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Utility of the AHDriFT Camera Trap System to Survey Snakes in a Wetland Complex

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***Abstract.*—Survey methods that are effective and low cost are necessary for maximizing limited resources during herpetological studies. Coverboards are widely used to inventory snake populations but require regular monitoring and may be biased by conditions at the time of data collection. The Adapted-Hunt Drift Fence Technique (AHDriFT) system combines motion-sensing cameras with a drift fence, providing a continuous accumulation of encounters during surveys. Here, we compare the effectiveness of AHDriFT systems and coverboard transects for surveying snakes at an Indiana, USA, wetland complex. From March to October 2021, we placed coverboard transects adjacent to AHDriFT systems on upland sites: a Mesic Prairie, a planted Oak Forest, and a Mesic Broad-leaf Forest. Overall, AHDriFT surveying resulted in over twice the number of total unique snake observations, cost 43% less per observation, and had a lower latency to initial detection than coverboard surveying. Furthermore, AHDriFT systems collected a greater average number of unique snake observations per survey at the forest sites. We observed Common Garternsnakes (*Thamnophis sirtalis*) and Dekay's Brownsnakes (*Storeria dekayi*) with each survey method, but *T. sirtalis* made up most observations. Our results suggest that AHDriFT systems provide a viable passive monitoring technique for detecting snakes adjacent to a temperate wetland. AHDriFT systems, however, are currently unable to be used to collect data that typically require handling of individuals (e.g., sex, physiological characteristics, etc.). As such, we recommend AHDriFT systems be considered for use in conjunction with traditional survey methods to gain a more comprehensive view of herpetological communities.**

Key Words.—Common Gartersnake; Dekay's Brownsnake; drift fence; Indiana; marsh; *Storeria dekayi*, surveying; *Thamnophis sirtalis*

Introduction

Knowledge of local reptile ecology and life history is important for environmental management (Gibbons 1988). Although the detection of cryptic species can be challenging, a rise in interest towards the conservation of herpetofauna has led to the development of many survey techniques (Graeter et al. 2013). Common methods include funnel and box traps (Fitch 1951; Plummer and Congdon 1994), pitfall traps (Enge 2001), opportunistic encounters (Martins and Oliveira 1998; Bernarde and Abe 2006; Araujo et al. 2010), visual surveys (Boback et al. 2020), glue traps (Costa et al. 2018), and coverboards (Grant 1992; Godley 2012). Coverboards are often favored for snake surveys because they eliminate the risk of snake entrapment and decrease the likelihood of observer bias, which can occur during opportunistic encounters and while searching under natural cover (Grant 1992; Mills et al. 2013). Each of these methods, however, requires regular intervals of fieldwork to maintain or to collect sufficient data for research. Thus, new, less-intensive methodologies are needed.

In response to limited time and funding in wildlife research, camera trapping methods have become increasingly popular. For example, McCleery et al.(2014) developed a novel technique using camera traps to monitor small mammal distribution, activity, and behavior. This Hunt Trap method involved an inverted bucket with opposing openings cut into the sides. Plexiglass was used to replace the bottom of the bucket (now the top of the system) and served to mount a motion-sensor camera, which photographed individuals that entered the bucket. The cameras also recorded the date, time, and internal bucket temperature when individuals were observed. Martin et al. (2017) modified the Hunt Trap method into the Adapted-Hunt Drift Fence Technique (AHDriFT) to survey small terrestrial vertebrates, including reptiles. AHDriFT systems consist of a centralized drift fence with Hunt Traps on either end. Each bucket has small wooden funnels on the openings to direct the small animals intercepted by the drift fence through the Hunt Trap, where the camera captures photographs. Because of the novelty of the AHDriFT system, evaluations of its effectiveness relative to traditional survey methods remain limited.

