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A Review of the Direct and Indirect Effects of Paving Flathead County Road 486, the North Fork Road

Flathead County Road 486 begins in Columbia Falls, Montana with ten miles of standard two-lane paved road leading to the North Fork of the Flathead River that lends the road its more familiar name, the North Fork Road. From there to the Canadian Border the road parallels the North Fork of the Flathead. To the east across the river lies Glacier National Park while the Flathead National Forest and the much smaller Coal Creek State Forest flank the road to the west, often with a thin strip of private land between the road and the public forest land. After the ten miles of pavement the road is mostly gravel to the Canadian border with the exception of a half-dozen miles of thin, non-standard asphalt that ends about a mile before the settlement of Polebridge. The roughly sixty mile gravel portion of the North Fork Road is lightly populated with approximately one hundred year-round residents. For nearly forty years, North Forkers have debated whether to pave the road, resulting in lively discussions at the North Fork Community Hall at Whale Creek each year. The purpose of this study is to provide accurate and comprehensive information on the direct and indirect effects that paving would have on the North Fork of the Flathead River Valley.

Direct and Induced Effects of Road Improvement

Road improvements have both *direct* and *induced* ecological impacts. Direct impacts include things like contamination of runoff, change in groundwater flow and stream morphology (Malecki, 2005), and vehicle collisions with wildlife (Trombulak and Frissell, 1999). Ledec and Posas identify induced impacts as “the result of those human activities which road construction or improvement make possible, rather than of the road works themselves" (Ledec and Posas, 2003). They report that "the induced impacts of road works on biodiversity are both more serious and more difficult to control than the direct impacts" (Ledec and Posas, 2003), recognizing increased human access as the most serious of the induced impacts. They emphasize that if biodiversity is to be protected road improvement projects should be avoided in areas of natural habitat, and they identify forested lands as some of the most vulnerable to human impacts (Ledec and Posas, 2003).

Road improvement intensifies both the direct and induced effects of existing roads by increasing access, traffic volume, and speed, and adding chemical pollutants from paving materials and vehicle tires and exhaust (Trombulak and Frissell, 2000; Forman and Alexander, 1998; National Research Council, 2005; Criley). Trombulak and Frissell (1999) list the major ecological effects of roads as the following: construction-related wildlife mortality, mortality from vehicle collisions with wildlife, modification of animal behavior, alteration of the physical and chemical environment, spread of exotic species, and increased human use of the area. Other impacts on wildlife include habitat degradation and fragmentation (Forman and Alexander, 1998), road avoidance (Forman and Alexander, 1998, Trombulak and Frissell, 2000), and increased encounters with humans and their food sources, which usually leads to problems for both the humans and the wildlife (Benn and Herrero, 2002; Herrero et al., 2005; Herrero, 2002), as well as increases in the number of animals killed in Defense of Life or Property (DLP) (Suring and Del Frate, 2002).

Richard Forman (2002) notes that most transportation engineers fail to consider the effects of roads on a broader landscape level, instead focusing their attention "closely on the road or highway itself and the critical narrow band alongside." He explains that the span of the zone affected by a road depends on several factors, including the species present in the area and the characteristics of the soil and water (Forman, 2000). Traffic speed, volume, and temporal patterns also come into play (Forman and Alexander, 1998).

