ENVIRONMENTAL REGULATIONS:

Can't live with them, can't live without them

Photo taken in the Bitterroot National Forest in August 2000 by John McColgan, Forest Service

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1. Introduction

As far back as the late 1600's, more than 200 years before Arthur Tansley coined the term ecosystem, individuals realized the importance and utility of the ecosystem services that a functioning environment can provide. William Penn, the founder of the state of Pennsylvania, outlined this view when laying out the building regulations for Philadelphia, mandating that his constituents retained one acre of forest for every five acres cleared (Lingelbach, 1944). As of 2015, 58% of the total area in Pennsylvania was covered by forest, a tribute to the legacy of this 300-year-old regulation (Northern Research Station, 2016).

Environmental regulation from colonial times to today has developed with knowledge and appreciation of ecological systems and environmental contamination on human health. However, the political climate of today's United States is significantly more divisive than that of an individual colony centuries ago. Since the 1970s, the politicization of environmental issues has been increasing, compounded by an increasingly substantial and diverse set of issues coming to head, including global scale land degradation, changes in regional and global climate patterns, and an ever-growing population. This combination has led to a dichotomy of viewpoints concerning regulation of the environment with roots based in tribalism, rather than strictly policy-based objections and acceptances. While these disagreements sometimes work to stymie the conversation surrounding effective and pragmatic regulation, they represent an important conversation that is necessary for national legislative efforts. It's important to keep an open mind to all attitudes regarding environmental regulations on a national scale to more effectively address the environmental uncertainties that face the world today.

As graduating seniors from the Land Resources Environmental Science (LRES) department at Montana State University, drawing on the accumulated knowledge and skillsets from our collegiate education, we provide an overview of regulation via a variety of robust viewpoints, including historical, economic, and justice based investigations. It is our hope that by eliminating misconceptions and providing information on the whole of environmental regulation, we can provide readers with a framework for making informed decisions concerning this topic in the future, catalyzing positive change.

The Process of Regulation

Regulations are directives or rules that are mandated and subsequently enforced by an

acting authority, such as a governmental agency. These directives are typically manifested as enforceable legislation that have both direct and indirect effects on companies, governments, or individuals. These mandates are prevalent in all industries, and their scope varies depending on the entity responsible for the legislation, varying from city and state mandates—such as a ban on plastic shopping bags in Boston or California—to national regulations like the United States Clean Water Act, or even internationally, such as the U.S.-Canada Air Quality Agreement.
In the United States, anyone can draft bills in an attempt for them to become law, but they must be introduced by a member of Congress. Once introduced, bills must be passed by both the House of Representatives and the Senate. After successful passage through both houses of Congress, legislative actions are subsequently signed into law by the president. These laws are often broad, and don't contain specific instructions on how individual entities must behave to follow the law. The specifics of lawful behavior are then laid out by federal agencies via the establishment of explicit regulations. These regulations outline the extent to which a specific action is tolerable under the law's provisions, as well as the penalties for failure to adhere to the standards. Agencies write regulations that are applicable to individuals, industry both small and large, and even state governments. The process and authority for writing and implementing regulations vary across nations and organizations, however the mandate and enforceable aspect of regulations remain constant.

The Controversy Behind Environmental Regulations

While environmental regulations are often controversial, there are many regulations that everyone can agree upon. Regulations are not passed solely to act as constraints on industry, but also to protect human health and safety. Clean air and water cannot be taken for granted, nor can the regulations that protect the provision of these resources in perpetuity. Without them, terrible crises such as the water quality disaster that occurred in Flint, Michigan in 2016 would be all too common, rivers like the Cuyahoga would continue to catch on fire, and acid rain and smog would decimate air quality across the nation, as it currently is doing in less developed parts of the world. The controversy over regulations can be attributed to the timing rather than content of regulations; if any of the aforementioned circumstances happened repeatedly, public support and power would be behind implementing regulations. It would be naive to ignore societal reliance on industries and businesses that utilize natural resources. Many people rely on the natural world

for their livelihoods and survival, the rest rely on the products of these industries. As such, the challenge and controversy of regulating our impact on the environment lies within the process of finding the balance between protecting and sustaining the resources we rely on and not restricting economic gain of a resource that supports people's' lives.

Ecologically, many environmental regulations are beneficial to restoring, preserving, or conserving natural ecosystem processes and functions. However, many regulations also allow for ecological harm to occur, in an attempt to find the balance of preserving the ecosystem and providing resources humans need. These complex social implications of environmental regulations lead to the development of a spectrum of opinions. Some argue that regulations don't go far enough to protect the environment, while others are happy there is any sort of preservation and conservation of natural ecosystems. There are others who loathe any and all environmental regulations for various reasons. Many times, environmental regulations are measured not by their benefit for the environment, but the resulting economic implications.

Summary

Environmental regulations are written primarily, however not exclusively, with the intention of making some change to how we manage the environment. These regulations are based on principles in society, existing in an effort of balancing the conservation of natural resources and values with industry . In the following chapters, we will introduce environmental regulations, justifications for them, and the history of these regulations in the United States. Chapter 1 will focus on the history of regulations and their justification in regards to protecting human health and safety, as well as all other sectors of life. Then we will discuss the history and implications of regulations surrounding wildfires in the western U.S. in Chapter 2, before Chapter 3, where we focus on the ecological effects and economics of the Endangered Species Act of 1973, pivotal legislation working to prevent the extinction of species. This will lead to our diverse, yet in depth analysis in Chapter 4 of environmental regulations on ecology and the economy. We explore all sides of the economic effects of regulations, from the issues surrounding compliance, the comparative effects on small and large businesses, carbon incentive programs, and the range of economic effects stemming from regulations. Regulations are many times considered too stringent and an overreach by governments on the public's livelihoods, however in some cases, the public supports regulations that are stringent and have negative

effects on themselves at the expense of protecting natural resources. Environmental regulations will be looked at through the ecological, economic, and social perspectives in the analysis of case studies on the hard rock mining industry, specifically for copper. With case studies in Chapter 5, we evaluate the history and current state of copper mining in the U.S. and abroad; and the social effects of mining will be discussed in an international and national setting.

These compiled papers attempt to address all aspects of environmental regulations from ecology to economy at various scales. Through the synthesis of this document, we aim to provide a robust, cohesive view of the role of environmental regulations, their effects, and their ultimate importance. It is our hope to inform a wide audience of stakeholders, scientists, and concerned individuals, and provide them with the ability to confidently speak about regulation in a holistic, pragmatic manner.

2. Foundations

2.1. Cultural Worldview Implementing Environmental Regulation

Emily Lindner

A growing population leaves an increasing pressure on the environment, and anthropogenic activity has had unexpected consequences on the natural world. The complex issues of managing human population growth and environmental impacts are real, controversial, and occur worldwide. Society, politics, and economics influence the management of increasing environmental problems. Typically, environmental degradation is addressed through policy because of public awareness of environmental issues and political pressure to act. Implemented policy looks differently throughout the world because of different cultural worldviews. In LeBaron's article (2003), worldview is defined as the "shared values and assumptions on which rest the customs, norms, and institutions of any particular society." Based on the complexity of human interactions because of varying beliefs, practices, values, ideas, technologies, economies, and other social domains, environmental problems are approached differently due to cultural variation in what individuals consider most important. These socially constructed perceptions influence how individuals interpret and interact with social and environmental issues (Cherry et al., 2017). Ultimately, an individual's perspective of environmental degradation formed by cultural norms and the awareness of the need for environmental protection leads to regulation (Wang et al., 2016). This process may be messy because of the disagreements and conflict that arises from different ways of thinking. It is important to recognize that an individual's worldview is embedded within their fundamental understanding of their world; improved communication between people to develop shared meanings can address these complex problems revolving around environmental regulation (LeBaron, 2003). An analysis of three countries – China, Philippines, and India – will provide insight of how cultural worldview plays a role in implementing environmental regulation. This is a global effort to change anthropogenic impacts on the environment.

China is the world's largest exporter, and their contribution to international trade has had significant impacts on the environment. Water and air quality in China are characterized as

"relatively poor" or "very poor," levels which present harm for public health. Heavy pollution is a progressing issue in China because of the less strict environmental regulation (Wang et al., 2016). These low cost privileges of producing material for cheaper have given "heavy polluting" companies an opportunity to migrate to China due to economic benefits of a less strict environmental process. In one point of view, to mitigate the challenges of pollution, more precise environmental quality standards need to be placed; while on the other hand, there is a cultural fear that increased regulation will slow down international economic growth (Wang et al., 2016). China has enacted many laws and regulations to ensure enterprises comply with environmental regulation through command and control, market based regulations to meet green demand, and reluctant regulation through stakeholders (Wang et al., 2016). China's international trade is a significant source of economic growth, which in turn provides market opportunities; environmental regulation plays a role in motivating companies to provide "green and pro-environmental products" (Wang et al., 2016). Wang et al. (2016) also addresses the limitations of studying just China's impacts from the increased strictness of environmental regulation without including trade partners. A discrepancy between the law and implementing policy has been a challenge in China because the laws in place remove limits on fines for pollution, which in turn allows companies to pay the low fines instead of taking more expensive routes to control anti-pollution measures (Kaiman, 2014). Now, stricter legislation is in place to penalize companies that violate actions to control pollution through prosecution and potentially shut down. Implementing these laws may fail because of overlapping control of multiple local agencies rather than national government (King, 2016). Conflicting interests of stimulating local economies rather than protecting the environment influence policy implementation. Overall, changing policies in China are influencing the environmental impacts, social factors, and economical standpoints.

Another study focused on the relationships between attitudes, behavior, and sociodemographic variables with Filipino perspective on environmental issues. Generally in developing countries, economic development is of higher priority than implementing environmental protection policies because of minimal political support, insufficient resources, and underdevelopment. For the Philippines, the societal values have seen the importance of environmental protection and private non-governmental organizations (NGO's) have struggled and fought for environmental protection; they have maintained societal values of ecosystem

integrity (Reyes, 2016). The variables addressed in the study conducted by Reyes allowed insight that the Filipino's agreed to an international commitment of multilateralism of green governmentalism. Green governmentalism recognizes the increasing environmental degradation and resource depletion from an increasing population and seeks to advocate strategies for sustainability (Reyes, 2016). In the Philippines, participation of multiple stakeholders has influenced change in sustainable development principles at the national level. The viewpoint that less-developed countries of lower economic status should not be expected to protect the environment as effectively as more-developed countries has not affected the green governmentalism attitude among the Filipinos. Overall, positive results indicated that the Filipino culture desires to protect their environment.

Another influential participant in the global climate is India. India remains amongst the worlds lowest in per capita greenhouse gas emissions, while being the fifth largest source of greenhouse gas (Atteridge et al., 2012). The Indian government is challenged with the task to address this environmental issue while managing other domestic priorities like reducing poverty. This includes the bottom-up (domestic) and top-down (international) approaches in framing policy for climate change. The political leaders of India are influenced by domestic social norms and interests, in addition to being influenced by ideas and aspirations at the international level (Atteridge et al., 2012). For example, mass media has played an influential role in maintaining ideas for sustainable climate policy. At the international level, India is motivated to agree to emission commitments based on equity and global status in order to gain international reputation (Atteridge et al., 2012). The linkages between implementing policy through the multi-directional influences have powerful consequences that will shape worldviews to initiate cooperation between international trading partners (Atteridge et al., 2012). With this perspective, other countries and international negotiators are able to work with India to accomplish policy objectives and implement sustainable development to monitor international climate actions (Atteridge et. al, 2012). India's willingness to cooperate with other culture's worldviews is shifting their climate policy.

Overall, observing social, political, and economic effects on environmental regulation is important to understand that people's livelihoods are based on available resources and the government's role in implementing and enforcing policy. This is a complex network of issues that derives from individual's inclination to engage in issues that are important to them -

sometimes that includes environmental policy and other times not. Within the three countries addressed, an awareness of environmental degradation is increasing and stricter policy is being enforced to maximize sustainability efforts. Decisions are made through cultural influence, open communication, and an increase of technology. Many diverse systems across the globe seek to understand how environmental policy influences people groups worldwide.

2.2. Cultural Views in the United States Through Time

Haley Gonsalves

A little closer to home, an in-depth study of the history of environmental regulation within the United States helped standardize environmental integrity throughout the county to understand how national perspective shapes federal policy. Environmental laws were created to protect the environment and the health of the American population. In the 1970's President Nixon signed the National Environmental Policy Act (NEPA); this act initiated environmental protection in America. Soon after NEPA was signed into effect, the Environmental Protection Agency (EPA) was created, as a central agency to handle environmental issues. In the 1970's Americans supported protecting their environment because there were so many issues in the country. The goals of the EPA are to protect the people's health and to protect our environmental assets. These regulations are passed by Congress which has given the EPA authority to create laws to uphold environmental justice through NEPA. Since the time that Nixon created NEPA and the EPA was established, environmental regulations have sparked outrage of many concerned Americans. The issues that arise from these regulations are shaping how Americans look at science and how they turn away from the idea of regulations.

The beginning

Since the beginning of regulations some Americans have not believed in the federal environmental protection system and have questioned the agencies which protect our nation's environment. The general public has been asked since the 1970's "should the country do whatever it takes to protect the environment?" (Seigel, 2016). The divide between the response to that question in regard to the Republican and the Democratic parties through the years has grown wider. In the early 1970's, this partisan divide was minute, the Democratic Party was at

85% yes about protecting the environment and the Republican Party was at 71%. During the 1970's, there were a lot of environmental problems in the United States so environmental regulations were seen as a necessity rather than a partisan issue. In 1969 an oil well off the coast of Santa Barbara, California exploded, with over 235,000 gallons of spilt oil. In that same year the Cleveland River (which had caught fire before) caught fire because companies were dumping hazardous waste in the river. Love Canal in New York had become a dumping waste site from the industries around the area, causing health issues for local people. At the Three Mile Island nuclear power plant in Pennsylvania, an estimated 40,000 gallons of radioactive coolant leaked into the Suschaquaan River. The president at this time, Richard Nixon, was under a lot of pressure from the American people to put environmental policies in place. Nixon's response was to create the National Environmental Policy Act (NEPA), an organization whose sole purpose was to "require all federally funded projects to produce an Environmental Impact Statement, which outlines in detail the ways the project would affect the environment" (Kirk, 1993). This Act was the starting of the environmental revolution in America. In this time many acts were passed that were used as a basis for regulations created today. The Lead Based Paint Poisoning Prevention Act, Federal Water Pollution Control Amendments of 1972, Safe Drinking Water Act, and the National Energy Conservation Policy Act were all created because of this environmental revolution that Nixon sparked by creating NEPA and the EPA. Americans were supportive of environmental cleanup and the action being taken by the government. With all of the good that comes out of environmental regulations, the American view on the necessity of them changed with the passing years.

Present day

Fast forward to the 1990's. The divide between Republican and Democratic views on environmental regulations had changed drastically. With the majority of Americans still concerned about the environment, there seemed to be more pressing matters in the United States like the war on terror, our economic standing, racial outbursts, and gender equality that have been pushed to the forefront of American society. In 2015, 44% of Americans believed that the government had taken environmental regulations too far. This percentage of Americans believe that homegrown small businesses are being forced to abide by these regulations which in return can harm their livelihood (Bialik, 2016). In one study, American business men and women were

asked what bothered them most about environmental regulations, there responses include: "The EPA fails to take into consideration the effects on small business due to regulations". Martin a businessman said about the carbon regulation, "as EPA itself admits, electricity prices--which are one of the largest concerns of small businesses--will go up as a result of this proposal. In fact, energy costs are one of the top three business expenses for 35% of small businesses" (Bialik, 2016). With the American people concerned about the economic standing of their nation, over 58% say that environmental regulations result in fewer jobs and make it harder for American companies to be successful. The other large issue of trusting regulations is the EPA's cost benefit analysis in creating regulations. Another business woman wrote "The Agency did not use a whole-economy modeling approach here, which would have captured a much more accurate picture of the likely job losses from this proposal. The EPA also continues to avoid undertaking an employment analysis under Section 321(a) of the Clean Air Act, which requires the continuous review of potential job losses and shifts in employment due to the implementation of the Act" (Bialik, 2016). Presently, American are more concerned with economics because they see that current environmental regulations are effective, and they feel that our government needs to push economic standing rather than more environmental regulations. With reading how business men and women feel in this country, it seems as though Americans have felt like they have not been heard and that a lot of jobs are being taken away and moved to other countries, just because of environmental regulation.

Issues Americans face with Environmental Regulations

The difference of opinion in society has led to controversial speculations about environmental regulations. "Early regulations were usually written by bureaucrats with only limited information about company operations and the costs of alternative remedies" (Bartick, 1988). Businesses not feeling like they have been heard has created an issue in keeping the American people supportive of environmental regulations. The American business men and women are less supportive because with overall costs increasing due to regulations, they understand that these regulations are in place to keep them out of business which lowers their motivation levels to abide by them because they cannot stay in business and find ways to meet the standards. Regulations, as said before, were enacted so our natural resources remain clean and usable for future generations. Trust of the government has declined and is at an all-time low

with only 20% of Americans trusting the government (Anderson, 2016). There has been a decline in trust between the US Government since the Nixon administration and now with the Trump Administration, only 20% of Americans trust their government (Figure 1).

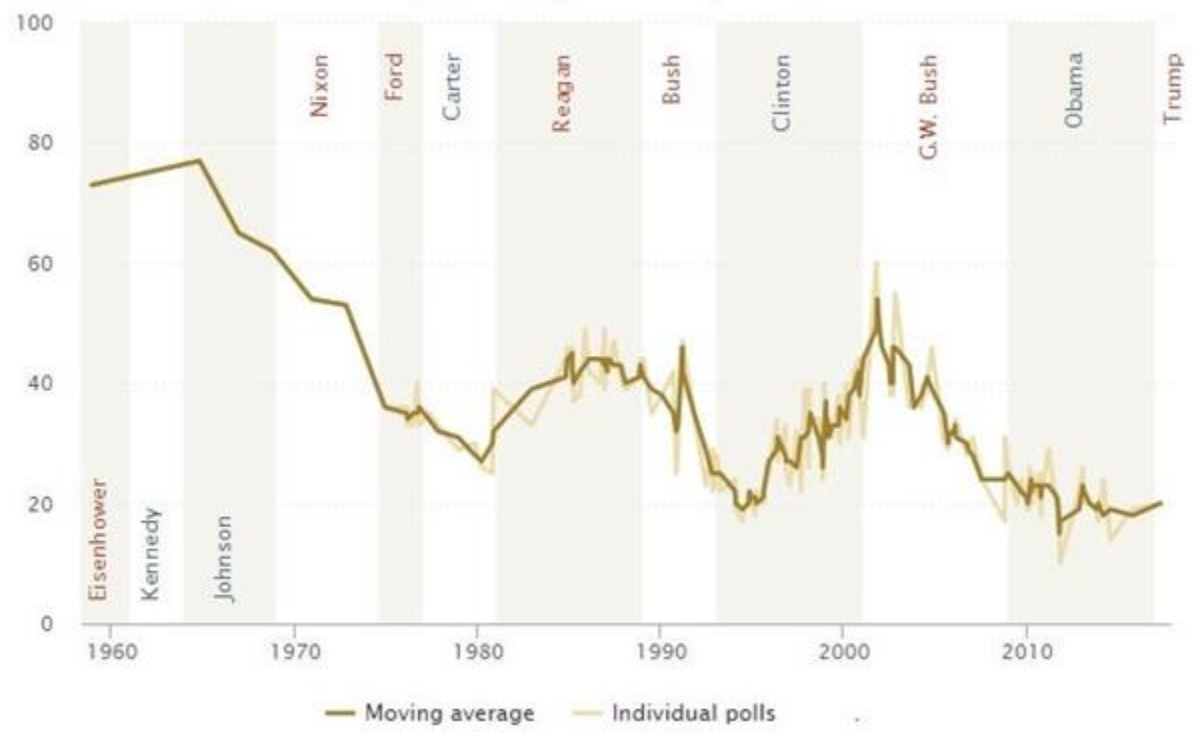

Figure 1.2.1. Poll of the percentage of Americans who trust the government since the Eisenhower to the Trump administrations (Daniels et al. 2016).

