Effect of diet on mass loss of bobcat scat after exposure to field conditions

Ivy A. Godbois, L. Mike Conner, Bruce D. Leopold, and Robert J. Warren

Abstract Many studies have related estimates of predator diet to prey detectability in scats, but no studies have examined effects of diet on deterioration of scat in the field and the ability to recognize the species depositing the scat. Scats from captive bobcats (*Lynx rufus*) fed 1 of 3 diets—(mice [*Mus musculus*] and rats [*Rattus norvegicus*], rabbit [*Oryctolagus cuniculus*], and deer [*Odocoileus virginianus*])—were used to determine the effect of prey species on the integrity of an exposed scat. Diet affected ($P<0.001$) mass loss of scats. Mass loss of scats containing mice and rats was similar ($P>0.05$) to mass loss of scats containing rabbit, but mass loss of scats containing deer was greater ($P<0.05$) than scat containing mice and rats or rabbit. If mass loss of scat reduces the ability of biologists to identify the species depositing the scat, those scats that lose mass at a faster rate would become unidentifiable sooner. These scats would then not be collected or would not be included in predator-specific diet analyses, which could bias the results (e.g., underrepresent the importance of deer in bobcat diet). We suggest that diet-specific mass loss of scats may occur in other species and that research is needed to evaluate this possibility. Studies also are needed to determine adequate sampling intervals to eliminate effects of mass loss bias.

Key words bobcat, captive study, deterioration, diet analysis, mass loss, scat

The food habits of carnivores are primarily studied by scat analyses (e.g., Miller and Speake 1978, Buttrey 1979, Story et al. 1982, Baker et al. 2001). These studies rely on identifying what species deposited the scat and what species' remains are contained within the scat. The source species of a scat is normally determined by the shape, size, and smell of the scat (Danner and Dodd 1982, Story et al. 1982, Bowyer et al. 1983, Ackerman et al. 1984). The species contained within the scat are determined by hair, teeth, bones, toenails, or scales (Stains 1958). Because scat collection is an accepted method for determining food habits (Putman 1984), several studies have focused on improving this process.

Prey digestibility and detectability within scats have received much study (Floyd et al. 1978, Weaver and Hoffman 1979, Meriwether and Johnson 1980, Johnson and Aldred 1982). Floyd et al. (1978) found that larger prey were more digestible, and therefore frequency of occurrence was underestimated in scat relative to actual occurrence in the diet. In contrast, Weaver and Hoffman (1979), Meriwether and Johnson (1980), and Johnson and Aldred (1982) found that smaller prey were more likely to be highly digested and therefore would be underestimated in scat. Kelly and Garton (1997) examined the indigestible matter in scat and linked it back to the occurrence of prey species' remains in scat. They found that amount of bone and teeth of small mammals digested by coyotes (*Canis latrans*) was affected by meal size, prey size, and

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meal composition, but amount of hair digested was not affected by these factors.

Although much research has been done on digestibility of prey items, no research has examined deterioration (i.e., mass loss) of scats containing different prey. Deterioration of scats when exposed under field conditions is attributable to numerous factors, such as desiccation, degradation, decomposition, removal by invertebrates, weather, and so on. If scats containing a particular prey item deteriorate at a faster rate, that prey could be underestimated in the food habits of the predator. It is important to point out that these scats need not completely deteriorate to be underrepresented in a food-habits analysis; they need only deteriorate to the point that a researcher cannot determine the species depositing the scat (e.g., cannot tell whether a bobcat [*Lynx rufus*] or a coyote deposited the scat). It is important to determine whether different dietary items affect the rate at which mass is lost from scats exposed under field conditions. Therefore, we assessed mass loss in bobcat scats containing 3 prey items: mice (*Mus musculus*) and rats (*Rattus norvegicus*), rabbit (*Oryctolagus cuniculus*), and deer (*Odocoileus virginianus*) after exposure under field conditions for 3 or 6 weeks.

Study areas

Captive bobcat facility

We used captive bobcats housed at the Mississippi State University bobcat research facility located on the Forest and Wildlife Center's Blackjack research site in Starkville, Mississippi. The research facility consisted of outdoor pens approximately 6 × 6 × 3 m in size with food bowls and water buckets in each. All housing facilities were approved by the Mississippi State University Institutional Animal Care and Use Committee (IACUC #96-008).

