ENVIRONMENTAL CONTAMINANTS IN BLOOD, HAIR, AND TISSUES OF OCELOTS FROM THE LOWER RIO GRANDE VALLEY, TEXAS, 1986–1997

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Abstract. The ocelot (*Felis pardalis*) is an endangered neotropical cat distributed within a small range in the Lower Rio Grande Valley (LRGV), in Texas, U.S.A. Studies of the impacts of environmental contaminants in wild cats are few. Approximately one fourth of the estimated population (about 100) of ocelots in the LRGV was sampled to evaluate the impacts of chlorinated pesticides, polychlorinated biphenyls, and trace elements on the population. Hair was collected from 32 ocelots trapped between 1986–1992, and blood was collected from 20 ocelots trapped between 1993–1997. A few blood samples were obtained from individuals recaptured two or three times. Tissue samples from 4 road-killed ocelots were also analyzed. DDE, PCBs, and Hg were some of the most common contaminants detected in hair and blood. Mean Hg levels in hair ranged from 0.5 to 1.25 μg g^{-1} dw, Se from 1.5 to 3.48 μg g^{-1} dw, and Pb from 0.56 to 26.8 μg g^{-1} dw. Mean DDE concentrations in plasma ranged from 0.005 μg g^{-1} ww to 0.153 μg g^{-1} ww, and PCBs ranged from 0.006 μg g^{-1} ww to 0.092 μg g^{-1} ww. Mean Hg levels in red blood cells ranged from 0.056 μg g^{-1} dw to 0.25 μg g^{-1} dw. Concentrations of DDE, PCBs, or Hg, did not increase significantly with age, although the highest concentrations of DDE and Hg were found in older animals. Overall, concentrations of DDE, PCBs, and Hg were low and at levels that currently do not pose any threat to health or survival of the ocelot. This is further supported by good reproduction of the ocelot in the LRGV, where adult females averaged about 1.5 kittens/litter. Thus, it seems that the current major threat to recovery of the ocelot in the LRGV may be habitat loss, although potential impacts of new generation pesticides, such as organophosphorus and carbamate insecticides need further study.

Keywords: contaminants, endangered species, Lower Rio Grande Valley, mammals, ocelot, organochlorines, Texas, trace elements

1. Introduction

The ocelot (*Felis pardalis*) is a neotropical cat which used to inhabit east, south, and central Texas, Western Louisiana, and southern Arkansas in the United States (Woodward, 1980; Navarro-Lopez, 1985). Currently, however, the ocelot is lim-

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ited to a small range in the Lower Rio Grande Valley (LRGV), Texas, and the population has been estimated at about 100 individuals (Tewes and Everett, 1986; Laack, 1991). The ecology, behavior, movements, and distribution of ocelots in the LRGV have been well studied (Navarro-Lopez, 1985; Tewes, 1986; Laack, 1991). However, the impacts of environmental contaminants on ocelots in this area have not been addressed.

The ocelot was listed as endangered under the Endangered Species Act of 1973 by the U.S. Fish and Wildlife Service (1982). Habitat loss and fragmentation endanger the recovery of ocelots, and potential ocelot habitat includes only about 1.6% of the south Texas area (Tewes and Everett, 1986). Ocelots' home ranges can be as large as 18 km^2 (Tewes, 1986); thus, in the LRGV their foraging habitat includes agricultural areas that are exposed to pesticides. Ocelots prey on small to medium-sized mammals and birds, but they may also take reptiles, fish, and invertebrates (Mondolfi, 1986; Emmons, 1987; Konecny, 1989).

One objective of the recovery plan for the cats of Texas and Arizona was to evaluate and control or eliminate threats to the survival of the ocelot (U.S. Fish and Wildlife Service, 1990). A number of contaminant issues have been raised in the LRGV which give cause for concern for ocelot recovery. In 1992, two deformed reddish egret (*Egretta rufescens*) chicks were observed near the Laguna Atascosa National Wildlife Refuge (LANWR) in south Texas (S. Thompson, pers. comm., Figure 1). Additionally, bird deformities and a high incidence of birth defects reported in humans in the LRGV in the early 1990s (Texas Department of Health, 1992), led us to suspect that continuous exposure to increased concentrations of agricultural and industrial chemicals in those areas might have caused such anomalies. Therefore, assessing contaminant threats to ocelot populations is considered a relevant aspect of determining likelihood of recovery.

The use of blood plasma to estimate concentrations of environmental contaminants in wild populations is well accepted (Henny and Meeker, 1981; Elliot and Shutt, 1993; Mora *et al*., 1993). Monitoring contaminants in plasma permits sampling of threatened or endangered species and allows for repeated sampling of the same individuals. The main objective of this study was to determine if ocelots were affected by environmental contaminants such as PCBs, chlorinated pesticides, and trace elements in the LRGV.

