10-17-2003

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Kurt C. VerCauteren
USDA-APHIS-Wildlife Services, kurt.c.vercauteren@usda.gov

Michael J. Pipas
National Wildlife Research Center

Phil Peterson
USDA/APHIS/Wildlife Services program

Scott F. Beckerman
USDA-APHIS-Wildlife Services Program, Sc.Beckerman@aphis.usda.gov

From the Field

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Kurt VerCauteren, Michael Pipas, Phillip Peterson, and Scott Beckerman

Deer (*Odocoileus* spp.) cause an estimated loss of $100 million in United States agricultural production each year (Conover 1997). In 1984 the Wisconsin Department of Agriculture, Trade and Consumer Protection surveyed producers in the state and estimated that white-tailed deer (*Odocoileus virginianus*) damage to all agricultural products exceeded $36 million annually (Wisconsin Department of Agriculture, Trade and Consumer Protection 1984). Nationwide, for stored crops alone, wildlife reportedly caused $26 million in losses in 1989 (Wywialowski 1994). Despite sometimes biased producer estimates of the value of wildlife-caused losses (Wywialowski 1994), many landowners are willing to accept a certain level of damage for the aesthetics and recreation deer provide. Thus, although agricultural producers' tolerance of deer is influenced strongly by crop-damage concerns (Brown et al. 1978), they are typically willing to accept damages of ≤10% of the crop's value (Craven et al. 1992). Sociological and ecological factors, however, complicate crop-damage management decisions (Campa et al. 1997).

Many producers believe that during the winter when food is limited, deer arrive at stored crop sites with empty stomachs and consume large amounts of crop. Managers need methods to accurately estimate agricultural losses caused by deer and other wildlife, but few have been developed. Techniques developed for evaluating damage have targeted crops standing in the field rather than stored crops. Our literature search of several databases found no citations enumerating losses of stored crops to wildlife.

In Wisconsin, agricultural producers who meet certain eligibility requirements may be reimbursed by the Wildlife Damage Abatement and Claims Program (WDACP) for deer damage to crops, including stored crops. Personnel from the United States Department of Agriculture's Animal and Plant Health Inspection Service-Wildlife Services (WS) program, or a trained county representative, are responsible for assessing deer damage to crops in Wisconsin. These assessments are used by the Wisconsin Department of Natural Resources (WDNR) to compensate eligible agricultural producers through the WDACP (Horton and Craven 1997). In 2000 the WDACP identified over $1.5 million in deer damage to agricultural crops (Carter et al. 2001). Because they currently have no validated method to assess stored-crop damage, the WDNR, WS, and other agencies that measure and provide compensation for wildlife damage base their decisions on subjective, observational, educated estimates. These managers need reliable, objective, and efficient methods for estimating losses of stored crops to deer.

Our objective was to determine the quantity and value of stored agricultural crops (alfalfa haylage, whole-kernel corn, and corn silage) consumed by

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white-tailed deer during a single visit to a stored-crop site. Results of this study will be used by WS to develop an appraisal technique, based on the number of deer feeding at a site over time, for estimating losses and calculating claim payments for deer damage to stored crops. Our methods were approved by the WS-National Wildlife Research Center (NWRC) Institutional Animal Care and Use Committee.

Table 1. Number of white-tailed deer (*Odocoileus virginianus*) collected entering (pre-feeding) and departing (post-feeding) stored-crop sites, by sex and age, southwestern Wisconsin, 25 January–1 March 2001.