Despite the usefulness of coverboards, there are some limitations in their use (Graeter et al. 2013). Coverboard surveys have been observed to result in lower numbers of snake encounters than drift fence and pitfall surveys (Grant et al. 1992; Ryan et al. 2002) and may have a sex bias with some species (although this bias also was observed with the use of drift fences; Bartman et al. 2016). The method involves temporal bias, as only snakes under the coverboards at the time of checking the boards are recorded (Grant et al. 1992). Variation in environmental conditions throughout the survey (Grant et al. 1992; Parmelee and Fitch 1995; Brown and Geluso 2022), the material used (Engelstoft and Ovaska 2000; Mills et al. 2013; Halliday and Blouin-Demers 2015), and the size and state of decay (Hecnar and Hecnar 2011; Brown and Geluso 2022) of coverboards may also lead to bias in the species and number of encounters observed. Thus, a selection of coverboard types may be necessary to maximize species detection within a community (Halliday and Blouin-Demers 2015). This practice, however, can increase survey effort due to varying degrees of degradation of coverboard material. The materials used, frequency of maintenance, and persistence of surveys cause a summative impact on the total cost of conducting a snake survey.

AHDriFT systems have continued to be used to successfully observe a variety of herpetofauna, including the Eastern Massasauga (*Sistrurus catenatus*; Amber et al. 2021a, 2021b), a species listed as Threatened under the U.S. Endangered Species Act (U.S. Fish and Wildlife Service 2016). Martin et al. (2017) reported observations of 21 species of reptiles, three species of amphibians, eight species of small mammals, and a single species of bird at Merritt Island National Wildlife Refuge, Florida, USA, during the first reported deployment of the AHDriFT system. The effectiveness and cost efficiency of this novel technique compared to traditional snake survey methods, however, remains uncertain. Here, we describe a year-long study utilizing AHDriFT systems and coverboard transects during a snake survey conducted in a restored urban wetland complex in northeast Indiana, USA. We compare the effectiveness of the two methods and estimate the financial costs of their use to monitor snake communities.

Materials and Methods

***Site description*.—**We conducted the study at the Eagle Marsh Nature Preserve in Allen County, Indiana, USA. The Little River Wetlands Project (LRWP) restored Eagle Marsh, a 336-ha wetland, in 2006 to emulate hydrology prior to agricultural development at the site. During the restoration, LRWP removed drain tiles and water pumps and modified vegetation through the reintroduction of over 45,000 native trees and shrubs along with herbaceous angiosperms such as forbs and graminoids (Ruch et al. 2016). Personnel of LRWP continuously manage the wetland through invasive plant removal and controlled burns (Barton et al. 2020). We sampled three upland sites within the larger wetland complex: an Oak Forest, a mesic mature Broad-leaf Forest, and a Mesic Prairie. The Oak Forest consisted almost entirely of young, planted Bur Oak (*Quercus macrocarpa*). Mature Silver Maple (*Acer saccharinum*), Eastern Cottonwood (*Populus deltoides*), and Pin Oak (*Quercus palustris*) dominated the Mesic Broad-leaf Forest. The Mesic Prairie had a large area of American Pokeweed (*Phytolacca decandra*) running parallel to a mixture of native herbaceous angiosperms, including Big Bluestem (*Andropogon gerardii*) and non-native Reed Canary Grass (*Phalaris arundinacea*).

***Data collection*.**—Coverboard transects consisted of two rows of five plywood coverboards (2 × 61 × 122 cm) laid 5 m apart and located 15 m from a parallel AHDriFT system. We deployed a single coverboard transect at the Oak Forest and Mesic Broad-leaf Forest sites from 19 March through 4 October 2021. We added another coverboard transect to the Mesic Prairie site 11 June through 4 October 2021. Coverboards were checked opportunistically, often aligning with Sherman trap surveys associated with a concurrent small mammal study (White et al. 2023). We checked coverboards at Eagle Marsh 22 times, resulting in 51 coverboard surveys between sites. On average, we surveyed coverboards once every 9 ± 1.8 d (mean ± standard error; range of values 1–32) in the afternoon (1435 ± 0.50 h; range of values 0700–1900). Snakes under each coverboard were counted and identified to species. If captured, individuals were weighed and marked according to Brown and Parker (1976). After processing, we released snakes adjacent to their coverboard of capture.

