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**RARE EARTH AT BEARLODGE:
EXTRACTIVE MINERAL DEVELOPMENT, MULTIPLE USE
MANAGEMENT, AND SOCIO-ECOLOGICAL VALUES IN THE
AMERICAN WEST**

A dissertation submitted in partial satisfaction
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ENVIRONMENTAL STUDIES

by

Jeffrey S. Jenkins

June 2016

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Abstract

Rare earth at Bearlodge: Extractive mineral development, multiple use management, and socio-ecological values in the American west

Jeffrey S. Jenkins

Mining is recognized as the "highest and best use" of U.S. Forest Service lands that are also designated for multiple use through statutes that often give precedence to extractive mineral development over local livelihoods and recreation. The complexity associated with governance of these lands arises from the need to reconcile political-legal mandates with the cultural, economic, and other interests of different stakeholders (i.e. agency decision-makers, public land users, and market interests) and the changing natural processes shaping the landscape (e.g. ecological, geologic, hydrologic). Theory from political ecology and socio-ecological systems provide a framework to understand the natural resource management challenges of public lands in an era of increasing resource demand, ecological scarcity, changing climatic conditions, and land use conflict. Together these fields of study have not explicitly addressed how different valuation methods and stakeholder values towards nature shape management of common property resource public lands with a dual mandate of extractivism and conservation. My research fills this gap with the case of a proposed rare earth mine in the Black Hills National Forest - the nation's first multiple use public land - to show how the value and values associated with one use and the many compete. My focus takes three parts: 1) the historic role of the regulatory state in creating conditions for present day land use conflict; 2) the competing economic and

environmental perspectives that emerge from public participation in environmental review; and 3) a comparison of social and ecological valuation techniques to assess commensurability in the acquisition of additional land for the siting of mine waste. Methods used in this research include: geographic information systems, archival data collection, Q-sort discourse analysis, real estate property valuation, ecological diversity transects, and recreational user surveys. Findings from this research indicate that project decision-making between land managers, land users, and market forces could be greatly bolstered by integrating economic, ecological, and socio-cultural valuation techniques with competing biocentric and anthropocentric stakeholder perspectives, and by realizing the historical role that the regulatory state plays in shaping present day outcomes.

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Introduction

Contested terrain of extractive industries in the American West

The American west has seen a resurgence of capital investment in extractive mineral development on federal lands, emanating from the recent global financial crisis. For instance, between 2007 and 2013 Wyoming's overall gross domestic product increased by 12.6 percent while gross domestic product contributions from the mining sector increased by 25.7 percent resulting in mining making up 34.3 percent of the 2013 state economic output. Mining made up between 5 and 10 percent of the 2013 gross domestic product for Colorado, Nevada, New Mexico, and Montana, and this lower figure, though still a significant economic sector, may be due to more diversified economies emanating from larger urban population centers (BEA 2014).

For extractive projects, like with energy development more broadly, struggles over knowledge persist in the pre-operational phases of exploratory access and environmental review when political-legal rights and scientific facts are coordinated, codified, and contested. Through the lens of first-world political ecology themes related to rural land use conflict and access to resources include community-based resource management, the question of competing scientific and lay knowledge systems, and intersecting processes of social and environmental marginalization (McCarthy 2002, Schroeder, Martin and Albert 2006). In terms of knowledge and power, local claims stand in contrast to the political, legal, economic, and historical

interests of the state and corporation when they converge or diverge around how nature works (ontological constructs of biophysical reality and ecological interrelationships), and who controls the environment (political-legal claims to natural resources informed by competing epistemologies and sets of values) (Benson 2012, Robbins 2006). And in the case of subterranean extraction, or what Bebbington and Bury (2013) refer to as a "political ecology of the subsoil", political scale, claims to ownership, and how knowledge is constructed about proximate and ultimate causes of environmental degradation are further embedded in the social terrain.

Political-legal systems have emerged at various scales as a way to regulate the contradiction between capital accumulation and degradation to natural processes that underpins the material production of society, however the distribution of these outcomes is often indirect, unjust, or marginalizing which is why conflict persists despite the many forms of governance (Bridge 2000, O'Connor 1988). Stakeholders from community, market, and state groups share knowledge and exhibit power over one another in various ways across the political-legal landscape through co-management, public-private partnerships and private-social partnerships at different scales (Lemos and Agrawal 2006). A regional scale perspective of governance regimes provides theoretical utility because it can "emphasize that 'local' politics are shaped by [and shape] broader economic, social, and environmental forces ... [and that] political ecology is most distinctive and powerful when it ascends in explanation from the site of environmental interaction through scales of individuals, households, communities, regions, and states" (Walker and Fortmann 2003).

In the American west the economic structure of rural communities has important ties to social structure and demographics; livelihoods are linked to the region's competing land uses, either associated with natural resource extraction or amenity-migrant economies (Robbins *et al.* 2009). The boom and bust of the minerals extraction industry influences the expansion and contraction of community social structure and local economic activity, which in turn is driven by a combination of regulations, land ownership, commodity prices on the global market, technological innovation and geophysical setting (Aschmann 1970, Gulliford 1989, Hostetter 2011). "Ecotransformation" describes the economic and environmental transformations jointly taking place in rural areas, specifically the American west; global economic restructuring has shifted the region's extractive resources base, including timber, mining, agriculture, and livestock to economies that rely on the amenity-value of the landscape in the form of exurban housing, recreation tourism, and service-based industries (Duane 1999). One caveat to this simplified explanation, is that this economic shift is no longer bifurcated neatly between the 'old' extraction and the 'new' amenity. Rather, the 'next' west will be neither the 'old' west of commodity-extraction dependent communities nor the 'new' west of amenity-driven communities, it will continue as a hybrid of the two where macro-level factors such as cheap credit, costly energy, and climate change contribute to local land use conflicts. In the context of extractive development, there will be increasing pressure for the federal government to lease lands for energy development or delegate authority to the state; increasing pressure for energy development in response to high

prices (e.g. oil) or decreasing production costs (e.g. natural gas in shale); increasing opportunity to trade federal lands that are suitable for energy development for private lands that are critical for ecosystem conservation; and increasing pressure for domestic strategic mineral development (e.g. rare earth elements) (Duane 2012).

The regional scale of analysis is a core conceptual tool in political ecology because it heuristically sets the discipline apart as a field (or subfield) based on *what* is to be explained: interactions of power and agency, socioecological processes, and stakeholder networks, particularly as it relates to scalar politics of the state's control over access to resources and the environment (Neumann 2009b). The use of a middle ground allows one to adopt a type of scalar gaze in response to ecological events where one is disabused of a priori assumptions, theories, or biases about the importance of some type of political factor as an explanation of environmental change (Vayda and Walters 1999). The concept of a region allows the inquisitor to enter the issue in need of explanation at any given level so long as it is relative to both larger and smaller scales of causation with degradation as both the start to and end of the story. Region is particularly pertinent in issues of natural resource or land use conflict. As Neumann (2009a) points out in reflection of Blaikie and Brookfield's (1987/2015) work on regional political ecology, regions take on the ontological position of 'things' transformed by external forces (local and global), and this is especially the case of commodity-producing regions that are as discursively produced as they are materially produced through state regulations, global markets, and local livelihoods that reproduce social and ecological relationships (Jenkins 2011).

The Bearlodge rare earth mine is proposed for development in the Wyoming portion of the Black Hills N.F. and the mining corporation, Rare Element Resources recently received approval for the final draft environmental impact statement by the Forest Service. Mineral development for rare earths will likely take place in the Bearlodge due to the National Forest Management Act and the 1872 Mining Law which together facilitate hardrock mining as the "highest and best use" of federal lands (Glicksman and Coggins 1997). It is no surprise that many of the citizens who reside in Sundance, the closest city to the proposed project, are in favor of the mine for economic development, and a coalition of environmental groups oppose the mine due to issues such as groundwater impacts. However, the primary opposition to the mine has come from those engaged in multiple use activities – primarily hunting, off-road vehicle use, and cattle grazing – whose access to the land will be curtailed by the mine, if developed. An analysis of public comments demonstrates that these land users are anthropocentric conservationists because: they hold their own economic development above biodiversity; believe that nature has never been pristine and so does not need to be restored back to any particular point; recognize the resilience of nature even in light of direct human disturbance; and don't believe biocentric preservationists are acting in the best interests of the American public (Doak *et al.* 2014). With this in mind, it's important to note that well-known environmentalists throughout history (e.g. Thoreau, Muir, Leopold, etc.) worked land for their own utility while simultaneously advocating for protection of wild lands (Kareiva *et al.* 2012). It's important to recognize the continued role anthropocentric resource users

will have to play in conserving lands prior to, during, and after extractive development has occurred, especially as coalitions under the banner of formal environmentalism continue to be entangled in the constant cycle of litigation.

The Black Hills N.F. was the nation's first multiple use landscape; Gifford Pinchot treated the Black Hills N.F. as his flagship forest to test multiple-use principles when the U.S. Department of Agriculture became responsible for the national forest system in 1905 (Geores 1996). In terms of land ownership, the Black Hills N.F. is one of the most fragmented national forests in the country; 101,000 hectares out of the 485,000 hectares managed by the Black Hills N.F. are private land, most of these inholdings were initially acquired through homesteading prior to the national forest designation and are now used for cattle grazing. Despite being one of the smaller national forests, the Black Hills N.F. is the highest yielding timber producer in the system; in 2009 the Black Hills N.F. produced 112 million board feet [34 million cubic meters] of lumber (USFS 2011). One-fifth of all deer and one-third of all pronghorn harvested in Wyoming come from the area surrounding the Bearlodge Mountains – a unit of the Black Hills N.F. - and between 2010 and 2012 there were 161 mountain lions legally hunted within the forest and among surrounding lands (Thompson 2013). Today, many of the local land users in the Black Hills N.F. still perceive of the landscape as a "working wilderness", however the level of human intervention, biodiversity loss, and degradation from off-road vehicle use, hunting, fire suppression, and timber production makes this

anthropocentrically conserved landscape a far cry from a place "untrammelled by man, where man himself is a visitor" (Brown and Cook 2006, Sayre 2005).

In chapter one I make the claim that present day land use conflict between mining and multiple use is contingent upon federal lands management regulations that are embedded in the landscape over time, and in contradiction with other eras of common property resources. To test this claim I ask: *How is current land use conflict contingent upon previously existing political-legal and economic geographies of the regulatory state?* I demonstrate how the regulatory state attempts to overcome social and ecological contradictions embedded in property over time through different common property resource regimes: the disposal of single use property for homesteading; the enclosure of natural resources through the creation of the forest system; the allocation of subsurface rights through surface exploration; and the current period of scientific management. Sectional records from Bureau of Land Management archives are used to reconstruct the historic land tenure to show how political-legal regimes of state regulations can be unevenly embedded in the landscape. These findings demonstrate that land use conflict emerges where social and ecological contradictions are not sufficiently reconciled.

In chapter two I operate under the premise that tension between civil society, the mining corporation, and the state as dual regulator/facilitator of natural resource development is most apparent during the public comment period of the environmental assessment process. Such is the case with the Bearlodge mine in the Black Hills National Forest of Wyoming, which has the potential to be the only domestic

producer of critical rare earth elements. Therefore, I ask: *How do perspectives about control of and access to common property resources, and the role of humans as part or separate from an ecological system converge or diverge between community, state, and market stakeholders?* To answer this, a Q Method survey was carried out from groups representative of the different economic and environmental perspectives related to mining development: environmentalists, the mining/energy sector, state/federal regulators, foresters, local land holders, and recreationalists. Results show that stakeholders fall into two categories: anthropocentrists who desire economic development from the mine for human benefit, even given the potential for environmental harm and curtailed access to multiple use activities; and biocentrists who continue to push for a no development alternative where nature is preserved for nature's sake and existing livelihoods that help to maintain an already altered environment are able to remain and sustain rural economies.

In chapter three I take an interdisciplinary approach to understand the trade-offs of value in a land exchange associated with mining development. Land exchanges were originally envisioned to promote forest regrowth and conserve ecological function through contiguous lands management. The land exchange process is also used to acquire property needed for mineral extraction, tailings waste piles, and associated infrastructure within or adjacent to public lands. Whether exchanges are equitable hinges on the commensurability of economic (property), ecological (functional habitat), and socio-cultural (recreational) values. This chapter uses the case of the Black Hills National Forest - where a rare earth mine is proposed

and where a land exchange was carried out between Rare Element Resources, the Moskee Land Corporation, and the State of Wyoming - to ask: *How do the economic, ecological, and socio-cultural value of exchanged lands compare in a multiple use landscape?* To compare these values between exchanged parcels, I analyze: resource utility in terms of grazing and timber potential along with property tax assessor data to map economic value; plant diversity and abundance (native and non-native) along with big game habitat spatial suitability to assess ecological value; and hunter visitation records and harvest surveys to arrive at socio-cultural value. The results of these analyses reach a conclusion that is much different from the entirely economic appraisal conducted by the state: the per acre value of the disposed state parcel – Section 16 – is greater than that of the acquired private parcel – Moskee – when land is additionally appraised for its (non-monetary) ecological and socio-cultural values. These findings demonstrate the interconnected nature of different types of economic goods, ecosystem services and cultural landscape values used to derive property value in a multiple use landscape. Integrating these values into a socio-ecological whole that is other than the sum of its parts has to date been missing from the methods used to inform decision-making by public lands managers working with private corporations and local land users. This chapter puts forth such a methodological design that can be used by land managers to assess the integrative socio-ecological value of the landscape.

Finally, this dissertation concludes by reviewing the key historical, social, and ecological findings from each chapter.

Chapter One

The political economy and historical contingency of federal lands conflict between mining and multiple use

I. Introduction

Rare earth elements are used in modern technologies from renewable energy to consumer hi-tech to military defense in order to raise energy-efficiency, magnify power output, and heighten missile guidance sensitivity. In addition to consumer-driven innovation for hi-tech devices such as smart phones, the demand for rare earth inputs has risen as legislation and policies aimed at reducing carbon emissions have increased the market share of technologies like NiMH electric car batteries which rely on rare earths (Alonso *et al.* 2012). These elements, though not geologically rare, occur in low concentrations otherwise not economically viable to mine unless political incentives, the social license to operate, environmental regulations, and lands management policies align with the current market demand. Certainly this is the case with almost any material extracted at a large-scale in modern history. For instance with the case of copper from Butte, Montana that was used to produce cable to electrify America, supply existed before the use and demand: (1) the need to recuperate costs from previous eras of (gold and silver) mining created economic conditions for further extractive speculative investment in other materials (copper), and (2) this drove innovation in uses for said material (copper) that existed in short supply but was not yet industrially mined, which through (3) innovation feedback temporarily increased the demand, until (4) new sources were able to supply the

technological demand and drive commodity prices down, to (5) the point when production was barely, marginally or not profitable, and (6) the treadmill of production repeats (Curtis 2014).

Molycorp's Mountain Pass facility in California's Mojave Desert was the leading U.S. producer, and the world's first and largest commercial producer of rare earths from the 1950s to the 1980s. In the 1990s and 2000's Molycorp dealt with environmental compliance issues in the face of economic restructuring which offshored much of the American mining industry and value-added production (e.g. permanent magnets). Molycorp was able to reopen in the years following the Great Recession due to this economic restructuring and the skyrocketing commodity prices it helped to create. It is also the case that investment from Goldman Sachs, among other firms, helped to drive the resurgence of the rare earth industry in the U.S., and this is likely due more to speculative investment in the flow of capital itself through financial derivatives, rather than investment in the profits from actually existing material commodity production (LiPuma and Lee 2005). However, Molycorp filed for bankruptcy due to its over-investment in a retrofit of existing infrastructure including a water treatment facility rumored to be in excess of \$100 million and a bust in commodity prices, and is currently in 'maintenance mode' leaving no domestic rare earth mines in operation. This bankruptcy marked the point when the U.S. rare earth industry went from step 4 to step 5 in the commodity super cycle list mentioned above. China currently produces approximately 85 percent of global rare earth output, though as outlined in a 2012 white paper by the Chinese government

environmental pollution and human health impacts are pervasive. Meanwhile in the U.S. mining corporations must go through strict environmental assessment mandated by the National Environmental Policy Act years before production actually begins. In the western United States there are 17 indicated reserves of rare earth elements on public lands that could contribute to the domestic supply (Long *et al.* 2010), and outside of Mountain Pass, which has gone through a cycle of boom and bust over the last 50 years, the Bearlodge project is the only rare earth mine with a completed environmental impact statement in place should the demand for rare earths recover.

The Bearlodge mine was proposed near Sundance, Wyoming on the Black Hills National Forest (BHNF), and the BHNF was the lead agency for the Environmental Impact Statement. The environmental review process is promulgated through a combination of the National Environmental Policy Act, National Forest Management Act and the General Mining Law of 1872, the latter of which nearly guarantees mineral development, less the mine's continued economic viability in changing markets. The proposed rare earth mine received much of the attention that proposed mines are often associated with. Mines are seen by some as a boon to the regional economy and by others for its potential to catastrophically pollute the environment. Still other local land users are more concerned with the limitations that it may place upon their livelihoods and recreational opportunities, such as grazing, hunting, off-highway vehicle use, and snowmobiling, all of which depend on access to public lands and may otherwise be curtailed by pits, tailing waste piles, processing facilities, roads, and fences.

The historical antecedents to present day land use conflict in the BHNF can best be understood through a narrative of successive, though non-serial, land tenure as different types of common property resources of the forest community (Geores 1998). Common property resources are used here to speak about common pool resources that specifically take the form of land-based property, and which can be accessed, exchanged, and controlled by an individual, state, or market entity based on shared norms and laws regulating use. The history of land tenure in the BHNF reflects regimes of national priorities and legislation seen throughout the western frontier, namely (1) disposal of land rights, (2) enclosure and utilitarian conservation of surface resources, (3) surveying and accumulation of subsurface resources, and (4) management challenges emerging from contested science and competing values (Glicksman and Coggins 1997, Nie 2009). This land use conflict has emerged out of tensions between processes of market-based accumulation, environmental degradation, land-based livelihoods and state regulation.

The history of the Black Hills at the dawn of colonial settlement speaks to the emergence of land use conflict. Colonel Custer's expedition travelled to the region in 1874 and noted the abundance of gold which sent settlers rushing to the area to stake mineral claims as well as homesteads, a process which led to the dispossession of native lands (Worster 1992). This mining activity and the new settlements it created led to a demand for forest resources throughout the hills that created large-scale forest to grassland conversion and subsequent biodiversity loss, including large mammals such as black bear and beaver (Ripple and Beschta 2007). Between 1874 and 1898

approximately 1.5 billion board feet of timber was harvested by miners and town builders in the Black Hills, though none of this timber was paid for and the region was on the brink of large-scale deforestation. Given this situation, the first timber sale in the country was carried out by the Black Hills Forest Reserve to the Homestake Gold Company in 1899 (Mitchell 2009). Case No. 1 as it is now referred to set an important precedent for more sustainable limits to timber production. The Black Hills National Forest was the first public land in the country to be designated as a common property landscape; starting in 1905 Gifford Pinchot, as founding Chief of the USFS, began to use the 'Island in the Plains' as a proving ground for his concept of multiple use forest management (Geores 1996). And, shortly thereafter President Theodore Roosevelt designated the country's first national monument, Devil's Tower, or the Bear's Lodge in Lakota. The designation ensured the protection of this site in the face of increased tourism, however now as then recreational activities clash with native spiritual values for who has a right to control and access the tower (Dustin *et al.* 2002).

