SURVIVAL AND SOURCES OF MORTALITY IN OCELOTS

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Abstract: Survival and cause-specific mortality estimates are needed to develop effective conservation strategies for the endangered ocelot (*Leopardus pardalis*) in the United States. We radiomonitored 80 ocelots (36 F, 44 M) from 1983 to 2002 and analyzed survival and cause-specific mortality rates. Pooled estimates of annual survival rates differed between resident ($\hat{S}$ = 0.87) and transient ($\hat{S}$ = 0.57) ocelots (P = 0.02); therefore, survival and cause-specific mortality analyses were partitioned for resident and transient ocelots. Sex-specific annual survival was similar between resident ocelots (M = 0.92, F = 0.83, P = 0.16) and transient ocelots (M = 0.53, F = 0.63, P = 0.75). Most mortalities were from human (e.g., ocelot–vehicle collisions; M = 45%) and natural (e.g., animal attack, disease; M = 35%) sources. Transient ocelots had higher natural mortality rates (disease, intraspecific mortality; M = 0.26) than resident ocelots (M = 0.04, P = 0.03). Other sources of mortality did not differ ($P \geq 0.10$) between resident or transient ocelots or male and female resident or transient ocelots ($P \geq 0.08$). Human population expansion within the Lower Rio Grande Valley of southern Texas, USA, will increase transportation-related problems and decrease the quantity of ocelot habitat, leading to increased ocelot–vehicle collisions and possibly cause more transient behavior, thus significantly lowering ocelot survival. Research and development of ocelot road underpasses should be conducted to mitigate ocelot–vehicle collisions.

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Key words: endangered species, *Leopardus pardalis*, mortality, ocelot, resident, survival, Texas, transient, vehicle collisions.

The ocelot population within the United States once ranged from Arkansas to Arizona and is now limited to 80–120 individuals in southern Texas (Hall 1981, Tewes and Everett 1986). During 1989, the ocelot was listed in Appendix I by the Convention on International Trade in Endangered Species (CITES; Sunquist and Sunquist 2002), which prohibits international commerce of skins (i.e., pelts) and live animals. In addition, the ocelot is listed as federally endangered within the United States by the U.S. Fish and Wildlife Service (1982). Ocelot persistence in a declining population can be assisted by understanding population processes, particularly factors affecting their survival.

Estimates of survival and cause-specific mortality rates are needed to assess population viability and to develop conservation strategies (White 1983). Seasonal, age, and sex-specific survival rates represent important information for conservation biologists to plan recovery strategies. This information will allow biologists to identify major sources of ocelot mortality and allow researchers to model ocelot populations under different management scenarios to predict population response. However, these estimates are difficult to obtain for secretive, long-lived mammals that occur at low densities, such as the ocelot (Lindzey et al. 1988).

Estimates of small cat survival and cause-specific mortality rates have been primarily limited to bobcat (*Lynx rufus*) studies in temperate regions of the United States (Fuller et al. 1985, 1995; Knick 1990; Chamberlain et al. 1999; Kamler and Gipson 2000; Nielsen and Woolf 2002). Bobcats are similar to ocelots in size and co-occur with ocelots in southern Texas (Tewes 1986). However, ocelots are more specialized, requiring areas of dense cover and high rodent density (Tewes 1986, Emmons 1988). The few ecological studies on ocelots have not reported survival or mortality rates (Emmons 1987, Ludlow and Sunquist 1987, Konecny 1989, Crawshaw 1995). Results of our study represent the first assessment of these population parameters for ocelots. Our objectives were to (1) estimate seasonal and annual survival for male and female resident and transient ocelots, (2) estimate annual survival for resident and transient ocelots during drought conditions, (3) estimate seasonal and annual cause-specific mortality rates for male and female resident and transient ocelots, and (4) evaluate differences in seasonal and annual survival rates and differences in cause-specific mortality rates between male and female resident and transient ocelots.

