HAIR-SNARE SURVEY TO ASSESS DISTRIBUTION

OF MARGAY (*LEOPARDUS WIEDII*) INHABITING

EL CIELO BIOSPHERE RESERVE,

TAMAULIPAS, MEXICO

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Felidae consists of 37 species evolved from a common ancestor 12 to 2

million years ago. Felids recognized today are a result of 4 radiations from this ancestor

(Collier and O'Brien 1985). The first radiation occurred 12 million years ago and led to

the ocelot lineage consisting of the ocelot (*Leopardus pardalis*), margay (*L. wiedii*),

tigrina (*L. tigrinis*), Geoffrey's cat (*Oncifelis geoffroyi*), kodkod (*O. guigna*), pampas cat

(*O. concolor*) and Andean mountain cat (*Oreailurus jacobita*). The second branch

occurred 8–10 million years ago and includes close relatives of the domestic cat such as

the jungle cat (*Felis chaus*), sand cat (*F. margarita*), and Pallas cat (*Otocolobus maul*).

The third branch radiated several times 4–6 million years ago giving rise to the

pantherine lineage, e.g., jaguar (*Panthera onca*), lion (*P. leo*), leopard (*P. pardus*): and

again 2 million years ago leading to a split between the pantherines and the lynx (*Lynx*

canadensis: Collier and O'Brien 1985).

The Neotropical Region has been inhabited by 10 extant species of felids since

the Pleistocene, 1–5 million years ago (Eizirik et al. 1998). These species appeared in

South America 2-5 million years ago during the formation of the Panamanian Isthmus

(Johnson et al. 1998). Seven of the 10 species comprise the ocelot lineage (Johnson et al.

1998), of which the ocelot and margay are considered sister species (Eizirik et al. 1998).

These species are considered sympatric throughout most of their range from the southern

United States (ocelot) or northern Mexico (margay) to South America (Eizirik et al. 1998

Today, most felids are listed as threatened or endangered by the Convention on International Trade of Endangered Species (CITES 2001: Collier and O'Brien 1985). Margays were listed on Appendix 1 of CITES in 1989 (Nowell and Jackson 1996) and are classified as insufficiently known by the IUCN (de Oliveira 1998).

The margay was one of the most heavily exploited Latin American cats in the 1970s and 1980s. Demand for pelts increased and coincided with exploitation of other spotted cats, namely the ocelot and jaguar. An average annual trade of 14,000 margay pelts was reported to CITES from 1976 to 1984. Hunting is prohibited throughout most of its range with the exception of Ecuador, Guyana and El Salvador (Nowell and Jackson 1996). Today, international trade has virtually ceased, but margay numbers are still in decline due to habitat destruction (Sunquist and Sunquist 2002).

Schinz named the margay *Felis wiedii* in 1821 in honor of the Prince of Wied who discovered this felid while on expedition to South America (Guggisberg 1975). The genus name has since been changed to *Leopardus* (Pocock 1941). Before 1852, the margay held status as a member of the fauna of the United States as verified by 1 specimen recorded at Eagle Pass, TX. This individual is believed to have been a vagrant and is the sole record of the subspecies *L. w. cooperi* (Tewes and Schmidly 1987).

In Mexico, the margay occurs along both coasts from Tamaulipas in the east to Sinaloa in the west. Their range then extends southward to the Isthmus of Tehuantepec and finally through the state of Chiapas and the Yucatan Peninsula. This species inhabits all of Central America and the South American countries of Colombia, Venezuela, Guyana, Brazil, Uruguay, Argentina, Paraguay, Bolivia, Peru and Ecuador (Tewes and Schmidly 1987).

Today, 10 subspecies of margay are recognized (de Oliveira 1998). All subspecies have been distinguished on the basis of coat color and pattern and/or skull measurements (Pocock 1941). The names and ranges of the subspecies (Figure 1) are as follows: *L.w. amazonica* - Amazon, Brazil; *L.w. boliviae* – Brazil, Bolivia; *L.w. cooperi* – Nuevo Leon; *L.w. glauculus* - Sinaloa through north Oaxaca; *L.w. nicaraguae* - Honduras to Costa Rica; *L.w. oaxacensis* -Tamaulipas to Oazaca; *L.w. pirrensis* - Panama to northern Peru; *L.w. salvinia* – Chiapas, Guatemala, El Salvador; *L.w. vigens* - Orinoco to the Amazon basin and *L.w. yucatanicus* Chiapas to northern Guatemala and Yucatan (de Oliveira 1998).

The margay closely resembles and is often mistaken for the ocelot. In some areas of South America the margay is even referred to as "little ocelot" (Guggisberg 1975). Although not identical, the spotting pattern of their coats is similar and both felids share a darker head, tail and back and white belly. Despite the similarities in coat pattern, the margay is smaller and more slightly built than the ocelot, and proportionately a longer tail and back legs (Guggisberg 1975).

Margays are arboreal and physically well-designed to exploit this ecological niche. The most prominent adaptive feature is a highly flexible ankle joint that can supinate through 180° (Alderton 1993). This feature allows the margay to travel head first down a tree trunk and the ability to grasp a branch equally well with fore or hind paws (Tewes and Schmidly 1987). Margays also have been known to move from limb to limb in forest canopies often suspending by one leg. Other adaptations to an arboreal lifestyle include broad feet with long claws, highly mobile toes for gripping and stability

(Sunquist and Sunquist 2000), and a proportionately longer tail for balance (Tewes and Schmidly 1987).