Scholarship in political ecology related to extractive industries has focused on the role of the state in establishing conditions for the accumulation of resources through the commodification of property and the concomitant conflicts between the market, biophysical nature, and civil society (Bebbington and Bury 2013, Bridge 2013, Emel and Huber 2008). However, it's often the case with land use conflicts, and with politicized environmental issues more generally, that adequate attention hasn't been given to the weight of history in shaping present day outcomes. Historical

geographies of extraction offer greater explanatory power than ahistorical accounts by carefully retracing causal relationships of accumulation and degradation, political economic processes of enclosure and valuation, scalar relationships between regulations and natural processes, the role of innovation in driving extraction versus the role of oversupply in driving resource use, competing ontologies of landscape, and perspectives on reworking biophysical nature (Cronon 1992, Braun 2000, Bury 2005, Brechin 2006, Huber and Emel 2009, Benson 2012, Benson 2014). Historical accounts can provide causal linkages through abductive analysis; inductive reasoning from a known event to a result or deductive reasoning from a result back to a known event (Walters and Vayda 2009). Going backward in time and outward in scale – from a proposed mine and its attendant land use conflict in the present day to the surrounding federal landscape back through time – allows the researcher to realize the larger political economic processes shaping the local landscape. For broad applicability to natural resource management and forest communities I ask: *How can common property resource regimes be used to understand land use conflicts over the use of federal lands, particularly between mining and multiple use?* To answer this question, the chapter continues by first providing a history of sectional land surveys across the western frontier and a background of the cartographic science that disembedded local social and environmental factors from property. A discussion of the political economic theories informing social and ecological contradictions is then given. This is followed by a methodological overview of cartographic representation and analysis using archival documents. Lastly, the resulting maps are discussed in

relation to the history of federal land regulations in each common property resource regime.

II. Common property resources and covering over contradictions

'What we call land is an element of nature inextricably interwoven with man's institutions. To isolate it and form a market for it was perhaps the weirdest of all the undertakings of our ancestors.'

- Karl Polanyi, *The Great Transformation*

The current land use conflict associated with the proposed Bearlodge mine and the multiple use activities in the Black Hills National Forest is historically contingent on the state's discursive regulatory process that attempts to sublate, or more aptly cover over, the contradictions of values between capital accumulation, ecological degradation, and local livelihoods (Bridge and McManus 2000, McCusker 2013). I argue that the allocation of property ownership can be traced back through the local landscape and framed as different types of common property resource regimes that embody federal lands regulations. These different types of common property resource regimes, adapted from Geores (1998) classic study of the forest community, include: single uses such as land given as homesteads, state enclosure of forest resources, many uses of the surface and subsurface, and a fourth now common theme that I will add, contested expertise in environmental planning between human utility and preservation for nature's sake (Table 1). What is important to understand is that different regimes of common property resources have been rolled out by the state as way to cover over contradictions between ecological values associated with

biophysical nature, economic values associated with capital, and non-economic values associated with civil society (Prudham 2005, Castree 2007). This process of sublation where new regulations are rolled out by the state to facilitate market expansion allows the state to maintain control over the relationship between people, the environment, and the economy. However, at some point a natural resource on a given property is physically, legally, and economically accessible to more than one user thereby allowing contradictions between these common property resources to be uncovered, and inevitably leading to land use conflict. This is especially the case with present day federal lands in the American west where different types of common property resource regimes *exist in concert with one another across the landscape at the same time* like with multiple use and hardrock mining.

‘Property’ applied to natural resources is a primary social institution that refers to bundles of rights in use and transfer, and with property comes associated secondary institutions, including taxation, credit, and tenancy (Ciriacy-Wintrup and Bishop 1975). ‘Common property resource’ has been used by political economists to refer to different empirical situations, including property owned by the state, property owned by no one, and property owned and defended by a community of resource users (Schlager and Ostrom 1992). The term is also used to refer to discrete resources and known users, which can include market-based entities, to explain benefits and costs flowing from a single resource to the greater community (Ostrom 1990). ‘Common property resource’ is a more nuanced use of the term ‘common pool resource’ used to describe a type of economic good. Both types of resources share

Common Property Resource Regime	Defining Features	Types of Land Use
Single Use (1862-1904)	-Parameters of resource specified -Exclusive group entitled to stream of resource benefits	-Mining -Homesteading -Timber
State Enclosure (1905-1945)	-The (forest) community as commons -Those entitled to benefits the same as those who monitor resource use	-Grazing allotments and wood products -Split estate: State enclosure of subsurface despite private surface
Many Uses (1946-1969)	-(Forest) resources should serve individual/entrepreneurial interests -'All-knowing' state defines public interest	-Uranium exploration by private corporations -Department of Defense atomic facilities
Contested Expertise (1970-Present)	-Policies for collaborative planning -Collaborative planning strategies allow expertise to be contested	-Human utility of nature versus nature for nature's sake: Working/recreational lands versus preservation/protection

Table 1. Common property resource regimes matrix for the Black Hills forest community.

two economically important attributes: 1) it is costly to exclude users from accessing the economic good either through legal instruments or physical barriers, and 2) benefits consumed by one user subtract from the benefits otherwise available to others (Ostrom and Hess 2007). Using property to describe a common pool of resources reinforces the idea that goods that share these two attributes also share a type of property regime over time. In the case of lands in the American West different types of common property resources exist across a landscape amid a checkerboard township and range pattern of public and private lands. This brings us to the

important difference between common property resources and goods that are open access. With open access goods no user has the legal right to exclude others from using the resource, whereas with common property resources only users from an explicitly recognized group have a legal right to exclude nonmembers of that group from using the resource.

It is important to recognize that a forest is more than the sum of its parts. Not all of the uses of the forest will exist over time; some extractive forest resources are renewable, such as timber and the regeneration of grasslands needed for grazing, while extractive resources like mining are non-renewable and through legacy pollution such as with groundwater quality impairment can impact the renewability of other goods. Still other processes like flood, fire, drought, and disease lead to non-equilibrium dynamics of ecological succession over time. Suffice it to say, availability and access to the economic goods of nature is geographically uneven and this is further conflated when coupled with the formal rules and informal norms of the forest community. Institutions deploy rules of engagement – formal regulations or informal norms - to define rights of access/management for the market or civil society and rights of withdrawal/enclosure to obtain land and resources administered by the state. Not all common property resources are single entities suited for one purpose. Forests are complex common property resource communities that include single use property such as a single user private goods, enclosure of surface resource as pure public goods openly accessible to all users, and property with many uses - below and above ground - as impure public goods made legally available to only a select group

of users (Geores 1998). The shared expertise between market users and state managers in federal lands natural resource planning, although not grounded as a material entity like the aforementioned goods, is greatly shaping the way property is governed. Previous scholarship has pointed out how common property resource regimes persist until new land uses diminish the ability of previous land uses to be economically viable (Schlager and Ostrom 1992). The four non-discrete and overlapping types of common property resource regimes – single use, enclosure, many use, and expertise – can be used to frame the continued and uneven incorporation of biophysical nature and local livelihoods into the capitalist economy.

Conflict emerges out of contradictions between the values of capital, biophysical nature, and civil society. In particular, these tensions are brought to the surface when the state's rules for governing the commons - federal lands regulations - prove insufficient at covering over the incompatibilities of access to, enclosure of, control over, and expertise on property (see Figure 1). The contradictions between values that are relevant to the common property resource regimes discussed here include the 'second contradiction' of capital and the market's 'double movement.' There are indeed many contradictions of capital, Harvey (2014) put the number at seventeen; for instance the first contradiction, 'the demand crisis' is commonly associated with getting more surplus capital out of less labor through increased hours, lower wages, etc., which creates the unintended effect of less demand for commodities because fewer consumers, themselves laborers, have excess surplus capital. The 'second (ecological) contradiction' operates under the premise that

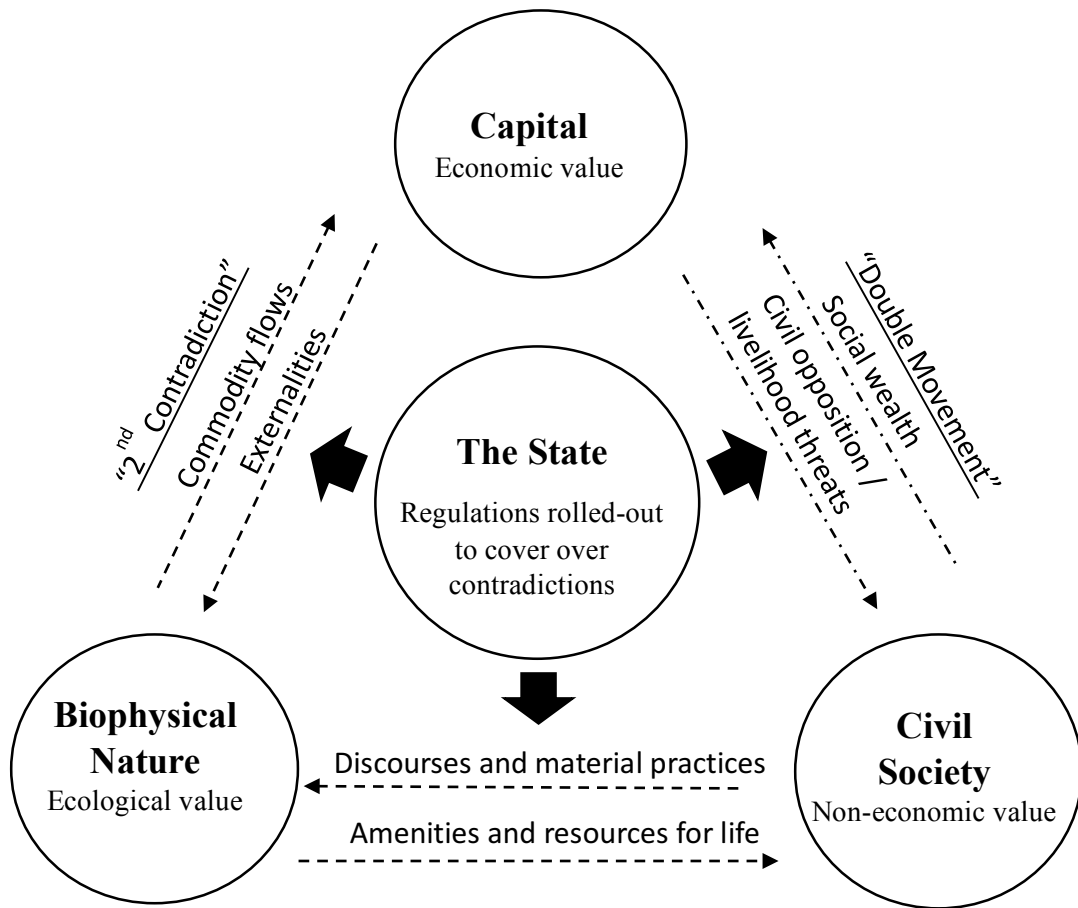


Figure 1. Common property resource regimes: Sublation of contradictions between economic, ecological and non-economic values. Adapted from (Castree 2007)

capital is accumulated through the commodification of nature, but when the process of resource extraction results in degradation beyond the carrying capacity of the environment or when a non-renewable resource is extracted beyond recoverable levels then the process of accumulation has undermined its ability to accumulate further (O'Connor 1998). The 'double movement' can be explained in two parts. The

first movement is a push by the capitalist class who own most of society's wealth and means of production to disembody the market from society's social norms and rules, which is accomplished by transforming people and nature into 'fictitious commodities' of labor and land. The second movement is a push back by civil society against the commodification of its labor potential and the dispossession of production means for the market, for instance the commodification of nature as property to serve an elite class via the market rather than a local land user (Polanyi 2010).

III. Methodology

A. The science of section surveys

'In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province... In the Deserts of the West, still today, there are Tattered Ruins of that Map.'

—Jorge Luis Borges, On Exactitude in Science

Land demarcation is one of the earliest activities of organized human activity. In the modern sense it's been used to define property boundaries, parcel shapes, and plot locations that are the basis for land markets. In 1785 congress passed the Land Ordinance to dispose of lands in the western territories through the rectangular survey system. In the thirteen original colonies the United States had used the decentralized system of metes and bounds, where each parcel was defined independently, often using impermanent features such as rocks, trees, streams, structures, and adjacent properties. The rectangular system offered an advantage in its centralization through

the designation of shape, size, and directional alignment independent of topographic features. This uniform structure lowers enforcement costs, lowers trading costs in land markets, and lowers coordination costs in infrastructure investment (Libecap and Lueck 2011). In fact, lowering transaction costs was a central point in congressional debates at the time; Alexander Hamilton stated that ‘the public lands should continue to be surveyed and laid out as a grid before they were sold’ (Linklater 2002). This science of property law would prove to be invaluable for expansion into the western frontier, just as it was throughout the history of British colonialism; a universal system ‘dephysicalised’ the material nature of land and flattened local cultural customs governing exchange, thereby creating something fungible and placeless, capable of being infinitely traded without regard to local social or ecological factors (Graham 2011).

The partitioning of lands across the American west is reflective of the prevailing national priorities from the different political-legal regimes of federal land management policies and regulations including the need for the state to direct frontier expansionism, domestic production and defense priorities, and mediate local land user resource conflicts (Glicksman and Coggins 1997, Nash 1999). These regimes may be used to frame the continual, yet uneven incorporation of land and natural resources of the region into the capitalist economy (McCarthy and Guthman 1998). The centralized rectangular system uses a set of principal meridians (north-south line) and baselines (east-west line), 37 in all, which are spread throughout the nation to counter Mercatorial distortion. Each side of the principal meridian contains townships that are

six by six square miles. A column of townships running north to south is referred to as a range. Accordingly, the rectangular system used throughout the U.S. is colloquially referred to as township and range. Each township is divided into 36 sections, and each section is 360 acres or one square mile. A misunderstood feature of the sectional layout is the boustrophedon, or bi-directional, organization beginning in the northeast corner of the township with section 1 and ending in the southeast corner of the township with section 36. In turn, each section can be divided into 160-acre quarter sections that are identified with a compass direction of northeast, southeast, southwest, or northwest.

B. Data collection and analysis

Site visits to archival sources and digital archival access were carried out in the summers of 2013 and 2014. The Bureau of Land Management (BLM) General Land Office records automation website was used to access historic land status records for the Bearlodge Ranger District of the BHNF referenced to the Wyoming 6th principal meridian. Wyoming was the last territory to be surveyed by the General Land Office in 1870 and wasn't granted statehood until 1890 (Galatowitsch 1990). Several important federal land acts (e.g. Morrill Act 1862 and Homestead Act of 1862) were ratified into law by congress before land began to be formally appropriated throughout the state in 1870. Therefore, to retrace historic land use allocation a 'base datum' of 1870 is used to reproduce the political-legal landscape (Swetnam, Allen and Betancourt 1999).

Historians rely on archival data collection as a methodological basis to avoid internal invalidity in an argument, avoid spurious claims at the beginning of a research endeavor and rule out rival explanations to increase the confidence in one's own account (Vitalis 2006). Furthermore, a critical take on human-environment relations over time should further understanding on such themes as the legal and cultural paradigm of society, the socioeconomic segmentation of land-based livelihoods, access to and control over natural resources in light of state hegemony, how human agency modifies nature and the built environment through material activity, and how the fictitious commodities of land, labor or fiat currency reproduce nature (Worster 1988, Rajan 1997, O'Connor 1997).

The written records of 5,184 parcels, or 324 square miles, between 1870 and 2014 were cartographically digitized and categorized into various common property resource regimes as a way to visualize the concomitant federal lands management regulations embodied in surface and subsurface USFS lands. The division of these regimes include: single use land grants as private goods, ranging from the surveying of the Wyoming territory in 1870 to 1904, an era when 74,006,557 acres of what would become USFS were reserved through the Division of Forestry and Bureau of Forestry across the nation; state enclosure of land as public goods, ranging from the creation of the USFS in 1905 to 1945, an era when 104,266,752 acres of USFS lands were reserved under applicable Forest Service operational laws across the nation; reconciling the many uses of the surface and subsurface, from post-WWII development in 1946 to 1969, an era when 1,614,705 acres of USFS lands were

reserved across the nation; and contested science, knowledge, and values over human utility versus ecological function from the passage of the National Environmental Policy Act in 1970 to the present day, an era when 281,126 acres have been reserved as USFS lands across the nation.

IV. Discussion of findings: Common property resource regimes

A. 1870 – 1904: Single use land grants as private goods

The federal land regulations in the single use common property resource regime set discrete uses for land by ceding the common property of the state to individual landowners. In this way, single now private uses, such as mining, timber, grazing and settlement are a type of common property resource since those working the resource base acquired their lands and associated rights of use from the common property of the state. The Morrill Act (1862) granted sections to states for natural resource extraction to fund agricultural colleges, the Homestead Act (1862) granted property to individuals who could settle and live off the land, the General Mining Law (of 1872) created a system to stake claims on subsurface mineral resources, and the Timber Culture Act (1873) extended homesteading to those who could improve the land by planting trees.

The Morrill Act of 1862 was created to fund land grant agricultural colleges through revenues of natural resource production on lands ceded to states; parcels usually included the 16th and 36th sections (640 acres each) of a township and range unit, regardless of topography or natural resource conditions. This checkerboard

pattern persists today largely based on two factors: 1) 30,000 acres given for each senator or representative the state or territory held based on population in 1860, and 2) how much of the land was immediately sold to create revenue versus how much was retained for state resource extraction and funding in perpetuity. Regardless, the Act was both a boon to education and to state governments. State Section 16 (seen in the middle of the dashed mine study area in Figure 2) was managed for timber, grazing, and recreation, though it has now been traded in a land exchange with the USFS to the mining corporation. No longer in state ownership, it is proposed as the site for mine tailings.

The Homestead Act of 1862 deeded 160 acres to those who took residency upon the plot and ‘improved’ the conditions of the land, reflecting the Jeffersonian ideal of a ‘virtuous yeoman’ settling the frontier. Title to 160 acres could also be secured through Cash Entry patents where the land was acquired through purchase at a nominal fee. In the Bearlodge Mountains, and throughout the west, homestead and cash entry parcels were limited by environmental factors: proximity to land that could be either tilled (relatively flat) or grazed (grasslands as opposed to trees), that had readily available water resources (rivers and perennial creeks, or seeps and sinks in the mountains), and that could be accessed through existing trails (and later roads). Thus, these claims were first made amongst the open prairie and perimeter of the forest, rather than the more contoured interior terrain of the Bearlodge Mountains.

The General Mining Law was approved in 1872 and codified the system for acquiring and protecting claims, a system that was informally developed in California

and Nevada in the preceding years of the gold rush. This federal law enabled the subterranean claims of civil society to be formally integrated into the market economy through a standard deed fee per acre, however the law stated nothing about mitigating the environmental burden placed upon the adjacent and downstream parcels. If the Gold Rush began with California's 49ers, then the beginning of the end of artisanal gold mining frontier for the West was in the Black Hills when Colonel Custer's entourage encountered Sioux carrying gold. The Black Hills can be seen as the last frontier in the lower-48 since it was (and continues to be) a much-contested region where conflict between settlers and the Sioux emerged over the 1868 Treaty of Laramie that was broken by the continued and unabated settlement by those mining for gold, which reached its apex in 1876. Though most of the gold reserves were concentrated around the Lead/Deadwood area, claims were instated through the 1872 Mining Law at Warren Peak in the heart of the Bearlodge. Mining claims, unlike land grants, weren't limited to the township and range section, but rather followed the subterranean extensions of mineable (economically recoverable) veins. And, the space where the present day rare earth mine is proposed was nearly developed for gold extraction ten-years prior though the price of gold decreased enough to make it no longer viable.

The Timber Culture Act of 1873 was a follow up to the original Homestead Act that allowed homesteaders to receive another 160 acres if they planted trees on a quarter of the land, which for many was existing prairie grass considered useless in terms of productive potential. These lands are most often located next to existing

homesteads at the edge of the forest where owners could more easily plant trees and where these claimants could access the water, game, and (more) timber of the unclaimed, more mountainous forest interior of the Bearlodge Mountains that would later become the BHNF.

These newly ceded lands allowed the state to expand its capitalist reach into previously unincorporated surface and subsurface resources. Minerals, wood, meat and grain not only served the newly settled populations, but were also sent back from this hinterland to the great cities of the West and Midwest, and the collective coffers of the state and federal government became lined through the integration of these resources into the market, which in turn drove the economic engine of western resource extraction and settlement to continue apace. The settlement of the west was not just economic, the frontier created political subjects. As Frederick Turner's thesis argues the frontier forged a special American character marked by individualism, pragmatism, and egalitarianism (Cronon 1987). However, if the frontier had vanished after the 1890 census and with it those principles that it engendered then, as Turner argued, a new (economic) foundation for American (political) life was needed. The single use properties in this regime and their accordant social and ecological conditions of production are important in understanding future land use conflict throughout the west because subsequent regimes underpinned by the changing political and economic values of American society would be in contradiction with the original regulatory groundwork that was laid.

