Chemical attractants for Central American felids

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All 36 species of felids are listed in either Appendix I or II of CITES (Nowell and Jackson 1996). Study of felids is critical to their conservation, but is difficult due to their low population densities, nocturnal activities, and avoidance of humans (Nowell and Jackson 1996). Scent-station surveys are a relatively inexpensive means to study low-density carnivores and are preferred over track surveys when road or trail surfaces do not permit clear prints.

Scent stations have been used to study habitat use, population density, and distribution of bobcats (*Lynx rufus*; Knowlton and Tzilkowski 1979, Conner et al. 1983, Linscombe et al. 1983, Diefenbach et al. 1994). However, scent-station visitation rates of bobcats are typically low, with a maximum reported rate of 6.5% (Morrison et al. 1981). Comparisons of the attractiveness of different lures have been made for bobcats (Sumner and Hill 1980, Morrison et al. 1981) and domestic cats (*Felis catus*; Clapperton et al. 1994). The only study examining attractiveness of lures to other felids was by Nachman (1993), who reported no difference between scent-station attractiveness of the commercial lures Pro's Choice (Russ Carman's, New Milford, Pa.) and Cat-man-do (Milligan Brand, Chama, N.M.) to jaguars (*Panthera onca*), margays (*Leopardus wiedi*), and ocelots (*Leopardus pardalis*). However, her lures were chosen for surveys of mammals in general and not specifically for felids. To increase the efficiency of scent stations for study of Central American felids, I compared responses to 4 attractants using both captive felids and free-ranging felids in Guanacaste Conservation Area, Costa Rica. Native felid species in Central America are the jaguar, jaguarundi (*Herpailurus yagouaroundi*), little spotted cat (*Leopardus tigrinus*), margay, ocelot, and puma (*Puma concolor*).


Captive jaguar, Cañas, Costa Rica. Photo by R. Harrison.

Study area

Captive felids were located at Las Pumas, a private zoo in Cañas, Guanacaste Province, Costa Rica. Felid species tested at Las Pumas included jaguar (2 M), jaguarundi (2 M), little spotted cat (1 M), margay (2 M, 3 F), ocelot (1 M), and puma (1 M). Felids were kept in enclosed outdoor areas with natural vegetation.

Scent stations were placed in the Santa Rosa and Pocosol sectors of Guanacaste Conservation Area, Guanacaste Province, Costa Rica. The study area was located in tropical dry forest (Hartshorn 1983). All areas were in stages of secondary succession (1-400 yrs) after a complex history of cutting, burning, grazing, and farming (Janzen 1986). Areas still covered primarily by grass were not sampled. Elevation was 0-350 m. Rainfall averages 90-240 cm, occurring entirely between May-October (Janzen 1986). Guanacaste Conservation Area was chosen as the study site for several reasons: the presence of all Central American felid

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species except the little spotted cat, the extensive network of roads, and the proximity to Las Pumas.