The margay is strongly associated with wooded habitats, primarily tropical evergreen lowland forests and cloud forest. Its arboreal nature may render it more vulnerable to the effects of deforestation than other felids such as the ocelot (Tewes and Schmidly 1987). However, sightings of margays in cocoa and coffee plantations in South America suggest it can be adaptable if necessary (Mondolfi 1982).

Knowledge of margay ecology is extremely limited because little formal in-situ research has been conducted in any part of its range. To date, only 1 published study has collected data on the home range and activity patterns of margay (Konency 1989). This information was gathered for 6 months in Belize in 1985-1986 on a young radio-collared male. The home range of this individual was found to be 10.95 km^2. A second male was captured but not radio-collared. Results of this study showed the margay to display a strongly nocturnal activity pattern with peak travel rates from 0100 to 0300 and lowest rates at the 1200 hr. This activity pattern was supported by observations of captive margays. Traveling occurred on the ground and in the forest canopy. During daylight hours this male rested in trees 7-10 m above ground. Ambient moonlight did not appear to affect movement rates (Konency 1989).

A second in-situ study conducted from 1990 to 1994 (Carrillo et al. 2000) used track records and arboreal sightings to compare the abundance of mammals, including margays, in Corcovado National Park (CNP) and Golfo Dulce Forest Reserve (GDFR). Both areas are located in Costa Rica, have similar environmental characteristics, but have different hunting regulations. Hunting is prohibited in CNP, but allowed in GDFR.

4

Results of this study showed the abundance of margay on GDFR to be less than CNP and that margay abundance actually increased on CNP during the study (Carrillo et al. 2000).

To date, little is known of wild margay reproduction but some information has been derived from captive studies. Females display estrous cycles of approximately 32 days with periods of heat lasting 7–10 days. In captivity, gestation has been measured at 81 days, whereas in the wild it is estimated to be 70 days. Females in captivity give birth to one or 2 kittens per litter (Tewes and Schmidly 1987).

It is often difficult to obtain an accurate measure of population size of most carnivores due to their secretive nature and low abundance (Sargeant et al. 1998). However, an estimate of relative abundance is often a useful substitution. The scent-station technique is one such method that allows wildlife biologists to estimate carnivore abundance and monitor trends in these populations (Chamberlain et al. 1999). Originally developed by J. E. Wood in 1959 to determine abundance of gray fox (*Urocyon cinereoargenteus*) and red fox (*Vulpes vulpes*) in southeastern United States (Hon 1979), this technique has since been applied to coyote (*Canis latrans*; Roughton and Sweeney 1982), lynx (McDaniel et al. 2000, Weaver 2002), bobcat (*Lynx rufus*; Diefenbach et al. 1994), river otter (*Lutra canadensis*), mink (*Mustela vison*; Conner et al. 1983) and multiple species surveys (Chamberlain et al. 1999).

Recent studies have indicated the scent-station technique is best suited for monitoring trends or fluctuations in carnivore populations over time as opposed to relative abundance as a point in time (Chamberlain et al. 1999). However, limitations to this method exist. For example, the scent-station technique is ill-suited for localized monitoring of wide-ranging carnivores and species that are rarely detected (Sargeant et

5

al. 1998). Recommendations to refine the scent-survey method include conducting multiple surveys each year, having surveys contain as many stations as possible, and placing stations as far apart as possible (Diefenbach et al. 1994).

The design of the traditional scent-station is a 1.0-m diameter circle cleared of vegetation and sifted with fine soil to permit track identification. The desired attractant is presented in the center of the circle by a variety of means including drops applied to a clump of grass (Hon 1979), a saturated cotton ball (Brady 1979; Conner 1983), encapsulated (Knowlton and Tzilkowski 1979) or on a plaster of Paris disc (Chamberlain et al. 1999). Scent-stations are typically established at equal intervals along a transect and checked daily for visitation.

Harrison (1997) examined the efficiency of scent stations of Central American felids. In this study, captive margays showed highest investigation times with bobcat urine. Scent-station visitation by wild felids including margays was too infrequent to test specific attractants for individual species (Harrison 1997).

The hair-snare station differs from the scent-station in that it depends on microscopic or genetic analysis of hair left on a snare to determine species. Weaver expanded the idea and designed a new methodology to detect lynx (Weaver 2002). Lure is placed on a carpet pad between 2 rows of nails. The pad is nailed to a tree at cheek height to the lynx. A lure, Cat Call™, was formulated to elicit face-rubbing behavior in lynx. A pie plate was hung near the lure site as a visual attractant. In 1996 the protocol was tested with over 100 test snares in the Kootenai forest of northwest Montana.   A total of 39 hits were recorded during the trial with lynx detected on 28 snares (Turbak 1998).

The objectives of this study were to use hair-snare stations (1) to assess seasonal habitat use of margay and (2) to determine which microhabitat variables are preferred by margays. I predicted a significantly higher wet-season abundance of margays in the cloud forest based on margay habitat and diet preferences. Cloud forest is reported to be the preferred habitat of margays (Tewes and Schmidly 1987) and rodents comprise much of their diet (Konecny 1989). Rodents have been documented to have higher wet-season abundances in cloud forest in the Sierra de Manantlan Biosphere Reserve, western Mexico (Vazquez 2000). Also, as margays are small, arboreal felids, I predicted selection for station sites with higher canopy cover and understory cover.

STUDY AREA

El Cielo Biosphere Reserve is located approximately 400 km south of Brownsville, TX, in the southwestern corner of the state of Tamaulipas, Mexico. Situated on the Tropic of Cancer, the 1445.3-km^2 Reserve occurs between 22 55'30" and 23 25'50" N and 99 05'50" and 99 26'30"W. This area is dominated by the north-south trending mountain ranges of the Sierra de Guatemala, a region of Sierra Madre. The topography is mostly Cretaceous karstic limestone with most slopes exceeding 20% (Peterson 2001).

