USING TECHNOLOGY TO INTERACT WITH THE NATURAL ENVIRONMENT: PART II

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Abstract.—In 2005, the underwater remotely operated vehicle (ROV) was introduced at the Northeastern Recreation Research Symposium as a tool for connecting people with the natural environment. During 2004 and 2005, we used the ROV to support research and involve the public in educational programs, thereby fostering a greater understanding of our underwater resources of Lake Superior and other Great Lakes and, potentially, strengthening the connection visitors felt toward these places. In this management session, opportunities for using the ROV for public monitoring of invasive species and for remote marine observation were explored in depth. Challenges encountered, such as light and power limitations, entanglement, expense, and operator requirements were also part of this discussion. Prior to the session, conference attendees used the ROV in Lake George. Feedback confirmed the ease of using the ROV and gave attendees the opportunity to observe and negotiate challenges discussed in the management session.

1.0 INTRODUCTION

This management session addressed the issues regarding using an underwater remotely operated vehicle (ROV) to explore marine environments, monitor underwater habitats, and educate people regarding aquatic ecosystems. Two issues that emphasize the importance of this topic are the role that education has traditionally played in natural resource management and the increased prevalence of technology in the United States.

Natural resource education has played an important role in supporting management objectives of public land managers (Jensen & Guthrie 2006). From the beginning, organizations such as the National Park Service and U.S. Forest Service have used public education in the process of gaining the support needed to maintain those organizations. Sharing of information by writers (e.g., John Muir and Anne LaBastille), painters (e.g., Thomas Church), poets, and photographers (e.g., Ansel Adams) played a significant role in the creation and protection of public lands throughout the United States. Early managers such as Stephen Mather further strengthened the beginning educational efforts that are represented in today's parks by supporting the development of on-site museums, public displays, and ranger presentations.

More recently, natural resource education is being influenced by technology. The widespread use of technology and multitude of technological advances (e.g., GPS units, waterproof materials, lightweight metals, computers, and Internet access) has changed and impacted the way Americans view much of their lives as well as their relationship with nature. These changes can have a long-term impact on the way people view public lands and the way they are managed.

This session examined, in-depth, how a remotely operated vehicle, a relatively recent type of technology, can be used to help the public understand their underwater natural resources. Many public land areas have resources within them that are located underwater, and rarely does the public explore or understand those areas firsthand. Because of the advancement of technology, public land managers have an opportunity, to expose the general public to those underwater resources through educational efforts.

1.1 Underwater Remotely Operated Vehicles

Underwater robots, referred to as ROVs, were used for public program demonstrations in various natural resource areas in the Great Lakes during 2004 and 2005. ROVs are designed in many different sizes, from hand-held to those requiring cranes to move them from ships to marine environments, and accomplish a wide range of missions under water. Generally, ROVs have cameras, navigational motors, and lights, and are controlled

from the surface by a tether which provides power to operate the motors, cameras, and lights. ROVs can be operated from boats or, in some instances, the shore. Often a technician operates the ROV, but in many cases, participants are also allowed to operate the ROV.

1.2 History of Underwater ROV Development

The use of underwater ROVs dates back to approximately 1950, when Jacques Cousteau used an underwater sled with automatic cameras to explore the Atlantic Ocean. While Cousteau found his early ROV demonstrations to be useful, they were not as successful as the manned submersibles used on marine exploration and data-gathering expeditions (Ballard & Hively 2000). As a result of the success of manned submersible, Cousteau continued development of marine environment exploration, but he did not return to unmanned vehicle development.

Following Cousteau's early efforts, an American explorer, Edwin Link, developed an ROV to be used in submarine rescue. This was largely in response to the death of his son in a small submersible and was designed to facilitate the rescue of manned submersibles as well as allow for unmanned marine exploration. That ROV was the forerunner of the ROVs in use today. Interestingly, Link's ROV was ultimately used to explore the shipwreck, *Edmund Fitzgerald*.