Considering the Bigger Picture

Sax and Keiter (2006) describe the importance of recent road closures and reductions of timber harvest on the Flathead National Forest that "provide Glacier [National Park] with a buffer-like zone in the North Fork that secures important wildlife migration corridors." They go on to predict that more "recreational activity in the North Fork and elsewhere on the park's perimeter would reduce wildlife security and intensify commercial development pressures" (Sax and Keiter, 2006). The Forest Plan for the Flathead National Forest is currently under revision, but in recent years the Forest has been managed in a way that is more consistent with the "preservation mission" of Glacier National Park, partly because of federal mandates that encourage consistency in regional management (Sax and Keiter, 2006). This is not to say that the Forest Service necessarily defers to the Park's agenda, but they have at least made efforts to manage the forest with the effects on Glacier in mind, although many of these management changes were born out of litigation rather than of the Forest Service's own accord. When these lands were designated for management under different agencies less was known about ecology and appropriate wildlife and land management strategies, "but modern environmental knowledge and concerns increasingly reveal conventional borders to be dangerous irrelevancies" (Sax and Keiter, 1987). John Weaver (1991) emphasizes the importance of managing the entire Flathead River basin "as one integral, ecological unit." Armed with the ecological knowledge and understanding we have today, we can no longer manage land adjacent to protected areas without considering the effects on the protected ecosystem at the very least. Although the North Fork Road is now a County road rather than a Forest Service road, the implications of road improvement on adjacent protected lands should still be considered, especially with the presence of threatened species. Furthermore, the North Fork of the Flathead River is protected under the Wild and Scenic Rivers Act, which mandates that the river's watershed and shoreline be maintained in pristine condition (Sax and Keiter, 1987). Increased human access could easily threaten the pristine condition of this river. While the Forest Service works to decommission and restore roads on the Flathead to improve grizzly bear habitat (Sax and Keiter, 2006), some residents push to pave the North Fork Road, undermining these efforts to preserve the rare, wild nature of the North Fork region.

In 1982 Glacier National Park officials spoke out against the proposed paving of the North Fork Road, describing the plan as "incompatible with the park's management objectives and philosophy" (National Park Service, in Sax and Keiter, 2006). Two years before that, as part of the federal consultation requirement of the Endangered Species Act (ESA), the U.S. Fish and Wildlife Service (USFWS) published its biological opinion on the potential effects of the project on grizzly bear *(Ursus arctos)*, gray wolf *(Canis lupus)*, bald eagle *(Haliaeetus leucocephalus)*, and peregrine falcon *(Falco peregrinus anatum)*, all species that were listed as endangered or threatened at the time. Under the Section 7 of the ESA, the project would not be permitted to go through if it were to jeopardize the continued existence of any species listed as endangered or threatened under the Act (Plater et al., 1992). They found that the proposed improvement was "likely to jeopardize the continued existence of grizzly bear and gray wolf (USFWS, July 14 1980)." The agency cited Federal Highway Administration (FHWA) research that found a large number of grizzly bears in the North Fork due to abundant high-quality grizzly habitat and a relatively low level of human presence. "Feeding, denning, etc., are important bear uses which would be impacted by further human encroachment on this area" (USFWS, 1980). When the Department of Transportation issued its Final Environmental Impact Statement, they determined that the North Fork Road should remain unpaved in light of the USFWS jeopardy determination. At the time of writing, the USFWS has just announced the removal of the gray wolf from the Endangered Species List, and the grizzly bear may also be removed soon. However, since the 1980 biological opinion was issued two other natives of the North Fork, the bull trout *(Salvelinus confluentus*) and the Canada lynx *(Lynx canadensis)*, have been listed as threatened under the ESA. The impacts on the wolverine *(Gulo gulo)*, a carnivore known for its avoidance of human development as well as its slow rate of reproduction, should also be considered due to its sparse and vulnerable population.