El Cielo claims several distinct climate and vegetation types as a result of the topography and altitudinal gradient, which ranges from 200 to 2200 m. The lowest altitude (200-800 m) is a subtropical deciduous climate zone characterized by a semi-warm humid climate with rains from May to October. Natural vegetation is predominately tropical-deciduous and semi-evergreen forests. The canopy is 11-15 m high, and includes a dense understory of trees and shrubs. The most common tree species

include *Bursera simaruba, Brosimum alicastrum, Enterolobium cyclocarpum, Pseudobombax ellipticum, Phoebe tampicensis, Cedrela mexicana* and *Savia sessiliflora* (Gram and Faaborg 1999).

The next highest climate zone (800-1400 m) is humid-temperate. Mean annual rainfall is 2,000-2,500 mm with year-round rain. This habitat, known as montane mesophyll forest or "cloud forest", claims El Cielo as its northernmost extension in the Americas (Jones 2000). Canopy height is 20–30 m and epiphytes are common (Gram and Faaborg 1999). The dominant tree species in this habitat are *Quercus sartotii, Q. germana, Liquidamber styraciflua, Acer skutchii, Magnolia tamaulipana, Fagus mexicana* and *Podocarpus reichei.* (Gram and Faaborg 1999).

Higher elevations (1400-1800 m) are characterized by a temperate sub-humid climate with oak and oak-pine forest predominating. This habitat differs from cloud forest in that it contains fewer understory trees, tall shrubs and epiphytes. Mean canopy height is 20 m. The dominate tree species in this habitat are *Quercus affinis, Q. mexicana, Pinus montezumae, P. patula, Liquidambar styraciflua* and *Acer skutchii.* (Gram and Faaborg 1999).

It was my observation that oak-pine forest occurred at a lower elevation than specified by Gram and Faaborg (1999). The frequency of oak and pine trees increased, epiphytes became less common, and understory density decreased at approximately 1200 m in elevation. For the purposes of this research, cloud forest will be designated from 800 to 1200 m and oak-pine and pine forest will be designated from 1200 to 1800 m.

The climate of El Cielo depends largely upon altitude. The lowlands are typically humid and hot whereas the highlands are comparatively cooler. El Cielo is considered to

have 2 seasons, a rainy season and a dry season. The rainy season begins in May or June

and lasts through October. The dry season continues from November through April

(Peterson, 2001)

METHODS

HAIR-SNARE SURVEY

I conducted 8 hair-snare surveys for margays during the course of the study. Wet-season (May–October) surveys were conducted in September 2003 and May, August and October 2004. Dry-season (November–April) surveys were conducted in November 2002, April and December 2003, and March 2004.

Hair-snare stations were established along a transect represented by the 15-km road leading from the village of San Jose at 1400 m in altitude to the north end of Gomez Farias at 200 m. This road traversed all 3 habitat types surveyed in this research — oak-pine forest, cloud forest and subtropical-deciduous forest. Habitats were sampled in a manner equivalent to the relative occurrence along the transect. Approximately 30 hair-snare stations were established at 500-m intervals and alternated between the left-hand and right-hand sides of the road. Each station was placed 50 m perpendicular to the transect. At each station altimeter, northing and easting readings were taken with a Magellan GPS unit.

Stations consisted of an 8 X 8 cm carpet pad studded with 2 rows of 2.2-cm nails through the back of the pad. Pads were nailed to trees approximately 0.61 m above ground with the nail rows oriented vertically. This design allowed the lure pad to act as a hair snag. Lure pasted with catnip (*Nepetu cataria*) was placed between the rows of nails.

This method was modeled after the technique employed by the Wildlife Conservation Society (WCS) to survey Canadian lynx in Montana (Weaver 2002). Lure (Weaver's Cat Call™) was purchased from John Weaver, a carnivore biologist for the Wildlife Conservation Society. Weaver has tested the lure on many species of felids in captivity including margays. In all species tested, the lure successfully elicited the natural face marking behavior of felids (J. Weaver, personal communication).

Surveys were conducted for 8 days. At the end of each survey, all stations were examined for the presence of hair. If hair was present, the lure pad including all nails was sealed in a plastic sandwich bag. Date and station number was recorded twice for each pad, once on the outside of the bag and again on a small piece of paper placed inside the bag. All lure pads were bagged individually. Lure pads not containing hair were thrown away.

VEGETATION SAMPLING

For each station, I sampled understory cover by the Daubenmire method (Bonham 1989) in a 1-m^2 plot at each lure site and in 1-m^2 plots 10 m from a lure site in northeast (45°), southeast (135°), southwest (225°) and northwest (315°) directions (Figure 2). Data included cover of forbs, grasses, bare ground, rock, and leaf litter. To sample over story cover, canopy cover measurements were averaged from the 5 plots at each station using a spherical densiometer (Bonham 1989).

A margay model was used to measure visual obstruction. The model consisted of white fabric with large black spots cut to the dimensions of a margay profile. The cloth margay was then adhered to the base of a 0.91-m x 1.22-m black cloth. One person stayed seated at the lure site while a second walked backwards in each of the northeast

(45°), southeast (135°), southwest (225°) and northwest (315°) directions holding the model at ground height. The point where the margay model was no longer visible from the lure station was determined for that direction. In the event only one person collected the data, the model was nailed at the lure site facing the 4 direction at ground height. The collector walked backwards in each direction. The point where the model could not be seen from a seated position was recorded for that direction. The 4 visual obstruction measurements were averaged at each site. This average was considered the index for understory density.