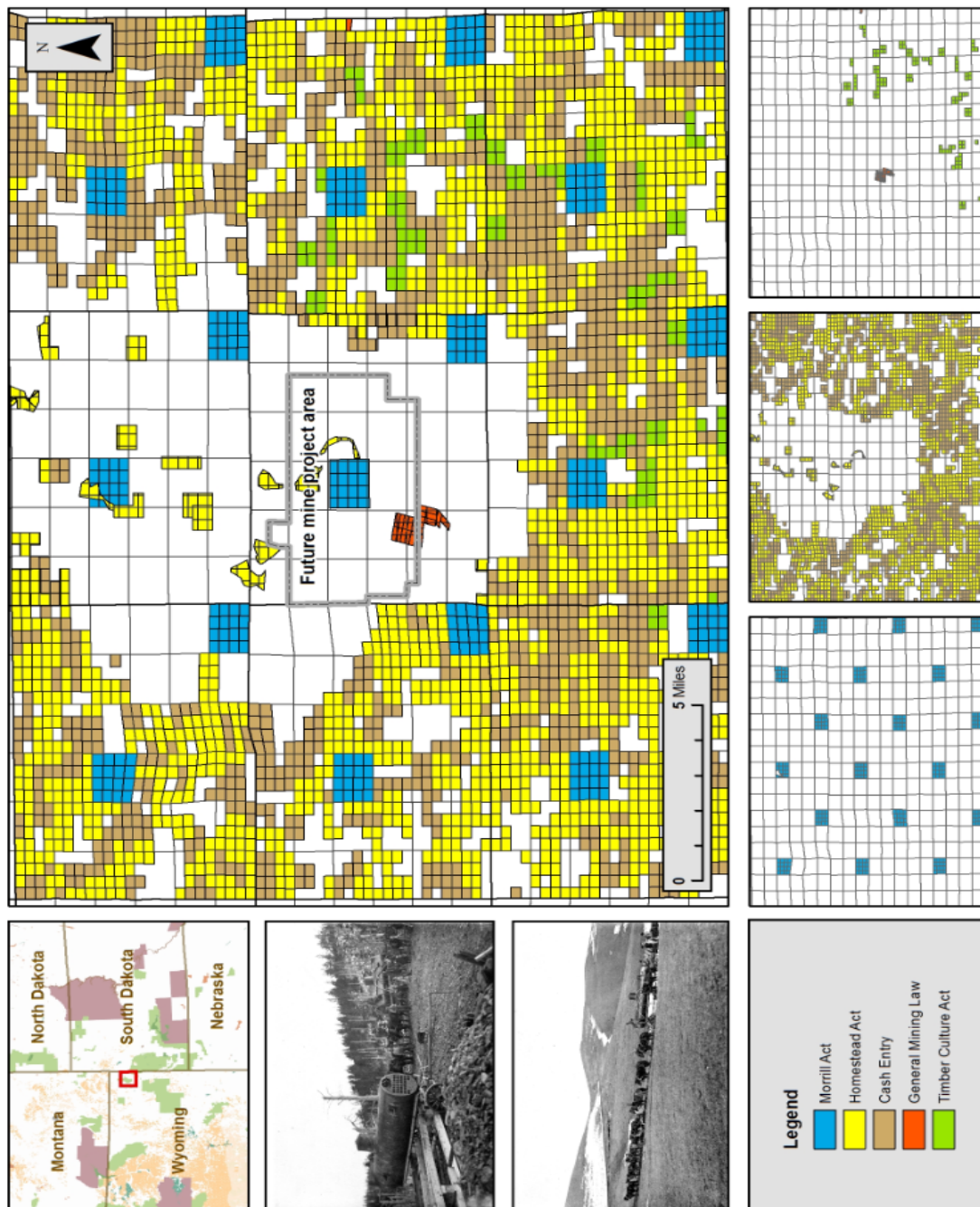


Figure 2. Common property resource regime: Single use - Land grants as private goods. Data source for analysis: BLM, General Land Office record. Photo source: Crook County archives.

B. 1905 – 1945: State enclosure as public goods

The federal land regulations in the state enclosure regime began with the incorporation of lands into the U.S. Forest Service in 1905 for utilitarian conservation and economic gain. The Transfer Act (1905) incorporated forests into the utilitarian conservation economics of the USFS, the Antiquities Act (1906) enclosed culturally and historically significant objects and landscapes as part of a national trust, and the Stock-Raising Homestead Act (1916) granted surface rights while in effect enclosing subsurface mineral rights. Regulations in this regime focused on securing the multiple surface resources of the forest through state enclosure, acquiring lands of national cultural and geological significance, and ceding remaining lands for homesteading that were previously deemed unfit for that designation, but notably precluding these land grants from subsurface mineral rights.

The Transfer Act of 1905 transferred forests from enclosure by the Department of Interior to the Department of Agriculture and established the U.S. Forest Service, previously named the Division of Forestry under the former agency. This act was significant because of the different management brought to the state's enclosure under the leadership of Gifford Pinchot, in that a greater emphasis was placed on science-based management of natural resources to provide dually for both ecological versus agronomic outcomes. However, the *raison d'etre* of the agency remained intensive production that relied on faith in technological fixes and 'trained experts backed by enlightened government policies' (Hirt 1996). Despite their optimism utilitarian resource managers lacked a full understanding of ecological

concepts that today are taken for granted as a starting point in USFS adaptive management, such as trophic interactions, climate change induced shifts, and non-equilibrium stages of succession. The Bearlodge National Forest was established in 1907 to manage the threat wildfire was placing on grazing and forest livelihoods, and to employ silviculture conservation techniques throughout otherwise unmanaged timber cuts driven by large-scale gold mining operations. This jurisdiction was later incorporated into the Black Hills National Forest as the Bearlodge Ranger District in 1915. The BHNF continues to acquire inholdings and adjacent properties through land exchanges with state and private owners in an effort to ease the management constraints emerging from discontinuous holdings.

The Antiquities Act of 1906 was passed with the intention to protect objects of historic and scientific interest, and gave the President the authority to create national monuments that are confined to an area commensurate with the scale of management needed to protect the object or landscape. Devils Tower was the first National Monument to be designated under the Antiquities Act, declared in 1906 by Theodore Roosevelt. The site of the present day proposed mine is located approximately 19 miles from the Monument. Although not within the BHNF, Devils Tower remains part of the public discourse in the environmental impact statement process because of the potential for reduced air quality and light pollution to penetrate the Monument's enclosed space and the impact this may have on cultural practices therein.

The Stock-Raising Homestead Act of 1916 differs from previous iterations of the Homesteading Act in that it provides settlers much more land (640 acres), but separates subsurface mineral rights from surface ownership, resulting in what today has become known as the 'split estate'. Congress enacted this policy to maintain mineral rights because mineral exploration was escalating at this time to serve World War I efforts; the legislature recognized that some federal lands had surface that was valuable for agriculture and grazing while the subsurface was valuable for strategic minerals needed to fuel the economy. The land granted through this act consisted of land not deemed valuable in previous rounds of homesteading and was thus allotted on discontinuous, barren and barely irrigable lands. The federal government's retention of mineral rights created a de facto, patchwork enclosure of the subsurface simultaneous to single use land grants claimed on the surface. Lands granted from this Act would later contribute to uneven mineral exploration claims and activity, particularly during post-WWII years, when the Black Hills and Bearlodge Mountains were extensively surveyed, and in some places developed, for uranium.



Figure 3. Common property resource regime: State enclosure – The forest as public goods. Data source for analysis: BLM, General Land Office record. Photo source: Author.

C. 1946 – 1969: Reconciling the many uses of the surface and subsurface

The federal land regulations in a regime of many uses were an attempt to reconcile various surface activities on national forest lands with subsurface mineral exploration and development. Mining impacts lands on the surface beyond the pit or adit (entrance) itself, through exploration drilling and buildings, road development (and closure of existing rights-of-way), processing and conveyance infrastructure, associated power lines, noise impacts, air pollution, and both the quality and quantity of water resources needed for the many human uses of the forest and the ecological landscape. The Atomic Energy Acts (1946 and 1951) incentivized exploration for uranium on federal lands, the Multiple Use Mining Law (1955) set stipulations for what was considered a valuable mineral and in turn limited the surface activities not directly associated with a claim, and the Multiple-Use Sustained-Yield Act (1960) managed for the sustainability of renewable forest resources, timber, grazing lands, water resources, recreational activities, and wildlife among them.

The Atomic Energy Act of 1946 incentivized a wave of exploration for uranium-containing ore throughout the western United States. The Black Hills naturally emit low levels of radiation from their sandstone composition and uranium was discovered there in 1951. A later iteration of the Act in 1954 allowed for private involvement in the nuclear industry as part of the military industrial complex and new rounds of claims accumulated through airborne Geiger surveys. In the Bearlodge these claims were limited to the lower elevations of the forest where uranium-containing sandstone is exposed on and near the surface. Thus the higher elevation

interior of the Bearlodge, where rare earth element mining is proposed, was left unclaimed until gold exploration in the 1980s.

A phenomena associated with mineral claims across western public lands stemmed from individuals who claimed parcels for mineral resources through the 1872 Mining Law, but made little effort to actually mine anything, instead using their status as claimants to build a cabin or otherwise occupy the land for a non-mining activity. The Multiple Use Mining Law was enacted in 1955 to confront these squatters who curtailed access to the surface resources for the rest of the forest community. While most of these illegal structures are disassembled, some cabins remain in the Bearlodge, but these historical structures date back to the original land grants and remain standing because of their status on private property.

With the onset of the Cold War another atomic land use took hold on Warren Peak, the highest point of the Bearlodge Mountains and just above the proposed rare earth mine, though this facility was neither entirely subterranean nor surface-related. The Sundance Air Force Station was the only radar station in the United States ever to be fueled by a nuclear reactor, which was half submerged in the hillside. The radar station and reactor operated from 1961 to 1968 with a minor leak and stoppage reported in 1964 (Reinhold and Worthington 2000). The Air Force has since cleaned up the remaining plumes of leaked coolant water and continues to monitor the site. Interestingly, the Air Force granted an exemption to the proposed mine to allow for development within a restricted groundwater monitoring radius. Rare earth elements naturally co-occur with radioactive mineralogy containing uranium so it is interesting

that in the area proximate to the proposed mine that the groundwater is actually less radioactively laced due to the anthropogenic alteration of the water table and subsequent clean up.

The Multiple-Use Sustained-Yield Act of 1960 was passed to allow for the equal management, not necessarily equal economic return, of the renewable resources of the forest community, including timber, grazing, water, recreation, and wildlife. Notably these resources do not include non-renewable mining reserves that are considered ‘the highest and best use’ of federal land through the General Mining Law of 1872. Whereas multiple use refers to the management of renewable resources to be utilized in a combination that will best meet the needs of the American people, sustained yield refers to a regular periodic output of renewable resources in perpetuity without impairment of the productivity of the land. Timber production and grazing can directly impact water quality; recreation competes for land with the aforementioned activities and can have multitude effects on wildlife habitat or in the case of hunting, wildlife itself. These are just a few examples for how different land uses can impeded and impact other land uses of the forest community, and thus warrant a multiple-use sustained-yield approach to management. However, mining poses risks to all of these land uses, either by directly occupying the land where these activities take place, or with spillover effects such as water resource impairment and fragmented habitat.

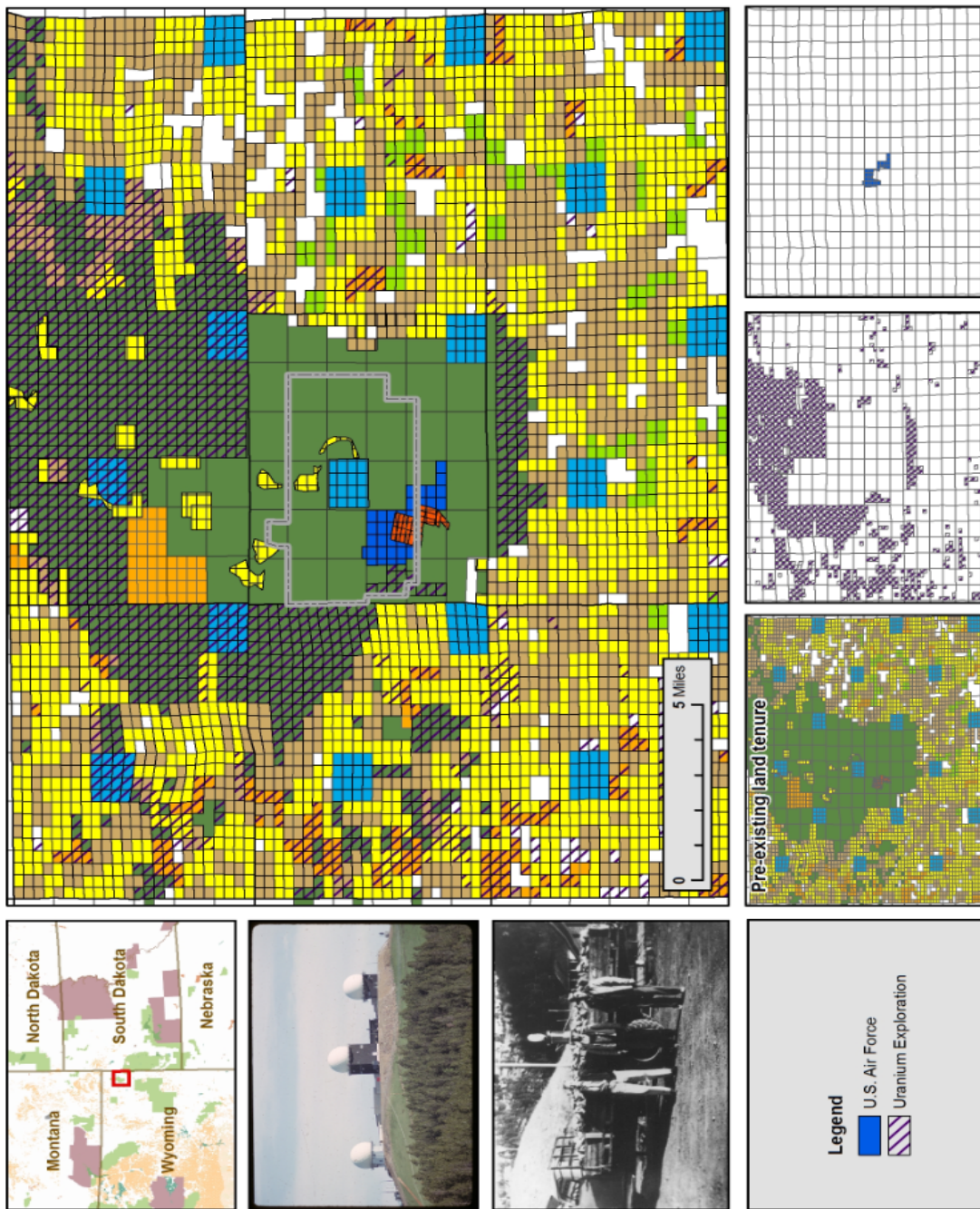


Figure 4. Common property resource regime: Many uses – Surface and subsurface resource management. Data source: BLM, General Land Office record. Photo source: Crook County archives.

D. 1970 – Present: Science for human utility versus ecological function

Every parcel in the Bearlodge Mountains has been granted, enclosed or claimed, indeed this is the case throughout the west where the frontier has long since disappeared. A regime of federal lands regulations operates in the present day to manage the interactions between different common property resource types that lie on a spectrum of human utility to ecological function.

The National Environmental Policy Act of 1970 mandates that an Environmental Impact Statement (EIS) is to be conducted by federal agencies, including the USFS for any major federal project that may cause significant impacts on the environment. The USFS as lead agency works with coordinating agencies such as the EPA, Army Corps of Engineers, state environmental agencies, and consulting scientists to develop information and meet regulations for the EIS, which includes five stages: public scoping of issues, screening a list of potential project alternatives, analyzing a selection of alternatives, preparing a comprehensive Draft EIS with expert data, and responding to comments on the draft EIS, and preparing a Final EIS with a preferred alternative. There are several challenges with the EIS public comment process related to human utility versus ecological function. Virtually any alternative selected will have some adverse impact on different common property resources valued for human use or the intrinsic features of the environment like biodiversity. However, depending on the degree of agency directive versus communicative action undertaken in the EIS process, the final alternatives may not

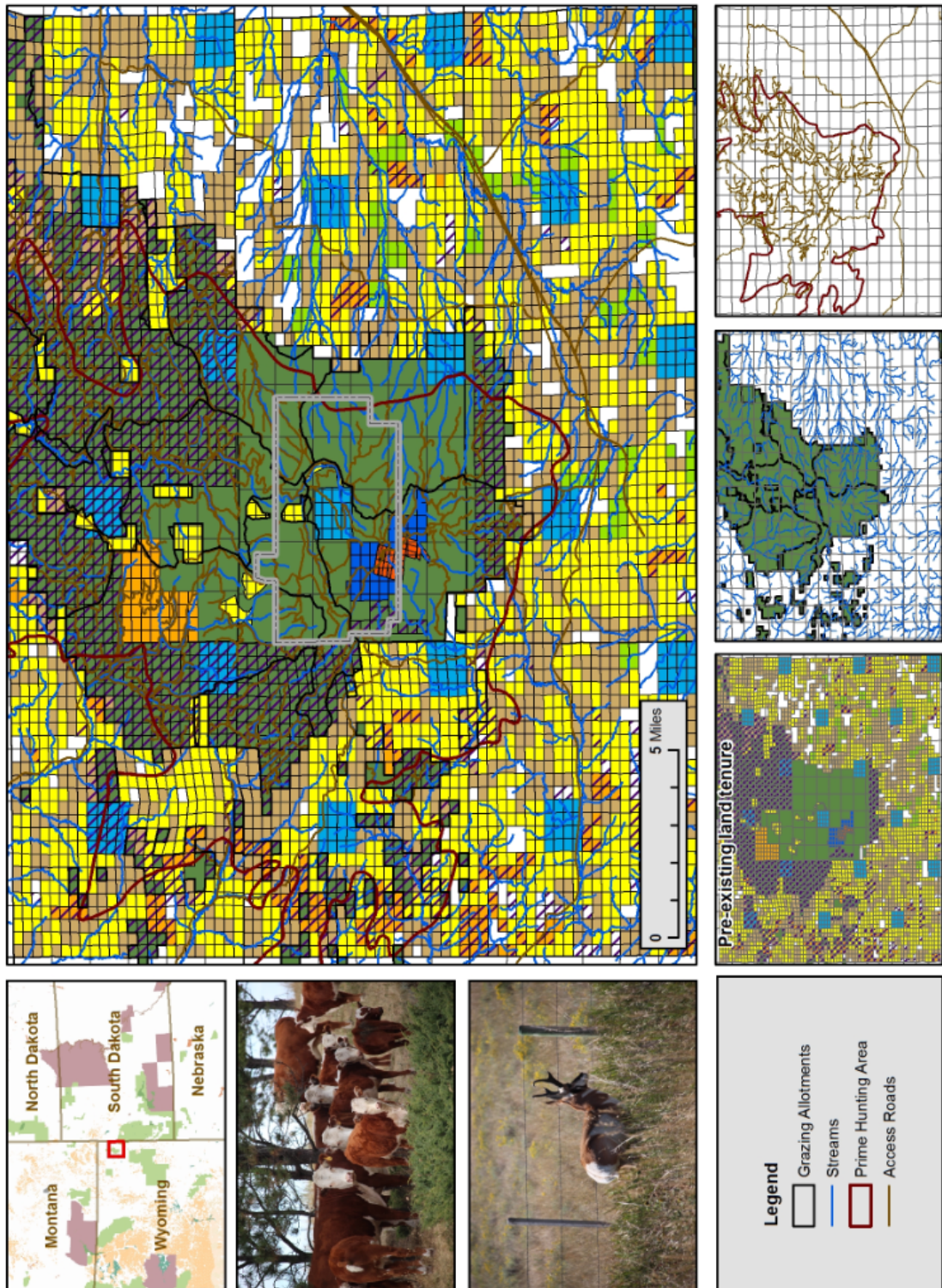


Figure 5. Common property resource regime: Contested expertise – Scientific management of the environment and natural resources. Data source: BLM, General Land Office record. Photo source: Author.

take into account the full spectrum of stakeholder-desired alternatives informed by livelihoods, disciplinary expertise, and values that can otherwise contribute towards management of the forest community as a common property resource.

