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The Potential of the Apple Inc., AirTag™ as Monitoring Devices for Tracking Animals

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ABSTRACT: Monitoring devices are used extensively for wildlife applications including tracking, home-range identification, and facilitating the recapture of animals. In the spring of 2021, Apple Inc., began marketing the AirTag™. This small device costing $20.00 - $25.00 can be attached to items and located remotely using iPhones. While Apple Inc. indicates the AirTag™ is not intended for use on pets, there may be applications for monitoring animals. The objective of this study was to evaluate the potential use of AirTags for animal tracking purposes on a college campus with urban and suburban-type environments. Initially, human subjects carried individual AirTags (n=40) to 10 designated locations (n=40) within the 50-ha study area to simulate live tracking of individual devices. The actual location of the device compared to the location indicated on a stationary iPhone were recorded. In the second phase of the study, parameters related to the recovery of stationary devices (n=40) placed at randomly selected locations in the study area were collected. Finally, AirTags (n=4) were attached to domestic sheep via a collar in a more remote region of the campus to evaluate monitoring potential. Actual location of AirTags at designated sites compared to the location indicated on an iPhone varied from .09 ha - 5.4ha area. Recovery of AirTags hidden at various locations within the 50-ha area, took longer ($p < 0.05$) when using the iPhone visual locating method alone (78.4 ± 3.91 min) compared to using the visual display and an audio transmission from the AirTag™ (43.0 ± 1.21 min). Utilization of the AirTag™ to monitor free-ranging sheep in the more rural location was not effective. Results of this study suggest the use of Apple AirTag™ has some utility for monitoring animals remotely under certain physical and environmental conditions.

KEY WORDS: AirTag monitoring movement, surveillance, telemetry, urban-suburban environment

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INTRODUCTION

Technology is increasingly playing a role in the development and use of methodologies to monitor wildlife species. Extensive reviews have been published related to the availability and use of several types of cameras, forms of radar, thermal imagery, and unmanned aerial vehicles as platforms for visual monitoring devices (Lahoz-Monfort and Magrath 2021, Corcoran et al. 2021, Prosekov et al. 2020). Commonly utilized methods to monitor animals include tracking devices such as UHF radio signal transmitters/receivers (Margenau et al. 2022), and GPS units capable of providing information of locations at an unprecedented scale (Lahoz-Monfort and Magrath 2021). Conventional radio telemetry and GPS units can cost several hundred dollars to thousands of dollars per unit, with a lifespan ranging from weeks to several years. While being extensively utilized, all methodologies have limitations of cost relative to the quality of the information provided (Margenau et al. 2022, Lahoz-Monfort and Magrath 2021, Gilbertson et al. 2021, Corcoran et al. 2021).

In the spring of 2021, Apple Inc., began marketing the AirTag™, a device about the size of a quarter, intended for use on items such as backpacks, luggage, which can be located using later versions of iPhones. These devices cost $20.00-$25.00 each, with an estimated operating time of one year. AirTags use a common watch battery (CR 2032) that is easily replaced, and costs approximately $1.25.

AirTags are paired with a single iPhone, which stores and displays information regarding the position of the tag (Apple Inc., 2022). The AirTag™ functions using Bluetooth technology, which can probe, and identify certain Apple Inc. products in the immediate area, utilizing the location of those devices to transmit an approximate location of the AirTag™ ultimately to the paired iPhone. When the AirTag™ is within approximately100m of the paired iPhone, utilization of the ultrawide band technology between the devices allows for the direct location features and distance measures that can facilitate recovery of the AirTag™ (Hernandez-Orallo et al. 2023, Apple Inc. 2022). The AirTag™ also contains an auditory signal generator that can be activated by the paired iPhone to assist in recovery of the device.

While marketing from Apple indicates the device is not intended for use on pets or other animals, there may be applications for tracking and monitoring wildlife or domestic animals. Therefore, the objective of this study was to evaluate the potential use of AirTags for animal tracking purposes in an urban and suburban-type environment.

METHODS

Study Area

The Berry College campus encompasses 11,340-ha within the Ridge and Valley physiographic province (Hodler and Schretter 1986) in Northwest, Georgia, USA. We conducted Phase I and Phase II, of this study in a 50-ha area (34°17'00.80" N 85°11'.16.58" W; elevation: 187m) on the South end of the 170-ha main campus. An aerial photograph of the study site was used to further delineate the area into 17 regions of approximately 3ha each (Figure 1). This area consists of academic buildings, dormitories, single and multi-residential faculty, staff housing, outdoor recreation facilities, and roads and parking lots typical of a college campus. The landscape within the study area includes expansive lawns containing fescue (*Schedonorus*