Trust between the government and its people has been declining because of recessions, wars, and political parties. People lose confidence when they feel like they have no say, and lack of support for environmental regulations have been subsumed into the issue of not trusting the government.

Regulations have protected the environment from degradation and have helped preserve the environment from future damage. Scientists have worked hard in preserving the environment by providing facts and scientific research that test regulations which are created, but those scientists have failed to keep Americans understanding why these regulations are necessary to keep the nation's environment pristine. This lack of communication as led to a lack of trust between the American people and the government. When the public started having trust issues

with the government, the citizens started questioning environmental regulations. With the decline in economic stability, homegrown businesses have a hard time staying in business. This fear of not being able to provide for our own country has led people to believe that environmental regulations have gone too far.

2.3. U.S. Environmental Regulations: A case study on the National Environmental Policy Act

Mathew Bain

In the United States, environmental regulation is an increasingly contentious political issue. Beginning in the 1960's, environmental degradation gained increasing attention both from the public and from lawmakers. Of the numerous regulations that came out of this time, the National Environmental Policy Act (NEPA) was "the most significant federal environmental statute" (Anderson, 2010). NEPA has had the greatest impact in U.S. history on public planning and decision making, and has been hailed as 'the keystone legislation of the thirty-year period from the sixties to the nineties' (Michaels, 1997). To better understand what gives NEPA this reputation, one must explore the history of the National Environmental Protection Act, the political climate and public opinion under which it formed, the arguments for and against this regulation, and the consequences of its establishment.

When signed into law on January 1, 1970 by President Richard Nixon, the National Environmental Policy Act (NEPA) set a new precedent for environmental protections in the U.S (Anderson, 2010; Michaels, 1997). NEPA is unique to laws which preceded it, such as the Bald Eagle Protection Act or Air Pollution Control Act, as well as subsequent laws such as the Endangered Species Act and Clean Water Act, all of which pertain to niches or particular issues in the environment (Mas, 2003; Fairbrother, 2009). Instead, NEPA was designed to address the full extent of environmental impacts, making it one of the most adaptive and flexible laws for protecting the environment. Title I of the act established a "national environmental policy" which requires that all federal agencies evaluate all potential environmental impacts, including social impacts, of their actions through an inter-disciplinary approach which integrates both social and natural sciences in the decision-making process (Anderson, 2010; Mandelker, 2010; Mas, 2003).

To determine whether an action is going to have a 'significant impact on the human

environment' the agency must carry out an Environmental Assessment (EA) (Anderson, 2010). If the action is found to have a significant impact following the EA, the agency then must prepare an Environmental Impact Statement (EIS) which documents the potential environmental impacts, as well as those of any potential alternative action (Anderson, 2010). Once the EIS is complete, the agency then files a Record of Decision (ROD) which states whether or not the agency plans to move forward with the proposed action (Anderson, 2010). Alternatively, if no significant impact is found from the EA, the agency will release a Finding of No Significant Impact (FONSI) (Anderson, 2010). Title II of the act established the Council on Environmental Quality (CEQ) whose duty it is to administer and review NEPA (Anderson, 2010; Mandelker, 2010). Ultimately, the responsibility of ensuring that Title I of the act is followed properly is that of the CEQ. Title I of the act lacks detailed direction in how compliance to NEPA is to be carried out by agencies (Mandelker, 2010). NEPA itself does not explicitly prevent any action from being carried out. Rather, it establishes procedure for identifying all possible impacts of an action. The establishment of this procedure and its required reports has resulted in increased transparency for the actions of federal agencies (Michaels, 1997). These reports can be used by third party organizations to argue against an action in the court of law, to enforce environmental protections.

NEPA was developed during a period in U.S. history when the public had faith in the government to act rationally and develop comprehensive legislation to address the nation's concerns (Mandelker, 2010). Today, this act serves as an example of successful grassroots and bi- partisan efforts to push Congress and in turn push the President to act (Michaels, 1997; Mandelker, 2010). NEPA arose out of growing public concern for human health and dissatisfaction with increasingly apparent environmental pollution. These sentiments emerged from environmental disasters such as the Cuyahoga River fire in 1969 and the Santa Barbara oil spill that same year (Michaels, 1997; Fairbrother, 2009). Additionally, public opinion was heavily influenced by popular culture at the time. Works of literature such as Rachel Carson's *Silent Spring* incited a feeling of impending environmental collapse and inspired grass-roots activism (Michaels, 1997; Fairbrother, 2009; Anderson, 2010). The result of this mounting pressure was an innovative and holistic policy calling for "productive harmony" between the economy and the environment (Michaels, 1997).

There are two perspectives on the effectiveness and necessity of NEPA. Critics of the act

claim that NEPA's procedural emphasis lacks substantive requirements for environmental protection (Anderson, 2010). A proposed action simply must undergo the previously described series of assessments before it can be carried out, but it is then up to a third party to intervene in the implementation of the action. In practice, the agency itself is unlikely to move forward with an action once it has been found to have a significant impact, however, this is not a statute within NEPA (Mandelker, 2010). Critics claim that the lack of requirements beyond the assessments makes the act itself ineffective, and instead places the burden on third parties to ensure a system of checks and balances (Anderson, 2010). Additionally, these critics argue that NEPA's procedure only serves to increase governmental gridlock and inefficiency, resulting in the inability of federal agencies to carry out their duties (Anderson, 2010; Mandelker, 2010). Furthermore, many people argue that the limited reach of NEPA only to federal agencies does not address many of the threats facing the environment from private entities.

Supporters of NEPA argue that the procedural nature of the act results in a significant behavioral change, resulting in more holistic decision making with fewer negative environmental impacts (Anderson, 2010; Michaels, 1997). Those who make this argument suggest that following the procedures established in Title I of the act and enforced by the CEQ forces agencies to think through alternate strategies for accomplishing their goals that result in lesser environmental impact. In addition, supporters point out that EAs and EISs increase transparency and are useful tools for third parties to ensure checks and balances are in place for the actions of federal agencies (Anderson, 2010). There are countless cases to support this claim, such as *City of Davis v. Coleman* in which the Ninth Circuit Court of Appeals found that a proposed new highway interchange outside of the city of Davis, California had not adequately addressed the full impacts that the resulting growth would have on the environment (Mandelker, 2010). Supporters of NEPA also refute the argument that the act is too limited in its scope, citing the fact that NEPA has considerable reach into the private sector due the fact that an action is defined as any "programs or projects partly or entirely funded, assisted, conducted, regulated, or approved by federal agencies" (Mas, 2003). While NEPA does not contain the language to mandate agencies avoid all possible environmental impacts, it encourages innovation and long-term holistic project development through its procedure. Additionally, due to increased transparency there is increased motivation for an agency to pursue the best means possible to mitigate impacts.

The legacy of NEPA is that of the environmental impact assessment. Since the 1960s, this concept has spread beyond the U.S. federal government into the work of state government, international governmental agencies, and international non-governmental organizations (Anderson, 2010; Michaels, 1997). Since NEPA's implementation in the U.S., states have developed their own Environmental Policy Acts which are generally similar to NEPA, but may vary in their jurisdiction, documentation of impacts, and public participation (Mas, 2003; Anderson, 2010). Some states have even gone so far as to extend the EIS concept to the private and local government sectors (Anderson, 2010). Since it was passed into law, NEPA has served as the foundation for further milestones such as the Clean Water Act (1977) and the Environmental Response, Compensation, and Liability Act of 1980 (CERCLA; Fairbrother, 2009; Anderson, 2010; Mandelker, 2010).

There are numerous examples of adaptation of NEPA's principles into the work of other countries and organizations, such as New Zealand's 1991 Resource Management Act (Mas, 2003). The EIS principle continues to spread through the efforts of the United Nations Environment Program (UNEP), which provides training to developing countries on how to implement impacts assessments, as well as the Organization for Economic Co-operation and Development (OECD) which provides member-states with advice on the to use EIS in their development aid programs (Anderson, 2010). The International Association for Impact Assessment, which formed in 1980 currently has over 1,700 members from over 120 nations (Anderson, 2010; IAIA, 2017).

While the value of NEPA is continually contested, it is clear that it has been foundational in the development of environmental regulations both in the U.S. and internationally. NEPA serves as an example of successful policy innovation, not only for its lasting influence, but also for the way in which it was formed which represents the way in which the democratic system can and should operate. While there is still room for NEPA to develop and improve, its significance cannot be denied. The role of the CEQ in monitoring and reviewing NEPA is essential to its success as a regulation. Continuing this review in the context of more recent environmental disasters such as the 2010 BP Deepwater Horizon oil spill in the Gulf of Mexico and the ongoing water crisis in Flint Michigan will be essential for future implementation of the regulation. Additionally, a review of the development and effectiveness of current regulations will provide insight into how to improve our environmental conservation efforts.

2.4. Environmental Regulations and Public Health

Jacklynn Lathrop

Environmental regulations are important to public health, especially water and air regulations that create a threshold for allowable toxins. The federal Lead and Copper Rule (LCR) was created in 1991 to control lead and copper in drinking water. According to the World Health Organization, lead can bioaccumulate in humans and can cause damage to multiple body systems. Lead is especially harmful to children even at low exposure rates, which can cause a lowered IQ, antisocial behavior, reduced attention span, anemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. There are many ways lead can enter drinking water, one of which is through corroding pipes (Lead Poisoning and Helath, 2017). The LCR states that drinking water from taps should be monitored and that no more than 10% of taps sampled can be at or above 15 parts per billion lead and 1.3 parts per million copper. Two things are required if levels of lead and copper exceed these limits: action to reduce corrosion in the water system, such as adding an anti- corrosive agent, and advising the public about precautions they should take to protect their health (Lead and Copper Rule, 2017). The Flint Michigan Water Crisis occurred because the city failed to comply with the LCR.

April of 2014 marked the start of the Flint, Michigan water crisis, an event that devastated a community when corrosive water caused pipes to leach lead into the city's drinking water. This event highlights the importance of environmental regulations to public health and demonstrates the backlash that can occur when compliance with regulations fails. The crisis began when Flint temporarily switched its water supply to the Flint River. The city planned to switch its water supply from the Detroit Water and Sewerage Department to the Karegnondi Water Authority in an effort to save money. This switch would take time so until that access was set up, a temporary water supply was used; the Flint River. Water from Flint River proved to be highly corrosive and within weeks of the switch, citizens of Flint grew concerned that their water was unsafe. The corrosion occurred because the city failed to treat the water properly. Under the LCR, Flint is considered a large system (more than 50,000 people served) and Flint city officials neglected to meet the corrosion treatment standards for a large system (Kennedy, 2016).

During the next few months a whirl of warning signs popped up that should have prompted officials to act, but instead they denied there was a problem with the water and ignored

Flint residents' concerns. Citizens complained that their water was discolored and smelled different after the switch to the Flint River. In one case, city tests showed a Flint home had nearly seven times the acceptable lead concentration. A study from Hurley Medical Center in Flint confirmed an increase in children's lead blood levels after the switch. In September, a team from Virginia Tech gathered samples from hundreds of Flint homes. The Virginia Tech test results should have had concentrations similar to the city tests results but revealed a higher concentration of lead. The Michigan Department of Environmental Quality (MDEQ) discarded two samples from their lead level report. Without these two samples, the levels fell within federally acceptable levels (Kennedy, 2016).

After a long drawn out plea for action from the citizens, the city of Flint reversed its water supply back to Detroit and the city's lead concentration in tap water has receded substantially (Flint Drinking Water, 2017). Despite the lowered levels of lead in water, residents remain skeptical of the water's safety. In a poll of 400 Flint residents, 70% said they didn't trust government assurances that the filtered water is safe to drink, 11% said they did and the remaining 19% said they weren't sure (Egan, 2016). Denise Daniels, a Flint resident in an interview said 'It [the water] was messed up and they didn't tell us before. They can come out and test it all they want. I'm still not going to drink it'(Bosman, 2016). This type of mistrust in the government highlights the importance of compliance with regulations and good communication between the public and officials. Karen Weaver, the mayor of Flint who was elected amid the crisis, said in an interview with NPR that she is 'adamant about letting people know what's going on every step of the way, letting them know if it's good news or bad news' as a way to rebuild trust between the public and the government (In Flint, mayor, 2016). Michigan plans to spend $87 million to replace some of the outdated lead pipes to correct the contaminated water system. This action will also settle a lawsuit that blamed city and state officials for not protecting residents from drinking leaded water for over a year (Bosman, 2017).

Environmental regulations like the Lead and Copper Rule are important to public health because they reduce exposure to toxins. Public health disasters such as Flint Michigan can occur when compliance with the regulations and communication between officials and the public fail.

2.5. Environmental Regulation and Bureau of Reclamation Operations

Jacob Hoffman

Recent environmental concerns such as the Flint, MI water quality incident that erupted in 2014 make us wonder who maintains our water resources. With increasingly intense droughts, especially in western states, it is likely crucial that we secure our water storage and irrigation infrastructure created throughout the mid-twentieth century. Intuitively, if the water quality and sediment composition in reservoirs depends on the surrounding watersheds, then maintaining the ecosystem structures and functions of those watersheds should maintain favorable water quality. Implementing an idea such as this would require a multi-agency approach with a consensus to shift management paradigms. This section introduces a prominent federal western water management agency and examines the impact of environmental regulations on management paradigms such as the one described above.

The Bureau of Reclamation (USBR) is a federal agency that has developed major tributaries West of the Mississippi River. In fact, no USBR project extends east of the Dakotas, Nebraska, and Kansas. Large waterways such as the Missouri, Colorado, Columbia, and Platte Rivers were all dammed for flood control and irrigation and, resultantly, nearby population centers took root. Indeed, Reclamation projects have helped expand Los Angeles, Salt Lake City, Oklahoma City, Seattle, Portland, and most other major Western cities. The public has seen some Reclamation projects as contentious; and it is not uncommon for the social, political, and economical environments surrounding certain projects to be forgotten.

Some dams were constructed for the sole purpose of future electricity generation and sales; others are now mainly recognized for their recreation opportunities. USBR now manages 8.7 million acres of land associated with their irrigation and hydropower. With a Mission Statement "to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public", USBR has balanced their operations and maintenance of reservoirs and nearby lands with legislation placed to enable power generation, as well as environmental protection.

Many regulations, especially those involving hydropower and environmental protocols, have required Acts of Congress. These Acts of Congress often develop their own suites of rules, regulations, and standards that ultimately influence the way Federal public land management

decisions are formed. However, most of these Acts of Congress are best known for their environmental, social, or economic implications rather than the rationale and motivation behind their creation. For example, the 1928 Boulder Canyon Project Act pulled-together the funds to create Hoover Dam, a monumental engineering feat that demanded aww and distracted views of environmental contention as well as the ninety-six human deaths at the dam site.

Many pieces of legislation led to USBR's creation and additional regulations have since fundamentally altered the way in which business is conducted, certain areas are protected, new projects are created, and areas are managed in general. USBR was established when the Reclamation Act of 1902 set aside the proceeds of public land sales for the construction of irrigation projects in Western states. The Reclamation Act furthered the expansion of the west; from homesteading came irrigation. This Act, along with the 1906 Town Sites and Power Development Act created the storage and sales of water to the public. This Act enabled the construction of multi-million dollar projects for the sole purpose of power production due to profits that would be generated by the sale of hydroelectricity. USBR became its own entity in 1907 and the Reclamation Extension act of 1916 allowed the Operations and Maintenance branches of USBR to incorporate new technologies while maintaining existing structures. The Federal Water Power Act of 1920 enabled governmental harvest of electricity on public waters and sell it to private entities. This act resulted in the creation of numerous publicly contentious plans that were seen to have rationalized the flooding of whole valleys for the benefit of hydropower generation.

The 1930's, 40's, and 50's produced unique pre-environmental-regulation-age legislation like the Fish, Wildlife, and Game Act of 1934 that created the department of Fish, Wildlife, and Parks; and the River & Harbors Act and the Bonneville and Reclamation Project Acts that essentially secured the future of water resources for use and sales for decades to come. The Flood Control Act of 1944 and the Fish and Wildlife Coordination Act of 1946 permitted the sales of USACE power, created the Pick-Sloan project, and created public shooting and fishing areas on public lands. Most of the Acts passed in the thirties, forties, and fifties served as small prerequisites leading up to more major environmental regulations such as the Wild and Scenic Rivers Act of 1968 and the National Environmental Policy Act of 1969.

The 1960's was arguably the most important decade for the environmental protection of Federal public land. This decade, Congress passed the Water Resources Planning Act of 1965

which established the President's Water Resources Council, composed of Cabinet Representatives such as the Secretary of the Interior who would collectively evaluate federal water projects and determine standards for Federal Agencies' river basin plans (Div. of C&L Affairs, 2013). At the same time, the Federal Water Project Recreation Act was developed under the consensus that "there is a Federal responsibility to provide opportunities for public recreation at Federal water projects". This would prove to be a lucrative Act; an annual supply of capital, in the form of public recreation, that now sometimes provide large portions of State government budgets.

The National Environmental Policy Act (NEPA) of 1968 is the most important piece of legislation protecting the environment as we know it, or at least the most commonly cited. NEPA's most common legacy in current Reclamation operations is its Categorical Exclusion Checklist (CEC). This paperwork applies to any minor project (usually less than one million dollars) whose implementation accrues no inherent environmental concerns. The CEC is essentially NEPA's lowest enforcement authority but documents whether agencies have analyzed a project's potential environmental impacts.

With most environmental regulations established in the mid-twentieth century a question that now may arise is: are new Acts being created to protect our water resources? In fact, Reclamation offers cost-share funding for research on public lands through their WaterSMART (Sustainable Management of America's Resources for Tomorrow) program which is funded by the SECURE water Act of 2009. The Secure Water Act compiled climate change impact studies which revealed threatened future water resources and motivated the creation of WaterSMART to open research opportunities to universities and stakeholders.

Older than most other Federal entities, the Bureau of Reclamation is a relic agency whose presence ought to remind us of America's great achievements and a motivation to innovate and preserve our resources moving into a time of especially non-predictable water security. A warming climate is adjusting weather patterns and increasing drought in western states. Innovating with efficiency, restoration, and replacement of existing irrigation and water storage structures, while maintaining watershed structure and function might be wise investments for secure water quality into the future. As our land management decisions change, so too I believe, will our environmental regulations and the Acts of Congress that place them in effect.

3. Wildfire Regulations in the United States: History, Cost, and Causation

Aden Norris, Lee Barbisan, Todd Schlotfeldt

The Northern Rockies region contains many fire adapted and dependent forests that are currently seeing longer fire seasons due in part to an increase of overall annual temperatures and sustained summer highs, leading to less overall moisture late in the summer and making fuels flammable for longer, hotter, and drier fire seasons. The other major factor affecting the increase of fire magnitudes in western US forests is the history of forest fire management and fire suppression, creating increased fuel loads for fires to burn larger and more sustained than in the past (Loehman, 2017).

According to the National Interagency Fire Center, since 2007 the U.S. has seen a 10-year average of just over 6 million total acres burned annually, with the summer of 2017 fires greatly exceeding that average by over 2 million more burned acres (8.8 million total, NIFC, 2017a). In the Northern Rockies region alone, which includes all of Montana, North Dakota, and the northern panhandle of Idaho, 3,100 fires burned a total of 1.4 million acres this year. Fire management of the 2017 season in the Northern Rocky Mountain region has been a culmination of "let it burn" policy and 234 prescribed burns to reduce fuel hazards for the future (NIFC, 2017a).