2. Materials and Methods

2.1. HAIR COLLECTION

Approximately 0.5 g of hair was collected from 32 ocelots trapped during 1986–1992 in the LANWR and surrounding areas in Cameron and Willacy counties (Table I, Figure 1). Except for a few cases, most hair samples were from individuals from which blood was not collected for the analysis of environmental contamin-

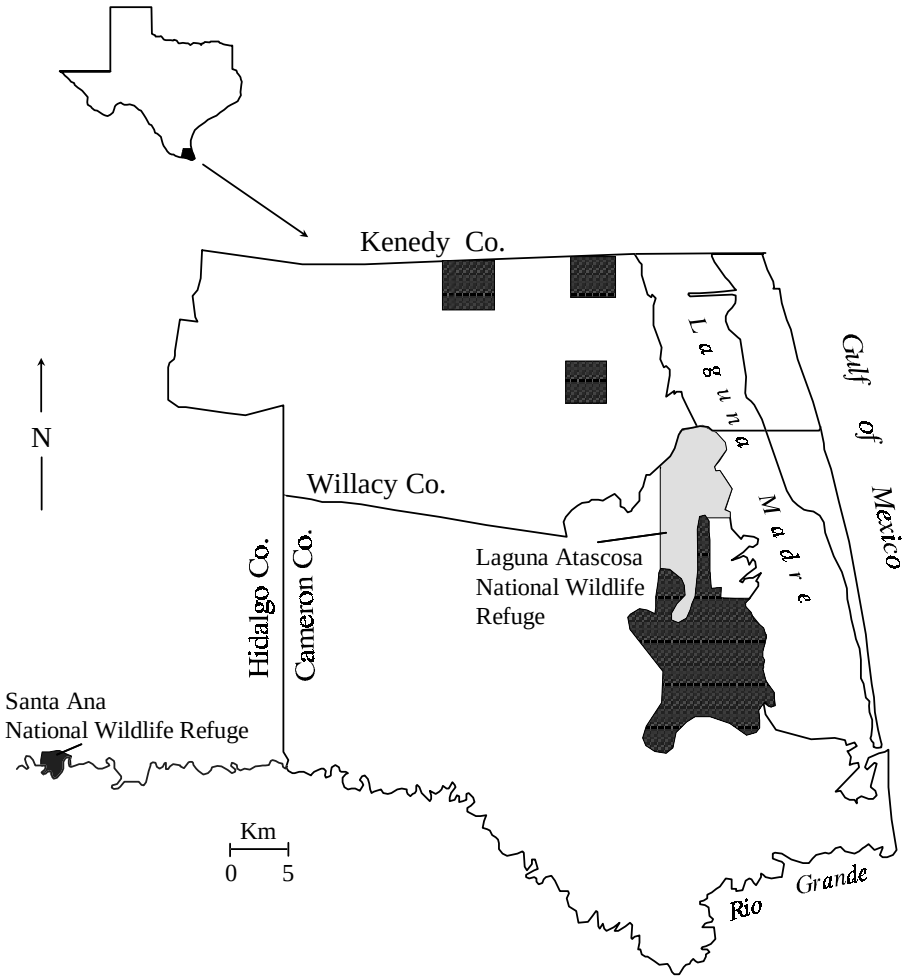

Figure 1. Map of the Lower Rio Grande Valley showing the wildlife refuges and additional locations (hatched) where ocelots were captured.

ants. Individual hair samples were placed in plastic bags and stored in the freezer until they were analyzed for mercury (Hg), selenium (Se), and lead (Pb).

2.2. TISSUES FROM ROAD-KILLED OCELOTS

Liver, kidney, muscle, and fat were collected from four ocelots found dead in Cameron and Willacy counties (Figure 1). The carcasses were found at different stages of decomposition; thus, only two kidney and three liver samples were analyzed for trace elements. One fat and four muscle samples were analyzed for chlorinated pesticides and PCBs.

TABLE I

Average age and weight (± SD) of ocelots from which hair samples were collected, 1986–1992[a,b]

N	Sex	Age (yr)	Weight (kg)
19	M	3.9±1.9	9.4±1.9
13	F	3.4±2.0	6.8±0.8

[a] Most cats were trapped in Cameron County, at the Laguna Atascosa National Wildlife Refuge; however, some were also captured at Willacy and Kenedy counties (Figure 1).
[b] Age of nine males and seven females could not be determined.

2.3. BLOOD COLLECTION

Ocelots were captured with wire box traps ($108 \times 51 \times 40$ cm; Tomahawk Live Traps, Tomahawk, Wi). A cage ($52 \times 51 \times 40$ cm) was attached to the back of each trap with a live chicken as bait. Traps were checked daily in the morning and were left open 24 h day^{-1}. Twenty ocelots (13 males and 7 females) were trapped between November 1993 and April 1997 in the LANWR, Cameron and Hidalgo counties. One male ocelot (M132) was trapped three times between November 1994 and March 1996. Three other males were trapped twice in February and December 1994 (M174), in March 1995 and February 1996 (M192), and in May 1995 and March 1997 (M193).

