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Feed depredation by European starlings in a Kansas feedlot

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Abstract: Confinement cattle-feeding operations have been associated with large populations of starlings (*Sturnus vulgaris*) during the winter months. Starlings can eat nearly 1 kg each of feed per month (Besser et al. 1968). In the first of our 2 studies, we evaluated feed selection and feed depredation by starlings using 5 concentrate-based cattle finishing diets. Four diets evaluated were in traditional meal-type form, and 1 diet was an extruded pellet. We placed rations into a section of the feed trough that we made accessible to starlings but not to cattle. Of the original 13.6 kg of steam-flaked corn and alfalfa hay ration placed into the feed trough at 0750 hours, only 1.9 kg ($P < 0.05$) of residual feed was recovered after starlings returned to their evening roost. Starlings preferentially selected steam-flaked corn (i.e., starch), thereby concentrating the crude protein and crude fiber fractions ($P < 0.04$) in residual feed. We observed similar trends for feed disappearance for the other meal-type rations. However, crude protein content was similar ($P \geq 0.10$) between fresh and residual feed for dry-rolled corn and alfalfa hay diet and for steam-flaked corn and corn silage diet. Quantity and chemical composition between the fresh and residual extruded pellets were similar ($P \geq 0.57$). In Experiment 2, the amount of feed delivered increased 36% for cattle ($n = 13$) that were fed traditional meal-type ration compared to cattle ($n = 13$) that were fed extruded pellets during a period of severe starling infestation. Following seasonal dispersal of starlings in early March, feed deliveries of traditional meal-type ration decreased to pre-starling levels, while feed deliveries of extruded pellets remained unchanged. Starlings consumed 2,327 kg of feed from troughs with a total value of $563 throughout a period of 47 days, increasing daily cost of production by approximately $0.92 per feedlot animal.

Key words: cattle, feedlots, depredation, human–wildlife conflicts, *Sturnus vulgaris*

European starlings (*Sturnus vulgaris*) were first introduced to the United States in the late 1800s (Linz et al. 2007). It is believed that starlings were imported from Europe and released in New York City's Central Park so that all birds mentioned in Shakespeare's works would inhabit the new country. For the next 50 years, the starling population grew exponentially, and by 1942 it had spread to the West Coast (Cabe 1993). Nearly one-third (i.e., 200 million) of the world's starling population inhabits the North American continent (Feare 1984). Starlings inhabiting the High Plains are not considered migratory and remain in the same general area throughout the year (Dolbeer 1982). However, starlings from northern climates can escape snow-covered feeding grounds by migrating up to a distance of 1,500 km (Linz et al. 2007). During much of the year, small, inconspicuous flocks of starlings feed on seeds, fruits, and insects (Tinbergen 1981). However, during winter months, large flocks of several hundred to 1 million starlings will share common feeding and roosting sites. These large flocks prefer to roost in coniferous trees, which provide protection from wind and other adverse weather conditions (Clergeau and Quenot 2007). Bray et al. (1975) documented an average distance of 18 km between roost and feedings sites, which is consistent with the range of 8 to 40 km previously cited by other researchers (Wynne-Edwards 1929, Boyd 1932, Marples 1932, Guarino 1968). Concentrated animal feeding operations (CAFOs, i.e., feedlots and dairies) have been associated with large populations of starlings during winter months (Feare and Swannack 1978, Feare and Wadsworth 1981, Lee 1988). Large flocks of starlings are attracted to the continuous supply of fresh feed in troughs within CAFOs. Previous research has documented that a starling weighing 85 g can consume nearly 1 kg of feed in a 30-day period (Besser et al. 1968). Based on 1968 feed cost ($0.03/lb), Besser et al. (1968) estimated that 1,000 starlings would consume $84 worth of feed during the winter months. With today's ration cost

(≈ \$0.13/lb), this would equate to \$364 worth of feed for 1,000 starlings during the winter months. One report from a California feedlot estimated a \$1,000 daily loss of feed due to a flock of 1 million starlings (Levington 1967). The objectives of our 2 experiments were to evaluate starling depredation on several meal-type rations compared with a pelleted ration containing similar ingredients.

