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Mammal Capture Success of Scent Stations and Remote Cameras in Prairie and Forest Habitat

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Two common noninvasive (i.e., no stress to the animal) methods used to survey mammals include track stations (i.e., track captures of mammals) and remote camera-traps (i.e., photo-captures of mammals). Our objectives were to compare capture effectiveness of both track stations and remote cameras in both forested and prairie habitats. This project was conducted on 4 study sites (2 forested sites and 2 prairie sites) located in Fayette County, Iowa. Each study site had 6 trapping stations $\geq$ 100 m apart. We monitored traps for a total of 216 trap nights and we recorded a total of 368 captures composed of 19 different mammal species. We found that in forest habitat remote camera-traps captured significantly more mammals compared to track stations ($n = 53$) ($P<0.01$; $df = 1$) while in prairie habitat we found no significant difference in the number of mammals captured between trap sites ($P=0.27$; $df = 1$). We recommend the use of digital remote cameras with no glow infrared technology in combination with the monitoring of mammal tracks to maximize mammal capture effectiveness.

INDEX DESCRIPTORS: Forest, Iowa, mammals, non-invasive trapping, prairie, remote-cameras, scent stations.

An important aspect of managing and/or conserving wildlife populations is identifying what species occur in the field and how their relative abundance changes in response to implemented wildlife management activities (e.g., harvest, habitat restoration, invasive species control, etc.) (Harrison 2006). Two common noninvasive (i.e., no stress to the animal) methods used to survey large and medium sized mammals include track stations and remote camera-traps. Track stations (e.g., scent stations, track plates, monitoring of animal tracks) have been found to be effective at recording and indexing the relative abundance of wild mammal populations based on captures of animal tracks (Sargeant et al. 1998). Remote camera-trapping is a more recent survey technique which has become very popular in recording wildlife abundance data based on photo captures (Carbone et al. 2001).

Numerous studies have compared the capture effectiveness of both track stations and remote cameras but the results of these comparisons have varied. For example, Silveira et al. (2003), Barea-Azcón et al. (2007), Hackett et al. (2007) and Lyra-Jorge et al. (2008) found higher capture effectiveness using track stations compared to remote cameras, while Gompper et al. (2006) and Vanak and Gompper (2007) found higher capture rates using remote cameras when compared to track stations. Barea-Azcón et al. (2007) suggested that inconsistent results using different non-invasive survey efforts may be the result of survey efforts being conducted within different regions and habitat types. Differences in capture effectiveness based on trapping techniques or habitat type can impact abundance and density estimates of wild mammal populations, which could lead to incorrect decision making when managing their populations.

The goals of this project were to compare the number of animals captured and initial time to detection of mammals using track stations and remote cameras in both prairie and forest habitats within northeast Iowa. Our null hypothesis was that remote cameras and track stations would produce a similar number of mammal captures and initial time to detection in both forest and prairie habitats.

STUDY AREA

This project was conducted on 4 study sites (2 forested and 2 prairie sites) located in Fayette County, Iowa (Fig. 1). The 2 forested sites included Echo Valley State Park (2 km^2), managed by the Fayette County Conservation Board, and the Volga River State Recreation Area (30 km^2), managed by the Iowa Department of Natural Resources (Fig. 1). Both parks contain upland oak woodlands and bottomland forests. The dominant oak trees within upland oak woodlands consist of white (*Quercus alba* Linnaeus), red (*Quercus rubra* Linnaeus), and black (*Quercus nigra* Linnaeus) oak with a growing number of sugar maple (*Acer saccharum* Marshall) and American bass wood (*Tilia americana* Linnaeus) tree species (Mutel 2008). Bottomland forests mainly consist of common hackberry (*Celtis occidentalis* Linnaeus), common hawthorn (*Crataegus monogyna* Joseph von Jacquin), green ash (*Fraxinus pennsylvanica* Marshall), boxelder maple (*Acer negundo* Linnaeus), and black walnut (*Juglans nigra* Linnaeus) tree species among others (Mutel 2008). Forest sites also consisted of areas with closed canopy with a relatively open understory.

