DOCUMENTING GRIZZLY BEAR HIGHWAY CROSSING PATTERNS USING GPS TECHNOLOGY

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Introduction

Grizzly bears currently occur in only 5 isolated populations: the Yellowstone Ecosystem of Idaho, Montana, and Wyoming; the Northern Continental Divide Ecosystem (NCDE) of Montana; the Cabinet/Yaak Ecosystem of Montana; the Selkirks Ecosystem on northern Idaho; and the Northern Cascades Ecosystem of Washington (Servheen 1990). The extent of grizzly bear movement between these ecosystems is unknown, but may be nonexistent; no movement between ecosystems has been documented (Kasworm et al. 1998). Linkage between these populations is important to maintain genetic diversity within each population and to lesson the impacts of demographic and environmental stochasticity (Wilcox 1980). The consequences of reduced population size, isolation, and subsequent inbreeding and demographic vulnerability have been widely discussed in the scientific literature (Wright 1931, Soule 1980, Gilpin and Soule 1986, Lande 1988, Mills and Smouse 1994, Lande 1995). Grizzly bears are especially vulnerable to these effects because of their low reproductive rate and limited dispersal capabilities (Allendorf et al. 1991).

Habitat fragmentation is the separation of previously continuous blocks of habitat into one or more disconnected pieces (Forman 1995). Human transportation corridors and their associated developments can cause fragmentation of the habitats of many different species (Garland and Bradley 1984). Maintaining Alinkage zones@ between habitat patches may partially offset the negative effects of fragmentation (Noss 1987). Linkage zones are usually linear habitats that connect two or more larger blocks of suitable habitat across areas of unsuitable habitat. Conserving linkage zones benefits species if they foster connectivity between patches of suitable habitat. Currently, there is little empirical evidence for the conservation value of linkage zones, especially for those species most likely to benefit from the existence of such zones (Simberloff and Cox 1987, Simberloff et al. 1992). Beir and Noss (1998) described the difficulties conducting replicated, randomized studies of movement through linkage zones at landscape scales, but suggested that valuable information can be obtained by using well designed observational studies. The first step is to understand actual animal movement patterns within and between patches and linkage zones.

As stated earlier, human developments have nearly completely fragmented remaining grizzly bear habitat into 5 separate populations. These remaining 5 populations are bisected by transportation corridors and thus are threatened with further fragmentation. Developing techniques and procedures to prevent fragmentation requires studying grizzly bear movement patterns in areas of Aincipient fragmentation@. That is, areas where corridor development has not yet prohibited all animal crossing. Furthermore, there must be sufficient numbers of animals crossing the corridor, on numerous occasions, to provide suitable sample sizes for statistical inference. The U.S. Highway 2 corridor, between Glacier National Park and the Bob Marshall Wilderness, is such an area. Servheen et al. (1998) proposed a research framework to understand grizzly bear highway crossings in this area with the purpose of formulating predictive models with broad applicability. This paper summarizes the progress of this research effort.

The specific objective of this project is to understand grizzly bear movement patterns across U.S. Highway 2 in relation to terrain, habitat, and highway features including highway design and traffic patterns. Specific research questions include: (1) Do resident grizzly bears utilize specific crossing areas to traverse US 2, or do they cross at random locations? (2) If crossings do occur repeatedly at specific locations, do these locations differ from non-crossing areas in a measurable way? (3) Are there temporal patterns to crossings? If so, are they related to patterns in highway or railroad traffic levels? (4) Are resident grizzly bears actively avoiding areas near the highway or corridor? That is, are their movements biased away from the highway? If so, what is the nature and extent of this bias, and does the bias result in displacement from preferred foraging sites?