Blood was collected mostly during the winter months to avoid heat stress in immobilized animals. Since blood was primarily collected for a genetic study, in most cases, hair was not collected from the same individuals. Prior to blood collection, the animals were anesthetized with a 100:1 mixture of ketamine hydrochloride and acepromazine maleate, administered with a pole syringe into the biceps femoris. Average sedation was approximately 19 mg ketamine kg^{-1} body weight. Ocelots were handled between 15–30 min. The animals were allowed to recover from anesthesia before release. Blood (5 mL) was collected from the vein of one front leg. The blood was placed in vacutainer tubes containing heparine. Plasma was obtained by centrifuging the blood for 10 min at approximately 2000 rpm. The plasma was separated from the red blood cells and stored at –20 °C until chemical analysis.

2.4. CHEMICAL ANALYSIS

Hair, kidney, liver, and red blood cells were analyzed for trace elements by atomic absorption spectrophotometry and inductively-coupled plasma-mass spectrometry

(ICP-MS). Approximately 0.5 g of sample was digested with nitric and perchloric acids. The digest was analyzed for most elements with a Perkin Elmer, Model ELAN 5000, ICP-MS. Arsenic and Se were analyzed with a Varian VGA-76 hydride generation accessory mounted to an AA Perkin Elmer, Model 3030. For the analysis of Hg, approximately 0.2 g dry weight of the sample was digested with a mixture of nitric acid, sulfuric acid, and potassium permanganate-persulfate in a hot water bath. After digestion, excess permanganate was reduced with hydroxilamine hydrochloride and the Hg (II) in solution was reduced to Hg (0) with stannous chloride. Mercury was analyzed by the standard cold vapor atomic absorption method. The lowest detection limits for trace elements varied with tissues but ranged from 0.006 μg g^{-1} dw for Cd to 2 μg g^{-1} dw for Al. Percent recoveries of spiked samples and certified reference materials were above 90% in most cases. Mean relative percent differences between duplicates were $<$10%.

Plasma samples were analyzed for congener specific PCBs and organochlorine pesticides at the Geochemical and Environmental Research Group, Texas A&M University. Two mL of plasma were denaturized with methanol and extracted with 5 mL portions of 1:1 hexane-diethyl ether. Further cleanup was conducted in a mixed bed alumina/silica micro column. Cleanup extracts were concentrated to 1 mL with a turbovap vortex evaporator. Chlorinated pesticides and congener specific PCBs were determined by gas chromatography and electron capture detector, GC-ECD (^{63}Ni) in splitless mode, and a DB-5 (30 $\times$ 0.25 mm ID) fused-silica capillary column (J&W Scientific, Folsom, CA.) (Sericano *et al*., 1990). The column temperature was programmed from 100 to 140 °C at 5 °C min^{-1}, 140 to 250 °C at 1.5 °C min^{-1}, and 250 to 300 °C at 10 °C min^{-1}, with 1 min holding time at the beginning of the program and before each program rate change, and 5 min at the final temperature. Total run time was 94 min. Injector and detector temperatures were 275 and 325 °C, respectively. Helium was used as the carrier gas, and argon/methane (95:5) as the make-up gas. Ten percent of the samples were confirmed by second injection on a DB-17 capillary column. Spike recoveries were above 80% in all cases; variation between duplicates was within 15%. The lowest detection limit for OCs was 1 ng g^{-1} ww.

Muscle and fat samples were analyzed for organochlorine pesticides and PCBs at the Mississippi State Chemical Laboratory, Mississippi State, MS. The samples were mixed with anhydrous sodium sulfate and extracted with hexane. The hexane extract was then evaporated and the lipid sample was reextracted with acetonitrile saturated with petroleum ether. The extract was cleaned up in a florisil column and eluted with a 6:94% mixture of diethyl ether/petroleum ether for Fraction I, and 15:85% volume ratio for fraction II. Fraction I was further cleaned up in a silicic acid column to separate PCBs from other organochlorines. Residues in fractions I and II were quantitated by packed or megabore column and GC-ECD. Detection limits for chlorinated pesticides were 0.01 μg g^{-1} ww, and 0.05 μg g^{-1} ww for total PCBs. Percent recoveries of spiked samples were $>$80%. Relative percent differences between duplicates were $<$5%.

