The Effects of Edges on Grizzly Bear Habitat Selection

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Abstract

Understanding grizzly bear (Ursus arctos) habitat selection is critical for managing threatened populations. The goal of this paper is to develop a better understanding of grizzly bear habitat use through a comparison of grizzly bear location data with landscape edge inventories. We utilized GPS telemetry data from 26 grizzly bears from 2005-2009 in the foothills of the Rocky Mountains in west-central Alberta. The locations were compared to a series of landscape transitions extracted from landcover data, and linear features, such as streams, roads, and pipelines. Results show variation between seasons and sexes in edge distance, selection, and density. Wetland edges comprise a small proportion of the study area (< 2%) but females select edges of this type up to 7% of the time, with little variation between seasons. Roads are selected for by females, but avoided by males, and hydrocarbon pipelines show similar results to roads, indicating these are also important grizzly bear edges. Seasonal differences indicate that females and males select for edges more in the fall, due to changes in feeding and security, or as a result of contracting home range following the mating season. These results indicate that while managing for anthropogenic disturbances in grizzly bear habitat is of utmost concern, understanding bears' reactions to natural transitions can provide new management opportunities not related to resource extraction activities. Specific focus should be paid to maintaining wetlands, as these areas are selected by grizzly bears, but they comprise a very small part of the study area.

Background

Grizzly bears require diverse habitats due to their seasonal diets (Nielsen et al. 2004a), and their diurnal feeding patterns (Klinka and Reimchen 2002). Much of this food can be found at transitions between homogenous landcover types. Natural and anthropogenic transitions provide important food sources not always available in either adjacent patch (Fortin et al. 2001). As such, grizzly bear habitat selection can be viewed as the selection for, and avoidance of edges, where edges are the boundaries separating distinct habitat patches (Ries et al., 2004), and can be either natural landscape features or anthropogenic disturbances.

Edges play an important role in ecosystem dynamics as they alter the flow of energy, materials, and organisms, which, in turn, alters the community structure at edges (Ries et al. 2004). Edge community structure can increase mortality, when it exposes species

to increased predation (Gardner, 1998) or parasitism (Murcis, 1995), or improve conditions when it provides access to complimentary habitat patches in close proximity (Nielsen 2004a; 2004b). Edges can come in many forms, such as natural transitions between a forest and meadow, or as anthropogenic disturbances, such as roads and hydrocarbon developments.

The goal of this project is to quantify grizzly bear use of edge habitat; both natural and anthropogenic. There are three main objectives for accomplishing this goal. 1) To quantify edge density in available grizzly bear habitat (available being defined as area inside a bear's home range). 2) To quantify the frequency of bear edge use, and the distance of that use. 3) To statistically evaluate if the frequency and distance of observed bear locations to nearest edge types is unexpected relative to random (where random is conditionalized on factors known to impact grizzly bear habitat selection). These goals will be evaluated based on seasons and sex.

Methods and Data

Numerous edges were extracted for comparison to grizzly bear telemetry data. Landcover transitions were extracted following Wulder et al. (2010). The final transitions used were shrub-conifer, shrub-broadleaf, shrub-mixed, and wetland-forest (all three forest classes were grouped together for wetland edges). As well, vector datasets for roads, streams, and pipelines were obtained from the Foohills Research Institute (http://foothillsresearchinstitute.ca).

A 95% by volume isopleth of a kernel density estimation was used for home range deliniation, as this is a method widely used in habitat analysis (Seaman and Powell 1996). For each season, individual grizzly bear home ranges were calculated. Bandwidths were calculated using direct least-squares cross validation, with a Gaussian kernel (Ruppert, Sheather, and Wand 1995). Total length of each edge type in each home range was compared to the area of the home range to create an edge density in m / km2. These densities were tabulated for season and sex, and boxplots were created to compare edge density.