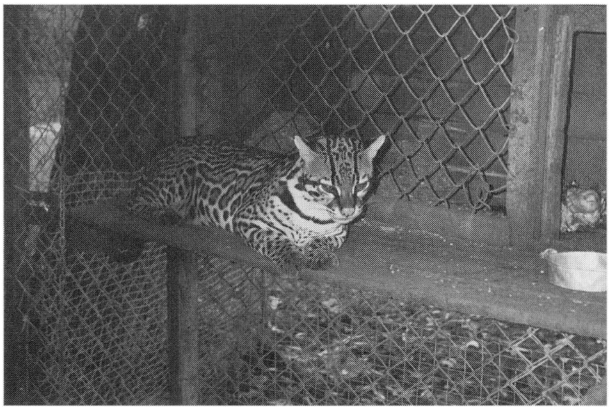
Methods

Enclosure tests and field scent-station surveys were conducted simultaneously in April, 1996. I chose attractants from those found most attractive to domestic cats (Clapperton et al. 1994) and bobcats (Sumner and Hill 1980, Morrison et al. 1981). Attractants tested were the commercial attractant Hawbaker's Wildcat 2 (WC2; R-P Outdoors, Mansfield, La.), bobcat urine (Rocky Mountain Fur Co., Caldwell, Id.), synthetic fatty-acid tablets (FAS; Roughton 1982, Roughton and Sweeny 1982; Pocatello Supply Depot, U.S. Dep. Agric., Pocatello, Id.), and catnip (*Nepeta cataria*) oil (Lebermuth Co., South Bend, Ind.). Concentration of the active ingredient of catnip oil, nepetalactone, was not tested, but was represented as >90% by the supplier. Silver vine matatabai (*Actinidia polygama*) is also a highly effective attractant for domestic cats (Clapperton et al. 1994) and other felids (Leyhausen 1973) but was not used in this study due to the possibility of brain damage in uncontrolled situations (Leyhausen 1973).

Enclosure tests

Captive felids were not removed from their cages for testing. Lures consisted of white, perforated plastic capsules (38 x 10 mm; Tissue-Tek, Baxter Sci. Products, McGaw Park, Ill.) stapled to a tongue depressor and containing about 2 ml of liquid attractant on cotton wool or 1 FAS tablet. Control lures contained an empty capsule. Lures were suspended outside of cages upwind, within view, and out of reach of the felid being tested. Responses were measured by recording the time each animal spent investigating the lure and by a behavior score. The behavior score was the total number of separate observed behaviors; these included approaching the lure, sniffing, raising the head, attempting to reach the lure by extending a paw through the cage wire, rolling, vocalizing, rubbing the head against the cage, licking the cage, and getting up. One point was given for each separate occurrence of a behavior, with the exception of approaching the lure, which required getting up and sniffing. Approaching the lure was counted as 3 points.

I randomized the presentation sequence of the 4 attractants and the control to individual felids within blocks of 5 tests. Different individuals had different attractant sequences, so all felids were not tested with the same attractant on the same day. I presented each felid only 1 lure/day of testing, which consisted of a 10-minute observation period. All observations were conducted in late afternoon, prior to daily feeding. The observation period began when I presented the lure. I arranged the testing sequence of individuals from downwind to upwind to prevent individuals from smelling attractants prematurely. I conducted enclosure tests every other day until each felid had been tested 3 times with each lure.



Captive ocelot, Cañas, Costa Rica. Photo by R. Harrison.

I compared investigation times between lures by randomized block analysis using Friedman's test (Zar 1984) and used simple linear regression to test whether investigation times declined as testing proceeded. I compared behavior scores between lures with log-likelihood ratio goodness-of-fit tests (Zar 1984). Scores were totaled if >1 individual of a species was tested. Correlations between investigation times and behavior scores were measured with Spearman rank correlations (Zar 1984). Regressions and correlations were calculated with the program SYSTAT (Wilkinson 1990).

Field tests

I created scent stations by removing vegetation from a 1-m-diameter circle, covering the circle with silt that had been collected from roadbeds and sifted through window screen, smoothing the surface, and placing a lure in the center (Linhart and Knowlton 1975). Lures were identical to those presented to captive felids, except that lures were placed vertically in the ground. Two strips of tinfoil (5 x 30 cm) were placed in nearby shrubs as visual attractants (New Mexico Trappers Assoc., pers. commun.). A station was judged operable if a boot imprint placed on the edge of the station was clear when the station was observed.

Scent stations were located at 600-m intervals along roads. Attractants were assigned randomly within blocks of 5. Tracks were observed on 3 successive days. I renewed the attractants and smoothed the station surface prior to each night of observation.

Table 1. Mean and standard error of investigation times in seconds for lures presented to captive felids at Cañas, Costa Rica, April 1996. Attractants were Hawbaker's Wildcat 2 (WC2), bobcat urine, synthetic fatty acid (FAS), and catnip oil. n = no. individuals tested. Each individual was tested 3 times with each type of lure. χ_r^2 = Friedman's test statistic, 4 df, *$P < 0.05$.