The 2 prairie sites included the Rush Farm Prairie Preserve (1 km^2), managed by the Fayette County Conservation Board, and the UIU prairie site (0.12 km^2), managed by the Department of Biological Sciences at Upper Iowa University (Fig. 1). Both sites can be considered mesic prairies containing well drained, dark, and rich soil in areas with ample rainfall. These prairies contain a wide variety of wildflowers, prairie forbs, and tall grasses such as big bluestem (*Andropogon gerardii* Vitman) and Indiangrass (*Sorghastrum nutans* Nash) (Mutel 2008). Prairie sites also consisted of areas of no canopy cover with very dense vegetative ground cover.

MATERIALS AND METHODS

Research was conducted from 30 July 2009 through 17 September 2009, with the use of 3 different trap types (scent

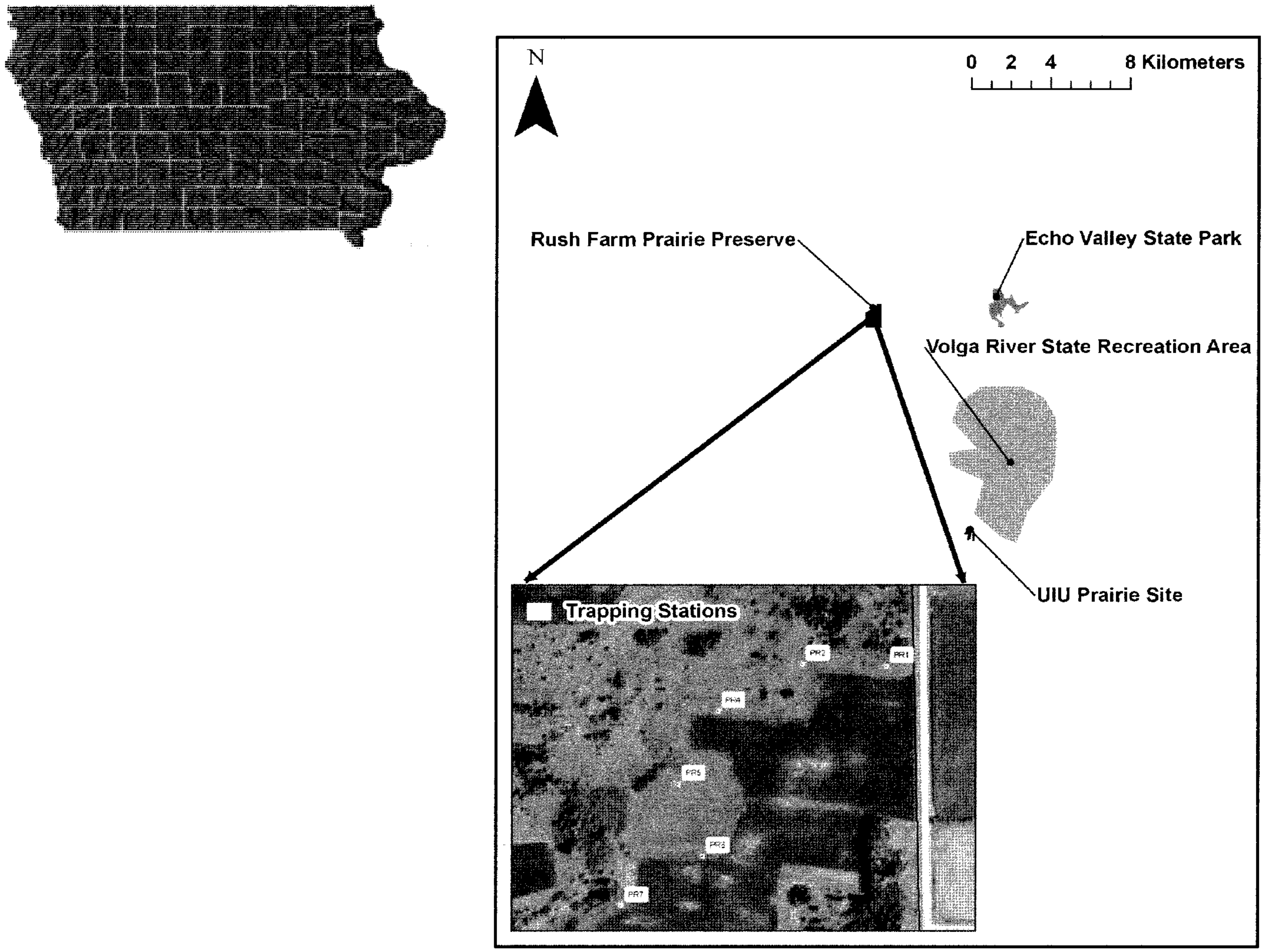

Fig. 1. Our 4 study sites located in Fayette County, Iowa. Two forest sites included the Volga River State Recreational Area and Echo Valley State Park, and the 2 prairie sites included the Rush Farm Prairie Reserve and the Upper Iowa University (UIU) Prairie Site. Trapping stations are illustrated for the Rush Farm Prairie Reserve. Trapping stations are spaced ≥ 100 m from each other.

stations, camera traps, and a combination trap). Scent station trap setups consisted of a 1 m diameter area of cleared and sieved soil used to accurately detect mammal tracks. A shovel was used to loosen the soil by breaking apart plant material and loosening rocks. Sieving was then conducted to remove large pieces of soil, rock and plant material. A shovel was then used to smooth and level the soil surface to allow for accurate track identification (Elbroch 2003). Remote camera-trap setups (i.e., camera) consisted of a Reconyx® silent image RM45 rapid-fire passive sensor camera. These camera traps were set up 0.5 m above the ground 1 m in front of a scent station area (all trapping stations contained a scent station area). In prairie sites, a steel fence post was used to mount cameras, while on forest sites trees were utilized. The Reconyx® silent image RM45 cameras addressed some of the remote camera shortcomings outlined by Lyra-Jorge et al. (2008). This remote camera model minimizes capture delays with a 1/10 second trigger speed for quicker captures, and it uses high powered infrared illumination for night photos instead of a bright flash, which can reduce camera shyness in mammals. Combination trap setups (i.e., combo traps) consisted