Following the design of Martin et al. (2017), we deployed one AHDriFT system per site. We buried a 10 m long and 1 m tall silt fence, acting as the drift

Figure 1. Sample Common Gartersnake (*Thamnophis sirtalis*) photograph taken by the Adapted-Hunt Drift Fence Technique (AHDriFT) in a northeastern Indiana, USA, wetland complex. AHDriFT systems use Hunt Trap buckets overturned on each end of a drift fence. The focal distance of each camera was decreased by covering the camera lens with a reading glass lens. Cameras recorded date, time of day, and the internal temperature of the bucket at each photograph. (Photographed by Trevor L. Proctor).

fence of the AHDriFT system, 15 cm into the ground to prevent animals from burrowing under the fence. We installed the drift fences in an east-west direction with Hunt-trap buckets placed on each end. We attached a motion-sensor camera (BTC-4P Command Ops Pro Trail Camera; Browning, Morgan, Utah, USA) inside each bucket, facing the ground, and affixed 2.75–3.75× diopter reading glass lenses over the camera lens to adjust the focal distance to approximately 30 cm (the distance between the camera lens and the ground). The cameras had a 0.5-sec trigger speed, with a 10-sec delay between triggers, and collected three-image bursts. We attached two 19 × 89 mm wooden boards outside of the entrance of the bucket to funnel animals into the bucket, two 19 × 38 mm boards inside the bucket to guide animals under the camera focal point, and holes on either side of the bucket to allow animals to move through the system freely. We installed the AHDriFT systems in February 2020 and allowed them to continuously record data until October 2021. Here, however, we only include snake data collected during the dates that coverboards were deployed. We checked AHDriFT systems for damage, available storage memory, and battery life each time coverboards were checked. We changed memory cards approximately once per month and batteries as needed.

***Data analysis*.—**We selected the photograph in which the animal was most easily identifiable from each three-round burst of images collected by AHDriFT systems. We recorded time of day, date, bucket temperature, presence or absence of an animal, and species ID (if present) from selected images (Fig. 1). We provided each image with a unique photographic ID and organized them by date and site. If an AHDriFT system captured multiple images of the same species within a 60-min time interval, only one was counted as a unique observation (Amber et al. 2021a). Similarly, we considered each snake captured under a coverboard to be a unique observation, regardless of past capture history.

To evaluate the effectiveness of each survey method, we compared the number of unique snake observations per survey period for each site and within the overall wetland complex. For AHDriFT systems, we defined a survey as a 1-week sample period per system, pooling image data by week. We defined a coverboard survey as a single check per array (i.e., 10 coverboards) (Amber et al. 2021a). We were unable to transform data into normal distributions, so we used Wilcoxon Rank Sum tests to compare the number of unique snake observations per survey collected between survey methods. We did this for data collected from each site separately and for all sites combined. We used a Kruskal-

Wallis test to compare the total number of unique snake observations per survey between sites, using data pooled from both survey methods. Pairwise Wilcoxon Rank Sum tests served as *post hoc* tests to analyze which sites differed. We used a Spearman's Correlation to determine if there was a correlation between the number of snake observations during coverboard surveys and time of day. Furthermore, we plotted the number of unique snake observations against the time of day to visually search for patterns of nonlinearity. We conducted statistical analysis using R programming language 4.3.1 (R Core Team 2023), with an alpha level of 0.05. Additionally, we calculated the latency to initial detection (LTD) per site for each survey method (Foresman and Pearson 1998), without conducting a formal analysis, using the date of the first snake observation.

