

Non-invasive Mountain Lion Population Study in Zion, Bryce Canyon, and Capitol Reef National Parks



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ZION encompasses approximately 600 km² in Kane, Iron, and Washington Counties of southwestern Utah. BRCA straddles Garfield and Iron counties and contains 145 km² within its boundary. CARE is located primarily in the south-central Utah counties of Wayne and Garfield (small northern portions lie in Emery and Sevier Counties, but no fieldwork was conducted there) and comprises approximately 980 km² of which about 77 km² is state-owned.

Climate, geology, and vegetation are typical of southern Utah's Colorado Plateau. Winters are cold and dry, often below freezing with snow regularly at higher elevations and sporadically at lower elevations. Elevations range at ZION from 1,128 to 2,660 m, at BRCA from 1,878 to 2,778m, and at CARE from 1,183 to 2,731 m. Summers are hot and dry except for the "monsoons" which typically occur in July and August, often accounting for the highest monthly rainfalls. Average rainfall is around 38 cm, 39 cm, and 18 cm for ZION, BRCA, and CARE, respectively (Sprinkel et al. 2000). However, drought conditions have been present in the region over the last several years. (Meteorologists have suggested that the "drought" is in fact more indicative of the region's climate and that it is really just a return to "normal" conditions after decades of unusually wet conditions).

All three parks are characterized by spectacular geologic formations including some of the highest sandstone cliffs known in ZION, formations resulting from erosion known as hoodoos in BRCA and a monoclinical uplift, Waterpocket Fold, that stretches approximately 160 km within CARE. In addition, there are slot canyons, high plateaus, mesas, spires, and intricate water-worn sandstone features. Much of the sandstone is Navajo, but may also include Chinle, Entrada, and Kayenta, among other formations (Sprinkel et al. 2000).

Vegetation within the parks varies dramatically with altitudinal changes and moisture availability. Riparian areas harbor cottonwood (*Populus* spp.), seepwillow (*Baccharis* spp.), willow (*Salix* spp.), and rushes (*Juncus* spp.). Piñon (*Pinus* spp.)-juniper (*Juniperus* spp.) communities are widespread and ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*) are common at the higher elevations. Spruce (*Picea* spp.)-fir (*Abies* spp.) communities dominate the highest elevations. Considerable areas are covered by shrub communities dominated by sage (*Artemisia tridentata*) and black brush (*Coleogyne ramosissima*). Complete biotic community descriptions for the region may be found in Brown (1994).

METHODS

Hair sample collection occurred from 15 May 2005 through 30 September 2005. Samples were primarily obtained using hair-snares. Snares consisted of pre-constructed 11x11 cm carpet pads with "barbed" collated roofing nails (manufactured in wire rolls for use in nail guns) driven through them (purchased from B. Baxter, Libby, Montana) (Fig. 2). Snares were nailed to tree trunks (Fig. 3) or fence posts 0.60-1.0 m above the ground and arranged in transects composed of 5 snares. The range in height is due to a height increase in snare placement to minimize hits by foxes. Transect lengths varied due to the width of canyons, but typically consisted of 5 snares placed approximately 100 m apart.

Snares were initially scented between 15 May 2005 and 30 September 2005 with a commercially available scent lure, Canine Call (Sterling Fur Company, Sterling, Ohio), which elicited substantial attraction and rubbing behavior in captive mountain lions (E. York, wildlife biologist at Santa Monica Mountains National Recreation Area, *pers. comm.* 2002). A second scent, a mixture of beaver castorium, catnip oil, glycerin, and propylene glycol was also utilized in the study. Dry catnip accompanied the snare scent lure.

In addition to the scent on the hair snare, a lure-scented carpet pad accompanied each snare and measured approximately 6x6cm (Fig. 4). These lure pads were suspended from branches, typically 1.5-2 m from the ground and 2-3 m from the snare, using monofilament line and swivels. Lure pads were scented with Canine Call. Bright aluminum pie slice shaped visual attractants, approximately 104 cm², were incorporated in the hanging lure assemblies (Fig.2).