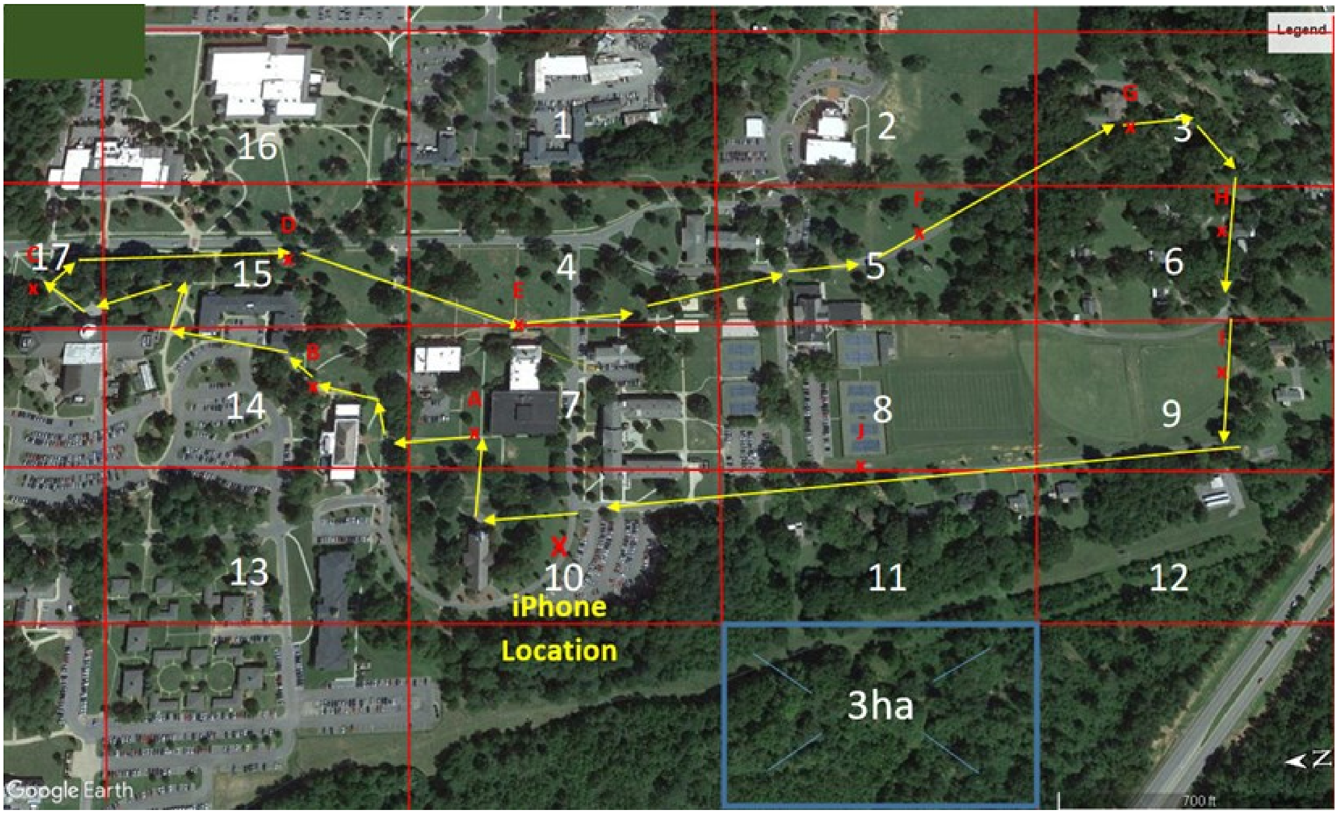

Figure 1. Designated regions (1-17) and specific locations (A-J) to examine Apple Inc. AirTag™ estimated and actual locations (Phase I) and device recovery (Phase II) within a 50-km test area of the Berry College campus, Georgia.

phoenix), white clover (*Trifolium repens*), and Bermuda grass (*Cynodon dactylon*), horticultural gardens, as well as numerous species of native trees including pines (*Pinus* spp.), oaks (*Quercus* spp.), hickories (*Carya* spp.), and non-native trees.

Phase III of this study was conducted at the 13.8-ha, Berry College Sheep Center (34˚18'00.99" N, 85˚11'.45 .37" W). This facility is approximately 1.9km north of the Phase I and Phase II study site, and 1.6km north of the core of the main college campus. This area contains animal and equipment barns, hay storage and living quarters for up to 8 students. The fenced pastures consist primarily of fescue (*Schedonorus phoenix*), white clover (*Trifolium repens*), and Bermuda grass (*Cynodon dactylon*), and predominantly various species pines (*Pinus* spp.).

Procedures

AirTags (Apple Inc., Cupertino, CA) were purchased at a local retail center. Each device was linked to a single iPhone (Model 12, Apple Inc., Cupertino, CA) for completion of all components of this study.

