An evaluation of EGG™ and wire cage traps for capturing raccoons

James Austin, Michael J. Chamberlain, Bruce D. Leopold, and L. Wes Burger, Jr.

Abstract *Raccoons (Procyon lotor) are captured frequently for research purposes using wire cage and various restraining traps, and gender biases exist in the animals' response to traps. Previous studies have demonstrated the effectiveness and humaneness of the EGG (EGG Trap Company, Springfield, S.D.) trap compared to foothold traps, but researchers primarily use wire cage traps to capture raccoons. In this paper we compare performance of wire cage traps and EGG traps for capturing male and female raccoons and discuss cost-effectiveness of using both trap types during a 3-year field study in Mississippi. EGG traps were more likely to capture raccoons than cage traps; both genders also were more likely to be captured in EGG traps. EGG traps were particularly more effective at capturing male raccoons than cage traps. Events in which traps were sprung but no raccoons were captured were greater when using cage traps. Purchase costs were considerably lower for EGG traps. Our findings suggest that EGG traps perform better at capturing raccoons than wire cage traps. Given our findings, and earlier studies demonstrating reductions in injuries with EGG traps relative to foothold traps, we recommend that researchers consider using EGG traps to capture raccoons in field studies.*

Key words EGG TM trap, Mississippi, *Procyon lotor*, raccoon, trap performance, wire cage trap

Raccoons *(procyon lotor)* are frequently studied, and researchers trapping raccoons commonly use wire cage traps because of the relatively low injury rates to captured animals and the ease of releasing nontarget animals associated with their use. Similarly, EGG TM traps (EGG Trap Company, Springfield, S.D.); (reference to trade names or companies does not constitute endorsement) have been found to be a humane and effective alternative to several types of foothold traps to capture raccoons (Proulx et al. 1993, Hubert et al. 1996). However, no published studies have compared the performance of EGG and wire cage traps, although a review of current raccoon literature demonstrates that most researchers rely partially or solely on cage traps (see Chamberlain et al. 2003, Gehrt 2003).

Previous studies have suggested that raccoons may exhibit a gender-biased response to cage traps, with males having a greater probability of capture than females (Sanderson 1951, Johnson 1970, Gehrt and Fritzell1996). This difference in capture probabilities may result from males having larger home ranges and making greater movements than females, thus increasing their probability of encountering a trap set. Furthermore, Gehrt and Fritzell (1996) suggested that differential responses by male and female

raccoons to cage traps was likely due to a difference in behavior and probability of capture, which likely resulted from differing movement patterns and individual response to traps. Gender-specific response to traps has important implications to research; therefore it is important to evaluate alternative trap types that may reduce or eliminate this gender bias. Additionally, the performance of trap types is important when selecting traps for research purposes. For instance, the capture *of* nontarget animals and instances where traps are sprung but no animal is captured may negatively affect capture studies. Therefore our objective was to compare the performance *of* EGG and wire cage traps for capturing raccoons. Secondarily we discuss cost-effectiveness related to purchase cost.

Study area

We conducted this research on the 2,024-ha Black Prairie Wildlife Management Area (BPWMA) located in Lowndes County, Mississippi, in the Black Prairie physiographic region. Mean annual precipitation was 150 cm, and mean annual temperature was 17°C (Owenby and Ezell 1992). Prior to our study, BPWMA was farmed intensively and used for cattle production. Primary land use during our study consisted *of* pasture and hayfields (28%), crop fields (25%), Conservation Reserve Program (CRP) fields (24%), woody cover (20%), ponds and lakes (1%), old fields (1%), and roads (1%). The BPWMA was purchased by the Mississippi Department *of* Wildlife, Fisheries and Parks in 1996 with the primary goal *of* providing high-quality habitat for northern bobwhites *(Colinus virginianus*) for bird-dog field trials and public hunting. Since then management on BPWMA has included prescribed burning and herbicide application to aid in removal of exotic grass species, strip disking to maintain early-successional plant communities, and addition *of* woody corridors to increase interspersion and juxtaposition of cover in large crop fields.

