Northern Rockies Ecosystem Protection Act

Environmental and Scientific Analysis

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An Environmental and Scientific Analysis of the Northern Rockies Ecosystem Protection Act of 2019

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Executive Summary

The Northern Rockies Bioregion, covering the states of Wyoming, Idaho, Montana, Washington, and Oregon, contains some of the last remaining intact wilderness in the continental United States and areas of high ecological, recreational, and cultural importance. The region provides habitat for endangered and threatened species, such as grizzly bears and bull trout, as well as some of the country's most iconic public lands, such as Yellowstone and the Grand Tetons. In addition, the high value of the area's natural resources has driven regional economies for generations through timber harvesting, oil and gas extraction, and mining. Over time, however, these industrial activities have jeopardized the overall ecological integrity of the region. The infrastructure and practices surrounding natural resource extraction, such as road development, pollute waterways, cause land degradation, and threaten wildlife, thereby prompting a call for further environmental protections.

In February of 2019, the Northern Rockies Ecosystem Protection Act (NREPA) was re-introduced to Congress to provide sweeping landscape-scale designations, to improve long-term ecological health and to establish a green economy in the Northern Rockies Bioregion for local populations. This area is of great national significance as the last remaining largely intact wilderness areas found in the United States. Thus, the legislation proposes to designate and protect over 24 million acres of remaining roadless areas as wilderness, under the Wilderness Act of 1964, and over 1,000 miles of waterways under the Wild & Scenic Rivers Act of 1968 from future degradation. The NREPA will also designate 19 biological connecting corridors to bridge ecological gaps between fragmented protected areas in the Northern Rockies by creating physical pathways for wildlife. Furthermore, over 1 million acres of land that have been degraded by human activities will also be designated as restoration and recovery areas. An interagency team will be formed to monitor and evaluate progress and make recommendations to improve the long-term results of the NREPA.

This report will analyze the main ecological threats facing the Northern Rockies Bioregion caused by the development and practices of extractives industries and other human activities. It will then describe the science behind and impact of the land designations proposed under the NREPA. In addition, it will explore some scientific controversies around the efficacy of these designations. Finally, it will provide examples of key ecological indicators that could measure the success of the new protections, should this legislation pass.

TABLE OF CONTENTS

INTRODUCTION

The exceptional ecosystems of the Northern Rockies Bioregion have high levels of biodiversity, provide habitat for threatened and endangered species, and serve as the most popular wildlands for outdoor recreation in the country. The region also contains some of the largest remaining wilderness in the continental United States, with large, ecologically-intact areas with minimal human impact. At the same time, the region's economy depends on natural resource extraction, primarily timber, oil and gas extraction, harvest and mining.

A large percentage of the total land in the Northern Rockies is owned and managed by the federal government relative to other more populated areas of the country (Figure 1; Hoover et al., 2019).

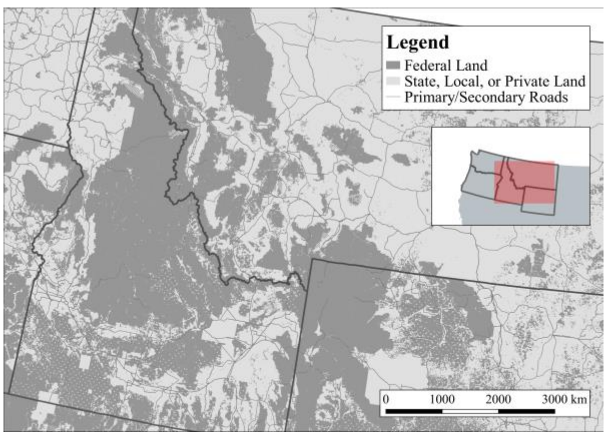

Figure 1 Federal land administered by the U.S. Forest Service, Bureau of Land Management, and National Park Service. Source: U.S. Geological Survey, U.S. Census Bureau. Map: Beryl Sinclair.

This land is nearly exclusively administered by the U.S. Department of Agriculture's Forest Service (USDA-FS) and as well as the U.S. Department of the Interior's Bureau of Land Management (BLM) and National Park Service (NPS). On land designated for production, the USDA-FS and BLM provide leases to private industry to extract resources such as timber, minerals, oil, and gas. Other parts of the Northern Rockies are designated as wilderness by the federal government under the Wilderness Act of 1964 and prohibit human activity with the exception of outdoor recreation. The Northern Rockies is also home to several of the country's flagship national parks: Yellowstone, Grand Teton, and Glacier.

Despite the scale of this protected landscape, wildlife populations, landscape structure, and water quality are still impacted by human activity. Extractive industries carry out projects that fundamentally alter the land. For example, the timber (Figure 2) and mining industries have contributed to soil erosion and water quality degradation (Clark et al., 2004). Infrastructure projects, such as road building to support timber harvest, have also impacted wildlife by fragmenting habitat.