of a scent station and a remote camera trap used together at the same site. These sites were used to compare the results of running both trap types (scent station and remote camera) at the same station to further determine capture differences between remote-cameras and scent stations. When using a combo trap, if the same mammal was captured by both the remote camera and scent station we considered this as one successful capture when comparing combo traps to remote cameras and scent station traps. However, when we compared the capture success of scent stations and remote cameras used within the combo traps, the same mammal was treated as a separate capture event for comparative analysis.

All trap set-ups were baited with a sprinkle of Shake Away® (a commercial animal scent consisting of bobcat and coyote urine granules) and a 2 cm cube of beef liver, which was placed in the center of the scent station area. All captures recorded at trapping stations were only recorded within the limits of the scent station area (all trapping stations contained a scent station area). If an animal was outside the scent station area, but was detected by track or remote-camera, it was not recorded as a capture.

Table 1. Total number of captures for each mammal species within each habitat type (i.e., prairie and forest) by each trap type (i.e., scent station, remote-camera, and combination of both [combo]).

	Forest Habitat				Prairie Habitat				
	Trap Type			Habitat	Trap Type			Habitat	Total
Mammal Species	Camera	Combo	Scent	Total	Camera	Combo	Scent	Total	Captures
Peromyscus spp.	41	43		84	3	1		4	88
Sciurus carolinensis Gmelin	37	33	14	84			1	1	85
Procyon lotor Linnaeus	19	25	21	65		3	1	4	69
Odocoileus virginianus Zimmermann	10	13	4	27	6	1	7	14	41
Sylvilagus floridanus Allen	3	1		4	3	14	2	19	23
Didelphis virginiana Kerr	5	6	5	16			1	1	17
Tamias striatus Linnaeus	9	4	2	15					15
Scalopus aquaticus Linnaeus		5	4	9					9
Neovison vison Schreber					1	3		4	4
Zapus hudsonius Zimmerman						3		3	3
Felis catus Linnaeus		1	1	2		1		1	3
Microtus spp.					2			2	2
Canis latrans Say			2	2					2
Rattus norvegicus Berkenhout		2		2					2
Canis lupus familiaris Linnaeus					1			1	1
Spermophilus spp.							1	1	1
Mus musculus Linnaeus					1			1	1
Blarina brevicauda Say					1			1	1
Marmota monax Linnaeus						1		1	1
Totals	124	133	53[a]	310	18	27	13	58	368

[a]Significantly lower number of captures compared to combo and camera trap types in forest habitat based on a p-value < 0.05.