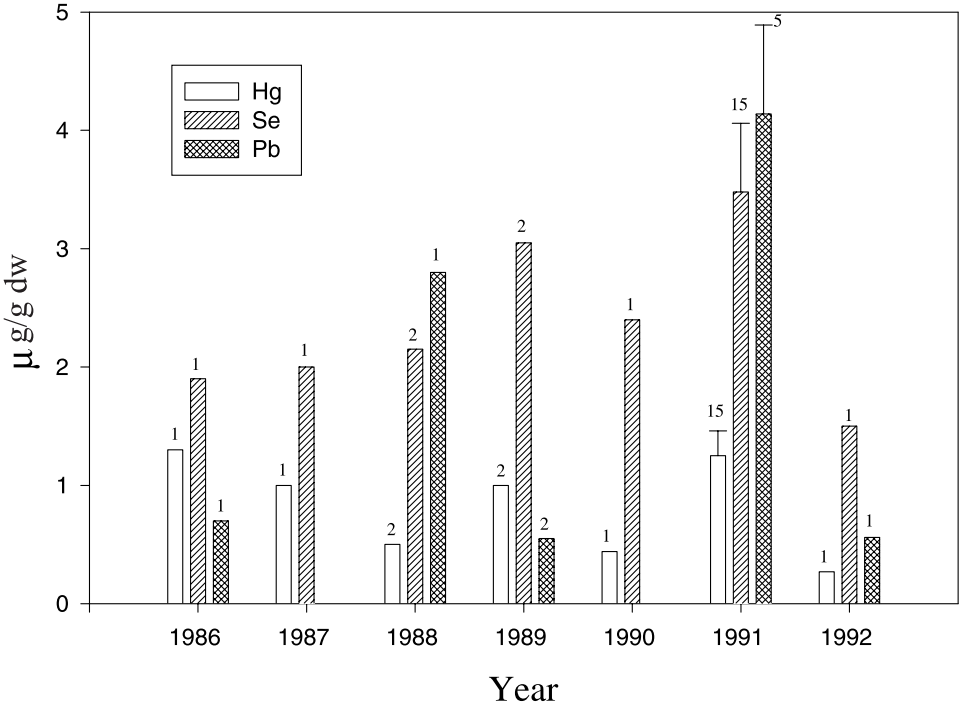

Figure 2. Mercury, selenium, and lead (μg g^{-1} dw) in hair of ocelots from the Lower Rio Grande Valley, 1986–1992. Values are arithmetic means, standard errors were possible only for 1991 samples. Thirty-two samples were analyzed, numbers above bars indicate number of samples with values above detection limits. One outlier value for lead (150 μg g^{-1} dw) was excluded from the figure.

2.5. Statistical analysis

Comparisons of concentrations of DDE and PCBs in plasma, and Hg in red blood cells, among years were carried out by analysis of variance of log transformed data. There were not enough samples to compare differences in concentrations among sexes, except for years 1994 and 1995.

3. Results

3.1. Contaminants in hair

Average weight and age of ocelots from which hair samples were taken are shown in Table I; concentrations of Hg, Se, and Pb in hair are shown in Figure 2. Most ocelots from which hair was collected (19 of 32) were captured during 1991. Mercury and Se were detected in 72% (23) of the total number of samples analyzed, and Pb was detected in 34% (11). Maximum mean concentrations of Hg, Se, and Pb were reached during 1991, possibly because that was the year when most of the

TABLE II

Organochlorines (μg g^{-1} ww) and trace elements (μg g^{-1} dw) in tissues of four ocelots found dead in the Lower Rio Grande Valley. Values are arithmetic means±SD. Numbers in parentheses indicate number of samples with values above detection limits[a,b,c]

Tissue type	DDE	PCBs	Hg	Se	Pb
Hair			0.70±0.56	5.87±3.81	0.70
			(3)	(3)	(2)
Kidney			0.31±0.22	5.25±2.19	
			(2)	(2)	
Liver			0.28±0.19	4.80±3.20	
			(3)	(3)	
Muscle	0.09±0.09	0.07±0.01			
	(4)	(2)			
Fat	4.20	1.90			
	(1)	(1)			

[a] Two of the four ocelots were females, one male, and one carcass could not be identified.
[b] Additional trace elements analyzed in kidney and liver included Al, As, B, Ba, Cd, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Sr, and Zn.
[c] Other organochlorines were detected infrequently and at concentrations <0.3 μg g^{-1} ww.

samples were collected, but also in the case of Pb because one ocelot had a high Pb value of 150 μg g^{-1} dw. However, even when the high Pb value was excluded, the mean was still greater than 4 μg g^{-1} dw (Figure 2). Mean Se concentrations were approximately 3.4 times higher than Hg concentrations in hair.

3.2. CONTAMINANTS IN ROAD-KILLED OCELOTS

Concentrations of DDE, PCBs, Hg, Se, and Pb in tissues of road killed ocelots are shown in Table II. DDE and PCBs were the most common chlorinated compounds detected in fat and muscle. Some common trace elements in tissues were Hg, Se, and Pb; however, Cd, Cr, Cu, Fe, Mg, Mn, Mo, Sr, and Zn were also reported. Concentrations of Hg were somewhat higher in hair than in kidney or liver; however, Se concentrations were similar among tissues. Overall, Se concentrations were approximately 9-fold higher in hair, 24-fold higher in liver, and 27-fold higher in kidney, than Hg concentrations in respective tissues.