Scat exposure site

We placed scat samples in a small, fallow food plot on Ichauway, the research facility of the Joseph W. Jones Ecological Research Center in Baker County, Georgia, USA. Soils were in the Dougherty Plain physiographic province (Beck and Arden 1983). Soils had a high sand content and overlaid Ocala and Lisbon limestone (Soil Conservation Service 1986). The average maximum daily temperature for the first 3 weeks was 26.28°C, the average minimum daily temperature was 10.56°C, and the total rainfall for the first 3 weeks was 10 cm. The average maximum daily temperature for the entire 6 weeks was 27.06°C, the average minimum daily temperature was 12.67°C, and the total rainfall for the entire 6 weeks was 13.77 cm (Georgia Automated Environmental Monitoring Network, http://www.griffin.uga.edu/bae/).

Methods

Bobcat feeding

We obtained frozen mice, rats, and rabbits from The Gourmet Rodent™ (Archer, Flor.) and Perfect Pets, Inc. (Belleville, Mich.). Mice weighed 23–35 g, rats weighed 100–150 g, and rabbits weighed 928–1,560 g. We obtained the deer diet from hunters. Although it is more likely that a bobcat would eat a combination of prey species, we were interested in how each type of prey species would affect mass loss of scat. Therefore, we used diets composed of one prey type for each bobcat.

We used 12 bobcats in the feeding trials, 6 males and 6 females; all but 2 (1 male and 1 female) were adults. Both juveniles were about 6 months old. All bobcats except the 2 juveniles were housed individually. We fed bobcats a whole chicken and then fasted them for 24 hours. We then fed each bobcat their weighed, trial diet for 5 days and collected scats daily before cleaning the pens. We fed juveniles housed together the same diet and collected together all the scat deposited. Feedings occurred from 3 March 2002 until 8 March 2002.

We assigned diets randomly to bobcats. Each mouse and rat diet consisted of an average of 432.2 ±13.9 g per day. Each deer diet consisted of an average of 807±101.8 g of scrap meat (e.g., meat, hide, and bone) per day. Each rabbit diet consisted of half a rabbit, an average of 580.7±97.4 g per day. We alternated rabbit diets between head half and tail half to ensure that each animal got the same amount of hair and bone (Van Domelen et al. 1992). Although the meal size among diets was variable, we kept the amount of consumable material as constant as possible. We provided water ad libitum.

We placed scats in paper bags labeled with the date, diet, weight of scat, and animal identification. We then placed them in a plastic container and stored them for up to 4 days before they were placed in the field. In an attempt to keep scats as natural as possible, we did not freeze them.

Scat deterioration

Once we collected all scats, we assigned them a number and divided them into 2 sections to standardize scat size. We broke each scat along natural breaks of the scat to minimize disturbance of resulting segments. We placed sample scats in the selected field, grouped by date of collection, but placed them in the area in random order. We placed them in a grid of 6–8 lines with 2–3 individual scats/line. We placed each group of scats about 5 m apart, with individual scats 30 cm apart. We collected and weighed half of the scats in each group after 3 weeks, on 3 April 2002, and the other half after 6 weeks, on 24 April 2002. We calculated the variable "percentage of mass remaining" (final mass/initial mass) after 3 and 6 weeks of exposure. We used an analysis of variance (ANOVA) within a general linear model (GLM) (Dowdy and Wearden 1991) in SAS (SAS Institute, Inc. 1992) to determine whether the arcsine-transformed percentage of mass remaining varied as a function of exposure time, diet, and their interaction.

Results

The mean mass of all sample scats was 17.0±2.1 g (±SD). Sample scats containing deer ranged between 9.8 and 20.8 g, with a mean mass of 16.4 ±2.8 g (±SD). Sample scats containing rabbit ranged between 14.0 and 21.6 g, with a mean mass of 17.4±2.0 g. Sample scats containing mice and rats ranged between 15.3 and 20.3 g, with a mean mass of 17.3±1.2 g. Diet and exposure time did not interact ($F_{2, 83}=0.69$, $P=0.50$) to affect percent of mass remaining. The percent of mass remaining in scats varied as a function of diet ($F_{2, 83}=30.90$, $P<0.0001$). The percent of mass remaining in scats consisting of mouse and rat (65±3 %; ±SE) and rabbit (72±2 %) was similar ($P>0.05$), but there was more mass ($P<0.05$) remaining in scats containing mice and rat or rabbit than in scats containing deer (44±3 %) (Figure 1). Predictably, the percentage of mass remaining in scat also varied as a function of exposure time. Scat picked up after 3 weeks had more ($F_{1, 83}=52.01$, $P<0.0001$) mass remaining (72 ±2 %) than scats picked up after 6 weeks (49±2 %) (Figure 1).