Sex	Age	Pre-feeding	Post-feeding
Male	Adult	3	1
Male	Fawn	1	6
Female	Adult	6	4
Female	Fawn	1	5

Study Area

We conducted the study on 2 private farms in southwestern Wisconsin, one in Dane County and one in Iowa County. Agricultural production was the primary land use, and farm fields were bordered by hardwood and coniferous stands and wetlands. Deer mortality due to severe winter weather was rare in the area (Wisconsin Department of Natural Resources 2001). Deer density was approximately 80/km^2 of deer range, well above the goal of 55 deer/km^2 (Wisconsin Department of Natural Resources 2001). Deer densities, deer–vehicle collisions, and crop-damage levels were higher than at any time on record (Wisconsin Department of Natural Resources 2001). Deer damage to stored crops is a relatively new problem that has been increasing in recent years, primarily in late winter (S. Beckerman, United States Department of Agriculture–Animal and Plant Health Inspection Service–Wildlife Services, unpublished data).

Methods

We determined differences between the amount of stomach contents in deer before and after feeding on stored crops. Differences were evaluated by sex and age. We operated with appropriate depredation permits issued by the WDNR to collect 27 deer via sharpshooting. The deer were to be harvested to reduce local population density, regardless of our study. The crops were stored in tubes of thin plastic and were composed of ≥1 of the following types: high-moisture whole-kernel corn, corn silage, or alfalfa haylage. We collected deer on 6 nights between 1900–2300 hr from 25 January through 1 March 2001. Collection took place in late winter, when deer depredation was most prevalent. We collected 11 deer as they approached the stored crops and 16 after they fed and were leaving the stored crops (Table 1). After we determined the age (fawn or adult), sex, and live weight of each deer, we removed the entire stomach and esophagus. We froze the stomachs pending overnight shipment to the NWRC in Fort Collins, Colorado, for processing. We immediately collected reference crop samples from each stored-crop site after deer fed, from the same area. We also froze and shipped these to NWRC.

To process stomach contents, we cut through the rumen wall and removed the contents from all 4 chambers of the stomach and esophagus. We then weighed stomach contents and determined their moisture level by analyzing 3 randomly chosen 4.0-g samples in a moisture analyzer (Mettler Toledo, Greifensee, Switzerland) at an operating temperature of 130°C. We then dried the stomach contents in a forced-air oven (VWR Scientific Products, West Chester, Penn.) at 65°C. We dried contents to the moisture level of the reference sample, which was determined with the same moisture analyzer, so that stomach-content weights were equivalent to when the crop was consumed by the deer.

We used ANOVA (general linear models procedure) to examine differences in stomach-content weight for the independent variables sex, age, and collection time (pre- or post-feeding). We conducted all analyses using SAS (SAS Institute Inc. 1988).

Results

The mean weight of stomach contents, prior to drying, of deer collected while entering a stored feed site was 1,789 g (SE=194.6, range=988-3312, n=11), with a mean moisture content of 81.8%. For deer collected after feeding, the mean weight of stomach contents was 2,201 g (SE=147.5, range=891-3189, n=16), with a mean moisture level of 75.5%. After drying stomach contents to the moisture level of the corresponding reference silage, the mean weight of the stomach contents of deer collected pre-feeding was 500 g (SE=52.9, range=

255-830, $n=11$) and the stomach contents of those collected post-feeding was 643 g (SE=41.2, range = 292-932, n = 16). Hence, deer consumed an average of 143 g dry-weight per visit; this was not a marked difference (F=3.15, P=0.09). Oven-drying time of stomach contents averaged 3 hr 16 min.

The rumens of females contained a mean of 547 g (SE = 40.3, range = 290-807, n=16) of dried feed, while those of males contained 640 g (SE=60.4, range=256-932, n = 11). We found no significant difference between sexes in the amount of feed in the stomachs (F=0.02, P= 0.89). Fawn stomachs contained more feed ($\bar{x}$=608 g, SE=57.3, range=256-932, n=13) than those of adults ($\bar{x}$=563, SE=42.0, range=290-830, n=14), but the difference was not significant (F=0.54, P= 0.47). We did not find any interaction effect between sex and age (F=1.84, P=0.19).