Transects were initially deployed in a systematic manner aligned perpendicular to likely travel routes and corridors (e.g., across washes, trails, and canyons). They were also located in areas of high visitor use (i.e., Zion Canyon in ZION, highway 63 in BRCA, and the Fruita/Hwy. 24/Scenic Drive areas in CARE) since the primary focus was determining human/lion interfaces. As the project progressed, effort was expanded to survey more remote areas of the parks, but snares continued to be deployed in these high visitor use areas at lower concentrations. An additional change was from a systematic deployment of transects to a more focused approach that targeted areas of known lion activity (e.g., where tracks or scat sites were observed).

Transects were typically active for approximately 3 weeks and then were examined and removed. Any snares with "hits" (i.e., hair present) were removed upon checking and replaced if the transect was to run longer. Snares were only handled with latex-gloved hands, to avoid DNA contamination, and were placed in brown paper envelopes marked with the date, park's name, and station number. All snare locations were recorded using GPS units, or plotted on maps if satellite signal quality was poor. Only samples appearing to have lion hair were sent for genetic analysis. DNA analysis was still ongoing at the time of drafting this report.

Remote cameras were another component of this project and were used from 15 May 2005 through 30 September 2005. The research utilized 35mm passive infrared motion-triggered cameras (CamTrakker™, Watkinsville, Georgia) deployed with color print film. These cameras were set to capture photos for identification of the animals attracted to and passing within the areas of the snares and predation sites. An additional function of the cameras was to procure photos for public education. Typically aimed across trails or natural corridors, the cameras were attached to tree trunks 0.3- 0.5 m above the ground with bungee cords. The cameras operated day and night with a 20 second delay between exposures. Camera sites were located at the third or first hair snare station of a transect.

RESULTS

DNA Analysis

Methods

All DNA extractions and polymerase chain reactions (PCR) were performed in a low quantity DNA laboratory that is dedicated to processing bone, scat, and hair samples to avoid contamination errors (Taberlet et al 1999). Hair samples were extracted using a Qiagen tissue kit with a modified protocol and fecal samples were extracted using the Qiagen fecal DNA kit. Samples were amplified using primers developed by Farrell et al. (2000) that have been optimized to amplify a variety of mammalian taxa. Products were purified using the ExoSapIT enzyme method (Amersham Biosciences). Purified PCR products were used as templates for cycle sequencing reactions prepared using the Big Dye Terminator Ready Reaction Kit (PE Applied Biosystems) following a modified version of the manufacturers protocol. Products were sequenced in one direction. Unincorporated primers and dye-terminators were removed using Sephadex spin columns. Sequence reactions were loaded on a 5% long ranger (BW Products) denaturing gel on an ABI prism 3130 automated sequencer (Applied Biosystems). Sequence data were analyzed using GeneScan and visualized using Sequencing Analysis software (Applied Biosystems). Sequences were blasted in Genbank to identify species matches.

Results

DNA was obtained from all samples and species ID was successful. The results for each sample are in Table 1 below.

Table 1.

Lab ID	Field ID	Collection Date	Sample type	Result
Zk1	Watchman Houses	July 19, 2005	10 hair follicles	Grey fox
Zk2	Admin 5	July 19, 2005	5 hair follicles	Coyote
Zk3	SB	Aug 10, 2005	9 hair follicles	Grey fox
Zk4	BH5	Aug 21, 2005	10 hair follicles	Grey fox
Zk5	SB?	Aug 9, 2005	10 hair follicles	Cougar
Zk6	NVC 5	Aug 21, 2005	10 hair follicles	Grey fox
Zk7	WC?	Aug 9, 2005	10 hair follicles	Grey fox
Zk8	CARE Schoolhouse #1	July 5, 2005	Scat	Cougar
Zk9	CARE Schoolhouse #2	July 5, 2005	Scat	Cougar

If NPS would like to do future analyses of individual ID's to see if the same cougar (or coyote or fox) is traveling to different locations, it would be possible using these DNA extracts. This analysis costs \$60 for hair samples and \$200 for fecal samples.

Camera Stations

From the 32 camera stations (14 at ZION, 10 at BRCA, and 8 at CARE), a total of 336 pictures were taken over the 448 camera nights (196 at ZION, 140 at BRCA, and 112

at CARE), but only 2 were of lions (Table 2). Lion photos were captured at two cameras, one in CARE (Fig. 5) and one in BRCA (Fig. 6).