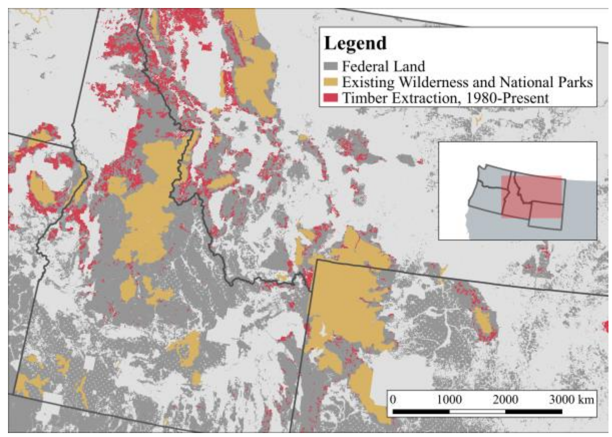

Figure 3 Existing wilderness areas and planned timber leases on U.S. Forest Service land from 1980 onward. Source: U.S. Geological Survey, U.S. Forest Service, U.S. Census Bureau. Map: Beryl Sinclair.

In an effort to manage these impacts, the Northern Rockies Ecosystem Protection Act (NREPA), would enact limits on extractive industries through the designation of new protections. Congresswoman Carolyn Maloney (D-NY) introduced the NREPA as H.R. 1321 to Congress in February 2019, and Senator Sheldon Whitehouse (D-RI) introduced a parallel bill S. 827 to the Senate. In March 2019, each piece of legislation was referred to the House Committee on Natural Resources, Subcommittee on National Parks, Forests, and Public Lands and the Senate

Committee on Energy and National Resources, respectively.

The Northern Rockies Ecosystem Protection Act (NREPA) seeks to add additional protections to federally-owned lands and waterways in the Northern Rockies through several new designations (Figure 3):

- New Wilderness areas, following the Wilderness Act of 1964
- New Wild & Scenic Rivers, following the Wild and Scenic River Act of 1968
- Biological Connecting Corridors
- Wildland Restoration/Recovery Areas

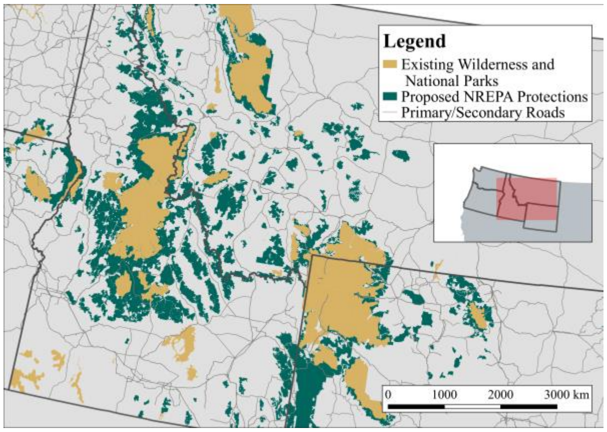

Figure 4 Proposed new designations under the Northern Rockies Ecosystem Protection Act. Source: U.S. Geological Survey, U.S. Census Bureau, Save America's Forests. Map: Beryl Sinclair.

The NREPA proposes stricter protections than are currently in place to address environmental problems such as habitat fragmentation, loss of biodiversity, and ecosystem degradation resulting from the extraction of natural resources. The NREPA makes claims that these protections will improve the long-term health, profitability, and beauty of the Northern Rockies Bioregion for local populations and for all the people of the United States. This report will evaluate the scientific reasoning behind the proposed legislation.

LAND

ENVIRONMENTAL PROBLEMS

The Northern Rockies Bioregion is well known for its beautiful landscapes. However, industries such as mining, timber, and oil and gas have carried out projects that have fundamentally altered the landscape structure. The breaking of large, intact ecosystems into smaller fragments separated by degraded lands has led to a wide range of environmental issues like habitat loss and degradation (Franklin & Foreman, 1987), soil erosion and habitat fragmentation.

The construction of roads and infrastructure to support these industries disturbs the ability of wildlife to move through these areas (Megahan & King, 2004). Fragmentation of natural habitats caused by road construction changes the distributions of both wildlife and vegetation within an ecosystem (McDonald & St. Clair, 2004). The construction of roads around logging sites can also increase the abundance of invasive species that threaten native biodiversity (Tyser & Worley, 1992). Finally, the removal of vegetative cover and leaf litter during road construction accelerates surface soil erosion (Rice et al., 1972).

The Rocky Mountain region has vast deposits of coal, gold, silver, copper, and other minerals, making it an attractive site for mining activities over the 19th and 20th centuries (Butler, 2005). Mining processes in mountain regions require heavy machinery to be brought in and the land to be cleared, altering the topography and composition of the area's ecosystems (Palmer et al., 2010). Furthermore, mining in the Northern Rockies Bioregion has had devastating environmental consequences in the past. An example of this is the Bunker Hill lead smelter, perhaps the region's most infamous, which operated from 1917 to 1981. When operation ceased, the site was highly contaminated and was designated as an EPA Superfund site (Committee on Superfund Site Assessment and Remediation in the Coeur d'Alene Basin, 2005). Over the past 40 years, silver, lead and zinc mining operations have declined significantly, but there are still active operations (US Geological Survey 2018; Hecla Mining Company n.d.; Atkinson 2016).

Nearly 1 million MBF (thousand board feet) of timber were cut on USDA-FS-managed land in the region in 2018 (Haggerty, 2019). In the Cabinet-Yaak area of northwest Montana, there are already over 22,000 acres of clear-cuts, and 3,458 acres of new clear-cuts will be added as the projects in the area continue to develop (Kohler, 2018). While clear-cut logging practices (Figure 4) are less common than in the past, unsustainable forestry practices have increased erosion of soils causing runoff of sediment, minerals, and organic materials (McDaniel et al., 2018; Baron 2002) and have disrupted systems of nutrient cycling and carbon sequestration (Baron, 2002).