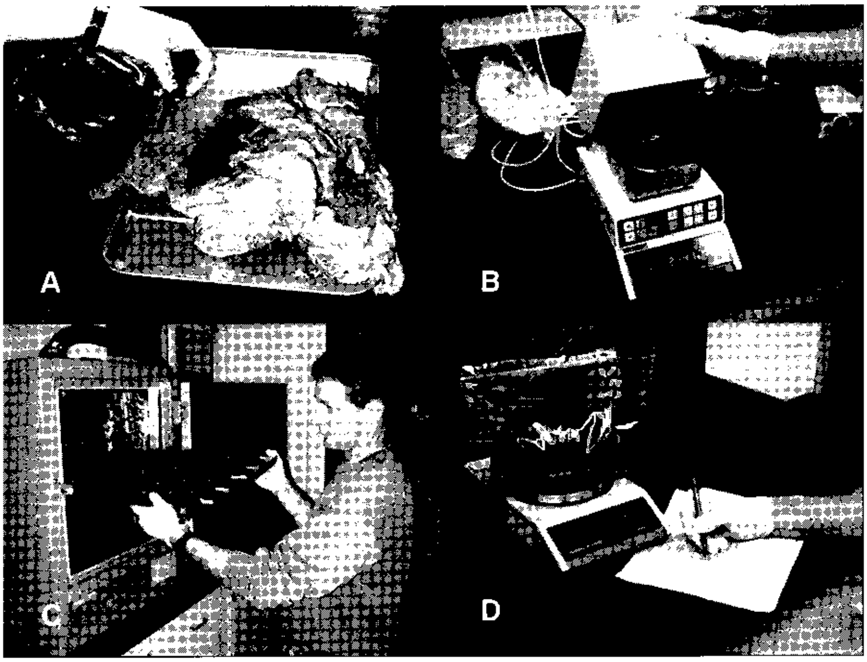

Deer approach a stored-crop site to feed. Note heavily used deer trails on right side of image.

Discussion

The perceived magnitude of the depredation problem was diminished because we found that the 16 deer collected after feeding on stored crops had not filled their stomachs. The economic impact, therefore, was also less than suspected. With corn silage (the most common of the 3 types of silage) currently valued at $19.01/metric ton, the average value of the stored crops consumed/visit was just 0.3¢/deer/visit. In our study, if a local population of 20 deer fed at a site once each day for 60 days, they would consume $3.60 worth of corn silage. We must recognize, however, that the inherent value of stored crops is probably higher than the market value suggests because they are end-use products (grown, processed, and stored on-site) and not typically available on the free market.

Deer in northern latitudes reduce their food intake during winter (French et al. 1956), and their metabolism slows to a relatively torpid, almost semi-hibernating state (Verme and Ullrey 1984). A deer requires about 3,200 kcal of digestible energy each day to maintain itself during this time of year (Ullrey et al. 1970). The amount of digestible energy for stored-crop types at the sites averaged 332 kcal/kg (alfalfa haylage=272 kcal/kg, whole-kernel corn= 399 kcal/kg, and corn silage=326 kcal/kg; online at http://animalscience.ucdavis.edu/extension/pcdairy.htm). Deer eating stored crops containing 332 kcal/kg of digestible energy would need to consume 9.6 kg of stored crops each day to maintain their body condition. The 143 g of stored crops consumed/visit represented only 1.5% of this amount.

Research is required to determine from what other sources deer that depredate stored crops obtain food. Upon an a posteriori examination of the areas surrounding our study sites, we found 6 sites within 2.4 km where supplemental feed (alfalfa hay and whole-kernel corn) had been put out for deer by landowners (who were not agricultural producers). Deer hunters in the area and throughout the region commonly establish bait piles throughout hunting seasons to attract deer to their hunting stands. They bait with agricultural products, primarily corn. Deer begin to visit stored-crop facilities in late winter, after hunting seasons have ended and most hunters have ceased baiting. Hunters and landowners who feed deer are potentially training them to depend upon and seek out these artificial sources of food. An implication of this practice is an increased risk of disease transmission among deer because it concentrates their populations and feeding activity (Wobeser 2002).



