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BLACK BEAR (URSUS AMERICANUS) AUTUMNAL USE OF FOOTHILLS RIPARIAN HABITATS ON CITY OF BOULDER MOUNTAIN PARKS AND OPEN SPACE LANDS

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ABSTRACT. —This study investigated, for the third consecutive year, the use of foothills riparian habitats by black bear (Ursus americanus), as fall foraging areas. We surveyed 30 riparian drainage segments for bear scat and examined and recorded scat contents. We noted general abundance of shrub and tree species, but made the assumption that this variable remains fairly constant from the 1996-1997 studies. We recorded approximately 174 scats in the riparian segments, the majority of which contained fruit remains (seeds, skins or fruit). Much of the fruit remains recorded were apple (Pyrus malus). Also abundant in remains of scat sampled were chokecherry (Prunus virginiana, 35.6%), hawthorne (Crataegus spec. 17.8%), and wayfaring (Viburnum lantara, 16.1%). Scat density was positively correlated with an abundance of fruiting tree and shrub species. As in the 1996 and 1997 studies, we used Spearman rank correlations to examine

association between variables. Scat density related to elevation was also recorded. Lower elevation riparian foothills areas apparently represent important fall foraging habitats for black bears.

The purpose of this study was to continue the studies of Berry, M. 1996, and Merkle, W. 1997, investigating the autumnal use of foothills riparian habitats by black bears. Specifically we continue to hypothesize that bear use will be higher in drainage segments with higher abundance of fruiting trees and shrubs. Fall is a critical foraging period for black bear (Ursus americansus) as they must increase their body fat to survive winter hibernation (Pelton, 1982). In the fall, riparian habitats with abundant fruit production are preferred foraging sites for black bear because these fruits provide the sugar, starch and fat resources needed by the bears for hibernation (Gill and Beck 1990).

Even though black bears are commonly observed in low elevation riparian drainages, they are secretive and difficult to observe consistently for census. Because of the difficulty with direct observation and the variety of vegetation in these drainages, bear scat was used as a means of quantifying relative bear use of riparian habitats. Bear scat can also be identified and located with relative ease. Black bear tend to rest and forage in the same habitats. Direct field observation from the past two years of this study, specifically related to age of scat, indicates that bears tend to defecate in the same areas that they are foraging. It should also be noted that recreational trails exist in almost all of the drainages surveyed for scat. Although the black bear is highly adaptable and often tolerant of human disturbance, it does tend to avoid humans (Gill and Beck, 1990, Pelton, 1982). Intense human use may disturb and reduce bear use of these areas.

STUDY AREA

As in 1996 and 1997 studies (Berry, 1996 and Merkle, 1997) we conducted our study in the foothills drainages west of the city limits of Boulder. Boulder Creek is the north boundary and South Boulder Creek or Eldorado Canyon the south boundary of the study area. To be included in the study, drainages had to meet the criteria of exiting from the foothills to the east. Drainages were surveyed from their upper end or highest elevational point, approximately 2,195 meters to the point where they exited forest habitat and enter grassland, approximately 1,744 meters to 1,815 meters. The exception to this was Gregory Canyon, which continues into the city limits of Boulder and the boundary was where public and private land meet. The total length of drainages surveyed is approximately 21 kilometers. All distances and elevations noted are estimated from a 1:24,000 scale USGS topographic map.

METHODS

After obtaining the appropriate research permits from the City of Boulder land management agencies, each drainage was surveyed once between 4 October and 19 November 1998. We attempted to minimize observers bias by consulting with one of the past researchers Merkle, conducting a sample survey as a group in the field and reviewing dried study samples, prior to actual field inventory work. All drainages surveyed in 1996 and 1997 were included in this study (note: in 1997 only 18 segments were surveyed).

As in the past studies, drainages were divided into segments based on hydrology and topographic landmarks. The breadth, length and time spent in each segment were recorded. The presence of major recreational trails and social trails was noted, as were dominant trees and shrubs for each segment. The documentation of these last two variables by individual observers was incomplete and we assumed these variables were constant from 1996 and 1997 studies. We also used the index of fruit abundance by summing up the assigned ranks for each of the following species in each segment: hawthorn, plum, chokecherry, wayfaring tree, apple, mountain ash and buckthorn.

Each segment was surveyed for scat and some observers noted other signs of bear activity. Recording of observations of other bear sign was not consistent within our group of observers. Each scat located was recorded for age (fresh, moist, dry) and scat content (seeds, fruit, grass, hair, insect parts). When possible, fruits, hair, seeds and insects were identified to species.

