WILDLAND ROAD REMOVAL: RESEARCH NEEDS

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Abstract: Wildland road removal is a common practice across the U.S. and in some parts of Canada. The main types of road removal include ripping, stream crossing restoration, and full recontour. Road removal creates a short-term disturbance that may temporarily increase sediment loss. However, research and long-term monitoring have shown that road removal both reduces erosion rates and the risk of road-induced landslides. Research is needed to determine whether road removal is effective at restoring ecosystem processes and wildlife habitat. We propose several research questions and the types of studies needed to further road removal efforts. With greater understanding of the impacts of road removal, land managers can more effectively prioritize which roads to leave open and which roads to consider for future road removal projects.

Introduction

Almost a million kilometers of roads have been built on public wildlands in the U.S. (Havlick 2002). These roads have provided vital economic and social benefits by facilitating resource extraction, recreation, and transportation. However, the lifespan of many roads is finite, leaving us to ponder the fate of a road once it outlives its usefulness. At a some point, the benefits of roads are outweighed by the negative impacts which include hydrologic and geomorphic changes, direct habitat loss, fragmentation, and associated human impacts leading to decreased terrestrial and aquatic habitat quality (Trombulak and Frissell 2000, Wisdom et al. 2000).

Federal and state land management agencies are decommissioning roads to mitigate these problems. For example, in January 2001 the Forest Service adopted the National Forest System Road Management Strategy (Roads Policy) outlining the potential expansion of unroaded areas by five to ten percent by decommissioning up to 160,000 kilometers of roads over the next 20 to 40 years (USDA FS 2001). Most National Forests and Grasslands have recently decommissioned roads. In fact, the Forest Service reports that it has decommissioned over 17,000 kilometers of system and non-system roads over the last five years. Additionally, the Bureau of Land Management, Park Service, and private land owners have also decommissioned roads.

The Forest Service defines road decommissioning as "activities that result in the stabilization and restoration of unneeded roads to a more natural state" (36 CFR Part 212 Sec. 212.1). "Activities used to decommission a road include, but are not limited to, the following: reestablishing former drainage patterns, scattering slash, recontouring, blocking the entrance, or other methods" (36 CFR Part 212 Sec. 212.5). Road decommissioning, however, is an ambiguous term used inconsistently to describe road mitigation methods ranging from gating roads (road closure) to full road recontour. The ecological, physical, and economic costs and benefits will vary along this gradient of options. The Forest Service does not appear to track road decommissioning projects consistently, so it is difficult to determine the character or scale of work done on the 17,000km previously mentioned. In this paper we refer to the more intensive forms of decommissioning as road removal. This is clearly a more appropriate term to represent the physical restoration of a roadbed rather than simple road closure.

Types of Road Removal

The most common types of road removal include ripping of the roadbed, stream crossing restoration, and full recontour. Ripping of the roadbed involves decompacting the road surface, typically with a bulldozer and followed by the addition of organic materials. Restoration of stream crossings involves removal of the culvert and all associated fill, and recontouring of the adjacent slopes. Full recontour is the most thorough and expensive form of road removal. This treatment involves excavating the fillslope that was sidecast during construction and placing it on the cutslope thus recontouring the slope. After treatment, native organic materials are often placed on the former roadbed and followed by seeding.

Summary of Research

Although many Forests and Parks have created protocols outlining methods for road removal, the science of road removal has not caught up with the pace at which such removals are being carried out. This has led to speculation that road removal may actually increase sediment yields. There has, however, been some research conducted on the effectiveness of road removal for restoring hydrologic and geomorphic conditions. As a whole, road removal has been found to decrease chronic sediment loss on roads and reduce the risk of road-triggered landslides. Some key examples of road removal research are provided below.

Ripping reduces erosion, increases infiltration, increases the rate of revegetation, and discourages weed invasion (McNabb 1994, Horn 1995, Luce 1997, Bradley 1997, Bloom 1998, Madej 2001, Bergeron 2003). The degree of effectiveness of road ripping is related to the stability of the slope (Bloom 1998), soil texture (Luce 1997), and the use of soil amendments (Hektner and Reed 1989, Cotts et al. 1991; Stonesifer and McGowan 1999, Bradley 1997, Bergeron 2003).

Stream crossing restoration eliminates the risk of catastrophic failure of stream crossings resulting from debris torrents and greatly reduces chronic erosion (Klein 1987, Bloom 1998, Madej 2001). However, one short-term impact is localized erosion immediately following treatment (USDA FS 2000, Brown 2002). Channel incision and bank erosion were the most common forms of stream erosion reported (Klein 1987, Bloom 1998, Madej 2001). Post treatment erosion was found to be related to stream power, the amount of large wood in channels, and percentage of coarse material in stream bank soils (Klein 1987), as well as hillslope location and proximity to fault lines (Bloom 1998), and the amount of road fill excavated (Madej 2001).

Full road recontour has been found to effectively reduce landslides and chronic erosion in northern California (Bloom 1998, Madej 2001), western Washington (Harr and Nichols 1993), coastal Oregon (Cloyd and Musser 1997), north central Idaho (McClelland et al. 1997, USDA FS 2003) and Montana (Hickenbottom 2000). Important factors determining the risk of failure following treatment include proximity to fault lines, locations with excess water, hillslope steepness, and history of mass failure (Bloom 1998, Madej 2001).

