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Evaluation of Unmanned Aerial Vehicles (UAVs) for detection of cattle in the Cattle Fever Tick Permanent Quarantine Zone

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ABSTRACT

An unmanned aerial vehicle was used to capture videos of cattle in pastures to determine the efficiency of this technology for use by mounted inspectors in the cattle fever tick permanent quarantine zone (PQZ) along the Texas -Mexico Border. Two pastures, 20 acres each, located at the USDA-ARS Cattle Fever Tick Research Laboratory, Moore Airbase, Edinburg, TX were used for the study. These videos were shown to inspectors and cattle were detected in both pastures at an average percentage of 72 and 84 respectively for pastures 1 and 2 even in the thick brushy habitats that are characteristic of South Texas. Age of the inspector was not a significant factor in detection of cattle in the videos. UAVs appear to be useful tool for detecting cattle and/or wildlife in the PQZ and could improve the efficiency and safety of inspectors working in this environment.

Additional Index Words: : Rhipicephalus microplus, Rhipicephalus annulatus, pathogenic landscape, livestock entomology, nilgai, cattle

Unmanned Aerial Vehicles (UAVs) may be an important new tool for detection and management of Cattle fever ticks (CFT) *Rhipicephalus microplus* (Canestrini) and *Rhipicephalus annulatus* (Say) in the U.S. Dept. of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, (USDA-APHIS-VS) Cattle Fever Tick Permanent Quarantine Zone (PQZ), which runs along the Rio Grande between Del Rio and Brownsville, TX. Cattle fever ticks *R. microplus* and *R. annulatus* are native to south Asia and Mediterranean Europe, respectively, and both are invasive livestock pests in tropical, subtropical, and warm temperate areas across the world including the border region between Texas and Mexico (Wharton 1974, Goolsby et al. 2016). Because cattle fever ticks (CFT) are vectors of bovine babesiosis and anaplasmosis, they present an important obstacle to livestock production worldwide (Pérez de León et al. 2012). Graham and Hourrigan (1977) estimated that cattle fever ticks and bovine babesiosis caused losses to the U.S. livestock industry close to $3 billion annually in today's currency before they were eradicated from the U.S. An eradication program based on continuous surveillance by mounted inspectors and the use of acaricides has been implemented in the US along the Texas-Mexico border to manage periodic outbreaks, but due to growing evidence of acaricide resistance, the emerging role of white-tailed deer and exotic nilgai as tick hosts, and the invasion of pathogenic landscape-forming species such as carrizo cane (*Arundo donax*) and other exotic plant species that favor CFT, novel strategies need to be examined and implemented for the continued effective and efficient detection, suppression and eradication of CFT in the PQZ (Perez de León et al. 2012, Racelis et al. 2012, Busch et al. 2014, Rodriguez-Vivas et al. 2014, Esteve -Gassent et al. 2014).

Detection of cattle and alternate wildlife hosts in the PQZ is becoming increasingly difficult due to changes in vegetation that restrict visibility and dangers associated with work on the international border. Currently, the USDA-APHIS-VS, Cattle Fever Tick Eradication Program (CFTEP) relies on continuous surveillance of the PQZ by mounted inspectors. Frequently, the presence of stray cattle from Mexico or exotic wildlife are detected, but they can be difficult to locate when hidden in the dense vegetation in the PQZ which is adjacent to the Rio Grande. UAVs appear to be useful tools for inspectors to search for cattle and wildlife. Although UAV technology is actively adopted in rangeland management (Dunford et al., 2009, Rango et al, 2009, Hung et al., 2012), its use for detecting and counting cattle, especially in PQZ environments, has not been addressed in previous studies. Some studies suggested an electronic cattle monitoring system that utilizes a Bovine Mobile Observation Operation (BMOO) unit, but this must be attached to individual cattle and does would not be useful for detecting stray cattle from Mexico or wildlife hosts of CFT (Nagel et al., 2003).The technology, cost, and legality of using UAVs in the environment has become more accessible (Marris 2013). Our study evaluated the utility of UAVs to detect cattle in vegetation similar that found in the PQZ. These results could be used by decision makers in government and private industry to make informed choices about the application of this technology in the agricultural environment, including the PQZ.