Table 2. Lion project camera nights for CARE, BRCA, and ZION.

Park	# of camera stations per park	# of camera nights per station	Total # of camera nights per park
ZION	14	14	196
BRCA	10	14	140
CARE	8	14	112
Total	32		448

DISCUSSION AND MANAGEMENT IMPLICATIONS

DNA samples provide information on species and individual identity. A collection of samples provide a bank for comparison with additional and new samples, giving park management tools to remove the correct lion in the rare case of a lion attack. By combining the DNA information, hair trap locations, and camera results in a Geographic Information System, management may infer habitat use and distribution from the maps produced.

While hair samples were collected from snares during the early days of this project, the majority of them were thought to be from species other than mountain lion. This speculation is based on hair characteristics, fox tracks at stations, and photos of foxes visiting stations. As shown in the table above, DNA analysis confirmed that only three were from cougars, one from a coyote and all other hair sample were from foxes.

The lack of effectiveness of the snares is further supported by occasions in CARE and BRCA when lions either approached or passed by snares, within 2 m as evidenced by photographs, and failed to rub against them. Similar behavior has been noted with radio-collared lions in Santa Monica Mountains National Recreation Area (E. York, wildlife biologist Santa Monica Mountains National Recreation Area, *pers. comm.* 2003). DNA results show that species identification and individual DNA profiles can be established, but the hair snare technique and/or the associated attractants were not conducive to securing cougar hair samples, even when cougars were immediately present in the vicinity of the snares. Further assessment of this technique for lion research is warranted.

Camera stations captured a variety of species in ZION including gray fox, mule deer (*Odocoileus hemionus*), wild turkey (*Meleagris gallopavo*), and coyote (*Canis latrans*). In CARE, on a social trail paralleling the Fremont River a lion passed nearby to a camera and was photographed but left no hair. This kind of miss may be unavoidable. However, even with complete camera and snare coverage and numerous photographs, lion population estimates cannot be made unless individuals can be positively identified by unique natural or artificial markings. Population trend indices and species distribution may be derived from camera surveys, but they could just as easily, and less expensively, be established through track surveys. It must be noted that while many researchers and agencies rely on indices to investigate population trends, there are many examples of

these indices having little correlation with actual trends (Smith et al. 1984, Rotella and Ratti 1986, Nottingham et al. 1989).

The use of remote cameras may be most valuable in the impact they have on public education. Most visitors are never privileged to see lions in the wild, but the ability to show them photos of these animals in their respective parks has far greater impact than verbal descriptions. This is vitally important if lions pose a threat, however minimal. Efforts have been and are currently being undertaken to inform the public on how to react if they encounter a lion (Fig. 7).

In comparing ZION, BRCA, and CARE, it appears that ZION has the largest and most active lion population within the park. This opinion is based primarily on direct observations of lion sign (i.e., tracks and scat) and comparative size of ZION versus CARE and BRCA. Within ZION, lion tracks were found with regularity in the vast majority of areas explored, while very little sign was found in CARE and BRCA. Some of this discrepancy in sign, especially tracks, may be due to differences in substrate composition. Lion sightings were also more frequent in ZION, but this is possibly a result of human visitation rates not lion numbers.

Due to the shape of CARE and BRCA's boundaries, long and narrow, and their north-south orientation with mountains to the west and valleys to the east, it appears that lions are primarily passing through the park and using it as a corridor. All the lion sign from CARE were in stream corridors like the Fremont River and Sulphur Creek. Considerably more deer sign was observed on the east side of Waterpocket Fold than in other areas of the park, with the exception of Fruita which has a high resident deer population. This aggregation of mountain lion prey base may result in an increased chance of a human/mountain lion encounter.

