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# Characteristics of Mountain Lion Bed, Cache and Kill Sites In Northeastern Oregon

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# CHARACTERISTICS OF MOUNTAIN LION BED, CACHE AND KILL SITES IN NORTHEASTERN OREGON

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*Abstract:* We described mountain lion (*Puma concolor*) habitat characteristics during two studies in the same area of northeastern Oregon during the 1990s. In the first study (1992-1994) we evaluated micro-habitat features associated with 61 diurnal bed sites that were not associated with kills. We used similar techniques in the second study (1996-1998) to evaluate habitat features at 79 cache sites near lion-killed prey. A dog was used to find 93% of the diurnal bed sites. Radio telemetry triangulation was used in the second study. Characteristics of diurnal bed sites and cache sites were compared with random habitat plots. Rock structure and downed logs were identified as important habitat components at diurnal bed sites. Canopy cover at cache sites was significantly higher than at random sites. Cache sites also were associated with rock structure, but not to the same degree as diurnal bed sites. In both studies mountain lions used sites in close proximity to habitat edges more frequently than expected based on random plots. Understanding the similarities and differences of habitat use at diurnal bed, cache and kill sites sheds light on the ecological adaptation of mountain lions to the multiple environmental influences and disturbances of managed forests.

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**Key words:** *Puma concolor*, microhabitat use, diurnal bed site, cache site, kill site, habitat edge, forest management

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Mountain lion recovery has been one of the great wildlife conservation success stories of the 20th century. As we move into the 21st century, the challenges for mountain lion conservation are less related to species persecution, and more related to concerns with habitat fragmentation and issues of human-lion coexistence on the expanding fringe of urbanization. The interface between human resource development and mountain lion habitat use has persisted for centuries in North America. Historically, mountain lions have occupied most habitats occurring on this continent. Mountain lions have typically been associated with the rugged, rocky, forested terrain of the Rocky Mountains in the western United States; however, this species is so adaptable it can thrive in deserts, swamps, tropical jungles, and sub-alpine forests (Hornocker 1976). The lion has come into conflict with humans on several fronts. In the past, the majority of interactions between humans and mountain lions were associated with settlement and agricultural practices (Young 1946). With increasing human population and urban sprawl, the zone of conflict has shifted to the urban-wildland interface (Beier 1995).

Habitat fragmentation can take a more subtle form than the direct effect imparted by urbanization. Across much of the mountain lion's range, logging has occurred at various intensities. Studies in Utah and Arizona, found that mountain lions either avoided active timber sale areas (Van Dyke et al. 1986) or adjusted their activity pattern from the norm (Ackerman 1982), to maximize night-time concealment from human contact. Timber sale size, relative to a resident mountain lion's home range, was a big factor on the degree of disturbance and influence on a lion's willingness to maintain its home range (Van Dyke et al. 1986). Small-area logging operations were less of a negative factor for resident adults. Van Dyke et al. (1986) also concluded that dispersing young animals were more adversely affected by logging and road system development than were established adults. By comparison, Gagliuso (1991) did not find avoidance by radio-collared lions to either recent logging or high road densities in his southwestern Oregon study area. Differences in his findings from Van Dyke et al. were related to under-story density and rapid recovery of brush in newly logged areas. The southwest Oregon study area had more than twice the precipitation of the Arizona and Utah studies.

We compare the results of our studies within the same northeast Oregon study area and discuss similarities and differences with studies in Utah, Arizona and southwest Oregon (Van Dyke et al. 1986, Gagliuso 1991). Our studies in northeast Oregon were conducted in a climatological, geographical, and anthropogenic situation somewhere in-between those areas described by Van Dyke et al., and Gagliuso. The objectives of this paper are to: 1) connect 2 habitat investigations to gain a more complete understanding of microhabitat use relative to mountain lion life history, and 2) compare mountain lion microhabitat use in northeast Oregon with similar work in other regions of the western United States.

## STUDY AREA

Both of these studies were conducted in the Catherine Creek Wildlife Management Unit in northeast Oregon. The Catherine Creek study area is approximately 845 $km^2$ in size. Elevations range from 940 to 2,450 m. This area is flanked on the west by range and agricultural lands of the Grande Ronde Valley and on the east by the Wallowa Mountains within the Eagle Cap Wilderness Area. Most of the area (60%) is on the Wallowa Whitman National Forest, with the remaining being divided between Boise Cascade Corporation lands and other private ownership. Vegetation varies from subalpine coniferous forest to mixed conifer forest to rangeland and cropland. Road density varies from medium-high density (1.4 $km/km^2$) to small road closure areas. Approximately 20% of the work from these studies was conducted within a Boise Cascade road closure area that had received various levels of logging activity. The majority of this area is mid-elevation coniferous forest with various forms of rock structure including rimrocks and outcrops.