SPECIES TESTING

The Wildlife Genetics International (WGI) lab in Nelson, BC, performed all genetic analysis. Samples of blood drawn from margays in ECBR (Carvajal 2005) also were analyzed for reference. Samples were extracted using QIAGEN's DNeasy Tissue kit following the manufacturer's instructions. WGI did not exhaust all of the sample material nor was all the DNA extracted. Leftover sample and DNA will be archived for five years. WGI determined the species of hair samples using a sequence-based analysis of the 16s rRNA mitochondrial gene (Kocher et al. 1989, Johnson and O'Brien 1997). Although specific primers and conditions are proprietary, results can be fully reproduced following procedures in Johnson and O'Brien (1997).

DATA ANALYSIS

A Chi-square test using the categorical data modeling procedure (PROC CATMOD) of SAS (SAS Institute Inc. 1990) was applied to test the relationship among the frequency of success and failure at hair-snare sites by habitat and season. Success was measured as hit or miss; habitat was measured as oak-pine forest, cloud forest or sub-

tropical deciduous forest; and season was wet or dry. I conducted stepwise logistic

regression with backward elimination (PROC LOGISTIC; SAS Institute, Inc. 1997) to

evaluate the use of vegetation variables (e.g., understory cover and density, overstory

cover) in predicting the presence (hit) or absence (miss) of margays at individual hair-

snare sites. An $\alpha = 0.05$ was chosen as the level of significance

RESULTS

A total of 117 hits were recorded during the 8 surveys. Species analysis did not

detect margay on any pad. The largest proportion of hits (44.4%; 52/117) was gray fox.

Other species identified from the hair samples included dog (*Canis familiaris*), domestic

cat (*Felis domesticus*), goat (*Capra hircus*), long-tailed weasel (*Mustela frenata*) and

horse (*Equus caballus*). A total of 23 samples failed to produce results after 2 attempts at

species identification, 8 samples were of unknown identity (7 were the same identity),

and 3 samples were not extracted due to lack of material.

Due to the lack of margay data, statistical analysis was conducted using only gray

fox data. The frequency of hits by gray fox varied by habitat*season interaction ($\chi^2 =$

5.90, P = 0.052). Success was uniformly high across seasons in the oak-pine forest,

higher in the cloud forest during the dry season but higher in the wet season in the

subtropical-deciduous forest (Figure 3). The frequency of fox successes also varied by

habitat ($\chi^2 = 8.64$, P = 0.013). Hits occurred most frequently in oak-pine forest, followed

by cloud forest and then sub-tropical–deciduous forest. Logistic regression analysis

indicated no microhabitat variable or combination of variables reliably predicted success

or failure of a hair-snare station (Table 1).

CONCLUSION

The hair-snare technique failed to detect margay although they were known to exist in the area. Carvajal (2005) captured and radio-collared 8 margays (5 males, 3 females) in the cloud forest of El Cielo from June 2001 to August 2004. The males maintained an average home range size of 4.03 km^2 and a primarily nocturnal activity pattern. Carvajal (2005) also captured 14 gray foxes in the same study area.

I became aware of several recently published and unpublished hair-snare studies targeting felids during my study. Results of these studies revealed clear patterns in the success of hair-snare studies (Table 2). In areas outside the range of gray fox or with low gray fox density, the hair-snare technique has proven successful in detecting felids. Lynx have been detected north of the range of gray fox in Canada (McDaniel et al. 2002, Weaver 2002), Idaho, Montana and Washington (Potter and Plumb 2001). Ocelot have been detected in South Texas, an area of very low gray fox density (Weaver 2002, Shinn 2002; Figure 4). However, surveys within the range of gray fox failed, with the predominant species detected being gray fox (Table 2; Figure 4).

No obvious difference in the lure used in successful and unsuccessful studies was observed. McDaniel et al. (2002) tested the efficacy of 5 different attractants including beaver castoreum and catnip oil, Cat Passion™ , Pacific Call™, Hawbacker's Cat Lure #1™, and BB1™. All 5 lures tested successfully detected lynx ($n = 60$) with beaver castoreum and catnip oil eliciting the greatest visitation ($n = 21$). Weaver et al (2003)

and Shinn (2002) successfully employed Cat Call™ to detect ocelot in south Texas. All

successful studies employed a visual attractant. Hair-snare studies that primarily detected

gray fox utilized Cat Call™, Canine Call™ and beaver castoreum and catnip oil. Visual

attractants were employed in only some of these trials. All lures employed in

unsuccessful trials are known to be effective in attracting felids.

As opposed to hair-snare studies, scent-station surveys have successfully detected

and/or monitored bobcat population trends in areas within gray fox range (Brady 1979,

Hon 1979, Knowlton and Tzilkowski 1979, Morrison et al. 1979, Chamberlain et al.

1999). The method of species detection is the main difference between the 2 techniques.

By virtue of the hair-snare design, visitation at a given station is only recorded by hair

left on the pad. The scent-station design utilizes track identification for detection and

consequently is not dependent on an animal's face-marking behavior. It is therefore

possible to detect species that may have approached a station and turned away.

The existence of the above pattern in hair-snare studies warrants investigation of

possible interference by gray fox with felid markings.   For example, perhaps the skunk-

like odor emitted from gray fox when marking (personal observation; M. Chamberlain

personal communication) renders the station unattractive to felids. If true, cats may

approach the station out of curiosity, but choose not to face-rub. This behavior would

explain the higher success of scent-station studies in detecting felines approaching the

site and also the consistent failure of snares to gather hair in areas of gray fox. Testing

this hypothesis with captive animals would be informative.