Figure 5 Clear-cut logging. Source: geograph.org

Clearcutting impairs the land's future productivity. It increases the light and moisture that reaches the forest floor, adversely altering nutrient cycling properties and causing nutrients to be lost from soils (Baron, 2002). The loss of nitrate (NO_3) levels in the soil after timber harvesting causes the acidity of soil to rise (Jussy et al., 2004), and low pH levels then will affect the activity of microbial biomass in the soil. Microbes transform nutrients bound in the surface into forms available for plant uptake. Therefore, damage to microbial activity can have far-reaching effects on nutrient availability in the soil and impair the soil's future productivity (Entry et al., 1986).

One area that directly shows the impacts of soil erosion due to timber harvesting is the Payette National Forest in Idaho. This mountainous region has supported extensive timber harvesting and associated road construction. The erosion rate in the spring after the first year of road construction was 220 times higher than undisturbed forest slopes in the same region (Megahan & Ketcheson, 1996). Moreover, the average amount of sedimentation after road construction was 45 times higher than the average deposition in undisturbed areas (Megahan and Kidd, 1972).

SOLUTIONS AND CONTROVERSIES

The bill proposes two main solutions to the problems associated with landscape alteration and soil degradation. The first seeks to prevent future damage by designating additional wilderness areas. This would change land management by prohibiting extractive industries and associated infrastructure and would reduce human activity and motorized vehicle access, helping to improve habitat for species.

The prohibition of extractive industry from designating additional wilderness areas comes with some controversies. Since the Northern Rockies Ecosystem's stocks of timber, mineral, and gas resources have been increasingly under pressure from growing demand (Barrera, 2009), the implementation of more sustainable practices emerge as an alternative solution to the problems produced by extractive industries. Because these industries support employment and economic development in the region, the implementation of sustainable industry aims to meet the needs of the human population while reducing the impact on land and wildlife.

Sustainable forestry's goal is to mimic the "natural patterns of disturbance and regeneration" while balancing the needs of the "environment, wildlife, and forest communities" (Rainforest Alliance, 2016). This can be achieved through various practices such as understory thinning, harvests coupled with understory planting, weeding and cleaning, salvage and sanitation cutting, and

CASE STUDY 1: CONTROVERSIES OF ACTIVE VERSUS PASSIVE RESTORATION

The quaking aspen (Figure 5) is of great ecological and cultural importance to the Northern Rockies Bioregion. Aspen are widely-distributed fire-induced successional tree species found across North America (Little, 1971; Perala, 1990; USDA-FS, n.d.) and provide habitat to many species of birds, small mammals and insects (Campbell & Bartos, 2001). In addition, the trees are popular among hikers, naturalists, and campers for their beauty (NPS n.d.). However, aspen stands are declining (Worrall et al., 2008). Severe environmental disturbances like excess ungulate browsing, reduced fires, drought and climate change are the main drivers of this decline (Stevens-Rumann et al., 2017).

Figure 6 Quaking aspen. Image: Nathan Anderson

Stevens-Rumann et al. (2017) compared active and passive restoration strategies for aspen trees in Yellowstone National Park and in Bridger Teton National Forest/Grand Teton National Park. In Yellowstone, the case with passive restoration, there was an increase in the tree population resulting from natural wildfires and wolf reintroduction in the 1990s. The study showed that the wolves controlled herbivore numbers, thus positively affecting aspen growth. In the case of the actively restored Bridger Teton National Forest, controlled fires were used to stimulate tree growth. Aspen stem regeneration increased more in places with controlled fire treatments. The authors concluded their study with recommendations for pursuing context-dependent research before carrying out either aspen restoration strategy in areas across the Northern Rockies.

prescribed fires. Utilizing these treatments would allow some timber to be harvested without significant damage to the environment, enabling the ecosystem to provide a range of services while satisfying the demand for timber (Woodworks, 2011).

Mining is inherently less sustainable because it involves extracting a finite resource and produces persistent contaminants as by-products. The goals of sustainable mining are to reduce the impacts of the extractive process and to aid in subsequent ecosystem restoration. Technologies that can minimize the environmental impact include suppressing the dust that gets into the atmosphere and storing impermeable tailings to prevent toxic leaching (Gorman & Dzombak, 2018). By banning extractive industries on protected areas, the 2019 NREPA comes into conflict with local businesses who depend on these activities for their livelihoods, regardless of whether their practices are more or less sustainable.

The second solution proposed by the NREPA seeks to restore already degraded areas by using the designation of Wildland Recovery Areas. There are different ways to restore environmentally degraded areas. Active restoration involves management strategies like planting native vegetation and controlling invasive species. In passive restoration, no action is taken apart from the interruption of the exploitative activity taking place on the site. The area is then allowed to reestablish itself on its own (McIver & Starr, 2001). Although both techniques have been carried out in several cases (Meli et al., 2017), there is no consensus as to which is more efficient or appropriate. The NREPA advocates for active restoration, in part because this activity would provide an economic stimulus to the region, a case study on quaking aspen populations in the region demonstrates the debate over the active restoration approach (Case Study 1).