Wildfires affect far more than the western states: the fires and smoke plumes that go with them influence air and water quality levels around the U.S. in the late summer months every year. Smoke from the western U.S. can migrate east and spread hazardous breathing conditions across the country (Gabbert, 2017). However, western forest ecosystems have adapted to fire as a natural disturbance and depend on fires to regenerate the area by interrupting forest vegetational succession, preparing native seeds for germination, releasing nutrients, and increasing detritus in soil and water systems. Understanding all the positive and negative effects of fire on the surrounding ecosystem based on scientific knowledge is vitally important to forest management. Since it was established in 1905, the U.S. Forest Service has been adapting wildfire management in an effort to incorporate public and administration collaboration, as well as looking to reliable science to inform policy.

Early Regulations

As most of us know, wildfires are intense events; however, fires are a natural part of the environment throughout most of the US. The need to control fires and manage our forests to prevent wildfires was acknowledged early on following the expansion of European immigrants throughout the modern US. As more citizens came in contact with wildfires, we improved our understanding of wildfires and the circumstances that affect them. This was the beginning of our knowledge base on how to manage wildfires.

In 1886 in Yellowstone National Park (YNP), the nation's first wildland firefighters were employed by the Yellowstone Calvary to battle raging fires across the park. This same calvary had to request funds for 20 axes and 20 rubber buckets a few years later; this request is laughable compared to today's firefighting needs and techniques. The US Forest Service was established in 1905 and would become the major source of funding, equipment and manpower for wildfires on national forest land, which comprises much of America's forests. Before we understood the ecological importance of wildfires, it was believed that all fires were bad and should be extinguished. Even the Forest Service followed this ideology by creating the 10:00 am rule, stating that all fires must be suppressed by 10 am the morning after they were spotted (National Park Service n.d.). This ideology would come back in the future with deleterious consequences.

As our scientific knowledge base grew, we changed regulations to better suit our needs and understanding. In 1946 the chief of the Forest Service began to allow prescribed burns. This idea was implemented after rigorous scientific testing proved its viability. This research was conducted by prescribing burns in 1926-1927 and examining the effects during the following years. This research had shown with empirical evidence that prescribing burns can reduce an area's capability to ignite and lessens intensities of burns (Ontario, 1927). About 20 years later the USFS began prescribing burns to areas that are prone to natural burning, potentially harmful to people if ignited, or with unnaturally high fuel loads.

Throughout the 20th century as the science of ecology developed, the role of fire in biological interactions was recognized. For example, after a fire, nutrients are released back into the soil to be utilized by seeds that have been dropped by previous plant generations. Any insect pests or pathogens are exterminated by the fire, creating a healthy environment for plants to begin their life cycles. New growth begins and succession occurs changing forests from short lived grasses, forbs and shrubs to to old growth forests. Wildlife species find higher nutrients in

young growth and are drawn to these areas. Eventually these old growth forests will catch fire and release nutrients back into the soil allowing another generation to grow and adapt to any changes in the environment. When the ecological importance of fire was scientifically proven the Forest Service changed their policy to account for this. In 1972, the "Let it Burn" policy was adopted and natural fires (lightning caused) were able to run their course depending on certain circumstances (National Park Service n.d.). By allowing natural fires to burn, we preserve ecosystem processes and are better able to allocate funding to higher need areas. Carrying out these regulations can create massive monetary needs; just how much does suppressing wildfires cost us?

Cost of Suppression

The cost of wildfire suppression is a key factor in the creation of new regulations. Without funding, there is no way to control wildfires and their potential impact on the places we live. Unfortunately, wildfires are a huge expense and diminish Forest Service's budget every fire year. From 1985 to 2016, we have seen drastic increases in fire suppression costs. Over these 32 fire seasons, 2,393,512 fires occurred burning 162,458,689 acres (NIFC, 2017b), an area equal to about 1.5 times the size of Montana. The median fire size is 4,470,584 acres. The number of individual wildfires over the last 30 years fluctuates from year to year, but the number of acres

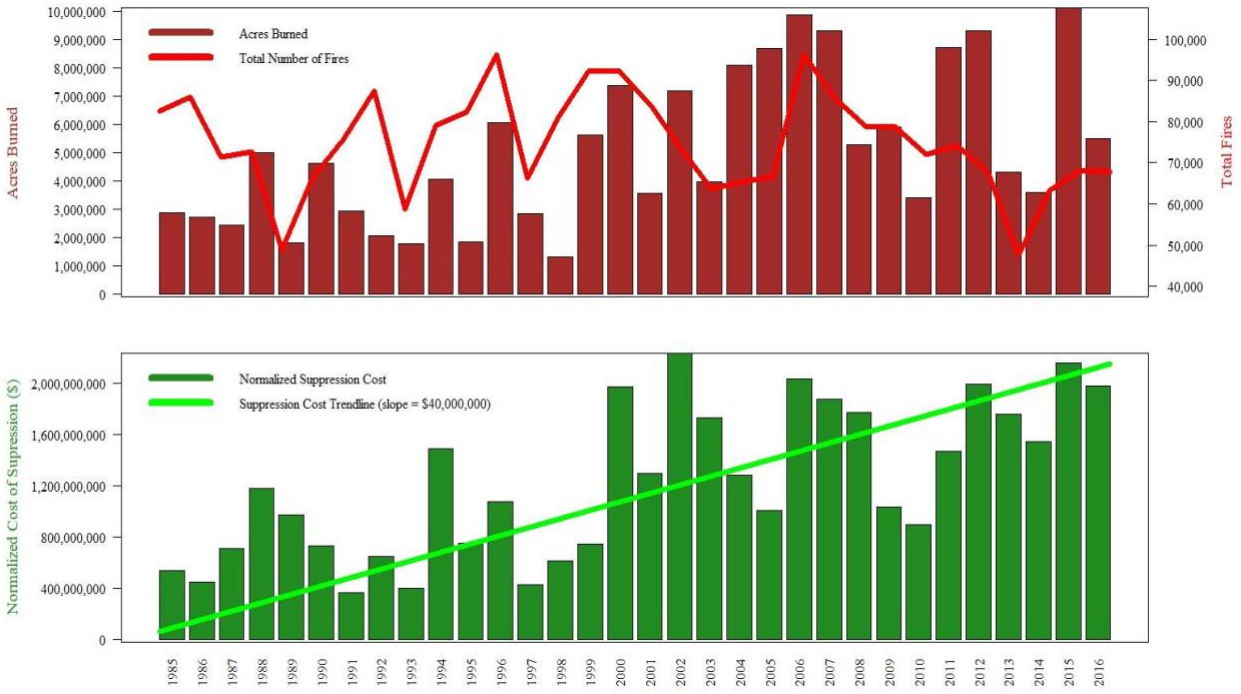

Figure 3.1 *- (Upper Plot) The column chart shows the number of acres burned by wildfires each year (maroon) on the left axis and the number of wildfires that occur each year (red) on the right axis. (Lower Plot) The column chart shows the number of US dollars spent on wildfire suppression each year (forest green); amounts are adjusted to the 2016 consumer price index to account for inflation. The trendline shows the average increase in spending on wildfire suppression each year; slope = 40,000,000 dollars (light green). (NIFC, 2017b)*

burned each fire season has increased after 1998 (Figure 3.1). The cause of the increase in acres burned goes beyond the scope of this paper, but is affected by increasing aridity due to climate change as well as management practices. When it comes to suppressing fires, most money is spent on very large and risky fires. These are high intensity fires that may have started close to a city or suburb. Over the same 30-year time span, fire suppression has cost $39,050,206,014 (Figure 3.1; NIFC, 2017b). The dollars spent are normalized to 2016's consumer price index to account for inflation. Although $39 billion seems like a lot of money, we currently have no better solutions for protecting citizens in danger from these natural disasters. Furthermore, the general trend of suppression costs shows an increase of around $40,000,000 per year. High cost years generally correlate with large fire years. We also see that there has been a steeper increase in costs after 1998, the same time that fires began to burn larger areas. To stabilize costs of suppression, we must invest in our understanding of fire processes and further adapt our wildfire

regulations. Federal funding comes mostly from the U.S. Forest Service as well as Department of Interior agencies such as the Bureau of Indian Affairs, Bureau of Land Management, National Park Service, and the US Fish and Wildlife Service (NIFC, 2017b). These agencies have very minimal funding and wildfires cause budgets to dwindle almost every year. Refining our knowledge of how to predict areas that are prone to burn, predict how climate change will affect an area's capacity to burn, and how to manage forests to maximize natural processes as well as economic welfare is an important step to bettering our wildfire regulations (US Forest Service, 2017). For our nation to reach a point of environmental stasis and economic sustainability, we must continue to improve forest management and wildfire prevention.

Yellowstone

One year that was particularly influential in shaping wildfire management strategies was 1988, the single most catastrophic fire season in recorded history of Yellowstone National Park. Severe drought conditions led to fire outbreaks across the park and prevailing winds caused rapid spreading. The evident severity of the fires warranted a temporary hold on the "let it burn policy" and the Forest Service began to take action. The fires burned into November when early snow dampened the last of the flames. In the end, the fires swept across 1.2 million acres in the greater Yellowstone area and burned 36% of the park itself (National Park Service 2016). This devastating event gave rise to the 1988 Fire Management Policy Review Team as well as a revised Yellowstone fire management plan in 1992.

Recent Fire Management

The 1988 Fire Management Policy Review Team was assembled with the goal of reviewing the national fire policy. Among other revisions, they established more specific criteria regarding prescribed burns and when naturally occurring fires should be allowed to burn. In 1995, the Federal Wildland Fire Management Policy was put into effect, with the intention of unifying policies across administrative boundaries to maximize the efficiency of management efforts. After an uncharacteristically severe fire year in 2000, the National Fire Plan was created, which provided a broad framework regarding wildfire management. This plan addressed all aspects of management from hazardous fuel reduction, to community assistance, to rehabilitation protocol after destructive fires (National Park Service n.d.).

To update fire management across the U.S., a new National Forest Planning Rule took effect in 2012. The planning rule, which took into account 326,000 public comments, is a set of guidelines for land managers while developing or revising a specific Forest Plan, and explains what information must be contained within a National Forest Land Management Plan. There was also a Federal Advisory Committee with 21 committee members ranging from land managers, scientists, and Native American tribe members to timber industry, recreation, and sportsman representatives (US Forest Service, 2017). This committee can inform on revisions to current national forest plans, which will all be examined and updated due to policy in the 2012 Planning Rule.

Causation

While the public has more opportunity to get involved in revision of Forest Plans to encourage management of the forests to decrease the effect of fires on surrounding communities, there are still numerous wildfires started anthropogenically each year. Between 1985 and 2015, 21,544 fires burned across Montana (Figure 3.2). 64% of these fires were started by lightning and over one fourth (28%) were human caused. Over half of these fires started by humans were attributed to out of control campfires.

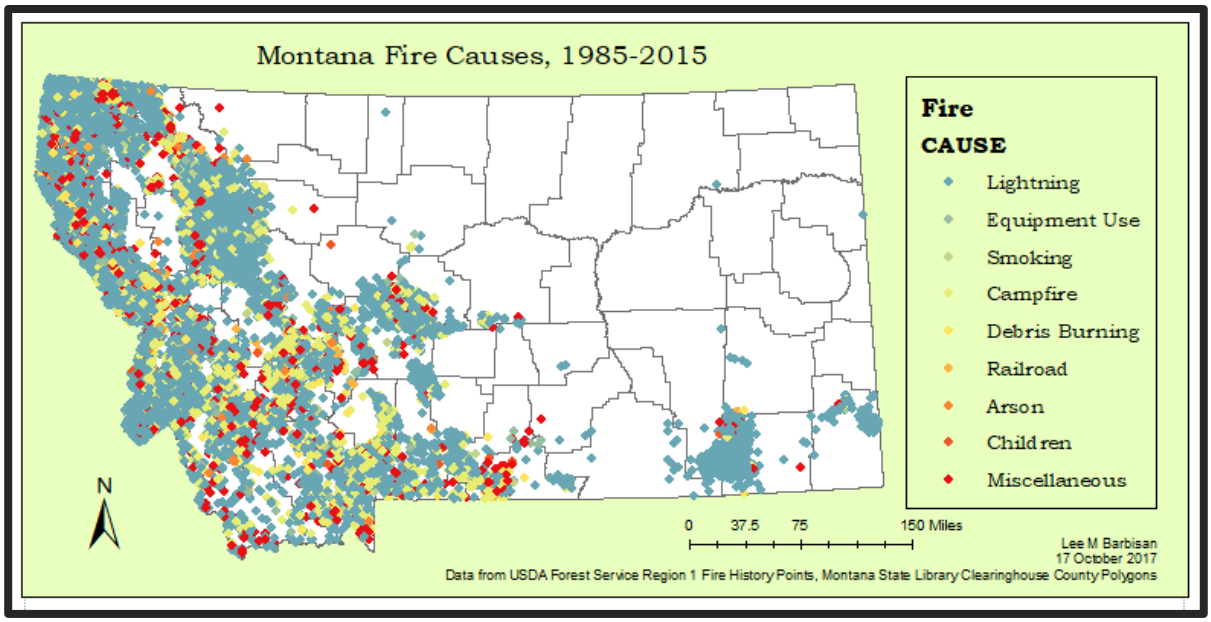

Figure 3.2 *- Montana fires recorded from 1985 to 2015. Of the 21,544 fires in Montana from 1985 to 2015, 13,842 were caused by lightning, 3,119 from campfires, 1,840 were miscellaneous, 1,219 from burning debris (slash piles), and 407 from smoking hazards.*

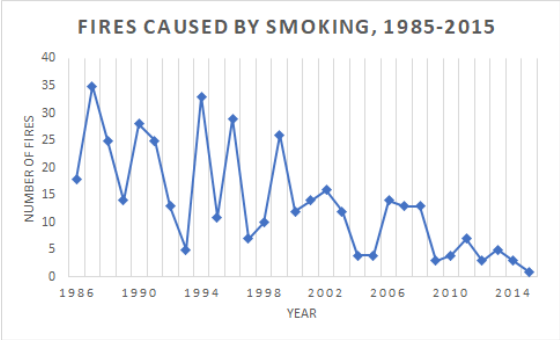

Figure 3.3 *- Montana fires caused by smoking. This chart accounts for 407 of the total 21,544 wildfires (2%). Since 2009, fires caused by smokers has remained in single digits every year.*

The only category of human-caused fires to decrease over the twenty year period were smoking-caused wildfires, which accounted for 2% of the total; only 1 wildfire was started by smoking in 2015 (Figure 3.3). Despite this slight decrease in smoking-caused fires over the last 20 years, 28% of Montana wildfires that have gone on to burn millions of acres and destroy numerous structures and properties around the state, have started because of human activity.

Conclusion

Wildfire management in the US has changed much over the past decades, shifting gradually from strict suppression policies, such as the 10:00am rule, to strategies that take into account the ecological importance of wildfires. The use of fuel reduction techniques, such as prescribed burns and thinning, have been developed to reduce fire severity in the future. The recognition of fire as an important role in ecological succession has led to policies such as “let it

burn", in which small-scale, non-hazardous fires are left to run their course. Collaboration and unification across administrative boundaries has been emphasized to increase the effectiveness of management efforts.

In the US over the past several decades, wildfire frequency, magnitude, and cost of suppression have all been increasing. While 98% of fires are extinguished before reaching 120 ha, the 2% that escape suppression account for 97% of the annual firefighting budget and approximately 50% of the Forest Service's annual budget (North, 2015). The increase in fire frequency and severity is due partially to changes in precipitation patterns, which lead to severe droughts and longer wildfire seasons. 2017 has been a particularly severe fire season especially for the western US. Historically, wildfire management policies have arisen from particularly large fires and landmark seasons, for example the 1988 Fire Management Review Team following the 1988 Yellowstone fire. With such relentless fires this year, the steady increase of suppression cost, and the recent shift in office, the US may be due for a change in wildfire management.

4. The Endangered Species Act: History, Successes, and Failures

4.1 History and Implementation

Raeleigh Price

The United States first legally recognized a need to protect species from extinction in 1966, when Congress passed the Endangered Species Protection Act. It gave the federal government the power to list endangered species and protect them, mainly by preserving their habitat. In 1969 it was amended to protect foreign endangered species by preventing their importation into the US. The Act also suggested that an international convention should be called, to address endangered species around the world. This was realized in 1973, when the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was held in Washington, D.C. and signed by 80 nations. CITES monitors and restricts international trade in endangered species. This was swiftly followed by the Endangered Species Act of 1973 (ESA), which differed from the original Endangered Species Protection Act in several ways. First, it enacted CITES protection in the US. It also gave clear definitions of endangered and

threatened species, and allowed plants and invertebrates to be included on the list. It expanded protections on endangered species habitat and individual organisms. Finally, it allowed states and other landowners to apply for federal grants to protect endangered and threatened species ("A History," 2016). The stated purpose of the ESA is to protect endangered and threatened species and the ecosystems they depend on, as well as to comply with international agreements such as CITES and migratory bird agreements. The Act defines conservation as the use "of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary" (16 U.S.C. §§ 1531-1544). It also defines critical habitat as habitat that is "essential to the conservation of the species and may require special management considerations or protection" (16 U.S.C. §§ 1531-1544). The Act defines endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range", and for the first time, identified threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. §§ 1531-1544). The ESA prohibits "takings" of these protected species without a special permit. A take is defined as any attempt, successful or otherwise, to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" an individual (16 U.S.C. §§ 1531-1544). Protected species should also have designated recovery plans, which include site-specific steps for recovery and time frames and criteria for assessing recovery (Taylor et al. 2005).

Listing Species

Species are collated on the List of Endangered and Threatened Wildlife and the List of Endangered and Threatened Plants, often referred to collectively as the Endangered Species List. Species are proposed for the lists through either the petition process or the candidate assessment process ("Listing and Critical Habitat: Overview," 2017). In the petition process, the public submits a petition to list a species, subspecies, or population. The U.S. Fish and Wildlife Service or the National Marine Fisheries Service has 90 days to reject the petition or decide that more data is needed. Then they have one year to collect data, at which point the species can be rejected, listed, or designated a "candidate species." Candidate species are of concern, but their situation is not urgent enough to make them a priority for listing. They must be reviewed

annually. These species are often referred to as “warranted but precluded,” a paraphrasing of the ESA text that makes this legal. (“Listing and Critical Habitat: Petition Process,” 2017).

An important point to note is that the ESA requires that species be listed regardless of where they reside. This prevents imports, exports, and any other commercial activity involving foreign endangered organisms and their byproducts in the US. It also prevents takes for these species, but of course this only applies to persons under the legal jurisdiction of the U.S. Listing a foreign species can help bring attention to its status. As a “demonstration of the commitment of the [US] to the worldwide protection of endangered…and threatened species” (16 U.S.C. §§ 1531-1544), the president can offer limited assistance to other nations in the form of financial aid, primarily for the acquisition of lands for preservation. The Secretary of the Interior, through cooperation with the Secretary of State, can offer training, management plans, and personnel for the development of conservation programs. (16 U.S.C. §§ 1531-1544; “Foreign Species: Overview,” 2017) American Indian lands are not subject to federal public land laws (“Working with Tribes: Overview.”).The Department of the Interior, Bureau of Indian Affairs, and Native American Liaison offices work with tribes to protect endangered species on tribal land based on their individual goals and conservation plans (“Working with Tribes: Partnership,” 2017).

Considering a species closer to home, the grizzly bear is a keystone species in the Greater Yellowstone Area. Their transition to being removed from the list and hunted again is an important case study of how to help species recover and delist them effectively.

4.2 Delisting of the Yellowstone Grizzly Bear

Jerad Hoy

On June 30, 2017, following an announcement from Secretary of the Interior Ryan Zinke, a native of Montana, the Yellowstone grizzly bear was removed from the endangered species list after 42 years of being listed as “threatened”. The announcement cited several factors that contributed to the decision to delist, including improved numbers and distribution of the grizzlies, as well as the quantity and quality of habitat available (Secretary Zinke Announces, 2017). This has, however, not been without controversy and contention among scientists and politicians alike.