Study Area

U.S. Highway 2 is the only high-speed highway bisecting the U.S. portion of the NCDE. It is a 2-lane highway separating Glacier National Park to the north from the Bob Marshall Wilderness complex to the south. Our study area contains 24 miles of US Highway 2 between Essex, Montana to the west and the Blackfeet Indian Reservation boundary to the east. The western portion of the highway study area lies in the valley bottom of the Middle Fork of the Flathead River to its confluence with Bear Creek. Here the highway continues to follow the Bear Creek valley in a northeasterly direction until it rises to cross the Continental Divide at Marias Pass (elevation 5282 ft). East of Marias Pass, the highway drops into the prairie biome, paralleling the Two-Medicine River to the western boundary of the Blackfeet Indian Reservation. A major railroad line parallels the highway for its entire length. This railroad line is a primary freight corridor between Minneapolis and Seattle. It is also the primary means of transporting grains from eastern Montana and North Dakota to markets on the west coast. Railroad traffic was reported to be approximately 1 train/hour (L. Ross pers. comm.). Trains have been, and continue to be, a significant source of grizzly bear mortality. Grizzly bears have been attracted to the tracks by grain spilled during train derailments and during normal operations. On average, 2 grizzly bears per year are killed along this railroad segment.

Small concentrations of seasonal home sites, businesses, ranches, and small communities exist within the highway corridor, but the majority of the area is undeveloped. Significant numbers of grizzly bears are presumed to cross the highway because it lies in an area with a high density of grizzly bears (T. Manley, MFWP, pers. comm.).

US Highway 2 is the northernmost US highway that crosses the Continental Divide. 1996 and 1997 Montana Department of Transportation traffic counter data collected at Marias Pass showed average daily traffic volumes of 1465 and 1405 vehicles per day respectively. Posted speed limits were 55 mph in 1996 and 1997, a Areasonable and prudent@ speed rule was in effect during 1998, and is currently posted 75 mph.

Associated roadway topography varies from flat, valley bottom to steep mountainside. Dominant vegetation is primarily coniferous forest in the western portions of the study area, with open grass/ forb/aspen communities in the eastern portions. Riparian areas associated with the Middle Fork Flathead River and Bear Creek parallel the highway for much of its length within the study area. Avalanche chutes, preferred grizzly bear foraging area (Waller and Mace 1997), occur in numerous locations, often close to the highway.

Most of eastern Montana lies within a climatic transition zone between Pacific Maritime dominated climates west of the Continental Divide and continental dominated climates east of the Divide. This transition is most abrupt along the eastern front of the Rocky Mountains, a portion of which lies within the study area. The collision of these 2 climatic regimes results in unsettled weather conditions during much of the year. Snowfalls are heavy and persistent west of the Divide, but less so east of the Divide. Temperatures can vary from B40 f. during winter to over 100 f. during summer east of the divide, but are moderated by Pacific Maritime weather patterns west of the Divide (Alwin 1993).

Methods

Grizzly bears were trapped in the study area using Aldrich snares at baited trap sites following standard procedures (Johnson and Pelton 1980, Jonkel 1993). Trap sites were placed equidistantly along the highway, as access allowed, to obtain a representative sample of the corridor population. Perpendicular distance of the trap sites from the highway ranged from 500 m to 5 km. During 1998, captured female and sub-adult male grizzly bears were fitted with VHF radio collars to identify those individuals that crossed Highway 2 and ascertain the extent of trans-highway movements. In 1999, efforts were made to recapture these previously marked bears and fit them with GPS collars. Both VHF and GPS collars were located twice per week from fixed-wing aircraft.

We used Telonics Generation II GPS collars programmed to obtain fixes every hour, 24 hours per day. The manufacturer advertised 15 m accuracy when differentially corrected. Due to the extreme demands placed on the battery by a 1-hour relocation interval, all fixes are stored in the collar. The collars are equipped with an automatic disconnect device programmed to release the collar on a predetermined date. After the collars drop off, they can be retrieved and downloaded to a computer. The battery life of the GPS unit is conservatively estimated to be 90 days. The collar also has a VHF transmitter with a 1-year battery life. The GPS collars weighed 2100 g, therefore only bears weighing at least 90 kg were fitted with GPS collars.

