Documentation of methods to establish and calculate density of motorized roads or routes to achieve the desired conditions for grizzly bears

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Numerous studies using various methods have documented that excessive road density in grizzly bear habitat affects behavior and habitat use and lowers their survival rate during the non-denning season (Boulanger & Stenhouse, 2014; D. J. Mattson, Herrero, Wright, & Pease, 1996; David J. Mattson, Knight, & Blanchard, 1987; Bruce N. McLellan & Shackleton, 1988; B. N. McLellan & Shackleton, 1989; Waller & Mace, 1997). Here we document the methods that we used to describe and calculate the density of motorized roads or routes and to evaluate the effects on grizzly bears on National Forest System lands in the Northern Continental Divide Ecosystem (NCDE).

Background: Draft NCDE Grizzly Bear Conservation Strategy

The draft NCDE grizzly bear conservation strategy (USFWS, 2013) identifies a Primary Conservation Area and three additional management zones (Zone 1, Zone 2, and Zone 3), as well as two Demographic Connectivity Areas within zone 1. These are adopted in the action alternatives for the Flathead National Forest revised forest plan and amendments of the Helena, Kootenai, Lolo, Lewis & Clark forest plans. There are varying levels of habitat protections applicable to these management zones, depending on their relative importance to the NCDE grizzly bear population. The overall goal of habitat management on public lands is to maintain conditions compatible with a stable to increasing grizzly bear population in the NCDE.

The primary conservation area (which is the same as the NCDE recovery zone) is designed to serve as a source area for grizzly bears. Survival and productivity of adult female grizzly bears within the primary conservation area is key to sustaining or increasing the bear population.

In comparison, the objective for zone 1 is continual occupancy by grizzly bears but at expected lower densities than inside the primary conservation area. The intent for the demographic connectivity areas is to support occupancy by female grizzly bears and potential dispersal to the Cabinet-Yaak and Bitterroot ecosystems.

The management emphasis in zone 2 is on conflict prevention and response.

Terminology: Roads vs. Routes

The term motorized “routes” is used to encompass both roads and trails that receive motorized use. The effects of motorized trails on grizzly bears were not part of the Swan Mountain Range study and have not been well studied.

High-Intensity Use Non-Motorized Trails

In 1994 and 1998, the Interagency Grizzly Bear Committee chartered a task force to creating standard definitions and procedures for managing motorized access in grizzly bear recovery zones. At that time, the task force recommended that the impacts of “high intensity use” non-motorized trails be considered in calculations of “core” habitat (IGBC, 1998, p. 4). Because there were no data or literature available to determine what the threshold number of parties was that defined a “high intensity use” trail or how this number may relate to grizzly bear population parameters, the threshold value was determined by a panel of experts. The panel recommended that trails receiving > 20 parties per week for at least one month

during the non-denning season be considered “high intensity use” non-motorized trails for the purposed of identifying core habitat. National Forests in the NCDE have used this definition since 1995.

However, while several studies have documented displacement of individual grizzly bears in response to non-motorized trail use (Jope, 1985; Kasworm & Manley, 1990; Mace & Waller, 1996; B. N. McLellan & Shackleton, 1989; Schallenberger & Jonkel, 1980; White, Kendall, & Picton, 1999), none of these studies demonstrated increased mortality risk or population-level impacts associated with non-motorized trails. Because of the lack of scientific literature documenting population-level impacts, the subjective method of establishing the threshold value of 20 parties per week, and the lack of objective data to quantify non-motorized use levels, the NCDE conservation strategy team recommended removing consideration of high intensity use non-motorized trails to define core habitat. To avoid confusion, the draft conservation strategy uses the term “secure core” with the revised definition. We have adopted the same terminology and definition in developing the action alternatives for the forest plan revision/amendments. The qualitative effects of non-motorized trails on grizzly bears are discussed for all alternatives in the biological assessments and final environmental impact statements.

Route Density in the Primary Conservation Area – Moving Window Analysis Method

A moving-window analysis was used for establishing plan components and analyzing effects of motorized use in the recovery zone/primary conservation area, but a different method for establishing plan components and analyzing the effects of motorized use was selected for zone 1 (including the demographic connectivity areas) in recognition of the differing grizzly bear management objectives for each zone. , in recognition of the differing grizzly bear management objectives for the demographic connectivity areas and Zone 1.

For the recovery zone/primary conservation area, research findings from the Swan Mountain Range of the Flathead National Forest have been used to evaluate the effects of motorized route density on grizzly bears in the NCDE. Mace et al. (1996) converted a linear road map to a total road density map using a 1 km^2 (0.39 mi^2) moving window analysis, and reported the following relationships to road density:

- Road density was lower within the composite of the multiannual home ranges of 14 adult and subadult female grizzly bears (1.1 km/km^2 or 0.95 mi/mi^2) than was road density outside the composite home range (1.1 km/km^2 or 1.7 mi/mi^2);
- As total road density increased, probability of selection by grizzly bears declined;
- Fifty-six percent of the composite female home range was unroaded, compared to 30 percent outside the composite home range;
- Within seasonal ranges, grizzly bears were more likely to use areas with higher road densities during spring than during other seasons;
- Selection for habitats within a 0.5 km buffer around roads decreased as traffic volume increased.

