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Authors: Elsey, Ruth M., and Trosclair, Phillip L.

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The Use of an Unmanned Aerial Vehicle to Locate Alligator Nests

Ruth M. Elsey[1,*] and Phillip L. Trosclair III[1]

Abstract - Coastal marshes of Louisiana provide nesting habitat for *Alligator mississippiensis* (American Alligator). Helicopters are typically used to locate Alligator nests in remote interior marshes. We tested the use of an unmanned aerial vehicle (UAV) to detect Alligator nests on Rockefeller Wildlife Refuge in Grand Chenier, LA. Three brief flights with a combined search time of approximately 25 minutes and 9 seconds were conducted in a single afternoon, covering 28.2 ha. While in the field, we observed 6 Alligator nests with the UAV, and later review of video imagery recorded allowed us to detect an additional 6 Alligator nests. The use of UAVs may be a useful tool for detecting Alligator nests.

Introduction

The use of unmanned aerial vehicles (hereafter UAVs, or drones) has been examined as a practical tool for wildlife management and research in recent years. As early as 2002, preliminary work to examine potential applications of an UAV to assess *Alligator mississippiensis* Daudin (American Alligator, hereafter Alligator) populations was undertaken (H.F. Percival, Florida Cooperative Fish and Wildlife Research Unit, USGS-BRD, and University of Florida, Gainesville, FL, pers. comm.). A more detailed assessment of small UAVs for wildlife research captured imagery of numerous wildlife species, including the Alligator, as well as an Alligator nest (Jones et al. 2006). Other studies using drone technology documented the size of an Alligator without requiring actual capture and handling (Martin et al. 2012, Watts et al. 2010). A recent publication reviewed the evolution and development of the technology of this wildlife tool, and the benefits and drawbacks of the use of drones in wildlife work (Martin 2014); others have summarized some 15 years of applications of drones in wildlife research and management (Burgess et al. 2015, Carthy et al. 2014). Drones have been used as a tool for behavioral research, including a case study that successfully identified 2 *Crocodylus porosus* Schneider (Estuarine Crocodile) nests in 5 flight hours in the Malaysian state of Sabah (Evans et al. 2015).

The state of Louisiana has a large commercial Alligator-farming program, which includes legal collection of wild Alligator eggs (egg "ranching") under permit from nests on privately owned wetlands (Elsey and Kinler 2012). Alligator nests are typically located by helicopter, and less often by ultra-light aircraft. Each summer, biologists in Louisiana's Alligator-management program receive requests from licensed Alligator farmers for the estimated peak of Alligator nesting, to aid in scheduling helicopter flights. It is advantageous for commercial

[1]Louisiana Department of Wildlife and Fisheries, Rockefeller Wildlife Refuge, 5476 Grand Chenier Highway, Grand Chenier, LA 70643. *Corresponding author - relsey@wlf.la.gov.

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egg collectors to work economically and efficiently, by initiating flights to locate nests only after the majority of each season's Alligator nests have been constructed and egg deposition has occurred. This avoids conducting nest flights too early, and thus requiring a second flight over the same wetlands to find later-constructed nests. Helicopter rental can be expensive, at approximately \$300–\$500/hour or more in Louisiana, and possibly higher in other regions. The inherent danger of using airplanes and helicopters for wildlife work has been well documented (Sasse 2003). We initiated this study to determine if drones could be used to detect Alligator nests in coastal marshes.

Methods

We performed the study on the State of Louisiana's Rockefeller Wildlife Refuge in Grand Chenier, LA, on the afternoon of 23 June 2015. The refuge boundaries and predominant vegetation have been described (Selman and Baccigalopi 2012), and this study was conducted in the south Superior System of the refuge, which is known to support dense Alligator nesting (Joanen and McNease 1989). We tested a drone obtained from DronesMadeEasy (DJI Phantom 2 Deluxe Mapping Bundle, GoPro Hero4 Black +1.2W Vtx) and used a LCD screen (FlySight 32 Ch Black Pearl 5.8 Ghz 7" Diversity Monitor) for immediate viewing.

We selected a site on the refuge that had not been surveyed by helicopter for Alligator nests but that we knew from past experience was excellent Alligator-nesting habitat. We launched the drone from an airboat; after a brief period of hovering and the drone was stabilized, we began searching (using manual controls) for Alligator nests using low-level flights within approximate grids, but without set established transect lines nor pre-planned flight paths. Winds were light (estimated at 5–10 knots) from the southeast. This project was not an attempt to get a total nest count/Alligator nest density; it was simply a pilot study to determine if we could visualize Alligator nests using the drone. We quickly ascertained a height of about 8–10 m allowed us a good overview of the marsh; viewing approximately 50 m to each side. Some glare on the LCD screen made field observations imperfect, but we could make some immediate observations.