Although there is a lot of information on active and passive restoration strategies across the world, there is no conclusive answer as to which strategy is more effective. Meli et al. (2017)

conducted a meta-analysis of 166 restoration projects and showed that passive restoration can be a better option in some cases, especially because passive restoration generally has much lower costs. However, this study emphasized the need to continue doing more research because it is likely that the success of one strategy over another depends on the metrics for success – for example, biodiversity, biogeochemical cycles, soil composition, etc. Moreover, it is important to consider the broader economic impacts of each strategy: active restoration under the NREPA would create employment opportunities that can benefit local economies and could accelerate ecosystem recovery to meet the other stated goals of the bill.

WATER

ENVIRONMENTAL PROBLEMS

Rivers in the Northern Rockies region are facing pollution and other impediments from human activities such as oil and gas extraction and metal and mineral extraction. Oil and gas extraction, which is a major source of revenue in the region, has been linked to the intensive exploitation and contamination of important groundwater basins and watersheds (Warziniack et al., 2018). Oil spills, pipeline leaks, and hydraulic fracturing can cause chemicals to accumulate in freshwater bodies, thus harming aquatic life and compromising the quality of the resource for human use (EPA, 2016).

Another driver of water pollution in the Northern Rockies is metal and mineral extraction. The region has vast deposits of coal, gold, silver, copper and other minerals in the riverbeds and underground, making it an attractive site for mining activities over the past two centuries (Butler, 2005). Toxic chemical waste produced during mining activities has detrimental effects on water quality and aquatic life. This threat may continue to exist even after mining sites are closed, best exemplified by the Gold King Mine disaster in August of 2015. An accident during an investigation of a leak caused one million gallons of wastewater containing heavy metals, including lead and arsenic, to enter a tributary of the Animas River, posing a serious risk to drinking water in the creek (Daniel, 2015).

One of the biggest mining communities in the Northern Rockies is the Silver Valley around the South Fork of the Coeur d'Alene River. The region has rich deposits of silver, lead, and zinc (National Research Council of the National Academies, 2005).

The main sources of contamination from the silver mines are mine tailings, or the rock and sludge leftover after extracting the ore. During early years of operation, these tailings, which contained 75% of the metals in the ore, were directly discharged into the river (National Research Council of the National Academies, 2005). These metals, mainly lead and zinc, accumulated in the sediments in the riverbed and poisoned fish (Clark et al., 2004). The increased concentration of zinc also posed health threats to humans who drank the water and ate the fish, with children particularly at risk due to impacts on neurological development.

Due to the severe contamination and declining markets, operations in the Silver Valley near Coeur d'Alene have decreased over the past 40 years. However, two large mines - the Lucky Friday Mine and the Galena Complex- are still active and present pollution risks to the river. Though present mining operations export ore rather than smelting it on-site, ore debris, which has a high concentration of lead, and gangue, which contains highly toxic minerals such as arsenic, are still produced and impair water quality. In 2015, these two mines alone produced 6.8% and 11.8% of US-produced lead and silver respectively (US, Geological Survey 2018; Hecla Mining Company n.d.; Atkinson, 2016). According to a 2001 National Water Quality Assessment study of the area, several metals, such as lead concentrations in streambed sediment from the South Fork and Coeur d'Alene Rivers were among the highest one percent of national concentrations (Clark et al., 2004). The lead concentration along the river was mostly higher than 1500 ppm (Figure 6). Thus, the Coeur d'Alene River is still highly susceptible to the pollution from metal and mineral extraction.

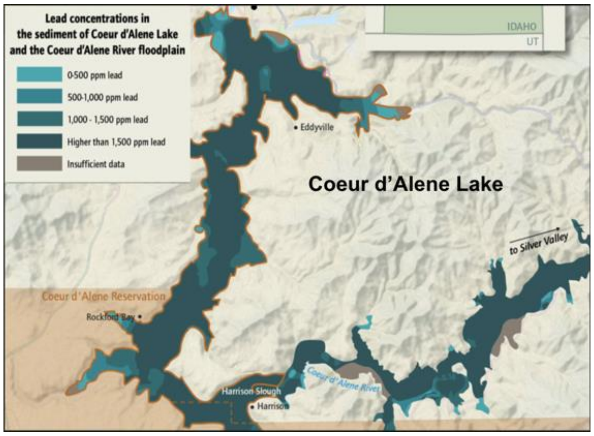

Figure 6 Concentration of lead in the sediment of Coeur d'Alene Lake. Darker blue means higher concentration. Source: High News Country

CASE STUDY 2: WATER CONTAMINATION IN THE SMITH RIVER AND KLAMATH RIVER

To show how a Wild and Scenic designation would protect rivers, two rivers are selected here for comparison: Smith River in Montana, a 12-mile portion proposed to be designated as Wild and Scenic under NREPA, and the Klamath River on the California-Oregon state border, a designated Wild and Scenic River since 1981. Both rivers faced historical and current threats from mining but received different levels of protection.

The Smith River watershed includes a large copper mining claim known as Black Butte Project (Save Our Smith, n.d.). The development of this project would likely pollute the river by creating acid mine drainage, which is formed when underground sulfuric acid is exposed and reacts with water during mining operations. This drainage that contains toxic metals would flow along the Sheep Creek, arrive at the Smith River quickly in less than 5 hours, and pollute the water (American Rivers, 2017). Water quality and aquatic life could both be threatened by these pollutants.

