Anatomy of a Snake Fence Intended to Prevent Escape of Non-Venomous Rat Snakes (*Elaphe obsolete*) From an Enclosure

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ABSTRACT: We constructed a fence enclosure with the objective of preventing escape of rat snakes (*Elaphe obsolete*) as part of a repellent study. A 25cm trench was dug in a 30m × 30m square (0.1ha) in an unimproved pasture. Wood posts (8.9cm × 8.9cm × 2.0m) were secured on corners and at 15m intervals between each corner at an average height of 128.5cm ± 0.5 height with an inward slope of 17.1° ± 0.5. Steel T-posts (2.0m) were erected to a similar height and angle at 4m intervals between wood posts and fitted with plastic insulated caps. Three strands of 17-gauge wire were secured to the top, middle and 10cm above the ground of each post. Plastic sheeting (3.04m × 30.4m × 4mm) was draped over the suspended wires with the bottom 25cm secured within the trench with dirt. All overlapping seams of plastic were secured with polypropylene tape. A single strand of 17-gauge electric fence wire and a strand of electric polyfence tape were attached by duct tape to the top of the inside of the plastic fence. An additional strand of electric polyfence was attached by duct tape to the plastic 20cm above the ground. A loop of the electric polytape was also attached in each corner and connected to the wire and polytape on the top and lower strand of polytape. The electric fence strand and all polytape was energized by a solar powered charger with an output > 5000v. During two releases of 5 mature rat snakes (n = 10; 136.7cm ± 6.4), containment within the enclosure was similar ($p > 0.05$), and limited to 9.1h ± 1.8 and 9.4h ± 1.8 respectively. Video analysis indicated snakes were climbing the electric charged polyfence tape and escaping over the fence without evidence of receiving an electric shock. This fence design was not sufficient to maintain mature rat snakes.

Key Words snake enclosure, rat snake

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The effects of fencing for snakes has been evaluated for decades. In some cases, concern of mortality of snakes as a result of entanglement in fencing, predominantly intended for erosion control, has been reported (Kapfer and Paleski 2011, Walley et al. 2005). However, most efforts related to fencing have been for exclusion purposes.

The development of fencing designs and materials tested are numerous. Materials suggested for fencing purposes have included: textured cloth/erosion fencing

(Baxter-Gilbert et al. 2015, OMNR 2013, Walley et al. 2005), weather shade (Perry et al. 1998), wire mesh (Anderson et al. 1998), netting (Perry et al. 1998), vinyl (Vice and Pitzler 2000, Perry et al. 1998), masonry (Perry et al. 1998), concrete (Perry et al. 2001, Vice and Pitzler 2000), flyash applied to a foundation wall (Rodda et al. 2007), and various combinations of electrified fencing often in association with materials previously presented (Campbell 1999, Perry et al. 1998, Hayashi et al. 1983).

Several designs of snake exclusion fences include details of construction but little evidence of effectiveness (OMNR 2014, Byford 1994, Brock and Howard 1962). Perry and coworkers (1998) reported that success in development of an exclusion fence requires consideration of fence height, an overhang or lip at the top of the fence, as well as a smooth surface. The addition of electrified wire or poly tape has also been found to be a useful component of an effective fence, particularly if mortality of the animals is not a concern (Campbell 1999, Perry et al. 1998, Hayashi et al. 1983). It has also been suggested that burying the fence below ground level is important to prevent snakes from escaping at or below ground level (Baxter-Gilbert et al. 2015, OMNR 2013, Byford 1994, Brock and Howard 1962).

The recommended height of snake exclusion fences ranged from <1m (Baxter-Gilbert et al. 2015) to 2m (OMNR 2013). However, effectiveness of some of these fence heights is not reported (OMNR 2013, Byford 1994, Brock and Howard 1962) or found to be ineffective (Baxter-Gilbert et al. 2015). For the Brown tree snake (*Boiga irregularis*), an arboreal species, fences ranging from 1.1m to 1.4m in height, with an overhang of .2m has been reported to be effective using various fence materials (Rodda et al. 2007, Perry et al. 2001, Campbell 1999).

Cost of implementation of the fence as well as longevity and maintenance are important considerations. While concrete or masonry structures are reported to be effective, they would likely be cost prohibitive under a number of scenarios. Therefore, the objective of this study was to construct an inexpensive, short-term fence designed to keep snakes within an enclosure as a component of a repellent study

STUDY AREA

This study was conducted on the 1,215 ha Berry College Wildlife Refuge (BCWR) within the 11,340 ha Berry College campus in northwestern Georgia, with the approval of the Berry College Institutional Animal Care and Use Committee and under the Georgia Department of Natural Resources Scientific Collecting Permit. The site used for this study was characterized as an unimproved pasture at the Berry College Sheep Center. The forage consisted predominantly of fescue (*Schedonorus phoenix*), orchard grass (*Dactylis glomerata*), and interspersed with Bermuda grass (*Cynodon spp.).* Forested areas within 200m include various species of pines (*Pinus* spp.), oaks (*Quercus* spp.) and hickories (*Carya* spp.).

