REFERENCE

Ujvári, M., H.J. Baagøe, and A.B. Madsen. Effectiveness of Acoustic Road Markings in Reducing Deer-Vehicle Collisions: A Behavioural Study. *Wildlife Biology*, Vol. 10, No. 2, 2004, pp. 155-159.

INTRODUCTION

Acoustic road markings are sound-producing materials painted on to the roadway that produce sound when they come in contact with the tires of moving vehicles (no pictures of these devices were provided in the article referenced above). The studied summarized in this document was designed to evaluate the behavior impacts and potential habituation of free-roaming fallow deer to the sounds made by these devices. The behavior of these deer when the recorded sounds of acoustic road markings were projected into the woods was documented for 13 nights. This test occurred in an isolated, undisturbed portion of forest in Denmark that contained mixed hardwoods and conifers.

SOUNDS CONSIDERED

The recorded sounds from two acoustic road markings were used in this study. The NCC Roads "longflex" and the NCC Roads "spossflex" designs were applied in sequence along a nearby roadway and the researchers recorded the sounds they produced as vehicles passed over them. The frequencies varied with the speed of the vehicles, but in general the "longflex" produced low sound frequencies and the "spossflex" produced frequencies that are slightly higher. The sound frequencies produced by each marking were isolated (i.e., vehicle noise was eliminated) and varied with vehicle speed. The recorded sounds from both road markings, repeated for 70 sequences (each separated by ¼ second), were stored on two compact discs (CDs). The strongest frequencies on the first and second CDs ranged from 7.0 to 14.0 kHz and 5.6 to 12.0 kHz, respectively (and lasted 0.16 and 0.11 seconds respectively). The sounds from each CD were then projected at 58 dB near free roaming fallow deer within the feeding area of the study site and the researchers recorded their behavioral responses. The loudness of the sounds was equivalent to that heard 150 meters (492.1 feet) from a roadway.

DATA COLLECTION

The data collection time period consisted of 13 nights between February 16th and March 5th of 1997. During this time period the researchers observed fallow deer behavior near a feeding area (maize was placed every day before sunset) through a night-vision scope from a covered shed. The behaviors recorded by the researchers were defined as the "most powerful response" of each deer (during the sound projection time period). Four responses were recorded and classified as *flight*, *alarm*, *movement of head*, or *no reaction*. The data collected was pooled for each night and the mean amount of time each activity was observed was calculated.

The sounds projected during the data collection time period were varied. During the first two nights no sounds were projected. Observations during these two nights were made at 15-minute intervals and used as a control. The acoustic road marking sounds on the first CD were then projected on the third to twelfth nights. The sounds were played 10 minutes after the arrival

of the fallow deer and continued until they left the area. Six intervals of sound exposure were used (e.g., 5, 2, 7, 3, 1, and 2 minutes). Sounds from the second CD were projected on the last night in the same manner as the first CD. The researcher changed the CD on the last night to test the impact that variation in the sound frequency might have on fallow deer behavior (after 10 nights of the same sounds from the first CD).

STUDY RESULTS

During the 13-night data collection time period 2,789 fallow deer behavior observations were collected. The researchers used a chi-squared test to evaluate the distribution of the deer behavior during the data collection time period and a Spearman rank to determine if a correlation existed between the amount of sound exposure and the *no reaction* behavior (a *no reaction* observation was considered to be a measure of the ineffectiveness of the acoustic marking sounds). The statistical tests were applied to evaluate whether the fallow deer habituated to the sound projections.

The researchers that designed this study concluded that the statistical tests showed a variation in fallow deer reactions from night to night and that the number of deer that did not react to the recorded sounds increased with time. Almost all (i.e., 96 and 99 percent) of the observed deer behavior during the two control nights was classified as *no reaction*. During the first night of sound exposure, however, approximately 13 percent of observations were classified as *flight* and 15 percent were classified as *alarm*. Approximately 65 percent were classified as *no reaction*. The statistical test results, however, showed that the fallow deer reaction to the recorded sounds steadily decreased during the ten days observation time period. The percentage of *no reaction* responses during the last three nights of the ten day time period was 88, 90, and 99 percent. Similar responses were also recorded when the sounds on the second CD were projected on the 11th night. Overall, the researchers concluded that the results suggest fallow deer likely habituate to the acoustic road marking sounds even if they are varied (at least within the range of sounds considered in this study). They also concluded that after 10 days the fallow deer appeared to become indifferent to the acoustic roadway marking sounds. The researchers propose that their experiment may approximate the sounds from acoustic road markings at a long distance (i.e., at a location where the vehicle noise and lights are not an additional stimuli). They also believe their results would apply to other species of deer.

DVCIR CENTER FINDINGS

This article summarized here focused on the potential impact and habitation of fallow deer to sounds produced by two acoustic road markings in Denmark. The acoustic road marking designs that were considered, however, were not documented in the article and this limits its value to the practitioner. The design of these types of devices (along with the speed of the vehicle) impacts the sounds they make. The study was specifically designed to evaluate the potential impacts of the acoustic markings sounds and purposefully did not replicate an actual roadway (with vehicle engine noise, lights, etc.) with wild deer. This approach limits the application of the research conclusions and this is indicated by the article authors. Overall, however, the study findings generally agree with several other studies from the past. First, it was shown that unusual sounds (or other stimuli for that matter) may initially startle or produce a

reaction from deer, but that this impact may decrease relatively quickly. Second, it was concluded that this habituation, at least for acoustic road markings, may continue even if the frequency is changed (although this conclusion was based on a limited amount of data). These results generally support the idea that any deer-vehicle crash mitigation measure that relies on an animal reaction to some type of stimuli needs to be studied for both short- and long-term impacts. The amount of time required for habituation to different mitigation measures may vary for different stimuli (e.g., sounds, lights, etc.). The results of this study should be taken into account when similar types of deer-vehicle crash reduction mitigation measures are considered and evaluated.