The grizzly bear (*Ursus arctos horribilis*) originally inhabited a large range, from Alaska down to Mexico. Figure 4.2.1 (Grizzly Bears in, 2017) shows the historic, current and potential range of the grizzly in the western United States. By the mid 1970's, the species had been reduced from a population of nearly 50,000 (Grizzly Bear, 2017) to between 800-1,000 bears and inhabited only 2% of its original range south of the Canadian border. The isolated populations in the Greater Yellowstone Ecosystem (GYE) were down to an estimated 136 bears (Grizzly Bears &, 2017).

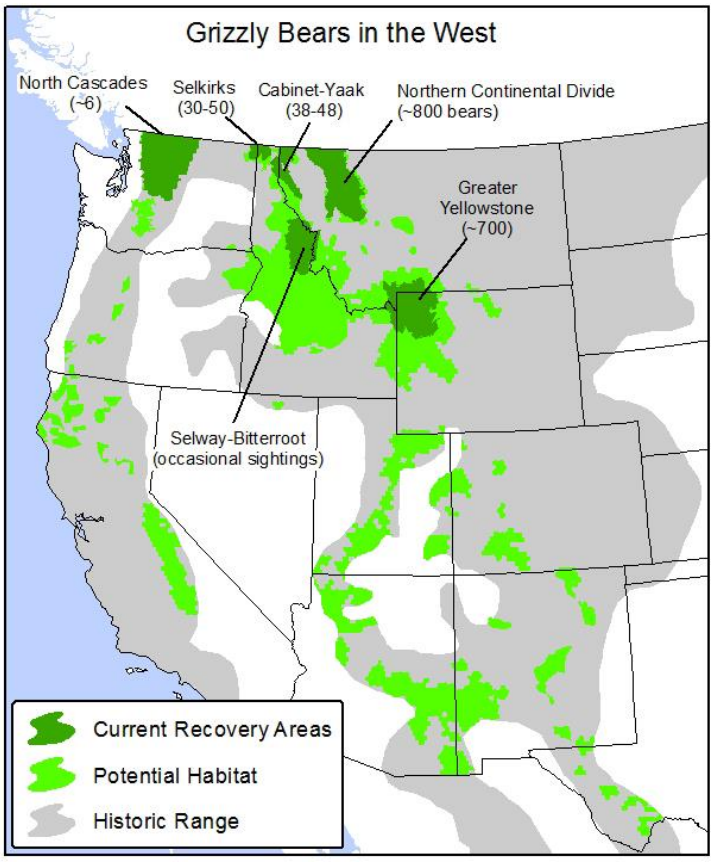

Figure 4.2.1: Historical and current extent of grizzly bears.

On July 28, 1975, the GYE grizzly bear population was listed as threatened under the Endangered Species Act (Delisting Species, 2017). This halted all grizzly bear hunting taking place outside of Yellowstone National Park, established the Yellowstone Grizzly Bear Recovery Area (as seen in Figure 4.2.2) by combining national park and public lands surrounding Yellowstone, and created two teams, the Grizzly Bear Study Team and the Grizzly Bear

Committee, to coordinate and communicate grizzly bear research, monitoring and management in the recovery area.

Figure 4.2.2: GYE grizzly bear recovery area.

These teams devised the Grizzly Bear Recovery Plan, a document originally drafted in 1982, but substantially revised in 1993 and 2006. The Recovery Plan laid out a long-term path for recovery and management of the grizzly bear, focusing on decreasing human-bear conflicts, monitoring, habitat loss prevention, and habitat restoration. State wildlife agencies were given the primary responsibility of managing the grizzly bear populations outside of the national parks,

and are tasked with creating their own conservation plans outside of the recovery area (Grizzly Bears &, 2017).

Since these measures have been implemented, Grizzly Bears in the GYE have undergone a remarkable recovery, now totaling approximately 700 bears (Secretary Zinke Announces, 2017), nearly as many as were remaining in the continental U.S. in the 1970's. By 2003, the goals of the Recovery Plan were met for the sixth consecutive year, prompting federal officials to begin the process of delistment, the ultimate goal of all Endangered Species recovery efforts. In 2005, the U.S. Fish and Wildlife Service (USFWS) proposed the delistment, and after addressing criticisms of the Recovery Plan with respect to methods of estimating grizzly bear population sizes and sustainable mortality rates, finally removed the GYE grizzly bear population from the list of threatened species (Grizzly Bears &, 2017). This, however, would not last long.

Immediately following the decision, several conservation groups sued the federal government, arguing that the proposed Recovery Plan was inadequate and unenforceable, and that the delisting decision had not properly taken into account the potential impacts of climate change on a key food source of the GYE grizzly bear population, whitebark pine nuts (Grizzly Bears &, 2017). These high elevation trees are at risk from increasing forest fires and infestations of the mountain pine beetle, both of which are expected to increase in severity and extent with climate change (Logan et. al., 2010). In 2009, a federal district judge in Missoula, Montana ruled in favor of the conservation groups, overturning the delisting decision and returning the grizzly bear to the threatened species list. The USFWS appealed the decision in 2010, and an appeals court upheld the decision, ruling that while the original Conservation plan was indeed adequate with respect to enforcement, it did not properly address the potential impacts of climate change (Grizzly Bears &, 2017).

In 2013, the teams originally tasked to coordinate the study and management of the grizzly bears all recommended that the grizzly bear be delisted, despite the climate change concerns. They cited that alternative food sources were available in lieu of whitebark pine nuts, and that pine nuts were not currently impacted to a large degree (Grizzly Bears &, 2017). However, this was highly debated.

On May 5, 2016, a group of scientists and conservationists sent the then-Secretary of Interior, Sally Jewell, and the Director of the USFWS, Daniel Ashe, a letter summarizing their opposition to delistment. The arguments laid out in the letter stated that the GYE grizzly bears

were not close to recovered with respect to their pre-European settlement population, that trophy hunting could damage populations, and as argued in previous challenges to delistment, that there are numerous threats to primary food sources of grizzly bears. Along with the climate change threat to whitebark pine, the letter described threats to cutthroat trout from invasive species, climate change threats to Army cutworm moths, and decreasing berry forage from increasing droughts (Goodall et al., 2016). This has resulted in a greater reliance by grizzly bears on big-game meat, such as elk, deer, and bison, species that are also in decline in the GYE (Morellow, L., 2014). Despite these concerns, the federal government proceeded with the delistment effort.

Finally, in June 2017, the GYE grizzly bear population was taken off the endangered species list. The Conservation Strategy, finalized in December of 2016, was implemented and will guide the future conservation of the grizzly. Montana, Wyoming, and Idaho are currently in the process of drafting hunting regulations as part of their post-delistment management plans (Grizzly Bears &, 2017). As of now, the Yellowstone grizzly bear is officially delisted; however, several groups are currently gearing up to sue and overturn this decision once again.

4.3 Hunting Endangered Species

Bryce Murphy

"Sustainable hunting will continue to be a major conservation tool in the 21st century. It conserves wildlife populations and biodiversity in general, whereas hunting bans can speed up extinction," said Dr. Ralph D. Baldus in the Sports Afield magazine. Sustainable hunting is achieved through extensive lists of hunting regulations that differ from state to state. Regulations govern how many animals can be killed, the time of year certain species can be hunted and most importantly they ensure ethical fair chase of the hunter to the animals. When poorly regulated, hunting can be – and has historically been found – damaging to wildlife populations with dramatic examples of extinction (Macdonald, 2008).

A common controversy regarding hunting is that it can drive certain animals to endangerment if not extinction. More times than not, hunting conserves wildlife populations and assists in sustaining healthy populations that the ecosystem can support. One case that will be discussed is the delisting of grizzly bears in the Greater Yellowstone Ecosystem and the hunting management and regulations that will guide the future hunting of grizzly bears. Another species

of concern that is not considered endangered is the sage grouse and how hunting efforts are managed to ensure the sage grouse is not driven to endangerment. These species, along with other successes and failures, will be explored to see how hunting regulations are managed around species of concern.

The goal when listing a species to the Endangered Species Act is to recover a species to a self-sustainable population that no longer needs to be federally protected. Once the grizzly bear was listed, recovery plans and management strategies were put in place to assist the recovery of the populations. These included: a ban of hunting grizzlies in the Greater Yellowstone Ecosystem, establishing a Yellowstone recovery area, putting together a study team to monitor and research bear habits and behavior, and compiling a communication committee to better cooperate among all managers in recovery efforts.

As discussed previously, after 42 years of intensive recovery efforts, the grizzly bear was removed from the threatened species list in 2017. Further efforts will need to continue to reduce bear conflicts with people and to provide habitat expansion. With this delisting, states now have the chance to provide hunting opportunities outside of park boundaries. For example, Montana has compiled an extensive outline of hunting regulations to allow hunters the chance to take a trophy animal. These regulations include a special drawing process that limits the number of tags given to the public so only a set number of bears can be harvested per year. They also ensure that every harvested bear be reported with an exact location as there will only be 7 different hunting districts for bears. The license fee of hunting and harvesting a grizzly bear would cost a resident $218 and a non-resident $1,075. So not only will hunting efforts help manage a well recovered population but it will also provide additional revenue for the state's economy. The hunting of grizzlies has not yet started but as soon as state commissions approve and finalize seasons and regulations, limited hunting will be allowed in the Greater Yellowstone Ecosystem (Grizzly Bear Delisting, n.d).

The greater sage grouse is a species of concern because of the loss of habitat due to agricultural production and energy developments. Sagebrush steppe, the preferred habitat for sage grouse, is being converted into agriculture land for increased production causing a significant decline in sage grouse populations. In 2015, the bird was of debate by the US Fish and Wildlife Service on whether to list it on the Endangered Species List as threatened. Due to the ongoing work of habitat conservation, it was decided to not list sage grouse as threatened.

Along with habitat conservation, states such as Montana, closed the hunting of sage grouse in 2014. After all the conservation efforts and favorable weather in the spring of 2014, the sage grouse numbers in the three management areas in Montana, increased on average by 17%. Biologists use 88 different mating areas to count sage grouse and use population numbers dating back to 1980 to set their standards for management of bird populations today (Lemon, 2016).

After the conservation success story in 2014, the hunting of sage grouse re-opened in Montana. While some were concerned that hunting would cause another decline in numbers, FWP believes hunting has little impact on bird numbers. Conservation efforts will continue to be focused on habitat management to maintain a stable population of sage grouse. There have been 1,300 birds collared in the last 16 years and of those collared birds, only 9 have been harvested from hunters. The new regulations imposed for hunting sage grouse included a two-bird daily bag limit and a season starting on September 1st and ending on September 30th. In fact, Montana is the only state in the west that is completely open for sage grouse hunting and has the longest open season. (Lemon, 2016). In contrast, Utah has a more conservative season where only two birds can be taken during the entire season and a greater sage grouse permit is required through an application and drawing process. It is clear that different states manage their regulations when it comes to species of concern in regards to managing populations numbers so they are not driven toward endangerment.

4.4 Funding, Effectiveness, and Criticisms of the ESA

Raeleigh Price

Funding

The ESA is a powerful piece of legislation that is administered by two separate agencies. The Department of the Interior's Fish and Wildlife Service (FWS) manages land and freshwater species, while the National Oceanic and Atmospheric Association (NOAA) in the Department of Commerce manages marine and anadromous species ("Endangered Species Conservation," n.d.). The responsibility of reporting all annual federal expenditures under the ESA on a species-by-species basis falls exclusively to the FWS (16 U.S.C. §§ 1531-1544). One source of expense under the ESA is financial assistance for foreign endangered species, provided under Section 8. Another source is individual states that form agreements with the federal government for the

protection of species, and then apply for a grant for funding to carry out the plan (16 U.S.C. §§ 1531-1544). These are known as Section 6 grants. The rest of the funding comes directly from the federal government. Funding can be used to acquire habitat, do research, or for enforcement (Gibbs and Currie 2012). Many listed species have recovery plans, which include suggested expenditures. However, this often does not reflect actual expenditures. Funding correlates very well with recovery, but recent research finds that expenditures are disproportionate and, in many cases, could be distributed more effectively (Gerber 2016).

Effectiveness

The first part of an effective species protection system is the ability to accurately identify species in danger and list them quickly: "imperiled species lists…are firmly established as valuable tools for biological conservation" (Harris et al. 2011). As stated above, the FWS or NOAA has 15 months to list or reject a species once they have received a petition. Alternatively, species can be listed as candidate species. Many species remain in this position longer than they should because of the backlog in evaluating potential and candidate species (Harris et al. 2011). As of October 2017, there are 139 active petitions, which include actions to list or delist a species or a subset of its population, to reclassify a species by down-listing it as threatened or up-listing it as endangered, or to classify critical habitat. Only eight of these petitions have been received within the past 15 months ("Endangered Species Act Petitions," n.d.). Some actions on the list are labeled "petition findings not yet made," meaning that no decision has been made. Species can also be labeled as "warranted but precluded," meaning that they are candidate species that should be reassessed every year. Some active petitions were received as long ago as 1990. Candidate species go years between reassessments, and some appear to not have been reassessed since 2004 ("Endangered Species Act Petitions," n.d.). The average listing time for all species between 1974 and 2003 was over ten years (Harris et al. 2011).

Another way to assess the accuracy of the ESA's ability to list threatened and endangered species is to compare it to an international authority. The International Union for Conservation of Nature produces the Red List of Threatened Species, which is "the world's most comprehensive inventory of the global conservation status of plant and animal species…[and] is recognized as the most authoritative guide to the status of biological diversity" (IUCN, 2017). The Red List differs from the ESA's list because the IUCN lists every species, subspecies, and variety that it

has data on. Species are then classified on a gradient from least concern to near threatened, vulnerable, endangered, critically endangered, extinct in the wild, or extinct (IUCN, 2017). Species are considered imperiled when they are vulnerable, endangered, or critically endangered. Harris et al. (2011) compared the IUCN list of imperiled species in the US to the species recognized as imperiled under the ESA. The IUCN recognized more species as imperiled: only 25.9% of the species they listed were listed by the ESA. Only 59.7% of birds, 50% of mammals, 20% of amphibians, and 4.8-10.1% of invertebrates recognized by the IUCN were also recognized by the ESA. Species that are more endangered are more likely to be listed by the ESA. Harris et al. (2011) provides possible explanations for this phenomenon: the FWS may be overwhelmed and unable to consider all species, so they list severely endangered ones first; the ESA relies on a petition process and civilians may be more likely to campaign for more endangered species; and the ESA may accept a higher risk of extinction than the IUCN does. This is costly to both the species and the budget, because the more imperiled species are before they receive protection, the harder it is for them to recover (Harris et al. 2011).

The next step in assessing the ESA's effectiveness is to look at how listing benefits species. Taylor et al. (2005) performed a quantitative analysis of the effectiveness of the ESA and several of its specific measures. As of 2004, only 13 of 1300 listed species had ever recovered enough to be removed from the list, and two-year analyses found that a majority of protected species were declining (Taylor et al. 2005). By 2015, only 4 additional species or populations had recovered and been removed ("Final Rules," 2017). However, they suggested that species need longer to recover and should not be evaluated only on short time-scales. Populations were more likely to be improving the longer they had been listed, suggesting that the ESA needs longer time scales to work effectively (Taylor et al. 2005). The ESA requires that listed species have designated critical habitat and recovery plans, but this doesn't always happen, and less than 2% of recovery plans are adhered to. However, when these two tools are implemented, they do help species recover compared to species with no critical habitat or recovery plan (Taylor et al. 2005). Endangered species are more likely than threatened species to have recovery plans, but equally likely to have critical habitat. Endangered species are much less likely to be improving than threatened species (Taylor et al. 2005). This suggests that critical habitat may play the most important role in recovery, and that it may be more efficient to list species before their status becomes critical. Other research suggests that funding is the most

important tool for species recovery: Species that are listed but do not receive funding tend to decline, showing that listing alone actually tends to be worse for a species than not being listed at all. Listing plus funding does tend to lead to recovery in some studies (Ferraro 2007), but not all (Gibbs and Currie 2012).

Criticisms

The ESA provides several tools for the recovery of species: listing, protection from takes, designation of critical habitat, funding, recovery planning, and Section 7 protection, which requires other federal agencies to consult with FWS and NOAA to protect listed species in their jurisdiction (Gibbs and Currie 2012). Gibbs and Currie (2012) found that these tools were "at best, only weakly related" to recovery. The number of years listed, the number of years with a recovery plan, and the amount of funding had positive correlations with recovery. However, the improvements were small, and the use of the tools explained less than 13% of the variation (Gibbs and Currie 2012). They hypothesized that a large part of this problem was poor evaluation after the use of tools: species counts and population data are extremely lacking. Ferraro et al. (2007) used a statistical matching method to simulate a control group for the ESA in an attempt to understand how population trends of listed species would have differed if they had not been listed. They discovered that listed species tend to recover with substantial funding, but that without significant funding, species fare worse than they would have if they had never been listed.

One way to approach the chronically overwhelmed budget of the ESA would be to perform triage: pull funding from expensive but excessive recovery efforts and invest that money into species that are declining but receiving very little funding (Gerber 2016). Spending over the amount requested in the recovery plan does not appear to aid in recovery, so this wasted surplus could be shifted to neglected species where it could have a more meaningful impact (Gerber 2016). Another way to increase effectiveness would be to use economic strategies such as return on investment to triage species and actions. This would include steps to define a clear and measurable objective and then to consider tools available and their approximate cost and effectiveness (Gerber 2016).

Conclusion

The ESA has shown itself to be a valuable and powerful tool for the preservation of species such as the grizzly bear and sage grouse, but it would be wrong to assume that it could not be improved. The lack of sufficient funding is a serious problem. The funding that is available to the ESA may be better focused on listing and helping less-critical species before their situation becomes critical. More funding should also be allocated to follow-up studies on populations, which are crucial for assessing the effectiveness of tools and determining how to prioritize in the future.

5. Economics

5.1 Environmental Regulations: Necessary for the Economy

Jack Heneghan

In 1899 the United States passed its first environmental law, the Rivers and Harbors Act, which made it illegal to dump waste into any navigable waterway in the US without a permit. Since the act was passed there have been a flurry of other regulations passed to protect our environment from anthropogenic degradation. In the 1960's and '70s many high-profile laws were put into place, helping chart the course for environmental regulations in the decades since. The most notable of these acts were the Clean Air Act of 1963 (revised in 1970, 1977, and 1990) and the Clean Water Act of 1972. These two milestone acts set the tone for how our country responds to environmental degradation both proactively and reactively. In the decades since these two acts were passed it is hard to believe that there could have been any opposition to the passing of these laws. Even the names themselves have extremely positive connotations; people want clean air and clean water. At the time however, there was strong opposition to the passage of these laws. The American auto industry strongly opposed the Clean Air act of 1970 (which called for car emissions to be reduced by up to 90%) based on the possible negative impacts that it would have on the economy and their industry. History has proven that these concerns were unfounded and that the act's benefits have outweighed their costs. Since the early 1970's a

number of studies have looked at how environmental regulations affect our economy; the overall consensus is that environmental regulations do not have long term detrimental effects on the economy (Ferris, et al. 2017). In modern times we see our domestic and international societies' impacts on the environment more clearly than before, as more environmental regulations and laws have been proposed, debated, and passed. However, the debate between protecting the environment and protecting the economy has not stopped.

Given the current political climate in the United States, environmental regulation has become a more polarizing and contentious topic than ever before. Internationally however, this is not the case. On December 21, 2015, the 21st Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) drafted the final version of the Paris Agreement. The Paris Agreement was negotiated by the representatives of 196 countries, major international cities, and multinational corporations to deal with greenhouse gas emission mitigation, cultural adaptation, and economic changes to mitigate climate change. This was a landmark moment in international relationships concerning the environment. In June of 2017 President Donald Trump announced his intentions to back the United States out of the Paris Agreement on the basis that it would disproportionately hurt the American economy. Since Syria signed on to the Paris Agreement on November 7 The United States is now the only country in the world to reject the agreement.