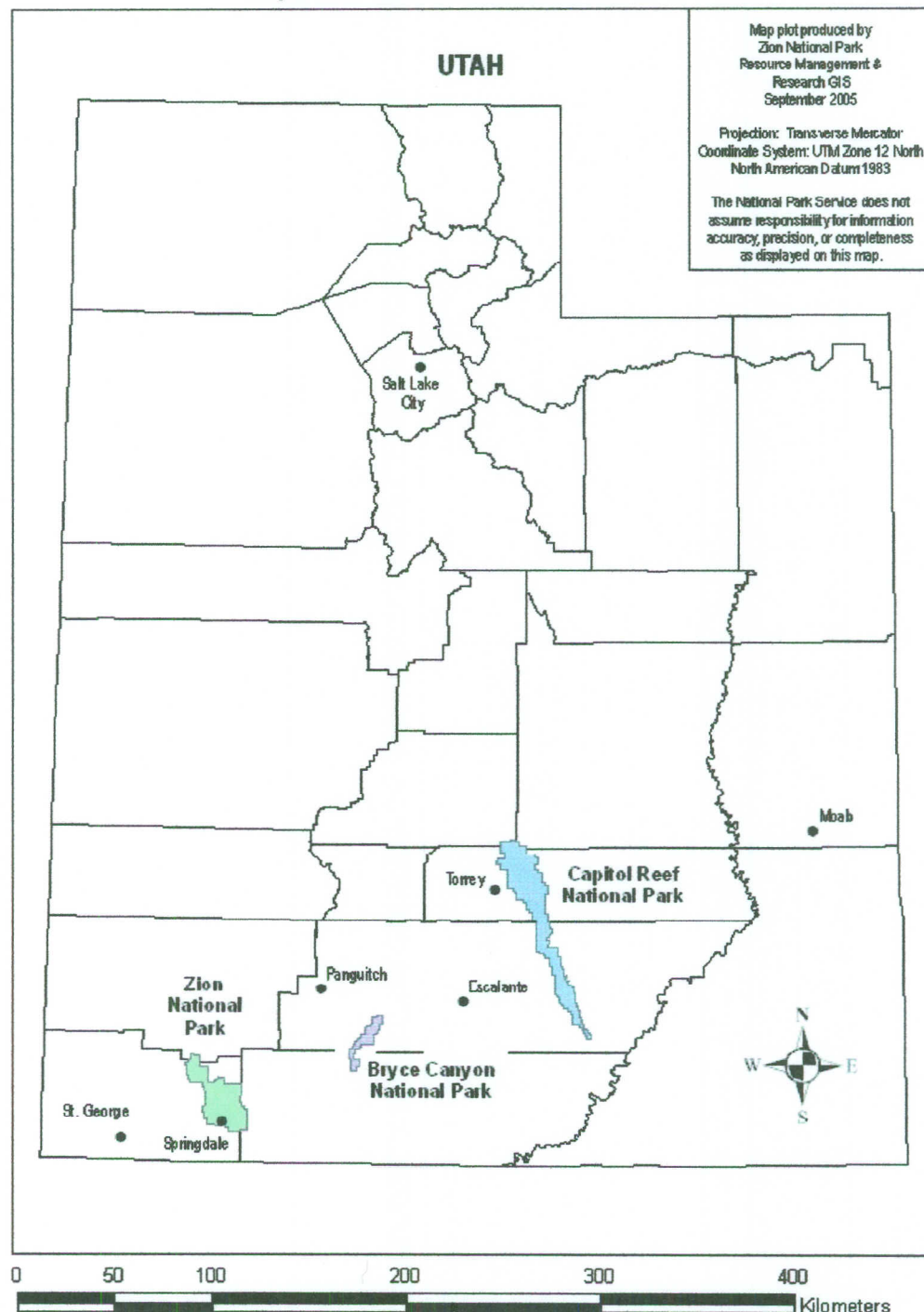
If lions are utilizing CARE and BRCA as suspected, these parks do not function significantly as a refugia or population source. The majority of land management practices (private, Bureau of Land Management, United States Forest Service) around CARE and BRCA allow for hunting or removal of lions. Without changing land use on adjacent properties, it appears unlikely that CARE and BRCA will ever harbor a large lion population.

Conversely, ZION appears to have a relatively large lion population. While ZION's boundary layout is more conducive to territory formation within the park, there are still threats immediately outside the boundary. As at CARE and BRCA, land management adjacent to ZION allows for taking lions, but it is unclear how frequently this occurs.

