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Efficacy of road removal for restoring wildlife habitat: Black bear in the Northern Rocky Mountains, USA

T. Adam Switalski [a,*], Cara R. Nelson [b]

[a] Wildlands CPR, PO Box 7516, Missoula, MT 59807, USA
[b] Department of Ecosystem and Conservation Sciences, College of Forestry and Conservation, University of Montana, 32 Campus Dr., Missoula, MT 59812, USA

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ABSTRACT

Forest roads reduce habitat quality for wildlife, in part by increasing susceptibility to hunting and poaching. Road removal is an increasingly common strategy for restoring habitat; however, little is known about responses of wildlife to road removal versus other methods of road closure. We assessed effects of different types of road closure (gated, barriered, and recontoured) on black bear (*Ursus americanus*) frequency and habitat on 18 open and closed road pairs in the western USA. Over 4 years, 44 bears were photographed during 3545 camera-trap days. Bear frequency was significantly higher (2.4 versus 0.6/100 days, respectively) and human frequency was significantly lower (2.4 versus 361.6/100 days, respectively) on closed than on open roads. Additionally, abundance of fall foods was higher (23.9% and 12.8%, respectively) and line-of-sight (a measure of habitat security) shorter (54.9 versus 69.4 m, respectively) on closed compared to open roads. Bears were detected on closed but not on open roads during daytime, suggesting avoidance of humans. Among-road-treatment differences included significantly higher frequency of bears on recontoured than on gated or barriered roads (4.6, 1.6, and 0.5/100 days, respectively), and significantly higher cover of fall bear foods on recontoured than on gated or barriered roads (39.3%, 12.1% and 16.4%, respectively). Frequency of bears was negatively correlated with frequency of humans and line-of-sight distance and positively correlated with abundance of fall foods and hiding cover. Results suggest that while all types of road closure benefit sensitive wildlife, removal by recontour may be the most effective strategy for restoring habitat.

1. Introduction

Roads are a leading cause for global biodiversity loss (Fahrig and Rytwinski, 2009; Benítez-López et al., 2010), and their closure and removal is often the first step to restoring ecosystem function and resilience (Robinson et al., 2010). The negative impacts of roads on wildlife are persistent and include fragmentation, disturbance, and loss of habitat amongst others (Trombulak and Frissell, 2000; Coffin, 2007; Fahrig and Rytwinski, 2009; Benítez-López et al., 2010; Robinson et al., 2010). Bears, in particular, are highly sensitive to roads, which are a key contributor to their decline worldwide (e.g., Clevenger et al., 1997; Wong et al., 2004; Liu et al., 2009); globally, bears have been eliminated from more than half of their historic ranges, and six of eight species are experiencing significant population declines due to human persecution and habitat loss (IUCN, 2011).

In North America, where most investigations of the effect of roads on bears has been conducted, both black (*Ursus americanus*) and grizzly (*Ursus arctos horribilis*) bears have been found to become nocturnal or entirely avoid open roads in response to increased hunting pressure or disturbance (e.g., McLellan and Shackleton, 1988; Brody and Pelton, 1989; Powell et al., 1996; Mace et al., 1996). Studies have also found that bears resume using roads when they are closed (Miller, 1975; Brody and Pelton, 1989; Mace et al., 1996; Gibeau et al., 2002; Wielgus et al., 2002; Kasworm and Manley, 1990). Land managers are attempting to mitigate the negative impacts of roads on bears and other wildlife by closing them with gates or barriers, or removing them entirely by ripping the roadbed, removing culverts, and/or fully recontouring the roadbed to restore hillslope hydrology, ecosystem processes, and fish and wildlife habitat (Switalski et al., 2004). Although wildlife habitat security in general, and bear habitat security in particular, is an increasingly important objective of road removal (Powell et al., 1996; Nielsen et al., 2006, 2008; Roever et al., 2008a,b), to date there has been no study of the response of any wildlife species to road removal compared to other methods of road closure.

There are several different methods of road closure and removal, and each has different effects on bear habitat quality. Whether the road is simply closed or fully recontoured to a natural state can influence the degree of hunter access, availability of hid-

* Corresponding author. Tel.: +1 406 543 9551.
E-mail addresses: adam@wildlandscpr.org (T.A. Switalski), cara.nelson@cfc.umt.edu (C.R. Nelson).

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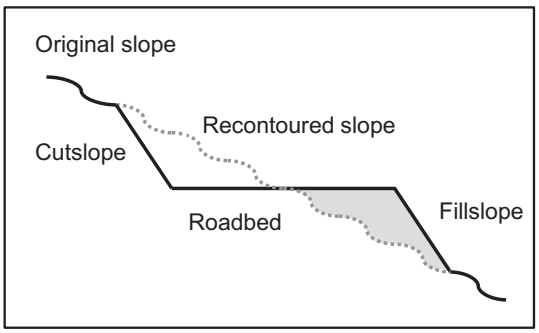

Fig. 1. Cross section of a typical road (including cutslope, fillslope, and roadbed), and slope after recontour (gray dotted line).

ing cover, and presence of food. While abandoning old forest roads or closing them with gates and barriers is common around the world (e.g., Guariguata and Dupuy, 1997; Zang and Ding, 2009), active removal of roads through full recontour is primarily occurring in North America (e.g., Madej, 2001; Switalski et al., 2004; McCaffery et al., 2007), although there are examples from Africa (Burke and Cloete, 2004) and Europe (Dolan and Whelan, 2007; Tarvainen et al., 2008).