Humans and Wildlife

Increasing human access to prime grizzly bear habitat such as the North Fork region can have negative impacts on humans because it increases the odds of bear-human encounters and introduces bears to human-related food sources, often resulting in food-conditioned "problem bears" (Herrero, 2002). Wolves can also become food-conditioned in the face of human development, learning to eat pet and livestock feed and to prey on domestic animals, as occurred with increased frequency in developed parts of Alaska during the winter of 2007-2008 (Halpin, 2007; Mowry, 2008). However, due to a natural wariness of humans, wolves in North America are not as susceptible to food-conditioning as the more opportunistic grizzly and black bears *(Ursus americanus)*. According to the FHWA as quoted in the 1980 USFWS biological opinion, “Such increased use would probably result in increased bear depredation on property, increased bear-human confrontation, increased illegal killing of bears, loss of high-quality grizzly habitat, and interference with grizzly behavioral and physiological requirements for isolation” (FHWA in USFWS, 1980). They report similar findings in their assessment of potential impacts on wolves, predicting increased human-wolf encounters and depredation on livestock and pets, as well as interference with wolf breeding and rearing activity due to loss of security. The report goes on to identify ongoing developments in the North Fork drainage that include rapid subdivision of private lands, increased logging and logging truck traffic, increased recreational use, and prospective oil, gas, and coal exploration and development, all of which cumulatively affect the quality and wildness of the North Fork drainage. While the USFWS found that the proposed road improvements would not actually jeopardize the continued existence of the other species it examined, the agency did report that there may be negative impacts on nesting and migratory bald eagles due to increased human activity. It is important to keep in mind that these reports were completed in 1980 and wildlife populations and their dynamics have changed since then, but it is presumable that similar issues are at stake today although the specifics vary. Today we have the additional concern of the proposed Cline Mine just north of the Canadian border at the headwaters of the Flathead, as well as other mining pressures such as phosphates, gold, and petroleum adding to the cumulative effects of human development on the region. In February 2008 British Petroleum (BP) and the province of British Columbia announced that they would spare the Canadian Flathead from the BP tenure referral for gas development in light of the Flathead’s value as a pristine, biologically diverse area, but this does not eliminate the threat of future gas development, nor does it protect the watershed from other forms of resource extraction (Jamison, 2008). In fact, the following week a BP spokesperson announced that the company is still interested in drilling in the Canadian Flathead in the future (Jamison, 2008b), causing confusion among the media, politicians, and the public and highlighting the capricious nature of resource extraction. When asked to identify the most serious external threats to Glacier National Park, Park Service officials "feared that oil and gas activity would intensify human impact in critical corridors for park wildlife…by increasing road access for hunters (especially poachers) and recreationists" (Sax and Keiter, 1987). In the case of the North Fork Road project, the increased access would not come diectly from resource extraction, but the implications would likely be the same, at least where access is at stake. The Outdoor Recreation Council of British Columbia recently listed the Flathead River as the most endangered river in North America (Outdoor Recreation Council of British Columbia, 2007).

Several biologists, including Schwartz and Arthur (1997), McLellan et al. (1999), Benn and Herrero (2002), and Suring and Del Frate (2002), have established that the number of bears killed in Defense of Life or Property (DLP) increases with the rate of human access and development. Benn and Herrero (2002) explain that when human access is improved by roads in high quality bear habitat, the potential for negative bear-human encounters increases, especially when seasonal food resources such as berries occur near roadsides. Dalle-Molle and Van Horn (1998) also found that bear-human conflicts increase with improved access to the backcountry. Regardless of how one feels about bears, an increase in the number of DLP kills would not be good for humans *or* bears. Adding more people to an area dominated by bears increases the likelihood of animals becoming food-conditioned, which is typically a dangerous and unhealthy situation for humans and wildlife alike (Benn and Herrero, 2002; Herrero, 2002; Herrero et al., 2005). Stephen Herrero, a leading authority on bear attacks and bear-to-human human habituation, explains that when bears become habituated to humans, humans are more likely to act inappropriately or illegally (such as approaching bears for photographs or feeding them), the cumulative odds of a negative encounter increase, and habituated bears, especially subadults, are more likely to approach humans (Herrero et al., 2005). Furthermore, human-habituated bears are more expensive and difficult to manage than wary bears, since they interact more with humans and are less likely to flee from human activity, and they may destroy property or endanger humans trying to get to human-related food sources (Herrero et al., 2005).

Impacts on Birds

Increased human activity can have detrimental impacts on bird species. Glen Frederick points out that the human disturbance that roads facilitate can have severe negative effects on the nesting and roosting behavior of raptors (Frederick, 1991). A Montana Chapter of the Wildlife Society study of the effects of recreation on wildlife in the Rocky Mountains found that Canada Geese *(Branta canadensis)* are particularly sensitive to human activity in their nesting areas, resulting in nest desertion and abandonment of nesting areas simply in reaction to humans fishing around the nesting areas (Wildlife Society, 1999). The same is true of nesting ducks – waterfowl in general are very sensitive to human activity. "Waterfowl are wary, seeking refuge from all forms of disturbance, particularly those associated with loud noise and rapid movement" (Wildlife Society, 1999). Even when birds do not completely abandon their nests they will flush from their nests in human presence, exposing eggs to fluctuations in temperature and increasing the chances of depredation (Wildlife Society, 1999). When avian communities exist near busy roads they are alienated by traffic noise (Forman, 2000; Reijnen, M. et al. 1995; Reijnen, R. et al. 1995, 1996). Songbirds are particularly sensitive to noise disturbance (Forman and Alexander, 1998).