Gray fox are sympatric with coyotes throughout much of their range (Figure 5)

and competition for resources such as space and food would be expected.   Negative

spatial relationships exist between gray fox and coyotes. Coyotes seemed to limit the abundance and distribution of gray fox more as a result of physical dominance and intraguild predation than dietary competition (Fedriani et al. 2000). Gray fox, in turn, alleviate spatial competition with coyotes through behavioral avoidance. Consequently, low dietary competition was documented by Fedriani et al. (2000) in the Santa Monica Mountains of California. The low dietary overlap between the omnivores was explained by predation on different species of small mammals (rodents and lagomorphs) due to differential habitat use.

Gray fox are also sympatric with bobcats throughout much of its range (Figure 6). In the Santa Monica Mountains of California, intraguild predation has been documented by bobcats on gray fox as well as a high dietary overlap between the species. However, behavioral avoidance by gray fox to alleviate spatial or dietary competition is not reflected in this relationship. The authors suggested circumstances such as behavioral dominance of gray fox over bobcat or the combined interaction of coyote, gray fox and bobcat as possible explanations (Fuller, personal communication).

Bobcat and gray fox have been known to overlap their home ranges, yet their core areas were separate (Chamberlain, personal communication). Fox will be more apt to mark their core areas more frequently than the remainder of their home range. The information presented from the present study and from previous hair-snare studies (Table 2) suggests avoidance by felines. Conversely, there is no evidence of gray fox avoidance of felid markings. The core-area partitioning observed between gray fox and bobcat may be a case of felid avoidance of gray fox. Further study is required to address this question.

Results of this study suggest gray fox select macrohabitats as a whole, i.e., oak-pine forest, and not individual microhabitat variables. These findings are comparable to previous studies. Chamberlain and Leopold (2000) noted gray fox preferred mature pine stands in nearly all seasons. Casselmen (1989) reported similar findings of gray fox selection of mature pine sawtimber in Louisiana. In Missouri, oak-hickory forests are selected by gray fox for cover and foraging (Haroldson and Fritzell 1984). In light of these studies, it appears hair-snare trials were an effective means to study habitat use of gray fox.

MANAGEMENT IMPLICATIONS

Felid hair-snare surveys, regardless of design, are not effective or recommended in areas inhabited by gray fox. However, John Weaver's hair-snare protocols utilizing Cat Call™ and a visual aid appear to be sufficient in determining felid presence in areas outside the range of gray fox or in areas of low gray fox density.

It is improbable that one can redesign the hair-snare station to prevent gray fox marking. Raising the height of the station above the cheek level of gray fox is problematic due to the species' ability to climb (Neale and Sacks 2001). An alternative would be to change the lure. Fox, however, are motivated by olfactory stimuli (Chamberlain et al. 1999) and will presumably investigate any novel scent in their surroundings. The presence of a visual attractant is not relevant due to the apparent refusal of felids to face-rub sites previously marked by gray fox.

I recommend a modified scent-station technique instead of the hair-snare design to determine feline presence or absence in areas inhabited by gray fox. Scent-stations

18

rely on tracks for species identification; therefore, they have the ability to detect species that may have approached the station but turned away.

Traditional scent-stations were originally designed to detect canids; therefore the protocols need to be customized to meet the demands of detecting felids. Despite the type of lure station (i.e., scent or hair-snare) a possibility exists that a felid will approach, but turn away if a gray fox has marked it. Chamberlain et al. (1999) augmented the station's ability to detect felids after concern that low visitation was due to bobcats approaching the stations but not being recorded. The addition of 100-m transects consisting of roadside ditches and edges was made adjacent to each scent-station. Visitation to these transects was recorded as well. Another option would be to increase the diameter of the tracking circle. The use of sifted agricultural lime rather than soil to cover the tracking surface is another alternative (Morrison et al. 1981). Although claimed to have increased bobcat visitation in the study, no comment was made as to whether or not higher visitation was directly a function of higher readability potential with lime.

Felids hunt with their eyes and ears whereas canids are more olfactory hunters. I strongly advise the use of a visual or audio attractant at each station. Chamberlain et al. (1999) reported highest bobcat visitation rates at stations equipped with a mechanical cottontail rabbit (*Sylvilagus floridanus*) distress call. Weaver considers hair-snare stations incomplete without the aid of a pie plate for visual attraction (Weaver, personal communication).

Another alternative to the hair-snare technique is the use of camera traps. Advantages to this methodology include that it is not subject to observer bias and it has

an increased ability to differentiate individuals. Disadvantages include cost and reduced

sampling effort.

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Table 1. Microhabitat characteristics of hair-snare sites on the El Cielo Biosphere

Reserve. Sites include those marked by gray fox (hit) or all other sites (not hit).

Herbaceous Variable	Hit			Not Hit		
	N	$\overline{x}$	SE	N	$\overline{x}$	SE
Canopy Cover (%)	52	31.2	3.2	111	29.9	1.9
Grass (%)	46	1.4	0.7	112	1.2	0.4
Forb (%)	50	23.4	3.0	114	30.2	2.1
Bare ground (%)	48	14.3	3.0	110	10.8	1.5
Litter (%)	51	49.0	4.1	113	48.5	2.5
Rock (%)	51	19.5	2.7	114	20.0	1.8
Understory density (m)[1]	51	12.1	1.3	113	9.7	0.4

[1] Distance at which margay model could not be seen from hair-snare site.

Table 2. Summary of results from published and unpublished (*) hair-snare studies targeting felids.