Study area

This study was conducted between October 19, 2006, and March 11, 2007, at a research cattle feeding facility located in Manhattan, Kansas. The research feedlot contained >200 pens of various sizes and had a 1-time capacity of 1,200 animals. A small portion of the pens is fully enclosed, but most were partially or completely open to the environment. One-third of the pens were dirt-surfaced, and the remaining ones were concrete-surfaced. The surrounding area (i.e., within 1.5 km of research feedlot) consisted of native grasslands, cropland, timber, and residential areas. In addition, there was a swine (160-sow capacity) and dairy (200-cow capacity) research operation within 0.2 km of the feedlot. European starlings arrived at the feedlot in January 2007 and dispersed in mid-March 2007. The starlings roosted in mature eastern red cedar trees (*Juniperus virginiana*) located 2.4 km southwest of the feedlot. They arrived at the feedlot at approximately 0750 hours and returned to the roost site at about 1650 hours each day.

Methods

Experiment 1

We used 4 different meal-type diets and 1 extruded pellet diet (Table 2). Dry-rolled corn was processed to a mean geometric particle size of 4.1 mm (ν = 23) using a single-stack roller mill. Steam-flaked corn was processed to a flake density of 360 g/L with a mean geometric particle size of 5.7 mm (*n* = 159). Extruded pellets were processed using a co-rotating, fully intermeshing, twin-screw extruder (Model BCTG-62, Bühler AG, Uzwil, Switzerland). We agglomerated all ingredients, including the dry-rolled corn and alfalfa hay, using the extruder and forced it through a die to form pellets that were 19 mm in diameter and approximately 75 mm in length.

In trial 1, 30 individual feeding sites were constructed by dividing a concrete fence-line feed trough (Pappas Concrete Inc., Holcomb, Kan.) into 76.2-cm sections. Each feeding site (i.e., 6 feeding sites/ration) received 13.6 kg of respective ration prior to the arrival of starlings (0750 hours). Feeding sites were constructed by adhering a 5.1-cm-thick × 15.2-cm-tall piece of wood to the bottom of the feed trough. We secured a 2-gauge wire mesh cattle panel to the pen side of the feed trough to prevent disturbance of feed by cattle. Feed aliquots were made available to starling for the entire day (i.e., 9 hours). After starlings left the feedlot and returned to their evening roost (1650 hours), we weighed and sampled the residual feed. We analyzed samples of fresh and residual feed for crude protein (Leco FP-2000 nitrogen analyzer, Leco Corporation, St. Joseph, Mich.), crude fat (Goldfisch ether extraction method), starch (Herrera-Saldana and Huber 1989) using a Technicon Autoanalyzer III to measure free glucose according to Goldman and Schmitz, 1972) and crude fiber (ANKOM-Fiber Analyzer, ANKOM-Technology, Fairport, N.Y.). This 1-day procedure was repeated for 7 consecutive days (i.e., February 1 to February 7, 2007).

We took photographs of starlings' feed depredation using a digital scouting camera (Cuddeback Expert, 3.0 megapixel, Non Typical Inc., Park Falls, Wis.) approximately 2.5 m above the feed trough. The scouting camera was programmed to record an image hourly from 0600 to 1900 hours. In addition, the motion sensor was activated with a 15-minute delay.

Table 1. Nutrient content of individual feed ingredients used in experimental diets.

Ingredient (%)	Crude protein	Crude fat	Crude fiber
Steam-flaked corn	9.7	4.3[1]	9.0[1]
Dry-rolled corn	10.1	4.3[1]	9.0[1]
Alfalfa hay	14.5	2.4[1]	59.4
Corn silage	8.8	2.6[1]	49.7
Dried corn distiller's grains	29.6	10.0	31.8
Corn steep liquor	32.0	-	-
Urea	291.0[1]	-	-
Soybean meal, dehulled	54.0[1]	1.6[1]	7.8[1]
Supplement	-	-	-

[1]Nutrient content based on 1996 nutrient requirements of beef cattle (National Research Council).

Table 2. Composition of total mixed rations, % (dry matter basis).