3.3. CONTAMINANTS IN BLOOD PLASMA AND RED BLOOD CELLS

Average age and weight of 20 ocelots from which blood was analyzed are given in Table III, and contaminant concentrations in Table IV. The organochlorines most

TABLE III

Average age and weight (± SD) of ocelots from which blood samples were taken in the Lower Rio Grande Valley, 1993–1997[a,b]

N	Sex	Age (yr)	Weight (kg)
13	M	5.0±2.7	8.5±1.1
7	F	5.3±2.4	7.4±0.6

[a] Most cats were trapped at the Laguna Atascosa National Wildlife Refuge, except for one which was captured at the Santa Ana NWR.
[b] Age of five males and one female could not be determined.

TABLE IV

Geometric means and range for DDE and PCBs (μg g^{-1} ww) in plasma, and Hg (μg g^{-1} dw) in red blood cells of ocelots from the Lower Rio Grande Valley[a]

Year	Sex	N	DDE	PCBs	Hg
1993	M	1	0.006	0.006	0.154
1994	M	4	0.017	0.014	0.088
			(0.004–0.040)	(0.005–0.055)	(0.084–0.162)
	F	3	0.017	0.009	NA[b]
			(0.004–0.076)	(0.003–0.036)	
1995	M	6	0.034	0.019	0.249
			(0.010–0.143)	(0.005–0.034)	(0.103–0.522)
	F	2	0.034	0.019	0.056
			(0.003–0.387)	(0.005–0.072)	(0.048–0.065)
1996	M	5	0.079	0.073	0.155
			(0.012–0.452)	(0.038–0.201)	(0.068–0.396)
	F	1	0.055	0.035	0.088
1997	M	2	0.153	0.092	0.196
			(0.117–0.200)	(0.080–0.106)	(0.075–0.507)
	F	1	0.005	0.026	0.100

[a] Chlordane was detected in plasma of 12 ocelots at low levels (0.001–0.007 μg g^{-1} ww).
[b] NA: Not available.

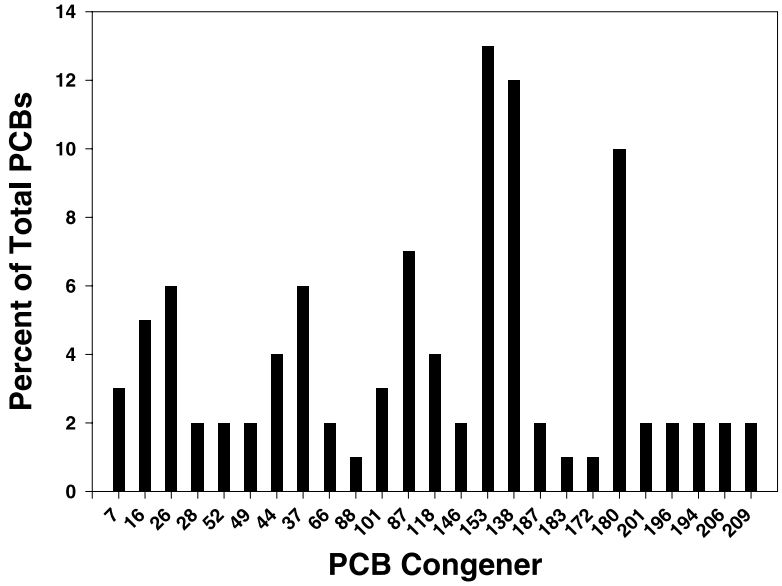

Figure 3. Relative contribution of PCB congeners to total PCBs.

commonly detected were p,p′-DDE, PCBs, and chlordane. Other OCs were reported infrequently and were near detection limits. Mean (or individual in some cases) DDE concentrations in plasma ranged from 0.005 μg g^{-1} ww to 0.153 μg g^{-1} ww, and PCBs ranged from 0.006 μg g^{-1} ww to 0.092 μg g^{-1} ww. DDE residues greater than 0.100 μg g^{-1} ww were detected in only six samples. Five of the six ocelots with highest DDE concentrations were trapped in the LANWR, and one was trapped in the Santa Ana National Wildlife Refuge. Mean concentrations of DDE in plasma were not significantly different among years. Concentrations of DDE were not significantly different between pooled data for years 1993–1995 and 1996–1997.

Overall, total PCB concentrations in plasma were low and only three samples had PCB residues greater than 0.100 μg g^{-1} ww (Table IV). However, total PCB concentrations were significantly different among years ($P < 0.05$) and were higher in plasma of ocelots trapped in 1996 than those trapped in 1994. PCB concentrations also were significantly higher for years 1996–1997 than for 1993–1995 ($P < 0.001$).