## METHODS

We compared the primary findings of habitat characteristics at diurnal bed sites in Akenson et al. (1996) and at kill and cache sites in Nowak (1999). The 2 studies were compared qualitatively and the similarities and differences were described and discussed in an ecological context. The methods utilized in the 2 studies are briefly described below.

Akenson et al. (1996) used various methods of locating and identifying mountain lion diurnal bed sites including snow tracking, radio telemetry, and a trained lion hound that located scent at bed sites. These methods were modified from Anderson (1990) for locating bobcat loafing sites in Colorado. A bed site was confirmed through visible evidence of either soil or litter disturbance or tracks, and by alert reactions of a reliable dog. Beds were typically visible as a depression in snow or duff, or flattened grass. Once a bed site was identified, the surrounding area was searched for prey remains to determine whether the bed was associated with a kill. The actual bed site became the center of a 50-meter radius plot for collection of data to determine the physiographic and vegetative composition of the site. Habitat descriptions were aided by the handbook "Plant Associations of the Wallowa - Snake Province" (Johnson and Simon 1987).

Akenson et al. (1996) evaluated 6 primary habitat features at each plot site including rock structure, forest structure, canopy cover, shrub cover, plot visibility and overall security from human disturbance. This study emphasized the structural influence of vegetation and topography on a mountain lion's security from detection. Other environmental influences such as distance to roads and abrupt habitat edges were also recorded. The distance to road measurement was recorded from the plot center to the nearest drivable road. A habitat edge typically marked a forest break or the beginning of a rock wall or large rock outcrop. For comparison, habitat data were also collected at randomly selected sites distributed throughout the study area. Random sites corresponded to the same square-mile section corner in 30 sections drawn from a pool of 185 possibilities, which all occurred in the known home ranges of the 5 subject mountain lions. All mountain lion age and sex classes were included. Habitat plots were categorized as summer (April 15 to September 1), winter (December 15 to March 15) or random, and data were summarized and compared using chi-squared tests for differences between the 3 plot types. Values were considered significant at $\alpha = 0.05$.

Nowak (1999) applied the term "cache site" to the location where a mountain lion kill was first found, whether or not the lion had moved it after making the kill. The exception to this was if the kill had obviously been moved from the original cache site for subsequent feeding and the original cache site could be identified. The term "kill site" referred to the location where the mountain lion actually killed its prey. The distinction between cache and kill site involved a combination of telemetry triangulation when the lion was present, and then an investigation of the area after the lion moved a safe distance away. As with other studies on lions, the majority of information was obtained from locating radio instrumented animals on the ground (Anderson et al. 1992). Once the cache or kill site was determined, then this site became the center of a 25-meter radius plot for collection of physiographic and vegetative data.

Work closely followed Akenson et al. (1996) to facilitate comparisons between the 2 studies. Data were collected for 25 habitat variables to evaluate rock structure, forest structure, canopy cover, plot visibility and proximity to potential disturbance. This study likewise emphasized the influences of vegetation and topography on mountain lion security but also on the security of kills, which may be left unattended for long periods of time. In this study, distance was recorded to both the nearest open, drivable road and to the nearest road of any kind, open or closed. As with Akenson et al., a habitat edge was typically a relatively abrupt change in stand composition and/or structure or topography. For comparison, habitat data were also collected at randomly selected sites distributed throughout the study area but within the subject lions' home ranges. UTMs for random plots were generated by a computer random number generator (Microsoft Excel) using known study animal home ranges as limits to the generated coordinates. Habitat plots were categorized as cache, kill or random, and data were summarized and compared using forward, stepwise, logistic regression for differences between the 3 plot types. Values were considered significant at $\alpha = 0.05$. Only adult female mountain lions, with and without young, were included.

## RESULTS

Akenson et al. (1996) recorded habitat characteristics at 61 diurnal bed sites, 32 during winter and 29 during summer. Most (87%) of these sites were not associated with kills. They collected the same habitat data at 30 randomly selected plots. Nowak (1999) collected habitat data at 79 cache sites, 19 kill sites and 101 randomly selected sites.