Ingredient	DRC[1] with alfalfa hay	SFC[2] with alfalfa hay	SFC with corn silage	SFC with dried distiller's grains	Extruded pellets[3]
Steam-flaked corn	-	81.7	77.8	65.7	-
Dry-rolled corn	84.7	-	-	-	81.7
Alfalfa hay	6.0	6.0	-	6.0	6.0
Corn silage	-	-	12.0	-	-
Corn dried distiller's grains	-	-	-	25.0	-
Corn steep liquor	6.0	6.6	-	-	6.6
Urea	0.4	1.2	1.1	0.4	1.2
Soybean meal, dehulled	-	-	4.6	-	-
Supplement	2.9	4.5	4.5	2.9	4.5

[1]DRC = Dry-rolled corn.
[2]SFC = Steam-flaked corn.
[3]Composition identical to SFC with alfalfa hay diet. Ingredients were agglomerated together to form a pellet by extrusion processing.

Table 3. Feed consumed by European starlings during a 9-hour period (0750 to 1650 hours).

Item	DRC[a] with alfalfa hay	SFC[b] with alfalfa hay	SFC with corn silage	SFC with dried distiller's grains	Extruded pellets[c]	SEM[d]	*P* value
Feed delivered (kg)	13.6	13.6	13.6	13.6	13.6	-	-
Residual feed (kg)	4.7^{ae}	1.9^{b}	3.3^{c}	2.9^{c}	13.6^{d}	0.6	0.01
Feed disappearance (%)	65.5^{ae}	86.0^{b}	76.2^{c}	78.7^{c}	0.0^{d}	4.3	0.01

[a]DRC = Dry-rolled corn finishing diet.
[b]SFC = Steam-flaked corn finishing diet.
[c]Composition identical to SFC with alfalfa hay diet.
[d]SEM = Standard error of the mean.
[abcde]Means within row with unlike letters are different ($P < 0.05$).

Experiment 2

Twenty-six crossbred yearling heifers were housed in individual pens (1.5 m × 7 m), each of which was equipped with a fence-line feed trough (1.5 m) and water fountain. We covered half of the pen and feed trough with a roof. We randomly assigned heifers to diets containing steam-flaked corn and alfalfa hay (i.e., 81.7% and 6.0%, respectively) or to an extruded pellet containing the same ingredient proportions (Table 2). We fed the cattle their respective diets once daily at 0800 hours. We adjusted the amount of feed delivered to each pen daily so that only trace amounts of unconsumed feed remained in the feed trough 22 hours after delivery. We monitored the amount of feed delivered to each pen of cattle for 142 days (October 19, 2006, to March 11, 2007). The objective of this experiment was to evaluate the effects of physical form of rations on feed delivered to cattle as influenced by starling depredation.

Statistical analysis

Feed disappearance due to starlings was analyzed as a randomized complete block design using the mixed procedure of SAS (Version 9.1; Cary, N.C.). Individual feeding sites were grouped into 6 different blocks. Within each block, diets were randomly assigned to one of the 5 homogeneous feeding sites. Feeding site served as the experimental unit. Measurements were repeated for 7 consecutive days.

Seven randomly selected samples of residual feed and 2 randomly selected samples of fresh feed per diet were analyzed as a completely randomized design using the mixed procedure of SAS.