Research Needs

In spite of the limited amount of research done in this area to date, the benefits of road removal for erosion reduction has been documented and continuing research on hydrologic and geomorphic restoration will soon allow for meta-analysis. Although anecdotal evidence suggests that wildlife habitat is restored following road removal, to our knowledge no published research has been conducted on wildlife recovery. The negative effects of roads on aquatic and terrestrial habitat have been well documented, yet it is unknown if road removal reverses these impacts. In table 1, we propose some research questions that remain unanswered and the types of data required to answer these questions. The list is by no means exhaustive.

Conclusions

Roads in wildland areas have served numerous functions, but also have created numerous negative impacts. Road removal appears to reduce sediment loss and restore hydrologic and geomorphic function. Anecdotal evidence suggests that road removal also restores ecological integrity, but the degree of ecological recovery has not been quantified. By promoting and fostering additional research, we will more fully understand the benefits and impacts of road removal.

Table 1
Primary research questions and studies essential to further road removal efforts

Research question	***A sample of possible types of studies[1]***
Hydrologic restoration	
How does road removal influence hydrologic flow (including peak flows, low flows) and soil infiltration?	Long-term monitoring of stream flow volume Measuring soil infiltration rates over time
How can converted surface flow be returned to subsurface flow?	Experimental burying of exposed surface flow with different materials (mulch, sand, etc.)
How does road removal influence water quality (e.g., sediment loads, temperatures?	Measuring suspended sediments and temperatures
Geomorphologic restoration	

Table 1 (con't)

Does removal of the roadbed restore natural stream and floodplain functions and structures (i.e. substrate morphology)?	Long-term studies that can take into account temporal variability and the stochastic nature of streams
What is the channel response to crossing excavations, in terms of channel morphology, development of steps, pools, riffles and bars; channel substrate; sediment storage; large woody debris loading; stream temperature; and canopy cover?	Surveying longitudinal profile of the stream channel Measuring the effectiveness of mulch on reducing surface erosion and increasing vegetation success Monitoring bank erosion including success of bank armor (wood, rock, vegetation, and erosion control blankets) and the effectiveness of weirs and other energy dissipating structures
Can we measure a geomorphic response in streams downstream (not just locally)?	Measuring physical and biological parameters downstream of restoration efforts
Does the reduction of road sediment reduce substrate embedment in sand?	Conducting pebble counts, McNeil or freeze core sampler
How does road removal influence soil biochemical and biological processes and properties?	Measuring soil organic matter, microbial activity, and nutrient turnover
How does road removal influence soil aggregation and bulk density?	Study soil aggregation using rainfall simulation Measuring bulk density with a penetrometer at different soil depths and in different soil types
Aquatic habitat	
How does road removal affect fish migration?	Occurrence and non-occurrence and life history of migrant individuals (size distributions); mark and recapture
What are the impacts of road removal on fry emergence and juvenile densities?	Trend analysis measuring spawning success (redd counts), fry success (fry traps), and smolt success before and after road removal
How does road removal influence amphibian populations?	Population monitoring using mark and recapture
How are benthic organism populations influenced following road removal?	Functional group surveys of macroinvertebrates; analysis of habitat indicators
How does road removal affect algal production?	Measuring periphyton patches, chlorophyll, zooplankton to gauge net primary productivity
Terrestrial habitat	
How does road removal affect invasion by exotic plant and animal species?	Conducting vegetation surveys (point cover data and density data plots) to document presence of invasive species and rate of invasion
Does restoration of compacted/ rocky soils favor specific plant species?	Experimental comparison of soil types and change in species composition following road removal
To what degree is vegetational succession accelerated by different road removal practices?	Comparison of different amendments and road removal techniques experimentally
How does road removal reverse the impacts of edge effects on a landscape?	Sampling vegetation and focal animal species to document the abundance of interior species
How does road removal influence (+ or -) the dispersal and migration of animals and increase the connectivity of fragmented populations?	Documenting animal movements using mark and recapture Landscape-level analysis of road removal's ability to restore connectivity and linkage areas
Do amphibians, reptiles, birds, and mammals return to restored roadbeds? What is the dependence on vegetation and soil restoration?	Sampling of animal species to attain presence/ absence data over time Multivariate analysis of vegetation and soil vs. abundance and diversity of animals
Prioritization	
How do we effectively prioritize which roads to remove? How do we evaluate the effectiveness of prioritization strategies across many spatial scales?	Developing a comprehensive strategy for road removalprioritization using both aquatic and terrestrial models of prioritization Meta-analysis of prioritization strategies across spatial scales Assessment of current models of prioritization

[1] All studies in pre and post measurements with a comparison

Fig. 1. Ripping the roadbed. (Photo: Daniel Patterson)

Fig. 2. Stream crossing restoration, Clearwater National Forest, ID (Photo: Tim Brown)

Fig. 3. Full road recontour, Clearwater National Forest, ID. (Photo: Bethanie Walder)

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