Author/Year	Study Area	Type of lure	Visual attractant	Target species	Success	Total stations (n)	Hits by target species	Hits by gray fox	Success by target species (%)	Success by gray fox (%)
Mc Daniel et al. 2002	Yukon, Canada	5 types	Pie Plate	*Lynx canadensis*	Yes	390	60	0	15.4	0
Shinn 2002	Texas	Cat Call™	Pie Plate	*Leopardus pardalis*	Yes	250	8	2	3.2	0.8
	Texas	Cat Call™	Pie Plate	*L. rufus*	Yes	250	29	2	11.6	0.8
Weaver et al 2003	Texas	Cat Call™	Pie Plate	*L. pardalis*	Yes	89	23	0	25.8	0
*Beier 2000	Arizona	Cat Call™	No	*L .concolor*	No	20	0	12	0	60.0
*Harrison 2003	New Mexico	Cat Call™	Pie Plate	*L. rufus*	No	631	1	50	0.16	7.9
*Frangioso 2003	California	Cat Call™	Pie Plate	*L. concolor L. rufus*	No	115	1	52	0.87	45.2
*Childs 2004	Arizona	Canine Call™	No	*L. concolor Panthera onca*	No	?	11	190	?	?
*Downey 2005	Tamaulipas, Mexico	Cat Call™	No	*L. wiedii*	No	250	0	52	0	20.8

* P. Beier, Northern Arizona University; J. Childs, Wildlife Conservation Society; K. Frangioso, Wildlife Conservation Society; R. L. Harrison, University of New Mexico.

Figure 1. Geographic range of *Leopardus wieidii*: 1, *L. w. amazonica*; 2, *L. w. boliviae*; 3, *L. w. glaucula*; 4, *L. w. nicaraguae*; 5, *L. w. oaxacensis*; 6, *L. w. pirrensis*; 7, *L. w. salvinia*; 8, *L. w. vigens*; 9, *L. w. wiedii*; 10, *L. w. yucatanica* (de Oliveira 1998).

Figure 2. Diagram depicting layout of hair-snare station (center) and vegetation plots (5 plots/station) arranged 10 m from hair-snare station.
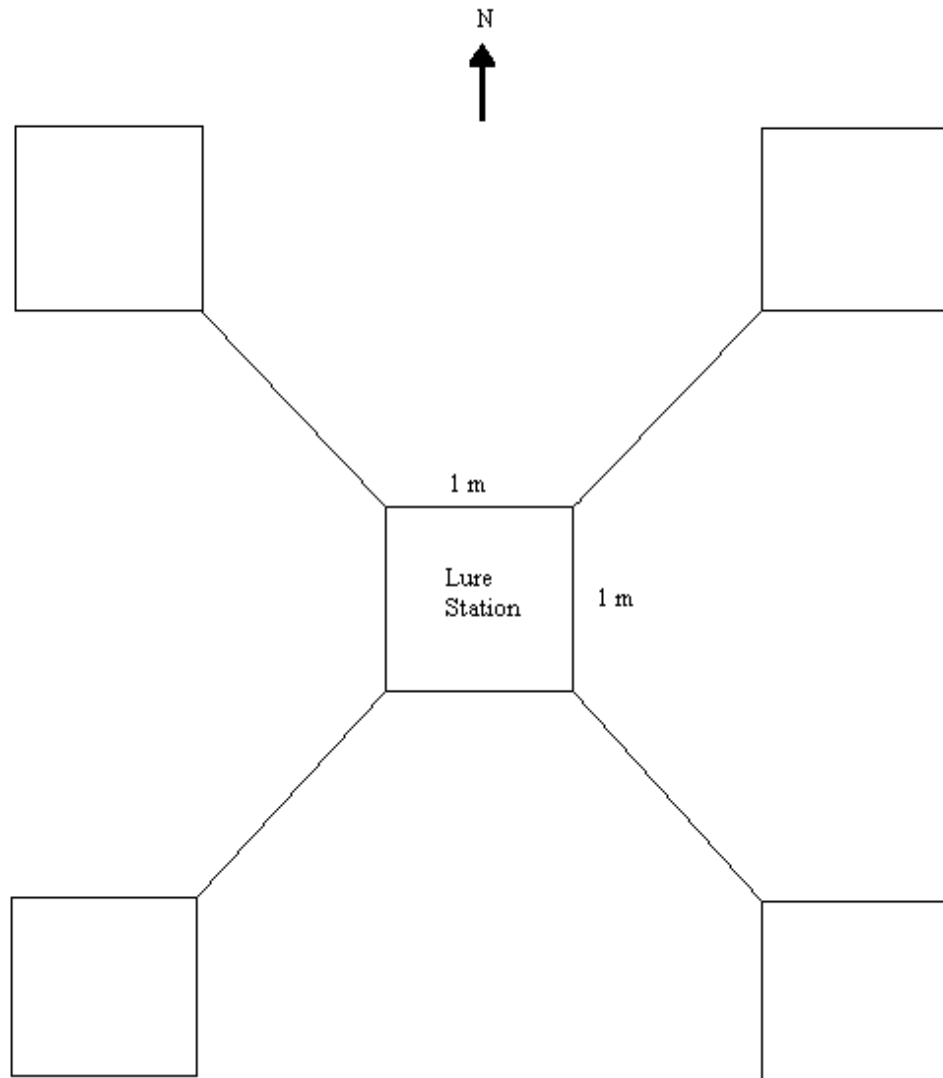
N