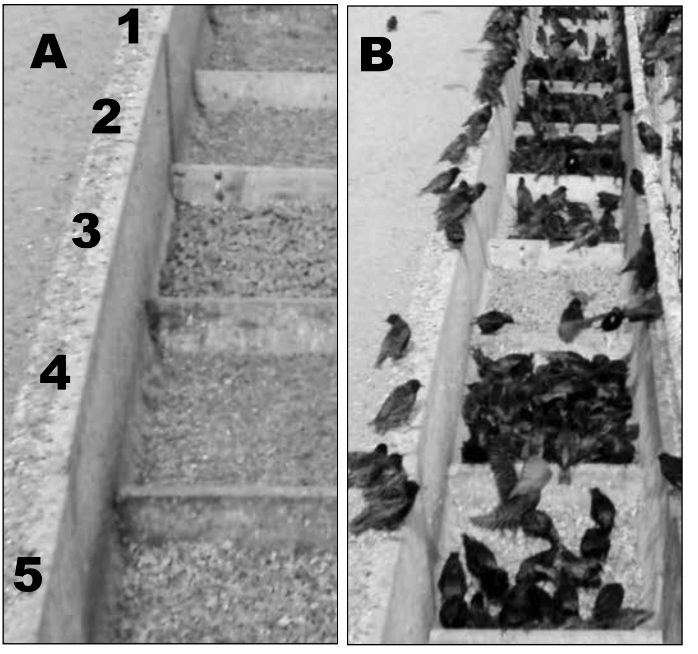

Figure 1. **A.** Illustrates feeding sites before arrival of European starlings. (1) Steam-flaked corn, alfalfa hay, and dried distiller's grains. (2) Steam-flaked corn and alfalfa hay. (3) Extruded pellets. (4) Dry-rolled corn and alfalfa hay. (5) Steam-flaked corn and corn silage. **B.** Illustrates preference by European starlings at the identical feeding locations.

Results

Experiment 1

Table 3 shows amount of feed delivered, residual feed recovered, and percentage of feed consumed by starlings over a 9-hour period. The steam-flaked corn–alfalfa hay ration was subjected to the greatest degree of depredation by starlings (86%; $P = 0.01$), whereas starlings also consumed 78.7% of steam-flaked corn-dried distiller's grain ration and 76.2% of steam-flaked corn-corn silage ration during the same period of time. Of the meal-type diets, the diet consisting of dry-rolled corn-alfalfa hay was the least affected (65.5%, $P = 0.01$) by starling depredation. Starlings did not consume any of the extruded pellets. Figure 1A is a representative photograph of the feeding sites before a feeding episode and Figure 1B during a feeding episode. No starlings were perched in the third feeding site containing the extruded pellets; however, the other feeding sites contained large numbers of starlings. Distribution and density of starlings remained fairly constant throughout the day.

Nutrient analyses of fresh and residual feeds are summarized in Table 4. Concentrations of crude protein were greater ($P \leq 0.04$) in residual samples of the steam-flaked corn-alfalfa hay ration and the steam-flaked corn-dried distiller's grain ration. Crude fat levels were higher ($P = 0.001$) in residual samples of the steam-flaked corn-dried distiller's grain ration. Crude fiber was greater ($P \leq 0.06$) in all of the residual samples collected from the meal-type rations compared to original concentrations. Concentrations of starch were lower ($P \leq 0.02$) in residual samples of all meal-type rations. Crude protein, crude fat, starch, and crude fiber were similar ($P \geq 0.57$) for both fresh and residual samples of the extruded diets.

Experiment 2

Figure 3 illustrates daily feed deliveries of both the meal-type and extruded pellet rations over a 142-day period. For the first 79 days, feed deliveries mirrored each other, with cattle that was fed the meal-type ration consuming 11.5 kg of feed per day. However, on January 8, 2007, feed deliveries started to diverge. From January 8, 2007, to February 23, 2007, feed delivery of meal-type ration linearly increased 33% from 11.5 to 17.2 kg of feed per day, whereas feed deliveries of the extruded pellet remained fairly stable. This divergence corresponds closely to the arrival (early January) and dispersal (early March) of wintering starlings. Delivery of the meal-type ration linearly decreased from February 23, 2007, to pre-starling levels on March 11, 2007, after the wintering flock dispersed.

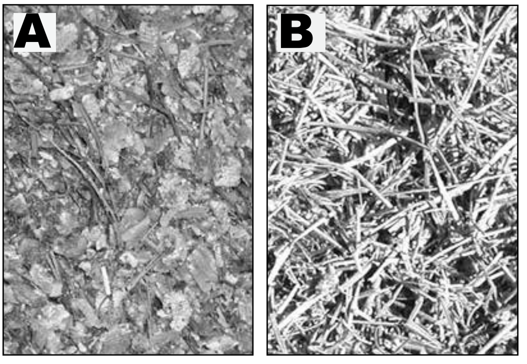

Figure 2. Steam-flaked corn and alfalfa hay diet (**A**) before and (**B**) after a 9-hour exposure (0750 to 1650 hour) to European starlings.