Outdoor recreation is an often overlooked form of human disturbance. With easier access to the backcountry recreational pressure increases, often displacing wildlife even when the recreation is non-motorized. "Because outdoor enthusiasts rarely view themselves as having a degrading effect on the environment, special management activities are needed to ensure that avian biodiversity is maintained" (Wildlife Society, 1999).

Habitat Alienation and Fragmentation

According to Forman and Alexander (1998), "the ecological impact of road avoidance must well exceed the impact of either roadkills or habitat loss in road corridors." They cite road width and traffic density as the most important determinents of the "barrier effect." When species learn to avoid roads, the roads act as partial or complete barriers to movement resulting in habitat fragmentation and alienation, reducing the available resources, and dividing existing populations into *metapopulations* (Forman and Alexander, 1998). Metapopulations arise when larger populations are divided and separated into smaller isolated populations, impeding genetic flow, increasing pressure on available resources, and increasing the likelihood of stochastic, or randomly occurring, extinction for each metapopulation, as well as decreasing the likelihood of recolonization (Forman and Alexander, 1998; Noss et al.,1996). Elk *(Cervus elaphus)* (Ward, 1976; Frederick, 1991), moose *(Alces alces)* (Dussault et al., 2007), grizzly bear, gray wolves, (Frederick, 1991), mountain lions *(Puma concolor)* (Dickson et al., 2005), Canada lynx, marten *(Martes americana),* wolverines, and other mustelids are all known to avoid roads (Frederick, 1991), especially those with higher speeds and volumes, making them highly susceptible to the barrier effect. Carnivores are especially sensitive to roads and human development, which can have wider implications for the ecosystem because top carnivores can regulate populations of prey species that may become overpopulated in their absence (Weaver, 1991). Weaver (1991) explains that “carnivores enact a vital and irreplaceable role in representing and maintaining the beauty and integrity of ecosystems,” and he identifies the Flathead River basin as possibly the most important area for carnivores in the Rockies. Road paving can lead to fragmentation of mountain lion populations due to their inherent distrust of paved roads (Dickson et al., 2005). Dickson et al. (2005) found that paved roads may impede mountain lion movement, but that they showed no aversion to unpaved roads. Riley (2006) found the same to be true of bobcats *(Lynx rufus)* and Canada lynx. Marten, favoring habitat with horizontal cover and highly susceptible to trapping, are especially vulnerable to habitat loss and fragmentation due to roads and increased human access (Weaver, 1991). The North Fork is considered the most important area in Montana for marten, and many biologists advocate for protecting remaining marten habitat (Weaver, 1991). Road widening can seriously impact the movement of small mammals and amphibians, creating barriers to genetic flow and habitat connectivity (Frederick, 1991). While Hornocker and Hash (1981) found that roads did not affect the movement of wolverines, the overwhelming cause of known wolverine mortality was human-related, particularly by fur trapping, suggesting that augmenting human access could increase trapping and poaching pressures. Van Zyll de Jong (1975) maintained that wolverine populations in remote parts of British Columbia and the Yukon Territory thrive because of large tracts of inaccessible habitat that allow for greater security.

Numerous studies show that elk avoid habitat near forest roads with higher traffic levels (Perry and Overly, 1976; Witmer and de Calesta, 1985; Rowland et al., 2000; Wisdom et al., 2005). Lyon et al. (1985) found that road avoidance among elk increased during hunting season. Rowland et al. (2000) found that elk may permanently change their habitat in response to persistent road-related disturbance. Gagnon et al. (2007) observed elk changing their behavior temporally to avoid areas near roads more strongly during times of heavier traffic. Marcum and Edge (1991) found that male elk are especially sensitive to roads and traffic levels. Overall, increased traffic exacerbates the problems of habitat fragmentation and alienation on existing roads (Gagnon et al., 2007).