1 m

Lure
Station

1 m

Figure 3. Frequency of gray fox hits at hair-snare stations by season in each habitat (oak-

pine, cloud, and subtropical-deciduous) at El Cielo Biosphere Reserve, Tamaulipas,
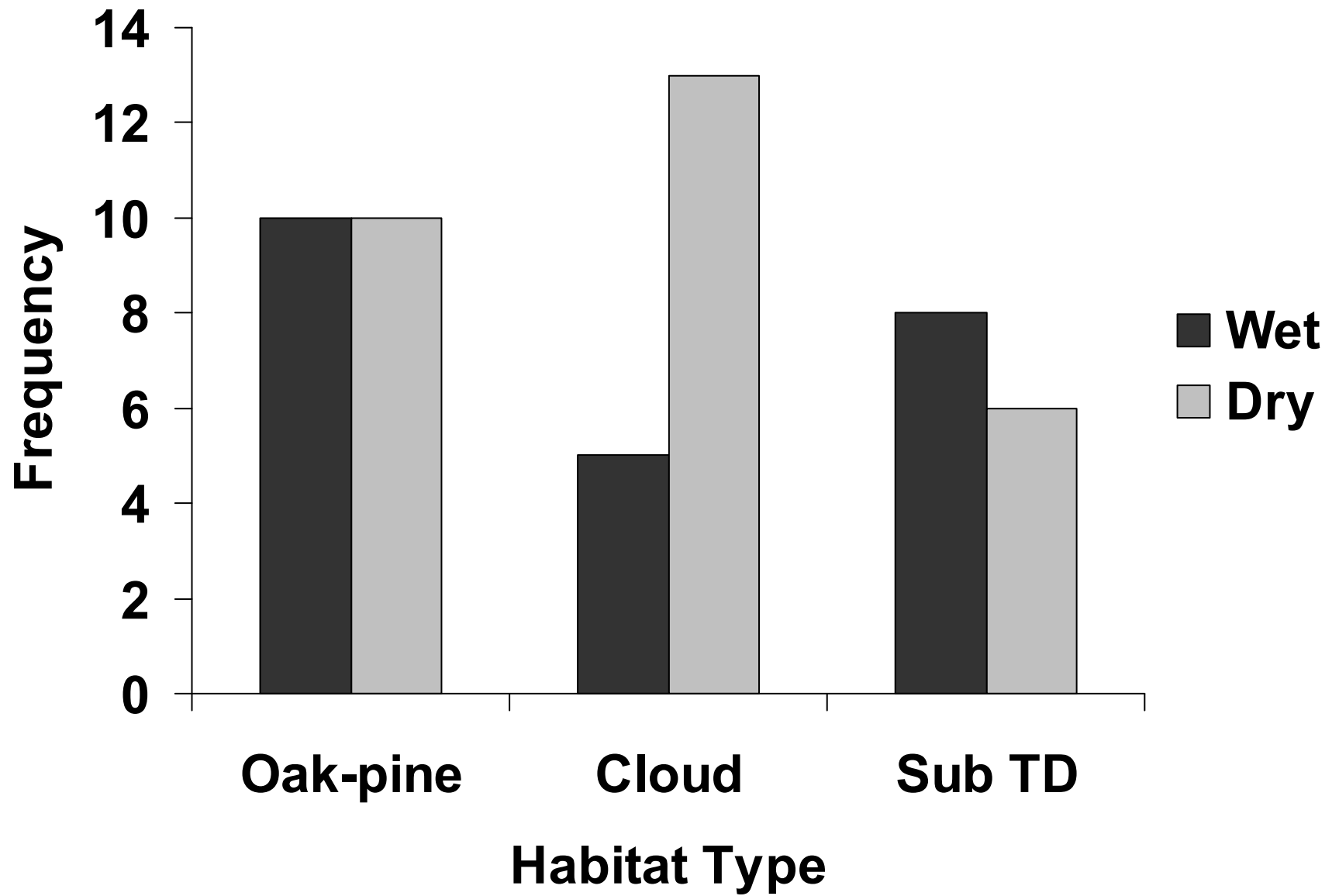
Mexico

