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Authors
Tewes, Michael E.
Hughes, Robert W.

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OCELOT MANAGEMENT AND CONSERVATION ALONG TRANSPORTATION CORRIDORS IN SOUTHERN TEXAS

Michael E. Tewes (361-593-3922, michael.tewes@tamuk.edu), and Robert W. Hughes (361-593-3922, ksrwh01@tamuk.edu), Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, MSC 218, Kingsville, TX 78363. Fax: 361-593-3924.

Abstract: The ocelot (*Leopardus pardalis*) is an endangered cat with less than 120 individuals remaining in the United States. Ocelot roadkills are an important problem potentially threatening ocelot persistence in southern Texas. Landscape planning can provide options for the resolution of traffic-ocelot conflicts. We suggest several conservation strategies and tactics involving important road-habitat interfaces, road underpasses, and fences. Support of alternative recovery strategies (e.g., habitat restoration) may help offset ocelot roadkills, particularly along road segments where practical management is not effective.

Introduction

Sometime during the past 30 years, vehicles probably overtook hunting as the leading direct human cause of vertebrate mortality on land (Forman and Alexander 1998). Various groups of wildlife are more prone to roadkills than others. Serious transportation problems have developed for the conservation of some rare carnivores in North America (Ruediger 1998), including the ocelot (*Leopardus pardalis*) in southern Texas (Tewes and Miller 1987).

The ocelot is listed as a federally endangered species (Tewes and Schmidly 1986). The known resident ocelot populations in the United States occur only in southern Texas (Tewes and Everitt 1986). One population occupies private lands in northern Willacy County (i.e., Willacy population), whereas the second population occurs in eastern Cameron County (i.e., Cameron population), primarily on and around the Laguna Atascosa National Wildlife Refuge. Other small populations may exist in southern Texas but have not been identified by conservation biologists.

Vehicular traffic on roads is a major problem for ocelots. Numerous ocelot roadkills have been found in southern Texas since we began monitoring in 1982. Most of these mortalities have occurred in the Rio Grande Valley of Texas. Because of the small population size of ocelots (<120 individuals) and their vulnerability to vehicles, we need to better understand the interplay of roads, traffic, and ocelot ecology (Tewes and Miller 1987).

Ecological principles are increasingly important in the formulation of environmental transportation policy (Forman and Anderson 1998). Following is a description of ocelot ecology and transportation issues that impinge on ocelot conservation in the United States. Some of the management tactics and conservation strategies we describe may be applicable to other felid-transportation situations (e.g., Florida panther [*Puma concolor coryi*], lynx [*Lynx canadensis*]).

Location of Ocelot Roadkills

Ocelot roadkills can be classified into two groups. One group of mortalities occurs in the coastal corridor of eastern Cameron County, primarily south of Laguna Atascosa Refuge where several roads traverse east-west through the landscape. These roads link human population centers (west) with the Gulf of Mexico resort on South Padre Island (east). Transportation corridors, listed in increasing distance from the ocelot population centered on Laguna Atascosa Refuge, include FM 106, FM 510, Hwy 100, and Hwy 48. Two other east-west transportation corridors that dissect the coastal corridor but do not terminate near South Padre Island include Hwy 4 and FM 186. Ocelot roadkills or ocelot crossings have been documented on all of these transportation corridors.

Although higher traffic volumes occur on Hwy 100 and Hwy 48, they are located farther from the core ocelot population on Laguna Atascosa Refuge compared to FM 106 and FM 510. The proximity of FM 106 and FM 510 to the ocelot population may increase felid risk even though these transportation corridors produce lower traffic volumes and speeds relative to the highways. Also, ocelot use of woody cover has been documented in areas immediately adjacent to FM 106 and FM 510.

The other group of ocelot road mortalities occur in less predictable locations, and could occur in much of southern Texas. Some of these roadkills were ocelots that originated from the Willacy population, but others may have dispersed from currently unidentified populations on private lands. Because of the unpredictability of the location of these roadkills, development of specific management tactics is more difficult and less likely to be cost-effective.

Landscape Planning

Transportation policy and planning needs to occur at a geographic scale broad enough to assess carnivore population and habitat variables, particularly for a felid capable of dispersing several kilometers. The application of landscape ecology can address many issues such as ocelot dispersal, metapopulation dynamics, effects of multiple road corridors, and overall road density.