The Klamath River faced similar risks from mining pollution but was successfully protected after being designated as a Wild and Scenic River in 1981. The Lighthill mining project, which began in 1933, is in the river corridor of the Scott River, a tributary of the Klamath. The company possessed full rights to conduct copper mining activities and access to the surface water in the area. However, after the Klamath River was designated, the Bureau of Land Management (BLM) limited the company's rights to surface uses required for mining (Interagency Wild and Scenic Rivers Coordinating Council, 2002).

The Wild and Scenic River designation also protects the Klamath River from dams. To meet demands for irrigation and hydropower, the PacifiCorp electric power company constructed six dams along Klamath River before designation from 1911 to 1967. The intense use of agricultural chemical in the upper basin and the presence of dams, created warm and stagnant water pools, causing extensive algal blooms in Klamath river (Otten, 2015). However, the water quality improved after designation prohibited further dam building and regulated agricultural practices. In the early years of designation, annual mean water temperature was still about or above 14.8℃, which is the max allowable temperature for juvenile fish population. Nevertheless, data in recent years (2017-2018) shows large improvements by stabilizing the temperature around 13℃ (Figure 7) (Wallace, 1998, Sauter et al., 2001, U.S. Geological Survey, n.d.).

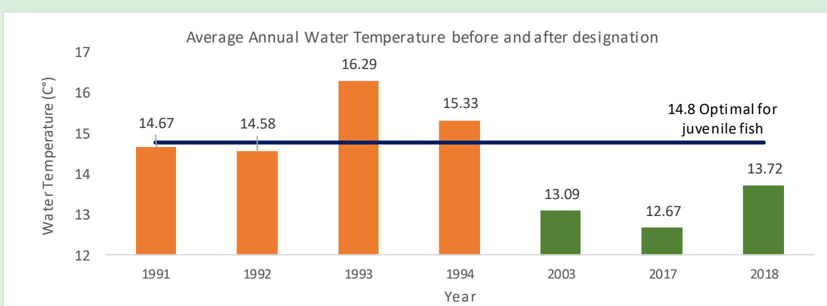

Figure 7 Average Annual Water Temperature of the Klamath River before and after designation. Source: BLM

Therefore, in the Smith River's case, a Wild and Scenic River designation could mitigate or eliminate certain levels of pollution sources by regulating the Black Butte Copper Mining in the short run and maintaining the river quality by prohibiting future harmful projects in the long run.

SOLUTIONS AND CONTROVERSIES

Like the Coeur d'Alene, many other rivers in the Northern Rockies are facing threats from mining. One solution to protect these rivers is to designate them as Wild and Scenic Rivers (WSR). The national Wild and Scenic River System, which was created in 1968, designates all or portions of a river into three classifications: wild, scenic or recreational. Designated rivers are free to flow without obstruction, have cultural significance and have good water quality. To ensure the river meets water quality standards within each state and with the federal Clean Water Act, the WSR designation protects the rivers and riparian areas from any activities that reduce flow, damage the shoreline, or pollute the waters, within 0.25 miles of the riverbank, such as the disposal of mining waste, hydraulic fracturing, and timber extraction (Palmer, 2017).

The NREPA seeks to designate approximately fifty-four rivers or sections of rivers under the Wild and Scenic Rivers Act. These proposed rivers are mostly susceptible to impairments such as unnaturally high-water temperatures, nutrient loading, waterborne pathogens, sedimentation, metals, mercury, and polychlorinated biphenyls (PCBs) from extractive industries, municipalities, and agriculture (Interagency Wild and Scenic Rivers Coordinating Council, 2018). Once designated, monitoring stations will be established to measure certain water characteristics such as temperature, dissolved oxygen, pH, nitrate levels, and turbidity. If those measurements fall below standards, a plan will be created to remediate and reverse the degradation of water quality (Maguire, 2001). Moreover, if during an initial assessment a point-source of pollution is identified, remediation could include working with the source polluter to eliminate that pollution (Mohr, 2015).

By maintaining water quality, Wild and Scenic River designations also protect aquatic life. In 1998, the bull trout native to the Coeur d'Alene River was listed as a threatened species under the Endangered Species Act, with an estimated effective population of just 180 bull trout (U.S. Fish & Wildlife Service, 2003). The declining population was mainly caused by dams, which impede the bull trout's migration, and mining operations, which impaired the water quality, channel stability and cover (U.S. Fish & Wildlife Service, 2003). The free-flowing conditions and water quality guaranteed under the Wild and Scenic River Act can help limit these harmful human activities and protect habitats for aquatic life.

WILDLIFE AND BIODIVERSITY

ENVIRONMENTAL PROBLEMS

The Northern Rockies Bioregion is one of the largest and most-intact landscapes of the United States that supports a rich diversity of organisms including birds, mammals, butterflies, reptiles and conifers (Ricketts et al., 1999). The Northern Rockies ecosystem also provides a sanctuary for several threatened or endangered species such as the Canada lynx which inhabits in the Rocky Mountain National Park, Colorado (Whitehouse, 2019; U.S. National Park Service, n.d.). However, activities such as mining, timber harvesting, and oil and gas extraction have adversely impacted the habitats and populations of wildlife in the region.

Extractive activities in the Northern Rockies such as clear-cut timber extraction and mining causes deforestation and land conversion which changes the landscape by altering the topography, hydrology, and composition of the area's ecosystems (Palmer et al., 2010). Ultimately, this leads to the degradation of habitat quality which severely reduces populations, and in some cases, increase extinction risk. Moreover, deforestation can leads to isolation within many protected areas, with terrestrial 'islands' surrounded by low-quality degraded lands (Wiens, 1989; Harris, 2013). The creation of roads facilitates the invasion of non-native species throughout the Northern Rockies because roads both alter terrestrial and aquatic habitat and provide new corridors for their movement (Trombulak et al., 2000).