We downloaded daily temperature and precipitation data from a National Oceanic and Atmospheric Administration (NOAA) weather station (National Weather Service Cooperative Observer Program Number = 123037) located at the Fort Wayne International Airport, Indiana (approximately 6.4 km from sites). We calculated the average maximum daily air temperature per survey week and the maximum daily air temperature for each day coverboards were checked. We also calculated the total amount of precipitation during an AHDriFT survey period and the total amount of precipitation during the day that coverboards were checked and for the preceding 2 d. For each survey method, we used a single Binomial Logistic Regression to determine if these weather characteristics impacted whether at least one snake was detected during a survey period. We did not standardize the predictor variables. We did, however, square and log transform data, as needed, to ensure normality before this analysis.

***Cost estimates*.—**We calculated the cost per observation for each survey method by dividing the number of snake observations by the total cost of each method. We included both cost of materials and cost of fuel for travel, between Purdue University Fort Wayne and Eagle Marsh, in the total price per method. For many researchers, the cost of employing a technician must also be considered. During this research, the federal minimum wage in the U.S. remained $7.25 per hour. The cost to the employer, however, is typically 1.25–1.40 times larger after taxes and benefits are considered (https://www.sba.gov/blog/how-much-does-employee-cost-you). To remain conservative, we assumed a cost of 1.25× the federal minimum wage per employee ($9.06/h). Travel time to the field site was approximately 17 min each direction. Actual time in the field was not recorded; however, we estimated that it took an average of 1.50 h to check all coverboards at all sites and 0.75 h to check AHDriFT cameras. Most of the time, a single technician performed the fieldwork. We assumed AHDriFT systems need be checked once per month in the cost of labor calculations. We used these calculations to estimate the cost of the field component of our research. We did not estimate the cost of the lab component (i.e., analyzing photographs) because we did not record the amount of time needed to check snake observations and there has been a continuous increase in efficiency and availability of photographic automation software, thereby limiting the time required for technicians to analyze images (Yu et al. 2013; Bogucki et al. 2018). Costs reflect prices at the time of our study.

Results

AHDriFT systems were more effective at surveying snakes than coverboards. Using AHDriFT systems, we detected snakes at all three sites and collected

Table 1. Average number of unique snake observations per survey and latency to initial detection using Adapted-Hunt Drift Fence Technique (AHDriFT) and coverboard transect surveys in three upland sites in a northeastern Indiana, USA, wetland complex. The average number of unique snake observations are reported as mean ± standard error (sample size). LTD is reported as the number of days from the placement of each survey method to the first snake observation made. When considering LTDs, it is important to note that AHDriFT systems recorded observations continuously while coverboards were checked approximately weekly. If we had checked coverboards daily, the LTDs may have been more similar. The abbreviation Na indicates that no snakes were observed.

	Unique snake observations per survey		Latency to Initial Detection	
Habitat	AHDriFT	Coverboard transects	AHDriFT	Coverboard transects
Oak Forest	1.00 ± 0.30 (28)	0.09 ± 0.09 (22)	3	56
Mesic Forest	0.57 ± 0.21 (28)	0.00 ± 0.00 (21)	1	Na
Mesic Prairie	2.94 ± 0.90 (16)	4.88 ± 1.88 (8)	1	21
Combined	1.26 ± 0.26 (72)	0.80 ± 0.38 (51)	1	21

Table 2. Number of unique observations for Common Gartersnakes (*Thannophis sirtalis*) and Dekay's Brownsnakes (*Storeria dekayi*) observed using Adapted-Hunt Drift Fence Technique (AHDriFT) and coverboard transect (CB) surveys in three upland sites in a northeastern Indiana, USA, wetland complex: an Oak Forest, Mesic Broad-leaf Forest, and Mesic Prairie.