We hypothesized that (1) survival of transient ocelots will be 50% lower than resident ocelots because transients will be more susceptible to mortality (e.g., vehicle collision, intraspecific mortality) in unfamiliar environments, (2) ocelot survival will be similar between male and female

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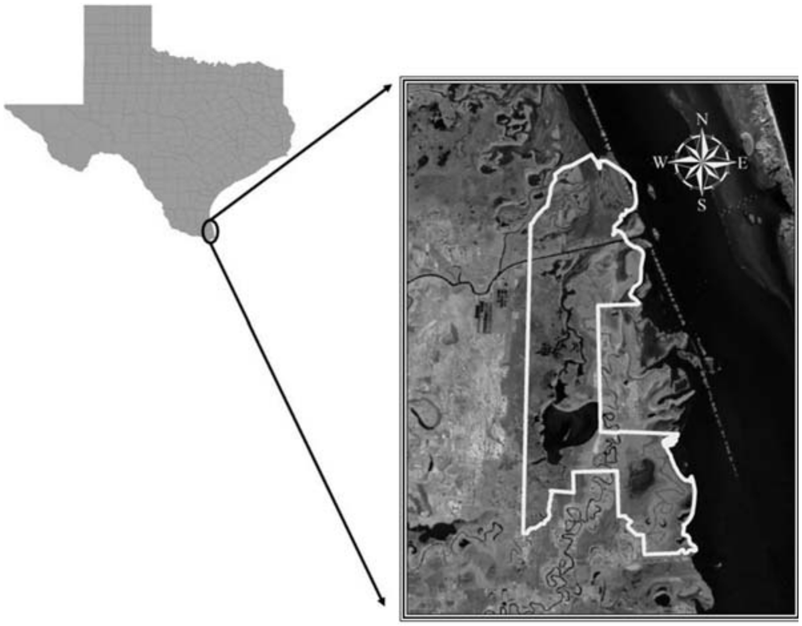

Fig. 1. Map of the Laguna Atascosa National Wildlife Refuge located in the Lower Rio Grande Valley, eastern Cameron County, Texas, USA.

resident and transient ocelots, as is the case with unexploited bobcats (Nielson and Woolf 2002), (3) ocelot survival will be 25% lower during drought conditions because prey resources will be limited, and (4) unnatural sources of mortality (e.g., ocelot–vehicle collisions) will represent 80% of total mortalities for both resident and transient ocelots, as found with unexploited bobcats (Nielsen and Woolf 2002).

STUDY AREA

We monitored ocelots in Laguna Atascosa National Wildlife Refuge located in Cameron County, within the Lower Rio Grande Valley (LRGV) of southern Texas, USA (Fig. 1). Laguna Atascosa National Wildlife Refuge is an 18,200-ha refuge that provides wintering and feeding areas for migratory waterfowl and habitat for ocelots. The LRGV is an alluvial plain dissected by numerous arroyos and ephemeral streams that flow into the Rio Grande River or the Gulf of Mexico (Everitt and Drawe 1993). The LRGV had diverse fertile soil types (Williams et al. 1977). The subtropical, semi-arid climate is characterized by hot summers and mild winters (Thornthwaite 1948, Lonard and Judd 1985). Mean length of the frost-free period was 330 days with winters frequently occurring without freezing temperatures. Mean annual temperature and rainfall were 23°C and 68 cm, respectively; however, rainfall fluctuated widely through the year (Norwine and Bingham 1985, Lonard et al. 1991).

This region supports various plants, wildlife, and habitats as part of the Tamaulipan Biotic Province (Blair 1950, Richardson 1995). Predominant woody species in the LRGV include spiny hackberry (*Celtis pallida*), crucita (*Eupatorium odoratum*), Berlandier fiddlewood (*Citharexylum berlandieri*), honey mesquite (*Prosopis glandulosa*), desert olive (*Forestiera angustifolia*), snake-eyes (*Phaulothamnus spinescens*), colima (*Zanthoxylum fagara*), and brasil (*Condalia hookeri*; Lonard and Judd 1993). However, >95% of the native rangeland in the LRGV has been converted to agricultural and urban land uses (Jahrsdoerfer and Leslie 1988).