		WC2		Urine		FAS		Catnip		Control			
	n	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	χ_r^2	P
Jaguar	2	15.7	7.4	40.2	23.3	7.3	3.2	55.0	31.4	2.1	1.6	3.33	0.343
Jaguarundi	2	31.0	29.8	70.1	34.9	9.0	7.3	81.8	73.7	0.0	0.0	8.43	0.081
Little spotted cat	1	4.0	2.6	19.0	17.5	0.0	0.0	1.0	1.0	0.0	0.0	3.33	>0.500
Margay	5	26.3	10.7	48.4	10.6	15.6	5.7	9.3	4.2	1.2	0.9	17.95	0.002*
Ocelot	1	20.0	20.0	80.0	43.6	41.0	38.0	200.0	200.0	0.0	0.0	2.33	>0.500
Puma	1	65.0	32.8	33.8	0.5	13.0	11.5	2.0	1.0	0.0	0.0	6.07	0.207

Visits to the same station by the same species on different nights were counted as 1 visit. The number of visits to stations were compared between lures with log-likelihood ratio goodness-of-fit tests (Zar 1984).

Results

Enclosure tests

Only captive margays showed a difference in investigation times among attractants and the control (Table 1). Margays spent more time with urine than other attractants (χ_r^2 = 12.24, 3 df, P = 0.007), but no differences of investigation time were found among WC2, FAS, catnip oil, and the control (χ_r^2 = 5.18, 3 df, P = 0.175). Mean investigation times were not different between individual captive felids (χ_r^2 = 7.73, 11 df, P = 0.737) or between species (χ_r^2 = 3.12, 5 df, P = 0.681).

Slopes of investigation times versus cumulative number of tests were not different from 0 (P > 0.050) for 9 of the 12 captive felids. Investigation times declined as testing proceeded for 1 jaguar (slope = -2.58 sec/test, F = 6.990, P = 0.020, n = 15 tests), 1 male margay (slope = -6.06 sec/test, F = 9.812, P = 0.008, n = 15 tests), and the puma (slope = -5.28 sec/test, F = 12.419, P = 0.004, n = 15 tests).

All felid species showed differences in behavior scores among attractants and the control (Table 2). The lowest scores in each species were for controls. Jaguars did not show differences of scores among attractants (G = 5.02, 3 df, P = 0.186). Jaguarundis had higher scores for urine than for the other attractants (G = 35.31, 3 df, P < 0.001), and higher scores for WC2, FAS, and catnip oil than for the control (G = 16.078, 3 df, P = 0.001). Jaguarundis did not have different scores among WC2, FAS, and catnip oil (G = 3.62, 2 df, P = 0.181). The little spotted cat did not have different scores among attractants (G = 6.63, 3 df, P = 0.088). Margays had higher scores for urine than for other attractants (G = 11.06, 3 df, P = 0.012). Margays did not have different scores among WC2, FAS, and catnip oil (G = 1.99, 2 df, P = 0.391), but they did have higher scores for WC2, FAS, and catnip oil than for the control (G = 13.71, 3 df, P = 0.004). The ocelot had higher scores for urine, FAS, and catnip oil than for WC2 (G = 10.91, 3 df, P = 0.013), but did not have different scores among urine, FAS, and catnip oil (G = 1.77, 2 df, P = 0.431). The puma did not have different scores among the attractants (G = 4.87, 3 df, P = 0.196).

Investigation times were highly correlated with behavior scores (Table 3).

Table 2. Mean and standard error of behavior scores for lures presented to captive felids at Cañas, Costa Rica, April 1996. Attractants were Hawbaker's Wildcat 2 (WC2), bobcat urine, synthetic fatty acid (FAS), and catnip oil. G = log-likelihood ratio, 4 df, *$P < 0.05$.

