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NOTES ON THE OPERATION OF TWO TYPES OF AQUATIC REMOTELY OPERATED VEHICLES USED DURING A MOCK FRESHWATER TURTLE SURVEY

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ABSTRACT: Aquatic remotely operated vehicles (ROV) show merit in providing *in situ* observations of sea turtles and freshwater turtles. However, turtles must be spotted above the water surface first then an ROV deployed for underwater observation. None have been used as a tool to survey for turtles solely under the water surface without direct observation first. Here we report on observations of two types of aquatic ROV used during a mock turtle survey to determine the potential of freshwater turtles being found under the water surface without being directly observed first and if accurate species identification could be done.

Key Words: ROV, Freshwater turtle

INTRODUCTION

Freshwater turtles play critical roles in their respective environments (Congdon et al. 1986; Mitchell 1988; Shine and Iverson 1995; Ernst and Lovich 2009; Mitchell and Buhlmann 2009; Lovich et al. 2018) and studying them *in situ* can be inherently difficult given their natural history. Most field study methods consist of snorkeling, sounding pole surveys, visual encounter with or without binoculars from a shore or boat, or trapping with baited and un-baited hoop nets or basking traps (MacCulloch and Gordon 1978; Vogt 1980; Sterrett et al. 2010). Traps can be difficult to transport and time consuming to set up and check frequently, with most studies involving several trap days. Observations of aquatic and semi-aquatic turtles *in situ* are often limited to surface activity, such as basking or foraging, making underwater behaviors in an environment largely underrepresented. Recent advancements with aquatic remotely operated vehicle (ROV) technology, also known as aquatic drones, are becoming useful tools in aquatic systems monitoring (Pedrosa de Lima et al. 2020), and show some merit in observing turtle behavior in marine and freshwater studies (Smolowitz et al. 2015; Karcher 2019). In these situations where aquatic ROVs have been used to view turtle behavior, the aquatic ROV was deployed after a turtle was spotted by direct observation from a boat or shore, by an unmanned aerial vehicle (UAV), or by tracking a satellite tag signal. None of these techniques have been used to fully survey for turtles in freshwater environments where individual turtles can remain submerged and initially out of sight of the operator. Presumably, an aquatic ROV used to survey submerged turtles without the surveyor spotting the turtle at the surface first can also allow the operator to find and make accurate species identifications while operating in real time and later during image or video review. Here, we report on observations gained from a mock turtle survey meant to determine if accurate species identifications could be made in freshwater environments under optimal operating conditions for two types of aquatic ROVs.

MATERIALS AND METHODS

Aquatic ROVs: Power Vision Power Ray and Power Vision Power Dolphin (PowerVision Inc., Beijing, China) aquatic ROVs were chosen based on their midlevel price range comparable to other consumer level aquatic ROVs (Figure 1). Both devices required a remote control and either a cell phone or tablet with an installed software program to operate the drone. For this study a Samsung Galaxy A50 cell phone with Android version 11 operating system was used with the Power Dolphin along with the installed software program Vision+2 required for operation. An Apple iPAD mini with iOS 9.3.6 operating system was used along with the installed software Vision+ required for operation with the Power Ray. Communication

Fig. 1. Power Ray and remote control (left) and Power Dolphin and remote control (right).

between the drone, remote control, and digital device occurred through a built in wifi signal.

The Power Ray had the capability to submerge in the water column as well as to propel across the water surface. Two propellers were oriented horizontally in the back for forward, reverse, and pivoting maneuvers. One propeller was situated vertically to allow ascension or descension in the water column. The camera was fixed on the front of the drone, offered a 95° field of view, and had no ability to pan in any direction independently of the ROV body. An external hard drive was attached to a communication cable 50m long that screwed into the top of the drone. During operation the hard drive stayed with the operator, while the cable and ROV were placed in the water.

The Power Dolphin floated on top of the water and was propelled by two rear propellers that were oriented horizontally. The camera was mounted on the front of the ROV with a user-adjustable tilt mechanism that could be oriented up and down for initial positioning, and operated remotely to pan up and down in real time using a remote control independent of the direction the ROV was moving along the surface. Field of view for the camera was 132°. For this study the camera was angled at 45° under the surface.

Study Site: Trials were conducted as transect surveys at Rogers Environmental Education Center in Sherburne, Chenango County, New York in an ~0.5-hectare pond. Submergent aquatic vegetation was nearly absent, and the water column was clear enough to view the bottom of the pond (maximum depth 5 m). Bottom sediments consisted of silt, sand, small boulders, and low growing vegetation. This site was chosen to simulate optimal operating conditions recommended by the manufacturer.