Methods

Before trapping was initiated we developed a 55- cell grid system using the fishnet extension in ArcView 3.2 (Arc View GIS Version 3.2. 2000, Environmental Systems Research Institute Inc., Redlands, Calif.) and projected the grid over a land-cover data layer *of* BPWMA. We constructed the grid-cell system to ensure a uniform distribution *of* traps throughout the area. Each grid cell was approximately 40 ha and contained one trap *of* each type. Within each cell we chose specific trap sites based on abundance *of* raccoon sign and ease *of* accessibility. We only used sites readily accessible with an all-terrain vehicle to ensure that traps could be checked in a timely manner (prior to 0900 hours) to minimize time spent in traps by captured animals.

Within each grid cell we used a paired design (Woodstream Corporation, Utitz, Pa.) positioned <5m apart and baited with one-half can of commercially produced cat food. We set EGG traps in dry sets - at each set the trap was buried except for its face. We placed cage traps near some type of structure (e.g., logs, brush tops, trees) or covered them using materials available at the site. We conducted trapping from 15 January-4 February 2000, 24 January-8 February 2001, and 13 January-l February 2002. Average daily temperatures during trapping sessions were 4.2°C for 2000, 6.8°C for 2001, and lO.4°C for 2002. Trapping was conducted under Mississippi State University Institutional Animal Care and Use Protocol Number 98-002 and its associated amendments.

We checked traps daily beginning soon after sunrise. Data recorded at the trap site included status *of*

each trap (e.g., sprung, undisturbed, or occupied) and species captured, if applicable. We anesthetized raccoons using an intramuscular injection of ketamine hydrochloride at 8-lOmg/kg of estimated body mass (Bigler and Hoff 1974) and injected them with a uniquely numbered passive integrated transponder (PIT tag). When applicable, we noted signs of injuries to captured animals (foot swelling, abrasions, etc.). We maintained captured raccoons overnight to facilitate recovery and released them the following morning at the capture site. All traps were replaced or reset the same day if necessary.

We developed hierarchical log-linear models to evaluate interactions between trap type, year, and each of the following factors: raccoon captures, gender of raccoons captured, and incidences where traps were sprung but no raccoons were captured. We constructed a saturated model for each factor, which included 3 main effects, all 2-factor interactions, and the 3-factor interaction. We used likelihood ratio tests to hierarchically test the 3-way interaction and select 2-way interactions. In all cases the 3-way effect contributed little to good- ness-of-fit and therefore was removed to produce a new full model with all main effects and 2-way interactions. We tested select 2-way interactions by constructing reduced models containing all main effects and 2-way interactions except the one of interest. The difference in 2 *x* In (L) of the full and reduced models followed a X_2 distribution and provided a measure of relative contribution *of* that effect to the model. To examine associations between trap type, year, and raccoon captures, we developed a saturated model with year (2000, 2001, 2002), trap type (EGG, cage), and raccoon capture (capture vs. all other outcomes) main effects, and trap *x* year, trap *x* raccoon capture, and year *x* raccoon capture 2-way effects. Outcome in this case included raccoon captures and all other outcomes (nontarget captures, cases where traps were sprung but no raccoon captured, and undisturbed traps). To evaluate effects of trap type and year on capture rate, we constructed reduced models with all main effects and 2-way effects except trap *x* capture or year *x* capture.

To examine associations between trap type, gender, and captures, we developed a saturated model with gender, trap type, and capture (capture of a particular gender vs. all other outcomes) main effects, and trap *x* gender, trap *x* capture, and gender *x* capture 2-way effects. Outcome included raccoon captures (within each gender category) and all other outcomes (nontarget captures, cases where traps were sprung but no raccoon captured, and undisturbed traps). To evaluate effect of trap type and gender on capture rate, we constructed reduced models with all main effects and 2-way effects except trap *x* capture or gender *x* capture. Lastly, to examine associations between trap type, year, and instances where traps were. sprung without capturing a raccoon, we developed a saturated model with year, trap type, and traps sprung without capturing a raccoon as main effects, and trap *x* year, trap *x* traps sprung without capturing a raccoon, and year *x* traps sprung without capturing a raccoon 2-way effects. Outcomes included traps sprung without capturing a raccoon and all other outcomes (Le., raccoon captures, nontarget captures, and undisturbed traps). To evaluate effect of trap type and year on the rate of traps sprung without capturing a raccoon, we constructed reduced models with all main effects and 2-way effects except trap *x* traps sprung without capturing a raccoon or year *x* traps sprung without capturing a raccoon.