For the purposes of this paper, maintaining current regulation means essentially freezing any new legislation concerning the environment without adding any new regulations or removing any regulations already in place. Predicting our economic future is difficult in these scenarios due to the high levels of uncertainty involved. These uncertainties arise due to the difficulties in predicting the baseline conditions (populations, economic output, emissions) from which possible scenarios are devised (Marten, 2014). However, there is research in the Stern Review: The Economics of Climate Change (Stern, 2011) on how specifically not changing our carbon emissions and following a Business as Usual (BAU) model will affect our domestic economy and the global economy. The BAU model is a mathematical model devised by Stern to predict how maintaining current regulations and failing to mitigate climate change will affect the global economy. In this context mitigation means to put forth a concerted effort to reduce anthropogenic greenhouse gas emissions to the atmosphere.

Under the BAU model, carbon in the atmosphere will rapidly increase to the point where it can no longer be sequestered by natural forces (greater than 400ppm). Initially, the BAU model will disproportionately affect developing countries much more negatively than developed countries. In fact, developed countries like the United States can actually gain a slight increase in economic growth in the very short term due to their well-established infrastructure. This allows them to withstand greater economic changes with fewer negative impacts. However, due to the global scale of climate change, by the time developed countries start to feel the negative effects of climate change the costs to mitigate or reverse its effects will be significantly higher than if action was taken now. Stern (2011) predicts that the cost to mitigate climate change now is approximately 1% of GDP ($187 billion for the United States, $780 billion globally), but if we wait to mitigate the costs could climb as high as 3% of GDP in the next fifty years ($557 billion United States, $2.34 trillion globally).

The social implications of failing to provide adequate environmental regulations to mitigate climate change may be much greater than the economic ones and may contribute to greater economic restrictions later. For the better part of the last eighty years The United States has been the de facto world leader. Our withdrawal from the Paris Agreement shows that we are no longer serious about maintaining our leadership role. As we sit by and do nothing a new leader must emerge. The evidence points to China as that new world leader. China is currently making huge capital investments, both as a country and by private Chinese corporations, into clean renewable energies (Li et al., 2017) to curb the impact of their growing population on the environment. In January the Chinese government, through their National Energy Administration, pledged to invest more than $360 billion into renewable energies to mitigate climate change. Additionally, China has invested billions of dollars into renewable energy internationally in the European Union (Curran et al., 2017). This shows that they are not only trying to mitigate their own contributions to climate change, but they are also helping other countries mitigate their impacts as well. With these massive investments China can become significantly more economically powerful than the United States and take over our role as the primary world leader. With China's rise so comes our fall. Economic power brings political and social power along with it. If we fail to provide adequate protections to the environment by putting forward environmental regulations to mitigate climate change we will lose our economic, political, and social powers on an international scale.

In the long term, maintaining the current level of regulation without change would negatively affect the American economy and society on both a global and domestic level. However, maintaining the current regulations without change is purely a hypothetical topic. It is unlikely that we would be inactive when it comes to putting in place environmental regulations while the rest of the world is moving in a more positive direction. This brings up an incredibly important question: what forms of regulation can we put in place to offset the long-term negative economic and social consequences caused by our failure to provide adequate environmental regulations to mitigate climate change? Here we examine this question through a variety of different lenses, on a local, regional, and international scale.

5.2 Principles of Environmental Economics

Emma Lathrop

The groundbreaking 2011 Stern report illustrated the need for systematic change in regards to the exploitation of natural resources in order to avoid the inevitable collapse of global economies as a result of climate change (Stern, 2011). As the effects of climate change become more visible and harder to ignore, changes will have to occur. In the near future, acting on climate change will no longer be a choice. For economic progress to continue, environmental and ecological constraints on the production of goods and services must be accounted for and understood.

In public debate and media coverage of issues, environmental policy and economic growth are rarely used together to form an argument. It seems to be a common belief that environmental regulation and protection will negatively affect the economy, or that a plan to boost the economy will have adverse effects on the environment. In fact, the Organization for Economic Cooperation and Development (OECD) identified disregard for the environment as a main cause of several global economic crises (OECD Strategic Response, 2009). For stable global economics, consideration of environmental impacts of economic policy is necessary. Examining how to balance the two components of policy is key to ensuring that societies can shift towards environmental sustainability in an ever-changing climate. Having already examined the impact of environmental regulation on economies at local and global scales, we must consider how effective environmental and economic policy can coexist.

Theories of Environmental Economics

The field of environmental economics and the theories of eco-economies and green growth provide alternatives to the idea that sustainable production always hinders economic growth. Environmental economics is a subfield within economics that focuses on the impact of economic policies, laws, and customs on the environment (Mulberg, 1996). Environmental economists aim to put economic and monetary value on environmental goods and services. Much environmental degradation in the past has been caused by devaluation of goods and services that impact of ecosystem function (Cumberland, 1995). The role of environmental economists is to ensure the value of products that negatively impact ecosystems takes into account the actual cost of producing such goods. By placing more value on an ecosystem service that is exploited, more sustainable use of the resource can be achieved.

In order to maintain a strong economy in the future, sustainable economic growth must be considered by policy makers. The theory of an eco-economy is described in Brown 2002 as an economy that works to supply needs without devaluing or jeopardizing the chance for future generations to supply those same needs. Essentially, it ensures that sustainable use and growth are taken into consideration when making economic policy and setting economic standards and principles. Adding value to a good that is not traded is important where the environment is concerned because ecosystem disruption is not a commodity (Mulberg, 1996). The idea that value must be applied to non-transferable environmental damage is central to the Stern report. If we don't make changes now, economic devastation will be much higher in the future.

The similar concept of green growth can also be used to show that economic growth and environmental sustainability are not in competition with one another. Rogers (2016) describes green growth as, "nurturing economic growth and development at the same time, ensuring that natural assets such as terrestrial, aquatic and atmospheric ecosystems continue to provide the resources and environmental services on which our well-being depends". Many intergovernmental agencies have adopted the term green growth in policy statements and strive for sustainable development when aiding developing countries. By providing economic incentive in regions that are struggling to grow an economy and turning to industries that have great environmental impact, green growth lessens the influence of industrializing nations on carbon levels in the atmosphere.

Prioritizing environmental conservation and sustainability does not mean disrupting economic growth. The above principles and theories are show that emphasis on sustainability and green growth can give rise to stronger economy in the future and one that will provide for the needs of future generations. Application of these theories and economic policies have been successful on small and broader scales.

Strategic Response to Changing Market Conditions

In 1997, the international climate agreement made in Kyoto, Japan, spurred global consideration of how to address the impact of economic activity on the environment. Some corporations and other non-governmental organizations (NGOs) resisted the change and regulation that the treaty required. Many companies, especially those in industries that will be heavily impacted by a changing climate, embraced the treaty as a way to innovate and take a proactive stance on anthropogenic climate change. These companies chose strategies to minimize the impact of the regulations on their business while achieving sustainable economic growth for their industry (Kolk & Pinkse, 2004).

The enactment of a new environmental policy can throw economies into disarray by creating economic disturbance. However, often times, economic innovation requires a disturbance of some sort (King & Levine, 1993) , and if that disturbance can create environmentally sustainable growth, corporations can play important roles in adapting to climate change. New environmental regulation and market shifts offer opportunities for companies to discover and pioneer innovative economic niches. Rather than resisting change, companies that embrace the chance for growth and innovation tend to have stronger businesses in the long run (Kolk & Pinske, 2004).

Benefits of a Market Shift Towards Environmental Sustainability.

Kolk and Pinske (2004) evaluated the types of corporate responses to climate change and environmental regulation to determine their effectiveness. The responses were characterized by the company's stance on the regulation or treaty at hand. Responses ranged from reactive (in which a corporation will deny responsibility and only act when forced to do so), to proactive (in which a corporation seeks opportunities to change). Many companies that acted proactively did so because they found market opportunities associated with a change in business and

improvement of public image. Even the companies studied that openly lobbied against an international treaty or regulation regarding the environment were simultaneously working to improve their business strategy and mitigate it from the effects of climate change (Kolk & Pinske, 2004). These seemingly opposite actions illustrate that companies recognize the importance and inevitability of adapting to the effects of climate change. There is no question that creating sustainable economic growth will benefit economies in the future.

In 2012, the United Nations Environmental Program adopted a new set of parameters and guidelines for assisting with development of industrialized countries (Rogers, 2016). The term "green growth" was used as a guideline for creating development plans. This term grew to encompass the socially-responsible economics. Instead of leading developing countries to grow economies that will not adapt or mitigate the effects of climate change, establishing a strategy to maintain and monitor natural resources more closely will improve the likelihood of sustainable economies in the futures of these countries. Encouraging and providing for sustainable growth in developing countries assists in mitigating the effects of climate change, as lower stages of development often contribute to the most environmental degradation in the industrialization process.

In essence, there is natural incentive created for corporations and economies that are forced (through regulation or international treaty) to shift towards the sustainable production of goods and services. Companies and governments that chose to be proactive about shifting their business practices tended to have stronger, more sustainable economies in the future. They become global innovators and lead the way as the first actors in the fight to adapt to a changing global climate.

Conclusion

There is no longer a question of whether or not to act on climate change. Its effects on economies across the globe are certain and the future does not look bright. In order to adequately address and respond to the changes in regulations, economic policies must be proactive and account for the effects of their actions on future growth.

5.3 Porter Hypothesis: More Regulation and Economic Performance

Jensen Howard

The environment is under quite a bit a pressure currently. There are claims that the economy isn't growing because of environmental regulation. The environment and earth on the other hand are dying from millions of little cuts, caused by pollution and human activity. Is there a future where the economy can grow while protecting the environment? The economist Michael Porter, formulated a hypothesis that through carefully crafted regulation the economy can grow while protecting the environment. But how can you grow with more limitation? The idea behind the Porter hypothesis is that through new regulations, companies are forced to innovate and become more efficient while performing in a more environmentally sound manner. This idea seems to be the perfect 'win-win' approach to mitigate environmental problems, so why hasn't it been applied? I will address that in my paper along with how increased environmental regulations will affect the major sectors of industry--manufacturing, building construction, the chemical and energy production industry, etc.? Finally, I asked whether the Porter Hypothesis works in the real world.

Discussion

Michael Porter hypothesized with the idea that well-crafted regulation will stimulate innovation in industry. That innovation, in turn, will translate more efficient performance and be environmentally sound while growing. There are several studies that evaluate the effects of more regulation on business performance. These studies look into two versions of the Porter hypothesis. The weak version of the hypothesis looks at how regulation stimulates innovation in industry, and will be referred to as the "weak hypothesis". The strong version of the Porter hypothesis looks at how more regulation affects business performance; this will be referred to as the "strong hypothesis".

In the European Building and Construction industry (B&C), it was found that more stringent regulation proved to be a positive stimulator for new innovation (Testa et al. 2011). When it came to innovation 56% of respondents had increased investment into green technologies, while 26% drastically increased investments. 45% of firms claimed that they used

resources to develop new environmental products, such as more sustainable raw materials and green buildings (Testa et al. 2011). There was a positive correlation between environmental regulation and competitiveness between companies. This can be explained because regulations set standards and those companies will meet those standards, either through investments into new technologies or innovation into new more efficient techniques. As more of these firms adopt newer and greener technologies, other companies invest in the newer and greener technologies to stay competitive.

These effects on business performance depend on the size of the firms. Small and medium sized companies faced challenges to comply with more regulations. This can be attributed to their lack of knowledge and resources compared to larger firms, making it more difficult to tackle compliance with new environmental regulations (Testa et al. 2011). Larger firms, in general, found it easy to comply with current regulation and claimed that they would be able to keep up with higher levels of regulation. As environmental regulations get stricter, would this mean that only large firms will be able to survive, leaving behind small and medium businesses in their wake?

The effects of more regulation would effects on a pollution intensive industry, the chemical and energy production industry, were more negative. Not surprisingly, a study looking at several pollution intensive firms the in the US concluded that more regulation will result in a net loss of profits with firms in the pollution intensive business performance (Rassier et al. 2010). This is mainly due to the large cost of treating the waste or effluent. The study also demonstrated that more regulation stimulated more innovation, supporting the weak hypothesis. In regards to incentives versus mandate regulations, Rassier et al. (2010) concluded that more innovation would be inspired with more incentive-based regulations in the pollution intensive industries. Another similar study by Ambec et al. (2013) suggests that when applying new regulation to the pollution intensive industry, one should make policies stringent enough to push for innovation while having enough flexibility so that firms are able to meet new standards.

When considering how more stringent environmental regulation would affect the European manufacturing sector, similar results were found. Researchers found that more regulation stimulated innovation and development of new technologies (Rubashkina et al. 2015). The key mechanism behind more regulation stimulating innovation is that as more innovation promotes a lower cost of compliance. This in turn makes firms more efficient with materials and

resources, while increasing product value, proving to be a ”win-win” strategy for environmental protection and business performances (Rubashkina et al. 2015). Research looking at the strong hypothesis found that increased environmental regulation had neutral to some positive effects on business performances. This is a contrasting result to studies of other industries that found that more regulation would depress productivity and economic growth.

When companies are faced with more regulation, what is stopping them from moving overseas where regulation are more relaxed? Such a move may be benefit business in the short term, but not in the long term. More firms are concerned with the environmental performance of their supplier (Testa et al. 2011). So overseas to avoid compliance with environmental regulations will potentially harm their business to business (B2B) relationships. When firms choose between a supplier who pollutes and a supplier that is innovative and progressive, the company usual will work with the more progressive company rather than the polluter (Ambec et al. 2013). This give both the supplier and the manufacturer an environmentally good reputation. Why would reputation matter in the world of business?

Many of these studies conclude that more regulation will stimulate innovation in many sectors of industry (Ambec et al. 2013; Testa et al. 2011; Rassier et al. 2010). But there are mixed results on how increased regulation will affect business performance. In general, business performs does not increase with more regulation, but rather decreases. This does not bode well for the Porter hypothesis. However, many of these studies have not considered the consumer. As the world changes so have the people. Consumers now value environmental friendly products and processes more than ever. People care about where and how their product was made, this is why business reputation is becoming increasingly important. This translates to business benefiting from a good environmental reputation (Ambec et al. 2013). Non-regulatory policies have also had some impact on how companies operate. One example is mandatory disclosure programs; these require firms to display all chemicals used in products. Growing evidence on mandatory disclosure programs, such as Toxic Release Inventory (TRI), when release to the public these firms stock prices declined, then that firms reduced emission following the decline of the stock price (Asensio et al. 2011). Arensio et al. (2011) attribute the decline in stock prices to the consumers not wanting to be invest in a pollution intensive firm. Even when regulation isn’t in place, consumers put social pressure on business to perform in an environmentally sound way.

Conclusion

Earlier studies did not find support for the Porter hypothesis, concluding more stringent environmental regulation would slow economic growth. But recent studies are finding the opposite. With the ever-changing world, the consumer has become more conscious of where and how products are made. More consumer today value green products and technologies than in the past. Also policy makers are more adept at making better suited market-based regulations that favor the Porter hypothesis (Van Leeuwen et al. 2017). Increased regulations does stimulate innovation (Rubashkina et al. 2015; Ambec et al. 2013; Testa et al. 2011; Rassier et al. 2010), supporting the weak hypothesis. More regulation promotes more innovation but this doesn't always translate to high business performance. There are mixed results when looking at business performance, but in general there is a decline with more regulation. There have been varying results because studies don't usually take into account the lag time between new regulation and innovation. Innovation doesn't just happen overnight and does cost money, so capital expenditure such as new technologies are acquired through the firm's budgetary cycle (Ambec et al. 2013). Because the company spends money on other necessary components, innovation may take several years before it is used in a productive fashion. R&D into green technologies seems to be one of the best ways to compensate the for cost of complying with more stringent policy. The cost of compliance is generally higher than the revenue developed from R&D (Ambec et al. 2013). To keep small and medium sized businesses competitive with larger firms, green technology should be incentivized to keep the market diverse and not allow large companies to take over (Anton et al. 2004). Through well crafted environmental policy and incentive programs, our economy will be able to grow while keeping it diverse with a more environmentally friendly undertone moving forward into the future.

5.4. Does Environmental Regulation Disproportionately Affect Small Business?

Faith Doty

Compliance with environmental regulation is often capital intensive; small businesses operating within a relatively narrow profitability margin may be unable to simultaneously

maintain production and comply with regulatory demands (Meyer 1995). This paper explores the relationship between economic interests and environmental regulation, specifically to determine if regulation places small business at a competitive disadvantage. On principle, as production increases a proportionate savings in cost is received; small businesses may be disadvantaged simply due to these economies of scale (Economies of scale. 2008). However, smaller operations may be protected by government's efforts to reduce economic asymmetries, alternatively smaller businesses may not be unequally affected by regulation -- they pollute in smaller quantities and may bear a lighter regulatory burden.

As of 2008, 89% of US businesses employed less than twenty employees (Crain & Crain, 2010). Small businesses are a crucial component of economic growth, recovery, and innovation as well as a socio-economic concern. Social value in the merit of entrepreneurship and small business is increasing, worry over economic asymmetries is fueled by concern for these values. Furthermore, costs associated with environmental regulation may perpetuate socio-economic imbalance. Research by Gurtoo and Antony (2007) suggested that low income groups will pay a higher percentage of their income to protect environmental privileges, relative to groups in higher income brackets. This is especially disquieting considering that low-income classes are most immediately and severely affected by loss of ecosystem services stemming from environmental degradation.

Literature with keywords 'environmental regulation,' 'disproportionate,' 'small business,' and 'economics' was reviewed and summarized. It became apparent that sponsorship of literature may affect the analysis and conclusions of authors. Considering this, the publisher was mentioned where deemed relevant. Throughout this paper, the term 'small business' is used to denote what the literature variably terms any business enterprise relatively less in employee base and gross profit as compared to major corporations. In this paper, environmental regulation is frequently referred to as merely 'regulation.' The focus of the literature review is on the US, but several relevant studies of European economies and examples from Canada are included for global context. Manufacturing and energy development are two of the most regulated sectors, thus this paper focuses on emissions and the regulation thereof.

Economies of Scale

As output increases, the average cost of production decreases. This phenomenon, referred to as "economies of scale," is defined as "a reduction in the cost of producing something…brought about especially by increased size of production facilities" (Merriam Webster). Economies of scale is a major driver of the success of corporations, and was "the main driver of corporate gigantism in the 20th century" (Economies of scale. 2008). Under environmental regulation, large businesses may have a competitive advantage due to economies of scale. Because compliance is generally capital intensive, small businesses may be disadvantaged simply due to narrow profitability margins.

Argument Against Disproportionate Effect

Becker et al. argue that environmental regulation does not disproportionately affect small businesses in a paper produced through the National Center for Environmental Economics, a project of the EPA (2013). While their literature review reflects the conflicting conclusions of academics regarding size of business and regulation, their results show that the cost of compliance increases at an accelerating rate as the size of the establishment grows larger. This suggests that large businesses are at a competitive disadvantage to small entities.

The authors used data from the Pollution Abatement Costs and Expenditures (PACE) surveys, which represent the manufacturing sector. PACE data from eighteen years was analyzed, ranging from 1974-2005. Their approach evaluates the proportion of money spent on reducing pollution, normalizing pollution abatement operating costs (PAOC) by economic activity. The resulting 'PAOC intensity' increases with size of establishment. That is, large businesses spend proportionally more money to reduce pollution than small businesses do, when normalized by output. When the same analysis was performed, but the number of employees replaced output in the denominator, similar results were achieved, in a weaker relationship. The severity of inequality between small and large businesses was reduced using this approach.