The National Forest Management Act of 1976 (NFMA) integrates non-timber, multiple-use values such as those associated with recreation, grazing, watershed, wildlife, and fisheries into the forest planning process. The Act also calls for public involvement in the planning process associated with preparing and revising forest plans; unit managers follow the Planning Rule to guide development of project plans and priorities on USFS lands. The 2012 Planning Rule includes a standard to prioritize ‘ecological sustainability’ over ‘species viability’, while ecological function can be sustained in-situ of human development, a specific species is nearly always less viable when habitat is compromised, fragmented, or eradicated. However, the tradeoff between ecological sustainability versus species viability is difficult to quantify in a working landscape maintained for species of capital like cattle and big game.

E. The historical contingency of land use conflict

The four regimes of common property resource types discussed above underscore how present day land use conflict in the west is inextricably linked with the contradictions of resource management policy from the preceding 150 years. Land use conflict emanating from disagreements over social values, resource scarcity, power imbalances, and a lack of clear institutional arrangements, including property

rights show that rules and norms governing the relationship between land and society are in continual flux (Brown and Raymond 2014). Throughout the frontier nature as land was granted, enclosed, managed and contested in each regime, respectively, to reflect unique convergences of science, politics, conservation, and management between the state, market, and civil society. The resulting knowledge used in management for each era was seen as ‘objective’; bureaucratic national agencies serving as both the source of information and the enforcers of policies tended – some would argue still do – to view their decisions as superior to that of locally, uninformed populations. But, the state’s role in serving the public’s interest is often misunderstood. The result of federal lands disposal was large-scale land conversion through clear-cutting of forests, over-grazing of ranges, and mining that plundered watersheds. This was not a tragedy of the commons but rather the tragedy of an open access regime, neither regulated nor enforced by the federal government at the height of westward expansionism (Charnley, Sheridan and Nabhan 2014). It is important to give more weight to single use lands disposal over the other common property resource types because as the first regime of accumulation it set the basis – and the need - for the state to sublimate the contradictions it presented - degradation and an eventual economic independence too far removed from federal oversight. That is, each subsequent regulatory regime is historically contingent on those regimes preceding it, the original of which provides a ‘sensitive dependence on initial conditions’ for those that follow (Robinson 2009). Land use conflict can be traced back to an initial set of conditions created by the state and enabled through the market

that reconfigure the relationship between land and society and shape the political-legal landscape for future non-serial regimes to come. In the case of land use conflict between mining, multiple use, and nature in the west this has resulted in issues related to: scalar governance – state rights movements; biocentric landscape level conservation efforts – preserving ecological function in the face of extractive development; and anthropocentric resource utility – contesting extractive development because of the risk it poses to rural land-based livelihoods (Jenkins 2016)

V. Conclusion: Antecedents of land use conflict beyond the rural

This chapter has substantiated the claim that land use conflict is historically contingent through a spatial analysis of previous regimes of property and natural resource. I have focused on one place, the Bearlodge Mountains of northeastern Wyoming, and a particular context, that of federal lands disposal in the American west over approximately the past 150 years. At first glance the focus on federal lands might be seen as a limitation in terms of understanding the origins of land use conflict more broadly, however I would contend that the theoretical framework employed here can be extended beyond rural and extractive landscapes. The contradictions between capital and nature as land presented here can be used to understand how different types of underlying common property resource regimes are in contradiction with one another with present day land uses. For instance, a park in a metropolitan area, currently accessible to certain segments of civil society but not others (those without property: the homeless staying overnight) operates as an enclosed space

regulated by some scale of the state (in this case the city) through a coincidence of the global market (let's say the financial sector, among others) and local rules (zoning and ordinances) that over time drive up the rent and preclude access to and acquisition of property to these landless denizens. Indeed, the prevailing right to the city is a relationship between land and the social rules governing the market, including both formal and informal decision-making networks that shape urban politics (Mitchell 2003, Stone 1989). The city, like the American west, is a frontier of accumulation; the urban growth machine expands horizontally to the suburbs and vertically through skyscrapers. This expansion is facilitated through subsidies and policies that allow an elite class to acquire property and the means to develop it, and while this development may not embody the precise types or occur through the same sequence of common property resources discussed here (i.e. single use, enclosure, many use, and contested expertise), it nevertheless progresses through history into the present day where multiple uses and rights of access are embodied in the underlying landscape simultaneously. Therefore, contradictions between nature that is commodified as property and those who vie for access to it given the present day rules of the market stands in conflict with the many other norms and uses not integrated into the current market system of exchange and access. Studies of urban social action, such as the Occupy movement and the everyday struggle to access safe and affordable community spaces that provide a basis for civil society to accumulate social and intellectual capital would benefit from a greater understanding of historical contingency of land use conflict. Indeed, this struggle is the embodiment of Polanyi's

double movement. To extend research on the historical contingency of common property resources and land use conflict future scholarship can look towards the region scale in order to go beyond rural livelihoods dependent on access to property for natural resource capital and urban livelihoods dependent on access to property to further social capital. Specifically, future research should envision a regional take on the flow of goods between the rural and urban to understand how regimes of common property resource types underlie demographic, health, environmental, and social disparities among different segments of a regional population. In terms of theorizing land use conflict this might entail looking at the historical development and ecologies of a region to understand the antecedents that are the causal factors of disparity and how this shapes who has access to nature, including rural open spaces and wildlands, and iteratively how this shapes social capital back in the city.

Chapter Two

Anthropocentric and biocentric perspectives of mining development in a multiple use landscape

I. Introduction: Rare earths as elements, rare earth as landscape

In the western U.S. there are 17 indicated reserves of rare earth elements (REEs) on federally accessible lands. These reserves, if properly developed with new beneficiation processes and regulated under existing environmental policy safeguards, could be used to meet the domestic demand for non-renewable inputs to renewable, clean and green technologies. REEs are critical to modern technologies as the non-renewable inputs to renewable energy, defense, and consumer applications. The technological basis to achieve global and national policy goals that aim to reduce greenhouse gas emissions is contingent on state control over access to these minerals through the environmental regulations and economic incentives associated with mining operations on public lands (Alonso *et al.* 2012). However, as the legacy of mining shows there are often unknown risks, or "normal accidents" that emerge in complex systems which have the potential to significantly alter the existing socioeconomic composition and environmental resources of a community beyond recoverability (Ali 2014; Bridge 2004; Perrow 2011).

The Bearlodge rare earth element mine was proposed by Rare Element Resources between 2013 and 2016 in the Wyoming portion of the Black Hills National Forest, the Bearlodge Ranger District. This area is recognized by rural land

users as a premier multiple use landscape for its large mammal trophy hunting, off-highway vehicle trails, seasonal snowmobile routes, timber stand production, cattle grazing allotments, non-motorized recreation like hiking and equestrianism, and the protection of water resources provided to the forest community. In fact, the Black Hills are noted as being the original proving ground for Gifford Pinchot's concept of "multiple use", a historical feature that has implications for present day common property resource management among a patchwork of federal lands and private inholdings (Geores 1998). The development of the environmental impact statement and its associated public comment process was recently carried out by the U.S. Forest Service (USFS) in conjunction with state permitting agencies and the mining corporation. A mine is considered "the highest and best use" of the land through the statutory basis of the General Mining Law of 1872, and as such its development takes precedence over the multiple uses of the forest community. However, the National Forest Management Act requires a procedural planning effort with the scoping of alternatives that could reduce or mitigate the impacts associated with the development of 1700 acres (1060 public, 640 private) of land where direct mining activity, associated infrastructure, and operations will restrict access to multiple use livelihoods and recreation.

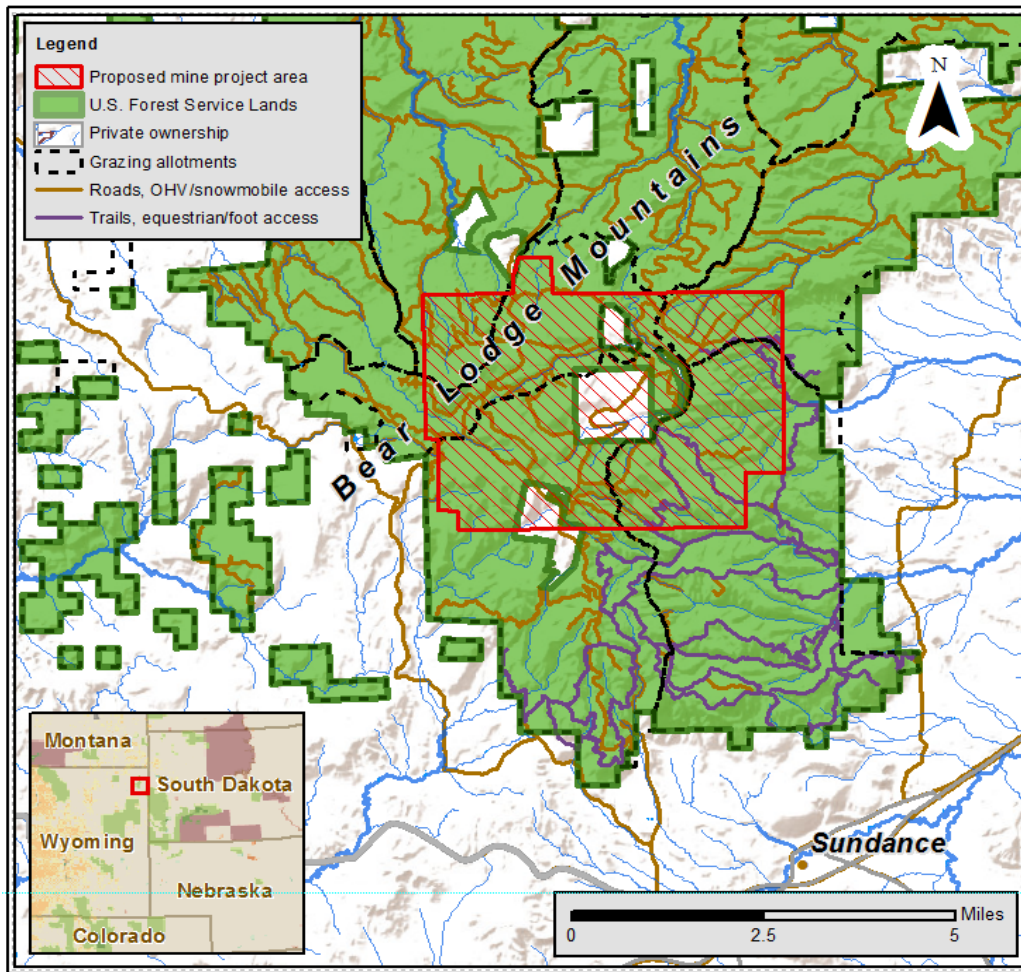


Figure 6. Study area in the Bearlodge Mountains of northeast Wyoming.

Rare earth is also a useful heuristic to begin to think about the contested scientific claims, ecological epistemologies, notions of common property, historical contingency of land use conflict, and truths about economic growth that underlie converging/diverging perspectives in natural resource planning efforts. Environmental groups have predictably and justifiably opposed the mine by citing the legacy of hard rock mines in the American west, however the majority of local opposition has come from a regionally novel type of ecological knowledge that is

shaped by access to the land. Local land users rely on access to the common property resources of the forest community and as such hold a knowledge about nature informed by their working of the landscape, a "cowboy ecology" (Worster 1992). The perspectives of both groups of multiple users have stood in contrast to those of the mining corporation and the state whom have produced the scientific knowledge informing the EIS process and whose jobs themselves are vested in the development and management of extractive resource development, namely mining, as the highest and best use. Therefore, specific to the EIS planning process for mining development in a multiple use landscape, I ask: *How do perspectives about control of and access to common property resources, and the role of humans as part or separate from an ecological system converge or diverge between community, state, and market stakeholders?*

To answer this question, the chapter unfolds as follows. First, an overview of the EIS process and regulatory frameworks that govern extractive development on federal lands will be discussed in terms of how statutes either serve the state agency's directive, the interest of the mining corporation, or broader communicative action between stakeholders. This political-legal background will help the reader to gain an understanding of the situated nature of knowledge production in public lands management where statutory mechanisms constrain or enable political subjects to utilize and act upon corporate science, cowboy ecologies, and historically contingent claims to the environment, among other perspectives. This is followed by a methodological overview of how factorial analysis can be used to identify subjective

perspectives, the steps used to carry out Q method for this study, and the resulting stakeholder perspectives on economy and the environment. The situated knowledge of stakeholder groups is then discussed in the context of the “new”, though ongoing, conservation debate between anthropocentric resource users and biocentric preservationists whom hold contending viewpoints on the role of humans in nature and how nature should best serve human needs.

II. The environmental impact statement and public participation

The General Mining Law of 1872 allows extractive mineral development as the “highest and best use” of federal lands. However, the process of extracting non-renewable subsurface resources impedes the livelihoods of those who rely on the renewable surface resources of national forests, a right established through the Multiple-Use and Sustained-Yield Act (Glicksman and Coggins 1997). The National Forest Management Act and its various planning rules, including the original 1982 Planning Regulation were written to plan and manage for the conflicting uses of the forest, including timber and non-timber values on the surface, subsurface mineral claims, and the hydro-geological ties between the two. The National Environmental Policy Act’s (NEPA) environmental impact statement procedural framework is used to assess future environmental and human health risks from a given project taking place on federal lands, and with projects such as industrial mining this may include several development alternatives that account for different processing facility locations, trucking routes, or hydrological regime scenarios.

Policy	Grants rights to...	By providing access to...
General Mining Law (1872)	Corporations or individuals that will improve the land for mineral extraction	Subsurface minerals and surface overburden on federal lands
Multiple-Use and Sustained-Yield Act (1960)	Land users that depend on the sustained productive capacity of the forest	Off-road vehicle trails, grazing allotments, timber cuts, etc.
National Forest Management Act (1976)	Extractive and amenity-based projects at the local, regional, and national level	Permitted and publically available natural resources of the forest
National Environmental Policy Act (1969)	Components of the natural world that provide a service or function for humans	Conditions that are safe for the environment and human health

Table 2. Select federal policies shaping local planning outcomes related to mining and multiple uses of the forest.

The main goal of NEPA was to establish a national policy on the environment, however it has also institutionalized the process of decision-making by requiring agencies to seek public comment as part of the environmental assessment process. NEPA states that, “each person has a responsibility to contribute to the preservation and enhancement of the environment” (§ 4331 6c). The USFS has generated more EIS’s than any other state institution; in 2006 the agency issued 144 final EIS’s, 25 percent of the total for all federal agencies (Brody 2012). The EIS process has become the primary tool for discourse connected with actions that involve western public lands and with it the general public’s belief that communicative action - in the classic Habermasian sense where unlimited information and transparency lead to compromise – would evolve in sync with the magnitude of the project and the number of stakeholder perspectives involved. The EIS process may increase public

involvement though it also dictates the rules of engagement through a bifurcated procedural framework between state and corporate experts whom control the flow of information, and the ostensibly lay public whom is left to respond within a narrowly defined scope of alternatives. Instrumental rationality insists that the cost of communicative action to involve the subjective opinions of the “uninformed” and “emotional” public is too high in time and money (Killingsworth and Palmer 2012). This “us” versus “them” mentality emerges from the instrumental rationality of agency directives that seek efficiency through bureaucratic hierarchies of technical specialization and increasingly the co-production of scientific information with market-based entities, including environmental consulting firms hired to supplement agency workloads and the use of baseline assessments produced by the corporation vying for a proposed project (Lave 2012). In an age of market-based environmental governance the local public’s interests often don’t scale-up to the political directives and economic priorities of the agency, hence the role of citizen is restructured from that where the system serves people to that where the citizen is a client of the system.

Early on in the pre-scoping phase of the project Rare Element Resources commissioned a survey on public perceptions of the proposed mine and processing plant in the northeast Wyoming counties of Crook and Weston. A majority of the 407 respondents - 82.3 percent - said they favor mineral development after being informed about the negative and positive aspects of the project. The survey asked people what their main concerns were regarding the project, and these responses included: possible risk of groundwater contamination (37.6%), impacts on aquifers

(19.7%), increased traffic (9.3%), impact on local streams (7.1%), altering the scenery (5.3%), impacts on outdoor recreation (3.9%), and all other responses (17.1%). Furthermore, on a scale of 1-10, 57.7 percent of those people surveyed said they are highly concerned, 9 or higher, about the environment, and only 5.7 percent ranked their environmental concern at 3 or lower. Northeast Wyoming is dominated by the energy industry, including extensive open pit coal mines in the Powder River Basin with a tenuous future under the soon to be implemented Clean Power Plan and a potential forthcoming boom in uranium extraction with the development of in-situ leaching technologies. It's no surprise that local communities are economically supportive of mining development in the context of the boom and bust cycle of energy development, though the high degree of concern about water resources (64.4%) reflects a perceived risk to hydrological resources on publically accessible land or adjoining private property needed to sustain rural livelihoods.

In its role as lead agency the USFS recorded and categorized public comments submitted during the scoping phase of the EIS. Those made in support of the project include beliefs that: the mine will stimulate economic growth in Wyoming and local communities; the Bear Lodge mine will provide 150 to 200 new local jobs; and domestic rare earth production is important for supply chains and national security. Comments made in opposition to the proposed project included concerns that: increased haul truck traffic will create noise and disturb the rural way of life; direct loss of acreage for public recreation will result from mine development; the headwaters, riparian corridors, and ecology associated with Beaver and Whitetail

Creeks will be permanently altered; impacts to air & water quality will result, particularly impacts directly affecting human health and safety agriculture producers, landowners and wildlife in the area; long term impacts will result as a legacy for future generations; and lands that have historic tribal importance like Devils Tower will be diminished.

III. Methodology: Identifying perspectives and assessing subjectivity

Q method (QM) has been utilized by researchers in ecological and natural resources related studies as a tool to better understand where subjective stakeholder perspectives, values, and understandings of science lie in relation to one another across a spectrum of statements specific to the conflict, debate, or issue at hand. Several recent studies that utilize QM in environmental governance and natural resource management include: the political nature and questionable consensus in achieving conservation outcomes that benefit both human well-being and biodiversity (Cairns *et al.* 2014); measuring perspectives on principles and key characteristics in effective community-based natural resource management programs (Gruber 2011); conflicting landscape aspirations between development based on “production for profit” versus land use multifunctionality and conservation (Milcu *et al.* 2014); competing visions among ecologists when it comes to knowledge needs in the role of science in policy (Neff 2011); and the incorporation of values into the development of a community-scale sustainable forest management plan (Rodriguez-Pineros *et al.* 2012).

QM is a form of factor analysis used to analyze situated knowledge and as such serves as a quantitative tool to infer qualitative phenomena. It was first put forth by William Stephenson who discussed the inversion of traditional factor analysis and detailed a standardized procedure to collect data (Stephenson 1935; Stephenson 1952). In QM the researcher looks for correlations between subjects (statements) across a spectrum of variables (people), rather than finding correlations between variables across a spectrum of subjects as would be done with R method. QM is especially useful for conflict studies of complex environmental problems where the researcher wishes to identify converging and diverging perspectives between groups of individuals. An important difference between QM and traditional surveys conducted to gauge support is that QM gives a picture of the *variety* of perspectives that exist among a groups of individuals relative to one another, rather than analyzing the level of support for a *predefined* set of issues among a population (Cuppen *et al.* 2010).

In a public participatory process, such as an EIS, stakeholders are often identified on an *ad hoc* basis where the criteria for a selection procedure can be limited or unjustified. For instance, random sampling doesn't serve the needs of stakeholder selection well because it's based on the implicit, although false, assumption that relevant expertise (e.g. values, interests, perspectives, beliefs) is evenly distributed among the population (Cuppen *et al.* 2010). Nor does stratified random sampling based on demographic variables (e.g. socio-economic class, age, ethnicity) accomplish the goal of identifying the full spectrum of variables because

selection based on these criteria operates under the false assumption that demography is necessarily equivalent with perspectives (Martin 2008). Carrying out a survey to identify relevant issues such as a common Likert survey (e.g. minimum and maximum values 1 to 5) may appear as one solution to identify similar perspectives representative of a larger population, however this method may not identify the full range of perspectives (Eyvindson *et al.* 2015). The key point is that perspectives are subjective; individuals' beliefs, opinions, and interests may correlate to relevant expertise, demographic characteristics, and along scales, but stakeholder perspectives in a complex environmental problem are nuanced and thus best understood across a spectrum of variables relative to that of other individuals.