Discussion

Experiment 1

As indicated by Table 3, rations containing steam-flaked corn were the most affected by starling depredation. In each case, steam-flaked corn made up the majority of the rations (>65.7%, dry matter basis; Table 2). Photographic images (Figure 2) illustrate that starlings preferentially selected diets containing steam-flaked corn. Differences in starch concentrations of fresh and residual feed samples further demonstrate the preferential selection of steam-flaked corn by starlings (Table 4). This is supported by concentration of non-starch nutrients, such as protein and fiber. For instance, protein and fiber both were higher in residual samples of the steam-flaked corn-alfalfa hay diet, suggesting that ingredients contributing to these nutrients were not consumed by the starlings (Table 1). Based on information from Tables 1 and 2, urea and alfalfa hay are the main contributors to crude protein and fiber, respectively. Therefore, it can be hypothesized that these ingredients were not preferred by starlings. However, in the steam-flaked corn-corn silage ration, protein concentrations were simil-ar between fresh and residual samples. Both urea and soybean meal were used as the protein sources in this ration. Similar to the steam-flaked corn-alfalfa hay ration, it is unlikely that urea was consumed by starlings. Therefore, it is plausible that the starlings selected a portion of the soybean meal. Protein, fat, and fiber were higher in residual samples of the diet containing steam-flaked corn-dried distiller's grains. One fourth of this ration (dry matter basis) consisted of dried distiller's grains, which contributed nearly 50% of the total protein and fat in this ration. It is likely that the starlings did not consume the dried distiller's grains, thereby concentrating both protein and fat in residual samples.

It is not clear why starlings selected more steam-flaked corn than dry-rolled corn. Dry-rolled corn was processed to a smaller particle size than steam-flaked corn (4.1 mm versus 5.7 mm, respectively). Particles of dry-rolled corn are generally granular shaped, whereas steam-flaked corn kernels were generally 1 to 2 mm in thickness, but often 10 to 20 mm in diameter. Steam-flaking corn results in higher gelatinization and increased disruption of starch granules, resulting in a more pliable structure than dry-rolled corn. Therefore, it is conceivable that steam-flaked corn could be reduced in size and more readily consumed than the hard, granular-shaped dry-rolled corn particles.

Results from this study suggest that starlings prefer steam-flaked corn over dry-rolled corn. In addition, urea does not seem to be consumed by starlings, but at least a portion of soybean meal is consumed. Likewise, very little, if any of the dried distiller's grains were consumed by starlings.

Nutritionists and feedlot managers strive

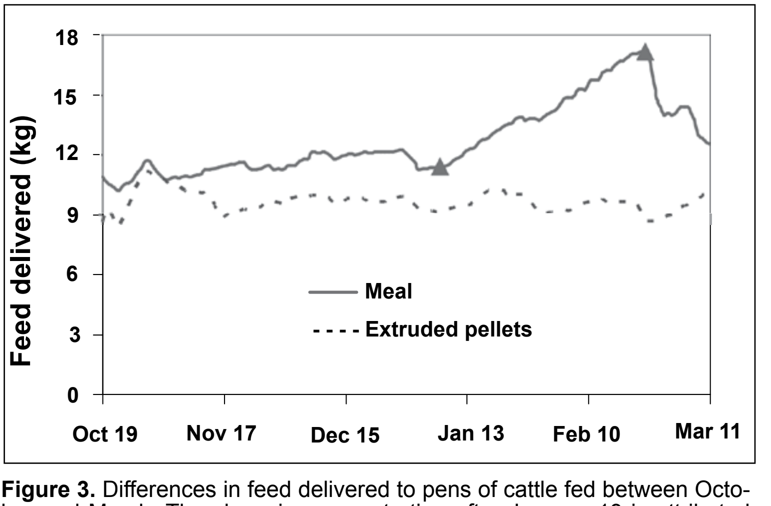

Figure 3. Differences in feed delivered to pens of cattle fed between October and March. The sharp increase starting after January 13 is attributed to the arrival of large numbers of starlings. Birds started to disperse around March 1.

Table 4. Nutrient contents of total mixed rations before (fresh) and after (residual) a 9-hour exposure (0750 to 1650 hr) to European starlings.