Based on these and related findings, Flathead National Forest Plan amendment 19 established limits for total motorized route density (no more than 19 percent with density exceeding 2 mi/mi^2), open motorized route density (no more than 19 percent with density exceeding 1 mi/mi^2), and secure core (at least 68 percent) within each bear management unit subunit that has more than 75 percent National Forest System lands. In bear management unit subunits with less than 75 percent National Forest System lands, no net increase in total motorized route density (the percent of area with more than 2 mi/mi^2) or open motorized route density (the percent of area with more than 1 mi/mi^2) was allowed, and no net decrease in the percentage of secure core in a subunit was allowed.

The moving window analysis method has been used to evaluate the effects of motorized route density on grizzly bears across the NCDE since 1995. Under the alternatives being considered for the Flathead Forest Plan revision and the amendments of the Helena, Kootenai, Lewis and Clark, and Lolo National Forests, this method would continue to be used to calculate motorized route density and to assess the effects on grizzly bears in the recovery zone/primary conservation area.

Road Density in the Demographic Connectivity Areas and Zone 1 – Linear Density Analysis

Instead of a moving window analysis, the linear density of roads or routes open to public motorized use was applied. The evaluation of effects of linear density on grizzly bears was based on research by Boulanger and Stenhouse (2014). This research is the best available science on the effects of roads on grizzly bears of different sex and age classes (C. Servheen, USFWS, pers. comm. to R. Kuennen, 2015). Linear density is calculated by simply dividing the miles of roads (or roads and trails) by the acres of land in a defined area.

Boulanger and Stenhouse studied 142 grizzly bears monitored in Alberta from 1999-2012. They found that sex and age class survival was related to road density. The roads in the Alberta study area were almost entirely (96.5%) gravel secondary roads associated with settlements and industrial resource extraction activities. In Alberta, for the most part, resource roads are all-weather gravel roads that are open for public use year round (Stenhouse & Boulanger, 2016). We believe all these roads would meet our definition of open for public use during the non-denning season. More recently there have been efforts at gating, but these have not yet formed part of Boulanger and Stenhouse's ongoing research. They are now looking at how effective these access control measures may be in terms of both human and grizzly bear behavior. There are very few motorized trails in the Alberta study area, but we assumed that the effects of motorized roads and motorized trails are similar, so the threshold values could be applied to analysis of motorized routes (roads and trails) in zone 1 and the demographic connectivity areas.

In the Alberta study, demographic modeling found strong spatial gradients in population trend based upon road density. Threshold values for road density needed to ensure population stability were estimated to refine targets for population recovery of grizzly bears in Alberta. A summary of the threshold values and how they were used in the FEIS analyses for the Revised Flathead National Forest Plan and Amendments is shown in table 1.

Table 1. A summary of the threshold values and their use in the FEIS analysis for the NCDE based on Boulanger and Stenhouse (2014).

Objective described in the Alberta study	Reported density km/km2	Converted to miles[1]	Where applied in the NCDE grizzly bear analysis
Grizzly bear presence – Distribution of collared bears shows most bears occurred within road densities of 1.5 km/km^2 or less (p. 10)	1.5 km/km^2	2.4 mi/mi^2	Used to evaluate the ability to provide for bear movement in the expanded grizzly bear distribution zone on the Helena National Forest (zones 1 and 2). Density calculation included both roads and trails open for motorized use in the non-denning season.
Occupancy by females –If lower survival rate of females with dependent young is considered, the threshold of road density that can be tolerated is reduced (p. 15)	1.25 km/km^2	2.0 mi/mi^2	Used to evaluate the ability of the Salish and Ninemile demographic connectivity areas to support female occupancy. Density calculation included both roads and trails open for motorized use in the non-denning season.
Grizzly bear mortality risk-	1.0 km/km^2	1.6 mi/mi^2	Used to evaluate grizzly bear mortality risk in the Salish and Ninemile demographic

Objective described in the Alberta study	Reported density km/km2	Converted to miles[1]	Where applied in the NCDE grizzly bear analysis
Most grizzly bear mortalities occurred at road densities greater than 1.6 mi/mi^2 , except for adult males where mortalities occurred across all road densities (p.10)			connectivity areas. Density calculation included both roads and trails open for public motorized use in the non-denning season on NFS lands.
Alberta core conservation area – Allows for survival rates of females with dependent offspring high enough to ensure an increasing population (p. 18)	0.75 km/km^2	1.2 mi/mi^2	N/A [see moving window analysis method in the primary conservation area]

[1] Formula: 1 km = 0.6214 mi; km^2 = 0.3861 mi^2

The authors explained their results suggested that the threshold of road density where population rate of change became negative depended heavily on assumptions about the effect of road density on adult female survival. If adult female survival was reduced for all adult females regardless of reproductive state, then the lambda value of l for population trend was reduced below 1 with a corresponding [open] road density of 1.25 [km/sq. km = 2.0 mi/sq. mi.]. If females with cubs/yearlings had reduced survival then l was reduced to below 1 at [open] road densities of 0.75 [km/sq. km = 1.2 mi/sq. mi.]. Therefore, considering reproductive-state specific survival lowered the threshold road density associated with a stable population trend (lambda = 1).

Boulanger and Stenhouse (2014, pp. 17-18) discussed several of the assumptions and limitations of their model. The model did not differentiate between gravel roads vs. paved roads or consider traffic volume, although these factors may influence bear behavior, fragmentation effects and mortality risk. The model also did not consider possible increases in reproductive rate due to habitat quality increases caused by vegetation management in some areas. The mechanism for the lower survival rates of females with cubs and yearlings as compared to females with two-year olds or no cubs is unknown. Nevertheless, the analysis showed that sex and age class survival was related to overall road density.

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