To ground the selection of themes for this study in social theory related to the environment and economy in the American west a broad literature search was conducted related to the values associated with 'old' extractive and 'new' amenity-based economies, along with a search related to values underlying biocentric conservation versus anthropocentric resource utility. Informal pre-interviews with stakeholders were then conducted with snowball sampling in order to elicit representative viewpoints of socioeconomic and ecological issues associated with mining and multiple use on federal lands. Next, records of public scoping comments for the proposed Bearlodge Draft EIS were obtained for the USFS, which included 153 individual submissions ranging from one sentence to three pages each. From these records a concourse of 304 statements reflecting the broadest set of issues and theoretical themes were chosen. The concourse was reduced to a sub-concourse of

106 statements that were brief, contained one salient point, didn't contain confounding grammar (e.g. double negative), and that were specifically relevant to the issue at hand (e.g. avoiding 'rider' issues or personal grievances not directly related to the proposed action). These statements were then coded to reflect socioeconomic and ecological issues associated with the proposed mining project and relevant theoretical themes (i.e. multiple use access, state control in mineral development, anthropocentric resource utility, and biocentric conservation). The sub-concourse was reduced to a final 32 statements chosen to represent an even distribution of themes that most inclusively summarized the issues first identified in pre-interviews.

Stakeholder participants (P=24) were contacted and asked to sort the final set of 32 statements within a pre-defined distribution of as many boxes from “least agree” (-3) to “most agree” (+3). The forced distribution resembling a bell curve included a middle column of zero salience, representing a "no opinion" value. Forced distribution, as opposed to a free rank-order distribution allows for the greatest statistical inference of factor types in terms of the statement preferences of individuals relative to other individuals (Brown 1971). Participants were asked to read over the full sample of 32 statements and differentiate statements that they agreed with, disagreed with, and had no opinion about prior to conducting the sort. Next, the participants sorted the statements into the pre-distributed boxes based on individual preference of opinion on statements relative to other statements. The participants were then asked a series of demographic questions, such as age, gender,

proximity to the national forest, and in what industry they are employed. Principle component analysis was used to complete a factor analysis of the 24 participant sorts. This was done by entering the participants' unique distributions into PQMethod software and rotating factors to identify the best solution using the Varimax algorithm.

IV. Discussion of findings: Situated rural perspectives of economy and environment

A. Knowledge production and the new conservation

Knowledge claims of community land users diverge or converge with that of the state and market-based stakeholders around how nature works – epistemological constructs of biophysical reality and ecological interrelationships that do or do not include human intervention, and who controls the environment – political economic constructs of rights that determine who maintains access to natural resources (Robbins 2006). In state land management agencies, the expert knowledge of scientists and the power of decision-makers is disseminated through organizational structures that best serve the agency's mission, the USFS is one such “bureaucratic shining star” (Clarke and McCool 1996). Corporate expertise is produced as scientists attempt to create intellectual capital – and discourses of uncertainty – that will enable new environmental and legal markets to function (Kirsch 2014; Lave *et al.* 2010). An environmental governance framework between community, market, and state stakeholders vying over economic and environmental claims can help to frame

epistemological constructions of the role of humans in nature and competing values (Lemos and Agrawal 2006).

Putting stakeholders into categories related to livelihoods is useful to help understand how different perspectives on the environment are grounded in one's mode of production, indeed "it is the daily struggle over resources in local political economy that gives rise to contending accounts of nature and environmental change" (Robbins 2000). In the regional context of the rural American west the difference in environmental values can be seen between "old" extractive industries and "new" amenity-based livelihoods, which generally pits old-timers whose ranching or logging operations are in decline against newcomers vying for endangered species protections, landscape preservation, and recreational opportunities (Duane 1999; Walker and Fortmann 2003). However, it's important to note that the differences in stakeholder types and regional livelihoods also elide a more nuanced view of rural environmental governance that is locally contingent. Rural people are often thought to live close to nature as a whole, in sync with its resources and staving off degradation, however development controls, especially those related to scenic values, are only as effective as the collective community value ascribed to the landscape as is the case with long held common property resources threatened by exploitation on private inholdings or adjoining lands (DuPuis and Vandergeest 1996; Robbins *et al.* 2009). It just depends on place. Land tenure and fragmented management across a patchwork of public and private ownership throughout the west, particularly in communities surrounded by federally managed lands, is a causal factor of land use

conflict; social conflict based on scarcity of land, natural resources, even endangered species and clean air or water, and cultural politics of class, race, and nation are but a few of the rider issues seemingly separate from the politics of the environment that drive contested knowledge about nature (Kosek 2006; Nie 2009).

For public lands conservation and resource management there is an epistemological divide over the ecological role of humans within or apart from the natural world and a socioeconomic rift over how lands should be administered for resource utility (Doak *et al.* 2014; Kareiva and Marvier 2012). Biocentrists claim that their efforts - underpinned by the protection of biological diversity, the belief that nature has intrinsic value, and the primacy of conservation efforts towards large contiguous wild spaces have been compromised by a “new” conservation ethic that claims to enhance natural systems for the benefit of the widest number of people, especially the poor, and that the instrumental value of nature (e.g. ecosystem services) should drive conservation efforts rather than pursuing the protection of biodiversity for biodiversity’s sake (Kareiva *et al.* 2012; Soule 2013). Popularizers of the ‘new’ anthropocentric resource utility ethic have been dubbed “neo-greens” for their adherence to beliefs such as: conservationists shouldn’t critique capitalism but rather partner with corporations to achieve better results; nature is highly resilient, not fragile; to succeed, conservation must serve human aspirations, primarily economic growth and development; maintaining “ecosystem services” should be conservation’s primary goal (rather than biodiversity); and conservation should prioritize better

management of the domesticated, “working landscape” rather than efforts for strictly protected wild areas (Kingsnorth 2014).



Figure 7. Land uses in the Bearlodge Ranger District (clockwise from upper left): Bull Hill, proposed site of the rare earth mine; timber cut on Section 16, acquired by the mining corporation for tailings disposal; off-highway vehicle and hunting access gate; cattle grazing on a private property inholding.

Neither biocentric nor anthropocentric perspectives are new; the term “new conservation” was first used nearly a half century ago by geologists whom advocated for a conservation approach in-situ of extractive development that would preserve air, water, and land for human benefit (Flawn 1966). The history of conservation and resource use in the United States has been a struggle between those shaping the

environmental/resource ethic of society; Thoreau, Marsh, Powell, Muir, Roosevelt, Pinchot and Leopold are but a few examples of individuals whose perspectives embody a nature-society dualism, a worldview that is at once inescapable, contradictory, and naturally subjective (Worster 1994). This dualism emerged from ancient Greece, where dialectic thought allowed philosophers to juxtapose and consider the dominion of earth by and expressly for human use versus humans as part of a natural system larger than themselves (Glacken 1973).

Along a spectrum of values, the two camps may be closer to one another than recent exchanges may lead one to believe, after all both are deeply committed to conserving nature, but what that common concept of ‘nature’ is remains elusive; “anthropocentrists seem to embrace the viewpoint of some ecosystem ecologists who focus almost entirely on the emergent properties of ecosystems such as productivity and stability [while biocentrists seem to embrace] the perspective of ecologists and evolutionary biologists who focus on species, especially the rates of local extirpations and global extinctions” (Hunter *et al.* 2014). What gets swept away in the, perhaps delusory, moral power of an anthropocentric discourse is the priority given to human needs and desires, in that, “it provides the economic and political power of appropriating whatever humans can use from the natural world – from oceans, forests, rivers, grasslands, coasts, wildlife, domestic animals, genomes, or the crust of the Earth. Anthropocentrism creates the ontological power to elide the acts of taking *as* [sic] acts of taking, through their ceaseless (small to mega) enactments as unremarkably ordinary” (Crist 2014).

Those advocating for an anthropocentric resource conservation ethic - in Pinchot's utilitarian sense - envision nature as a "rambunctious garden" where novel ecosystems can emerge in situ of human development, and celebrate the notion that the two can prosper together (Marris 2011). Anthropocentric conservationists have argued that their stance is underpinned by values, and that conservation outcomes on the ground should be the ultimate arbiter for whether people and corporations should be embraced within an evolving conservation ethic (Marvier and Kareiva 2014). However, if left unchecked, this notion remains somewhat dubious when one asks: to what degree can evolutionary and ecological processes be sustained so that nature remains highly functional and untrammelled in perpetuity? What land uses are appropriate, and where, is no doubt a subjective perspective based on individual and group concepts of property and resource use, anti-corporate or anti-statist views, and underlying epistemological stances on the role of humans in nature.

B. Interpretation of findings

Interpretation of survey results was conducted by comparing the distinguishing statements for each rotated factor with the positions of respondents across a plot. The distinguishing statements for Factor 1 (Table 3) represent the most significant shared opinions of stakeholders based on sorts, and are therefore defining viewpoints on either end of the spectrum for how people believe nature should be managed; humans as separate from nature and utilizing its resources or humans conserving ecological function for its own sake. Common themes for positively

ranked values align on anthropocentric resource utility with state regulatory control of resource extraction in light of geopolitics and national interest [#13 and #24] and with protecting the private property rights of both corporations and individuals [#18]. Whereas negatively ranked values reflect a biocentric perspective that the "integrity, stability, and beauty of the biotic community" in the unique high elevation headwaters of the mountains should be kept intact [#8 and #28], a viewpoint that is shaped by what the landscape is not: a sagebrush prairie already being altered by extraction, like with coal mining near Gillette [#23]. Distinguishing statements for Factor 2 (Table 4) likewise represent the most significantly shared opinions about rural economic development, either from proposed mining or from the multiple uses of the forest. Positively ranked statements reflect a perspective that mining is the "highest and best use" [#3] that will provide essential civic services [#10] and that without it the community will be swept into economic decay [#7]. Negatively ranked values align on the viewpoint that mining will degrade the land and water resources of the forest beyond its capacity to sustain multiple use livelihoods and recreation [#30, #27, and #5].

Distinguishing statements – Factor 1	Rank	z-score
24. Given that the Chinese dominance of the rare earths market has adversely impacted supply stability, rare earths should qualify as materials either strategic or critical to national security. The U.S. government should be providing a mechanism where access to federal lands for rare earth extraction is possible.	3	1.745
13. The USFS is mandated to follow The Mining and Minerals Policy Act of 1970 which states: "The Congress declares that it is the continuing policy of the Federal Government in the national interest to foster and encourage private enterprise in the development of economically sound and stable domestic mining."	3	1.563
18. It is of concern to anticipate that approximately 8.7 miles of NFS roads will be removed from public access. Denied or interrupted access to private property surrounded by federal land is a concern because of reliance on public road systems to access these inholdings.	2	1.334
28. Aldo Leopold's land ethic states that an activity is "right when it tends to preserve integrity, stability, and beauty of the biotic community" and "wrong when it tends otherwise."	-2	-0.920
8. The site of the proposed Bull Hill mine takes place in a unique high elevation area of the Bear Lodge Ranger District. These actions will result in the permanent alteration of headwaters, loss of critical wildlife habitat consisting of high elevation meadows, ponderosa pine and aspen forests and riparian ecosystems.	-2	-1.057
23. Rare Earth, I don't think anything better describes the Black Hills or the Bearlodge. It is a pristine beauty. A strip mine will forever change that beautiful landscape. This is not the sagebrush prairie by Gillette [coal country]. Some property is more valuable purely based on its beauty than others, and should be protected.	-3	-1.272

Table 3. Distinguishing statements for Factor 1 – Anthropocentric resource utility or biocentric conservation.

Distinguishing Statements – Factor 2	Rank	z-score
3. We should be encouraging the development of the abundant mineral resources which occur on that nation's public lands as the "highest and best use" for economic development.	3	1.584
7. We cannot afford to miss this opportunity for the health and viability of our communities. We must keep in mind that history is a relentless master. It has no present, only the past rushing into the future. To hold fast and not embrace new opportunity is to be swept aside into economic decay.	3	1.551
10. The tax dollars from mining development will benefit northeastern Wyoming counties and the region by retaining and improving our retail, service, utility, city, county, and educational jobs, help meet the needs of our area churches and volunteer ambulance and firefighting entities, and help support other groups.	2	1.034
30. Leaving the pit with no structural changes, as well as the pile of waste rock does not qualify as reclamation. Such a plan would greatly diminish the recreational, range, and timber uses of the NF.	-2	-1.282
27. Beaver Creek is the source stream of Cook Lake, which is the site of the USFS “Cook Lake Recreation Area,” a public swimming, fishing and camping area. There should be great concerns regarding the water quality and quantity of the aforementioned water sources.	-2	-1.535
5. Analysis of water quality and water supply, including drinking water and irrigation water, is critical because of the linkage to human health effects and ecosystem services.	-3	-1.803

Table 4. Distinguishing statements for Factor 2 – Economic development from mining or multiple use access.

The distribution of respondent perspectives from the QM survey (Figure 8) shows two major groupings of individuals across two factors. For Factor 1 – biocentric preservation or anthropocentric resource utility - one group of responses fall wholly within the anthropocentric category, while the second grouping conveys a more biocentric perspective, though some of these responses are just over the cusp of being anthropocentric. For Factor 2 – extractive mineral development or sustained multiple use forest access – those who identified in the anthropocentric category are evenly distributed between a preference for the economic benefits of mineral development and that of sustained multiple use access while those who group together as biocentric fall entirely within the sustained multiple use forest access category. Over 70 percent of participant responses value sustained multiple use access of forest resources over the potential economic gain of extractive mineral development, while participants were evenly divided about the role of humans in nature as either serving humans' needs or humans as part of a larger ecological process. The intra-group diversity may be the most interesting result of the survey because it confirms that those identifying as stakeholder groups who traditionally oppose one another on political issues actually share underlying epistemological constructs about the role of nature or share values on sustained access to the forest. That is, it doesn't come as any surprise that group A contains those identifying as working in the forestry or mining/energy sector, but a land holder whose statement sorting reflects a desire for sustained access to the land over mineral development and a state regulator whose preference is the opposite of this are both novel perspectives because they are separate from others within the

group they identify. The diverse composition of self-identified roles for group B is likewise novel as it shows that people who depend on access to the forest for their livelihoods or amenities have a biocentric construct of reality where humans are part of nature.

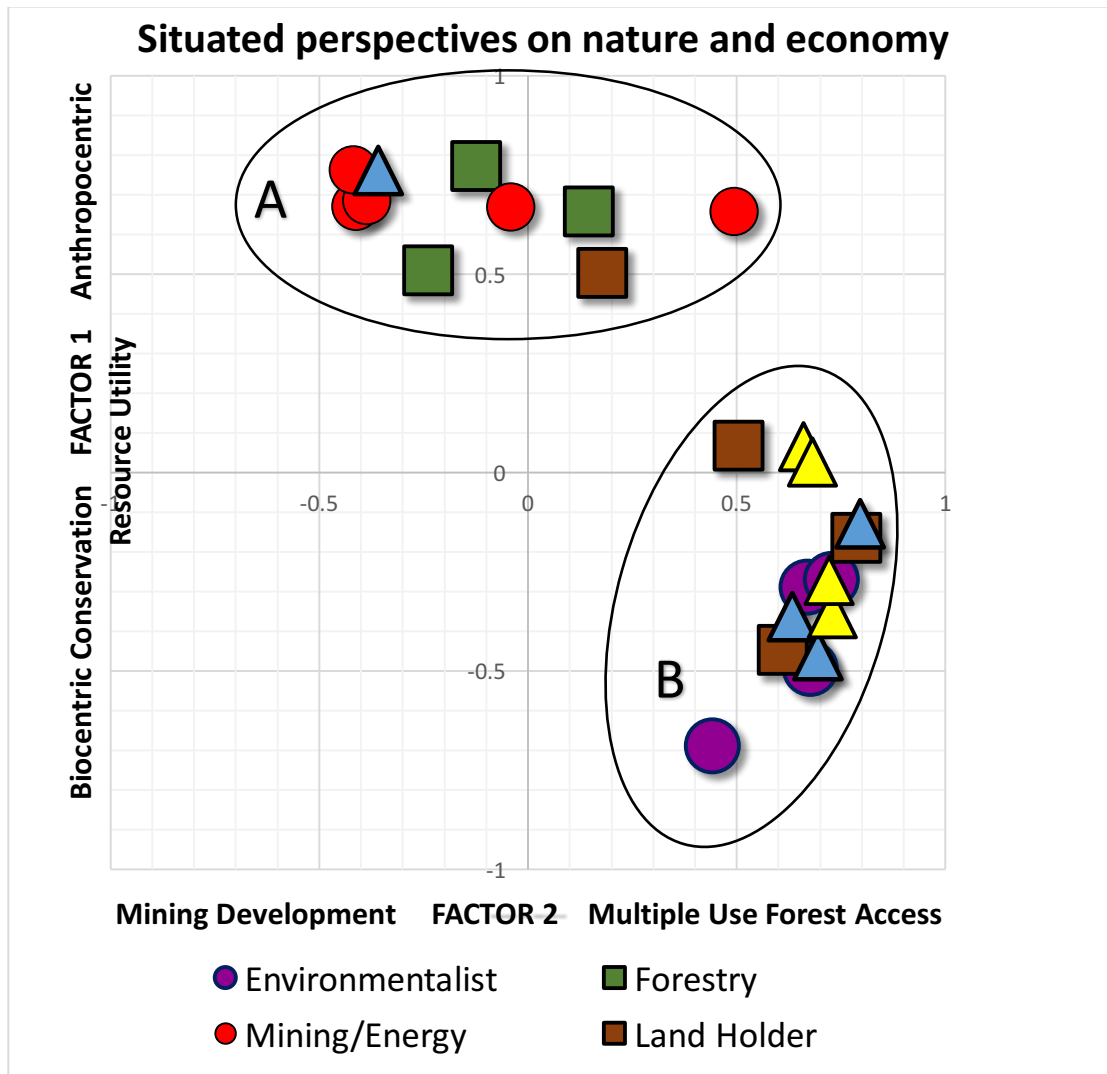


Figure 8. Situated perspectives on nature and economy: Axes of environmental knowledge and socio-economic perspectives.

Those who coalesce in group A share a common viewpoint that the U.S. supply chain for clean, green, high-tech and military technologies is threatened by a lack of domestic rare earth element production due to China's monopoly of the industry. This is emblematic of rural perspectives on resource scarcity more broadly associated with increasing global competitiveness in commodity production. All in this group serve in state and market roles that depend on either facilitating development (e.g. state permitting agencies) or working in the industries dependent on resources extraction (energy and mining industry) and see the length and scope of state environmental regulation as onerous but necessary to ensure sustained competitiveness, and their very livelihood. As such, these stakeholders share the desire for a more expeditious permitting process, specifically with rare earths given the criticality of these elements (Clagett 2013). Members of group A are also divided into those who value the multiple uses of the forest over economic development from mining. These anthropocentricists believe that common property resource lands, such as National Forests, should be used for human utility whether it is for their own recreation or the private economic gain of a corporation. Members of this group thus maintain a level of cognitive dissonance with the ecological contradiction they facilitate through extractive resource development; the future sustainability of clean air, water and soil resources underpin the multiple use forest that they rely on for recreation, but the environment that underpins the accumulation of capital for these activities is threatened by industrial mining (O'Connor 1998). This cognitive dissonance is not unfounded; while construction and operation of mining may reduce

access to land in the short-term, the potential for environmental impacts to water resources, for example, that local populations rely on likely won't be brought to bear until a point in the future beyond what will affect present day livelihoods (Bridge 2000). In the case of regulated commodities, especially those that are fixed in the ground as with hardrock minerals, a disconnect exists between capital accumulation and ecological impact in terms of the varying spatial scales of global market forces, national priorities, state regulations, and local socioeconomic life ways (Huber and Emel 2009). Thus, members of group A embody a type of scalar cognitive dissonance, in both time and space, embodied in the contradiction between the potential future local ecological cost, not ingrained in the value of global mineral commodities, and through their own economic activity to facilitate extraction that is contingent upon global markets.