A congener specific PCB profile of the 25 plasma samples showing the mean percent contribution of each PCB congener (detected in more than 50% of the samples), relative to total PCBs, is shown in Figure 3. PCB congeners 153, 138, and 180 (Ballschmiter and Zell, 1980) contributed about 35% to total PCBs. PCB congeners 26, 37, and 87 contributed 19%, to make up about 54% of total PCBs contributed by the 6 congeners.

Mean Hg levels in red blood cells, which contain about 90% of the mercury in blood (Wolfe *et al.*, 1998), ranged from 0.056 μg g^{-1} dw in females captured

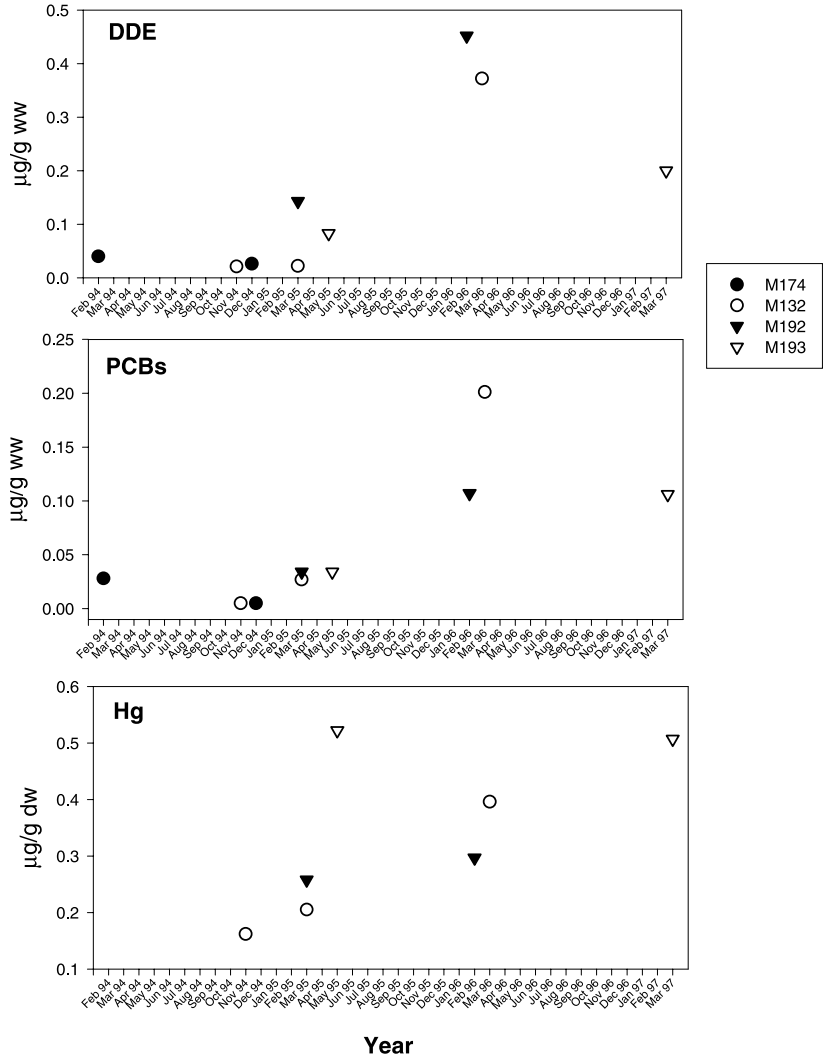

Figure 4. DDE, PCBs, and Hg in four male ocelots recaptured two or more times for blood collection.

in 1995, to 0.25 μg g^{-1} dw in males captured in the same year. Concentrations of Hg in ocelots captured in other years were between these ranges. Mercury concentrations were not significantly different among years.

3.4. DDE, PCBs, AND Hg TRENDS IN SELECTED INDIVIDUALS

Trends of DDE and PCBs in plasma, and Hg in red blood cells, of three male ocelots trapped twice and one male trapped three times, are shown in Figure 4. DDE and PCBs seemed to remain more or less stable in male M174 in 1994, and in M132 in 1994–1995; however DDE and PCB concentrations increased about

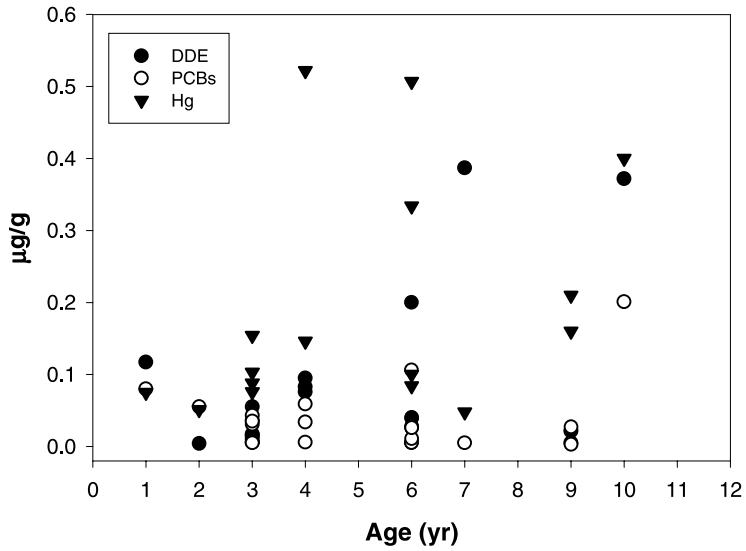

Figure 5. DDE, PCBs, and Hg relationships with ocelots' age. Concentrations are on wet weight basis for DDE and PCBs, and dry weight basis for Hg.