Using a landscape perspective allows conservation biologists to study the effects of road density on wild cat ecology. Road density can impact faunal movement, population fragmentation, and human access to wildlife areas (Forman and Alexander 1998). Human access and disturbance effects on remote areas tend to increase with higher road density (Mech 1989, Forman 1995).

The delta region west of the coastal corridor and Laguna Atascosa Refuge is dominated by an extensive agroecosystem with a high road density and only isolated fragments of potential habitat. The road network in this region presents significant risks to ocelot survival, and may function as a population sink by attracting ocelot dispersers that fail to successfully reproduce and establish a population.

Ocelot corridors that enter areas with a dense road network should have a positive end point or purpose. Corridors may pass through agroecosystems with high road densities if they have protected road crossings and lead to areas with sufficient habitat for colonization and population persistence. Although ocelots will sometimes occupy a corridor for an extended period, corridor habitats often have additional risks as a long-term habitat.

Development of a habitat specific model at the landscape scale can provide insight regarding the impact of different transportation projects on travel corridors and ocelot population persistence. Modeling could also evaluate the relative threats of habitat sinks near busy transportation corridors--a prerequisite to developing remedial strategies. Identification of landscape features and important habitat tracts near roads and potential crossing sites for ocelots should be an important conservation goal.

Road-Habitat Interfaces

Dense woody cover is important to ocelots (Shindle and Tewes 1998). Road segments that pass through woody communities used by ocelots represent important road-habitat interfaces. Many of these road segments have high potential for ocelot roadkills and should be prioritized for remedial conservation.

Understanding the relationship of ocelot activity patterns and traffic activity patterns of particular roads may provide useful management insight. Ocelot activity is primarily nocturnal with crepuscular peaks, whereas the specific traffic patterns are less known. Generally, vehicular activity on many of the coastal transportation corridors is reduced at night, but the crepuscular traffic patterns have not been quantified and should be studied for critical ocelot crossings. Reduction of traffic volume and speed may be necessary for critical road-habitat segments. Management tactics may include posting slower speed limit signs, particularly lower night speeds along important road-habitat interfaces to coincide with the activity of nocturnal cats.

Use of speed bumps or reduction of road pavement quality may be techniques appropriate for Laguna Atascosa Refuge. Substitution of gravel or caliche road surfaces for asphalt would reduce vehicular speed. Also, allowing dense thornshrub to encroach upon the road edge should slow vehicular traffic along critical road-habitat segments within the refuge. Narrow road corridors on the refuge may reduce possible landscape barrier or filtering effects on faunal movements, particularly where slow traffic occurs and visibility issues are minimal.

Mowing herbaceous cover in the right-of-way of primary highways with fast traffic can enhance the visibility environment. A cleared roadside would enable ocelots crossing at the road surface to better detect oncoming traffic. Drivers would also have increased visibility of wildlife and increased response time to avoid collisions. A negative consequence is roadside clearing may increase the barrier effect of the road corridor, possibly reducing faunal movements across the landscape. Woody or tall herbaceous screening cover (e.g., bunchgrasses) along the roadside that connects ocelot culverts and underpasses with adjacent corridors should be encouraged.

The conservation value of woody or screening cover in the median of a major highway has not been determined. Median cover may encourage ocelot crossing of a major transportation corridor and reduce the filter effect of this landscape structure. However, bobcats have been observed using the median woody cover for extended periods of time. Any felid attraction to the road corridor subjects the cat to increased risk.

Installation of "deer crossing signs" may be useful for public road segments. These signs could reduce the risk of ocelot mortality by encouraging drivers to be more alert for wildlife, but the specific location of an endangered ocelot would not be revealed to the public, thereby discouraging illegal poachers.

Application of deer reflective lights should be considered for alerting ocelots to oncoming vehicles. These light reflectors may be useful because ocelots are primarily active during nocturnal and crepuscular periods. However, caution should be used in implementing this tactic until we better understand the difference in response behavior (e.g., detection, reaction) of felids and ungulates.

Important road segments within the Laguna Atascosa Refuge include the initial section of the paved road that dissects the Granjeno Natural Area and the southern portion of the Bayside Loop. These segments are characterized by extremely dense thornshrub on both sides of the road. Public roads that have important road-habitat segments include FM 510, FM 106, and the section of the "Headquarters Road" where habitats managed by the Laguna Atascosa Refuge also occur on both sides of the road. Additional important road-habitat segments should be identified near ocelot populations.