Closing roads with gates can limit motorized access to hunters and poachers; however, gated roads allow non-motorized travel (e.g., foot and horse) and, although closed to public traffic, receive management-related and occasional illegal motorized use. In comparison, barriers block most motorized access (except illegal off-road vehicle use), thereby more effectively preventing human use. In addition, barriers also allow for some regrowth of vegetation on the former roadbed, potentially increasing two critical habitat factors for bears: hiding cover (Young and Beecham, 1986; McLellan and Shackleton, 1989) and food availability (Lyons et al., 2003; Vander Heyden and Meslow, 1999). Fully recontoured roads block all motorized access and entirely eliminate the roadbed by re-establishing the original hillslopes (Fig. 1). In addition, after roads are recontoured, early-seral vegetation in general, and fruiting shrubs in particular may increase either through colonization from the soil seedbank, planting of seed or salvaged material as part of road removal treatments, or vegetation spread from areas adjacent to the former roadbed (Grant et al., 2011). Thus, over time vegetation establishment and growth may be substantially higher on fully recontoured roads than on roads closed by other methods, leading to the greatest gains not only in protection from humans but also in hiding cover and food resources. For these reasons, we hypothesized that black bears would use recontoured roads more than those closed by other methods. We further hypothesized that time of day of bear use of roads would vary by road closure treatment, with only nocturnal use of open roads, but 24-h use of closed and removed roads.

Despite the fact that restoring bear and other wildlife habitat is a key objective of road closure and removal, this is the first study to directly test the effect of road closure and removal method on bear

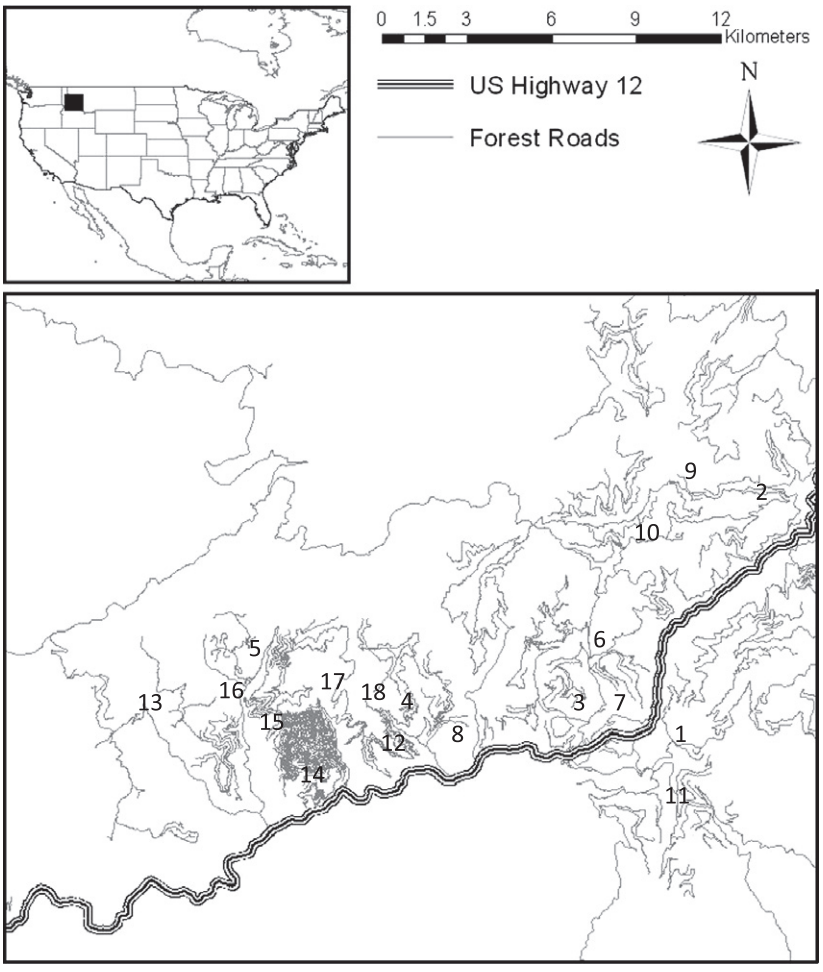

Fig. 2. Field site locations on the Powell Ranger District of the Clearwater National Forest in north-central Idaho. Numbers represent paired study sites and can be cross referenced with Table 1.