As in 1996 and 1997, an index for bear use of drainages and the number of scats per kilometer (scat density) was calculated. Spearman rank correlations were used to determine relationships between segment elevational midpoint and abundance of shrub species, index of fruit abundance, scat density, width of riparian zone, and width of streambed respectively. We also investigated correlations between scat density and trail presence, prevalent shrub and tree species and fruit abundance index. Width of streambed and riparian zone were also compared to abundance of shrubs and trees.

RESULTS

This year's results were compared primarily with Mark Berry's results from 1996 with data from all 30 segments. In 1997 only 18 out of the 30 segments were surveyed. When appropriate, comparisons were also made with Merkle's 1997 results of 18 segments.

We assumed that no significant changes in abundance of shrub and tree species occurred (data was only verified randomly); therefore, we adopted Mark Berry's rankings from 1996, which were also used in 1997. We used the same index of fruit abundance by summing up the assigned ranks for each of the following species in each segment: hawthorn, plum, chokecherry, wayfaring tree, apple, mountain ash and buckthorn.

Segment elevational midpoint was, as in 1996 and 1997, negatively correlated with chokecherry (Rho = -0.46807, $p < 0.05$), skunkbrush (Rho = -0.67104, $p < 0.001$), hawthorn (Rho = -0.69789, $p < 0.0001$) and index of fruit abundance (Rho = -0.62217, $p < 0.005$). A positive correlation between segment elevational midpoint was found for river birch (Rho = 0.57007, $p < 0.001$), quaking aspen (Rho = 0.55917, $p < 0.05$), mountain apple (Rho = 0.42723, $p < 0.05$) and wax flower (Rho = 0.62869, $p < 0.001$).

Width of the riparian zone was positively correlated with scat density in both 1996 (Rho = 0.53058, $p < 0.005$) and 1998 (Rho = 0.58555, $p < 0.005$), but in 1997 this relationship was non-significant (Rho = -0.01787, $p = 0.9439$). Width of riparian zone also seems to be a factor influencing fruit abundance. A positive correlation was found between width of riparian zone and plum (Rho = 0.54165, $p < 0.005$), apple (Rho = 0.36041, $p < 0.055$, i.e. marginal significance), poplar (Rho = 0.42993, $p < 0.05$), box elder (Rho = 00.35712, $p < 0.005$), Chinese elm (Rho = 0.37535, $p < 0.05$) and index of fruit abundance (Rho = 0.44710, $p < 0.05$). The same positive correlation could be found for width of the stream bed as compared to scat density in 1996 and 1998 (1996: Rho = 0.57620, $p < 0.005$; 1998: Rho = 0.48906, $p < 0.05$), plum (Rho = 0.45311, $p < 0.005$), willow (Rho = 0.50632, $p < 0.01$), poplar (Rho = 0.63201, $p < 0.001$) and box elder (Rho

= 0.38469, $p < 0.05$). The correlation between fruit abundance index and width of the streambed was not significant (Rho = 0.33781, p = 0.0731).

In 1998 a total number of 174 scats was found in 30 segments, 42% fewer than in 1996 (1996: 302). Fruit contents were found in 165 of the 174 scats or 94.8% as compared to 99.3% in 1996 and 98.7% in 1997. In both 1996 and 1997 the fruit most abundant in scat was hawthorn (1996: 62.1%; 1997: 60.4%), whereas in 1998 apple was most abundant in scats (63.2%). Hawthorn was only found in 17.8% and chokecherry in 35.6% (second largest percentage) of the scats in 1998. Insect remains were found in 5.2%, hair in 4.0% and grass in 10.3%.

In this year's study we found most of the scat in Gregory (72), unlike in 1996 and 1997 where the majority was found in Skunk (89) and Bluebell (121) respectively (note: Gregory was not surveyed in 1997). Scat density was highest in Lower Skunk (101.6 scats/ km) in 1996, in Lower Big Bluestem (205.71 scats/ km) in 1997 and in Gregory (74.54 scat/ km) in 1998.

Not a single scat was found in all 3 years in Shadow #3 and #4, Bear Creek #3 and in Skunk #4 (note: Skunk was not surveyed in 1997). Scat number was equal to or less than 5 in 1996 and 1998 in Shadow #1-4, Upper Fern, in Bear Creek #3 and #4, in Bear Creek S. Spur, in Bluebell #2, in Skunk #4, in Saddle Rock, in Gregory #3, in Long #2 and #3 and in Panther. Considerably fewer scats were found in 1998 in Lower Big Bluestem (1996: 22; 1997: 144; 1998: 6), in Big Bluestem N. (1997:10; 1998: 0), in Lower Shanahan (1996: 6; 1998: 0), in Upper Shanahan (1996: 6; 1997: 9; 1998: 0) and in Bluebell #1 (1996: 81; 1997: 118; 1998: 15).