Phase I – Two AirTags were linked to a single iPhone (Model 12, Apple Inc., Cupertino, CA). The iPhone operator remained at a specific location. Each device was transported by an individual person to each of 10 designated locations (A-J), each within one of 17, 3ha delineated regions, along a 2km walking route (n=20). The second device was transported by another individual in the opposite direction of the designated route (n=20). Each individual would inform the iPhone operator via 2-way radio upon reaching a designated location. The iPhone operator would record the location of the AirTag™ as observed on the iPhone. Phase I was completed between May 27, 2021 - August 2, 2021.

Phase II – Four individual AirTags were linked to a single iPhone (Model 12, Apple Inc., Cupertino, CA). During Trial 1 (n=10) each of the four devices was placed, at a height of 0.6-1.2m, within one of the 17 delineated, 3-ha regions, based on a random number generator. Once the AirTag™ was placed within the designated region, unknown to the iPhone operator, the iPhone operator was contacted and began each search from a consistent location (Region 10). The time from placement of the AirTag™ until initiation of the search was approximately 30 minutes. The operator attempted to recover each AirTag™, within a 90-minute period, using only visual display information on the phone. Information from the iPhone related to locating each unit including, actual location compared to the initial displayed location, battery usage, and total time to recover all AirTags, was recorded. During Trial 2, (n=10) placement of the AirTag™ devices was the same as Trial 1. However, in addition to using visual display information, utilization of the auditory emission feature from the AirTag™ was incorporated in the recovery process. Phase II was completed between September 30, 2021 - March 2, 2022.

Primary iPhone display features that occur during the AirTag™ recovery process include:

1. Initial Perimeter: Upon approaching an AirTag™, a perimeter, often over 50m, is presented. No additional information is displayed.
2. Initial Connection: The iPhone initially connects directly to the AirTag™, indicating a weak signal is detected. No directional information is provided.
3. Distance Established: As the distance between the iPhone and AirTag™ decreases, a display of distance to the device is presented. No directional information is provided.
4. Direction Established: At a certain distance between the iPhone and AirTag™, an arrow providing direction and the distance is presented.
5. Sound Production: The sound-producing feature of the AirTag™ could typically be activated via the iPhone upon reaching the Initial Connection stage. The undulating frequency, audio signal was emitted for 10-seconds for each activation.

Phase III − To determine the location of domestic sheep maintained on remote pastures, AirTags (n=4) were placed in a plastic keyring (Hatalkin, Shenzhen Guangdong, CN) attached to a conventional nylon sheep collar (Jeffers, Dothan, AL), using duct tape. To keep the AirTag™ on the collar in a dorsal position on the neck, a resealable plastic sandwich bag was filled with approximately 114g of lead shotgun pellets and secured to the collar by duct tape to the area of the collar that would correspond to the ventral region of the neck when placed on the animal. The location of the AirTags, attached by the collar to mature ewes, was recorded approximately 1.6km from the pastures maintaining the sheep and within the respective animal pastures.

Analysis of variance (ANOVA) procedures of SPSS 27.0 (IBM-SPSS, Amonk, NY) was utilized to determine differences in actual location compared to the observation of the iPhone at the test location site were utilized for Phase I. For Phase II, comparison of battery usage, time to complete recovery, and distance information provided by the iPhone during AirTag™ recovery were analyzed using ANOVA procedures of SPSS 27.0.

No data suitable for analysis purposes was collected from the AirTags fitted to collars attached to free-ranging sheep.

RESULTS AND DISCUSSION

Phase I − The objective of Phase I of this study was to evaluate the accuracy of location information produced by the AirTag™ devices in real time. AirTags were transported by humans to the 10 designated locations (n=10) within the 50-ha study area (Figure 1). Results indicate the actual location of the device ranged from .09ha - 5.4ha compared to the location presented on the iPhone (Table 1), recorded from a consistent location (Region 10). This result was not surprising. General corridors of human travel can be represented as collective tiers of areas. As the AirTags move from higher human activity areas with the potential presence of more iPhones to derive location data, to more remote areas with fewer Apple Inc. devices, less information on location becomes available. In the more remote regions, the previous transmitted location becomes the default, thus providing less accurate real-time information. The most accurate location of the AirTags occurs when approaching the linked iPhone (Region 10). This is likely due to the device being linked directly to the paired iPhone via the Bluetooth connection feature, thus providing a more accurate location of the AirTag™. It should be noted that this portion of the study was completed during the summer when far fewer individuals are on the campus. The typical number of students population during the academic year is approximately 2,100. During the academic year, with more potential iPhone products on campus, accuracy of the location of AirTags would likely increase, particularly in higher traffic corridors.