3-fold between 1995 and 1996 in male M192 and between 1995 and 1997 in male M193. DDE increased 17-fold and PCBs increased 7-fold in M132 between 1995 and 1996.

Mercury concentrations remained more or less stable in male M192 between 1995 and 1996, and in M193 between 1995 and 1997; however, Hg increased linearly (2.5 times) in M132 from 1994 to 1996. No Hg data were available for M174.

3.5. Relationships between contaminants and age

A plot of the relationships between concentrations of DDE, PCBs, and Hg with ocelot's age is shown in Figure 5. The figure includes data for 11 males and 6 females from which age was known. Hg data were not available for most females. Concentrations of DDE, PCBs, or Hg, did not vary with age, although the highest concentrations of DDE and Hg were found in older animals.

4. Discussion

4.1. Significance of contaminants in hair

Unfortunately, most of the ocelots from which hair was collected were not bled at the same time, therefore, a correlation of contaminants in hair and blood could not be established. Nonetheless, the combination of hair and blood samples, although mostly from different ocelots, allowed us to make an assessment of the

potential impacts of organochlorine and trace element contaminants on survival and reproduction of ocelots in the LRGV.

Only Hg, Se, and Pb were analyzed in hair of ocelots. It has been determined that about 20% of mercury or methyl mercury administered in the diet will end up in hair (Albanus *et al*., 1972), and hair usually contains higher Hg levels than other tissues (Gardner *et al*., 1978). The results from our analyses suggested that the highest concentrations of Hg detected in hair of ocelots (2.8 μg g^{-1} dw) were much lower than concentrations known to affect domestic and wild cats.

Many studies of effects of Hg on mammals have been performed on domestic cats (see Wolfe *et al*., 1998 for a review). Mercury in hair of bobcats collected during 1972–1973 in Georgia, Florida, and South Carolina, ranged from 1.14 to 24 μg g^{-1} ww (approximately 3.5 to 72 μg g^{-1} dw) (Cumbie, 1975). Deer mice (*Peromyscus maniculatus*) with Hg hair concentrations between 7–11 μg g^{-1} ww had decreased ambulatory activity and backing relative to mice with lower Hg concentrations (Burton *et al*., 1977). Mean Hg values in hair of ocelots in the LRGV were below the range of those found in bobcats and in mice.

Concentrations of Se in hair also seemed low, although they were 3-fold higher than Hg. In California, raccoons collected at Kesterson Reservoir, known to have Se-contaminated water, had Se concentrations of 28.3 μg g^{-1} dw in hair; whereas raccoons collected at Volta, a relatively uncontaminated nearby wildlife area, had nearly 30 times less Se in hair (Clark *et al*., 1989). No evidence was found that raccoons were affected by Se at those concentration levels. Concentrations of Se in hair of ocelots were much lower than those observed in racoons at Kesterson.

Lead residues in hair of ocelots were also low and not detected as frequently as Hg or Se, although mean Pb levels were relatively higher in ocelots collected in 1991 than in those from other years. This was probably due to the high Pb value (150 μg g^{-1} dw) found in one ocelot. This individual had probably been recently exposed to high lead concentrations perhaps by foraging along or near edges of roads with high automobile traffic; however, this could not be confirmed. Literature about Pb residue levels in cats is scarce or non-existent. Burger *et al*. (1994) pointed out that contaminants in hair or fur of wild animals have not been studied well. This agrees with a recent review which reported only one study with trace element data for mammals in the Lower Rio Grande Valley (Mora and Wainwright, 1998). Burger *et al*. (1994) found higher concentrations of Pb in hair of male than female opossums in Costa Rica. In our study we did not have enough data to compare Pb concentrations between sexes. The significance of the high Pb level in one individual could not be established.

4.2. Assessment of contaminants in road-killed ocelots

Organochlorine and trace element contaminants in the four road-killed ocelot samples seemed to be well below levels that could be associated with sublethal effects or mortality of any ocelot (see Wolfe *et al*., 1998, for a review). Mercury concentra-

tions in hair of one Florida panther found dead were 130 μg g^{-1} ww (Roelke *et al*., 1991), a level much greater than those observed in the ocelots found dead or alive. Limited available data of Hg in wild mammals suggests that a concentration of 30 μg g^{-1} ww in liver or kidney could be lethal or harmful (Thompson, 1996). Selenium levels in kidney and liver of two dead ocelots were somewhat elevated, however, at levels below concentrations which could be associated with negative effects.