Those whose perspectives coalesce in group B share a contradictory viewpoint about the role of humans in nature and what land uses should take economic precedence. The distribution of these stakeholders falls entirely within one quadrant that is both biocentric and multiple use. These shared perspectives are contradictory because adherents to a biocentric epistemology see humans as part of the ecological web of nature and recognize that human utility of natural resources needs to be limited in some areas in order to provide for the long-term viability of the natural world, however at the same time everyone in group B would prefer multiple use access to the land over mineral development and management for these multiple uses still requires some level of human intervention across the landscape in order to avoid

pervasive degradation. Ranching, forestry, off-highway vehicle use, and hunting can be carried out so that ecological impact is selective, diffuse, or at the least mitigated and restored. That is, a tragedy of the commons scenario can be avoided if these activities are managed under the rules of common property resources, which in the case of Forest Service lands is pursuant to the National Forest Management Act and Multiple-Use and Sustained-Yield Act. Though biocentric, these stakeholders are landholders, recreationalists, state/federal regulators, and environmentalists who make use of the land for different types of recreation and small-scale subsistence, such as hunting, grazing, off-highway vehicle use, or the scenic amenities of a rural landscape. It may be that the very reason these individuals associate with a biocentric epistemology is that through their livelihoods and use of the forest they have developed a nuanced understanding of non-equilibrium ecological relationships that is the product of a cognitive bias towards local effects of what are otherwise byproducts of global environmental change - like increased prevalence of pine beetle disease, fire outbreaks, drought, and more intense winters due to climate change – and thus perceive that their individual intervention is a necessity to maintain ecosystem function (Dizard 1999; Grabbatin and Rossi 2012; Shinneman and Baker 1997). This viewpoint dates back to the yeoman homesteader across the western frontier surviving with, improving upon and reproducing nature (Jenkins 2011). However, this view of necessary tinkering is also connected to a more recent history of large-scale mining in the Black Hills, a region whose aquatic resources and ecological integrity have been pervasively altered by eras of gold and uranium extraction.

V. Conclusion

This chapter has used the case of a hardrock mine proposed for development on multiple use forest lands to demonstrate how contending accounts of economic impact and environmental change are situated in more nuanced socio-ecological perspectives related to: state control over a multiple use landscape, local access to common property resources of the forest community, and underlying epistemologies about the role humans should play in managing environment as either separate from nature or part of an ecological whole. These findings suggest that the existing framework for public comment in the EIS process is limited in its ability to obtain synthesized socio-ecological viewpoints, and for the USFS this is especially true given the discourse of agency directive meant to facilitate natural resource extraction, which due to procedural frameworks, technical jargon, and reliance on corporate expertise is often at the expense of communicative action that would otherwise allow for the integration of local socio-ecological knowledge. The Final Draft EIS for the Bearlodge project is under review by the USFS. The chosen development alternative will depend on how the agency responds to the perspectives of the public on issues of environmental control, access, resource use, and preservation, for both perspectives represented within the EIS process and those in the discourse surrounding it.

Chapter Three

Comparing economic, ecological, and socio-cultural values in a multiple use landscape

I. Introduction: Rare earth in the American west

“There is no hunger like land hunger, and no object for which men are more ready to use unfair and desperate means than the acquisition of land.”

-- Gifford Pinchot, *The Fight for Conservation*

The U.S. federal government acquired over 1.8 billion acres of nearly contiguous land during the course of frontier expansionism into western states and Alaska. Through Congressional Acts nearly 1.3 billion acres of this land was conveyed from the federal government to private ownership for ranching, railroads, mining, timber, and right-of-ways. This vast acreage includes 3.2 million acres of mining claims that snake through the landscape above mineral veins and 70 million acres of specified sections conveyed to states for surface resources (Miller 2013). The western landscape has thus emerged as a patchwork of public and private land holdings through overlapping eras of homesteading, federal enclosure, surface and subsurface ownership, and scientific management. This discontinuous land tenure poses social and ecological challenges for landscape-scale conservation objectives (Charnley, Sheridan, and Nabhan 2014). However, it is not just this historical checkerboard pattern that has led to present day land use conflict. Scarcity is a theme present in lands management in terms of habitat connectivity, government funding for

conservation efforts in light of extractive industries, and the diminished population levels of iconic western species due to expanding impacts of human development are but a few drivers of land use conflict between nature and natural resource exploitation in the west (Nie 2008). Scale also plays a part in conflicts over how the environment should be valued. When it comes to wildlife policy state and federal decision-makers are often perceived as biased, exclusive, or unrepresentative of non-extractive stakeholder values resulting in an unlikely alliance among rural land users who engage in hunting and endangered species protection in order to conserve the viability of the landscape in the face of proposed energy or mining development (Nie 2004). The Black Hills National Forest in Wyoming and South Dakota is the most fragmented unit of the United States Forest Service (USFS) system containing within its boundaries over 300,000 acres, or 20%, of 1,534,000 total acres privately owned (BHNF 2011). This is in large part attributable to the historic timber and homesteading claims that emerged to support the Black Hills mining industry. However, the legacy of these inholdings continues to challenge land managers on issues that transcend property ownership such as right-of-ways, bark beetle eradication, fire suppression, and the aforementioned wildlife-oriented amenities (Nie and Miller 2010).

II. Land exchanges and the case of Bearlodge

The Bearlodge rare earth element mine is proposed in the Bearlodge Ranger District, which makes up the vast majority of the Wyoming portion of the Black Hills

National Forest (BHNF). The proposed mine project area is 1,700 acres, including 1,060 acres of National Forest mineral claims where open-pit mine development and

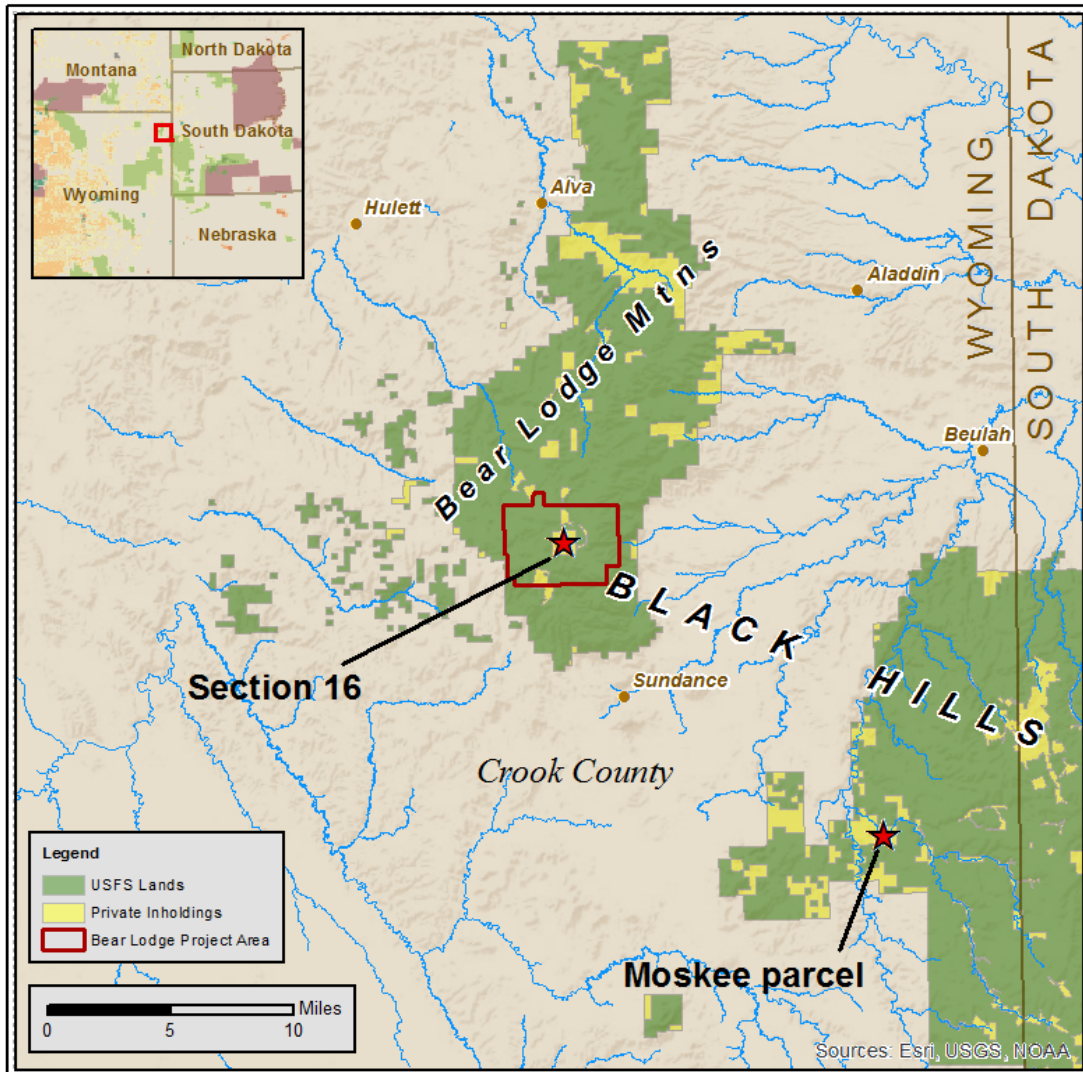


Figure 9. Locations of exchanged lands: Section 16 and Moskee parcels.

associated processing activity would take place and 640 acres of private land - formerly owned by the state but acquired through the exchange - where a waste tailing pile would be located. The mining corporation - Rare Element Resources - conducted a land exchange with the State of Wyoming in 2012 to acquire land for a

future waste tailing pile, however this process was not a connected action of the Environmental Impact Statement for the mine. The Weeks Act typically facilitates land exchanges that occur on federal lands, while the Black Hills National Forest Plan offers planning process criteria for recent land adjustments in the area but not for their value (BHNF 1997). In the case of state and private lands, the Wyoming OSLI facilitates land exchanges, and these lands are commonly adjacent to or are inholdings within federally managed lands (OSLI 2012). Rare Element Resources acquired a 640 acre Wyoming state trust parcel (referred to herein as Section 16) adjacent to the proposed mine in the Bearlodge Mountains in exchange for a 400 acre parcel it purchased from the Moskee Land Corporation (referred to herein as the Moskee parcel) along Grand Canyon Road, also located within the boundaries of the BHNF. This exchange will impact the value of the economic, ecological, and socio-cultural goods and services provided by the the forest community as a common property resource.

Traditionally, the USFS and other public land agencies have pursued land exchanges as a way to trade inholdings for outlying parcels and thereby augment contiguous ownership that can bolster conservation, recreation, and other management goals. These land swaps however are increasingly being used as a strategy for mining corporations to attempt to mitigate the social and ecological value of public lands. However, the exchange process does not provide sufficient opportunities for the public to provide input about where the best recreation is located or how the ecological composition of the land should be valued, which can result in

Mining Project	Lands Exchange	Select Exchanged Values	Purpose	Agencies Involved
Bearlodge (WY) - Rare Element Resources	State Land Trust (640 acres) for Moskee Lands Corp (400 acres)	Publically accessible state land <i>exchanged for</i> private land to mitigate hunting and ecological impact lost to mineral development	Tailings pile creation	Black Hills N.F.; Wyoming State Lands & Investment
Northmet Copper-Nickel (MN) – Polymet	USFS (6,650 acres) for five tracts (6,722 acres)	Wetland ecology impacted, <i>in exchange for</i> hunting and private forest inholdings	Acquisition of split subsurface mineral rights	Superior N.F.; Minnesota Dept of Natural Resources
Resolution Copper (AZ) - Rio Tinto	USFS Oak Flat (2,422 acres) for eight tracts (5,344 acres)	Spiritual and historically designated site impacted <i>in exchange for</i> discontinuous, though ecologically diverse, archeologically intact, and recreationally useful lands	Subsurface panel caving, surface subsidence	Tonto N.F.; Bureau of Land Management
Bingham Canyon (UT) - Kennecott/Rio Tinto	Suburban Land Reserve Inc. (3,100 acres) for land holdings and cash	Acquisition of development land to <i>relocate</i> railroad track to make way for expanded tailing impoundment (on existing property) <i>and</i> to acquire additional ecologically valuable land for offset	Relocation of railroad track for tailings expansion	Private transaction

Table 5. Recently approved and pending land exchanges for mineral development. Sources: (OSLI 2012), (Polymet 2016), (Resolution 2016), (Rio Tinto 2016).

an incommensurability of values, where mining as the “highest and best use” of the land trumps the multiple uses of the forest community (Glicksman and Coggins 1997). Importantly, and of special concern to civic governance, this process can

unfold prior to and separate from the environmental impact statement process that a proposed mining project is mandated to go through by the National Environmental Policy Act. Public property used for cattle grazing, timber production, hunting, off-highway vehicle use, and other outdoor recreational activities is now susceptible of being transformed into open mine pits, special concern to civic governance, this process can unfold prior to and separate from the environmental impact statement process that a proposed mining project is mandated to go through by the National Environmental Policy Act. Public property used for cattle grazing, timber production, hunting, off-highway vehicle use, and other outdoor recreational activities is now susceptible of being transformed into open mine pits, mining infrastructure, and waste tailing piles that carry associated impacts of impaired water resources, degraded habitat, and significantly reduced rights of multiple use access. Table 5 lists some recent land exchanges for mineral development.

This chapter reassesses the economic property value through spatial analysis, builds on an assessment of the socio-cultural value of the forest for recreational hunting use, and provides new plant diversity data to value the ecological function underpinning the social and economic values of the parcels traded as part of the Moskee land exchange for the proposed Bearlodge mine project. The development of a socio-ecologically integrated methodological model to assess the separate economic, ecological, and socio-cultural components of a land exchange for mineral development is an important contribution when land exchanges are being used more frequently by mining corporations to gain access to surface and subsurface resources.

Public – private land exchanges occur for a number of reasons, including consolidating public land through the acquisition of private inholdings, simplifying boundary management, and acquiring important resource lands. Exchanges are based on property value, not acreage, of the lands to be traded and thus rarely result in an acre-for-acre trade. Indeed, land values can differ drastically between and within urban, suburban, and exurban settings given the supply of available land and the demand for a particular type of land use. In Wyoming, where the exchange is proposed, the state can trade State held trust lands for private lands if the Wyoming State Board of Land Commissioners deems the exchange necessary to: 1) make state lands more manageable; 2) meet a specific need for a school or community; 3) better meet multiple use objectives; and 4) realize a clear long-term benefit to the trust which substantially exceeds the present value (OSLI 2016). In Wyoming, the process of a land exchange includes real estate appraisals, public notification, a brief comment period, and a public hearing in the county where the parcel is located.

What noticeably lacks in the land exchange process is an integration of the ecological value with the assessed social and economic value of the land. Ecological value is often inaccurately perceived to be incorporated into the value of property as a commodity. That is, in the context of exchangeable market commodities nature is only deemed quantifiable through abstracted units of weight, volume or time (Robertson 2006). This process of standardization creates value that is easily exchangeable though incommensurable with the holistic measures of ecology, therefore some aspects of nature are not represented and the commodified value of

land is inaccurately perceived, a whole other than the sum of its measured parts. The phase of assessment is another step in the socially constructed commodification of nature where the abstraction of nature's diverse qualities can be seen as a reduction where everything about the forest is ignored aside from the "merchantable" aspects of nature into abstract entities of animal unit months, million board feet of timber, tons of ore, etc. (Demeritt 2001).

For a land exchange to occur in Wyoming, the State Office of Lands and Investments (OSLI) must prepare a detailed analysis that includes an assessment of the following: A) An appraisal of the market value of the parcel; B) an assessment of the income-generating potential of the parcel; C) how the parcel will be managed D) the existence and importance of any wildlife habitat and wildlife-oriented recreational opportunities located on the parcel; and E) the existence and importance of any public recreational opportunities or cultural resources located on the parcel (OSLI 2016). This assessment does not get at the degree to which biophysical nature is intrinsically valuable as that is difficult if not impossible to measure outside of socially produced human constructs (Justus *et al.* 2009). However, what is possible to measure is the the degree to which plant diversity and landscape-scale habitat characteristics (e.g. core, intact, native plant habitat versus edge, non-endemic plant habitat amid a heavily trafficked and fragmented landscape) can provide supporting services or instrumental function for species such as ungulates, and by extension the socio-cultural value these species provide for activities deemed locally important like recreational hunting.

III. Methodology: Assessing ecosystem service and cultural values

Forest ecosystems provide many goods and services. Forest ecosystem services are defined as the process through which the forest and the species that live there support and satisfy human life (Daily 1997). Forest goods and services include: direct use values, such as economic provisioning goods like timber and grazing; non-use values, such as habitat support and related ecological diversity preservation; and indirect cultural services, such as the locally perceived value of hunting (Barrio and Loureiro 2010). Direct use commodity value and non-use ecological support services are iteratively shaped by the indirect socio-cultural values of the forest community such as attitudes towards environmental degradation and the value of non-human life. Many ecosystem goods and services do not have a market price to reflect the benefits they provide to society. This is not because these goods and services exist somewhere objectively “out there” waiting to be found and integrated into the market system. Rather, the very classification of economic “goods” and socio-cultural support “services” are elements of biophysical nature that have been abstracted through measurement and remain entangled with political economic institutions that have ascribed use value (Ernstson 2013).

There are various challenges in assessing trade-offs between the environment and development, and as previously discussed this is particularly a challenge within a multiple use landscape that must serve various mandates. Indeed, interactions among ecosystem services are likely to occur when multiple services respond to the same driver of change or when the services themselves interact with one another (Cotillon

2013). Such is the case in the Black Hills, where the historical influence of mining, or what Brechin (2006) has referred to as the “pyramid of mining”, has been the prime cause of land use change through: frontier settlement, landscape-scale forest to timber conversion, impaired water quality, cattle grazing, grassland degradation, invasive species introduction, large mammal hunting, and biodiversity loss. It is certainly convenient to assess economic, ecological, and socio-cultural value as a cumulative whole, however given the incommensurability between these types there remains a weak comparability of value given the interactions between ecosystem services that emerge through ongoing land use change (Martinez-Alier, Munda, and O’Neill 1998). Furthermore, the consistency and standardization needed to cumulatively compare is a challenge given the different perceptions stakeholders hold about the economic value of ecosystem services to society and the attendant scaling issues (e.g. rural property values linked to a global economy, habitat connectivity for ungulates, different perceptions of value between local versus out-of-state hunters) (DeGroot *et al.* 2010). Therefore, in order to assess the comparability of value between two parcels, this paper uses different methods of assessment for each value type to compare economic, ecological, and socio-cultural values between parcels rather than assessing commensurability of different value types among one parcel.

For the purposes of this study I will focus on the three main categories of goods and services – economic provisioning goods, ecological support services, and socio-cultural benefits (Stenger, Harou, and Navrud 2009). Economic provisioning goods include the provision of natural resources such as the production of timber

from trees and the grazing of cattle that rely on intermittent grassland. Ecological supporting services include the maintenance of essential ecological systems such as habitat for species and related genetic diversity. Socio-cultural benefits include the scenic amenity of the landscape and the recreational opportunities it provides such as hunting, given local land user perspectives about the role humans play in environmental change. I will use different methodologies to assess each economic, ecological, and socio-cultural value, however the method to assess each type of the three values will be the same for both parcels for the sake of inter-parcel comparability (Figure 10).