Akenson et al. (1996) found significant differences between diurnal bed sites and randomly selected sites in presence of rock structure, number of down logs in the plot, distance to habitat edge, sight distance (the median distance at which a person could be seen from plot center at about lion height), understory density and management status (Table 1). Nowak (1999) found significant differences between cache sites and randomly selected sites in canopy cover, understory density, elevation, and management status. Significant differences between kill and random sites were in elevation, management status and plot visibility (the mean distance at which a

**Table 1. Habitat characteristics at mountain lion diurnal bed sites, summer and winter, at cache sites, and at randomly selected sites associated with each study (Akenson et al. 1996, Nowak 1999). Asterisks (*) indicate features significantly different (p<0.05) between bed or cache sites and random sites; two asterisks (**) indicates the feature significantly different between cache & kill sites.** ***Note: Diurnal winter and random site data do not include sites located in non-forested habitat.***

| Primary Habitat Feature | Habitat Variable | Akenson et al. | | | Nowak | | |
|---|---|---|---|---|---|---|---|
| | | Summer | Winter | Random | Cache | Kill | Random |
| Rock Structure | No. (%) forested plots (no rock structure) | 9 (31%)* | 14 (44%)* | 11 (73%) | 63 (80%) | 16 (84%) | 85 (84%) |
| | No. (%) forested rimrock plots (rock structure present) | 20 (69%)* | 16 (50%)* | 6 (20%) | 16 (20%) | 3 (16%) | 16 (16%) |
| Security | Distance to habitat edge (m) | 30* (median) | 45 (median) | 100 (median) | 316 (mean) | 216 (mean) | 414 (mean) |
| | Distance to open road (m) | 200 (median) | 400 (median) | 200 (median) | 488 (mean) | 432 (mean) | 375 (mean) |
| Visibility | Sight distance (m) | 24* (median) | 31* (median) | 51 (median) | 29 (mean) | 25* (mean) | 47 (mean) |
| Forest Structure | Down logs (# in plot) | 30* (median) | 4* (median) | 10 (median) | 28 (mean) | 32 (mean) | 32 (mean) |
| | Canopy structure | 3 (median # canopy layers) | 3 (median # canopy layers) | 1 (median # canopy layers) | 2 (most common # canopy layers; 44%) | 3 (most common # canopy layers; 37%) | 2 (most common # canopy layers; 40%) |
| Shrub Cover | Understory density | 52* | 45 | 29 | 31* | 33 | 41 |
| Canopy Cover | Forest canopy (mean % canopy cover) | 57 | 61 | 50 | 69* | 47** | 55 |
| | Elevation (m; mean) | 1,516 | 1,192 | 1,458 | 1,402* | 1,395* | 1,499 |

person could be seen from plot center at about lion height). Kill and cache sites differed only in canopy cover (Table 1).

Large rock structure (forested rimrock) and down logs were present in significantly more diurnal bed site plots than expected but that was not the case for cache sites, although cache sites were slightly more likely to contain rock ledges than were the random sites in that study. Canopy cover was significantly greater in cache sites than in either kill or random sites but was not different between bed sites and random sites. Understory density was lower in cache sites but higher in summer diurnal bed sites. Akenson et al. (1996) found greater use of the old logged management type for diurnal beds in winter; Nowak (1999) found cache sites in old logged with similar frequency to random plots (Table 2). A relatively high percentage of cache sites were located in shelterwood but diurnal beds were in that management type with similar frequency to random plots. Cache sites were in the rangeland management type with less frequency than the random sites but bed sites were located in rangeland with about the same frequency as random sites.

Neither study documented significant differences in the distance to the nearest open road although both winter bed sites and cache sites tended to be farther from open roads than random sites. In Akenson et al. (1996), summer diurnal beds were significantly closer to a habitat edge than were random sites. Although not statistically significant, Akenson et al. (1996) and Nowak (1999) found that winter diurnal beds and cache sites both tended to be closer to a habitat edge than the random sites. Both studies documented significantly lower plot visibility/sight distance in sample plots compared with random sites. Both studies also showed seasonal variation, in elevation with both bed sites and caches at lower elevation in winter than in summer. When 4 seasons were considered, Nowak found cache sites were at higher elevation in fall than in summer, spring, or winter.