Argument For Disproportionate Effect

Despite arguments claiming balanced effects of environmental regulation on businesses, regardless of size, there are many arguments to the contrary. In 2010 Crain & Crain published a

report with the conclusion, "Overall and on almost every regulatory frontier, compliance costs place small businesses at a competitive disadvantage" (Crain & Crain, 2010). The report was repeated in 2014 and arrived at the same conclusion. Furthermore, environmental regulation is the major driver of the disproportionate effect. Published by the Office of Advocacy within the Small Business Association in the US, Crain and Crain published two sequential top-down analyses which deconstruct the effects of regulation. Four types of regulation were defined, and effects sorted by sector. Environmental regulation chiefly affects the manufacturing and energy development sectors, and according to reports, "represent[s] the second-most costly category" of all regulations. In 2008, the cost of environmental regulations was $281 billion, $183 billion of which was borne by the private sector. In 2012, regulatory cost to markets increased to $330 billion, $214 billion borne by the private sector, within which 99% was paid by the manufacturing and energy development sectors (Crain & Crain, 2013). When this cost was normalized by number of employees and categorized by size of business, manufacturing firms with fewer than 50 employees spent over $20,300 per employee on compliance with environmental regulations. In comparison, firms with over 100 employees spent just over $6,200 per employee, about 30% of what small businesses spent. Values from both reports are summarized in Table 5.4.1. The authors note that these values are imprecise, and intended for

***Table 5.4.1**, Summarized: Environmental Regulatory Costs in Small and Large Firms, 2008 & 2013 (Cost per Employee in 2009, 2014 USD, respectively), from Crain & Crain 2010, 2014*

2008	*Sector*	*Total*	*Businesses with <20 employees*	*Businesses with 500+ employees*
	Manufacturing	$7,211	$22,594	$4,865
	Energy Development*	$6,348	$13,760	$2,963
2013	*Sector*	*Total*	*Businesses with <50 employees*	*Businesses with 100+ employees*
	Manufacturing	$10,497	$20,361	$6,239
	Energy Development*	$9,018	$16,497	$4,215

**Energy development category is represented as 'Other' in publication*

comparison. The contrast is striking: “In the manufacturing sector, the estimated cost per employee for small firms ($34,671) is more than two-and-a-half times the cost for large firms ($13,750)” (Crain & Crain 2014).

The literature continues to provide evidence of asymmetries in the effect of regulation on small businesses. In the manufacturing sector, plants increase in size and decrease in number with compliance to environmental regulation (Pashigan 1984). This study took place in the mid 1970s, a period in which many new federal environmental regulations were implemented. The results suggest that small plants find it more difficult to compete with large businesses under environmental regulations and survive. It also suggests that environmental regulations are responsible for an increase in plant size. This argument is supported by Millimet (2003), and the finding of higher optimal plant size in US states with stricter environmental regulations. Regulations have also been shown to be a barrier to entry for small establishments, as well as increasing the minimum efficient operating scale (Dean et al. 2000).

Comparison and Contrast of Conflicting Literature

Literature on the effects of environmental regulation and business size is conflicting. Discussion of sponsorship, data attributes, and methodology help to refine understanding.

The argument that small businesses are not disproportionately affected by environmental regulations is a view largely purported by Becker et al. (2013). Although this paper was published in a peer-reviewed journal, it is also a part of the National Center for Environmental Economics working paper series, a project of the EPA. Comparatively, work by Crain & Crain was produced as reports for the Small Business Association, and not published in a peer-reviewed journal. The authors claim their work was subject to peer review, and their 2008 paper has been cited 114 times according to Google Scholar. However, results should be interpreted with the publisher in mind.

The approach of Becker et al. is limited because value of output is not tightly linked to profitability margin, and fails to consider economies of scale. This is a better metric of regulation intensity than an indicator of competitive disadvantage. The methods used by Crain and Crain were novel at the time of publication, and have been accused of ‘cherry picking’ data (Becker et

al. 2013). Although their methodology was justified, direct comparisons to other studies, such as Becker et al. (2013) are ambiguous.

Teasing out the effect of regulation on business is extremely difficult. Isolating effects according to establishment size and focusing on environmental regulation only further complicates analysis. Various metrics are reported in the literature. Some authors prefer to standardize by value of shipments, or output; others have determined number of employees a better standardization. The latter may be misleading, especially when considering the manufacturing sector where processes are becoming increasingly automated in the advent of technology advances. As seen in the literature, the denominator of the metric matters. While this paper is not a discussion of methodology, note that how effects are measured greatly influences the results and conclusion.

Governmental Efforts to Mitigate Adverse Effects

Further evidence of the disproportionate effect environmental regulation has on small businesses, are governmental efforts to reduce economic asymmetries. In January of 2017, the Canadian province of Alberta implemented a carbon tax. The levy was and remains controversial, but public opinion is beginning to trend positive. The immediate effect of the carbon levy was an increase in gas prices. Costs increased $0.04 (CAD) per liter, which is approximately $0.15 (CAD) per gallon; Albertans would begin paying approximately $3 (CAD) more for a fill-up of a 20-gallon tank (Carbon Levy, 2017). Controversy over the carbon levy included how family-operated ranches and farms and small local businesses would compete with large-scale farms and other operations likely to benefit due to economies of scale. The government of Alberta responded to this concern with an integrated approach. To mitigate adverse effects on low-income individuals, rebates of up to $200 (CAD) for adults were applied annually (Graney, 2017, January 2; Carbon Levy, 2017). To alleviate adverse effects on small businesses, the small business income tax was reduced by one third, from 3% to 2% annually. Marked farm fuels were exempt from regulation as well, easing the burden on local agriculture and ranching. The government of Alberta's Job Plan bolsters several programs which support investment in small businesses, and specifically encourages first-time investment. These tax credits may alleviate the barriers that environmental regulations create for small businesses

(Dean et al., 2000). January of 2018 will mark one year of Alberta operating under the new regulations; the long-term effects on small business are yet to be determined.

From a historic perspective at home in the United States, in 1980 the Regulatory Flexibility Act (RFA) was enacted; the bill was amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) in 1996 (5 U.S.C. § 601). The acts are collectively referred to as the RFA. The RFA requires the Environmental Protection Agency (EPA) and other federal agencies to consider the effect of rules and regulations on small business, defined by the Small Business Act of 1953. Specifically, the EPA must consider flexible regulatory options to minimize adverse effects of regulation on small entities. To comply with the RFA, federal agencies must conduct a formal analysis of potential adverse effects to small businesses from proposed regulations. The agency is also required to form a Small Business Advocacy Review Panel, and prepare a compliance guide for small businesses. Small entities adversely affected by a final rule may challenge the agency's compliance with RFA requirements in court. After a regulation is promulgated, the agency is required to review its effects on small businesses within ten years. If the EPA fails to comply with the RFA, they are liable to be sued (Summary of the Reg, 2017).

The RFA is intended to safeguard small businesses from asymmetrical effects of regulation. However, the mandate is process-oriented and does not necessitate agency action. That is, the EPA is required to consider how regulation might disproportionately affect small businesses, but is not required to change regulations to balance effects.

Take-Home Points

The literature encompasses conflicting arguments, disagreement stemming from metric, quality and nature of data, type of analysis, and likely sponsorship. When financial effects of environmental regulation are standardized by number of employees, the disadvantage from economies of scale to small businesses is glaring. Disregarding case studies and focusing on top-down reasoning, small businesses stand to be disproportionately affected by environmental regulations simply due to economies of scale. The establishment of the RFA in 1980 in the US, as well as the reduction of the small business income tax in AB, Canada in 2017 are examples of governments acknowledging these disproportionate effects and taking measures to mitigate

them. Large enterprises simply have an advantage over small ones due to larger profit margins, which allow the high costs of regulation to be easily absorbed. Small businesses may have the upper hand in other areas; as previously mentioned, the Porter hypothesis suggests that regulation increases innovation (Porter & Van der Linde, 1995). In ecology, the intermediate disturbance theory states that a moderate amount of disturbance increases biodiversity, and therefore ecosystem resilience and resistance (Connell 1978). This way of ecosystems may be mirrored in the economy. Under the pressure of intermediate regulation, small businesses may be able to shift production strategies to comply with new regulation more easily than large firms, owing flexibility to a shorter chain of command and scaled down operations. Because small businesses feel regulatory pressures more heavily than large ones, they may respond with innovation faster and gain competitive advantage. Of course, this advantage may be short-lived as large corporations also shift and resume dominance due to economies of scale.

Regardless of free markets and economic strategies, society seems to care on an emotional and social welfare basis that small businesses exist, and entrepreneurship continues. The potential for adaptability that small businesses possess diversifies the business sector, and may help stabilize the economy.

Despite the competitive disadvantage small businesses face under environmental regulation, regulation may be the only effective way to reduce emissions and ensure environmental responsibility from small entities. A survey in the European Union suggested that small firms lack a feeling of responsibility for problems, despite high awareness of environmental regulation (Hitchens 1997). Most importantly, small and medium entities are unlikely to change behaviors unless directly regulated. In 2014, Wood and Williamson found that small entities were less likely to voluntarily participate in programs with higher environmental standards, suggesting regulation as the biggest driver of small business environmental standards.

In conclusion, diversity of size and structure in the business sector may make the economy more resistant to perturbation and resilient to major disturbances. Therefore, it is crucial that processes dictated by the Regulatory Flexibility Act are actualized, and regulations are adapted to minimize adverse effects. However, because regulation may be the biggest driver of environmental responsibility for small businesses, it is equally critical that standards exist and continue to develop to facilitate an environmentally conscious economy.

5.5 Legislative Tools in Light of American Opinion on Regulation

Sam Leuthold

Introduction

Embedded within our society is the principle of free will and choice. Americans in particular put an enormous amount of stock in being able to be their own people. We built a country on this framework, arguing implicitly for the citizen who can make their own choices, determine their own priorities, and be responsible for the consequences of these decisions (Steinglass, 2012). The idea of being a puppet, beholden to someone else's manipulation is fundamentally contradictory to how we see ourselves as a nation (Wolf, 1981).

This American devotion to indeterminism can function against the betterment of society. It's hard to argue against the reality that we need a set of rules to ensure our society functions smoothly, and isn't rampantly and joyously destroying itself just to rebuild and do it again. The regulatory role of government acts to keeps citizens safe and healthy, in abstract. As soon as those rules are perceived as over-reaching though, as soon as they pass the threshold drawn at absolutely necessary and stray into "this would be good for the population" territory, there's an antithesis. No longer are these rules seen as *protecting* us; they're reframed as *restricting* us. In 2017, a 12-year trend established in 2005 continued, as more Americans are of the opinion that there is too much regulation put upon businesses and industry than think that there is too little, or the right amount (Americans Opinion on, 2017). This vilified realm of perception is the setting in which environmental regulations exist.

If regulations are so despicable in the eyes of the (American) public, to the point where our President enacted an executive order that requires agencies to cut two regulations every time they want to implement a new one, why do they exist? Largely, it's because we can't afford to trust people to do the right thing when nobody's asking them to. The ethical argument is moot. When some entity isn't holding your feet to the fire, why do the right thing, especially if it costs more? As such, we need regulation. Without it the environment would continue to suffer at the behest of the market. However, changes in the way we regulate are taking advantage of our industrious spirit. It's possible that in the near future, profits and sustainability won't be

paradoxical to each other, and instead work in tandem for a more prosperous, and more environmentally conscious nation.

Mandates

The traditional way in which regulations are thought of in the United States are as mandated regulations. This term is an umbrella term for technology or design standards, as well as performance based standards, which dictate how a business must be run. This has been the standard practice for environmental regulations for several decades, but has been declining in recent years as policy makers and businesses move toward incentive, or hybrid based policy. Command and control policy is often critiqued for a number of reasons such as stifling creativity, as well as being expensive and less efficient than economic incentives (Harrington & Morgenstern, 2007).

Nidumolu et al. (2009) argues that regulations can actually foster innovation just as well as incentive programs, if businesses are savvy enough. An example given in their article is that of Hewlett-Packard. Early in the 1990's, HP realized that the lead they used in their solders was toxic, and intuited that eventually this technology would be banned by governmental regulation. They spent that the next ten years developing a new type of solder, and when the EU banned lead substances in 2006, they were poised to take advantage of the shift in the market (Nidumolu et al., 2009). As far as efficiency, it quickly becomes extremely situationally dependent on whether command and control or economic incentives are more efficient and cost effective for businesses. In instances where reduction must be so great that not one but all available reduction strategies must be perused, mandated regulation works more quickly, and more efficiently than incentive based legislation (Harrington & Morgenston, 2007).

Incentives

Incentive regulation uses penalties and rewards to achieve goals while affording businesses some discretion in how to achieve these goals (Lewis & Garmon, 1997). Incentives tend to provide a more flexible, lower cost alternative to the typical command and control type regulation typically associated with environmental policy (Anderson, 2002). In addition, they

provide a vehicle for innovation, especially in regards to high-risk projects. The logic behind this is simple; if there is opportunity for higher success or profits, dependent on the completion of an arbitrary goal, be that greenhouse gas emission opportunity cutbacks, or working to control acid rain. Firms have the opportunity to pursue these incentives as long as they like, and typically will do so until it is no longer economically viable for them (Economic Incentives, 2017). There are four main types of incentive programs: marketable permits, emissions taxes, fees, and charges, subsidies, and a combination of the three.

Marketable permit systems allow businesses to capitalize on their actions, such that if they pollute less than they are permitted, they are able to sell the remaining allowance into the market. This allows environmentally conscious companies to profit both via the trade of the permit, as well as in the realm of social capital. Pollution fees are closely linked to mandates, but don't actually require anything. Instead they simply charge for every unit of pollution that is emitted by an entity. While having the advantage of being simplistic in nature, this methodology doesn't do well to target large, multinational corporations (Economic Incentives, 2017). The final type of purely incentive based legislation is the prescription of subsidies. Subsidies act as a type of financial support that can be used as a reward for positive actions. For example, tax subsidies given to research and development expenditures allow them to pursue cutting edge advances without the fear of bankrupting their company. For example, in Massachusetts, exemptions are provided from sales tax for property purchased to be used in R&D (Almeida et al., 2010).

Conclusion

Unfortunately, there's no easy answer. Regulation and incentive programs must coexist in a hybrid space if we hope to make meaningful policy changes in the coming years. We must be realistic about the driver of business in a capitalistic system, as well as understand the need for regulation when need be. We are arriving at a point in time where the collective consciousness of the American people is moving towards accepting the scale and certainty of anthropogenic climate change. Forty five percent of Americans "worry a great deal about it,"(American Opinion on, 2017). With this burgeoning support, we'll be able to put incentives in place that work to solve problems down the road, not just Band-Aid the immediate issue. We'll be able to

put regulations into place that solve the problems facing us right now, and see immediate change. Mandates and incentives are powerful tools, and using them in tandem just doubles this power. This increased power will be nothing if not necessary as we navigate the climactic and political landscape stretching out into the future.

5.6 Carbon Tax versus Cap-and-Trade:
A Comparison of Market-Based Instruments to Mitigate Climate Change

Braden Leach

Introduction

Humans are warming the planet primarily by burning fossil fuels, thereby releasing enormous quantities of heat-trapping gases into the atmosphere. Widely perceived as the preeminent environmental challenge of our time, "climate change" is unprecedented in scale and will yield disastrous consequences if unabated.

In July of 2017, President Trump announced that the United States will be withdrawing from the Paris Climate Accord, the strongest international effort yet to mitigate global greenhouse gas emissions. Since then, Nicaragua and Syria have proceeded to sign the agreement, leaving the United States as the only "climate fugitive" country on earth. As the historical emissions leader and a global superpower, the U.S. has a responsibility to address this problem head-on. As the manifestations of climate change like severe droughts, more powerful hurricanes, and more destructive wildfires become increasingly devastating to America and the world in the years to come, the federal government will face intense pressure to act on this issue.

When considering how to address global warming, the vast majority of scholars and policymakers consider command-and-control regulatory approaches more piecemeal, more time-consuming, costlier, more complex, and more litigation-prone than market-based solutions. Most experts believe that harnessing market forces is critical to developing the alternative technologies and operational changes needed to reduce carbon dioxide emissions (Avi-Yonah & Uhlmann, 2009). I will maintain this assumption in my review.

Fossil fuels are still priced in most places as if combusting them comes at no cost. Economists consider this a classic externality: a cost external to, or not included in, the price. To

correct this market failure, many economists, policymakers, and other experts support implementing economic policies that would include the negative cost of burning carbon in the price of fossil fuels. When the "true cost" of fossil fuel is reflected in the price, firms and people have economic incentives to shift away from dirty fuel and move towards cleaner alternatives (Avi-Yonah & Uhlmann, 2009).

The two most widely considered instruments to accomplish this are the carbon tax and the cap-and-trade system. A carbon tax, as its name eludes, puts a tax on fossil fuel in proportion to how much atmospheric heat-trapping it allows for, e.g. $10 per ton of CO_2 equivalent ('CO_2 equivalent,' or 'CO_2e', has become the accepted way to standardize the disparate global warming abilities of different greenhouse gases. In this schema, one ton of methane released can be expressed as 25 tons of CO_2e). Alternatively, a cap-and-trade system puts a limit, or cap, on emissions and distributes allowances to firms (commonly each worth 1 ton of CO_2e). The total number of allowances in circulation adds up to the cap. Firms must hold permits equal to the amount they pollute, but have the flexible option to either buy more allowances or reduce their pollution, whichever is cheaper.

In this paper, I will explain how carbon taxes and cap-and-trade systems function in more depth and evaluate their comparative strengths and weaknesses in various categories. My main setting will be the United States, but I will briefly zoom out to the global setting as well. It is extremely difficult to know which categories carry the most weight, thus no "winner" will be declared. Several authors note that these tools are opposite sides of the same coin; implementing either option, though they both possess unique challenges, is vastly preferable to pursuing inflexible command-and-control regulations or taking no action on climate change. A market-based approach may be the best way of solving this collective action problem.

How A Carbon Tax Works

A carbon tax places a fee on fossil fuel in proportion to how much atmospheric heat-trapping it enables. It is considered a Pigouvian tax because it includes a previously unaccounted-for, socially undesirable cost in the price of the good. By making fossil fuels more expensive, imposing what economists refer to as price signals, firms and people have incentives to use less of them and transition to cleaner energy sources (Avi-Yonah & Uhlmann, 2009). Economists tout that a broad-based carbon tax would reduce emissions at the lowest possible

cost. If abating emissions is cheaper than paying the tax, a rational actor will do this. If it is not, then they will simply pay the tax. Emissions reductions are thus allocated to those that can abate most cheaply (Lucas, 2017).

Carbon taxes can take many forms, and one is a 'carbon fee and dividend.' This approach was economically modeled for U.S. implementation by Regional Economic Models Inc. (REMI), and the policy design choices and analyses laid out in the following paragraphs are theirs. REMI has done significant economic modeling analyses for government agencies as well as fossil fuel corporations.

A fee would be placed "upstream," at the oil or natural gas well, coal mine, or location where fossil fuels were imported into the country. This would encompass fewer than 2000 firms and be fairly simple to administer. The fee would start small at \$10/ton CO_2e and increase by \$10 each year until greenhouse gas reduction goals were met. An increasing tax rate would reflect the increasingly harmful effects of carbon dioxide emissions (Avi-Yonah & Uhlmann, 2009). A federal agency, like the Department of Energy, would have the authority to slightly adjust the tax rate if emission reduction goals were over- or undershot.

If firms were taxed, they would bear part of the tax burden, but also pass some of it down onto consumers. Gasoline for vehicles, energy (derived from fossil fuels) for homes and businesses, and goods that require significant amounts of fossil fuel to produce would become more expensive. For example, a fee of \$10/ton CO_2e would increase the cost of a gallon of gasoline by roughly 10 cents (Nystrom & Luckow, 2014).

However, this tax would be "revenue neutral," meaning that the money raised would not be spent on growing the government or subsidizing renewable energy. Instead, all revenue minus small administrative costs would be returned to American citizens in the form of direct-deposit, monthly dividends. Even though fossil fuels would become more expensive as the tax increased by \$10/year, the monthly dividends would get larger as well, enough so that approximately 2/3 of Americans would have no net loss of wealth or even experience a net gain each month from the tax. The dividend would also offset many of the regressive effects of the tax; lower income individuals would not sacrifice a larger portion of their income than higher income individuals (Nystrom & Luckow, 2014).