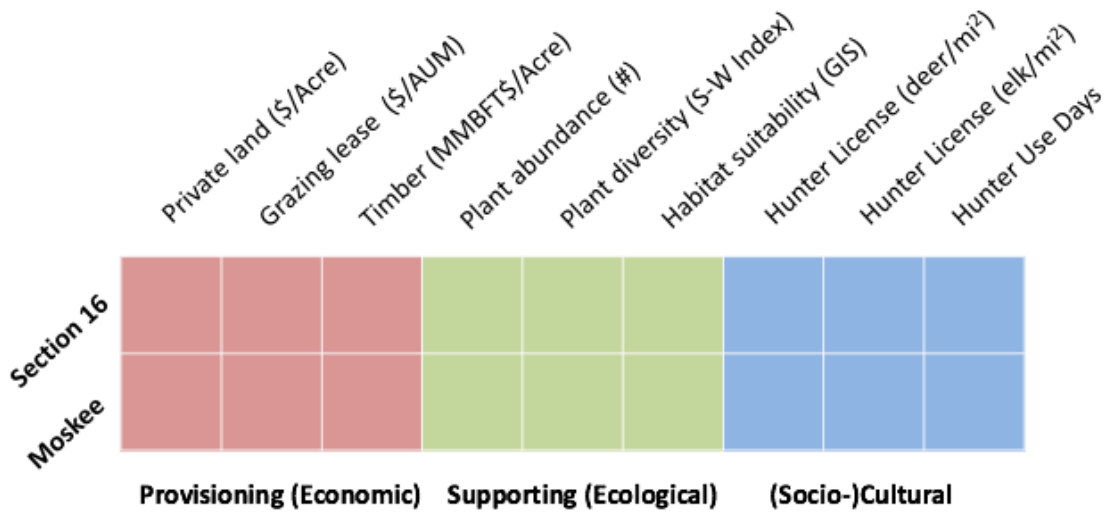


Figure 10. Metrics used to assess the comparability of economic, ecological, and socio-cultural values - Section 16 and Moskee parcels.

To compare economic value between the parcels I will conduct a spatial analysis of property values within an approximate 30-minute driving distance (6-mile radius) from each site. The Wyoming Department of Revenue Property Tax Division has this data available, though it will need to be linked with a GIS layer of parcels at

the county level through an APN identifier. This analysis will differentiate between public and private lands of different acreage class to account for the diminishing marginal value per acre of larger land holdings. In addition, the timber and ranching value of each parcel will be identified, and analysis of urban services proximate to each parcel will be undertaken based on local knowledge of each site.

To assess ecological support services for the sake of inter-parcel comparison, a plant abundance and diversity survey was conducted on each parcel, along with a spatial analysis of ungulate ranges. Plant abundance and diversity surveys were conducted using transect and quadrant field assessment and analyzed through a Shannon-Wiener index, which is a useful metric to infer approximate composition in conjunction with known floristic community types. Spatial analysis of summer, fall, and spring ungulate ranges were conducted through GIS by utilizing available data from the U.S. Forest Service (winter ranges are in lower elevations primarily off public forest lands, and away from the exchanged lands).

Socio-cultural value of each parcel was assessed through an analysis of existing harvest license data and hunter traffic surveys available through the Wyoming Department of Game and Fish. Harvest license issuances were used to assess hunting density per parcel as a proportion of the larger state hunt areas with the assumption that a greater density of licenses issued are an indicator that hunting opportunities are more abundant. In addition, Wyoming Game and Fish placed traffic counters along the roads of each parcel and conducted surveys to approximate hunter user days gained or lost at each site. This study leverages this data to assess the value

of each parcel for hunting and also considers how higher traffic counts may create a feedback that actually reduces hunting value due to avoidance by mule deer, white-tailed deer, and especially elk.

IV. Discussion of findings

A. Economic value: Public and private land comparisons

The Black Hills are widely regarded as the nation's preeminent multiple use landscape where hunting and other recreational opportunities take place among timber stands, grazing allotments, and mining development (Geores 1996). The value of land in the Black Hills is based upon the realized and potential for these multiple use activities and resources. The 400-acre Moskee Corporation parcel acquired by the State was assessed by the Wyoming OS LI at \$2,500/acre, a per acre value 67% above that of the 640-acre Section 16 traded by the State to Rare Element Resources, which is valued at \$1,500/acre and would host the waste tailings pile for the proposed mine.

These differences are partially representative of the different amenities accessible from each location. Section 16 is accessible by maintained paved and graded roads from Sundance, Wyoming, whereas the value of the Moskee parcel is claimed to be based on access to the amenities of Savoy, South Dakota. However, Savoy is only close to the parcel through seasonally accessible USFS graded roads without tracking back to the Interstate, and it contains only one lodge and restaurant combination. The City of Sundance has many more amenities as the seat of Crook County, with USFS facilities, lodging, restaurants, recreational outfitters, and a

hospital. Regardless of these differences, the rationale of comparing amenities is inconsequential in this situation; a quick driving direction search via a popular internet search engine shows that both parcels are approximately 30 minutes away from Sundance and 90 minutes away from Savoy via the interstate, respectively.

Local residents believe the speculated *future value* of Section 16 as a tailings pile influenced the price difference. That is, the state assessed this section of land as being less valuable in the present –prior to approval of the mine - because it will be covered in waste rock in the future. On the contrary, permitting agencies will require the land to be reclaimed, re-vegetated, and ostensibly this will remain useable for multiple use activities after the 40-year life cycle of the mine. It is difficult to say what this land will be worth to the forest community after reclamation, however in the interim it will certainly be less if access is restricted due to mining.

The Wyoming OSLI considers land within the Moskee area to be more valuable. However, the Moskee area is more ecologically fragmented from historic livestock use and timber production as a relic of its private management by the Moskee Corporation, whereas Section 16 has been historically managed by the state for the same uses but remains more intact given its location in the core area of the Bearlodge Mountains away from higher trafficked roads. The Wyoming OSLI went through with the land exchange because it met its statutory criteria, namely that the State Trust portfolio would stand to gain value by acquiring the Moskee parcel because of the higher *appraised* property value despite the lower acreage: Moskee = \$1,000,000 (\$2,500/acre x 400 acres) > Section 16 = \$960,000 (\$1,500/acre x 640

acres). But what do these per acre dollar values represent? I will first discuss the value of each parcel for its productive utility given on-site grazing and timber potential. Secondly, I will compare the value of each parcel with surrounding public and private property values of different acreage classes through a spatial analysis of tax assessor's data.

The per acre property values of lands in the Black Hills are reflective of multiple uses, including cattle grazing and timber production. Section 16 has a grazing lease estimated at 114 animal unit months – meaning that on-site forage material during grazing months can sustain 114 cow and calf pairs. For 640 acres this translates to 0.18 AUM/acre. In 2012, the lease of the land for 114 AUMs across 640 acres was \$547.00 or a rate of \$4.80/ AUM. In contrast, the smaller 400-acre Moskee parcel is estimated to have 85 AUMs or 0.21 AUM/acre with the future lease anticipated to be approximately \$408.00 or a rate of \$1.02 /AUM (OSLI 2012). The difference in value between the two parcels is similarly unequal for timber production. Prior to becoming privately held and logged, Section 16 was largely forested with ponderosa pine as the major tree species containing grasslands amid the larger coniferous structure. Its production of over 1.8 million-board-feet since 2008 has resulted in State Trust revenue of \$157,000 or \$245/acre. The next rotation of harvestable trees would be ready in approximately 80 to 100 years, however a tailings pile would cover the parcel if mineral development is approved and this would eliminate the possibility of a future harvest. In contrast, it is predicted that the Moskee parcel could produce a short-term harvest of 0.55 million-board-feet that would result

in \$48,000.00 in revenue or \$120.00/acre. If the 80 to 100-year rotation were applied to the Moskee parcel then it could produce additional revenue, however the same could be said about timber production on Section 16 without tailings.

To compare the value of lands a spatial analysis was conducted by coding parcels with state tax assessor data (Figure 11). Public and private lands were incorporated into this spatial analysis spanning a six-mile radius (approximately 30-minute driving) from each parcel, which resulted in different per acre property values for the Bearlodge Mountains surrounding Section 16 (Figure 11, A) and the portion of the Wyoming Black Hills surrounding the Moskee parcel (Figure 11, B). Public land value is first assessed and an explanation is provided on how using public land value averages is an insufficient and invalid method of comparison. This is followed by an assessment of private property \$/acre values. Private parcels marginally decrease in per acre value as total parcel acreage increases, and as such marginal property value at different total acreage classes is discussed.

A fee determination handbook of public land values was obtained from the nearby Bighorn National Forest in order to assess public property values in the absence of any information from the Black Hills National Forest. The Bighorn National Forest is the closest National Forest to the Black Hills National Forest, and both are part of Forest Service Region 2, and is thus suitable for comparability. This handbook stipulates that the value of federal forest land is marginally greater for smaller size parcels: <2 acres is \$35,000/acre; 2-4 acres is \$25,000/acre; 7-9 acres is

\$15,000/acre; 10-34 acres is \$6,000/acre; 35-79 acres is \$3,500/acre; 80-125 acres is \$2,000/acre; and >125 acres is \$1,500/acre (Bighorn National Forest 2013).

The average per acre property value of the public land in the Black Hills was derived through ArcGIS to be \$3,500/acre for both State and USFS lands. However, I will lay out some caveats to this figure that as an average is not suitable for comparing the origins of the \$1,500/acre and \$2,500/acre assessments. The range for state land included in this spatial analysis was 40 to 640 acres, while USFS lands ranged from 40 to 22,720 connected acres. The \$3,500/acre was derived by linking the state tax assessor's record for the property value of each public parcel within a 6-mile radius of each of the exchanged lands, respectively, to the digitized county-level parcel database in ArcGIS. I then estimated the assessed value for each acre of public land – federal or state – in the Bearlodge Ranger District by dividing the total taxable property value for each parcel by the acreage of each parcel in the ArcGIS database. \$3,500 was the resulting \$/acre value through separate iterations of this method. Given that this data was acquired from the state tax assessor's office it is reasonable to conclude that a state employee rather than a federal USFS employee originally input total property values as a function of their \$/acre monetary value. However, what is less clear about \$3,500/acre is whether it is an actual integrative estimate for the value of all activities that could take place on 1 acre of public land and applied to every acre in the Bearlodge, or if it is an arbitrary figure assigned in the absence of any true estimate. It is likely the latter, and although it is an interesting relic of the data used to assess property value, it is nevertheless an invalid method for comparing

economic value since average values are not an appropriate basis for comparing parcels and there is not a national standard for the per acre value of public land.

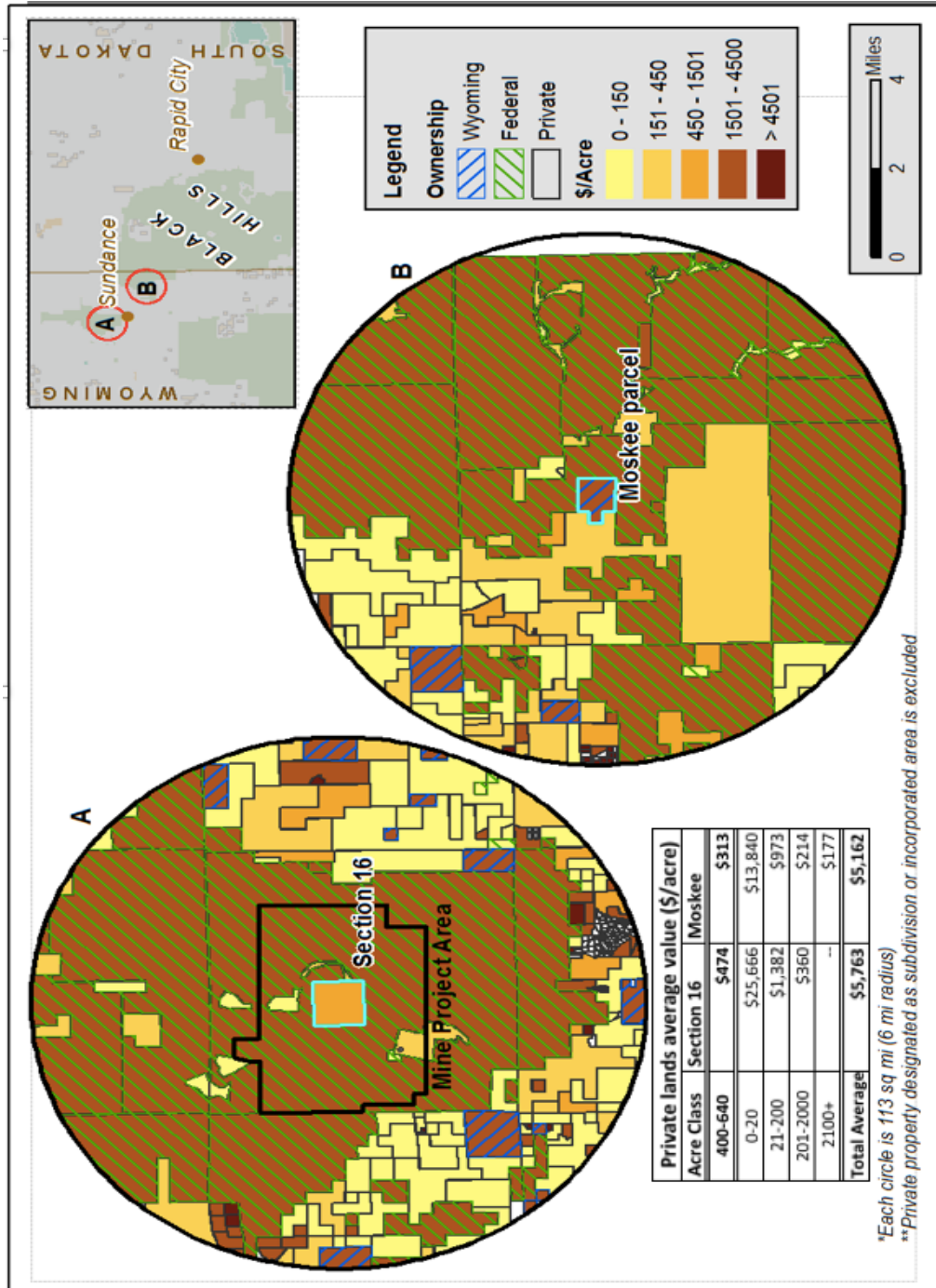


Figure 11. Property value comparison, 6-mile buffer from exchanged lands.

For private property, the cumulative \$/acre average of land within a 6-mile radius of Section 16 regardless of size was \$5,736/acre, whereas private property within a 6-mile radius of the Moskee parcel regardless of size was worth an average of \$5,162/acre. As shown in Figure 11 private lands were classified into different acreage size classes in order to assess: whether those surrounding Section 16 or the Moskee parcel are more valuable; whether there was decreasing marginal value of private land value with an increase in total parcel size; and to determine how the per acre dollar value of exchanged parcels compared with private lands of the same size (400 to 600 acres). Private parcel values surrounding Section 16 were worth more than those surrounding the Moskee parcel, which is likely due to the greater number of private residents within close proximity of services to the Sundance though not within its city limits, whereas there are also ranchette properties bordering the national forest in the Wyoming portion of the Black Hills proper though there are far fewer and these are all equally proximate to Sundance as those near Section 16. Property values in both areas marginally decrease with total parcel size. For those properties surrounding Section 16 averages include \$1,382/acre for parcels 21-200 acres in size, and \$360/acre for parcels 201-2000 acres in size. For those properties surrounding the Moskee parcel averages include \$973/acre for parcels 21-200 acres, and \$214/acre for parcels 201-2000 acres in size. The average value of private parcels of a similar size to that of exchanged parcels, (between 400 and 640 acres) is \$474/acre surrounding Section 16 and \$313 surrounding the Moskee parcel. Thus, private lands surrounding Section 16 are more valuable than those surrounding the

Moskee parcel. This is a function of greater potential for extractive land uses like ranching and timber, as well as closer proximity to both the recreational amenities of the forest and the urban services of Sundance.

This spatial analysis derived public lands to be worth an average of \$3,500/acre regardless of marginal value per total size, however as discussed an average is an insufficient method when comparing the value of lands given that the actual value of each acre of land has more or less worth based on the resources it holds and how proximate it may be to services. The spatial analysis derived private land values of the same size class as the exchanged lands (400 to 640 acres) to be worth \$474/acre surrounding Section 16 and \$313 surrounding the Moskee parcel. These figures show that land around Section 16 may be more valuable marginally per an equal size, however these land values are far less than either the \$1,500/acre or \$2,500/acre that was assessed by the state. This brings into question how these figures were derived by the state, and to what degree, if any, the value of surrounding public or private property influenced the assessment of exchanged lands. Regardless, the disparity in the assessment of property values supports the local claim that Section 16 was valued economically lower given the likelihood a waste tailings pile will occupy the land in the future. Since the origins of how the exchanged land values were produced is unclear and since it is difficult to rely on these economic figures alone for comparability, additional assessments of the (non-monetary) ecological and socio-cultural values will now be explained.

B. Ecological value: Plant composition and large mammal habitat

The Black Hills including the Bearlodge Mountains are an isolated range amid the Great Plains; as such the floristic diversity includes elements of Rocky Mountain forest, grassland, eastern deciduous forest, and northern coniferous forest. Much of the ecoregion is covered by ponderosa pine forests and aspen stands interspersed with montane grasslands (Hall, Marriott, and Perot 2002). The Bearlodge Mountains vegetation cover is predominately woodlands: ponderosa pine (68 percent), quaking aspen (18 percent), grasslands (8 percent), paper birch (3.5 percent) and bur oak, willow, and bromes dominate the remaining areas (Lefebvre 2009). Similar vegetation

	Section 16	Moskee
Common Name	% Cover	% Cover
arrowleaf bolsam root	0.28	1.1
aspen	2.2	0.6
bare ground and detritus*	9.68	19.0
bearberry	1.2	1.7
bergamont	4.45	1.9
black medic	-	2.0
blackeyed susan	-	2.3
blanket flower	-	0.9
blue jointed reed grass	9.92	-
bur oak	3.2	-
canada thistle	-	0.6
ceanothus	2.3	-
wild columbine	-	0.2
common juniper	2.9	1.4
dandelion	1.52	-
honeysuckle	-	2.0
kentucky bluegrass	-	2.8
harebell	1.04	-
low service berry	-	1.8
lupine	6.92	1.4
mountain brome	3.02	-
northern bedstraw	-	1.3
northern cinquefoil	-	2.4
oregon grape	-	3.9
ponderosa	8.2	2.2
poverty oat grass	-	2.8
red clover	-	3.7
service berry	-	2.5
tatarian honeysuckle	-	4.3
sword leaf rush	1.64	-
timothy grass	14.16	18.5
western snowberry	1.78	1.5
white clover	3.68	2.9
wild rose	2.4	-
yarrow	7.64	4.7
Abundance**	59	57
Diversity	2.93	2.78
Native Species	36	30

Table 6. Plant abundance and diversity.
 *Not included in Shannon-Wiener index.
 **Species <1% ground cover not listed.

exists at the Moskee area connected to the South Dakota Black Hills though it's important to note that cover type designations don't adequately reflect the understory diversity found in the area (Stefanich 2007). Stand understory and meadow groundcover offer forage for a variety of wildlife species, therefore a more detailed survey of these features can provide a basis for assessing and valuing healthy wildlife habitat and ecosystem function.

Plant abundance and diversity field surveys were carried out at both the Section 16 parcel and the Moskee parcel with *Plants of the Black Hills and Bearlodge Mountains* as a field guide to identify forb, grass, shrub, and tree species (Larson and Johnson 2007). Surveys were conducted using five randomly selected 100-meter long transects at each site with one sample quadrant every 10 meters along each transect for a total of fifty 1 meter squared quadrants at each site, analyzed through a Shannon-Wiener index (Magurran 2013). Species abundance and diversity were slightly higher on Section 16 than on the Moskee parcel (Table 6). The same amount of area was covered through the quadrant surveying method for each property so this is not necessarily a result of the differences in size between the two parcels. Rather this may be a reflection of the core habitat of Section 16 at the center of the Bearlodge Mountains versus the Moskee parcel location closer to the edge of the Black Hills. This also reflects a more intensive history of logging and grazing in the Moskee area, a patchwork of privately-held land, which contains an abundance of bare ground and invasive timothy-grass – together nearly 40 percent of ground cover surveyed.