We calculated log odds ratios by year for each factor to determine the relative probability of a particular outcome based on trap type. We combined trapping data across years to evaluate trap performance specific to raccoon gender. We excluded recaptures of raccoons from analyses to reduce biases

associated with individual response to traps. We discuss comparisons in trap performance (captures of raccoons by trap type), selectivity, and incidences of traps being sprung without capturing raccoons.

Results

We captured 173 raccoons during 5,112 trap nights. Specific to cage traps, we captured 39, 25, and 26 raccoons during 2000, 2001, and 2002 respectively. We captured 56, 33, and 27 raccoons in EGG traps during the same periods. We also had 299 capture events (175 in EGG traps, 124 in cage traps) associated with opossums (*Didelphis virginiana*), 4 with domestic cats, 13 with striped skunks (*Mephitis mephitis*), 3 with domestic dogs, and 5 with cotton rats (*Sigmodon hisPidus*). Besides opossums, all nontarget captures occurred in cage traps. Capture rates differed between trap types ($X_{2/1}$=3.43, P=0.064) and among years ($X_{2/2}$= 21.07, P<0.001). Log odds ratios indicated that EGG traps were 1.04-1.46 times more likely to capture a raccoon than cage traps.

We captured 93 males and 23 females with EGG traps, and 71 males and 19 females with cage traps. Capture rates did not differ between trap types ($X_{2/1}$ =0.01, P=0.92) but did between genders ($X_{2/1}$= 77.86, P). Log odds ratios calculated for each gender indicated that EGG traps were 1.32 times more likely to capture a male raccoon than cage traps, and 1.21 times more likely to capture a female.

EGG traps were sprung 4, 5, and 4 times without capturing a raccoon during 2000, 2001, and 2002, respectively, whereas cage traps were sprung 24, 20, and 7 times during the same periods. Rates of traps being sprung without capturing a raccoon differed between trap types ($X_{2/1}$=24.42, P<0.001) and among years ($X_{2/2}$= 13.14, P=O.OOl). Log odds ratios calculated within each year indicated that cage traps were 1.75-6.13 times more likely to be sprung without capturing a raccoon. At the time of our study, EGG traps cost approximately $114/dozen, whereas wire cage traps cost approximately $540/dozen (Hava-Hart, Woodstream Corporation, Lititz, Pa.).

Discussion

EGG traps were developed as an alternative to traditional foothold traps to capture raccoons and opossums. Specifically, the EGG trap was designed to preclude self-mutilation and was deemed more humane than foothold traps in controlled (Proulx et al. 1993) and field settings (Hubert et al. 1996). likewise, animal care concerns have prompted most researchers targeting raccoons to use various cage traps to minimize injuries to captured animals and allow easy release of nontarget captures. To our knowledge, no research projects on raccoons have exclusively used EGG traps, and a review of the literature indicated that EGG traps have not been reported as used in any current studies on raccoons (Gehrt 2003). Hubert et al. (1996) reported that EGG traps substantially reduced injury scores to raccoons relative to some foothold traps and were more efficient at capturing raccoons. Although one would assume that cage traps further reduce injuries in captured raccoons relative to EGG traps, no published research exists to support that assumption (International Association of Fish and Wildlife Agencies 2000). EGG traps performed better at capturing raccoons relative to wire cage traps in our study, indicating their usefulness in research or management programs, fur trapping, and problems involving nuisance wildlife. Furthermore, we noted no instances (based simply on visual assessments) of injuries to raccoons in EGG traps, and no raccoons exhibited obvious signs of injury (loss of dexterity, etc.) the day of release.

The current literature on raccoons is replete with references to population samples biased toward males (Gehrt and Fritzell 1997, Chamberlain et al. 1999), and a gender-biased response to traps has been reported, with males being more likely to be captured than females (Gehrt and Fritzell 1996). Inter-gender differences in capture probabilities presumably result from differences in encounter rates associated with movement patterns and rates, as well as intersexual differences in response to traps (Gehrt and Fritzell 1996). Overall capture rates differed between genders in our study, and the EGG trap was considerably more effective than cage traps at capturing males. However, the relative improvement in the capture of females using EGG traps was marginal, suggesting no substantial improvement in female capture rates compared to capture rates using cage traps.