To avoid giving unfair advantages to imports or hurting exports, border adjustments would be instituted. Goods imported from other countries would be taxed in proportion to how

much fossil fuel it took to produce them, or how "carbon-intensive" they were. This would prevent leakage, Americans only buying the cheaper goods produced in countries that did not take the whole cost of fossil fuels into account. The revenue collected from carbon-intensive imported goods would be used to subsidize exports, ensuring that internationally minded firms could continue to export at the same tenacity. The United States would thus suffer no handicap in international economic competitiveness (Goulder & Schein, 2013).

The REMI report predicts that this policy would reduce U.S. greenhouse gas emissions by 50% below 1990 levels in 20 years, add 2.8 million jobs to the economy, and prevent thousands of premature deaths by reducing harmful air pollution that accompanies the burning of fossil fuels (Nystrom & Luckow, 2014).

There are many ways that a carbon tax could be designed, and different choices have major policy implications. Instead of levying the tax "upstream" on the producers, it could be applied "downstream" at the point where carbon is actually being burned. However, most experts disfavor the downstream approach because of the increased administrative complexity and cost it implicates.

Some scholars recommend that tax revenues be used to subsidize renewable energy development instead of giving it back in dividend form. They argue that subsidizing renewables would yield cheaper clean energy and hasten the transition to it (Avi-Yonah & Uhlmann, 2009). Other scholars suggest using the revenue to reduce a distortionary tax like the income tax, because it would be more economically efficient than a dividend approach. Income taxes are also negative to the effect that they reduce incentives to work and save, and shifting taxes from "goods" like labor to "bads" like pollution would offer more straightforward incentives. While these are both valid ideas, empirical research suggests that public opinion of a monthly dividend is higher than public opinion of subsidizing renewables or reducing income tax (Nystrom & Luckow, 2014). To the chagrin of countless economists and experts, public opinion on any proposed policy is arguably the most vital component in actually getting it implemented.

How Cap-and-Trade Works

Cap-and-trade is another prominent market-based instrument that could reduce greenhouse gas emissions in the United States. A cap would be placed on emissions, and firms would need permits to cover their emissions for a given time period. The standard permit, or

allowance, would confer the right to emit 1 ton of CO_2e and the total number of allowances in circulation would add up to the cap. So, if there were a 10,000-ton cap, there would be 10,000 1-ton permits in circulation. The cap would decline over time, by definition reducing emissions (Goulder & Schein, 2013).

After the government distributed allowances, firms could buy and sell them on a secondary market. Under this schema, firms would pursue the most economically sensible choice: buying more allowances if it were cheaper than reducing emissions, or selling them to other firms if they could reduce their pollution at a lesser cost (Avi-Yonah & Uhlmann, 2009). Trading would have to be carefully monitored to prevent cheating and ensure that firms were punished if they exceeded their limit.

As with the carbon tax, most experts support an "upstream" approach to cap-and-trade, where producers and importers would need permits sufficient to cover the carbon contents of their fuels. The allowance distribution and monitoring associated with less than 2000 producers and importers would be simpler than it would be for a "midstream" or "downstream" system (Avi-Yonah & Uhlmann, 2009). Firms would pass down a share of their increased costs to consumers, much like a carbon tax.

Allowances could be freely distributed, auctioned off, or some combination of the two. Most experts favor auction because it would result in government revenue that could be used for a dividend, renewable energy subsidization, distortionary tax cuts, helping small businesses, and other things (Goulder & Schein, 2013). Auctioning would also prevent high-polluting firms from being perversely "awarded" with more allowances as would happen with free distribution, decreasing the incentive to abate pollution (Lucas, 2017).

Cap-and-trade proposals typically possess complex provisions for intertemporal banking and borrowing of allowances. Simply put, firms would be able to save some of their allowances for later or borrow from their future allowances, because a more elastic allowance supply would dampen temporary market instabilities. This could jeopardize meeting emission reduction goals in the short term, but should ostensibly result in the same long-term decrease in emissions.

Hybrid cap-and-trade systems are also being widely considered. Hybrids would feature a price floor, the minimum amount that an allowance can cost, and a price ceiling, the maximum amount that an allowance can cost, to prevent extreme market volatility. To enforce the ceiling, the regulator could introduce additional allowances into circulation or allow firms to pay a set

fee (usually the ceiling price) whenever it were reached. To enforce the floor, the regulator could buy up extra allowances or allow firms to pay a set fee (usually the floor price) when it were reached (Goulder & Schein, 2013). The tradeoffs between a pure cap-and-trade system and a hybrid system will be discussed in more detail in the next section.

Many experts note that the best cap-and-trade system functions essentially like a carbon tax, but with much additional cost and complexity (Lucas, 2017). While this is largely true, the following section will elucidate several advantages the cap-and-trade scheme has over a carbon tax.

Comparative Strengths & Weaknesses

Now that our two contenders have been firmly established, it is necessary to evaluate their comparative advantages and disadvantages. Scholars on the topic encourage us to keep in mind that the design of the instrument may be just as important as the choice between the two instruments (Goulder & Schein, 2013).

A. Cost Certainty and Benefit Certainty

A carbon tax and a cap-and-trade system differ in the certainties they ensure: a carbon tax offers cost certainty while cap-and-trade offers benefit certainty. With a carbon tax, the cost of pollution is simply the price of the tax, and any tax policy would detail exactly how the price would increase over time. Knowing precisely the current and future price of emitting carbon would allow firms and investors to safely plan for their future. However, with no cap on emissions, a carbon tax would not guarantee any particular emission reductions by certain dates (Avi-Yonah & Uhlmann, 2009). That said, these reductions could be extensively forecast through modeling and the tax rate could be increased or decreased if emission goals were exceeded or undershot, though this could involve political opposition. However, broad experience with other taxes has shown that once a tax is in place it is usually not as hard to raise its rate. This is why people say that "an old tax is a good tax" (Avi-Yonah & Uhlmann, 2009).

Cap-and-trade is theoretically the inverse: emission reductions are seemingly ensured with the cap on emissions, while price is left uncertain, dependent on the development of future

technologies which cannot be predicted with much accuracy (Avi-Yonah & Uhlmann, 2009). Lack of price certainty has allowed for some cases of extreme price volatility, exemplified in the European Union Emissions Trading Scheme (ETS), when allowance prices collapsed after it became clear that too many had been distributed. This potential volatility is why some support the hybrid system, with price floors and ceilings, or intertemporal banking and borrowing provisions. With a price ceiling, giving out additional allowances when the ceiling is reached is by definition raising the cap on emissions. With banking and borrowing, if prices spike, remain high for any significant period of time, and hurt businesses, serious political pressure to raise the cap or prevent the lowering of the cap would be expected. Implicit 'safety valves' in the hybrid system or expected 'safety valves' with banking and borrowing provisions sacrifices the benefit certainty of guaranteed emission reductions that cap-and-trade purportedly ensures. Therefore, any realistic cap-and-trade system would likely possess neither cost certainty nor benefit certainty (Avi-Yonah & Uhlmann, 2009). Avi-Yonah and Uhlmann (2009) conclude that the benefit certainty associated with cap-and-trade is illusory while the cost certainty with a carbon tax is very real, making it a superior instrument.

B. Prior Experience

If the U.S. eventually uses a market-based approach to combat climate change, it will depend on what has already been done here and abroad. In other countries, the relative popularity of the two approaches is currently mixed. Cap-and-trade has been implemented in the European Union, New Zealand, Australia, South Korea, and seven major cities in China with a national-level carbon market to come later this year. Partial carbon taxes are in effect in the UK, Italy, Sweden, Norway, Denmark, Finland, and several Canadian provinces. Canada says it will impose carbon taxes on provinces that haven't already enacted one by 2018 (Goulder & Schein, 2013).

Although America has had no direct carbon tax experience, proponents illustrate that we have extensive experience with economy-wide excise taxes on a wide variety of products, including gasoline. A carbon tax is just an excise tax, and it could be incorporated into the existing excise tax part of the Internal Revenue Code relatively simply (Avi-Yonah & Uhlmann, 2009). This also makes a carbon tax quicker to implement than cap-and-trade. Revising the existing tax code is a speedier process than crafting entirely new legislation, as would be

necessary for a cap-and-trade system. This is relevant when we consider how pressing an issue climate change is; we are expected to exceed the 2 degrees Celsius acceptable level of warming by roughly 2040.

The U.S. does, however, have several statewide and regional cap-and-trade systems for greenhouse gas emissions, led by California who has the second-largest carbon market in the world after the European Union's. The U.S. has also utilized cap-and-trade systems to reduce sulfur dioxide emissions and acid rain in 1990s, as well as nitrogen oxides and ground-level ozone in more recent years. Some experts say that these local experiences give cap-and-trade an advantage in the U.S., while others note that a nationwide greenhouse gas system would be far more complex than the previous ones (Avi-Yonah & Uhlmann, 2009). A hybrid cap-and-trade bill made a brief appearance in our Congress as well: the American Clean Energy and Security Act of 2009 made it through the U.S. House of Representatives before it was stifled in the Senate (Goulder & Schein, 2013). For these reasons, cap-and-trade comes out on top in terms of prior experience.

C. Public Opinion

We now arrive at arguably the most decisive category: how the public views these two instruments. Gary Lucas, Jr. (2017) approached public opinion on carbon taxation through the lens of behavioral public choice, an extension of behavioral economics to politics that examines how human psychology influences the law and public policy.

He challenged the conventional wisdom that Americans oppose a carbon tax purely because it features the word, "tax," conducted empirical research, and arrived at a slightly nuanced conclusion. Unlike the rational actors of economic theory, real people often suffer from so called "opportunity-cost neglect:" they don't think about the next best alternative foregone when making a decision if it isn't obvious. Instead of being generally tax averse, Americans just don't like obvious costs. Lucas' research showed that people strongly oppose a carbon tax because the costs are fairly salient. Although command-and-control regulations and subsidies are costlier, less effective tools, the public generally prefers them because the costs of the policies are concealed. In other words, policies with implicit costs appear to offer a free lunch. This divide between expert and lay opinion matters because the public exercises significant influence over government policy.

I have noted previously that cap-and-trade functions much like a carbon tax but with additional complexity. This very complexity might make cap-and-trade more politically viable because its costs are less salient. Sadly, Americans are woefully uneducated about public policy in general, and a policy that places the costs more "off-screen" could plausibly garner more American political support (Lucas, 2017).

Several scholars rebut this, saying that opponents of climate change legislation would argue that either approach would increase energy costs and further damage an already weakened economy (Avi-Yonah & Uhlmann, 2009). Goulder and Schein (2013) think that because the American Clean Energy and Security Act (the cap-and-trade bill of 2009) was stifled in the Senate without attaining a vote, some legislators might have switched focus to alternative approaches. They posit that if American public opinion on cap-and-trade was once higher than public opinion on a carbon tax, then that advantage has diminished or even disappeared entirely. Many carbon tax proponents think that a dividend approach would be most strategic for gaining public support. Shifting the focus from increased consumer costs to increased consumer benefits has obvious merits (Lucas, 2017).

Lucas (2017) illustrates that the reasons for the public's opposition to pricing carbon are largely psychological, and that public opinion on these policies can be hugely altered by changing the decision frame. By concealing or highlighting the costs or benefits of either approach, policymakers, news organizations, and other influential sources have substantial power to manipulate public opinion. There is no clear winner in this category.

D. Complexity and Cost

The view that a cap-and-trade system would be more complex to administer and costlier to monitor than a carbon tax is held in essential unanimity by the relevant experts. Under cap-and-trade, an elaborate mechanism would need to be set up to collect and distribute allowances, make sure that they were real, and keep track of ownership via a registry. This implies nontrivial transaction costs between firms and a non-optimal allocation of resources (Wiener, 1999). A new administrative body or office with new employees would also be needed to monitor polluters and penalize them if they polluted more than their allowances allow for. Conversely, a carbon tax could be enforced by the IRS with its existing staff who already possess expertise in enforcing excise taxes. Determining who gets how many initial allowances with free distribution, or

arranging and overseeing complex allowance auctions are unlikely to be simple, cheap exercises either (Avi-Yonah & Uhlmann, 2009). A carbon tax would be significantly cheaper and less complicated than a cap-and-trade system.

E. Loopholes

Some think that cap-and trade's inherent complexity would allow for more "cheating," polluting without paying. Some polluting industries would likely get too many allowances if they were freely allocated as well. On the other hand, a carbon tax would almost surely include significant exemptions and subsidies to certain high-lobbying industries. This phenomenon has been broadly recognized in the Scandinavian countries that have implemented carbon taxes (Lucas, 2017). It is unclear at present which mechanism would be more equitable.

F. Interaction with Other Regulations

A carbon tax would fare better than a cap-and-trade system when put in place alongside other greenhouse gas reducing policies. For example, if a heightened performance standard on vehicles was enacted in the presence of a cap-and-trade system, there might be no further reduction in emissions. The total amount of emissions would be controlled by the cap, so instituting the vehicle performance standard would simply lower the demand for allowances, causing them to fall in price until all allowances in circulation were demanded again, and yielding no decrease in emissions. Conversely, a vehicle performance standard would reduce additional emissions in the presence of a carbon tax because the price of pollution would still be the tax rate (Goulder & Schein, 2013). Many scholars predict that, if imposed, a carbon policy would very likely be in the presence of other greenhouse gas reducing regulations (Lucas, 2017). A carbon tax would mesh better than cap-and-trade. However, if Members of Congress thought cap-and-trade a better horse to back, the promise of abolishing all other greenhouse gas regulations could plausibly gather conservative political support.

G. Linking Globally

If the United States employs a carbon tax or cap-and-trade system, it would demonstrate leadership and help to bring other countries to the bargaining table. That said, an important aspect of either mechanism is its ability to fit within a global mechanism of the same type (e.g., a

U.S. carbon tax would fit within a global carbon tax). I will assume that it would be easier to tie a national carbon tax into a global carbon tax than into a global cap-and-trade system, and vice versa. For ultimately it doesn't matter if the U.S. takes extensive action if other important emitters do not; we all share the same atmosphere. This section will focus on how our two market-based instruments would perform at the international level.

The main challenges in designing a global instrument would be controlling "leakage" (emission reductions in one country causing emissions to rise in others) by maximizing coverage of pollution sources, engaging countries that would not otherwise benefit from climate policy, and overcoming free riding, thereby facilitating efficient collective action (Wiener, 1999).

My assumption throughout the paper has been that the United States government would mandate a carbon tax or cap-and-trade. When we zoom out to the global setting, however, there is no singular entity that could command all countries to take action. In this scenario, any feasible international climate treaty would have to attract countries to voluntarily give their assent. A treaty would bind only those who consented to be bound. Any treaty would therefore need to be collectively attractive as well as individually attractive, because no party would join if it would be made worse off. An international carbon tax or cap-and-trade system would therefore need to have "participation efficiency," the ability to secure countries' participation at the least cost (Wiener, 1999).

A global carbon tax would likely have very poor participation efficiency, because it would impose the highest costs on the pollution sources and would induce high rates of nonparticipation. The idea that "polluters pay" would not function in a voluntary assent situation, because polluters would simply decline to participate if they would be imparted with net costs. A global instrument would need to ensure that the beneficiaries of global environmental protection pay the non-beneficiary sources to garner their participation. Within a carbon tax, giving polluting countries side payments or subsidies would create very perverse incentives. Polluting countries would continue to pollute to keep receiving big side payments or subsidies (Wiener, 1999).

In contrast, a global cap-and-trade system could assign more initial allowances to countries that would otherwise be "net losers" from the policy. By embedding side payments into the allowance trading system, beneficiary sources could indirectly pay non-beneficiary sources

without giving them perverse incentives. These "headroom" allowances would attract broad participation from polluting countries as well as poorer countries (Wiener, 1999).

An international carbon tax system would also be vulnerable to countries "cushioning" their fossil fuel industries by subtly changing domestic tax and subsidy rules. Essentially, fossil fuel industries could be subsidized or their other taxes could be reduced to negate the effects of the carbon tax, resulting in no reduction in emissions from some countries. Meanwhile, cap-and-trade could be subject to jurisdictional problems like protectionist trade barriers and high transaction costs across jurisdictions (Wiener, 1999).

Some experts believe that the enforcement tools associated with cap-and-trade are superior to those of carbon tax (Wiener, 1999). Others see the opposite: the complexity of an international allowance trading system would implicate serious cheating concerns.

Similarly, scholars note that harmonizing carbon taxes (setting their rates equal) across jurisdictions is, by definition, harder on the countries with the lower tax rates. Getting cap-and-trade systems to function across jurisdictions could be quite problematic as well, especially if some systems had low price ceilings. If one country's ceiling were reached while allowances in other countries continued to rise, everyone would want to buy allowances from the country with the low ceiling (Goulder & Schein, 2013).

Two Stanford economists believe that the challenges involved in linking systems internationally for a carbon tax or cap-and-trade are significant either way, giving no instrument a clear advantage (Goulder & Schein, 2013). This opinion starkly contrasts with that of the legal scholar Jonathon Wiener, whose views were expressed earlier in the section. As a definitive non-expert, I will declare no victor in this category.

Conclusion

The goal in writing this paper was not to solve our global climate change problem by identifying the perfect corrective instrument. In the end, utilizing either of these mechanisms would be heads and shoulders above where the United States currently stands. As the preeminent historical greenhouse gas emissions leader, the United States has a responsibility to take leading action on this issue.

Lucas (2017) mentions the possibility of a Pyrrhic victory for Conservative opponents to climate change policies, where they are technically victorious but suffer such heavy casualties that it is tantamount to defeat. Most Americans, including most Republicans and the vast majority of Democrats, acknowledge that climate change is occurring and support advancing policies to combat it, making climate change policies inevitable. As we have already seen, Americans are biased towards expensive, complicated regulations as opposed to more efficient, market-based approaches, because their costs are hidden. Therefore, if conservative politicians continue to contest market-based approaches, they will, in effect, have helped advance costlier, less efficient, piecemeal climate change policies that are completely antithetical to their politics. "The conservative cause would arguably be better served if conservative leaders participated in shaping the government's response to global warming rather than maintaining that the government should not respond at all" (Lucas, 2017).

5.7 International Competition and Environmental Regulation

Jeana Ratcliff

Introduction

Along with trends in globalization, the world has seen an increase in environmental regulation, both in volume of laws and in enforcing powers of regulatory agencies. In 2015, world leaders adopted the 2030 Agenda for Sustainable Development at the United Nations Summit, a document inclusive of seventeen sustainable development goals to be achieved within the next thirteen years. Among these goals are commitments to provide access to clean and reliable energy sources, promote inclusive economic growth, build resilient infrastructure which facilitates industrialization, ensure responsible production and consumption of goods, take action to combat climate change, and finally, to revitalize the global partnership for sustainable development. This final goal, adopted by the 193 members of the UN, addresses improvements in finance, technology, capacity building, trade, and systematic issues as they relate to sustainability on a global scale (Sustainable Development Goals, 2017).

As demonstrated by these United Nations initiatives, there is an identified global responsibility to environmental health and a sustainable future. However, there is at the same

time a strong investment in promoting economic success through trade, production, consumption, and employment opportunities. It is arguably in the best interest of each nation to achieve economic growth, maintain stable markets, and promote successful business environments. These interests are often achieved through a strategic variety of political and regulatory methods. For extraction, manufacturing, and agricultural industries, environmental regulations and policies often have a major influence on economic competitiveness, at both local and international scales. The examples and studies herein explore the question of whether environmental regulations promote or inhibit economic competitiveness on an international scale.

Competitive Impacts of Regulation

As stated within a policy roundtable discussion conducted by the Organization for Economic Cooperation and Development (OECD) in 2006, environmental policy and competition complement each other. Together, these factors seek to correct market failures while improving social welfare in some way. In their discussion, the OECD recognizes the limitations that environmental regulations may impose upon competition. One of these limitations is that environmental regulation may concentrate industry success, by providing the most receptive business opportunities for large businesses (that can absorb regulation costs) and for domestic businesses. In addition, regulations tend to favor existing companies rather than new companies due to the typically high capital costs of compliance technologies, which existing companies have already invested in, as well as the simple idea that existing companies already understand the regulations regarding their industry and do not need to "learn" compliance methods and expectations. These factors effectively limit competition on both intranational and international scales, and may thus result in increased consumer prices or impacts (Environmental Regulation and, 2006).