People have become familiar with ROVs through the work of Robert Ballard, who is credited with discovering the shipwreck *Titanic*. As part of that exploration, he used the small ROV, *Jason*, to explore the wreck. He then produced and contributed to several films widely available to the public, including *Return to the Titanic* (Ballard 2004). His work facilitated the development of numerous underwater ROV education projects and research programs. His primary program, *The Jason Project*, continues to be a model for education programs using underwater ROVs (The Jason Project 2005). In addition, Ballard's work was instrumental in the use of ROVs to explore deep ocean areas by movie directors such as James Cameron, who increased public awareness of ROVs through popular movies such as *The Titanic* (Cameron 1997) and *Aliens of the Deep* (Cameron & Quale 2005).

2.0 DEMONSTRATION PROJECTS

Six demonstration projects (see Table 1) using a small underwater ROV were conducted during the spring and summer of 2005. For each of these projects, a small (approximately 24" x 18" x 18") ROV was used to facilitate education programs in a number of settings. The ROV was low-impact, able to explore up to 500 feet under water, had two TV cameras, lights, and a small arm, and weighed about 12 pounds. Controlled from the surface via a tether (or cable), it was operated from boats and from shore.

The settings for these demonstration projects varied from the Great Lakes to smaller inland lakes and wetlands. The locations included a marine sanctuary (National Oceanic and Atmospheric Administration Sanctuary at Thunder Bay, Michigan), a U.S. Forest Service site (Clear Lake),

Table 1.—ROV demonstration program descriptions

Program Location	Participants	Program Description
US Forest Service camp at Clear Lake	Junior High students on a multi-day camp experience	The participations operated the ROV in shallow areas of Clear Lake. They received brief instructions in the operations of the ROV and were then encouraged to teach each other. Additional structure was provided by asking participants to look for fish they could identify and to find zebra mussels (an exotic species) in the lake environment.
Indiana Dunes National Lakeshore (participating partner: Grand Valley State University)	K-12 Educators	For this teacher workshop, participants operated the ROV in a wetland located in Indiana Dunes National Lakeshore and then off the Grand Valley State University research boat, WB Jackson, in Lake Michigan. In this workshop, participants were able to observe and explore the underwater resources using the ROV, but a technician operated the vehicle.
Great Lakes on the Pier Wisconsin Tall Ship Denis Sullivan	General Public and K-12 educators	This demonstration involved two programs. The first program involved adults and the general public who were part of a Lake Superior cruise. During the cruise, the ROV was deployed to explore several shipwrecks, the lake bottom, and fish habitats. Participants observed the ROV explorations via video monitor on the ship's deck. The second program involved live TV broadcasts from NOAA's sanctuary at Thunder Bay, MI. Again, the ROV was operated from the ship's deck. The video feed was transmitted to classrooms in Michigan and Wisconsin. In those classrooms, students were able to hear a live explanation by two educators and observe the ROV technician operating the vehicle.
Inland lakes in northern Lower Michigan (participating partner: See-North)	General public – mostly adults	With the cooperation of See-North, small groups of adults were offered the opportunity to explore several small inland lakes in northern Lower Michigan using the ROV. They started exploring in depths of less than 5' and worked, in stages, to depths of up to 100' with an educator interpreting the observations.
NOAA Sanctuary at Thunder Bay (participating partner: Marine Advanced Technology Education - MATE)	Environmental and K-12 educators	For this demonstration, participants were first involved in an ROV building workshop (modeled after the MATE programs) designed to instruct educators in the usefulness of ROVs in the classroom. Participants designed and built ROVs and then operated them in a school pool. Upon completion, they were also able to operate our ROV in a pool.
George Mason University	College students	Undergraduate students operated an ROV in either a pool or small pond at the Prince William campus during which time they observed aquatic environments (in the pond) or negotiated small obstacle courses (in the pool).

a National Park Service unit (Indiana Dunes National Lakeshore), a Tall Ship (Pier Wisconsin) and a university pond (George Mason University). Participants were asked to conduct a variety of tasks during each of the demonstration projects (see Table 1).

3.0 ROV BENEFITS

For each of the demonstration projects, participants identified various benefits. As a research tool, the opportunity for real-time experiential learning was frequently noted. For example, participants in the See-North program were tasked with counting zebra mussels in a defined space. Follow up discussion explored the benefits (e.g., water filtration) and drawbacks (e.g., competition with native species) the introduction of this non-native species has had on the Great Lakes ecosystem.