METHODS

Trapping and Radiotelemetry

During 15 September 1982 to 11 November 2001, we captured 80 ocelots (36 F, 44 M) with single-door, 108 × 55 × 40 cm wire box traps (Tomahawk Trap Co., Tomahawk, Wisconsin, USA). We attached a separate compartment containing a domestic live chicken to the trap as bait. We placed traps in shaded areas and checked each morning to reduce the risk of hyperthermia.

We immobilized ocelots with a 9:1 ratio of ketamine hydrochloride and acepromazine maleate (Beltran and Tewes 1995). We injected this mixture with a pole syringe at a dosage of 20 mg/kg body weight. We sexed, weighed, and classified ocelots as adults or subadults based on maturation of morphological development, dental wear (sharp dentition for juveniles), canine length (>15 mm for adults), and weight (female adults >6.5 kg, male adults >8.5 kg). We fitted immobilized adult and subadult ocelots with collar-mounted radiotransmitters containing a mortality sensor and a frequency of 148–149 MHz (Telonics, Mesa, Arizona, USA). We used ground stations and aerial radiotelemetry to locate ocelots 2–3 times each week anytime between 1 hr before sunrise until 1 hr after sunset. We monitored radio signals with a directional H-antenna connected to a model LB12 receiver (Telonics Inc.). We located and recovered dead ocelots to determine cause of mortality. We conducted tracking from a small aircraft if a collared ocelot could not be found during ground searches. We classified mortality into 4 categories based on field observations and necropsy information: vehicle-caused, natural cause (i.e., mammal attack, disease), unknown, or other (other anthropogenic induced mortality; Tewes 1986, Laack 1991).

Survival and Cause-specific Mortality

We estimated annual and seasonal survival rates and cause-specific mortality rates of resident and transient ocelots using number of transmitter-days and total number of deaths within a defined time interval (Trent and Rongstad 1974, Heisey and Fuller 1985*a*). This was done using program MICROMORT (Heisey and Fuller 1985*b*), which is based on the Mayfield methodology (Mayfield 1961, 1975). To meet the assumptions of the Mayfield method, we assumed that constant survival occurred during the hot (16 Apr–15 Oct) and cool (16 Oct–15 Apr) seasons in the study area. Study assumptions included that newly collared ocelots had the same survival rate as previously collared ocelots, sampled ocelots were random and independent, working collars were always located, censoring was random, and trapping, handling, and radiocollaring did not impact ocelot survival (Winterstein et al. 2001). We used ocelots with transmitter failure in the data analysis for survival probabilities until signal loss occurred (Burger et al. 1995). We censored these cats from the survival analysis, but they were not considered mortalities (Pollock et al. 1989).

We pooled data across years because low annual sample sizes would have resulted in a low statistical power for the tests (Fuller et al. 1985, Cunningham et al. 2001, and Nielsen and Woolf 2002). Nielsen and Woolf (2002) stated that testing for differences in annual survival rates over years would have been biased due to differing number of radio days occurring for each year. Hence, Nielsen and Woolf (2002) believed that testing for differences in survival between years is unfounded and biologically meaningless (Yoccoz 1991, Cherry 1998). However, we did not pool years during 1989–1991 or 2000–2002 because during these years, the 12-month Palmer Modified Drought Severity Index (PMDI)—which assesses the severity of dry or wet conditions—was consistently lower from January 1989 to April 1991 and January 2000 to December 2002 than from January 1983 to December 1988 and May 1991 to December 1999 (Fig. 2).