Each study site contained six randomly placed trapping stations $\geq$ 100 m apart. The trapping stations contained one of three trap types per survey evening: scent station, remote camera, or a combo trap. Trapping stations were placed randomly off animal trails. All three trap types were present in both prairie and forest sites. Six trapping stations were monitored consecutively during three evening intervals, three in the forest and three in the prairie. After each evening scent stations were checked for tracks and trap types were switched between trapping stations so as to represent all trap types on each trapping station within the three evening period. After the third evening, trapping stations were moved to six new trapping stations, three in the forest and three in the prairie. These trapping stations were monitored for another three evenings and rotated in the same manner. This effort represented a survey week for a total of six trap nights for each trap type during a survey week. At the end of every survey week the cameras were brought back to the lab to review the pictures and record captures results. During the next survey week the other two study sites (one forest and one prairie) were surveyed and the methods outlined above were repeated. The trapping stations used in this study were logged using a GPS unit. In addition, the date, time, study site, habitat, trapping station ID, weather conditions, and survey results were recorded for each trapping station during each survey evening.

We used both Kruskal Wallace and Mann-Whitney tests to compare the number of animals captured in forest and prairie habitat using all three trap types (i.e. camera, scent, and combo). In addition, we used chi-square tests to test for differences in proportion of total number of species caught using different trap types within different habitat types, and we used chi-square tests to compare capture success of scent stations and remote cameras when using combo traps. Based on number of animals captured, we also determined the latency to detection of species, which is a timeline of the number of species captured using each trap type within each habitat type (Foresman & Pearson 1998). For latency of detection we also determined which trap type captured the greatest diversity of mammal species in each habitat type using a Kruskal Wallace test. Statistical significance was based on a $P \leq 0.05$, and all calculations were conducted using the program MiniTab®.

RESULTS

This study resulted in a total of 216 trap nights with 108 trap nights for each habitat type and 72 trap nights for each trap type. We recorded a total of 368 captures, with 160 captures using combo traps, 142 using camera traps, and 66 using scent stations. We found that the number of animals captured differed between trap types and habitat types ($z > 10.24$; $P<0.01$; $df = 2$). Using Mann Whitney tests we found that in forest habitat both remote cameras ($n = 124$) and combo traps ($n = 133$) captured significantly more animals compared to scent stations ($n = 53$) ($P<0.05$; $df = 1$), while in prairie habitat we found no significant difference in the number of mammals captured between trap types (remote camera $n = 18$, combo $n = 27$, scent station $n = 13$) ($P>0.27$; $df = 1$) (Table 1).

The total number of species captured during our study was 19. We recorded 11 species captured in the forest and 15 species captured in prairie. Seven species were captured in both habitats, 4 species were captured only in the forest habitat, and 8 species were captured only in the prairie habitat. We found no significant difference in proportion of species richness between trap types for forest habitat ($\chi^2 = 0.56$; $P = 0.76$; $df = 2$) and prairie habitat ($\chi^2 = 0.36$; $P = 0.83$; $df = 2$) and we found no significant interaction in proportion of species richness between trap types and habitat types ($\chi^2 = 0.39$; $P = 0.83$; $df = 2$).