Results

On the initial flight, we observed 1 Alligator nest and, after landing the drone, we visited the nest site via airboat and confirmed a nest containing Alligator eggs approximately 10–12 days old. As we approached the nest, we observed the female Alligator, which proceeded to actively defend the nest while we opened it to confirm the presence of eggs.

We then travelled ~1045 m southeast for the second test flight. On the second trial flight, we observed some areas of dead vegetation making detection of Alligator nests more challenging, but we did observe what we thought might be an Alligator nest. After visiting the site, we discovered that the Alligator nest was partially constructed but was now inactive and presumed abandoned. While travelling to check the inactive nest, we observed another Alligator nest we had not seen with the drone in the field (but later noted it was visible on video recorded); this nest contained eggs that were 7–8 days old. The female Alligator was present, but not aggressive. We then travelled via airboat some 230 m west for the next test flight. The third flight led to field observations of 4 Alligator nests. Upon verification in the field, we noted that 2 of these contained poorly calcified oviductal contents, 1 nest contained eggs that were estimated to be 8–10 days old, and the final nest contained similarly aged eggs. Since Alligator nests are built gradually over a 2-week period (Joanen 1969), fully completed Alligator nests are larger (and thus would likely be more readily visualized) than nests still under construction. Although females defend their nests infrequently (9.2%; Joanen 1969), it is possible that observing movement or presence of an attending female might also cue observers to a nest that otherwise might be overlooked.

Upon return to the office, we reviewed video footage obtained with the drone and detected several additional Alligator nests (Table 1). Alligator nests were

Table 1. Results of drone testing to detect American Alligator nests. Times noted are in minutes and seconds.

Flight	Total video duration	Nest search time	Battery remaining after flight	Nests seen in field	Additional nests observed after office review	Total nests detected	Approximate hectares searched
1	10:38	8:11	28%	1	2	3	11.5
2	12:14	10:41	26%	1	3	4	11.5
3	8:43	6:17	33%	4	1	5	5.2
Total		25:09		6	6	12	28.2

Figure 1. Aerial view of an Alligator nest from video imagery captured during a drone flight within Rockefeller Wildlife Refuge in Grand Chenier, LA, 23 June 2015.

easily visible at a distance (Fig. 1), and became clearer as the drone was overhead (Fig. 2). In calculating the "search times" for a flight, we defined it as ending when we clearly began a return path towards the airboat in preparation for landing. The first flight began at 13:36 h and we completed the final flight at 14:34 h; active nest-search time was only 25 minutes and 9 seconds, with the remaining time being to "ground-truth" the field observations, changing batteries between flights, photo documentation of nests, and airboat travel between nest sites. We might have been able to conduct longer flights, but were conservative and returned the drone to the airboat with ample battery life remaining (Table 1). Results of quantity of nests observed in the field, additional nests later noted upon video review, and approximate hectares covered in each flight are summarized in Table 1. Incidentally, while using the drone to survey a heron rookery on the refuge in early June, an additional Alligator nest was observed. Also, 2 more Alligator nests were seen during a brief flight conducted near the refuge headquarters a few days after the pilot study flights described above.

Discussion

Our results suggest drones may be useful tools for detecting Alligator nests in coastal marshes. Nests were relatively easy to see while in the field despite glare on the screen and our limited experience with drones. Additional nests were detected after review in an office setting of the recorded video footage. Screen anti-glare devices would likely improve field observations. One of us (P.L. Trosclair) had moderate experience using the drone in the field (15–20 prior flights of short duration), whereas other personnel (R.M. Elsey and a co-worker) could see some of the nests in the field despite no prior experience with the drone. We acknowledge we