	Oak Forest		Mesic Forest		Mesic Prairie	
	AHDriFT	CB	AHDriFT	CB	AHDriFT	CB
T. sirtalis	28	2	16	0	46	38
S. dekayi	0	0	0	0	1	1
Total	28	2	16	0	47	39

approximately twice the total number of unique snake observations (91 total snake observations) and 1.6 times the number of unique observations per survey ($W = 2430$, $n_1 = 72$, $n_2 = 51$, $P < 0.001$; Table 1) than coverboards (41 total snake observations at two of the three sites) overall. We observed 16 unique snake observations using the AHDriFT system and 0 using the coverboards, at the Mesic Broad-Leaf Forest site. Similarly, we observed approximately 14 times more unique snake observations in the Oak Forest site and 1.2 times more in the Mesic Prairie site using AHDriFT systems than coverboards (Table 2). Similarly, we observed substantially higher average unique snake observations per survey in the Mesic Broad-leaf Forest site ($W = 388.5$, $n_1 = 28$, $n_2 = 21$, $P = 0.005$) and the Oak Forest site ($W = 435$, $n_1 = 28$, $n_2 = 22$, $P = 0.002$) using AHDriFT systems than coverboards (Fig. 2). We did observe more snakes per survey using coverboards in the Mesic Prairie site, but the difference was not significant ($W = 58$, $n_1 = 16$, $n_2 = 8$, $P = 0.731$).

Combined survey methods gathered a greater number of unique snake observations at the Mesic Prairie than at the Mesic Broad-leaf Forest (W = 242, $P < 0.001$) or Oak Forest (W = 910, $P < 0.001$), but there was no significant difference between the Mesic Broad-leaf Forest and Oak Forest (W = 1,104, $P = 0.253$). Although most unique snake observations were *Thamnophis sirtalis,* for both survey methods, and a single *Storeria dekayi* was detected by both methods at a single site (Table 2). We recorded four Common Watersnakes (*Nerodia sipedon*) observations from the AHDriFT systems in 2020, but they were outside of the coverboard survey timeframe and therefore not considered here. Of the total snakes observed with coverboards, we identified 49% as unique individuals (n = 20). The remainder were either recaptured (n = 4), escaped (n = 16), or were otherwise unable to be checked for recapture (n = 1). Two of the escaped snakes were observations from the Oak Forest. Of the snakes found under coverboards in the Mesic Prairie, we identified 51% as unique individuals (n = 20).

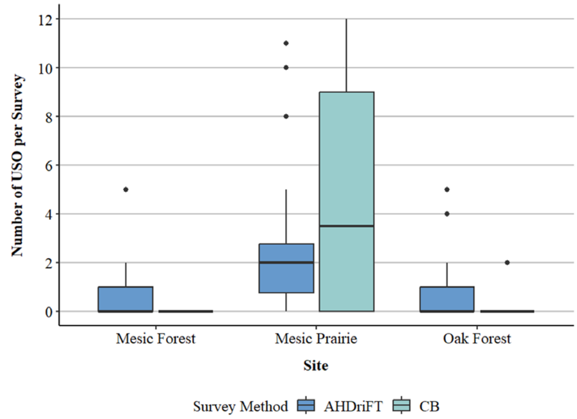

Figure 2. Comparison of the number of unique snake observations (USO) per survey between Adapted-Hunt Drift Fence Technique (AHDriFT) and coverboard transect surveys at three upland sites within a northeastern Indiana, USA, wetland complex. The box plot shows the median (horizontal lines), 50% interquartile range (boxes), range of values (vertical lines), and outliers (separate points).

We found no correlation between the number of unique snake observations and time of day for coverboard surveys ($\rho = 0.052$, $P = 0.714$). Furthermore, visually plotting the data showed no visual signs of a bimodal, or otherwise non-linear, relationship. Snake detection by AHDriFT systems was slightly affected by maximum daily air temperature ($z = -1.84$, $P = 0.066$), with the system detecting snakes less often when maximum air temperatures were higher ($\beta = -0.089$, standard error = 0.048). Alternatively, maximum air temperature had no effect on snake detection using coverboards ($z = 0.700$, $P = 0.484$). Precipitation had no effect on snake detection by AHDriFT systems ($z = -0.057$, $P = 0.584$) or coverboards ($z = -0.746$, $P = 0.456$).