4.3. SIGNIFICANCE OF CONTAMINANTS IN PLASMA AND RED BLOOD CELLS

Concentrations of DDE and PCBs in ocelots' plasma were relatively low and not of concern for negative effects on the population. However, the effects of PCBs on mammals could be diverse including depressed birth and weaning weights of offspring, and reduced fertility. Mink are among the most sensitive mammals to PCBs and levels of 4 μg g^{-1} ww in liver have been associated with lethality (Kamrin and Ringer, 1996). Most studies of PCBs in mammals have been conducted with marine species (Kamrin and Ringer, 1994), and very little is known about PCBs in wild felids (Roelke *et al*., 1991; Facemire *et al*., 1995). In general, adult males seem to have higher concentrations of PCBs than adult females, and levels in males seem to increase with age (Kamrin and Ringer, 1994); however, this is not always the case (Thompson, 1996). In our study, we did not find a significant correlation between PCBs and age, and the same was true for DDE, and Hg. Also, there were no significant differences in concentrations of PCBs between males and females.

Congener specific PCB data for mammals, particularly terrestrial mammals, are very few. The 3 predominant PCB congeners in ocelot's plasma (153, 138, and 180) were similar to those reported in other mammals. Congeners 153 and 180 comprised about 65% of the total PCBs observed in liver and fat of Arctic foxes (*Alopex lagopus*) collected in the Svalbard Archipelago in the 1970s and 1980s (Wang-Andersen *et al*., 1993). However, total PCBs were based on the sum of 7 of the most common PCB congeners. Our estimate of total PCBs was based on the sum of 25 congeners; thus, the contribution of PCBs 153 and 180 would have increased if only the 7 predominant congeners were considered as the sum of the total PCBs. PCBs 153, 138, 180 and 170 also were predominant in liver, muscle, and kidney of polecats (*Mustela putorius*) (Leonards *et al*., 1994). The similarities in the distribution of congeners among tissues led the authors to suggest that the patterns were determined mainly by metabolic processes and not by diet. Juvenile polecats had greater concentrations of PCBs than adult males and females. Differences in concentrations between juveniles and adults were probably due to PCB elimination via anal gland secretion in adults, which could be activated during maturation.

Similar to DDE and PCBs, geometric mean mercury concentrations in red blood cells of ocelots were also low. The concentration of Hg in red blood cells does not equal total Hg in blood; however, previous studies have indicated that 80-97% of

the Hg in blood is bound to the heme group (Albanus *et al*., 1972; Aihara and Sharma, 1986; Roelke *et al*., 1991). Thus, Hg concentrations in red blood cells are representative of total Hg in whole blood.

Roelke *et al*. (1991) found a significant difference in the number of surviving kittens to 6 months of age from lactating Florida panther females with blood Hg levels greater than 0.5 μg g^{-1} ww. Blood Hg concentrations at which clinical signs of toxicity appear in the cat are reported as 10 μg g^{-1} ww (approximately 40 μg g^{-1} dw, Charbonneau *et al*., 1974). Based on the above, Hg levels in blood of ocelots were below the threshold for negative effects on the population.

Documented variations in Hg tissue levels with sex and age of mammals are conflicting in the literature (Wren, 1986); the same may apply to contaminants such as DDE and PCBs. In this study, accumulation of contaminants was not correlated with age or sex.

4.4. MANAGEMENT IMPLICATIONS

Approximately one-fourth of the total estimated population of ocelots in the LRGV was sampled for this study of environmental contaminants and their impacts on survival and general health of this endangered species. DDE, PCBs, and Hg, were some of the most common contaminants detected in hair and blood and are of most concern for negative effects on the ocelot. Fortunately, concentrations of DDE, PCBs, and Hg were low, and at levels that currently should not pose any threat to health or survival of the species. Reproductive data compiled for the last 10 years indicate that ocelots are reproducing well in the LRGV, and females averaged about 1.5 kittens/litter. The main causes of mortality seem to be road kills. Causes of natural mortality include western diamondback (*Crotalus atrox*) snake bites, intraspecific aggression, predation, and disease (unpublished data). Thus, it seems that the current major threat to recovery of the ocelot in the LRGV may be habitat loss, and edge effects due to small reserve size (Woodroffe and Ginsberg, 1998). However, the potential impacts of new generation pesticides such as organophosphorus and carbamate insecticides, as well as herbicides, which were not addressed here, deserve further study.

Finally, it should be pointed out that the ocelot population studied here was confined to the northernmost part of the ocelot's range in America. Ocelots occur commonly in Mexico, Central America, and parts of South America. Thus, it is likely that some ocelot populations could be seriously impacted by contaminants in parts of the neotropics. Our data provided here could be used as a future reference for studies of contaminants in ocelots from the neotropics.

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