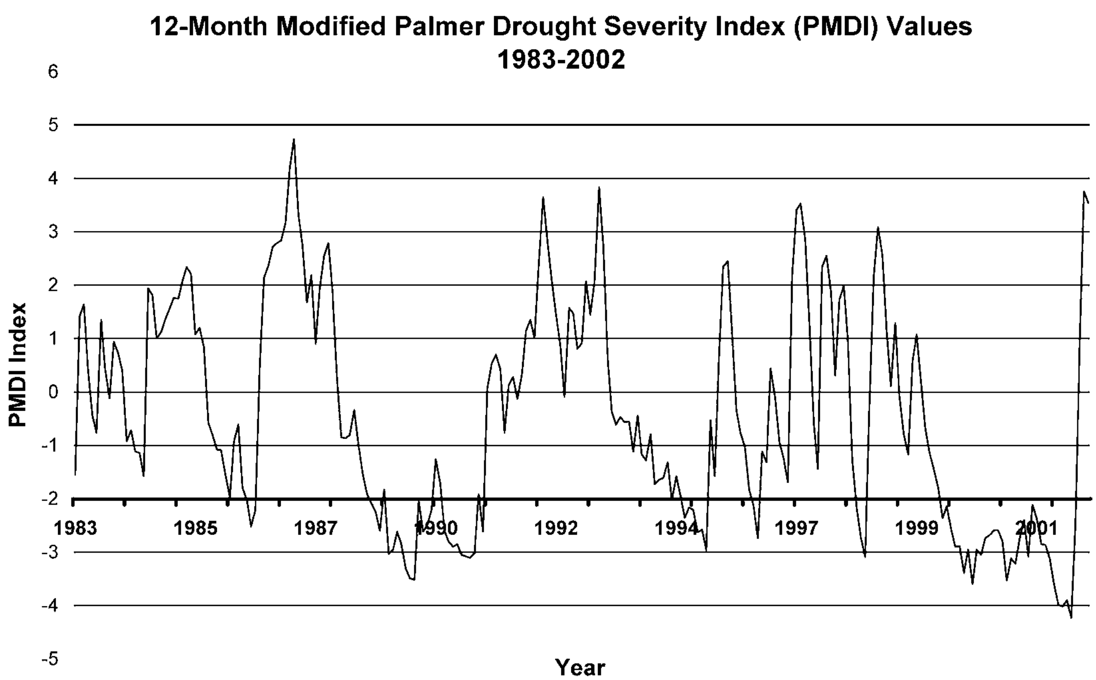

Fig. 2. The 12-month Modified Palmer Drought Severity Index within the Lower Rio Grande Valley of Texas, USA, Jan 1983–Dec 2002.

Blankenship (2000) found that on the Welder Wildlife Refuge (WWR) in San Patricio County, Texas, bobcat survival, fecundity, and prey density dropped dramatically during drought conditions in 1996. During 1996, the mean 12-month PMDI was –2.52 within the WWR area, which indicated moderate drought conditions. From January 1989 to May 1991 and January 2000 to December 2002, the mean 12-month PMDI was –2.42 and –2.48 within LRGV of Texas (which also indicated moderate drought conditions), whereas the mean 12-month PMDI from January 1983 to December 1988 and May 1991 to December 1999 was 0.55 and 0.11 (which indicated normal moisture conditions; National Climatic Data Center; http://www.ncdc.noaa.gov). Consequently, we analyzed survival of ocelots separately from January 1989 to May 1991 and January 2000–2002 to minimize differences in survival between years so they can be pooled. We analyzed cause-specific mortality from January 1982 to December 2002.

We used chi-square tests in the program CONTRAST to test for differences in annual survival and annual cause-specific mortality between resident and transient ocelots, and we pooled annual survival and cause-specific mortality rates between sexes and seasons for resident and transient ocelots (Hines and Sauer 1989, Sauer and Williams 1989). We tested for differences in annual and seasonal survival rates and annual and seasonal mortality rates between male and female resident ocelots, and between male and female transient ocelots. We also tested for differences in annual survival rates during drought and normal conditions for resident and transient ocelots. Experiment wise error rate was maintained during associated multiple comparisons by adjusting α with a Bonferroni correction factor (α/no. of comparisons; Neter and Wasserman 1974). Statistical significance was inferred at $P \leq 0.05$.

We defined resident ocelots as an individual that used a single restricted area (home range) for 3 months or more, and we defined transient ocelots as an individual that moved from the natal or breeding range and traveled nomadically until a stable range was established. We applied a resident status to transient ocelots following establishment of a stable breeding range. We correctly classified most transients as subadults with ocelots usually leaving their natal range at 2–3 years of age (Sunquist and Sunquist 2002). Resident ocelots included juvenile cats still residing on their natal range and adult cats with a defined breeding range.