AHDriFT systems cost 43% less per snake observation than coverboards (AHDriFT = $10.64 USD per observation, Coverboard = $18.78; Table 3). AHDriFT systems had a higher initial cost, however (AHDriFT = $849; coverboards = $262), due to a relatively high cost of materials, especially the cost of the cameras. The total costs of each method were $968 for the AHDriFT systems and $770 for the coverboards. The LTD of AHDriFT systems, beginning at the initial placement of coverboards, were: (1) 1 d at the Mesic Prairie; (2) 1 d at the Mesic Forest; and (3) 4 d at the Oak Forest. The LTD of coverboard surveys were 21 d at the Mesic Prairie

Table 3. Estimated costs associated with conducting our Adapted-Hunt Drift Fence Technique (AHDriFT) systems and coverboard transect surveys used to survey three upland habitat types in a northeastern Indiana, USA, wetland complex. Labor costs are estimated based on fieldwork, but exclude laboratory work (i.e., image processing and analysis). Numbers in parentheses are the total number of the items used. The corresponding 'Cost USD' shows the cumulative cost of the items purchased.

AHDriFT System	Cost USD	Coverboard	Cost USD
Command Ops Pro Game Cameras (6)	$540	2 × 123 × 244 cm plywood (8)	$262
AA batteries - 24 pack (3)	$60	Travel cost (23)	$77
SanDisk Ultra 32GB memory cards (12)	$84	Labor cost (47.53)	$431
2.75–3.75× diopter glass lens (6)	$39		
5-gallon bucket (6)	$30		
5 × 10 × 25 cm pine board	$15		
L-brackets (12)	$10		
Bolts with wing nuts	$15		
Superglue	$4		
1 × 30 m contractor silt fence	$45		
Pine stakes (12)	$7		
Travel cost (7)	$24		
Labor cost (10.53)	$95		
Total	$968		$770
cost per snake observation	$10.64		$18.78

and 56 d at the Oak Forest.

Discussion

Survey methods that are both productive and cost-effective are necessary for maximizing limited resources during herpetological studies. AHDriFT systems have previously been shown successful for detecting snakes (Martin et al. 2017; Amber et al. 2021a,b). Our results support these observations. During our study, AHDriFT systems had lower LTDs and produced more total snake observations per site than coverboards. When considering LTDs, it is important to note that AHDriFT systems recorded observations every day while coverboards were checked approximately weekly. If we had checked coverboards daily, the LTDs may have been more similar. AHDriFT systems had higher average snake observations per survey than coverboards at every site other than the Mesic Prairie. It is worth noting, however, that we surveyed the Mesic Broad-leaf Forest and Oak Forest for 7 mo, but the Mesic Prairie for only 4 mo. If there are temporal biases to the techniques, this inconsistency may have influenced the results. Regardless, our results indicate AHDriFT surveys can be considered to increase the number of unique snake observations in a wetland complex.

The time of day that coverboards were checked seemed, visually and statistically, to have no impact on the number of unique snake observations, indicating that the lower number of detections by coverboard surveys were not due to the time of day. We point out, however, that we conducted coverboard surveys sporadically and only during the day. Weather characteristics had little effect of snake detection using either method during our study. Average maximum air temperature over a survey period did have a slight negative association with snake detection. We detected most of our snakes, for both methods, during the summer, when air temperatures are warmer and *T. sirtalis* are generally more abundant and active (Gray 2014). For both methods, the Mesic Prairie site had the greatest number of unique snake observations of all three surveyed locations. Coverboards detected two unique snake observations in the Oak Forest and did not detect any snakes in the Mesic Broad-leaf Forest. The ineffectiveness of our coverboards placed in forested sites aligns with the results of another study did not find *T. sirtalis* under coverboards in Indiana forest habitats (Chelsea Clyde-Brockway, pers. comm.). The heat retention properties of coverboards are likely the primary variable in attracting snakes (Joppa et al. 2009), and shade from canopy cover may prevent coverboards from warming. Additionally, coverboards in the forest sites warped throughout the study. Although soil moisture data were not collected, coverboards in the shaded forest sites may not have dried quickly following rain events. If the thermal retention properties of coverboards were altered by warping of the wood, they may have produced variable microhabitats and therefore irregular results (Engelstoft and Ovaska 2000; Hecnar and Hecnar 2011). The low number of *T. sirtalis* observations made by AHDriFT systems in the forested habitats relative to the Mesic Prairie, however, suggests there is a higher abundance of the species in the Mesic Prairie, rather than bias due to coverboard avoidance. The increased abundance found in the Mesic Prairie may be due to greater availability of thermoregulatory habitat (Diaz and

Blouin-Demers 2017; Fouts et al. 2017).