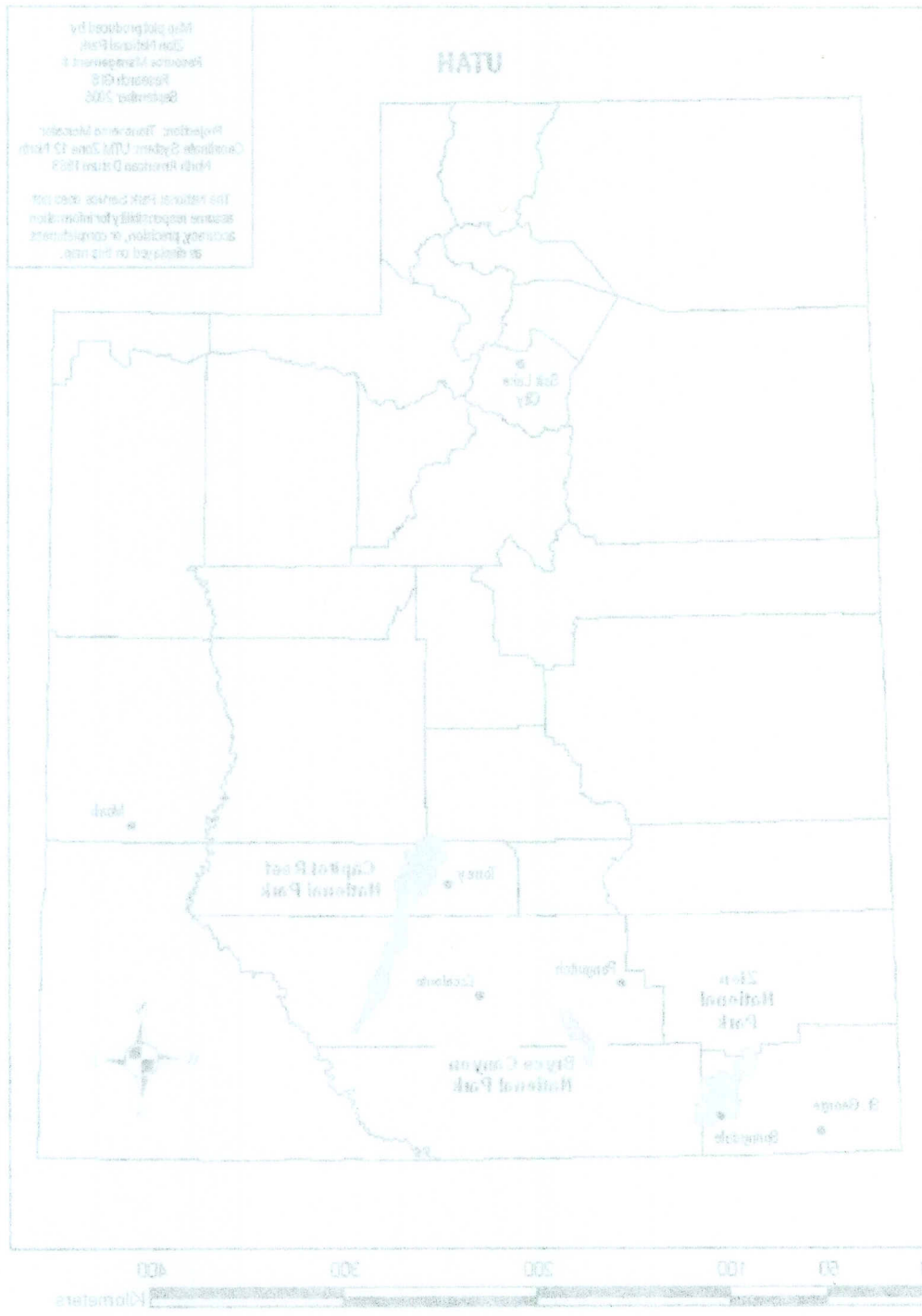
REFERENCES CITED

- Ackerman, B., F.G. Lindsey, and T.P. Hemker. 1984 Cougar Food Habitats in Southern Utah. *Journal of Wildlife Management* 48:147-155.
- Beier, P. 1991. Cougar Attacks on Humans in the United States and Canada, 1890-1990. *Wildlife Society Bulletin* 19:403-412.
- Brown, D. E. (editor) 1994. *Biotic Communities: Southwestern United States and Northwestern Mexico*. University of Utah Press, Salt Lake City, Utah, USA.
- Farrell, L. E., J. Roman, and M. E. Sunquist. 2000. Dietary separation of sympatric carnivores identified by molecular analysis of scats. *Molecular Ecology* 9:1583-1590.
- Lewis, L. and T. Chester. 2004. List of Confirmed Cougar Attacks in the United States and Canada 2001- now. <<http://users.frii.com/mytymyk/lions/attacks3.htm>> 13 July 2004.
- McKelvey, K.S., J.J. Claar, G.W. McDaniel, and G. Hanvey. 1999. *National Lynx Detection Protocols*. Missoula, MT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Nottingham, B. G., Jr., K. G. Johnson, and M. R. Pelton. 1989. Evaluation of Scent-station Surveys to Monitor Raccoon Density. *Wildlife Society Bulletin* 17:29-35.