The number of scats found was higher in lower elevations as compared to higher elevations. Scat density was again, as in 1996 (Rho = -0.62, $p < 0.001$), negatively correlated with segment elevational midpoint in 1998 (Rho = -0.41125, $p < 0.05$). In 1996, 1997 and 1998 scat density was positively correlated with the fruit abundance index (1996: Rho = 0.0.63, $p < 0.001$; 1997: Rho = 0.54, $p < 0.005$; 1998: Rho = 0.60238, $p < 0.005$) and wayfaring tree (1996: Rho = 0.62, $p < 0.05$; 1997: Rho = 0.41, 0.05; 1998: Rho = 0.53023, $p < 0.005$). Plum was positively correlated with scat density in 1996 (Rho = 0.59, $p < 0.005$) and 1998 (Rho = 0.43466, $p < 0.05$). A positive correlation with scat density was furthermore found for buckthorn (Rho = 0.38400, $p < 0.05$), apple (Rho = 0.51662, $p < 0.005$) and box elder (Rho = 0.44092, $p < 0.05$). The positive correlation between scat density and hawthorn found both in 1996 (Rho = 0.51, $p < 0.01$) and 1997 (Rho = 0.60, $p < 0.05$) could not be verified in 1998 (Rho = 0.25920, $p = 0.1666$). Scat density was not significantly correlated with the presence of trails in 1996 (Rho = 0.15, $p = 0.41$), in 1997 (Rho = -0.27, $p = 0.26$) and in 1998 (Rho = -0.02636, $p = 0.8900$).

DISCUSSION

This year's results substantiate once more, as in 1996 and 1997, the importance of the Boulder foothills as a fall foraging area for bears. We assumed that there were no significant changes in the abundance of shrub and tree species from the 1996 and 1997 studies. Therefore, the data used was adopted from Mark Berry's rankings and fruit abundance index from 1996.

The segment elevational midpoint is negatively correlated with chokecherry, skunkbrush, hawthorn and index of fruit abundance. This shows that as the elevation increased, species of fruiting shrubs and trees decreased. As a consequence, less scat was found because there was less available food for the bears to forage on. This may be a direct correlation to the time bears spend in these riparian areas during the fall.

In 1996 and 1998, there was a positive correlation between the width of the riparian zone and the scat density. However, in 1997 there was no significance in the amount of scat compared to the width of the riparian zone. If in fact there is any significance in this correlation, then perhaps it is due to the steep topography that is common in most of the more narrow, upper riparian zones. For example, in Shadow #3 and #4, the riparian zone is very narrow. In both of these transects, there was no bear scat found. This is also consistent with the lack of a single scat found in Shadow #3, #4, Bear Creek #3 and Skunk #4 in 1996, 1997, and 1998 (note: Skunk was not surveyed in 1997). In future studies it may be beneficial to not include these particular segments, since other drainages that were not looked at may give more insight into the use of foothills riparian habitats. Another option may be to survey the transects between our drainages, as bears do not only move east-west, but also north-south.

The width of the riparian zone seems to be a factor in influencing fruit abundance. Low abundance of fruit might again be due to the steep incline within some of the more narrow transects. Since these transects are much more narrow and steep, they are more likely to have limited availability of sun light, and less productive soil profiles. In 1996 and in 1998 the width of the streambed was a positively correlated with scat density. This may be a result of a correlation between the width of the streambed and soil moisture. When the streambeds are at their widest points, there may be more water and soil available that can support more fruiting tree and shrub species. The fruiting trees and shrubs may support an increased number of foraging bears, resulting in an increased number of scats.

In our 1998 fieldwork, we located a total of 174 scats in 30 segments. This number is significantly lower than previous years (302 scats in 1996). In 1996 and 1997 there were significantly more bears scats found in Lower Big Bluestem, Big Bluestem N., Lower Shanahan, Upper Shanahan and in Bluebell #1. The lower number of scats found this year could be attributed to some of the following: 1) the field work continued until 19 November, which is about three weeks later than the previous years, 2) snow cover may have prevented an accurate scat number count, 3) dense leaf cover from deciduous trees and shrubs may have also affected ability to visually observe scat, 4) the fruit abundance available for foraging may have decreased in our transects, and 5) there were possible inconsistencies in data collection between four individuals .