More significantly, road development to support extractive industries also modifies the landscape breaking up large, intact ecosystems into smaller fragments (Franklin & Foreman, 1987). This habitat fragmentation creates barriers to wildlife movements, thus changing patterns of distribution in an ecosystem (McDonald & St. Clair, 2004). This separation of populations or segments of populations has both genetic and demographic consequences. It can lead to both population reduction and isolation, which can result in genetically distinct subpopulations through genetic drift (Fahrig, 2003). Both reduction and isolation of populations can result in inbreeding and potentially decreased fitness or adaptability in response to ecological disturbances (Fahrig, 2003; McDonald & St. Clair, 2004).

The effects of fragmentation have been documented on a variety of species in the Northern Rockies ecosystem, including caribou, gray wolves, anadromous fish and grizzly bears (Fahrig, 2003). In the case of the grizzly bear (Figure 8), their range once extended from northwestern Canada south through Mexico and from the West Coast to the Great Plains.

Figure 8 Grizzly Bear in the Greater Yellowstone. Source: American Forests

Habitat degradation and fragmentation due to human settlement, roads and industries combined with unregulated hunting, reduced the grizzly bear population to 2% of their original range (Kendall et al., 2013). Now, grizzly bears are isolated in remnant disjunct populations across the Northern Rockies region, specifically Montana, and throughout Northwestern Canada and Alaska (Figure 9; U.S. Fish and Wildlife Service, 1993; Kendall et al., 2013).

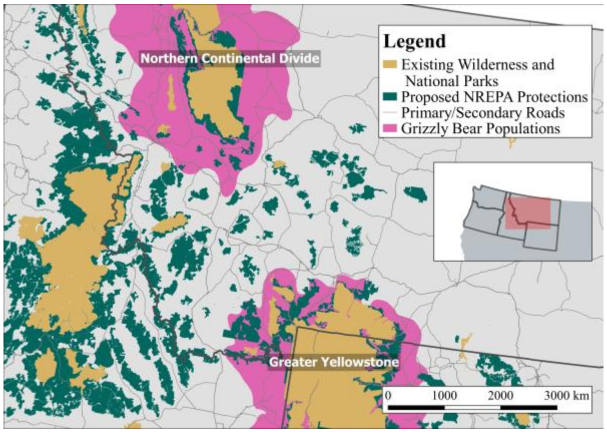

Figure 9. Grizzly bear populations from 2004-2014 in the Northern Continental Divide Ecosystem and from 2002-2016 in the Greater Yellowstone Ecosystem. Source: U.S. Geological Survey; U.S. Census Bureau; Montana Fish, Wildlife & Parks; Interagency Grizzly Bear Study Team. Map: Beryl Sinclair

Major roads such as the Route 93 highway which extends through Idaho and Montana can directly threaten bears from direct vehicle collisions, but traffic and other road disturbances can limit them from accessing food and mates (Mott, 2018). This reduces their growth potential. In fact, grizzly populations that have been fragmented are genetically distinct due to increased inbreeding, and their population is not likely to recover naturally due to the decreased range and reduced genetic variability (Proctor et al., 2011).

Another negative impact of natural resource extraction in the region is pollution. The rivers, lakes, and reservoirs of the Northern Rockies are known for their excellent water quality and abundant aquatic life (Clark et al., 2004). Road construction for timber harvesting can increase sediment loads into surface water systems like the Silver Creek River in Idaho. The Silver Creek River supports a high abundance of wildlife from trout and waterfowl to deer and elk (The Nature Conservancy, 2019). Sediment from timber operations clogs spawning grounds in gravel streams and in high levels that are lethal to fish (Perrigo, 2006).

SOLUTIONS AND CONTROVERSIES

The NREPA proposes three avenues to address the environmental problems impacting wildlife in the Northern Rockies. The first is the designation of wilderness areas under the 1964 Wilderness Act. Wilderness designations help preserve functional ecosystems and vast landscapes that support wildlife populations and the free-flow of water. By protecting ecosystems, wilderness areas play an important role in the provision of ecosystem services like tourism, water quality regulation, and climate control. Wilderness designations protect the vast habitat of large carnivores like the grizzly bear in the Greater Yellowstone and Northern Continental Divide ecosystems. The designation requires changes in land management including prohibiting commercial activity, motorized vehicle access, and roads, structures, and facilities. Protections from these activities have been linked to improved habitat quality for the grizzly bear (Proctor et al., 2018).

Biological corridors designations, the second solution proposed by the bill, are intended to bridge the ecological gaps between fragmented and protected areas by creating physical pathways for wildlife movement. The Greater Continental Divide and Greater Yellowstone ecosystems of the Northern Rockies, for example, each of which spans multiple wilderness areas and lands with varying levels of protection, need physical connections to maintain their biological diversity and ecological health (Rosenberg et al., 1997). Biological corridors would be managed to provide navigable passage (e.g. by protecting woodland and dense forests) for isolated elk and grizzly bear populations in this region (Figure 10).