- Rotella, J. J., and J. T. Ratti. 1986. Test of a Critical Density Index Assumption: A Case Study with Gray Partridge. *Journal of Wildlife Management* 50:532-539.
- Smith, L. M., I. L. Brisbin, Jr., and G. C. White. 1984. An Evaluation of Total Trapline Captures as Estimates of Furbearer Abundance. *Journal of Wildlife Management* 48:1452-1455.
- Sprinkle, D.A., T.C. Chidsey, JR and P. B. Anderson, editors. *Geology of Utah's Parks and Monuments*. Utah Geological Association, Publication 28. Publishers Press, Salt Lake City, Utah, USA.
- Taberlet, P., L. P. Waits, and G. Luikart. 1999. Non-invasive genetic sampling: look before you leap. *Trends in Ecology and Evolution*. 14:323-327.

Mountain Lion Study in Bryce Canyon, Capitol Reef and Zion National Parks



Capitol Reef and Zion National Parks Mountain Lion Study in Bryce Canyon



This map was prepared by the Utah Department of Natural Resources, Division of Parks and Recreation, in cooperation with the U.S. Geological Survey, Western Ecology Division, and the U.S. Forest Service, Grand Staircase-Escalante National Monument. The map is intended for informational purposes only and should not be used for navigation or other purposes. The map is based on the best available information and is subject to change without notice.