In the future, we recommend making the following changes in the sampling procedures for this study to improve consistency in data collection: 1) earlier collection of data (starting in late September and ending before November, 2) more standardized sampling, and 3) marking the beginning and the ending points of the segments in the field to assist researchers in locating the transects. In addition to improving the methods of this study consideration should be given to looking at the bear's role as a seed disperser. The Boulder foothills provide an important fall foraging area for bears and in return the bears may also have a significant impact on the vegetation through seed dispersal and thus may contribute to the persistence of this vital bear habitat.

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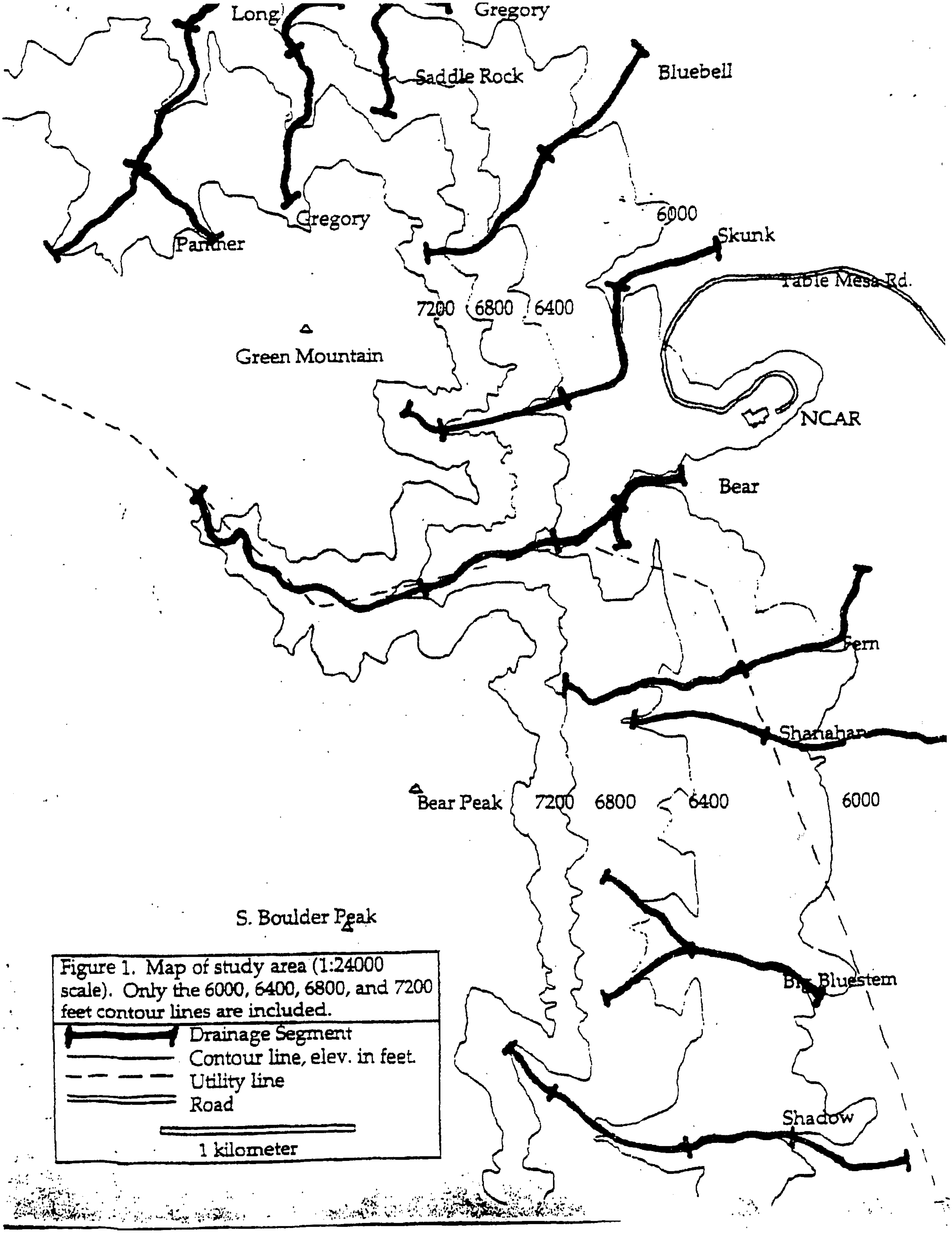

Figure 1. Map of study area (1:24000 scale). Only the 6000, 6400, 6800, and 7200 feet contour lines are included.