METHODS

A 25cm trench was dug using a commercial trenching machine, in a 30m × 30m square (.1ha) of the unimproved pasture. Round wood posts (8.9cm × 8.9cm × 2.0m) were secured on corners and at 15m intervals between each corner resulting in a vertical height of 128.5cm ± 0.5 and an inward slope averaging 17.1° ± 0.5. Steel T-posts (HDX, Model# 901176HD, Home Depot, Atlanta, GA), 2.0m in height, were erected to a similar height and angle at 4m intervals between wood posts and fitted with plastic insulated caps (Model #: ITCPB-ZC, ZarebaSystems, Lititz, PA). Three strands of 17-gauge wire (Model# 317752A, FarmGard, Glencoe, MN) were secured to the top, middle and 10cm above the ground of each post to provide a support lattice for the plastic sheeting. Plastic sheeting (Model # CFHD0410C, HDX, Home Depot, Atlanta, GA) with dimensions of 3.04m x 30.4m x 4mm, was draped over the suspended wires with the bottom 25cm buried within the trench with dirt. All overlapping seams of plastic were secured with polypropylene tape. A single strand of the 17-gauge electric wire (Model# 317752A, FarmGard, Glencoe, MN) was also attached to the top inside edge of the plastic fence using duct tape. An additional strand of electric polyfence tape (Model # 631666, Farm Supply, Barnesville, GA) was also attached by duct tape to the top of the inside of the plastic fence, and to the plastic 20cm above the ground. A loop (3m) of electric polyfence tape was placed in each of the four corners of the enclosure and attached to both the top electric wire and polytape and the lower section of polyfence tape. This configuration was done to energize the electric polyfence tape located near the ground and to reduce the chance of corners of the enclosure from being used to facilitate escape by the snakes. The electric wire and electric polytape was energized by a solar powered charger with an output >5000v and .07J (ZarebaSystems, Lititz, PA). Artificial and natural brush hides, as well as numerous containers with water were provided. Two white oaks (*Quercus alba*) and Loblolly pine (*Pinus taeda*) were also located within the experimental site.

Mature wild rat snakes (n=10; 136.7cm± 6.4) were hand captured for each of two release periods, and placed in 40L aquariums and provided water and food. Radio transmitters (Ag392, Biotrack LTD., Wareham,Dorset, UK) were attached externally approximately 25cm cranially to the cloaca, using cyanoacrylate glue and camouflaged duct tape. During each of the two release periods, snakes (n=5) were released into the enclosure with the location of each animal determined by using a radio receiver (R-1000, Communications Specialist Inc., Orange, CA), tuned to the attached radio transmitters, 3 times per day for each 7-day period. Digital day/night infrared cameras (SN502-4CH; Defender Inc., Cheektowaga, NY) were positioned 10m from each corner of the enclosure, and recorded on DVR's prior to the second release of snakes.

Evaluation of the duration snakes were maintained within the enclosure was conducted using one-way ANOVA analysis procedures of IBM SPSS 24.0 (SPSS 24.0 2016).

RESULTS AND DISCUSSION

Significant effort in snake fencing has been related to the Brown tree snake as an invasive species with tremendous impact on fauna where introduced. It is typically less than 3m length, and tends to be thinner, nocturnal, and more arboreal than many snakes (Rodda and Savidge 2007). Perry and coworkers (1998) outlined primary considerations in constructing a snake fence including: height, a smooth surface, an overhang to decrease the ability to climb vertically and the addition of electrified wire. It was also suggested that interior corners of a fence should be greater than 90° to prevent use of these edges to breach the fence. The height of fences reported effective for the Brown tree snake ranged from 1.1m – 1.4m (Rodda et al. 2007, Campbell 1999), with a .2m overhang, composed typically of solid smooth materials with various configurations of including electrified fencing (Rodda et al. 2007, Perry et al. 2001, Campbell 1999).

In the current study, the objective was to construct a temporary fence to create an enclosure as part of a repellent study. Concepts presented by Perry and coworkers (1998) were incorporated in the fence design. The average fence height was 128.5cm ± 0.5, with an inward slope of 17.1° ± 0.5 to serve as an overhang. Plastic sheeting was used as a smooth surface and was also buried in the ground at least 25cm. Electrified wire, and electrified polytape was utilized on the inside top of the fence, 20cm from the bottom of the fence and within the corners to discourage escape.

During the first of two releases of mature rat snakes, (n = 10; 136.7cm ± 6.4), containment within the enclosure was limited to 9.1h ± 1.8. With no visible evidence of how snakes escaped, digital recordings were obtained from cameras with day/night capabilities placed within the enclosure. Following the second release of snakes (n = 5), the duration (9.4h ± 1.8) of containment within the enclosure was similar ($p > 0.05$) to the first release. Analysis of the digital recordings provided clear evidence that snakes were utilizing the loops of electric polytape in the corners to escape. While it was verified daily that all polytape, the electric wire on top of the fence and the loops of polytape in the corner were electrified, the video recordings provided no visible evidence of a snake receiving a shock. It is likely that snakes were not being sufficiently grounded to receive an electrical shock intended to discourage climbing due to the exceptional drought conditions occurring during the experiment. Based on these results, this fence design was not sufficient to maintain mature rat snakes.

It should be noted that when a repellent being tested for this study was applied in a 20 cm strip along the interior of the plastic fence, a third release of snakes (n = 6) were maintained within the enclosure for the entire 7-day experimental period. Regardless, the pairing of a ground wire in close proximity to energized wires would likely increase the chance of a snake receiving an intended shock when using electric fence materials including potentially the corners.

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