RESULTS

From 1 January 1983 to 31 December 2002, we used 72 resident (33 F, 39 M) and 20 transient (6 F, 14 M) ocelots for 50,901 radio days ($\bar{x}$ days/ocelot = 749, range 11–1,669 days) for survival and cause-specific mortality analyses. Individual ocelots sometimes shifted between resident and transient status. We monitored resident ocelots for 46,550 radio days ($\bar{x}$ = 647 days/ocelot, range 45–1,669 days) and transient ocelots were monitored for 4,641 radio days ($\bar{x}$ = 218 days/ocelot, range 11–645 days). We monitored resident female ocelots for more radio days (25,549) than male residents (21,001 radio days) and male transient ocelots for more radio days (3,511) than female transients (1,130 radio days).

Twenty-nine mortalities occurred during the study with 21 residents (14 F, 7 M) and 8 transients (2 F, 5 M). Mortalities within resident ocelots included 7 (33%) vehicle-caused and 6 natural mortalities (29%). Natural mortalities included 2 diseased (chronic ear infection, heartworm {*Dirofilaria immitis*} infestation), 3 aggressive animal encounters (e.g., rattlesnake [*Crotalus atrox*] bite, attack from another cat, attack from another animal leading to septic peritonitis and pleuritis), and 1 predation. Five (24%) resident ocelot mortalities were unknown, and we classified 3 (14%) resident ocelot mortalities as other (killed by dogs [*Canis domesticus*], capture hyperthermia, and poisoned by organophosphate aldicarb [illegal predator control agent]). Mortalities within transient ocelots included 4 (50%) natural mortalities (1 mange, 1 lung abscess from plant material, 2 intraspecific mortality), 3 (37.5%) vehicle-caused, and 1 (12.5%) unknown. Overall, mortalities for ocelots did not differ dramatically between the cool (n = 14, 48%) and hot (n = 15, 52%) season. Vehicle-caused (35%) and natural (35%) mortalities were the highest sources of mortalities for ocelots in south Texas followed by unknown (20%), and other (10%) mortalities. Unnatural mortalities constituted 45% of total mortalities, which was lower than the 80% we had hypothesized.

Survival

From January 1983 to December 1999, during normal conditions, resident ocelots had a 30% higher annual survival rate than transient ocelots (Table 1). This supported our hypothesis that resident ocelot survival would be higher than transient ocelot survival, albeit not 50% higher. Annual survival rates did not differ (χ^2_1 = 1.98, P = 0.16) between male and female resident ocelots or between male and female transient ocelots (χ^2_1 = 0.10, P = 0.75; Table 1). This supported our hypothesis that survival between sexes would be similar.

Because annual survival differed (χ^2_1 = 5.22, P = 0.02) between resident and transient ocelots, we analyzed survival and cause-specific mortality rates separately between resident and transient ocelots. For resident ocelots, survival did not differ between the cool and hot season (Table 1). For transient ocelots, survival also did not differ (χ^2_1 = 0.54, P = 0.46) between the cool and hot season (Table 1). Survival did not differ (χ^2_1 = 1.25, P = 0.26) between male and female resident ocelots or between male and female transient ocelots during the cool season (χ^2_1 = 3.00, P = 0.08; Table 1). During the hot season, male survival was higher (χ^2_1 = 5.01, P = 0.02) than female survival for resident ocelots (Table 1), while survival between male and female transient ocelots did not differ (χ^2_1 = 0.07, P = 0.79; Table 1).