We found that the cost per unique snake observation was less with AHDriFT systems than with coverboards. Similarly, Welbourne et al. (2020) found an alternative method of camera trapping snakes to be more cost-efficient when compared to artificial cover and pitfall traps. Although our study did not compare AHDriFT or coverboard survey methods to visual surveys, past research has captured significantly more *T. sirtalis* with coverboards than with visual surveys (Halliday and Blouin-Demers 2015). It is therefore likely that visual surveys would have also cost more per unique snake observation when compared to AHDriFT surveys. Once set up, researchers only need to check the batteries and memory cards once or twice a month and make occasional repairs. Initial costs of AHDriFT materials are likely to be more than that of coverboards, but AHDriFT systems are likely to be more cost-effective for long-term monitoring, especially if fieldwork and travel expenses are considered. Past studies used expensive cameras, which included a manufacturer-modified focal distance. We reduced the costs of AHDriFT systems by using readily available optical lenses to adjust focal length of standard wildlife cameras (Meek and Cook 2022; White et al. 2023). Additionally, our AHDriFT systems held up well during the duration of this study, minimizing the cost of maintenance.

Despite their benefits, AHDriFT systems present limitations. For example, AHDriFT systems cannot easily be used to identify individuals (e.g., for mark-recapture surveys) and are ineffective for studies that require handling snakes (e.g., for blood sampling, sex-determination, and weight). Furthermore, the cameras can only photograph snakes funneled through a bucket by the drift fence. AHDriFT systems are dependent on movement. Therefore, the effectiveness of AHDriFT systems may change depending on the temporal patterns of the snakes and landcover use, leading to a fluctuation of outcomes under variable conditions. For example, Charland and Gregory (1995) found gravid *Thamnophis* spp. in southeastern British Columbia, Canada, had reduced rates of movement and used habitat with greater thermoregulatory potential. In this situation, coverboards may better detect the gravid females while AHDriFT systems would be more beneficial for post-parturition movements. Researchers may benefit from using both AHDriFT systems and coverboards to study temporal differences in snake phenology, natural history, and behavior or for detection in presence or occupancy studies.

Nerodia sipedon was reported present at Eagle Marsh during a BioBlitz conducted in 2014 (Ruch et al. 2016) and in our AHDriFT systems in 2020. Furthermore, an Eastern Milksnake (*Lampropeltis triangulum*) has been photographed on the property by a student researcher (Galen Burrell, pers. comm.). Although *N. sipedon* had been observed by our AHDriFT systems in 2020, neither of these species were observed during the duration of this 2021 snake survey. This is likely due to the placement of the survey methods in the upland areas, rather than in the aquatic habitats that *N. sipedon* frequent. Regardless, we suggest further work may be necessary to understand the potential trap bias and detection probability of the AHDriFT system on various species under a variety of conditions. Additional survey methods may be required to detect all species present.

In summary, our results suggest AHDriFT systems are an effective indirect method for detecting the presence of snakes in a variety of habitat types. AHDriFT systems are limited in application, but they may benefit those looking to identify the presence of an active species or maintain an affordable and low maintenance long-term monitoring program. The use of AHDriFT systems in conjunction with other survey methods, such as coverboards, may allow stakeholders to gain a more robust view of a snake community in the landscape. Further research is needed to explore the effectiveness of AHDriFT systems for surveying snakes in a greater variety of settings, but it is our hope that these reported findings will assist future researchers, land managers, and conservationists in deciding which survey method(s) may be best suited for them and stimulate future research about AHDriFT systems.

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