## DISCUSSION

Several authors have addressed the question of mountain lion habitat use, conducted studies in some diverse environments, and concluded that a primary factor in habitat selection for this carnivore was the presence of vegetation and terrain cover to enhance the stalking of prey, usually deer or elk. Hornocker (1970) felt that lions in his Idaho study area selected habitat on the basis of prey density and terrain features that were advantages for hunting. Logan and Irwin (1985) also noted a high occurrence of lion caches within canyon vegetation, draws, and on steep ridges demonstrating the importance of both

**Table 2. Management status at mountain lion diurnal bed sites, summer and winter, at cache sites, and at randomly selected sites associated with each study (Akenson et al. 1996, Nowak 1999). Asterisks (*) indicate features significantly different (p<0.05) between bed or cache sites and random sites.**

| Management Status | Akenson et al. | | | Nowak | | |
|---|---|---|---|---|---|---|
| | Summer | Winter | Random | Cache | Kill | Random |
| Unlogged | 12 (41%) | 7 (22%) | 11 (37%) | 11 (14%) | 2 (11%)* | 20 (20%) |
| Old logged | 10 (34%) | 20(63%)* | 7 (23%) | 46 (58%) | 9 (47%) | 60 (59%) |
| Shelterwood | 6 (21%) | 3 (9%) | 7 (23%) | 19(24%)* | 7 (37%)* | 11 (11%) |
| Old clearcut | 1 (3%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (5%)* | 0 (0%) |
| New clearcut | 0 (0%) | 0 (0%) | 3 (10%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Rangeland | 0 (0%) | 2 (6%) | 2 (7%) | 3 (4%) | 0 (0%)* | 10 (10%) |

vegetative and terrain cover. Seidensticker et al. (1973) concluded that a "vegetation – topography/prey numbers – vulnerability complex" determined both lion home range size and population density. We agree that the need for cover while bedding, hunting, or guarding a cache site is ecologically important. Our findings indicate that forest management strategies contribute to both prey abundance and enhanced stalking cover for mountain lions (Table 2).

Van Dyke et al. (1986) concluded that resident lions avoided portions of their home ranges with active logging activity, and found that transient lions were the primary users of areas with active timber harvest, or even newly logged areas. By contrast, Gagliuso (1991) found in southwestern Oregon that lions did not avoid timber harvest sites but rather were closer to these activities than expected at random. We observed a similar attraction to new logging, which we believed was related to the abundant "candy food" made newly available to deer and elk by logging that brought branches laden with lichen and mosses down to ground level. Once this resource was exhausted, deer and elk quit using these sites, as did hunting lions. We concluded from track evidence made in snow during winter, or dust during summer, that lions were using newly logged areas at night. Nocturnal movement patterns, in association with sub-optimal habitat cover, was also documented by Beier (1995) in California and Van Dyke et al. (1986) in Utah where they documented mountain lions using the most undisturbed habitats in their home ranges for diurnal localization. Our findings concur with these authors. On a micro-habitat scale, our findings also show the importance of specific features, such as forested rimrock and downed logs for diurnal bed sites, understory density for hunting and stalking cover, and canopy cover for kill cache sites.

The documentation of micro-habitat use is essential in understanding mountain lion daily adaptation to multiple environmental influences and disturbances. The use of specific habitat types by lions is largely dependent on the activity of the individual. A cougar that is bedding for the day selects a location that offers both concealment and nearby escape terrain, as indicated in our study by a strong selection for forested rimrock structure with a component of downed logs. Whereas a lion that is hunting is going to use areas preferred by prey species that also afford stalking concealment, usually in the form of understory vegetation or other close to the ground structure. Then, once the kill has been made, there is typically an effort made by the lion to cache the kill under a tree or brush, presumably to reduce detection by avian scavengers.

## MANAGEMENT IMPLICATIONS

Our findings on mountain lion habitat use have implications to both wildlife and habitat managers. There are many complex variables influencing mountain lion habitat use in different regions and levels of human influence. Several factors influence the way in which lions use their environment, or conduct "land tenure" as described by John Seidensticker (1973). Obtaining food, establishing and defending territories, breeding, reproducing, and raising kittens to dispersal age all have a bearing on how mountain lions use a given landscape. In comparing findings from this study with other studies, it appears that factors vary from region to region. However, habitat use seems to be driven by three ecological needs: security, cover, and food.

The mountain lions that we studied have co-existed with timber harvest for several lion generations. The literature suggests that lions will still use habitats that have been logged as long as the harvest areas are <100 acres in size (Van Dyke et al. 1986, Gagliuso 1991). Leaving strips of trees for buffers, in conjunction with small harvest units, creates an extensive habitat edge effect beneficial to mountain lions. Other important features are vegetative cover around rock structure for bedding security, downed logs, and ample understory density to allow for successful stalking. All of the diurnal bed-sites occurring in rimrock had either brush or trees at the bed. We did not document bed-use in newly logged areas or in rock structure without some form of vegetative cover. A timber management practice that leaves a forested buffer around rock structure is advantageous for mountain lion security. The size of the buffer would vary with vegetation type and density, but generally a 50-meter buffer would afford concealment for lions in our study area. We did not find a significant aversion to roads in the Catherine Creek study area, but our methods may not have effectively addressed this issue since most of our data was gathered in or near a Boise Cascade Corporation road closure area. The two primary land managers, the US Forest Service and Boise Cascade Corporation, have implemented travel management plans that vastly reduce human disturbance through established road closure areas. In general, our findings are more similar to results produced in southwest Oregon by Gagliuso (1991) than those described by Van Dyke et al. (1986) in Arizona and Utah. We feel these differences are due to mountain lions in Oregon having long-term exposure to logging, and the habitat having a quicker capability for regrowth with higher amounts of precipitation in two areas of Oregon than the more arid Southwest.