For all telemetry data, distance to nearest edge was calculated, and the edge type was stored. The nearest edge was considered 'used', and frequency of use, and average distance to nearest edge was calculated for each edge type. The values were compared to randomized points created though a conditionalized randomization, based on a resource selection function (RSF). The RSF evaluates third-order habitat selection for grizzly bears based on a series of underlying landcover datasets. The RSF explicitly removes edges from its calculation, so it accounts for all non-edge biological phenomena. The observed distance to edge and frequency of selection was compared to the expected (from the randomized points) to determine significant differences between sexes and between seasons.

Results

Females use habitats with a higher density of pipelines and roads than males. The difference between genders is significant at $\alpha = 0.05$ for spring and fall for pipelines, and

spring and summer for roads. Anthropogenic edges less common in grizzly bear home ranges than shrub-conifer edges, which are the most common in every season for both sexes, with females having significantly higher density in the spring. The wetland transitions appear to be much less common than any of the other transitions in bear home ranges, but this reflects the relative frequency of wetlands in the study area (~2%). Females are also found significantly closer to streams in the spring than males.

The analysis of distance to edge and frequency of edge selection shows a number of interesting results. Females select for wetlands more than expected, selecting edges 5.38%, 6.71%, and 3.93% for spring, summer, and fall respectively, where as wetland edges makeup only 0.74% of edges in their habitat. Males select for shrub-conifer transitions more than expected in the fall, using these edges 46.41% of the time, while the edge makes up only 34.5% of the habitat; conversely females use this transition approximately as expected throughout the year. Males select for the shrub-mixed transition more than available in every season at 10.53%, 11.16%, and 10.16% in the spring, summer, and fall compared to an availability of 6.65%. Males are found close to the shrub-broad transition often in the spring (21.48%), but that selection decreases throughout the year (11.48% in the summer, and 8.3% in the fall). Males select for streams only in the summer (36.38% versus 27.82% availability). Females appear to select for anthropogenic edges (pipelines and roads), whereas males avoid them in all seasons.

Discussion and Conclusion

Our results follow recent studies in this area that show females select for roads more than males (Roever, 2008a), as females are found closer to roads, more frequently than expected, and in areas with higher road density. A corollary to this is the selection of pipelines by female grizzly bears. Nielsen et al. (2006) used pipelines in an analysis of grizzly bear habitat and defined these as low impact human-access corridors; lower impact than either established roads or logging roads. Our results indicate that pipelines follow similar trends as roads, with females being closer than males and closer than expected.

The identification of edges as key grizzly bear habitat extends beyond anthropogenic disturbances. Whereas many studies have focused on grizzly bear attraction to anthropogenic disturbances, our work highlights natural edges as well. It is established in other species that there is variation in edge effects between natural and anthropogenic edges, but this has not been well investigated in grizzly bears. Our results show that natural transitions have substantial variation in selection by season. Females select for wetland edges much more than available. Despite the fact that these edges are uncommon in our study area (<2% of landcover), females use them up to 7% of the time in the spring. This could be due to important food resources, such as Heracleum lanatum, which grows in low lying, wet areas (Servheen, 1983). The importance of these wetland areas for females compared to their frequency makes these important areas for management considerations. Males are found near broadleaf edges more than females, and more than expected; however this selection decreases significantly from spring to fall. This could be due to variation in diet, as males feed more on ungulate than females,

or it could be due to mate selection, as males travel widely in search of females in the spring.

Current forest management regimes in the foothills of the Rocky Mountains focus on limiting road density (Roever 2008a; 2008b) and maintaining consistency in forest harvest industries, with small cuts in a patchwork of forest and harvest (Nielsen 2004a; 2004b). While both of these are essential to managing grizzly bear habitat, maintaining a balance of natural landcover, and natural landcover transitions should also be considered when designing management plans. Forest harvests create important edges for grizzly bear habitat, as these clearings are surrogates for natural clearings containing important food stuffs (Nielsen 2004b). Anthropogenic edges cannot, however, replace the resources derived from natural transitions. Maintaining a balance between natural and anthropogenic edges, and focusing on retaining equal percentages of all landcover should be priorities in managing grizzly bear habitat in this area.

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