Black bears avoid or select for different types of roads depending on their previous experiences with them and factors such as the intensity and type of use. For example, protected bears in the Harmon Den Bear Sanctuary in the Southern Appalachians learned to avoid paved roads more than gravel roads because they encountered hunters when they ventured outside of the sanctuary near paved roads (Brody, 1984; Brody and Pelton, 1989; Reynolds-Hogland and Mitchell, 2007). Conversely, black bears in the nearby Pigsah Bear Sanctuary avoided gravel roads more than paved roads, because they encountered more humans near the gravel roads and the paved roads (which posed little threat of vehicle-collision in this specific case) were mainly used by thru-traffic (Reynolds-Hogland and Mitchell, 2007). A study of black bears in Montana's Cabinet Mountains (Kasworm and Manley, 1990) showed bears avoiding habitat near open roads, while another study in Idaho found black bears near roads where important food sources existed in the roadside verge (Young and Beecham, 1986 in Frederick, 1991). Therefore, it is important to look at the big picture when considering road improvements, including spatial and temporal behavioral patterns of existing wildlife populations, historic use, potential changes in intensity and type of use, and specific characteristics of the area such as availability and proximity of cover (McLellan and Schackleton, 1989), existing wildlife linkages and corridors, and line of sight (Waller and Servheen, 2005). Many animals are more likely to frequent areas near roads if there is available cover to which they can retreat for safety (Ward, 1976; Dickson et al., 2005).

Vehicle-Wildlife Collisions

Vechicle-wildlife collisions are a serious problem for human safety and economics, as well as for wildlife. According to Forman and Alexander (1998), "sometime during the last three decades, roads with vehicles probably overtook hunting as the leading direct cause of vertebrate mortality on land." In the U.S. an estimated 120 people die every year in deer-related accidents (Romin and Bissonette, 1996, Gordon et al., 2004), and insurance companies estimate the average cost of vehicle collisions with deer between $1,468 and $2,000 in injuries and property damage per deer struck (Schwabe and Schyhmann, 2002; Langley et al., 2006; Gordon et al., 2004). In addition to those costs, Langley et al. (2006) point out that "deer and other type of game are considered a natural resource with value attached based on revenue from hunting. It has been estimated that the cost of a lost deer in a collision is between $700 and $800." Between the years of 1995 and 2004, Montana had the third highest rate of vehicle-wildlife collisions resulting in human fatality in the United States (Langley et al., 2006). Most vehicle-wildlife collisions occurred in rural areas on roads with higher speed limits, and Langley et al. (2006) recommend reducing speeds to avoid collisions with wildlife. They predict that vehicle collisions with wildlife will increase as the human population continues to encroach on wildlife habitat (Langley et al., 2006). Leblond et al. (2007) identify road improvements as a major contributing factor to the growing rate of vehicle-wildlife collisions. According to Reed Noss (1995), unpaved roads "are less dangerous in terms of roadkill," and roads with intermediate traffic levels tend to have higher roadkill rates. "Increases in traffic volume do result in more collisions on any given road…" (Noss, 1995). People inherently drive faster on paved roads, increasing the likelihood and impact of collision.

Clevenger et al. (2002) found that vehicle collisions with black bears in Banff National Park occurred at higher rates between areas of high quality bear habitat, especially when cover was available along the roadside. Bears were more likely to take the risk of crossing a road if it would allow them to move between high quality habitats and food resources, and the North Fork is certainly rife with high quality bear habitat. Additionally, bears and other carrion-feeders can be attracted to roadkills (Forman and Alexander, 1998), increasing the likelihood of further roadkill.

Spread of Invasive Species

In addition to their impacts on animal species, roads facilitate the invasion of non-native plant species and invasive weeds both by seeds carried along vehicles and by air turbulence from vehicle disturbance (Trombulak and Frisell, 2000; Forman and Alexander, 1998). These are both factors that intensify with increased traffic, a likely effect of road improvement. According to Reed Noss (1996), road improvements increase clearance and allow more sunlight to penetrate, increasing the amount of "edge effect," which attracts species that may become victims of vehicle collisions and decreases the presence of native flora and fauna. Gelbard and Belnap (2003) found that paving existing roads increases the occurrence of non-native plant species including forbs such as knapweed in roadside verges (areas of vegetation along roadsides), and that vehicles contribute to their spread (Gelbard and Belnap, 2003). They note that the area covered by weeds along improved roads tends to be wider than that along primitive roads (Gelbard and Belnap, 2003). In addition to the spread of exotics by vehicles, they identify road maintenance and habitat alteration during construction as contributing factors. Furthermore, "paved roads are also designed to shed water into roadside verges, which may increase the vulnerability of verges to invasion by improving moisture and nutrient availability" (Gelbard and Belnap, 2003). They cite US Department of Transportation data from 1999 showing that "the 117,205 km [72,828 miles] of rural paved roads in the state of Utah alone may have already converted as much as 164,087 ha [405,466 acres] of land from interior to roadside plant communities" (Gelbard and Belnap, 2003). Western Montana is already inundated with invasive plant species, and road paving will exacerbate the problem.