We felt that a 1-hour relocation interval was the best compromise between battery life and spatial and temporal resolution. The closer the relocation interval, the more precisely we can measure highway crossing events. Each highway crossing will be analyzed relative to the highway and associated environmental features using a computerized geographic information system (GIS). Features include topography (slope, aspect, elevation), vegetation (riparian areas, tree density, security cover), human developments (houses, trails, camp grounds, and secondary roads), and highway design features (width, perpendicular and horizontal sight distance). Thematic mapper satellite imagery (30m resolution) and digital orthographic photographs (1m resolution) will be used to map vegetation and development features.

The fine-scale movement data we obtain will also be used to validate 2 models developed during previous research efforts. The first is the Linkage Zone Prediction (LZP) model (Sandstrom 1993), developed to predict where grizzly bears are most likely to cross developed areas, and the second is the Cumulative Effects (CEM) Model (Waller 1998), developed to quantify the effects of development on grizzly habitat at landscape scales..

Grizzly bear movements will also be evaluated relative to hourly highway and railroad traffic. Directional traffic counters are located near each end of the study area. These counters tabulate the number of east and westbound vehicles crossing them every hour. We have access to Burlington-Northern dial-up train counters, also located near either end of the study area. These counters record the speed, number of cars, time, and direction of travel for each train crossing the counter sensor.

Results

Nine individual grizzly bears were captured during the 1998 spring (4 June B 24 June) trapping session (3 adult females, 4 adult males, 1 sub-adult male and 1 sub-adult female). We collected 208 radio relocations during subsequent telemetry flights and documented 44 instances where the radio-collared grizzly bears crossed U.S. Highway 2. Most of the crossings (42/44) were by 5 of the 9 bears. These 5 bears (the 3 adult females and 2 sub-adults) remained in the highway corridor during the remainder of their active season. Their 1998 95% adaptive kernel home range polygons were centered over the highway corridor. Two of the adult males left the study area and shed their collars. The remaining 2 adult males moved south into the Bob Marshall Wilderness.

In May 1999, prior to the spring 1999 trapping session, female grizzly #11 (one of the adult females radio-collared in 1998) was struck and killed by a train at the Java Cr. trestle. Anecdotal reports suggest that this trestle is frequently used by grizzlies to cross the Middle Fork Flathead River. Several other grizzly bears have been killed on or near this trestle in recent years.

During the spring 1999 trapping session (7 June B 1 July) we captured 11 individual grizzly bears (2 adult females, 3 adult males, 3 sub-adult females, 3 sub-adult males). The 2 adult females and 1 sub-adult female were fitted with GPS collars. The remaining bears were not collared. None of the 4 remaining previously marked grizzly bears were recaptured.

Between March and September, 1999, we collected an additional 113 aerial telemetry locations on the previously marked bears, and the 3 bears fitted with GPS collars. We documented an additional 18 crossings of US Highway 2, 2 less than for the same period in 1998. This can be attributed to the death of bear number 11 in May. We did not detect any highway crossings by the 3 bears with GPS collars, however all the radio-marked bears, including those with GPS, continue to live within home ranges that include portions of US Highway 2.

The traffic counters have been functioning well, and as of September 1st, 1999, we have collected over 1800 hours of traffic data. Access to the train counters is occasionally hampered by poor telephone communications, but we have successfully downloaded 1032 hours of train counts from the Pinnacle counter, located at the western end of the study area, and 624 hours of train counts from the Bison counter, located at the eastern end of the study area.

Plans for Continuing Research

Efforts to recapture those bears equipped with VHF collars will continue during spring 2000, the last field year for this research. Twice per week aerial telemetry flights will continue through year 2000. We will continue monitoring vehicle and train traffic during the bear=s active seasons. During year 2000, we will begin analysis of the GPS collar data collected during 1999. Also, we will begin compilation and preliminary analysis of traffic data. Refinement of relevant GIS data layers will continue. Final data analysis and presentation of results will occur in 2001.

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