Cage traps were more likely to be sprung without capturing raccoons than EGG traps. Trap events in which traps are sprung but an animal is not captured reduce capture rates and may bias density estimates derived from mark-recapture studies. For instance, Nottingham (1985) suggested that an underestimate of trap success occurs when traps are sprung, whether by target or nontarget species. Our results indicate that the EGG trap has a substantial advantage over cage traps in this regard, and using EGG traps would likely contribute to reducing biases created by excessive cases of nonproductive trap-spring events. Similarly, nontarget captures can affect estimates of animal density, and more nontarget species were captured in cage traps than EGG traps, except for opossums, which were captured frequently in both trap types. Having traps occupied by nontarget species eliminates the probability of capturing target animals. Further, observing occupied traps also could make target animals wary of revisiting the trap site.

Cost is an important consideration when selecting traps for research. In fact, we offer that in most research projects, the number of traps used is often determined by budgetary constraints (money available to purchase and monitor traps) rather than specific research objectives. Our findings suggest that using EGG traps in research programs targeting raccoons is more cost-effective, given their cost, efficiency (captures relative to sprung traps without target animal), and selectivity (reduced incidence of nontarget captures apart from opossums). However, lack of long-term durability of EGG traps could potentially affect overall cost-effectiveness. Hubert et al. (1996) reported that cooperating trappers in their study found EGG traps to be durable during a 1-year study and our findings were similar across the 3 years of our study. However, EGG traps used in our study were beginning to show considerable wear within the trap plate. Specifically, the single coil spring that powers the striking bar (see Hubert et al. 1996) showed signs of weakening by the end of our study. Although no EGG traps had to be discarded during our study, it was apparent that some would have to be replaced prior to a fourth trapping session. Research is needed to evaluate cost-effectiveness of various trap types over longer time frames.
We did not directly quantify time required to set either trap type we evaluated or other logistical considerations, such as transportation of traps. However, the relative bulk of carrying large numbers of cage traps may make EGG traps an attractive trap to use when transportation to remote field sites is a consideration. Alternatively, removing nontarget captures from EGG traps is more involved than when these captures occur in cage traps, given that the animal must be physically restrained in some manner. Notably, the design of the EGG trap is somewhat raccoon-specific and therefore limits the probability of nontargets being captured.

Management implications

Our findings suggest that EGG traps are a suitable alternative to wire cage traps in capturing raccoons for research purposes. Hubert et al. (1996) suggested that 3 aspects of trap performance be considered when selecting traps: humaneness, capture efficiency, and trap selectivity. The EGG trap was found to be more humane and efficient than foothold traps and substantially reduce physical trauma to captured raccoons (Proulx et al. 1993, Hubert et al. 1996). Similarly, our findings indicate that EGG traps perform better at capturing raccoons than wire cage traps, as quantified by the frequency of raccoon captures and incidences of traps being sprung without capturing raccoons. A cursory cost evaluation indicates that the EGG trap is more cost-effective than wire cage traps when only the costs of purchase are considered.

The only nontarget captures that occurred in EGG traps involved opossums, certainly because of its design, which is selective for raccoons and opossums. On the other hand, a variety of species were captured in cage traps, and this fact, combined with the significantly greater rate of unproductive trap-spring events in the use of cage traps, suggests that EGG traps are a suitable alternative to cage traps. On areas devoid of opossums, it is likely that EGG traps would greatly outperform cage traps.

Acknowledgments. We appreciate field assistance provided by C. Henner, S. Szukaitis, C. Class, and M. Walker, and the support of D. Godwin, R. Flynt, and R. Miller. The comments of 3 anonymous reviewers and R. Applegate were helpful in improving the manuscript. Funding and support were provided by the Mississippi Department of Wildlife, Fisheries and Parks, the United States Department of Agriculture/Wildlife Services, the Forest and Wildlife Research Center at Mississippi State University, the School of Renewable Natural Resources at Louisiana State University (LSU), and the LSU Agricultural Center.

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