe in her resting place at 350-475 feet beneath the surface. The project was carried out by a multi-disciplinary team, including an online community, using a vehicle modified for deeper dive operations. The mini-ROV (or drone) is emerging as a popular vehicle worldwide for underwater exploration.

The authors were invited to participate along with National Oceanic and Atmospheric Administration (NOAA) personnel to assist and learn from the engineers, software developers and explorers making up the team. This paper presents a brief history of Lake Tahoe steamers, including the S.S. Tahoe, a summary of the ROV technology employed, and lessons learned from the experience. It also presents some thoughts on the use of “Citizen Science” in the employ of archaeology and applied submerged resource management.

EARLY STEAMERS OF LAKE TAHOE

The shores of Lake Tahoe had proven an early attraction to people flocking to Nevada and California in the nineteenth century. The timber requirements of the Comstock mines led to massive logging in the region and the need to move logs, people, and supplies around the lake. Roads were scarce at the time, but Duane L. Bliss, a lumber magnate who owned more than 50,000 acres in the Tahoe Basin, recognized the advantage in applying steam technology to commercial vessels on Lake Tahoe. Between 1865 and 1900, at least a dozen commercial steamers plied the waters of Lake Tahoe. Notable early steam vessels included the *Governor Blaisdel*, the *Emerald*, the *Governor Stanford*, the *Meteor*, the *Nevada*, and the *Tahoe* (Figure 1).

S.S. Governor Blaisdel

In the spring of 1864 the first steam-powered vessel was launched on Lake Tahoe. The *Governor Blaisdel* was named after Nevada's first governor, H. G. Blaisdel, but was spelled incorrectly. The 42-foot-long side-wheeler was hand-built by Captain Augustus W. Pray, an early pioneer in the basin who settled in Glenbrook, Nevada, in 1863. Pray, an experienced seaman who had sailed the coasts of both the Atlantic and the Pacific, used his own equipment to mill the lumber necessary to construct the hull and engine house (McLaughlin 2015a). The boiler hardware, firebox, and steam engine were acquired in San Francisco and transported from there to Placerville, then over Echo Summit, and on to Glenbrook, in Washoe wagons (Landauer 1996). After its launch, parties were held around the lake celebrating the opening of steam navigation on Lake Tahoe. Although she was criticized for being short, squat, and slow, the *Governor Blaisdel* was the first steam vessel in the world operating in a fresh-water, high altitude lake (*Nevada State Register* 1864). After 13 years of operation, her boiler ruptured and she was beached on the south shore of Glenbrook Bay where freezing winter temperatures and waves broke her hull apart.

S.S. Emerald

The first steamer launched at Tahoe City was the *Emerald*, which fired its boilers and began service in July 1870 (McLaughlin 2015b). At 92 feet long, it was more than twice as long as the *Governor Blaisdel* and at full steam reached 12 mph. Unlike the *Governor Blaisdel*, which was locally



Figure 1. The S.S. Governor Stanford – a sidewheel steamer – was the first commercial vessel on Lake Tahoe built for the tourist trade. She was launched in 1872. Courtesy University of Nevada Reno Library.

constructed, the *Emerald* was fabricated at a San Francisco ship building plant. The steamship was loaded onto Central Pacific Railroad (CPRR) flatcars and delivered to Truckee on the recently completed transcontinental railroad. From there it took 12 burly oxen six days to haul the empty hull and superstructure to Tahoe City. The engines and other operating machinery were carried in separate freight wagons. The *Emerald* was the first of many boats on the lake to be fitted with an underwater propeller instead of external paddle wheels. She worked around the lake for the next 11 years but was decommissioned in 1881 (Landauer 1996).

S.S. Governor Stanford

The 100-foot steamship *Governor Stanford* was launched in 1872. It was a sidewheeler that carried up to 100 passengers. This was the first vessel built exclusively for tourist transportation. She boasted an extensive upper deck for sightseeing (McLaughlin 2015a). Similar to the *Emerald*, the *Governor Stanford* only lasted about a decade before harsh weather conditions took their toll on the vessel and she was retired in 1882.

S.S. Meteor

Duane L. Bliss had the *Meteor* built in Wilmington, Delaware and transported to Tahoe by railroad and wagon to Glenbrook, Nevada, where she was launched on August 27, 1876. The 80-foot-long vessel was the first iron-hulled ship on the lake, reaching a speed of 19.5 knots on her trial run on Sept. 15, 1876 (Hill 2016). In her day, she was the fastest inland steamer in the world and the fastest boat on the Pacific Coast (Landauer 1996). The *Meteor* towed thousands of log booms from areas around Lake Tahoe to Glenbrook for the mines of Virginia City between 1876 and 1896. Afterwards, she became a passenger ship and mail carrier. The cost of operating steamers eventually became economically infeasible and iron was not easily to recycle, so after more than 60 years of service, the *Meteor* was towed halfway between Tahoe City and Glenbrook and deliberately sunk on April 21, 1939.