Wildfire

Weeds are not the only problem that can be spread by increased access. Increased human activity in an area like the North Fork that is already fire-prone can lead to more human-caused fire ignitions. Brosofske et al. (2007) note that increased human access often increases the levels of both accidental and deliberate ignition. While many Montanans are careful about fire in the summer months, improved roads can lead to more tourism, inviting more visitors who may not be aware of the fire danger. Even those who are fire-aware can add to the fire danger simply by raising the cumulative odds of accidental fire-ignition. In a study of the spatial and temporal patterns of human-caused wildfires, Pew and Larsen (2001) found that human-caused fire occurrence was high close to roads and railroads, but that it decreased with distance from human infrastructure, "especially rapidly with distance from dirt roads." However, human-caused fires continued to occur as far as 20 km (12.43 miles) from paved roads. Fire budgets are strained as it is, and increased wildfire poses threats to human health, safety, and property. A human-caused change in the fire cycle will also present ecological impacts. As more people settle the region, the North Fork will face the same problem that growing rural communities face more and more across the west: increased human development in fire-prone areas where fire-suppression resources are already limited.

Chemical Pollutants

Increased traffic also increases the level of pollutants from vehicle exhaust in the air and in road runoff (Forman and Alexander 1998; National Research Council, 2005). According to Marnie Criley, “paved roads continue to be a source of chemical pollutants long after the construction is complete.” Soils near roadsides contain higher concentrations of heavy metals and these contaminants are spread further by runoff and stream dispersal, as well as through dispersal by animals that feed on roadside vegetation. Asphalt roads are known to leach carcinogenic polycyclic aromatic hydrocarbons (PAHs) both from car exhaust deposition and from the asphalt itself. PAH’s are also very toxic to the highway workers themselves who absorb them through their lungs, skin, and gastrointestinal tract (Criley). Paved roads leach inorganic pollutants such as lead, zinc, chromium, iron and chloride (Criley). Trombulak and Frissell list heavy metals, salt, organic molecules, ozone, and nutrients as five common pollutants from road use and maintenance (Trombulak and Frisell, 2000; Criley). Forman and Hersperger (1996) found that nitrogen oxide and ozone from vehicle exhaust pollute the atmosphere and damage plant life.

Conclusion

The North Fork of the Flathead River is a unique and wild place that so far has been spared the brunt of the hasty development that has sprawled across western Montana over the past few decades. Boasting a Wild and Scenic River, abundant and biologically diverse wildlife, and unmatchable natural beauty, this is a place that deserves to be looked after by the people who know and love it. Part of what makes this place so special is that you don't end up there by accident. You have to make an effort to get to the North Fork and the result is that visitors and residents alike are rewarded with a unique, rugged place that has not been homogenized into Anytown, USA. The watershed still hosts the full suite of predators that was here to greet Lewis and Clark two centuries ago (Weaver, 2001), and it boasts the densest inland population of grizzly bears in North America (McLellan, 1989). John Weaver identifies the transboundary Flathead as possibly "the single most important basin for carnivores in the Rocky Mountains," citing its importance as a linkage for wildlife habitat and the "density of species which are rare elsewhere" as factors that set it apart as a unique and valuable landscape (Weaver, 2001). Improvement of the North Fork Road threatens to erase the rugged, unique, and wild character of this place.