During drought conditions annual survival of resident ocelots ($\hat{S}$ = 0.77, SE 0.07) was higher (χ^2_1 = 6.08, P = 0.01) than for transient ocelots ($\hat{S}$ = 0.13, SE 0.25). We monitored 27 (16 F, 11 M) resident ocelots during the drought periods (Jan 1989–Apr 1991 and Jan 2000–Dec 2002) for 11,725 radio days ($\bar{x}$ days/ocelot = 434, range 20–1,095 radio days). Annual survival of resident ocelots during drought conditions ($\hat{S}$ = 0.77, SE 0.07) did not differ significantly (χ^2_1 = 1.89, P = 0.17) from resident ocelot annual survival during normal conditions (Jan 1983–Dec 1988 and May 1991–Dec 1999; $\hat{S}$ = 0.87, SE 0.05). Resident ocelot survival during drought conditions decreased by 10%, this supported our hypothesis that ocelot survival would decrease during drought periods. However, this decrease was not significantly different and was not as severe as the 25% decline we hypothesized. We monitored 4 (2F, 2M) transient ocelots during the drought periods for 553 radio days ($\bar{x}$ days/ocelot = 136.5, range 11–175 radio days), with 1 individual suffering from an intraspecific attack, another from an unknown mortality, and 2 with lost radio signals. Annual survival of transient ocelots during drought conditions ($\hat{S}$ = 0.13, SE 0.25) did not differ significantly (χ^2_1 = 2.44, P = 0.12) from transient ocelots ($\hat{S}$ = 0.57, SE 0.13) during normal conditions. However, we attribute this nonsignificance to the low number of radio days of transients during the drought period.

Cause-specific Mortality

Cause-specific mortality did not differ for resident (χ^2_1 = 1.61, P = 0.20), or transient ocelots (χ^2_1 ≤ 1.06, P ≥ 0.30) during the cool and hot season (Table 2). In addition, cause-specific mortality of male and female resident ocelots did not differ during the cool season (χ^2_1 ≤ 2.25, P ≥ 0.13) or the hot season (χ^2_1 ≤ 3.11, P ≥ 0.08). Similarly, cause-specific mortality of male and female transients did not differ during the cool season (χ^2_1 ≤ 1.44, P ≥ 0.23) or the hot season (χ^2_1 ≤ 2.89, P ≥ 0.09). Cause-specific mortality differed between resident and transient ocelots (χ^2_1 = 4.70, P = 0.03), with transient ocelots having higher natural mortality (M = 0.26, SE 0.10) than resident ocelots (M = 0.04, SE 0.02). Other forms of mortality did not significantly differ between resident and transient ocelots (χ^2_1 ≤ 2.78, P ≥ 0.10; Table 2).

If we include mortality data from collared and uncollared ocelots from 1983–2002, the summary of mortality rates include 26 (45%) road mortalities; 4 (7%) other human-caused mortalities; 6 (10%) disease, parasitism, infection; 8 (14%) predation, aggression; and 14 (24%) unknown mortalities. However, direct human-caused mortality

Table 1. Seasonal and annual survival rates ($\hat{S}$) of male and female resident and transient ocelots in Cameron County, Texas, USA, January 1983–31 December 1988 and 2 April 1991–31 December 1999 during normal moisture conditions.

	Residents				Transients			
	Mortalities	Radio days	$\hat{S}$	SE	Mortalities	Radio days	$\hat{S}$	SE
Male								
Cool[a]	4	8,368	0.92	0.04	2	1,318	0.74	0.15
Hot[b]	0	8,388	1.00	0.00	3	1,696	0.71	0.13
Annual	4	16,756	0.92	0.04	5	3,014	0.53	0.15
Female								
Cool	4	8,595	0.92	0.04	0	605	1.00	0.00
Hot	5	9,474	0.91	0.04	1	469	0.63	0.27
Annual	9	18,069	0.83	0.05	1	1,074	0.63	0.27
Pooled								
Cool	8	16,963	0.92	0.03	2	1,923	0.82	0.11
Pooled								
Hot	5	17,862	0.95	0.04	4	2,165	0.70	0.12
Annual	13	34,825	0.87	0.02	6	4,088	0.57	0.13

[a] 16 Oct–15 Apr.
[b] 16 Apr–15 Oct.

Table 2. Pooled seasonal and annual cause-specific mortality rates (*M*) of male and female resident and transient ocelots in Cameron County, Texas, USA, 1 January 1983–31 December 2002.