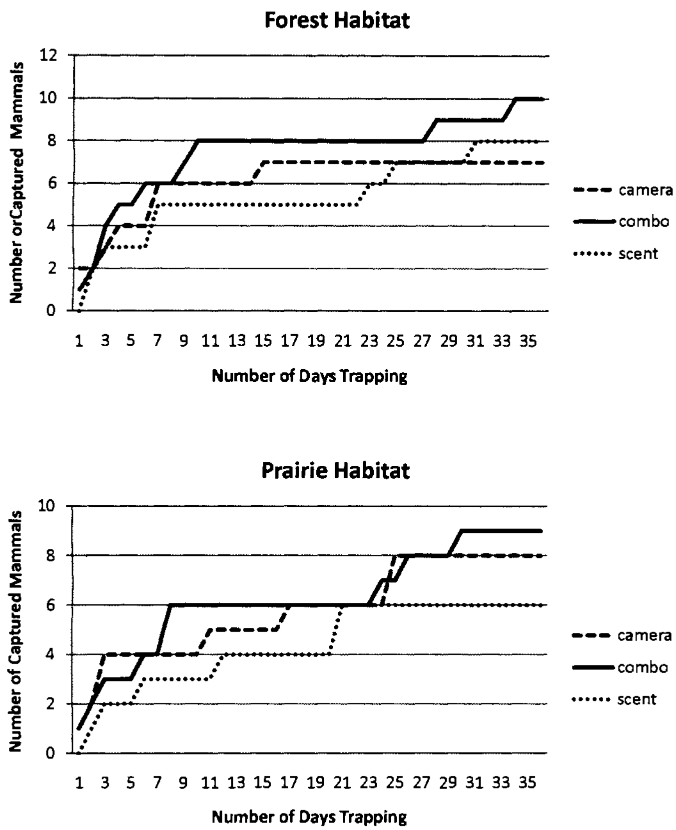

Fig. 2. Comparison of latency to detection (time between trap deployment and first detection) of all mammal species captured with remote camera traps (camera), scent station traps (scent), and a combination of remote camera and scent station traps (combo) within both habitat types (forest and prairie).

Using combo traps, we had a total of 153 separate captures from both remote cameras and scent stations in forest habitat. Of these captures, 117 were recorded using remote cameras, while 36 were recorded with scent stations. In the prairie habitat, we had a total of 36 separate captures from both remote cameras and scent stations. Of these captures, 26 were recorded by remote camera traps and 10 by scent stations. When analyzing combo traps separately, we found that remote camera traps recorded significantly more mammals than scent stations in both habitat types ($\chi^2 \geq 7.11$; $P < 0.05$; df = 1).

Analysis of latency to detection showed that both prairie and forest habitats had similar patterns in the number of mammals captured by trap type (Fig. 2). We found that combo traps and remote cameras caught a greater diversity of mammal species in 36 days compared to scent stations ($z > 2.89$; $P < 0.05$; df = 1) in prairie habitat. In forest habitat, combo traps caught a greater diversity of mammal species in 36 days compared to both scent stations and remote cameras ($z > 4.47$; $P < 0.01$; df = 1).

DISCUSSION

Results from studies that have compared noninvasive survey methods used to monitor wildlife populations have been contradictory, possibly due to different habitat conditions associated with the various studies (Barea-Azcón et al. 2007). The goal of this study was to determine which commonly used noninvasive technique, scent stations or remote-cameras, had the greatest capture success in 2 different habitat types. We found that our null hypothesis was not supported; combo traps had the highest capture success, while scent stations had lower capture success compared to combo trap and camera traps, especially in forest habitat (Table 1). Capture success of scent stations was greatly limited due to weather conditions since rain or extremely dry conditions could eliminate some of the potential capture data recorded in the tracks. Although Silveira et al. (2003) and Lyra-Jorge et al. (2008) had better capture success using track captures, they also noted weather limitations of using track capture techniques, and Silveira et al. (2003) recommend the use of remote-cameras to inventory mammals when surveying diverse environmental conditions. In addition, we found that the capture success of scent stations was also limited by their inability to identify small mammal species and multiple individuals of the same species. Also, the disturbance of scent stations by other species also impacted mammal capture success.

The use of covered track plates (i.e., covered traps that use carbon-soot and sticky paper to gather tracks) could address the issue of small species and weather issues for mammal track capture (Fowler and Golightly 1994). However, track plates become extremely cumbersome when they need to be covered to protect them from weather, and track plates still have to deal with other limitations of scent stations; disturbance of tracks by other species, the inability to consistently identify multiple individuals of the same species, and avoidance of covered track stations by certain mammal species (Baldwin et al. 2006).