CASE STUDY 3: THE AMERICAN BISON

After decades of extensive hunting, the American bison (Figure 12) population reached near extinction in 1902 until it became actively managed and protected within Yellowstone National Park. Over the last 115 years, the Yellowstone population has increased to over 4,500 individuals, growing at a rate of 10-17% every year (National Park Service, 2019). Bison are grazing animals, often migrating throughout the northern half of the park in search of foraging areas. Yet, the park is not enclosed and the movement of the growing bison population in search of food – particularly at low elevation areas during the snowy winter season – has led to migration out of the National Park and onto outlying state and private lands, causing conflicts.

Figure 7 The American Bison. Image: Eva Blue

The natural winter range of the bison, mainly in Montana to the north of Yellowstone, has largely been cut off by agricultural, residential, and recreational development. In addition to the fear of these large mammals coming into residential areas and causing property damage, there is ongoing friction between Montana cattle ranchers and the bison. The bacterial infection brucellosis, though originally from cattle, has been found in the Yellowstone bison populations. The disease causes early abortions in female cattle. When bison migrate onto livestock ranches in Montana, there is a possibility of ranchers not being able to sell their cattle because of the risk of violating animal health and safety standards. Bison movement outside of the park also results in overgrazing of private and state-owned grasslands, creating further conflict with ranchers (White et al., 2015).

In 1995, the conflict reached a boiling point when the state of Montana sued the National Park Service for the persistent encroachment of bison onto state and private land. The lawsuit resulted in the Interagency Bison Management Plan, a multi-agency effort to manage the Yellowstone bison population and keep the population at 3,000 individuals. This requires bison culling, which is unpopular but currently the most effective strategy for population control. Bison population growth and migration exemplify the potential future conflicts between recovering wildlife populations and humans' economic interests in surrounding state and private lands (National Park Service, 2019).

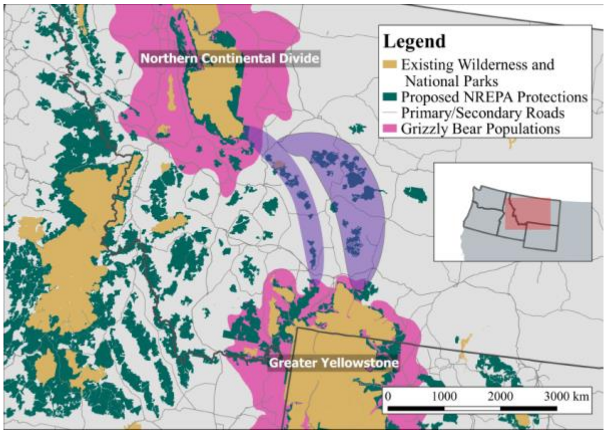

Figure 10. Proposed Biological Corridors (in purple) for grizzly bear populations from 2004-2014 in the Northern Continental Divide Ecosystem and from 2002-2016 in the Greater Yellowstone Ecosystem. Source: U.S. Geological Survey; U.S. Census Bureau; Montana Fish, Wildlife & Parks; Interagency Grizzly Bear Study Team. Map: Beryl Sinclair

In addition to allowing for population movement, biological corridors facilitate ecological processes such as predation, grazing, finding mates, and finding refuge (Walker & Craighead, 1997; University of Montana, n.d.). Moreover, these corridors improve the genetic diversity and the size of effective populations necessary for the long-term evolutionary potential of any species, irrespective of species dispersal abilities or population sizes (Christie and Knowles, 2015; Frankham et al., 2014). Corridors between the Continental Divide and Greater Yellowstone, as proposed in the Act, would prohibit timber harvest and new leases for mining, oil, and gas exploration or road construction.

The development of effective biological corridors involves determining the least-cost path that will maximize survival during wildlife movement. The least-cost path determines the path through the most suitable connected habitat with the fewest human-related impediments such as roads. This method uses algorithms in combination with geographic information system (GIS) technology to map routes with the lowest cumulative resistance between target locations (Parks et al., 2013). Overall, this process produces maps that guide protected area managers, including federal agencies, in identifying areas to designate as biological corridors. The implementation of biological corridors informed by ecological models could reduce the effects of habitat fragmentation, increase genetic diversity and decrease the probability of species extinction.

Lastly, for areas in the Northern Rockies region that are degraded by extractive industries, the bill proposes to designate over one million acres as wildland restoration and recovery areas. Wildland restoration and recovery areas would be designated in areas that have been degraded and thus cannot be considered wilderness. These areas will prohibit damaging timber practices and road development to encourage recovery to their wilderness character and ecosystem function (Whitehouse, 2019). One of the main rehabilitation strategies for this region will be restoring wildlife habitat such as native forest cover, which will require active management of soils. For example, adding soil amendments during seeding of native plants to former mining sites with compacted or degraded soils could significantly increase the drainage, aeration, nutrients and fertility (Burger & Zipper, 2018; Cohen-Fernandez & Naeth 2013). Consequently, these conditions encourage vegetation growth and thus improve wildlife habitat on degraded lands.

Another rehabilitation method is the re-introduction of key native species into the Northern Rockies that are crucial in restoring ecosystem health. For example, the gray wolf (Figure 11) is considered a very important species to the Northern Rockies ecosystem thanks to its role in controlling ungulate prey levels and more indirectly other plant and animal diversity (Defenders of Wildlife, n.d.).