Management Strategies for Ocelot Culverts

Ocelot culverts should be constructed at road locations most likely to receive use by the endangered felids. Ocelot passage under roads, instead of over the road surface, would significantly reduce roadkills. However, culvert and crossing structures are expensive to construct, and should be implemented through comprehensive planning.

Five factors can be used to determine the best location for ocelot road crossings: (1) proximity to known ocelot populations, (2) radio telemetry information, (3) reports of roadkills, (4) important landscape features used by ocelots, and (5) habitat tracts found near or leading toward a road. If multiple factors are present, then the potential utility of a culvert is increased.

The proximity, quality, and quantity of habitat near roads are relevant to placement of culverts. Consequently, the distribution of ocelot cover types near roads, particularly in the vicinity of ocelot populations, is important for ocelot management. The intersections of habitat or landscape corridors with roads represent possible locations for culverts. Landscape features used by ocelots for travel include resacas (i.e., old river channels), vegetation associated with irrigation canals and drains, natural drainages, overgrown fencelines, clay ridges with woody communities (locally called lomas), and corridors of woody communities. Resacas often have woody communities established on the banks of the old river channels, a landscape feature often used for ocelot travel. The location where a resaca intersects a road, particularly if it is located near an ocelot population can also be a good candidate for an ocelot culvert.

Private land use and management of habitats adjacent to culverts on public roads is a current weakness in ocelot crossing management. Although ocelot culverts are usually installed on public roads, private landowners control the connecting habitat. A mechanism is needed, preferably one with an economic incentive for the landowner, that will encourage conservation of culvert-related woody cover. Preferably, an agreement with the neighboring landowner to manage or maintain the cover linkage with the crossing can be established prior to culvert construction. If woody cover is removed on private lands after culvert construction, then the conservation value of the crossing is diminished considerably and funds expended on culvert construction are wasted.

Establishment of habitat staging areas a short distance from roads may have management value in selected locations. Habitat staging tracts connected to well developed road culverts with fences may reduce the barrier effect of roads. It may also encourage ocelot use of protected culverts, thereby reducing felid crossing at other less protected locations. Tewes and Blanton (1998) proposed the use of staging areas to increase the landscape permeability of a bridge-road system along the Rio Grande. However, various factors should be evaluated to ensure sink habitats are not created that would encourage ocelot roadkills.

Ocelots will temporarily use more open woody communities when there is an absence of dense cover. Ocelots may cross roads where few predictive factors occur, particularly transient or dispersing ocelots unfamiliar with the distribution of habitat or landscape elements.

The optimal structure criteria for ocelot culverts are unknown. It is difficult to design experiments and rigorous studies to determine these criteria for a rare, secretive cat, particularly for a species with endangered status. Nonetheless, conservation biologists need to determine effective features of ocelot culverts, underpasses, and fences.

Ocelot culverts should be large enough to encourage felid use. Generally, large culverts are probably better than small culverts for ocelot passage. However, culvert expense rises with culvert size, and at some point the additional ecological or conservation benefit of a culvert is minimal compared to sharp cost increases of larger culverts.

Small culverts may encourage resting or denning uses by bobcats (*Lynx rufus*), coyotes (*Canis latrans*), skunks (*Mephitis mephitis*), other mesomammals, and rattlesnakes (*Crotalus atrox*), instead of the intended purpose of ocelot passage under the road. Culvert occupation by antagonists or competitors of ocelots could function as a biological barrier to cat passage. Hypothetical biological barriers could be present in culverts, underpasses, and near the crossing entrance or adjacent corridor. Biologists need to determine if scent marking by coyotes or bobcats could deter ocelot use of the funneled locations. The possibility of a biological barrier supports the development of more than one culvert at critical ocelot crossings.

An advantage of a box culvert over a pipe culvert is the potential multiple paths, depending of the width of the cement box. In contrast, a pipe culvert would only have a single travel path. Culverts and underpasses designed for ocelot passage should be constructed at a level necessary to prevent water from standing within the culvert or the culvert entrance. Raising of roads could be an expensive prerequisite to the construction of raised culverts that remain dry. Occasionally debris and litter can accumulate in some culverts, thereby requiring periodic maintenance of the structures. Responsibility and funding needed to ensure this maintenance should be determined before culvert construction.