		WC2		Urine		FAS		Catnip		Control			
	n	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	G	P
Jaguar	2	2.5	0.5	1.7	0.8	2.2	0.8	3.7	1.9	1.0	0.6	10.90	0.029*
Jaguarundi	2	0.7	0.5	5.7	2.0	1.7	0.5	3.7	1.9	0.0	0.0	60.30	<0.001*
Little spotted cat	1	1.3	0.7	1.3	0.9	0.0	0.0	0.7	0.7	0.0	0.0	11.09	0.026*
Margay	5	1.7	0.6	2.6	0.3	1.2	0.3	1.2	0.4	0.4	0.3	29.22	<0.001*
Ocelot	1	1.0	1.0	3.7	1.9	5.7	4.7	3.7	3.7	0.0	0.0	29.66	<0.001*
Puma	1	3.0	1.5	3.5	0.3	2.7	1.8	1.0	0.6	0.0	0.0	18.49	<0.001*

Table 3. Spearman rank correlations between investigation times and behavior scores for lures presented to captive felids at Cañas, Costa Rica, April 1996. n = total no. tests of each species. *$P <$ 0.05.

	n	r_s	P
Jaguar	30	0.92	<0.001*
Jaguarundi	30	0.93	<0.001*
Little spotted cat	15	0.99	<0.001*
Margay	75	0.93	<0.001*
Ocelot	15	0.99	<0.001*
Puma	15	0.96	<0.001*

Field tests

I established 172 scent stations, surveying all available roads within the study area. Stations were operable during 97.7% of available station-nights. All stations except 1 were operable for at least 1 night, and 94.2% of stations were operable for all 3 nights.

Felids visited 7.6% of the stations. Scent-station visitation by felids was too infrequent (Table 4) for meaningful testing of attractants for individual species. No difference between numbers of visits to different lures was detected when all felid species were combined (Table 4).

Virginia opossums (*Didelphis virginiana*) visited 16.4% of stations. Opossums removed lures from 75% of WC2 stations visited, 25% of urine stations visited, and 22% of FAS stations visited (Table 4). Opossums removed WC2 lures more often than urine or FAS lures (G = 9.05, 2 df, P = 0.011). Opossums visited WC2 and FAS stations more than urine and catnip oil stations (G = 7.33, 1 df, P = 0.007), and visited urine and catnip oil stations more than control stations (G = 6.02, 2 df, P = 0.049).

Other carnivore species recorded at scent stations were coatamundi (*Nasua narica*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and skunks. When combined, carnivore species (Table 4) visited urine stations more than WC2 and FAS (G = 19.758, 2 df, $P <$ 0.001) and WC2 and FAS stations more than catnip oil stations (G = 18.67, 3 df, $P <$ 0.001).

Discussion

Application of these results to field surveys should be considered preliminary in nature because of the low number of observed visits to scent stations by felids. Bobcat urine elicited the highest behavior scores by margays and jaguarundis, the highest investigation times by margays, and the most visits to scent stations by carnivores in general. Bobcat urine was among the top attractants for the captive ocelot, based on behavior score. Bobcat urine is also more attractive to bobcats than FAS, fox urine, or rhodium (Sumner and Hill 1980, Morrison et al. 1981). However, the attractiveness of urine may depend on the type used (Clapperton et al. 1994). Opossums were less likely to visit and disturb stations baited with bobcat urine than those baited with FAS or WC2. At $0.01/lure, bobcat urine was cheaper than WC2 ($0.19/lure), FAS ($0.37/lure), and catnip oil ($0.77/lure). Of the attractants tested, bobcat urine appeared to be the best attractant for Central American felids.

WC2 and FAS were similarly attractive to captive margays and jaguarundis, and to opossums and carnivore species in general at scent stations. Only the ocelot had a different score between WC2 and FAS, reacting more strongly to FAS. Removal of WC2 lures by opossums precludes its use in areas where opossums are common. WC2 is a viscous substance that requires extra precautions to prevent soiling of field equipment and was the most difficult attractant to use.