		Residents			Transients		
	Mortality cause	Mortalities	*M*	SE	Mortalities	*M*	SE
Cool[a]	Vehicle	5	0.040	0.017	1	0.080	0.078
	Natural	3	0.020	0.014	2	0.160	0.100
	Unknown	2	0.015	0.010	0	0.000	0.000
	Other	1	0.010	0.001	0	0.000	0.000
Hot[b]	Vehicle	2	0.015	0.010	2	0.130	0.080
	Natural	3	0.020	0.014	2	0.130	0.080
	Unknown	3	0.020	0.014	1	0.065	0.063
	Other	2	0.015	0.010	0	0.000	0.000
Annual	Vehicle	7	0.050	0.020	3	0.180	0.095
	Natural	6	0.040	0.017	4	0.260	0.100
	Unknown	5	0.036	0.017	1	0.050	0.045
	Other	3	0.020	0.012	0	0.000	0.000

[a] 16 Oct–15 Apr.
[b] 16 Apr–15 Oct.

may be overrepresented as they were more likely to be found.

DISCUSSION

Our study provided the first survival and cause-specific mortality rates for ocelots. Resident ocelots exhibited a 30% higher survival than transient ocelots. Most transients were subadult individuals probably attempting to identify a breeding range; whereas, 3 transients were adult individuals probably trying to reestablish a breeding range elsewhere. Resident adult ocelots killed 2 transient ocelots. Intraspecific mortality within felids has been previously documented (Litvaitus et al. 1982, Zezulak and Minta 1987, Logan and Sweanor 2001). Intrasexual defense of a breeding range from intruding conspecifics is suspected for male and female ocelots (Tewes 1986, Laack 1991). Both mortalities coincided with the arrival of a same-sex intruder into an established breeding range of a resident ocelot, with the transient intruders exhibiting puncture wounds, and claw marks as lacerations and scratches. Soon after 1 of the transient mortalities was found, the resident ocelot of the area was captured and had claw scratches on its body. The canine spacing of the resident cat matched the cranial fracture wounds of the dead transient found on its range. Another source of natural mortality for a transient ocelot was notoedric mange, which had been previously reported in ocelots from southern Texas (Pence et al. 1995).

In 3 different studies that monitored the dispersal of 11 ocelots, 5 ocelots survived until study termination, humans directly killed (shot) 5 individuals, and a resident ocelot killed 1 individual (Ludlow and Sunquist 1987, Emmons 1988, Crawshaw 1995). Transient ocelots may be more susceptible to mortality by traveling over large unfamiliar areas, thus increasing the possibility of road kills, encountering other anthropogenic mortalities, and increased likelihood of intraspecific mortality and other animal attacks. Sunquist and Sunquist (2002) stated that cat movement over a large area increases encounters with highways and humans, the 2 primary sources of mortality for wild cats. Kamler and Gipson (2000) found that the survival rate of resident bobcats was twice as high as transient bobcats. They attributed this difference to resident bobcats occupying a military base that served as a refuge, and transient bobcats susceptible to hunting, trapping, and being vulnerable within unfamiliar areas.

Annual survival was similar between male and female resident and transient ocelots. Knick (1990) and Nielson and Woolf (2002) found that annual survival of male and female radiomonitored adult bobcats in unexploited populations were similar. We found a difference in sex-specific seasonal survival between male and female resident ocelots during the hot season with male resident ocelots having a higher annual survival rate than female residents. We have no explanation for this difference in survival. Chamberlain et al. (1999) found that female bobcat survival was lower during the parturition–young-rearing period (1 Jun–30 Sep) in central Mississippi. However, ocelots lacked a distinct breeding season and may breed when environmental conditions are favorable (Tewes 1986, Laack 1991).