MATERIALS AND METHODS

Cattle viewed in the UAV videos were located at the USDA-ARS Cattle Fever Tick Research Laboratory, Moore Airbase, Edinburg, TX. All cattle in the videos were Black Angus approximately 18 months old. Cattle were gathered prior to the experiment for an actual head count. Vegetation in the pastures is typical of the Tamaulipan thorn scrub brush of south Texas and the PQZ. Trees such as honey mesquite, *Prosopis glandulosa* Torr are common in the environment. They can grow up to 9 m, have spreading branches and can obscure visibility of cattle. Two pastures, 20 acres each, were used for the study.

Observers used in the study were cattle fever tick mounted inspectors with multiple years of experience detecting cattle from a ground-based perspective. Age was considered by to be an important variable to adoption of this technology. Each observer was shown two, twenty minute videos of the pastures and asked to count the total number of cattle in each pasture. Observers were instructed not to double count cattle. The videos were played without interruption for each observer on a Dell laptop with an 11 inch screen.

The UAV used in the study was 3DR Iris+ platform with GoPro 4 Black camera for video recording. The video camera was mounted on a 2 axis gimbal for image stabilization. The camera was set to record 4K resolution (3840 x 2160) video at 30 frames per second throughout the autonomous missions. Autonomous flying missions were created using Mission Planner (see http://ardupilot.org/planner/docs/mission-planner-overview.html) at 50 m altitude above ground. The autonomous missions were designed to have 3 flight lines to ensure seamless coverage of the study area without blind spot (Figure 1). Flights were performed with camera angle 30 degrees down from the horizontal plane. Data was analyzed using linear regression and corresponding analysis of variance was performed using JMP 10.0.0 (SAS Institute, Inc. 2012) and significant relationship between all dependent and independent variables was defined at $\alpha=0.05$

Fig. 1. Experimental pastures at the USDA-ARS Cattle Fever Tick Research Laboratory, Moore Airbase, Edinburg, TX. UAV flying path design (Solid red lines indicate autonomous flight path, blue arrows indicate flying direction, and green squares indicate ground control station where UAV was launched and landed after the mission.)

RESULTS

Cattle were detected in both pastures at an average percentage of 72 and 84 respectively for pastures 1 and 2. Years of experience of the observers was not significant for pasture 1 ($r2 = 0.0012$; F=0.006; P=.94), but highly significant for pasture 2 ($r2 = 0.75$; F=11.69; P=0.027). Age of observers was not significant for pasture 1 ($r2 = 0.21$; F=1.01; P=0.36) or pasture 2 ($r2= 0.002$; F=0.006; P=0.94).

DISCUSSION

The UAV produced a high quality video that allowed for efficient detection of cattle by all the observers. Although none of the observers were able to see the exact number of cattle in each pasture, their accuracy was high in all cases. Accuracy in pasture 2 was slightly higher most likely because the brush was not as thick as pasture 1. Accuracy was also similar for inspectors of all ages and actually increased by years of experience. This indicates that the use of UAVs to produce videos of the PQZ should be useful across the full range of the work force. Detection of the exact number of cattle would likely have been possible if we would have allowed the observer to zoom in, pause, or rewind the video. However, we felt this would have added inconsistency to the methods. In reality, inspectors will be able to manipulate the video to see areas they suspect have cattle/wildlife. They are also likely to view videos together to gain local knowledge from each other on local site characteristics, past cattle detections, and animal behavior. The inspectors were very enthusiastic about the technology and could see immediate applicability. Other sensors such as infrared could aid in detection of cattle in thick brush where they are not visible particularly in low light at dawn/dusk when animals may be most active. This sensor should be evaluated to determine its utility given that it will considerably increase the cost of the UAV platform.

In summary, UAVs seem to be a useful tool that could aid mounted inspectors, researchers, and ranchers that need to detect and count cattle and wildlife hosts of CFT in the PQZ or other similar brushy environments. This tool could allow for detection of cattle in environments that are too brushy to be accessed by foot or horseback. In addition, cattle did not appear to detect or be disturbed by the UAV and therefore could be more easily observed. Applications of UAVs in the PQZ and agriculture in general are many and are expected to be rapidly adopted.

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