Mock Survey Design: Three turtle shells were submerged in random locations on a transect line 25m long at a depth of 1m and at a distance ~2m from the shoreline. Shells of a Snapping Turtle (*Chelydra serpentina*) 287mm carapace length (CL), Red-eared Slider (*Trachemys scripta elegans*) 208mm CL, and Eastern Musk Turtle (*Sternotherus odoratus*) 88.6mm CL were designated as large, medium, and small-sized turtles, respectively.

Aquatic ROVs were driven along a transect line by five different operators each time recording video and capturing still images. The operator did not know where the turtle shells were placed on the transect line. For video, each operator positioned the ROV at the beginning of the transect and initiated recording before the ROV was driven down the transect line. At the end of the transect line, video recording was turned off. For still images, this procedure was repeated, however, the operator would take a picture for each presumed turtle shell on the screen of the digital receiver device being used. Images and video were later reviewed in the lab for clarity and quality in identifying species of turtle shells.

RESULTS

Both the underwater drone (Power Ray) and surface drone (Power Dolphin) provided clear images and video of the turtle shells along the transect (Figure 2). Identification of species based on the shell could be done in the field in real time with five out of five operators, 100%, visually confirming *C. serpentina* and *T. s. elegans* during their respective trial run, while *S. odoratus* was confirmed by only two of the five operators, 40%. Image and video review in the lab by the operators showed complimentary results to *in situ* observations with 100% of the operators identifying *C. serpentina* and *T. s. elegans* during the first video playback. However, only three out of five operators, 60%, were able to identify *S. odoratus* during the first video playback. Two additional playbacks were needed in order for all operators to identify *S. odoratus*. The difficulty in confirming *S. odoratus* was attributed

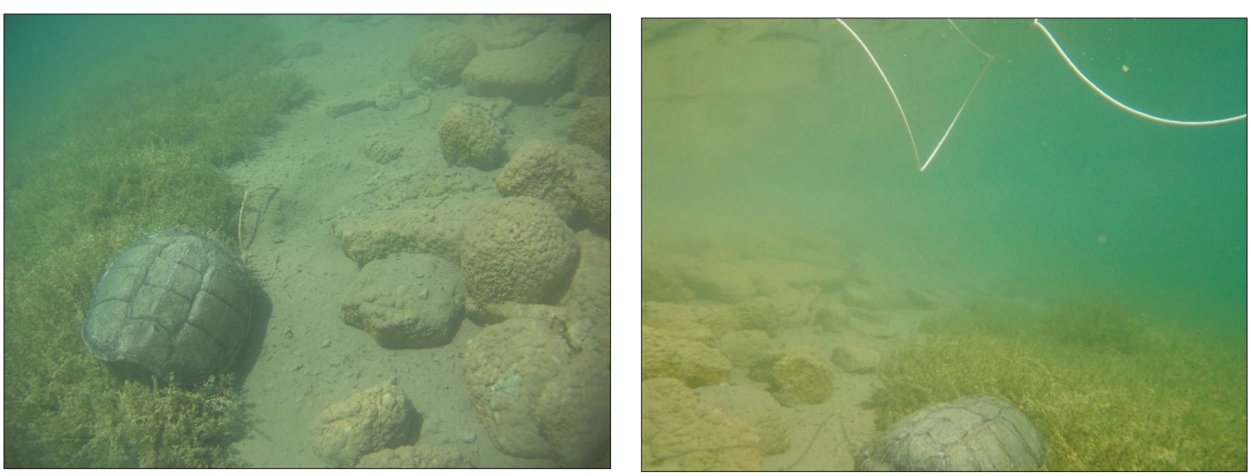

Fig. 2. Images of a Snapping Turtle (*Chelydra serpentina*) shell taken from Power Dolphin surface drone (left) and Power Ray underwater drone (right) during transect surveys while drone was moving over the transect.