Ocelot behavior at culverts and underpasses needs to be examined. Bobcats have been observed using cool, moist highway culverts for behaviors other than passage. Some bobcats rested in cool culverts during hot summer days. Cat attraction to the vicinity of roads (e.g., cool culverts) may ultimately increase roadkill rates.

The effects of traffic noise on wildlife may include increases in stress hormones and altering behaviors (Forman and Alexander 1998). Much traffic noise emanates from tire contact with the road surface. Use of specially formulated “quiet asphalt” at critical ocelot crossings would reduce the likelihood of behavioral disruptions to ocelots and may encourage passage through the culverts. In other situations, conservation biologists may determine that normal or “loud asphalt” has a role in discouraging ocelot crossing in undesirable or risky locations. Another tactic is the placement of sound barriers or walls at critical road-culvert junctures to reduce the noise and visual disturbance of passing vehicles. This application may be most useful for important ocelot crossings at locations with high traffic volume.

Use of native plants for screening cover between the pavement where vehicular activity occurs and the entrance of the cat culvert or underpass is a recommended management tactic. Evergreen thornshrub species will provide screening value throughout the year. Earthen piles or berms that are vegetated should also be considered as a visual screen and partial noise filter.

Roadside lighting should not be used at critical ocelot crossings. Felid behavioral disruptions caused by lighting are poorly understood, and conservative measures should be used at important ocelot road-crossings until these relationships are better understood.

Roadside Fences

One of the primary purposes of roadside fences is to restrict ocelot access to the road corridor, thereby reducing ocelot mortality and increasing driver safety by reducing other wildlife-vehicle collisions. Another use of fences is to guide or funnel ocelot movements to culvert or underpass entrances. If a culvert or underpass emerges in the median of a multiple lane highway before it crosses under the other side, fences will be required to restrict felid use to the passage lane and prevent it from entering the road corridor.

Optimal fence length and height appropriate for ocelots has not been determined. If the fence is too long without the proper number and interval of underpasses, then faunal movement may be affected at the demographic and landscape scale. If the fence length is too short relative to the adjoining habitat or landscape feature, then wildlife may pass around the ends of the fence and become trapped in the road corridor.

Roadside fences should be tall enough to completely block felid passage onto the road surface, if that is the goal of the conservation biologists. Alternatively, an intermediate fence height may discourage road crossing and funnel ocelots toward underpasses, yet be low enough to allow felid passage over the fence during emergency or stressed conditions. Spatially dispersed earthen berms on the roadside of the fence may allow wildlife trapped within the road corridor to escape over fences.

Metal posts are preferred over wooden posts because cats can use the latter for climbing a fence. Also, a vertical barrier or metal shield (e.g., predator apron) slanted downward can further reduce felids climbing posts. Some locations within the coastal corridor where fences are desirable occur in highly saline environments. Metal fences are susceptible to rust and will exist for only a short period. Alternative fence material or rust-resistant coating may be a preferred substitute. A plan for periodic maintenance of fences should be developed, similar to a culvert maintenance plan.

Mitigation

Often long stretches of highways and rural roads in southern Texas, particularly those located distantly from core ocelot populations, produce a nonpoint or dispersed threat to ocelots. An occasional ocelot roadkill may occur on these roads, particularly of a dispersing individual. Three ocelot roadkills were found during the 1990s on Hwy 77 in southern Texas. Each occurred in an unanticipated location and a considerable distance from known core populations. Highway 77 is scheduled to be upgraded into a new interstate (I-69) that will link NAFTA trade from Mexico to Canada. Strategies must be developed to resolve possible “nonpoint threats” that enhancement of I-69 or other transportation projects could have on ocelot mortality.

Possible mitigation for nonpoint or diffuse ocelot roadkills could include support of other recovery activities with much greater potential for ocelot conservation. Rather than build several expensive culverts and fences in nonspecific locations with little effective conservation for ocelots, equivalent funds could be redirected to habitat restoration within or adjacent to core populations with few roads. This tactic would facilitate population expansion without the need for ocelot dispersal into environments with many roads. Also, restoration of habitat tracts for ocelots that produce offspring could offset sporadic ocelot mortality from transportation corridors scattered in southern Texas.

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