Favorable environmental conditions in southern Texas may be dictated by precipitation, which fluctuates widely between seasons and among years; thus, we partitioned ocelot survival by normal and drought periods. During drought conditions resident ocelots still had a higher annual survival rate than transient ocelots. Survival of resident ocelots during drought periods ($\hat{S}$ = 0.77) did not differ significantly from resident ocelots during normal conditions ($\hat{S}$ = 0.87). In addition, there was no significant difference between the survival of transient ocelots during drought ($\hat{S}$ = 0.13) and normal ($\hat{S}$ = 0.57) conditions. However, the number of individual transient ocelots radiomonitored during drought conditions was only 4. This reduction in the number of radiomonitored transient ocelots during drought conditions may be due to (1) young ocelots staying within natal ranges during drought periods, (2) adult females producing few young during drought periods, or (3) the population of transient ocelots crashing during drought periods. More research is needed to test why the number of individual transient ocelots decreased during drought conditions. Blankenship (2000) found that during a drought year when primary prey of bobcats was reduced, bobcats had lower survival, no fecundity, and increased transient behavior. More research is needed to monitor the effects of drought conditions on ocelot fecundity and behavior.

Cumulative survival rates of resident ocelots ($\hat{S}$ = 0.87) was similar to survival rates of unexploited bobcats in Illinois ($\hat{S}$ = 0.82; Nielsen and Woolf 2002) but higher than unexploited bobcats in Idaho ($\hat{S}$ = 0.67; Knick 1990). However, Knick (1990) and Nielsen and Woolf (2002) did not differentiate between transient and resident bobcats. Knick (1990) found 50% bobcat mortalities in an unexploited population in Idaho were human-related. Nielsen and Woolf (2002) found 19 mortalities with 10 bobcats (52%) hit by automobiles and human activities causing 79% of the cumulative mortality. In our study both resident and transient ocelot mortalities were caused by both anthropogenic (e.g., vehicle collisions) and natural mortality (predation) factors, with transient ocelots having a higher rate of natural mortalities. We documented 29 total mortalities with human activity causing 45% of the cumulative mortality. However, natural mortality may be indirectly related to anthropogenic habitat fragmentation. Reduced habitat availability may cause ocelot populations to be more crowded, thus increasing intraspecific conflict, competition, and disease transmission.

When analyzing the assumptions of the Mayfield method for calculating survival in this study there was no evidence to support that any of the assumptions had been violated, with maybe 1 exception. One radiocollared ocelot was recaptured and suffered from capture hyperthermia. However, this was the only documented case in which an ocelot died from trapping and handling techniques during this 20-year study. Further, no ocelots were found dead directly after being collared. The shortest time interval from when an ocelot was originally collared until it experienced mortality was 95 days.

Our study found fewer female transients than male transients. There are usually fewer female transients than male transients in populations of solitary cats because females usually settle adjacent to or within their natal range to breed (Sunquist and Sunquist 2002). This same pattern of behavior has been documented for tiger (*Panthera tigris*), leopard (*Panthera pardus*), Iberian lynx (*Lynx pardinus*), and puma (*Puma concolor*; Smith et al. 1987, Bailey 1993, Lindzey et al. 1994, Ferreras et al. 1997).

MANAGEMENT IMPLICATIONS

Vehicle-caused mortality seems to be the primary anthropogenic factor causing ocelot deaths in the LRGV of southern Texas. Applications of remedial tactics within transportation corridors to promote safer felid movements have been proposed to minimize ocelot mortality, including cat underpasses (e.g., culverts), which have been constructed for ocelots in southern Texas (Tewes and Blanton 1998, Tewes and Hughes 2001). Proposed culverts should be placed in relation to habitat features and travel corridors, with barrier fences guiding cats to the culverts and crossing structures allowing for water drainage (Tewes and Hughes 2001, Cain et al. 2003). In addition, Beier (1995) recommended that artificial lighting and unrestrained pets should be excluded from culverts. However, culvert utility and effectiveness in reducing vehicular-caused ocelot mortality still needs to be assessed, and ocelot travel corridors should be assessed prior to construction of expensive culverts, as well as other developments that are designed for ocelot passage at specific locations (Tewes and Hughes 2001). This can be done by placing remote cameras within culverts or at proposed culvert locations to monitor ocelot activity and using telemetry to monitor ocelot movements around major roadways.

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