34

Figure 4. Felid hair-snare study sites plotted against gray fox range (shaded; IUCN/SSC 2004). Red sites successfully detected felids. Blue sites failed and predominantly detected gray fox.
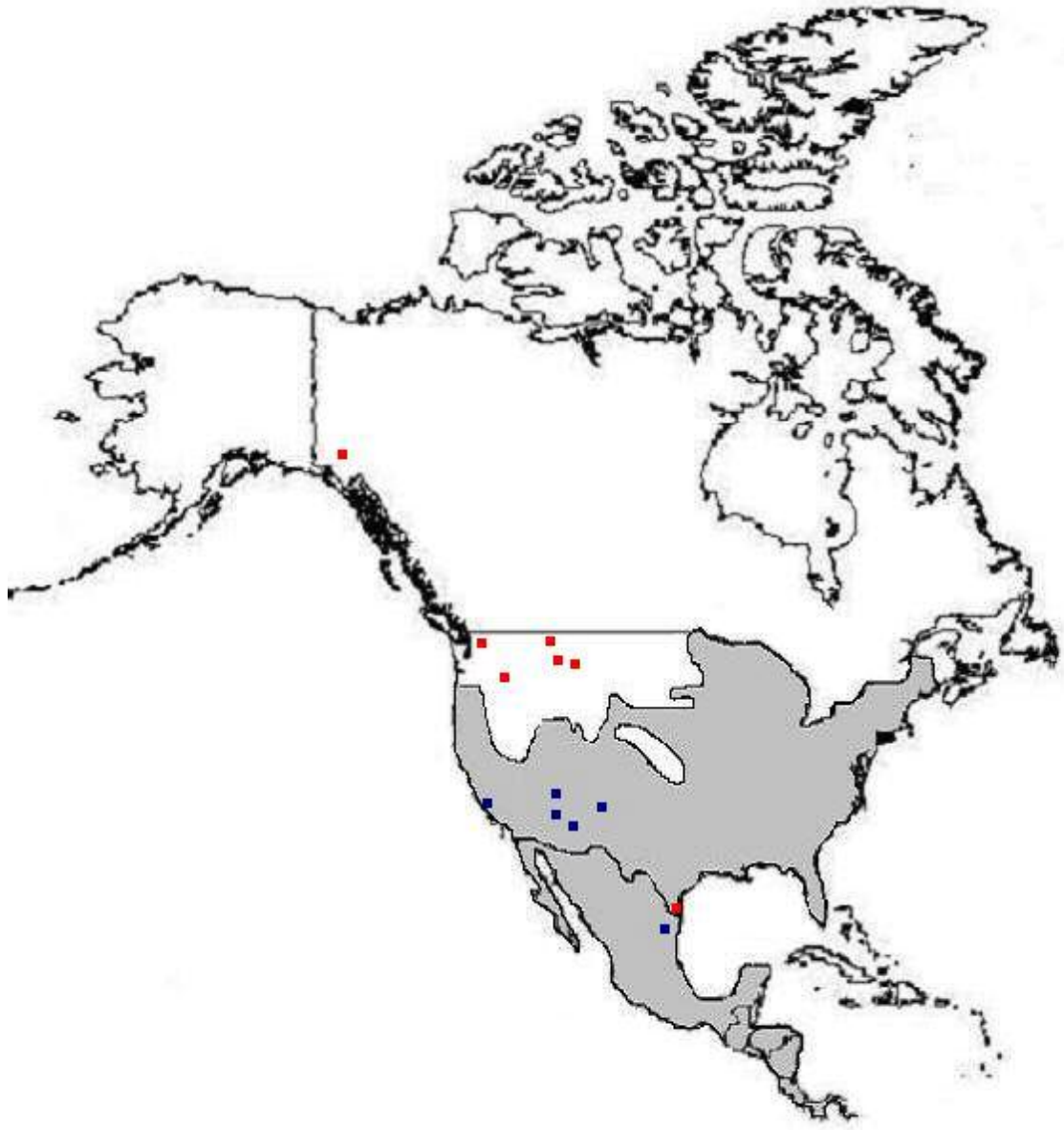
Figure 5. North American range of coyotes (*Canis latrans*; IUCN/SSC 2004).

Figure 6. North American range of bobcat (*Lynx rufus*; Cat Survival Trust 1996).

VIDA

Master of Science

Thesis: HAIR-SNARE SURVEY TO ASSESS DISTRIBUTION OF MARGAY
(*LEOPARDUS WIEDII*) INHABITING EL CIELO BIOSPEHERE RESERVE,
TAMAULIPAS, MEXICO

Major Field: Zoology

Biographical:
Education: Graduated from Bishop McGuiness High School, Oklahoma City,
Oklahoma, May 1988; received Bachelor of Science degree in Geology from
Oklahoma State University, Stillwater, Oklahoma in 1994. Completed the
requirements for the Masters of Science degree with major in Zoology at
Oklahoma State University in December 2005.

Experience:
Pachyderm keeper, Oklahoma City Zoo, 1999 through present

Professional memberships:
American Association of Petroleum Geologists
Wildlife Conservation Society

Name: Patricia J. Downey   Date of Degree: December, 2005

Institution: Oklahoma State University   Location: Stillwater, Oklahoma

Title of Study: HAIR-SNARE SURVEY TO ASSESS DISTRIBUTION OF

MARGAY (*LEOPARDUS WIEDII*) INHABITING EL CIELO BIOSPHERE RESERVE,

TAMAULIPAS, MEXICO

Pages in Study: 40   Candidate for the Degree of Master of Science

Major Field: Zoology

Scope and Method of Study: The margay (*Leopardus wiedii*) is an endangered
neotropical felid listed on Appendix 1 of CITES. Knowledge of margay ecology is
limited because little in-situ research has been conducted in any part of its range which
extends from northern Mexico to South America. The objectives of the research were to
(1) investigate seasonal habitat use of the margay and (2) determine which microhabitat
variables are preferred by margays inhabiting El Cielo Biosphere Reserve, Tamaulipas
Mexico. I conducted 8 hair snare surveys (4 wet-season and 4 dry-season) from
November 2002 to October 2004. Each survey consisted of 30 hair-snare stations placed
every 500 m along a transect spanning 3 habitats.

Findings and Conclusions: Species analysis did not detect margay on any pad. Gray fox
(*Urocyon cinereoargenteus*) was the predominantly detected species. Statistical analysis
was therefore only carried out on gray fox data. Of the 3 habitats surveyed, gray fox
detections were greater in oak-pine forest than cloud or tropical-deciduous forests across
seasons. Gray fox did not prefer any microhabitat variable or combination of variables. I
compared the results of unpublished and published hair-snare surveys and discovered
clear patterns in the success (i.e., detection of the target felid) of this technique. The
method succeeded only outside the range of gray fox. The technique fails within the
range of gray fox and the predominant species detected is consistently gray fox. I do not
recommend the hair-snare methodology to survey felids within the range of gray fox. I
advise a modified scent-station protocol equipped with a visual or auditory attractant to
survey felids within gray fox range.

ADVISER'S APPROVAL: Dr. Eric C. Hellgren