S.S. Nevada

Originally named *Tallac*, the 60' *Nevada* was a steel-hulled steamship launched in 1890. The 40-passenger luxury vessel was finished with rare woods, silk brocade and mahogany trim on the superstructure, and was fitted with white scalloped decorations that hung from the deck canopy (Landauer 1996). Fire later gutted the *Tallac* and she was rebuilt with an additional 25 feet of length and renamed the *Nevada* in 1892. *S.S. Nevada* carried the mail for 35 years before being dry-docked in Tahoe City in 1938. In October 1940, the Bliss family had her towed to the center of the lake, drenched with gasoline, and burned (Hill 2015).

S.S. Tahoe

The Steamer *Tahoe* was the “Queen of the Lake” and, more than any other vessel, came to epitomize luxurious travel on Lake Tahoe (Figure 2). She was the vision of D. L. Bliss, who saw the need to shift the region’s economy from logging and mining to tourism. The *S.S. Tahoe* was built by the Union Iron Works in San Francisco in 1894, disassembled, hauled over the Sierra by rail and wagon team, and refitted in Glenbrook. On June 24, 1896 she was launched with great fanfare--the largest vessel ever to ply Sierra waters (Renda 2015) (Figure 3). The *S.S. Tahoe* was 169 feet in length, with a beam of 17 feet, 10 inches – long and graceful in profile. She featured a straight stem and elliptical stern with a total displacement of 154 tons. She was also fast, being propelled by two wood-fired engines producing 1200 HP and burning 4½ cords of wood per day. Later upgrades converted her to a more efficient oil burner. Her massive 3-bladed bronze propellers on either side of her substantial rudder gave her a speed of 18½ knots. The *Tahoe’s* 200 passengers enjoyed luxury on the lake with mahogany finish work, electric lights and bells, steam heat, and marble fixtures in the lavatories. She featured a dining room that could seat 30 and a gentleman’s smoking lounge (Renda 2015).

Beginning in 1901, the ship operated daily in the summer from the Tahoe Tavern railroad pier in Tahoe City (Figure 4) in a counter-clockwise direction, visiting shoreline communities and carrying passengers, freight, and mail. She departed in early morning and arrived back at Tahoe City in late afternoon. The *S.S. Tahoe* served with great distinction for 40 years until the Great Depression slowed commercial activity (Figure 5). Business began to suffer when a road was completed around the lake in 1924, and a decade later she lost the lucrative federal mail contract and was laid up at her mooring in Tahoe City. The Queen of the Lake fell into disrepair.

THE QUEEN’S SCUTTLING

Instead of having her broken for scrap, the Bliss family decided to give the Queen a proper burial. On August 29, 1940 she was towed across the lake by the motor vessel *Quit-Cha-Kiddin’*. The plan was for her to be put to rest at a depth of 100 feet off Glenbrook, where visitors in a glass-bottom boat could see her from the surface. The Queen would forever reign and serve as a memorial to the bygone era of luxurious steam transportation and recreation on the lake.

It wasn’t to be. The Queen had other plans. Perhaps she decided to glide to deeper water; perhaps it was a depth miscalculation. The steamer left the airy world and impacted the soft lake bottom on a 30-degree slope of the Glenbrook Canyon shelf, sliding down into the depths. A trench marks her passage. She rests upright with her bow in 380 feet of water and her stern almost 500 feet deep. According to some, the Queen sent a final message as her flag “Tahoe” washed up near the Glenbrook pier the day after her sinking (Scott 1957).

GRAPPLING HOOKS AND TECH DIVES

The Queen of the Lake was gone but not forgotten. She rested for some three decades before a salvage attempt was made to snag pieces of the vessel with a grappling hook. This tore off some railing



Figure 2. The S.S. Tahoe reigned as Queen of the Lake from her launch in 1896 until her scuttling in 1940. She is shown here in service off Tahoma. Courtesy University of Nevada Reno Library.



Figure 3. Preparing to launch the Steamer Tahoe. She was built at the Union Iron Works, disassembled, shipped to Glenbrook, Nevada, reassembled and launched on June 24, 1896. National Park Service photo.



Figure 4. Lake Tahoe visitors could arrive at the Tahoe City wharf and transfer to the S.S. Tahoe for passage around the lake. The steamer made a daily counter-clockwise circuit delivering cargo, passengers and the mail. National Park Service photo.



Figure 5. The S.S. Tahoe was the largest and most comfortable passenger vessel ever to ply Sierran waters. National Park Service photo.

pieces and deck cover planks, but no serious damage was done. There was talk of raising the Queen, but no serious effort resulted.

In 1999, Martin McClellan established the nonprofit New Millennium Dive Expeditions and began raising funds to test their computer theory models related to decompression diving at altitude (6225 feet amsl) and to obtain the first imagery of the *S.S. Tahoe* wreckage. After three years of planning and fundraising, McClellan and colleague Brian Morris conducted four dives to photo-document the vessel, 60 years after it was scuttled (Renda 2015). They credited the work of Dr. Mitch Markun, who pinpointed the location of the shipwreck and worked on their behalf with the Nevada SHPO.