The key issue at stake is increased access. The paving of the North Fork Road is not simply a question of road surface, but also of the wider implications of the upgrade. Flathead County has seen rapid growth over the last two decades, increasing in population by 26 % between 1990 and 2000 and 9% from 2000 to 2004 (Sax and Keiter, 2006). Communities to the south are beginning to resemble Reserve Street in Missoula, and people are building more homes in areas that have previously been undeveloped or used for agriculture. Sax and Keiter note new residential development in the North Fork region as a concern (Sax and Keiter, 1987; 2006), and local residents are working to implement a community-generated neighborhood plan to guide subdivision and address zoning issues (Peterson, 2008). Improved roads mean more access, higher speeds, and more traffic, all elements that can significantly change the character of a place. Paving will result in more vehicle-wildlife collisions, alienation and fragmentation of wildlife habitat, more danger of wildfire, increased chemical pollutants in the air and the watershed, more pressure on local infrastructure, spread of invasive weeds, and human-habituation and food-conditioning of wildlife, which results in increased negative encounters with wildlife (Trombulak and Frissell, 2000; Forman and Alexander, 1998; National Research Council, 2005; Gelbard and Belnap, 2003). It will also "pave the way" for the sprawl that has been consuming the more accessible regions of the Flathead Valley. The rugged thirty-five mile drive to Polebridge that keeps the area an unspoiled secret would be a cinch on a paved road, welcoming irreversible commercial and residential development.

Paving may seem like a relatively minor change at first, but roads have a way of growing in increments. Improving a section or two of a gravel road facilitates easier access, and then road networks start to form as land is subdivided and developed. Recreational use of the area grows, and as it grows users demand more improvements until the area is no longer the wild and pristine place that attracted the users in the first place. The local community already faces problems dealing with sanitation and human waste from the small population currently living there. The human impacts on water quality and sanitation will only grow with increased access. According to Sax and Keiter (1987), "a proposal for paving a road parallel to the North Fork of the Flathead River is the first step toward development adjacent to the most remote region of [Glacier National] Park, where solitude and pristineness are still primary values."

Dust is an unfortunate consequence of living near an unpaved road, but there are mitigation strategies for dust abatement, including spraying water on the road, applying dust palliatives such as lignin, salts, polymers, vegetable oils, clay, or petroleum products (Missouri

Department of Natural Resources, 2006). These methods must be carefully examined, however, because they too can have negative impacts on the environment such as damaging plant life, attracting wildlife, and leaching into the groundwater (Missouri Department of Natural Resources, 2006). Dust can also be reduced by maintaining low speed limits. While road dust may increase sediments in the watershed, possibly affecting bull trout populations, bull trout and other species will also be negatively affected by increased chemical pollutants from leaching asphalt and increased vehicle traffic, not to mention increased human access if the road is paved. Although road dust degrades the air quality during the dry months, the overwhelming array of negative effects from paving the road far outweighs the dust problem. Instead of paving, which will increase human access to the area, alienate wildlife, increase the likelihood of wildfire, and degrade the unique character of the North Fork, Flathead County should maintain the existing gravel road, possibly applying an appropriate and environmentally safe method of dust abatement and adding more gravel as needed. Colleen Lux of the University of Montana has written an excellent review of potential maintenance options for the North Fork Road, available online at http://www.gravel.org/articles/LuxReport.pdf. After examining maintenance options and surveying landowner opinions, she concluded that "solitude, rustic lifestyle, scenic qualities, and wildlife viewing are the most commonly held values of landowners in the North Fork. This is significant in that these are the very qualities that are potentially at risk due to an increased rate of development, an increase in tourism, and higher speed traffic along the North Fork Road" (Lux, 2002).

Human access can have tremendous impacts on natural environments from displacing and alienating wildlife to increasing the levels of chemical pollutants in the environment. Western Montana is growing rapidly and, although commercial and residential development can bring conveniences to once-remote areas, this often occurs at the expense of the wild, unique, and pristine character that made those places attractive and special. Many Montana communities are embracing new economic development and allowing it to spread unchecked, resulting in strips of outside franchises and expensive seasonal homes that raise property values until locals can no longer afford to live in their own communities. As the crow flies, the North Fork is not far from the most rapidly growing communities in Flathead County. However, there is a gravel road that keeps the North Fork remote, wild, and apart from the urbanization of western Montana. To pave that road would open up the floodgates to development. Wildness is a quality that is easily destroyed and impossible to restore in our lifetimes. The North Fork is a rare gem of wild beauty in a rapidly changing region, and we cannot afford to lose this last best place.

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