In exploration situations, participants identified access as a major advantage. The *Denis Sullivan* programs, for instance, primarily involved shipwreck and marine habitat exploration in the Great Lakes at depths of greater than 100 feet. Participants were able to negotiate these situations without diving expertise and without the safety requirements associated with deep water dives.

Another benefit of the ROV was the ability of students to observe from a distance while receiving concurrent interpretation from their instructors, as in the case of the live broadcasts to classrooms in Wisconsin and Michigan from Thunder Bay. Students and instructors alike cited the real-time virtual interaction with the environment as a significant enhancement to their environmental education classes.

3.1 ROV Challenges

In addition to benefits, there were several challenges encountered during the demonstration projects. The most frequently encountered concern was entanglement, particularly when young people were operating the ROV. The horizontal movement of the ROV is operated by a standard joystick, similar to a video game, with circular knobs used to manage vertical movement. Unlike video games, however, the joystick is highly sensitive and even small movements result in quick responses from the ROV. Project participants, particularly younger people, tended to move the joystick in a forceful way, causing the ROV to speed forward, backward, and sideways in fast and jerky movements. The results were frequently an ROV that became quickly entangled in its tether or nearby objects. However, adults were more likely to use tentative movements and learned to operate the ROV at a speed that allowed for more control and extended observation of the underwater surrounds. These behaviors were also observed during the ROV demonstration in Lake George at the Sagamore Resort prior to this management presentation.

Light also presented a limitation to the usefulness of the ROV in settings such as highly silted or deep water. Movement from the ROV, particularly when near the bottom of a water basin, often stirred up any settled materials, which would then obscure the camera's view. Additionally, light filtration decreased as the ROV was sent to deeper locations, and the penetration of the ROVs lights was also reduced. This greatly limited the field of vision during deep dives and contributed to the increased possibility of entanglements with hidden objects.

An obvious limitation of the ROV is the tether, which is an integral component. A 500 foot tether, such as was used in these demonstrations, limited the field of exploration to approximately 450 feet in any direction. As the end of the tether was reached, participants found it difficult to maneuver the ROV. Additionally, the tether was influenced by the water currents. For example, strong currents were able to push the semi-buoyant tether in a direction that, in some cases, was counter to the direction in which participants were trying to send the ROV.

Finally, the most frequent challenge was keeping the ROV operational. Breakdowns that occurred during various demonstration programs were the result of cracked housing, broken wires, and loss of power. Replacement of the tether posed the most problems since it required purchase of a new tether which had to be sent from the ROV producer. Tethers frequently became unusable because they would be bent or strained beyond their design intent (often by users running the ROV at the end of the tether at high speeds) resulting in internal wire breakage. In other cases, the internal wiring of the vehicle became damaged due to excessive high-speed contact with immovable objects. In these instances, the ROV had to be dismantled and rewired, a process taking 4-8 hours. It is worth noting, however, that the ROV used in these demonstrations was particularly robust, and the company producing the ROV was very responsive to repair needs. This greatly facilitated the continued use of the ROV for the demonstration projects.

4.0 CONCLUSION

The use of technologically advanced equipment in natural resource settings is increasing. Whether people go into the environment to use their technology or use their technological equipment to get to the environment (Ewert & Shultis 1999), it is evident that technology influences interaction with these places. An underwater ROV is one technological tool that increases the ability of visitors and managers to interact with aquatic environments, in particular. Using the ROV as a tool for exploration as well as a way to empower individuals through self-exploration of underwater places may facilitate connections between managers and visitors with respect to recreation places. In addition, using the ROV allows visitors to explore environmentally sensitive areas with minimal disturbance.

While underwater ROV challenges such as operator expertise, equipment limitations, and environmental conditions must be negotiated, advantages (e.g., increased access and experiential learning) will continue to influence its use as an exploration and educational tool. The range of applications for managers is not yet completely explored. The ROV has been operated in the shallowest of wetlands to the deepest points in Lake Superior (over 1300 feet deep); it was maneuvered during hot summer days as well as under the ice during the middle of winter. Demonstration project participants from 10 years old to 85 years old have learned to successfully maneuver the ROV in a variety of settings.

Education has always been an important part of a manager's ability to support an organization. Continued efforts by managers to negotiate the challenges and explore the benefits associated with new technology are an integral component of successful public land management. The underwater ROV provides one such opportunity.

5.0 CITATIONS

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