We attribute our positive results for remote-cameras to the improved technology found in the Reconyx® cameras used in this study in comparison to the cameras used by Silveira et al. (2003), Barea- Azcón et al (2007) and Lyra-Jorge et al. (2008). For example, the remote cameras used in this study recorded captures with no noise, did not use bright light flashes but rather infrared illumination for nocturnal captures, and used digital recording which had a large storage capacity (15,000 photos) compared to 35 mm film (36–60 photos). Interestingly, Lyra-Jorge et al. (2008) noted that remote camera capture results also produced more accurate species identification, allowed an ability to identify individuals for mark-recapture analysis, and could provide insight to potential health or reproductive conditions of mammals.

Improvements in remote camera design have helped eliminate problems such as startled responses, fear-and-avoidance behavior, and displacement in the mammals that were being surveyed (Gibeau et al. 2009). Also, camera-traps can record time of capture to evaluate species activity patterns, and remote cameras do not have to be monitored constantly but can be left unaided in the field for several days, which over time could off-set the initial financial investment of purchasing a remote camera (Lyra-Jorge et al. 2008).

We recorded more successful captures in forest habitat compared to prairie (Table 1). This may have been the result of higher density of mammals occurring in forest habitat compared to prairie habitat. Another potential explanation may be that the dense ground vegetation found in prairie habitat may have limited animal movement or the detection area of our bait. In any regard, in both habitat types it was found that remote cameras appeared to be more efficient at detecting mammals compared to scent stations, especially when comparing the effectiveness of remote cameras to scent stations used in combo traps.

We captured a total of 19 mammal species over a 6 week period in this study. We found that this diversity of captured mammals was relatively high compared to other studies.

Gompper et al. (2006) captured 10 mammal species using track plates and baited cameras over a 3 month period in Albany Pine Bush Preserve in New York State, Lyra-Jorge (2008) only captured 6 mammal species using camera traps and track plots in a one month period in São Paulo State, Brazil, and Silveira et al. (2003) captured a total of 14 mammal species using camera-trapping and track counts in a 44 day period at Emas National Park, Brazil. Our high diversity in mammal captures may have been the result of improved remote camera design.

Of the 19 mammal species captured in this study, only one species was found in both habitats by all three survey methods; the white-tailed deer (*Odocoileus virginianus* Zimmermann) (Table 1). Other species recorded in this study but only found in forest habitat included the eastern mole (*Scalopus aquaticus* Linnaeus), eastern chipmunk (*Tamias striatus* Linnaeus), eastern coyote (*Canis latrans* Say), and Norway rat (*Rattus norvegicus* Berkenhout). Mammal species only captured in prairie habitat included a *Microtus spp.*, American mink (*Neovison vison* Schreber), meadow jumping mouse (*Zapus hudsonius* Zimmerman), domestic dog (*Canis lupus familiaris* Linnaeus), a *Spermophilus spp.*, short tailed shrew (*Blarina brevicauda* Say), and woodchuck (*Marmota monax* Linnaeus) (Table 1). The eastern coyote, a *Spermophilus spp.* and the eastern mole were only caught on scent stations, which may show a potential wariness of cameras, but there were only a few captures made of these species. In addition, most of the species captured in only one habitat or using only one trap type were caught in low numbers, thus a longer study would be required for further analysis of species specific capture patterns.

Management Implications

The advancement in remote camera technology has greatly increased their effectiveness to monitor mammalian abundance. We recommend that newer models of remote digital cameras with rapid photo speed, large memory storage capability and no glow infrared technology for nocturnal pictures (Gibeau and McTavish 2009) be used to maximize the number of captures of mammals. However, we also found that combining remote-camera survey efforts with scent stations resulted in more mammal captures and a faster latency to detection (Fig. 2). Gompper et al. (2006) found that the use of multiple independent survey techniques were most effective at detecting the presence of multiple mammal species. Thus, albeit track station designs have limitations, identifying areas with fine soil substrate (i.e., areas of mud and sand along puddles, creeks, rivers, and run-off) within a monitoring site to identify presence of mammal tracks while at the same time surveying the same site with newer models of remote digital cameras can increase the probability of mammal detection.

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