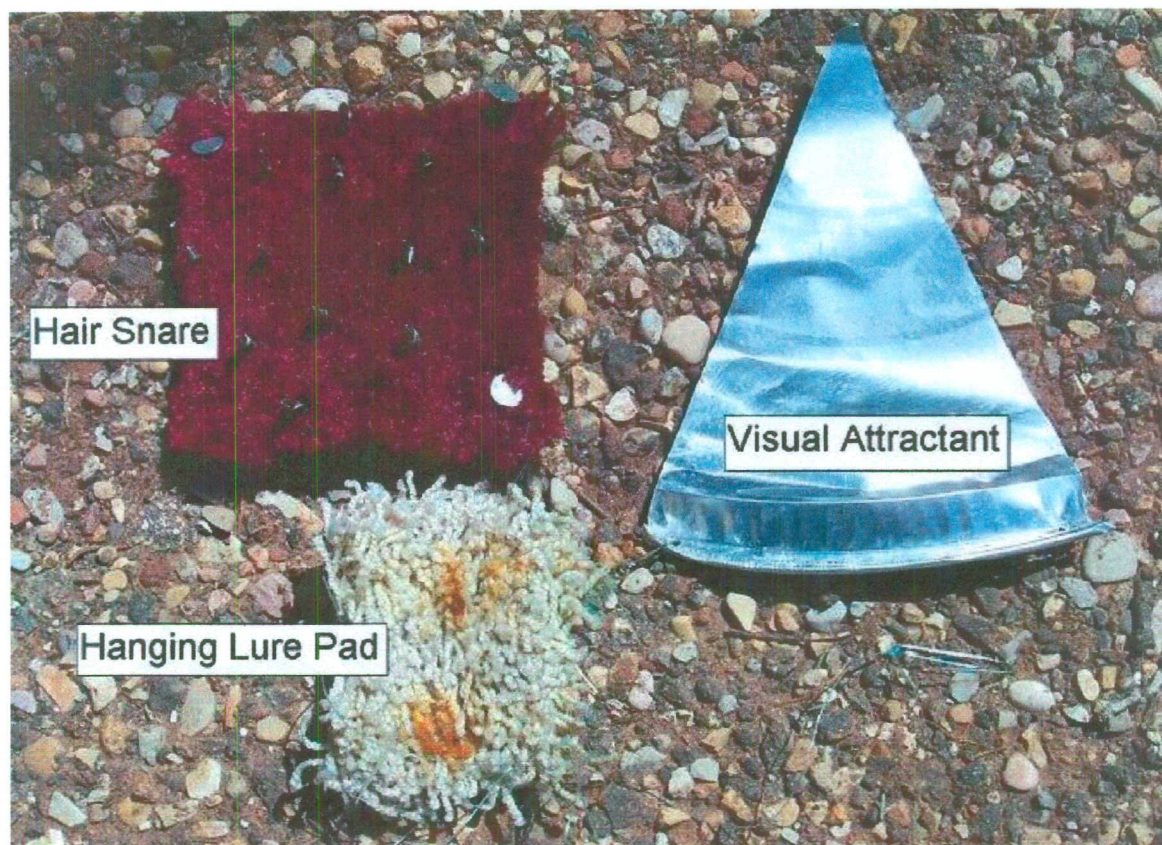


Figure 2. Station assembly components used for sample collection in Zion, Bryce, and Capitol Reef National Parks.



Figure 3. Hair station assembled *in situ*. Hair snare is approximately 0.9m from the ground. Hanging assembly is about 1.6m from the ground and 2-3m from snare.



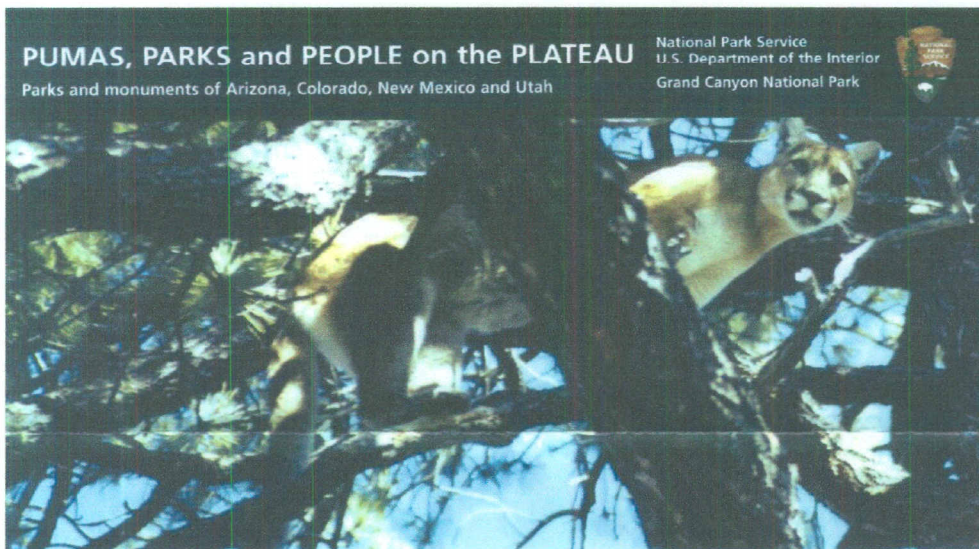
Figure 4. Hanging assembly of hair station composed of visual attractant and lure pad.



Figure 5. Photo of mountain lion in CARE along a social trail paralleling the Fremont River.



Figure 6. Photo of mountain lion in BRCA on Rigg's Trail near Yovimpa Point.



You are in Lion Country

Many national parks, monuments, and recreation areas in the west contain premier mountain lion habitat. This surprises many visitors and residents. These large, powerful animals have always been dominant predators in this country, preying primarily on deer and elk. In so doing, lions perform an important ecological role in nature.

Like any wild animal, mountain lions can be dangerous. With a better understanding of lions, we can coexist with these powerful and magnificent creatures.

Mountain lions rely on stealth for a successful hunt. As such, people rarely get more than a glimpse of a lion in the wild. Lion attacks on humans are extremely rare, but have resulted in serious injury and even death.

SAFETY REMINDERS

HIKE TOGETHER

DON'T RUN

PROTECT CHILDREN

BE LOUD

STAND UP

FIGHT BACK

REPORT ENCOUNTERS

Figure 7. Front cover of Lion Country handout.

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