EXECUTIVE SUMMARY

Animal–vehicle collisions affect human safety, property, and wildlife, and the number of animal–vehicle collisions has been increasing in many regions across North America. For this project The Western Transportation Institute at Montana State University (WTI/MSU) evaluated a relatively new mitigation measure aimed at reducing animal–vehicle collisions while allowing animals to continue to move across the landscape. WTI/MSU evaluated different types of animal detection systems from different manufacturers with regard to system reliability and operation and maintenance aspects. Animal detection systems detect large animals (e.g., deer, elk, moose, or pronghorn) as they approach the road. When an animal is detected, signs are activated warning drivers that large animals may be on or near the road at that time. Previous research has shown that, depending on road and weather conditions, the warning signs can cause drivers to reduce their speed. Warning signs may also result in more alert drivers, which can lead to a substantial reduction in stopping distance: 20.7 m (68 ft) at 88 km/h (55 mi/h). Finally, research from Switzerland has shown that animal detection systems can reduce ungulate–vehicle collisions by as much as 82 percent.

The main objective of this project was to evaluate the reliability of different animal detection systems from different manufacturers at the same site under similar circumstances and to recommend minimum standards for system reliability. A test facility (Roadside Animal Detection System (RADS) test-bed) was constructed near Lewistown, Montana. Nine different animal detection systems from five different manufacturers were installed to detect horses and llamas that roamed in an enclosure. Data loggers recorded the date and time of each detection for each system. The animal movements were also recorded by six infrared cameras with a date and time stamp. By analyzing the images and the detection data, researchers were able to evaluate the system for a variety of reliability parameters.

The results of the reliability tests showed that different detection technologies detect large animals more or less frequently as an animal passes through the detection area or line of detection. The percentage of false positives (i.e., a detection is reported by a system but there is no large animal present in the detection zone) and the average number of false positives per hour was relatively low for all systems (≤1%; ≤0.10/hr). The percentage of false negatives (i.e., an animal is present in the detection zone but a system failed to detect it) and the average number of false negatives per hour was highly variable (0–31%; 0–1.61/h) (all types of false negatives combined). The percentage of intrusions (i.e., animal movements across the detection line) that were detected varied between 73 and 100 percent. The results suggest that some animal detection systems are quite reliable in detecting large mammals with few false positives and false negatives, whereas other systems have relatively many false negatives.

The reliability of animal detection systems is influenced by a range of environmental conditions. High winds were associated with an increase in different types of false negatives for most passive infrared area-cover systems (i.e. systems that detect an animal within a certain range of a sensor, mostly through passive infrared or radar technology). High winds were associated with both an increase in false positives and a decrease in false positives for different types of systems, suggesting that passive infrared area-cover systems become less sensitive with high winds whereas break-the-beam systems (i.e. systems that detect an animal when the animal blocks or reduces a signal (active infrared, laser or radar) transmitted by a sensor and received by another sensor) that rely on a very narrow beam may start generating false positives, presumably because

the sensors sway slightly in and out of alignment. The latter suggests the importance of a stable foundation and pole for break-the-beam systems. Stable foundations and poles may also be beneficial to passive infrared area-cover systems, but it is unclear if the increase in false negatives for such systems is caused by movement of the sensors that tend to be higher up on a pole than sensors for break-the-beam systems, or by vegetation or pockets of hot and cold air that move in the wind across the detection zone. The effects of wind direction are hard to interpret, but it may be that winds oriented perpendicular to the systems caused vegetation or pockets of hot and cold air to trigger systems more often than winds oriented more parallel to the systems. Higher temperatures are generally associated with higher error rates. This could be due to temperature causing reduced performance of the equipment. In addition, passive infrared systems may not be able to distinguish clearly between pockets of hot air and moving animals. However, higher temperatures are concentrated in time (summer) and it is possible that factors other than temperature caused more errors in summer. Animal behavior and possible effects on the likelihood of correct detections and errors may have also been influenced by temperature. Three systems had fewer false negatives during the night compared to during the day. This may be related to lower temperatures or higher contrasts in temperatures of the animals and their surroundings during the night. However one system had more false negatives during the night compared to during the day. Excellent visibility was associated with fewer false positives for a break-the-beam system, which suggests that relatively low visibility may block or reduce the narrow signal path of optical break-the-beam systems. It is unclear why excellent visibility was associated with an increase in false negatives for one of the area-cover systems. Precipitation was rarely observed during the test periods and its effect on system reliability is unclear. However, higher relative humidity was mostly associated with an increase in errors, and to a lesser extent with a decrease in errors. Finally, llamas were substantially harder to detect for most systems, especially passive infrared area-cover systems, than horses, probably because of their smaller body size.

Three stakeholder groups—employees of transportation agencies, employees of natural resource management agencies, and the traveling public—were surveyed with regard to their expectations on the reliability and effectiveness of animal detection systems. There was considerable agreement in the responses of the three groups. Based on the results from the survey, the researchers recommend the following performance requirements for the reliability and effectiveness of animal detection systems:

- Animal detection systems should detect at least 91 percent of all large animals that approach the road.
- Animal detection systems should have fewer than 10 percent of all detections be false.
- Animal detection systems should result in at least 71 percent reduction of wildlife–vehicle collisions.

The recommended performance requirements for the reliability of animal detection systems were compared to the results of the reliability tests. Five of the nine systems tested met the recommended performance requirements for reliability. However, experiences with installation, operation and maintenance showed that the robustness of animal detection systems may have to be improved before the systems can be deployed on a large scale.

This report also presented a concept of operation and a review of Intelligent Transportation System (ITS) architecture and infrastructure for animal detection systems. Currently, roadside

animal detection systems present drivers with warnings displayed on road signs. In the future, roadside animal detection systems may also transmit warning signals to traffic approaching a location where a large animal has been detected on or near the road. This procedure would require a two-way GPS-based communication system. With animal detection system deployments becoming more numerous, standards for communication and ITS integration will have to be further developed and accepted.

Finally, the researchers reviewed seven sites in Montana for the potential installation of an animal detection system.

Based on the results of the study, the researchers concluded:

- Different detection technologies detect large animals more or less frequently as an animal passes through the detection area or line of detection. This implies that care must be taken in evaluating the reliability of different technologies, and in comparing them to other systems or minimum performance requirements.
- The percentage of false positives and the average number of false positives per hour was relatively low for all systems (≤1%; ≤0.10/hr). False positives do not appear to be a major concern with regard to the reliability of animal detection systems.
- The percentage of false negatives (all types of false negatives combined) and the average number of false negatives per hour under the test circumstances was highly variable (0–31%; 0–1.61/hr). The percentage of intrusions (i.e., situations where at least one animal was present in the detection area) that were detected varied between 73 and 100 percent. The results suggest that false negatives are a major concern for some animal detection systems, but not for others.
- Environmental conditions influence the reliability of animal detection systems. Therefore the environmental conditions at a site should be carefully evaluated before selecting a suitable system. In addition, since the size of the species affects the reliability of some of the systems, it is also important to consider the size target species and how that may affect the reliability of a particular system. Besides system reliability, system robustness (i.e. consistent performance over time, low monitoring and maintenance effort), size of the equipment (landscape aesthetics), and the road length that the sensors are able to cover needs to be considered.
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- Currently, roadside animal detection systems present drivers with warnings displayed on road signs. In the future, roadside animal detection systems may also transmit warning signals to traffic approaching a location where a large animal has been detected on or near the road. With animal detection system deployments becoming more numerous, standards for communication and ITS integration will have to be further developed and accepted.