## SUMMARY

In conclusion, we have added more information to the pool of knowledge supporting the concept of mountain lions as an adaptable, yet vulnerable species. Logan and Sweanor (2001) emphasize the importance of gaining a better understanding of mountain lion habitat use through identifying critical habitats, landscape linkages, and by assessing how human development, resource extraction, and habitat modification can degrade or enhance these habitats. We have demonstrated the importance of small-scale physiographic features within the larger scale habitat complex. Scientific management of mountain lions depends on both wildlife managers and land managers understanding this species' requirements of security, cover, and food, and how obtaining these ecological needs varies between regions and physiographic and climatological situations and conditions.

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## LITERATURE CITED

ACKERMAN, B.B. 1982. Cougar predation and ecological energetics in southern Utah. Thesis, Utah State University, Logan, Utah, USA.

ANDERSON, A.E., D.C. BOWDEN, AND D.M. KATNER. 1992. The Puma on the Uncompahgre Plateau. Colorado Division of Wildlife. Tech. Pub. No. 40.

ANDERSON, E.M. 1990. Bobcat diurnal loafing sites in southeastern Colorado. Journal of Wildlife Management. 54:600-602.

AKENSON, J.J., M.G. HENJUM, AND T.J. CRADDOCK. 1996. Diurnal bedding habitat of mountain lions in northeast Oregon. Abstract *in* Fifth Mountain Lion Workshop, 27 February-1 March, 1996, San Diego, California.

BEIER, P. 1995. Dispersal of juvenile cougars in fragmented habitat. Journal of Wildlife Management. 59:228-237.

GAGLIUSO, R.A. 1991. Habitat alteration and human disturbance: their impact on cougar habitat utilization in southwest Oregon. Thesis, Oregon State University, Corvallis, Oregon, USA.

HORNOCKER, M.G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. Wildlife Monograph No. 21: 1-39.

_____. 1976. Cougars up close. National Wildlife. 14(6):42-47.

JOHNSON, C.G. AND S.A. SIMON.1987. Plant Associations of the Wallowa-Snake Province. U.S. Forest Service handbook No. R-6 ECOL-TP-225B-86.

LOGAN, K.A. AND L.L. IRWIN. 1985. Mountain lion habitats in the Bighorn Mountains, Wyoming. Wildlife Society Bulletin 13:257-262.

LOGAN, K.A. AND L.L. SWEANOR. 2001. Desert Puma, evolutionary ecology and conservation of an enduring carnivore. Island Press. Washington, D.C., USA.

NOWAK, M.C. 1999. Predation rates and foraging ecology of adult female mountain lions in northeastern Oregon. Thesis. Washington State University, Pullman, Washington, USA.

SEIDENSTICKER, J.C. IV, M.G. HORNOCKER, W.V. WILES AND J.P. MESSICK. 1973. Mountain lion social organization in the Idaho Primitive Area. Wildlife Monograph 35:1-60.

SEIDENSTICKER, J.C. IV. 1973. Mountain lion social organization in the Idaho Primitive Area. Dissertation, University of Idaho, Moscow, Idaho, USA.

VAN DYKE, F.G., R.H. BROCK, H.G. SHAW, B.B. ACKERMAN, T.P. HEMKER AND F.G. LINDZEY. 1986. Reactions of mountain lions to logging and human activity. Journal of Wildlife Management, 50:95-102.

YOUNG, S.P. 1946. History, life habits, economic status, and control, Part 1. Pages 1-173 *in* S.P. Young and E.A. Goldman, eds. The puma, mysterious American cat. The American Wildlife Institute, Washington, D.C. USA.

Akenson, J., M. Nowak, M. Henjum, and G. Witmer. 2003. Characteristics of mountain lion bed, cache, and kill sties in northeastern Oregon. Pp. 111-118 *IN:* S. Becker, D. Bjornlie, F. Linzey, and D. Moody, eds. Proceedings of the 7th Mountain Lion Workshop. Wyoming Game and Fish Department, Lander, WY.