The attractiveness of catnip oil to captive jaguarundis and margays was not different from WC2 or FAS. For the ocelot, catnip oil had greater attractiveness than WC2 but was not different from FAS. Visitation to catnip oil stations by felids was the lowest of the attractants. Catnip oil as tested did not have a strong fragrance (to humans), which may have been the reason for the low visitation rate to catnip oil scent stations. Catnip oil is expensive and not widely available. The euphoric "catnip response" (Tucker and Tucker 1988), including rolling, playing, etc., was displayed once each by 1 jaguar and the ocelot,

Table 4. Number of scent stations visited by felids, carnivores, and Virginia opossums, and number of stations from which lures were taken by Virginia opossums at 171 scent stations in Guanacaste Conservation Area, Costa Rica, April 1996. Attractants were Hawbaker's Wildcat 2 (WC2), bobcat urine, synthetic fatty acid (FAS), and catnip oil. G = log-likelihood ratio, 4 df, *$P <$ 0.05.

	WC2	Urine	FAS	Catnip	Control	G	P
Number of Stations	34	35	34	34	34		
Jaguarundi	3	2	1	—	—	—	—
Margay	1	2	2	1	—	—	—
Ocelot	—	—	1	—	—	—	—
All felids	4	4	4	1	—	8.43	0.081
Carnivora[a]	8	14	9	1	—	27.91	<0.001*
Virginia opossum	12	4	9	3	—	20.40	<0.001*
Lures removed by Virginia opossum	9	1	2	—	—	9.05	0.011*

[a] Coatamundi, coyote, felids, gray fox, and skunks.

resulting in high investigation times and behavior scores for those 2 tests. Neither felid displayed the response in subsequent trials.

Decline over time of responses to attractants, as observed in this study for 3 individuals, was also observed over a period of 9 months in captive river otters (*Lontra canadensis*; Robson and Humphrey 1985). However, no significant decline was observed in the majority of captive felids. Furthermore, captive animals exposed repeatedly to the same scents over a short period are more likely to become accustomed to the scents than free-ranging animals that would encounter the scents at most a few times/year. Decline of interest in specific scents would probably not preclude the use of scent stations for long-term monitoring of felid populations.

Strong correlations between investigation times and behavior scores imply that either measure may be used to differentiate response to attractants. Behavior score produced more significant response differences and thus is the more useful index.

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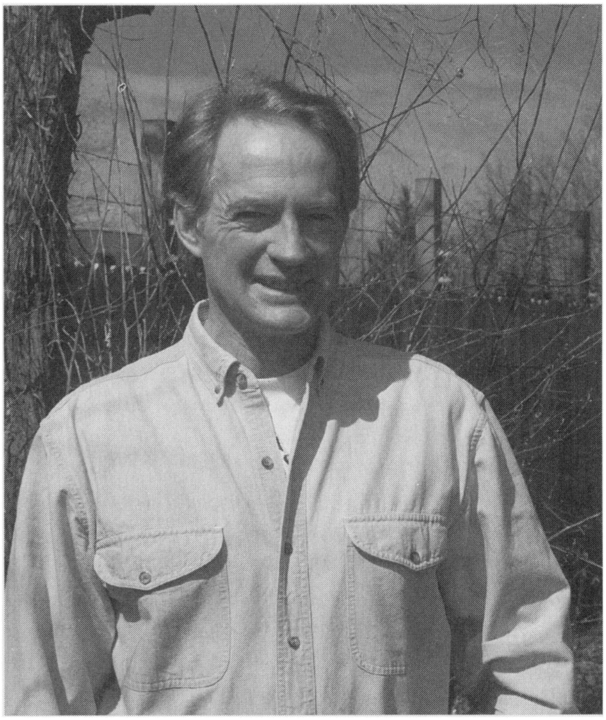

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