Figure 11 Gray Wolf. Image: Yannick Menard

However, despite the noble ideals and benefits the bill, there are controversies surrounding the strategies proposed for conserving and restoring the Northern Rockies Ecosystem. Species reintroductions and biological corridor designations which will help to connect species populations in the region, as proposed in the NREPA, will increase movement and species genetic exchange - ultimately increasing populations numbers. One controversy arising from this occurrence is human-wildlife conflict. Tensions ensue when successful population recovery and wildlife movement threaten or are perceived to threaten the safety of the livestock of commercial ranchers. The case study on the American bison (Case Study 3) demonstrates this human-wildlife conflict in the Northern Rockies. Additionally, despite least-cost path modeling which will guide biological corridor designations, there is a risk that wildlife species such as grizzlies and elk would not utilize these movement pathways.

MEASURING SUCCESS

The NREPA establishes several desired outcomes that can be monitored to measure the success of the bill, one of which includes protecting native species. This means protecting key wildlife species that can act as an indicator for the health of all other plants and animals that also fall within the same spatial range and its habitat (Block et al., 2001). The Canada lynx (Figure 13) is an example of such an umbrella species in the Northern Rockies. Canada lynx, protected under the Endangered Species Act, have higher rates of reproductive success in multi-storied, mature forests, indicating their co-dependence with healthy forests (Holbrook et al., 2019).

Figure 83 Canada Lynx in the Rocky Mountains. Image: Chris Talbot-Heindl

Very High Frequency (VHF) radio collars and GPS collars have been used to track Canada lynx individuals in order to study their natal dens and count their litters (Holbrook et al., 2019. Furthermore, due to the relationship between Canada lynx and multi-storied mature forests, lynx-specific habitats are measured as part of the conservation strategy for the lynx (Interagency Lynx Biology Team, 2013).

The success of Wild and Scenic River designation can be measured by monitoring different aspects of water quality and the health of native species. For rivers that were impaired by runoff from mining sites, the percentage of trace elements in sediments can be monitored to measure whether the harmful influence has been mitigated (Clark et al., 2004).

Finally, the improvement of land productivity can be measured by the species composition of its vegetation, as well as the structural complexity and diversity of the entire landscape. A key indicator of this whole-landscape complexity is its heterogeneity or varied spatial mosaic. Increasing horizontal complexity or increasing the spatial variation of patterns of vegetation on both stand and landscape scales, is an important restoration goal for the fire-dependent landscapes of the Northern Rockies that have been overly homogenized by timber extraction (Dickinson et al., 2016). Decreasing canopy denseness and increasing "patchy" forest cover better mimics the historical conditions of old-growth forests that depended on low and midseverity fires for maintenance (Addington et al., 2018). A study in the Colorado Front Range monitored the desired outcome of spatial heterogeneity by using a combination of indicators such as vegetative indices and other classification techniques through digital imagery (Dickinson et al., 2016; Lentile et al., 2006). This method could be applied to the Northern Rockies to track the success of landscape-scale restoration efforts over time.

CONCLUSION

The environmental problems facing the Northern Rocky Bioregion are diverse and interconnected. The legacy of generations of natural resource extraction and human settlement has fragmented the landscape, decreasing habitat connectivity and gene flow. Loss of habitat quality has led to a rise in invasive species and loss of native biodiversity. The physical conditions of waterways and soils have been impaired by the legacy of mining and associated contamination.

The NREPA will improve protections for federal land to protect the ecosystem services and biodiversity of this region. These new designations will work together to preserve the ineffable "wilderness character" and "ecological integrity" that the bill proposes to achieve. These outcomes would be achieved by the designation of new wilderness areas, wild and scenic rivers, biological connecting corridors and wildland recovery areas.

The bill calls for the establishment of an interagency team, composed of equal numbers of participants from the public and private sectors, to monitor, evaluate, and make recommendations to improve long-term results. The team will develop a geographic information system (GIS) to monitor the Northern Rockies Bioregion, including vegetation cover, human impacts, water, and air quality, and activities that bear on forest husbandry and restoration. The system must also produce status reports on the progress of ecosystem protection, corridor consolidation, forest recovery, and populations of threatened and endangered species. The team must also assess the potential to facilitate wildlife movement across or under major highways or rail lines within the biological connecting corridors.

Ecological measures of success would be developed to monitor the restoration of degraded landscapes and "wilderness character" in the Northern Rockies. Key indicator species are an example of a type of biological indicator that could be used to measure overall ecosystem health. Measuring the range, dispersal, and population dynamics of an umbrella species of wildlife such as the grizzly bear, lynx, or gray wolf can provide an indicator of the success of the native species that occupy the same range. Monitoring forest health through the spatial distribution of specific tree types, such as aspen and conifers, will likewise indicate the health of the native habitat. Measurements of water quantity and quality will indicate the health of aquatic species and riparian.

The NREPA is an expansive piece of legislation that seeks to protect an entire region of the United States to provide long-term ecological benefits on a large scale. The scientific basis of this legislation stems from an attempt to connect some of the last remaining roadless areas in the United States to protect vital habitats for critical species, preserve the ecological integrity of the land, and protect wilderness character of lands and waters with minimal human impact. The ecological benefits of such sweeping protections have been illustrated in this report, but the economic impacts of such changes have not been considered. From a conservation standpoint, however, the scale of the NREPA would have all encompassing and long-term benefits for the land, water, and biodiversity of not just the Northern Rockies, but the rest of the country and the world.

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