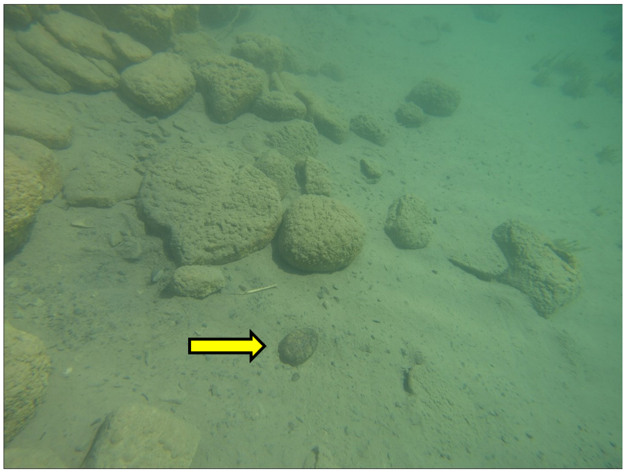

Fig. 3. Image taken from Power Dolphin surface drone showing shell of an Eastern Musk Turtle (*Sternotherus odoratus*)- (arrow).

to its superficial resemblance to rocks on the pond bottom (Figure 3). Viewing still images yielded better results with all five operators able to identify all shells upon first image review in the lab.

DISCUSSION

The objective of this exercise was to determine if aquatic ROVs allowed for accurate species identification without first having spotted the turtle. Testing under optimal conditions yielded accurate species identifications both in the field and in the lab for medium and large sized turtle shells. However, it was noted that small-sized turtles may be harder to spot if they are stationary in the water column. Further testing is also needed to determine if species with similar shell morphologies can be distinguished between one another, something we did not test in this study.

There were some operational difficulties worth noting. For the Power Ray, the operators had difficulty keeping the ROV on a straight path at a constant depth when it was submerged, even with data such as tilt, depth, and yaw displayed on the tablet screen. This difficulty resulted in more difficult image acquisition as the camera on the Power Ray was fixed and offered only a 95^{o} field of view. Therefore, the camera angle and field of view offered to the operator was limited to the direction the operator was driving the ROV. At times, the bottom of the pond could easily drift out of view during operation requiring the operator to drive the ROV very close to the bottom of the pond to view any potential turtle shells on the transect. This also increased the instances of times when large rocks and other obstructions had to be avoided. If the ROV drove too close to the bottom sediment, silt would plume up from the bottom and obscure the camera image temporarily. Although the images and video were clear, it was obvious that organisms on the bottom of the pond were going to be difficult to find. The communication cable of the Power Ray often got caught on itself and vegetation, effectively limiting the range and depth at which the ROV could be used. We found that while using this ROV, a two-person operation was best whereby one person operated the ROV while the other made sure the communication cable remained untangled.

The Power Dolphin, by comparison, was always visible at the surface making driving in a straight line, potential course corrections, and avoiding obstacles very easy. While this ROV could navigate a preprogrammed path, this feature was not used in this exercise due to the inability of the GPS signal to locate the correct area; however, this feature could prove useful in future surveys and should be investigated. The camera could easily be panned up and down remotely from the bank, but this feature was not necessary for this exercise and, therefore, remained fixed. This feature may also be useful in future surveys whereby turtles could be spotted at the surface first then followed, and the camera can be panned down to watch the turtle as it descends through the water column. The 132^{o} field of view of the camera offered a wide view of the submerged environment with resulting images and video very clear, making it easy to spot turtle shells. Video from the video recording surveys appeared fast-moving. This may have been attributed to the speed, depth of shells, and 45^{o} camera angle at which the ROVs was set, thereby requiring video to be reviewed at least twice to determine if a turtle shell was accurately spotted. We did not view video at slower playback speed nor frame-by-frame. Future studies could use these playback features which may help identify turtle shells.

The manufacturer recommends ROVs be used in optimal conditions to function appropriately. Vegetation and other obstructions could get caught in the propellers during surveys, presumably resulting in wasted survey time as the ROV is dislodged from vegetation which could also damage the propellers as well as disrupt turtle behavior. Conditions such as weather, water clarity, visibility, underwater terrain, and flow could make surveys using ROVs challenging for searches where freshwater turtles are not spotted from a bank or boat first. The trials described here were conducted on clear days with no cloud cover, which lead to the sun's glare obstructing underwater views depicted on tablet and cell phone screens. In such instances, having a sun shade surround the screen would have been useful and is highly recommended.

To our knowledge, no published literature exists regarding the potential for using aquatic ROV's to survey turtles under the water surface without first spotting them above the water. Results from this study indicate that with some limitation, aquatic ROVs can be useful tools in finding fresh-water turtles *in situ*. Despite some operational difficulties, aquatic ROVs have the ability to investigate the water column in a unique way. With practice, efficient operators could make accurate species identifications and conduct thorough underwater surveys, thereby in part closing the gap in *in situ* observations of aquatic turtle biology.

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