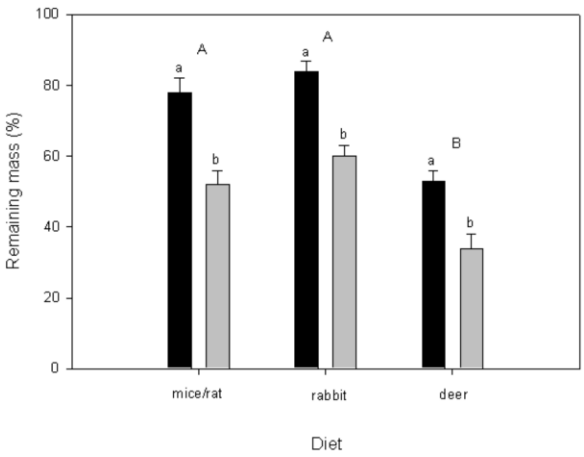

Figure 1. Percent of the remaining mass of bobcat scats (mean ± SE) by diet following 3 weeks (black bars) and 6 weeks (gray bars) of exposure in southwestern Georgia, USA 2002. Different lower-case letters represent differences in mass relative to time exposed within diet; different upper-case letters represent differences in diet regardless of exposure time.

Discussion, research implications, and future studies

Knowledge of scat deterioration is important to researchers for many reasons. Identifying the species that deposited a scat is most easily done when the scat is intact. Although none of the scats in our study disappeared completely, we suggest that mass loss of a scat is inversely related to the ability to correctly identify the source species. Further, because many diet studies are conducted using scat, prey-specific mass loss of a scat presents a potential source of prey bias (i.e., if the source species cannot be identified because a scat contains a prey that is more likely to deteriorate, that prey may be underrepresented in diet studies). For example, if we assume that a 50% mass loss of a scat would result in an inability to recognize the species that produced it, then a 6-week-old bobcat scat containing deer remains would never be collected, whereas one containing mice, rats, or rabbits would be collected (Figure 1). Hence, the occurrence of deer in this hypothetical study of bobcat diets would be underrepresented, solely because of this bias.

Our results suggest that mass loss of scats also may create a bias for researchers attempting to estimate biomass consumed from scat mass (Baker et al. 1993, Kelly and Garton 1997). Here, a correction factor is developed from freshly obtained scats to estimate biomass of prey consumed. Thus, our observation that scats lose mass over time indicates that biomass estimates of prey are likely to be underestimated. If prey-specific mass loss of scats occurs, then using correction factors to calculate

biomass of prey consumed could result in incorrect rankings of dietary items (i.e., rapid mass loss may result in underrepresentation of prey biomass, whereas slow mass loss may result in overrepresentation).

Although we fed a limited number of experimental diets, we suggest that prey size and differential digestibility best explain our results. We found that scat containing deer lost more mass than scat containing smaller mammals. Larger prey items contain proportionately less indigestible material (i.e., bones, teeth, hair) than smaller prey items (Floyd et al. 1978, Baker et al. 1993). Therefore, scats that contained deer contained more residual material that might be more affected by decomposing organisms, rain, or drying, thereby resulting in a faster rate of mass loss from the scats. The scat that resulted from the smaller prey items contained proportionately more bones and teeth that might be less affected by decomposing organisms, rain, or drying, thereby resulting in a slower rate of mass loss for these scats.

As expected, the longer scats were left in the field, the more mass they lost because there was more time for invertebrates or weather to affect the scat. However, this is an important factor in deciding how frequently to make routine searches for scats when conducting a diet study. Because we looked at only 2 time intervals, it is not possible to specify the optimum time to search for scats. To ensure that scats are recognizable as to species depositing the scat, searches should be done as often as possible. Reducing the time interval between searches should help prevent potential prey-specific biases.

Although we looked at mass loss only during spring, we suggest that relative prey-specific mass loss of scats would be similar during other seasons. The absolute rate of mass loss, however, may vary seasonally or under different climatic conditions. Studies should be conducted throughout the year to determine whether our results are applicable to other seasons. Also, similar studies should also be done on other predators to determine whether prey-specific mass loss of scat is a common bias.

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