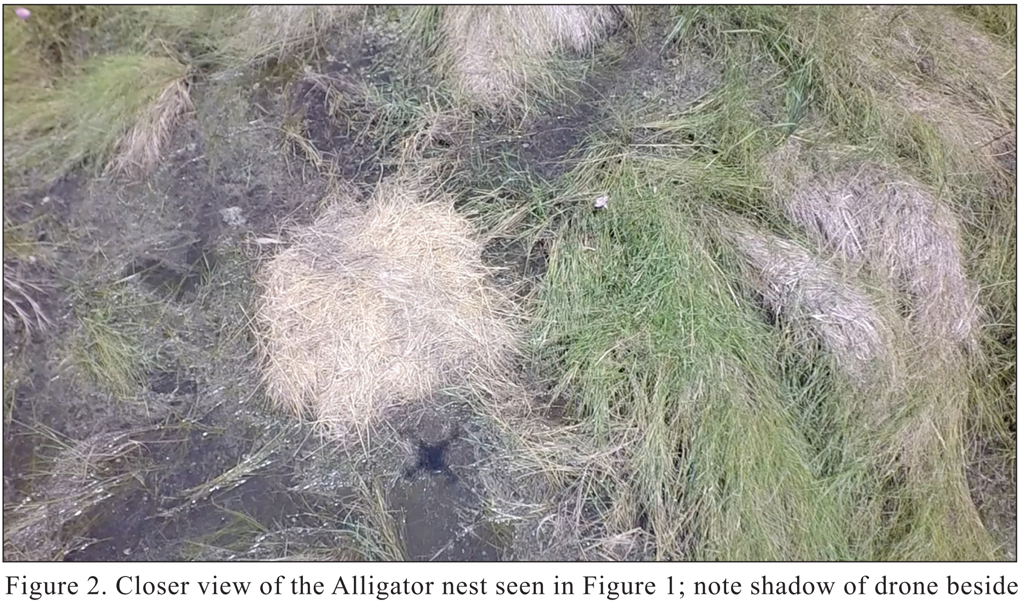

Figure 2. Closer view of the Alligator nest seen in Figure 1; note shadow of drone beside the nest.

did select an area where we anticipated high nest-density from past experience. Excellent habitat conditions and water levels in summer 2015 contributed to high levels of nesting efforts in the region. Also, our extensive prior field experience with Alligator-nesting research enabled us to diligently search habitat areas with landscape features (e.g., remote marsh with small ponds for dens) where we anticipated Alligator nests might occur. Our small sample size in this preliminary study precluded performing estimates of detection probability, which might be an area for future research.

Short flights such as those described herein may provide information to biologists and commercial Alligator egg ranchers as to when they should schedule subsequent helicopter flights to most efficiently fly once the majority of that year's nests appear to be under construction. They can also utilize this information to coordinate timing of egg collections once all eggs have been deposited. Alligators can take up to 20 days to complete their nests (Deitz and Hines 1980). Drones could allow investigators or commercial egg ranchers to estimate the status of nest construction via close low-level observation of the nest size and structure, so as to not schedule collections too early. Drones might allow observers to visualize the high cone (Deitz and Hines 1980) of a completed nest, or even a tail drag left in the mounded vegetation after the female leaves the nest. We do not suggest drones would be used for total nest counts, but rather as a tool to guide timing of scheduling helicopter flights that cover hundreds or thousands of hectares.

Drones may help readily identify nests where a female was seen in nest attendance or still on the nest while the nest was under construction; such information could aid researchers attempting to capture nesting female Alligators for specific reproductive ecology studies (such as Davis et al. 2001). Additionally, tropical storm surges and heavy rainfall can lead to nest losses due to flooding, and drones might help landowners rapidly identify areas where rising water levels might be a concern in order to guide egg collections sooner in areas at risk of flooding. Drones might also be useful in some non-coastal habitats where canopy cover reduces the efficacy of using helicopter flights to detect Alligator nests. The smaller size and agility of drones might make it possible to more effectively search wooded areas. However, challenges might occur for the controller as the drone travels a distance away in heavily forested areas due to interference from trees. Drones might also allow detection of additional nests missed on some properties, due to the advantage of reviewing video footage obtained. Indeed, even experienced observers detected only ~77% of Alligator nests on helicopter surveys in Florida (Rice 1992). However, the use of drones would likely be limited to days with clear weather and calm winds.

There is the potential for nest abandonment if female Alligators are disturbed by checking the nest prior to oviposition (Wilkinson 1983). Our limited data suggested the drone caused little disturbance to the female, as we observed 2 females at nest sites when we "ground-truthed" the nests soon after the drone over-flight. Helicopters can be loud with a decibel level of 100 dB (Purdue University 2015), whereas small, non-military drones are much quieter; however, in either case the actual time spent hovering at any nest site when searching is only a few seconds.

Drone technology is rapidly advancing, and more sophisticated models with geo-referencing and extended range of flights are available. The model we tested was relatively inexpensive ($2799 when obtained in November 2014), and numerous field applications would soon make this cost efficient, considering the costs for helicopter rental to locate Alligator nests as noted above. At an estimated cost of $500/hour for helicopter rental, the cost of less than 6 hours of flight time would pay for a drone similar to the one tested in this study. Furthermore, aviation accidents are also a concern when conducting Alligator nest work, and the potential costs (both in dollars and human lives) and impacts of such mishaps can be greatly reduced with use of drones for some surveys.

Future work in this area might help determine if there is an optimum time of day for using drones to detect Alligator nests or perhaps basking Alligators as a rough population index. In addition to Alligator work, we have found drones to be useful to select potential sites for construction and delineation of a *Grus americana* L. (Whooping Crane) holding pen, detect nesting *Ardea alba* L. (Great Egrets) and *Egretta caerulea* L. (Little Blue Herons), evaluate status of possible flooded Whooping Crane nest/eggs, and review progress of wetlands-mitigation projects.

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