Table 1. Approximate area (ha) of iPhone indicated location compared to actual location of Apple Inc., AirTags (n=40) from designated sites (A-J) on the Berry College main campus.

Location Group	Designated Site	Region	Area Range (ha)
Tier 1	X	10^{a}	<0.09
Tier 2	AJBF	7^{b} 8^{b} 14^{bc} 5^{cd}	2.25 - 3.25
Tier 3	HDE	6^{def} 15^{ef} 4^{efg}	3.26 - 4.30
Tier 4	IC	9^{gh} 17^{hi}	4.31 - 4.96
Tier 5	G	3^{ij}	4.97 - 5.40

Letters with different superscripts differ by ($p < 0.05$)

Table 2. Parameters associated with the recovery of four Apple Inc. AirTags (n=10) randomly placed within designated regions of the Berry College test area using the iPhone display or the iPhone display and sound emitting feature.

Parameter	Trial 1 iPhone Display Only	Trial 2 iPhone Display + Sound
Initial Connection (m)	70.23 ± 7.99^{a}	60.09 ± 3.79^{a}
Distance Established (m)	30.31 ± 2.89^{a}	31.06 ± 2.45^{a}
Direction Established (m)	20.17 ± 1.95^{a}	20.42 ± 2.37^{a}
Sound Production (m)		52.68 ± 3.83^{a}
Battery Usage (%)	35.50 ± 1.55^{a}	21.50 ± 0.93^{b}
Time to Recovery (min)	78.40 ± 3.91^{a}	43.00 ± 1.21^{b}

Letters within rows with different superscripts differ by ($p < 0.05$)

Phase II − Results of the recovery of AirTags (Phase II) randomly placed within indicated regions are presented in Table 2. There were no differences ($p > 0.05$) in most recovery parameters measured when using only the visual indicators of the iPhone, compared to the use of the visual indicators and activating an auditory sound cue to assist in recovery. However, when incorporating the auditory sound emitted by the AirTag™ into the protocol, recovery of devices took less time ($p < 0.05$) and subsequent less usage of the paired iPhone battery ($p < 0.05$) compared to using visual information alone. It was noted that on several occasions, the iPhone operator could be within 5 meters of an AirTag™ in the field and not have the direct indications of distance (m) or direction information presented on the visual display. This typically occurred when the device was located on a large object such as a tree trunk, on the opposite side of the structure from the iPhone operator, likely interfering with reception of the ultrawide band signal intended to assist in identifying the location of an AirTag™. When the iPhone operator moved to a location without the physical interference of an object, the distance and direction of the AirTag™ was displayed.

Activation of the auditory signal became functional within approximately 52.7m ± 3.8 of the actual device location. Recovery of the stationary devices was successful using the visual display information, but more time efficient when incorporating the use of the auditory signal feature. The use of AirTags for tracking animals may be effective with animals that tend to be more stationary during extended periods of time. It should be noted that this portion of the study was accomplished during the academic year when more students, with the presumption of more Apple Inc. products are in the general area aiding in the location identifying process.

Phase III − With the remote nature of the sheep pastures in this study, use of AirTags to aid in location identification was not effective. When monitoring the devices on sheep from approximately 1.6km away from the sheep pasture, it was indicated the animals are within a student housing duplex near the facility. Several students residing in this 8-student housing facility had iPhone products in their possession. Animals in close enough proximity (<100m) allows recognition of the Bluetooth signal emitted by the AirTag™ thus provide an initial location. With limited appropriate Apple Inc. products in the vicinity, the AirTag™ location remains with the last known iPhone location. In this case, the AirTags were indicated to be within the student housing duplex. When the iPhone linked to the AirTags was taken to the pastures and came within the Bluetooth range of the sheep, the location of the collar immediately moved from the housing unit to the adjacent pasture where the sheep, and AirTags were located. Due to the limited frequency and number of iPhones in the vicinity, obtaining an accurate location of the sheep wearing the AirTag™ devices was unsuccessful.

Results of this study indicate the use of the AirTag™ devices for monitoring animals is limited. Attempting to mimic live tracking when the devices were taken to specific locations provided a range of .1ha - 5.4ha from the true location, depending on the number of iPhones available in the area to provide location information. The fewer the number of iPhones located within the area, the less accurate the location information. Similarly, lack of accuracy of AirTag™ locations when the devices were attached to animals in a more rural environment was a result of minimal iPhones in the area to assist with the location-determining process. The AirTags location remained identified as being in the last known location.

The recovery of stationary devices was successful and more time efficient when using both the visual and auditory functions of the AirTag™ units. The use of the devices to provide timely and accurate location of animals that tend to be stationary for a given period, such as urban and suburban environments, would seem to be well suited for AirTag™ usage.

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