Treatment	Crude protein	Crude fat	Starch	Crude fiber
Dry-rolled corn with alfalfa hay				
Fresh (*n* = 2)	12.9 ± 2.3[1]	4.4 ± 1.0	69.6 ± 12.7	15.1 ± 8.1
Residual (*n* = 7)	15.9 ± 2.4	3.6 ± 1.1	43.5 ± 12.7	27.3 ± 7.9
P value (fresh versus residual)	0.10	0.32	0.02	0.06
Steam-flaked corn with alfalfa hay				
Fresh (*n* = 2)	15.7 ± 2.3	3.7 ± 1.0	69.3 ± 12.7	14.7 ± 8.1
Residual (*n* = 7)	19.5 ± 2.4	3.4 ± 1.1	29.6 ± 12.7	37.0 ± 7.9
P value (fresh versus residual)	0.04	0.66	0.001	0.001
Steam-flaked corn with corn silage				
Fresh (*n* = 2)	13.9 ± 2.3	5.1 ± 1.0	67.2 ± 12.7	18.9 ± 8.1
Residual (*n* = 7)	16.0 ± 2.4	4.4 ± 1.1	28.3 ± 12.7	41.3 ± 7.9
P value (fresh versus esidual)	0.24	0.43	0.001	0.001
Steam-flaked corn with dried distiller's grains				
Fresh (*n* = 2)	16.0 ± 2.3	5.3 ± 1.0	61.0 ± 12.7	21.8 ± 8.1
Residual (*n* = 7)	21.9 ± 2.4	7.3 ± 1.1	21.8 ± 12.7	36.4 ± 7.9
P value (fresh versus residual)	0.001	0.01	0.001	0.03
Extruded pellets[2]				
Fresh (*n* = 2)	15.2 ± 2.3	2.2 ± 1.0	72.6 ± 12.7	14.0 ± 8.1
Residual (*n* = 7)	15.0 ± 2.4	2.5 ± 1.1	66.7 ± 12.7	13.0 ± 7.9
P value (fresh versus residual)	0.90	0.78	0.57	0.87

[1]Standard deviation.
[2]Composition is identical to steam-flaked corn and alfalfa hay diet.

to provide a homogeneous and nutritionally balanced ration to cattle. Data from Table 4 and Figure 2 show distinct changes in chemical and physical composition of the ration over a 9-hour period due to feed depredation by starlings. When transitioning cattle from diets consisting predominately of forage (i.e., pasture) to high-grain diets (i.e., energy dense diets containing cereal grains), normal practice is to gradually adapt cattle over a period of 2 to 3 weeks. However, this adaptation process usually requires 2 to 5 transition diets, with each diet being fed for 4 to 11 days (Vasconcelos and Galyean 2007) to avoid acute and subacute acidosis (Owens et al. 1998). In the present study, depredation by starlings resulted in dramatic changes within hours, potentially predisposing cattle to metabolic insults.

Clearly, starlings preferentially consume energy dense portions of the ration (i.e., starch), which ultimately leads to changes in physical and chemical composition of rations, thereby decreasing growth rate and feed efficiency of cattle. Severity of these changes is largely determined by the number of starlings present relative to size of the feedlot.

Experiment 2

The 33% increase in meal-type feed delivered to the trough is directly attributed to feed depredation of European starlings. We believe that if starlings had not been present, cattle fed the meal-type ration would have continued consuming feed at a rate of about 11.5 kg per day. With this in mind, we calculated the difference between the actual amount of feed delivered to cattle and the hypothetical amount of feed delivered (i.e., 11.5 kg per day). Under these assumptions, this difference in feed delivered is the sum of feed consumed by starlings. Therefore, on average, starlings consumed 179 kg of feed per pen during the course of 47 days. Multiplying this (i.e., 179 kg) by 13 pens, results in 2,327 kg of total feed consumed by starlings. Most, if not all, of this feed consumed by starlings is the steam-flaked corn portion (i.e., starch) of the ration. Assuming all 2,327 kg of feed consumed by starlings was steam-flaked corn, the total cost would be $563, or $43 per heifer (i.e., $541 for whole corn and $22 for grain processing cost associated with steam-flaking). As a result, daily cost of production increased by $0.92 per feedlot animal.

Management implications

Starling depredation not only results in loss of expensive feed, but can also negatively affect livestock diet composition, which could affect livestock performance. Forming feed into large pellets that starlings cannot consume could prevent depredation by birds.

Acknowledgments

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Charles D. Lee received his B.S. degree (1975) in fisheries and wildlife biology and his M.S. degree in animal sciences and industry in 1988. For the last 15 years, he has been extension wildlife specialist at Kansas State University. His interests are wildlife damage management and implementing wildlife enhancement programs for landowners.