To determine the amount of feed a deer had in its stomach, we removed the contents of the stomach (A) and used a moisture analyzer (B) and forced-air oven (C) to bring stomach contents to the moisture level of reference samples of stored crops. We then weighed stomach contents (D).

Since our study, chronic wasting disease has been found at one of our stored-crop sites. Another implication is the increased potential for disease transmission to domestic livestock that might be fed stored feed contaminated by deer. Deer have been implicated for infecting dairy cattle with bovine tuberculosis in Michigan, and hunters baited heavily there (Schmitt et al. 1997).

Other collateral damage caused by deer at stored-crop sites relates to spoilage. Deer sometimes puncture the plastic tube protecting the stored crop from moisture; the resultant spoilage can lead to loss of a substantial volume of stored crops. In addition, agricultural producers occasionally express concerns regarding deer fecal and urine contamination of stored crops at the open end of the plastic tube where deer feed. Producers who choose to discard stored crops that may be contaminated lose approximately 70 L (2 bushels) each time they remove crop from the tube. These crop losses have the potential to be economically significant, and research is needed to address this issue.

Our method of estimating the amount of stored crops consumed by individual deer at 2 study sites on 6 occasions was simple and direct. It also was a meaningful way to gain information from deer that were collected on depredation permits as part of a management effort to reduce local deer density. The method could be applied easily to other types of stored crops and potentially to standing crops. Video, track plots, and other monitoring techniques could be employed to estimate the number of wildlife visits to a site and used to complement our method.

Acknowledgments. We thank D. Hirchert for assisting with sample collection. The Wisconsin Department of Natural Resources and the Sauk County Land Conservation Committee supported and helped fund the study. G. Witmer and R. Sterner provided valuable input on the manuscript.

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Address for Kurt VerCauteren and Michael Pipas: United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins, CO 80521-2154, USA; e-mail for VerCauteren: Kurt.C.Vercauteren@aphis.usda.gov. *Address for Phillip Peterson and Scott Beckerman:* United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services, 1201 Storbeck Drive, Waupun, WI 53963, USA.

Kurt VerCauteren (top left) is a research wildlife biologist in the Product Wildlife Disease Program of the National Wildlife Research Center. He received his B.S. from the University of Wisconsin–Stevens Point, and M.S. and Ph.D. degrees from the University of Nebraska–Lincoln. Kurt is a Certified Wildlife Biologist and is on the board of The Wildlife Society's Wildlife Damage Management Working Group. He has served as Secretary of the Colorado Chapter of TWS and as President and Secretary of the Nebraska Chapter. His current research involves devising methods to assess wildlife damage and tools and techniques to reduce wildlife damage. ***Michael J. Pipas*** (top right) is a biological technician with the National Wildlife Research Center and a Certified Wildlife Biologist. Mike received his B.S. from Indiana University of Pennsylvania (1988) and M.S. from Washington State University (1992). ***Phil Peterson*** (bottom left) is a wildlife specialist with the USDA–APHIS–Wildlife Services program in Wisconsin. He received a B.S. in natural history from University of Wisconsin–Madison. Phil is a member of the Wisconsin Chapter of The Wildlife Society. His professional interests include working with people to manage damage caused by Canada geese, wild turkeys, and white-tailed deer. ***Scott Beckerman*** (bottom right) is a supervisory wildlife biologist (district supervisor) with the USDA–APHIS–Wildlife Services program in Waupun, Wisconsin. He received B.S. (1988) and M.S. (1992) degrees in fisheries and wildlife from the University of Missouri–Columbia. He is a Certified Wildlife Biologist, has been a member of The Wildlife Society since 1987, and is a member of the Society's Wildlife Damage Management Working Group. He has worked with the Wildlife Services program helping people resolve conflicts with wildlife in Missouri, Iowa, and Illinois and currently supervises Wildlife Services' wildlife damage management activities in southern Wisconsin.