Landscape-level differences, such as native and non-native species abundance between core and edge habitat, and the different ground cover and over story types that compose habitat are indicative of how valuable land is for ungulate species, including white-tailed deer, mule deer, and elk. These species have co-existed in the Black Hills for millennia, although the Rocky Mountain elk was introduced between 1912 and 1914 after the extirpation of the Manitoban elk in 1888 (Shepperd and

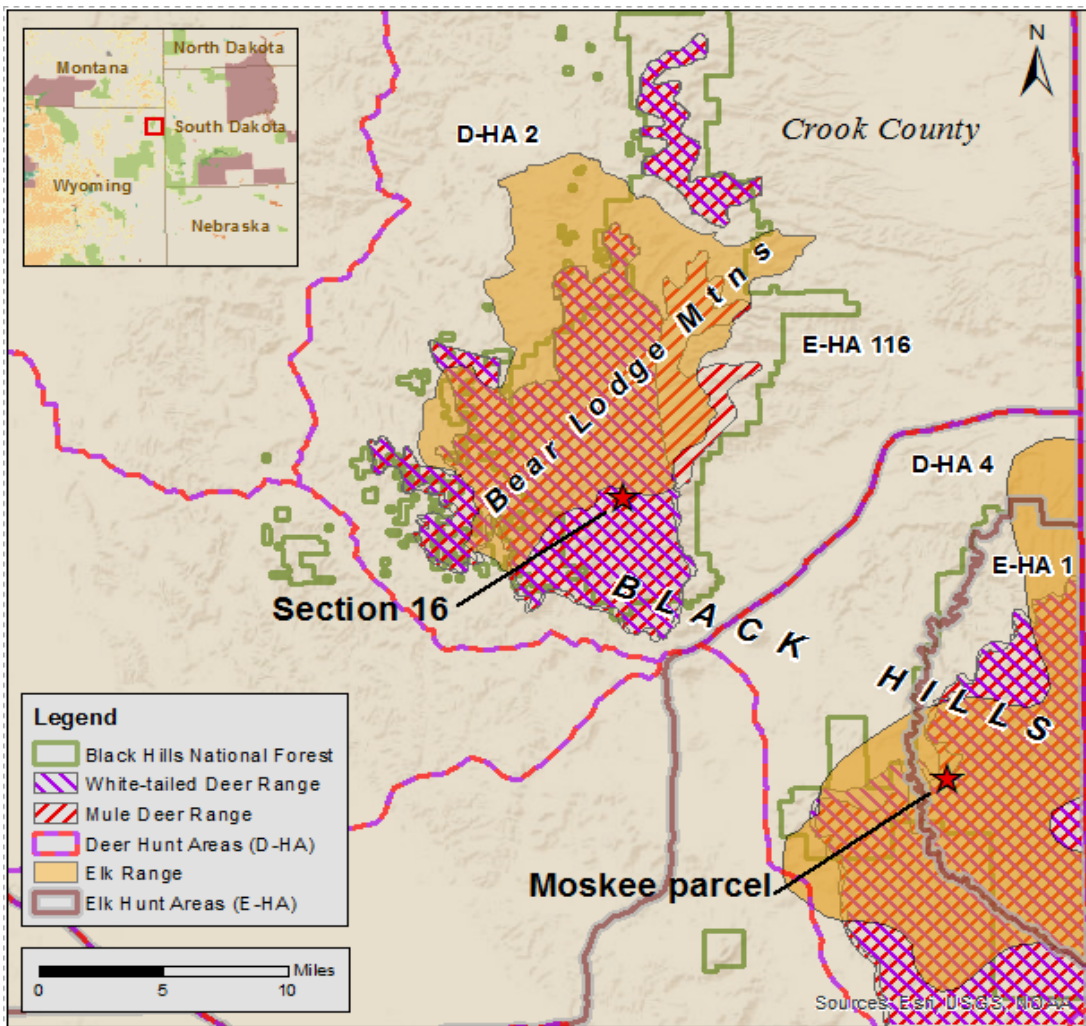


Figure 12. White-tailed deer, mule deer, and elk ranges – Bearlodge Ranger District.

Battaglia 2002). Ungulate species in the Black Hills are considered non-migratory, but do exhibit movement between seasonal ranges based on snow depth in the winter and availability of forage and grazing material as a function of precipitation and soil type at different elevations in the spring, summer and fall. Each ungulate species utilizes a unique habitat niche resulting in reduces forage competition. Elk consume mostly grasses, followed by forbs, whereas white-tailed deer and mule deer browse more on shrubs and forbs. Elk tend to select for shape complexity of meadows, distance away from human disturbance (e.g. human presence, vehicle use, silvicultural activities, etc.), and availability of nearby cover during parturition and early neonatal periods. Important habitat distinctions exist between deer species; mule deer tend to occupy more open habitats with rough, rocky terrain, while white-tailed deer are found in relatively denser habitats such as pine and aspen stands, and near riparian areas (Sieg and Severson 1996).

Section 16 lies at the edge of spring, summer, and fall seasonal ranges for Black Hills elk as delineated by the Wyoming Game and Fish Department, while the Moskee parcel lies at the core of these seasonal ranges (Figure 12). Winter ranges for elk are predominantly outside of USFS lands at lower elevations. In fact, nearly 73% of occupied elk range in the Black Hills is on private lands. Section 16 is good, though infrequent, elk habitat with occasional recorded use occurring exclusively in the summer and early fall. The Moskee parcel is good elk habitat with dense ponderosa pine stands and open forage areas, but the grass at this site is of less quality and quantity compared to that on Bull Hill in Section 16. However, the Moskee parcel

is effectively lower quality elk habitat given its proximity to the high-traffic Grand Canyon Road, which decreases the value to elk due to elk avoidance of traffic (Sandrini and Withroder 2014). Seasonal ranges for white-tailed deer and mule deer often overlap a fair extent in both the Bearlodge Mountains and Black Hills of Wyoming during the spring, summer, and fall, depending upon weather and forage availability. Breeding and fawning may occur at both sites and both areas at times provide limited winter range for both deer species. Correspondence with field biologists confirms that habitat quality and quantity for deer, and thus deer densities, were higher on Section 16 prior to mining exploration, given that foraging opportunities in the ponderosa pine savannah diminished, riparian habitat was altered, and vehicle use increased in the core of the Bearlodge Mountains (e.g. timber cuts, exploration machinery, road widening). This is opposed to the Moskee parcel where prior to the land exchange the influence of higher-traffic was already a contributor to avoidance and less desirable vegetative cover for big game was already observed with the presence of a dominant canopy that inhibits the understory growth that ungulates rely upon (Sandrini and Withroder 2014).

C. Socio-cultural value: Potential for big game hunting

The habitat value for ungulates and therefore the value of access for hunters differs between the exchanged lands. License issuance for each hunt area can be used to derive hunter density per square mile of each hunt area, and functions as a proxy for hunter use days, which are the estimated total days hunters spent in the field each

season (Sandrini and Withroder 2014). For white-tailed deer and mule deer, Section 16 is within the State's Deer Hunt Area 2 (1,011 square miles) and the Moskee parcel is within the Wyoming's Deer Hunt Area 4 (320 square miles). For both hunt areas general deer licenses are valid for the taking of bucks on public lands and any deer on private land, while doe/fawn licenses, and consequently harvest, are restricted to private land. Between 2004 & 2013 Hunt Area 2 hosted an annual average of 4,814 general license mule deer hunter use days (4.76 hunter use days per square mile), and 14,618 general license white-tailed deer hunter use days (14.46 hunter use days per square mile). Whereas, between 2004 & 2013 Hunt Area 4 witnessed an annual average of 1,472 general license mule deer hunter use days (4.6 hunter use days per square mile) and 4,600 general license white-tailed deer hunter use days (14.37 hunter use days per square mile). Most recently in 2015 Hunt Area 2 averaged 5.7 days/harvest for white-tailed deer and 7.1 days/harvest for mule deer, versus averages of 7.6 days/harvest for white-tailed deer and 9.9 days/harvest for mule deer in Hunt Area 2, suggesting hunters more easily found deer to harvest in Hunt Area 2 – something indicative of a more robust deer population in the Bearlodge Mountains where Section 16 is located. For elk, Section 16 is within State's Elk Hunt Area 116 (2,295 square miles) and the Moskee parcel is within the Wyoming's Elk Hunt Area 1 (101 square miles). Elk Hunt Area 116 was under a limited quota licensing system prior to 2013 but now operates under a general license system (wherein license issuance is not limited) with additional antlerless elk licenses being issued as well. Conversely, Elk Hunt Area 1 operates under the limited quota license system and is a

Section 16: Acquired for mining, public hunting access removed	Traffic Counts
Early Fall (Aug. 31 – Oct.30)	
<u>48 weekdays:</u> (15 vehicles/day x 85%) x 48 days x 1.9 hunters / vehicle	1,162 hunters
<u>16 weekend days:</u> (24 vehicles/day x 85%) x 16 Days x 1.9 hunters / vehicle	620 hunters
Mid Fall (Oct. 31 – Nov. 15)	
<u>11 weekdays:</u> (30 vehicles/day x 85%) x 11 days x 1.9 hunters / vehicle = 533 hunters + 30%	693 hunters
<u>5 weekend days:</u> (60 vehicles/day x 85%) x 5 Days x 1.9 hunters / vehicle = 485 hunters + 30%	631 hunters
Late Fall (Nov. 16 – Nov. 30)	
<u>8 weekdays:</u> (23 vehicles/day x 85%) x 8 days x 1.9 hunters / vehicle = 297 hunters + 30%	386 hunters
<u>7 weekend days:</u> (33 vehicles/day x 85%) x 7 Days x 1.9 hunters / vehicle = 373 hunters + 30%	485 hunters
3,977 traffic counts x 10% hunter correction = 398 lost hunter days	
Moskee land: Acquired by the state, public hunting access opened	Traffic Counts
Early Fall (Aug. 31 – Oct.30)	
<u>48 weekdays:</u> (37 vehicles/day x 85%) x 48 days x 1.9 hunters / vehicle	2,868 hunters
Mid Fall (Oct. 31 – Nov. 15)	
<u>11 weekdays:</u> (95 vehicles/day x 85%) x 11 days x 1.9 hunters / vehicle = 1,688 hunters + 30%	2,194 hunters
<u>5 weekend days:</u> (94 vehicles/day x 85%) x 5 days x 1.9 hunters / vehicle = 759 + 30%	987 hunters
Late Fall (Nov. 16 – Nov. 30)	
<u>8 weekdays:</u> (107 vehicles/day x 85%) x 8 days x 1.9 hunters / vehicle = 1,382 hunters + 30%	1,797 hunters
<u>7 weekend days:</u> (66 vehicles/day x 85%) x 7 days x 1.9 hunters / vehicle = 746 hunters + 30%	970 hunters
8,816 traffic counts x 1% hunter correction = 88 potentially gained hunter days	

Table 7. Traffic counts and hunter days: Hunting use removed from Section 16 compared with potential hunting access gained at the Moskee parcel. Data source: Wyoming Game and Fish Department, Sandrini and Withroder (2014) and (2015).

small hunt area with a very limited overall license issuance. In 2013, Hunt Area 116 had a total of 8,627 elk hunter use days (3.76 hunter use days per square mile), with a previous 10-year average of 3,708 elk hunter use days (1.61 hunter use days per square mile). Whereas, in 2013, Hunt Area 1 had a total of 1,687 elk hunter use days (16.7 hunter use days per square mile), with a previous 10-year average of 2,588 elk hunter use days (25.62 hunter use days per square mile). Most recently in 2015 Hunt Area 116 averaged 48.3 days/harvest versus 24.3 days/harvest for Hunt Area 1, suggesting more effort was needed to harvest elk in the Bearlodge Mountains.

The Wyoming Game and Fish Department (WGFD) conducted an analysis of impacts to recreational hunting in the Bearlodge Ranger District that would potentially result from the land exchange (Sandrini and Withroder 2015). These findings show that the smaller Moskee parcel has one-fifth of the potential for hunting with a projected 88 hunter days per year as opposed to 398 lost hunter days at Section 16 (Table 7). The WGFD results are based on in-person surveys and vehicle traffic counts to infer hunter use as a subset of those utilizing Forest Service roads that pass through or near each of the exchanged parcels. In-person surveys were conducted between September 1 and November 21, 2014 during specific windows of the fall hunt season in order to capture hunter activity during the big game archery season (September 1-30), deer rifle season (November 1-20/21), and a portion of the elk rifle season (October 15-November 30). During this time span 485 unique vehicles were encountered carrying a total of 935 hunters, resulting in an average of 1.9 hunters/vehicle. Digital traffic counters were placed over both lanes of traffic on

Forest Service roads used by hunters to access each parcel at different intervals between October 13, 2014 and August 21, 2015. The numbers generated from in-person surveys and traffic counters carry several educated assumptions based on historical forest use and hunting trends. For Section 16 in the Bearlodge Mountains, 85% of vehicles crossing the traffic counters were assumed to contain hunters, based upon non-hunting season traffic counts. Projected deer hunter use of this parcel was also adjusted to historical license issuance levels, as the counts were made during a time of low deer numbers and reduces license issuance. Finally, it was assumed that the 10% of hunters who contacted traffic counters in only one direction actually hunted on the parcel rather than it is arguable that at a minimum 1,300-acres of publically accessible Forest Service lands will experience indirect impacts from mining such as light, noise, traffic, and exploration activity that would lead to reductions in large mammal use of this area.

V. Conclusion

In the preceding sections I have compared the value of two parcels; the 640-acre Section 16 in the Bearlodge Mountains and the 400-acre Moskee parcel in Black Hills proper have different economic (provisioning), ecological (supporting), and socio-(cultural) ecosystem service values. This study has shown that in economic terms the average private property value in the surrounding 100 square miles is greater for Section 16 (\$5,736/acre) in comparison with the Moskee parcel (\$5,162/acre), and this is further bolstered by a higher value for grazing (\$4.80/AUM

at Section 16 versus \$1.02/AUM at Moskee) and timber production (\$245/acre at Section 16 versus \$120/acre at Moskee). In terms of ecology, plant species richness (59 for Section 16 and 57 for Moskee), plant diversity indices (2.93 for Section 16 versus 2.78 for Moskee), and native plant abundance (36 for Section 16 and 30 for Moskee) were measured slightly higher for Section 16 than at the Moskee parcel. And, while both parcels in question are within the occupied habitat of mule deer, white-tailed deer and elk, section 16 is not only situated more within the core habitats of mule deer and white-tailed deer, but it offers better habitat quality as well. In contrast, the Moskee parcel is located more within the core home range of elk and provides classically better foraging habitat for elk, however given the volume and proximity of vehicular traffic to this property it is likely that Section 16 may actually provide better elk habitat capability despite it being in an area of lower elk density. Section 16 and the Moskee parcel provide nearly equal hunting opportunity for deer in terms of density of hunter licenses issued per larger state hunting area encompassing each property. For mule deer: 4.76 deer licenses/mi² at Section 16 versus 4.6 deer licenses/mi² at Moskee. For white-tailed deer: 14.46 deer licenses/mi² at Section 16 versus 14.37 deer licenses/mi² at Moskee. For elk, the density of hunter licenses issued as a ratio of the parcel area within the larger state hunting area is significantly higher at Moskee: 1.61 elk licenses/mi² at Section 16 versus 25.62 elk licenses/mi² at Moskee. However, it's important to note that the Moskee parcel contains more heavily trafficked roads which can lead to avoidance for elk, which are more sensitive to disturbance than deer. In fact, conversations with local land holders

revealed that a fence exists along the southern extent of the property, and that this fence has historically inhibited movement of elk through the Moskee parcel. Finally, traffic count surveys showed that hunter use days were estimated at 398 hunter days lost for Section 16 upon its disposal to the mining corporation, while a gain of 88 hunter days was estimated with the acquisition of the Moskee parcel by the State.

	Private land (\$/Acre)	Grazing lease (\$/AUM)	Timber (MMBFT\$/Acre)	Plant abundance (#)	Plant diversity (S-W Index)	Habitat suitability (GIS)	Hunter License (deer/mi ²)	Hunter License (elk/mi ²)	Hunter Use Days
Section 16	5,736	4.80	245	59	2.93	MD: 4.76 WTD: 14.46 (Elk): 1.61			-398
Moskee	5,162	1.02	120	57	2.78	MD: 4.6 WTD: 14.37 Elk: 25.62			+88
	Provisioning (Economic)			Supporting (Ecological)		(Socio-)Cultural			

Figure 13. Findings for economic, ecological, and socio-cultural values - Section 16 and Moskee parcels.

What has become abundantly clear through this process is the real need to assess economic, ecological, and socio-cultural values as a cumulative socio-ecological system, especially given the diverse materialities of each. The values assessed here are not without their caveats. This study included local extractive values of ranching and timber rather than the global economic value of mining, the instrumental value of ecosystem function rather than that ascribed to it by humans,

and the regional wildlife-oriented amenities of hunting rather than values associated with preservation. Indeed, proper management through hunting can conserve animals where they would otherwise exceed carrying capacity without the influence of historical predators. This clash of values is ubiquitous throughout an increasingly interconnected and growth-dependent world, where market-based development, local livelihoods, ecosystem integrity, and regional socio-cultural values towards nature collide. Rare earth elements that are proposed to be mined are used in a variety of energy-efficient technologies that have the capacity to help mitigate larger processes influencing climatic change, but the extraction of these materials has the potential to contribute to proximate environmental trade-offs. However, the empirical capacity to measure the economic, ecological, and socio-cultural trade-offs between the cumulative environmental impacts of worldwide rare earth element extraction and the avoided costs of global climatic change is well beyond the scope of this chapter – let alone an assessment of the trade-offs from any other type of commodity and the services it provides. Economic value is the paradigmatic fiat for the values society associates with the use of nature, whether it be land, minerals, plants, or animals, and the political institutions in place exist to govern the exchangeability of nature as commodity. However, the most important aspect when considering value of nature lies in the unique ability of humans as sentient beings to consider the whole as other than the sum of its parts. Indeed, we must think of complex socio-ecological systems in a holistic, integrative way that is simultaneously ecosystem services, intrinsic ecological function, and cultural landscape values. In this sense, ecological justice is

in actuality socio-ecological justice since how nature is valued and for who depends on people's underlying perspectives across a spectrum of non-use preservation, wise-use natural resource utilitarianism, and all-out extractivism. This is especially the case in multiple use, common property landscapes where mineral extraction as one use can *displace* access to livelihoods, recreation, and nature for nature's sake.

Conclusion

In the preceding chapters of this dissertation I have used various theoretical and methodological approaches to explain land use conflict between mining and multiple use in the American west.

In chapter one, theories of common property resource use and political economic contradictions between capital and the environment were applied to the sectional disposal of land throughout the frontier to the present day in order to explain the emergence and historical contingency of present day land use conflict amid competing, non-serial regulatory regimes. This work has synthesized existing theories to explain the continual and uneven commodification of nature as property in the region of the west and provided an important methodological approach to empirically substantiate the theoretical framework. That is, the use of GIS to analyze competing resource regimes is a methodology that can be applied to other lands throughout the West in order to better understand the historical antecedents of land use conflict.

In chapter two, a novel qualitative-quantitative was used to compare the economic perspectives and environmental values of stakeholders involved in the public comment process of the environmental impact statement for the proposed Bearlodge mine. Q method was used to assess the subjective opinions of different stakeholder groups relative to one another, including foresters, mining/energy, local land holders, recreationalists, state/federal regulators, and environmentalists. This method demonstrates that the full spectrum of opinions isn't necessarily grasped in the environmental impact statement public comment process. That is, opinions on a

seemingly binary topic such as economy versus the environment - as is the case with mining on multiple use public lands - are situated in rural understanding of ecological scarcity, economic growth, and environmental change.

In chapter three, ecosystem services theory is used to compare the value of economic provisioning goods, ecological support services, and socio-cultural use of the land between two parcels that were unevenly exchanged. Different spatial, field sampling, and survey methods were used to arrive at each type of value. This data is an important empirical contribution since many of these values were previously assumed by state appraisers (correctly or incorrectly) though not previously quantified. As such, this mix of methods can be used as a model for future land exchanges in the West in order to assess integrative value.

Access to multiple use activities continues to be altered by mining as the “highest and best use” of some public lands. This dissertation has contributed to the theory, methods, and empirical data underlying this important issue, however it is only one part of the situation. Future research must address the human as well as the non-human value(s) shaping complex adaptive socio-ecological systems. This remains a challenge since it is hard to escape the anthropocentrism shaping the valuation of resource use. Whether biocentric or anthropocentric we as people utilize the land and its resources for our own utility in some way; preservation, conservation, or extraction are all human constructs. The challenge remains to theorize an American West in which humans are not only driving environmental outcomes, but also inextricably coupled to and dependent on the intrinsic value of nature.

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