In 2002, the *S.S. Tahoe* became Nevada's first submerged site listed on the National Register of Historic Places (McClellan and Bedeau 2002). She is an essential touchstone of *Tahoe's* collective identity and a treasured piece of the lake's history.

OPENROV DIVE TO THE WRECK

In 2016 OpenROV, a company founded by David Lang and Eric Stackpole, decided to test the latest version of their Remotely Operated Vehicle to capture high-resolution imagery of the *S.S. Tahoe* and surrounding site. They designed their efforts with attention to the telepresence model that *E/V Nautilus*, NOAA Ship *Okeanos Explorer*, and other ships use to engage on-shore science parties and the public during expeditions. They streamed the expedition live, captured high-resolution video, and engaged virtual citizen-explorers online to demonstrate best practices for citizen exploration (Figure 6).

The authors were there to identify elements of the wreck, document its condition, and answer questions from the online community. Jaffke and Foster later used the high-resolution video to prepare a supplemental site record.

A “command center” was set up at a house on shore to observe and guide dives, while a crew of two navigated to the wreck dive site and managed deployment of the ROV. They outfitted a small inflatable boat with long-range communication equipment, an ultra-short baseline acoustic positioning system, and a low-cost dynamic positioning system. The purpose for building this system was to demonstrate that many of the capabilities one might think would require a large research vessel could actually be achieved with off-the-shelf parts that are more portable and much less expensive.

The *Tahoe* is in remarkable condition, despite a few bumps and bruises (Figure 7). The vessel tilts only slightly to its port side. The rudder is bent at 90 degrees. The aft air funnels and boiler stack are warped from the impact. The roof, cabin, and pilothouse were dislodged from the vessel and remain in ruins where the vessel struck bottom at the 335-foot depth. The National Register nomination from 2012 reported that that the portholes were removed, but we confirmed that a few still remain in place. The upper deck area aft of the amidships engine compartment was damaged by grappling hook salvage. Debris now sits on both sides of the bow. The rear deck railing and decking are intact. Aside from the relatively minor damage, the Queen of the Lake is in fantastic condition (Figure 8).

TAKE AWAYS FROM UNDERSEA DRONES AND CITIZEN SCIENCE

Traditional undersea research is hugely expensive and involves highly technical ROVs deployed from commercial ships. With an off-the-shelf vehicle the size of a loaf of bread, the mini-ROV proved it could navigate to a depth of almost 500 feet, capture high-resolution video, and engage a citizen community. The deployed OpenROV vehicle can be assembled for about \$1,500, and the new version, “Trident,” has expanded capabilities for exploration and documentation. Undersea drones are also being produced by several other companies, and are being put in the hands of users to explore the underwater realm. As their design and capacities are tested, we can expect improved performance. The noted advantages for Underwater Park Management include:



Figure 6. An open hatch cover invites exploration. A mini-ROV designed by OpenROV made a successful descent to the S.S. Tahoe on June 7, 2016. OpenROV photo.



Figure 7. The S.S. Tahoe is in excellent condition after submergence for 76 years. The mini-ROV has great potential for application in undersea exploration, "Citizen Science," and resource management. OpenROV photo.



Figure 8. The graceful stern of the S.S. Tahoe looms in the darkness. The steamer rests at a depth of almost 500 feet. OpenROV photo.

1. Underwater drones can go deep, stay a long time, and capture quality video;
2. Underwater drones are excellent at running transects or descending to a given target;
3. The underwater ROV community seems willing to assist in exploration, environmental monitoring, and interpretation;
4. With proper guidance and shared best practices, this technology could enable citizens to contribute to park management; and
5. Underwater drone use is non-destructive and non-consumptive. Drones don't replace divers but could extend their reach.

As presently configured, the OpenROV vehicle is affordable, easy to operate, and particularly useful for exploration. The camera is forward-looking and fixed. There is no manipulator for sample grabbing, but scaling lasers allow useful measurements to be made. The drone glides through the water on a very light tether. Still images can be captured from the video, but more precise photo-documentation using photogrammetry, for example, has yet to be demonstrated. Also, this test was performed in Lake Tahoe. Open ocean conditions will likely demonstrate other limitations.

The potential advantages for involving citizen-scientists in the exploration and management of underwater resources are real. People are going to continue to explore our parks and public spaces, as they do already with geocaching and aerial drone use. It seems obvious that engaging them and inviting their contributions would be beneficial to all involved. The shared goals of knowing more about the underwater world and protecting the resources that exist there should enable the public to participate in exploration and resource documentation in a positive way. Through that experience we can expect to further a sense of stewardship and appreciation for our cultural resources. A needed step is the development of a best-practices model to guide these collaborative efforts in the future.

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