Considering these and other limitations, the OECD acknowledges the responsibility of policy makers to design regulations that do not limit or even that serve to promote market competition. Many nations have seen success in providing collaborative opportunities between economic and environmental regulatory agencies to design policies that meet the needs of both parties, and do not inhibit the market or industry. For example, the Japan Fair Trade Commission worked with the Ministry of Environment to revise emission requirements to allow for fair

competition between existing energy suppliers and new market entrants (Environmental Regulation and, 2006).

Despite these potential incongruities between competition and environmental regulation, it has been proposed that regulations in fact serve to *promote* economic competition. A study published by Harvard Business School affirms that "…environmental sustainability often correlates with superior economic performance and competitiveness for both companies and countries" (Charnovitz and Esty, 2015). The authors posit that environmental sustainability does not directly lead to competitive success, but certainly supports and motivates it. The top ten ranked nations in the 2012 Environmental Performance Index are similarly in the top half of the World Economic Forum Global Competitiveness.

There are many correlations between activities that promote sustainable business and that lead to economic success. Similar to the OECD conclusion, some studies show that sustainability leads to social welfare that benefits both communities and businesses. Less local pollution leads to a healthier local population, and thus a more effective workforce. In addition, regulatory standards often motivate companies to produce either more sustainable products or more efficient manufacturing methods. These innovations have compounding effects on sustainability by consumers who use those products or by other companies who imitate those manufacturing methods (Charnovitz and Esty, 2015). For example, in the early 1990's automobile manufacturers made a shift to reduce the amount of volatile organic carbon (VOC) released when painting vehicles. Manufacturers had a choice to either control the emission by using ventilation hoods to capture VOC's upon release, or to eliminate the chemicals initially by using paint with little or no VOC's. Besides spurring intense innovation in producing VOC-free paints, the cost-benefit balance of pollution source control versus pollution source elimination became clear. German and British car paint producers began making water-based auto paints, and dominated U.S. manufacturing markets, to the disadvantage of U.S. paint producers (Competitive Implications of, 1995). As illustrated in this example, environmental regulation often stimulates market and manufacturing innovations. More so, regulation may even motivate the creation of entirely new markets. For example, the introduction of the Toyota Prius as an electric car available to average consumers stimulated a completely new and highly competitive arena for production of electric or hybrid vehicles (Charnovitz and Esty, 2015).

Perhaps most simply, environmentally sustainable business practices often equate to economically sustainable business practices. Regulation and standards promote or require higher production efficiency by reducing inputs, eliminating waste, and enhancing recycling ability. While these activities may require significant upfront financial inputs, the money saved over time often results in substantial cost-savings. Defined by Michael Porter as "enhanced resource productivity", this concept may be thought of in colloquial terms as getting more bang for your buck (Charnovitz and Esty, 2015).

Evidence of Economic Impacts of Regulation

The relationship between economic competitiveness and rigor of environmental regulation remains contentious in an increasingly polarized global political arena. A statistically meticulous analysis of international economic competitiveness and environmental standards was conducted by Esty and Porter (2002) to support evidence of quantitative relationships between these factors. The study measured environmental performance by units of urban particulates, energy usage per GDP unit, and urban sulfur dioxide concentrations; and measured economic competitiveness by GDP per capita, growth index, and current competitiveness index. These gauges allow several different comparisons to be made regarding national success in both economic and environmental contexts. Overall, the results identified a strong positive correlation between a national environmental regulatory regime and economic competitiveness; in addition to a correlation between top performing economies and environmental performance scores. The authors suggest that these data act as short-term evidence of the Porter Hypothesis. It should be noted that the United States falls outside the identified trends, with a generally high economic performance rating and a moderate to low environmental regulatory regime (Esty and Porter, 2002).

Modeling the Future

In the emerging political and environmental challenges of globalization, the role of developing markets raises questions about the future of business and sustainability. A hypothesis dubbed the "race to the bottom" suggests that as developing nations open markets to international partners, they will tend to relax regulations (in this context, environmental regulations) in order to attract and maintain global trade. As discussed previously, a lack of

environmental value leads to a decrease in social welfare, so results in a race to the bottom (i.e., widespread pollution) by developing nations. Evidence for this theory has been difficult to collect and analyze, due to the challenges of comparing nations with GDP's that are orders of magnitude different (Quak, 2015).

A parallel theory to the race to bottom approach is illustrated by the Environmental Kuznets Curve (EKC; Figure 5.7.1). Conceptually, this model implies that as a nation develops, environmental degradation increases until it reaches some peak turning point. At that turning point, individuals, businesses, local governments, and nations have achieved sufficient economic prosperity to assign value to environmental resources. Once these entities have the necessary capital to implement sustainable and pollution-mitigating practices, environmental quality begins to improve and per capita tends to increase concurrently (Farhani et al., 2014; Agarwal, 2017).

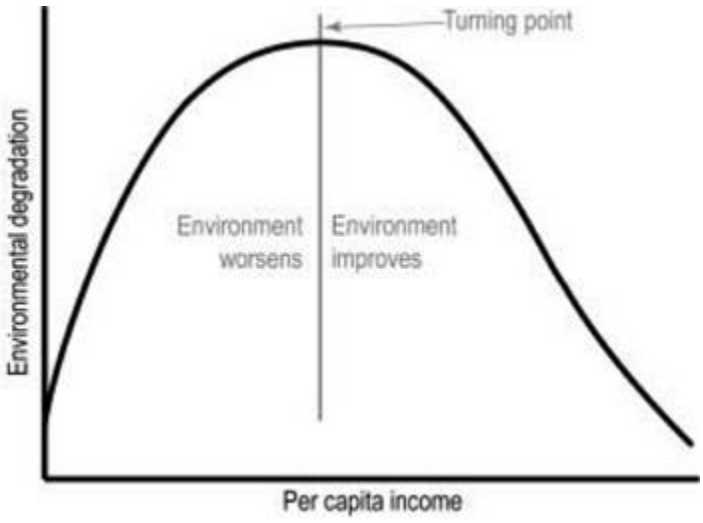

Figure 5.7.1: Environmental Kuznets Curve (Agarwal, 2017): Visualization of trends between per capita income and environmental degradation, with identified turning point.

Originally introduced in the early 1990's, the EKC theory has been scrutinized by several prominent economists. David Stern suggests that evidence supporting this model is statistically and empirically weak. In order to produce a classic EKC curve, many assumptions and initial conditions are required, especially within national and global economies (Stern, 2004). For

example, this model assumes that world income is distributed normally, while in fact the global median income is far below the global mean income (Stern et. al, 1996). Many development theories from the late 20th century cast a western industrialization timeline or process onto currently industrializing nations. However, many currently developing countries are accelerating or even circumventing these preconceived industrialization processes. Stern presents evidence that developing countries are adopting environmental values much more quickly than industrialized nations have, and in some cases are even outperforming these "first world" nations even as their growth rates and economies are increasing at exponential rates (Stern, 2004).

Implications of Changing Economic Powers

Along with the rise of developing third-world nations comes the transition of second-world nations to dominant global powers. As highlighted recently in political arenas, China is a rapidly rising major player in international dynamics. An October issue of the *The Economist* identifies Chinese president Xi Jinping as "the world's most powerful man" (Cover, 2017). A significant factor in Chinese markets is a shift away from emission-heavy coal as a primary energy source, towards more efficient alternatives including natural gas, solar, and wind, as well as to more efficient coal power production. The US Energy Information Administration (2014) has analyzed trends in Chinese energy resources and production, finding that coal consumption rates are stabilizing and trending towards decrease. This trend is observed during a period when coal prices dropped substantially, when one would expect consumption to increase drastically based on lower prices. Changes in Chinese energy economy are motivated by institutional policy changes, which have set goals to increase manufacturing efficiency and to evolve priorities from energy supply to energy sustainability. Due to a focus in utilization of cleaner coal and power production, these policies provide a competitive edge to domestic coal markets.

From an economic perspective, China has simultaneously experienced a shift toward less energy-intensive market sectors. In 2013, the service sector surpassed industry sectors in terms of GDP percentage, a trend which has continued over following years. The Chinese economy as a whole is focusing heavily on service industry growth, which in turn will decrease emphasis on manufacturing businesses (Chapter 4 - Coal, 2016).

Conclusion

In considering these many dynamic components of international competition and environmental regulation, it is clearly difficult to define definite trends or relationships. While there are almost certainly both positive and negative influences of regulation on economic success, success in both realms requires multidisciplinary cooperation on many levels. Within a national government structure, clearly defined communication channels between environmental policy makers, environmental regulators, and economic policymakers can improve the potential for national environmental and economic objectives to be in sync. By achieving this, a nation promotes opportunity for domestic industries to be competitive in international markets. When each nation makes commitments to achieve environmental sustainability, they contribute to accomplishing global goals to achieve social well-being for communities around the world.

5.8 Conclusion

The legal scholar Jonathon Wiener (1999) reminds us that the terms "economics" and "ecology" share the same root word stemming from the ancient Greek word meaning house. Economics and ecology are society's disciplines for managing our collective household. Our house is now a global one, bound by both economic and ecological interdependence. But despite the wisdom that "a house divided cannot stand," our two "eco" disciplines are often cast as adversaries and seldom united. This reconstitution is the project of market-based instruments for environmental protection. Internalizing external environmental costs is not only a good idea in the case of greenhouse gas emissions, but for other "commons" problems like overfishing and biodiversity loss as well. While some say that the environment is too important to leave to markets, the opposite is true. The environment is too important to leave out of markets.

6. Hard rock mining regulations and economics in the United States and internationally

6.1 Introduction

Historically, environmental regulation has been nonexistent or lax at best. This chapter explores some early- to mid-20th century metal mining operations as well as some modern international examples where regulations were either not in place or ignored. We explore the history of mining in Butte, MT which has been considered the richest hill in the world. We then transition to the pros and cons of metal mining at home versus third world and less regulated countries. Finally we will explore the social impacts of metal mining in both the United States and El Salvador.

6.2 Historical Examples from Butte, MT

Austin Wrem

Social views on mining have fluctuated throughout time. As technology advanced, mining became a major industry to supply society with the materials needed for its wants and needs. However, as we understand more about the potentially negative impacts of mining, the overall social view of mining seems to be following the same negative spiral. One such example of this trend is the combination of the Butte mine, referred to as the "richest hill on earth" (Marcus, 2000) and the Anaconda copper smelter. These impacts from the mining operations are commonly seen as a major disaster by the communities surrounding the area, and set the stage for opinions of future mining proposals. However, society is still advancing, still inventing new technologies, while still basing these advances off the same minerals as always. [ZC1] Therefore, society still needs mines to extract resources for needs and wants. This paper aims to follow the history of mining in Butte, MT, as well as the social views and policies influencing the mining operation.

Butte Mining History

Butte, MT has been a major producer of metals since people first started mining in the area. Sometime in the late 1850s to early 1860s, miners began flocking to the Clark Fork headwaters near Butte to pan for gold and silver (Marcus, 2000; Isokait, 2010). As the gold rush of Butte came to an end, the remaining miners turned towards hard rock mining of silver. This was heavily influenced by the Rock Mining Act of 1872, allowing miners to claim rights for the extraction of "valuable minerals" where these minerals were found. (Isokait, 2010).

This transition to silver mining once again boosted Butte's population, with miners expanding the population from under 300 to more than 3,000 by the late 1870s (Malone, 1995). One group of miners bore a shaft 300 feet deep, to what would be discovered as the largest copper sulfide deposit in the world at the time (Marcus, 2000; Isokait, 2010). Despite silver providing an economic boost to the area, silver mining soon gave way to mining a different precious metal.

In 1881, Butte began its shift into what it is most commonly known for today, copper mining. At the time, copper needs for the country were being met by a mine in Michigan (Isokait, 2010). However, the introduction of the railroad to Butte, and increasing implementation of electricity made Butte a much more promising opportunity (Marcus, 2000). Marcus Daly was one miner in charge of the 300 ft. deep mine shaft. He saw that silver was becoming less profitable, and that they had mined all the potential silver in the shaft anyways (Isokait, 2010). So, Daly convinced investors to support him with a multi-million dollar investment for copper mining in Butte (Malone, 1995; Marcus, 2000; Isokait, 2010). With this money, Daly consolidated mining claims in the Butte area, built the largest smelter in the world at the time, connected the smelter and mine by railroad, and created the Anaconda Mining Company (Marcus, 2000; Isokait, 2010).

By 1900, the Anaconda Mining Company became a major powerhouse in the area and became known to locals simply as "The Company", due to its overwhelming influence on Montana, and the country, at the time (Gunther, 1947; Marcus, 2000). The Company expanded its influence so rapidly by continuing to purchase mining operations in the area. They soon even began to make acquisitions allowing them to sell directly to consumers, as well as expanding their influence to timber and energy operations in the area (Bakken, 2007; Isokait, 2010). This

boom lead to Butte's peak population of 80,000 in 1917, being one of the largest towns in the northwest (Marcus, 2000). With its massive influence on the economy, Anaconda Mining Company was one of 20 companies to make up the Dow Jones Industrial Average from 1916-1925, and again from 1959-1976 (Marcus, 2000).

Even though Anaconda Mining Company was seen as a major success in the mining industry throughout its history, residents of the area began taking up issues with the company, and a darker history of the company was already being written. Death was a constant companion of the company in the early days. For the first 30 years, mining accidents caused an average of one miner fatality per day, or roughly 11,000 total miner fatalities (Marcus, 2000). During this time, open roasting of copper ore was a common practice. Open roasting uses wood to burn piles of copper ore until it is hot enough to sustain its own burn for 2-3 weeks to consume all the sulfur contained in the orebody (Isokait, 2010). This practice was linked to deaths by respiratory failure, including 246 people within a three-month span in 1891 (Isokait, 2010). The City of Butte attempted to quell the smoke by passing a law banning open roasting within three miles of city limits. The mining industry replied by claiming there was no scientific evidence that the deaths were linked to smelting emissions and that the city did not have the right to interfere with their practices (Isokait, 2010). Anaconda Mining Company, and the mining industry, had too much power for the government to make much of an impact at this point, so they continued with their practices unfazed. MacMillan (2000) describes Butte and the surrounding hillsides lacking all vegetation. Plus, the smoke became so thick people would stick out their arms to feel their way around town, trolleys would constantly ring bells to warn people of their passing, and workers would get lost during their commute, due to extremely poor visibility. (MacMillan, 2000).

When human health complaints didn't work, some members of the community sought retribution through damaged property instead. Even after smelters with smoke stacks were built to modernize the region's technology, degradation of the land and people's property continued. Thousands of cattle died just months after a new smelter was put into operation (MacMillan, 2000). Ranchers formed an association and filed a lawsuit against the Anaconda Mining Company, now known as Amalgamated Copper Mining Company (ACMC) after consolidating to control the market (Marcus, 2000; Isokait, 2010). After years of court battles and appeals, the

ranchers ultimately lost the case. (Marcus, 2000; Isokait, 2010). It was later discovered that ACMC spent anywhere from six hundred thousand to one million dollars over the course of the case to discredit the science behind the ranchers' case (MacMillan, 1972). Even though ACMC won the case, they still went through with installing a much taller smoke stack, 585 ft., to push the smoke high enough that it would leave the valley and not cause any more issues with the surrounding communities (Marcus, 2000).

The ranchers' case shows that ACMC had grown to a point of influencing the local, state, and federal government at the time. ACMC continued to prove its overwhelming power by purchasing smoke rights, which allowed the company to pollute an appropriate amount based on the economic impact of the company (MacMillan, 1972). This allowed the company to continue their practices without reducing emissions. In 1925, a Montana senator made an amendment to the National Forest Consolidation Laws of 1922 that allowed government to exchange national forest land for private land of equal value, within 6 miles of a national forest boundary in Montana (MacMillan, 1972; Isokait, 2010). Because mining was considered much more profitable than other land uses for National Forests, the amendment essentially allowed pollution of public land as a by-product of the mining and smelting operations (Isokait, 2010). From 1928 to 1937, ACMC made six land deals ceding land to the government to have more National Forest land close to their operations (MacMillan, 1972). This effectively got ACMC off the hook for damages it caused to those lands. It didn't harm local landowners, and damages were not their responsibility anymore.

After WWII however, ACMC began its decline, and eventual collapse. With the profitability of underground copper mining declining, ACMC turned towards the newer methods of pit mining (Isokait, 2010). In 1955, ACMC opened the Berkeley Pit. This allowed them to cut costs immensely, while being able to mine and refine lower grade ore (Schmitz, 1986; Marcus, 2000; Isokait, 2010). As ACMC fought financial issues with other operations as well, they were eventually bought by the Atlantic Richfield Company (ARCO) in 1977; ARCO was interested in the remaining mineral resources owned by ACMC (Marcus, 2000). The late 1960s and through the 1970s ushered in a new era of environmental regulation. With the staple laws of today's environmental regulation, the Clean Air Act and Clean Water Act, and the implementation of the Environmental Protection Agency (EPA), federal and state regulation finally gained traction

against the industry giants. Through new public health studies, the government was finally able to prove mining operations were a major cause for health problems and environmental degradation in the area (Isokait, 2010). Now that ARCO owned operations in the area, they were identified as the responsible party and were responsible for cleanup of the area (Marcus, 2000). All mining in Butte was shut down by 1983. Without a remediation plan in place, the Berkeley Pit was abandoned and water pumps were shut off. With nowhere else to go, water to begin flowing through the mine shafts towards the pit itself. Exposed sulfides reacted with flowing water to create sulfuric acid. Flowing sulfuric acid then collected exposed heavy metals and metalloids, contributing to the acid mine drainage (AMD). The Berkeley Pit almost immediately began filling up with AMD, and continues to fill today. After an EPA review in 1982, Butte and the surrounding areas were designated as a Superfund site to prioritize remediation of the abandoned mining operations (Marcus, 2000; Isokait, 2010). Despite the financial investment and responsibilities, Montana Resources purchased the Butte area operations to start mining in the area again (Marcus, 2000). Montana Resources opened a new mine, the Continental Pit, just east of the Berkeley pit to continue mining for copper, and is still in operation today (Marcus, 2000).

Despite its many problems through history, Butte is still commonly considered the richest hill on Earth. With mining operations still happening today, Butte has produced immense amounts copper, and other materials as byproducts from copper mining. It produced 98% of the manganese used for steel production by the U.S. in both world wars, and, according to a 2006 estimate, 6% of total world copper production in the prior 20 years (Czehura, 2006). While the percentage of the world's copper production is lower than historical values, the amount of copper still in the ground makes the Continental Pit a profitable operation to this day. Czehura (2006) estimated that ore reserves in the active mines measured 364 metric tons at a grade of 35% copper, or 127 metric tons of copper, suggesting the mine could produce a profitable amount of resources for at least another 10 years from today.

6.3 Mining and Surface Water Regulations: Case Studies in Montana

Rachel Phipps, Meg Harrison, and Riley Dodson

Introduction

The state of Montana is fortunate to possess an abundance of rushing streams, quiet lakes, babbling brooks, and turbulent rivers. These water sources are a finite resource and are fundamental to humanity's well-being, but the availability of clean freshwater is a constraining factor for many people across the globe. The earth's global water resource is comprised of 2.5% freshwater and approximately 24% of that water is available as surface water (Perlman, 2017). For the communities around the United States, issues regarding the water quality of surface waters will become more prevalent.

As a headwater state, Montana must recognize the benefits and responsibilities of achieving satisfactory water quality in its freshwater resources, particularly with regard to the remnants of its extensive mining legacy. Montana is a state rich in mineral resources due to a combination of many complex geological factors, and many gold, zinc, copper, lead and manganese operations were established in the state beginning in 1864 (Johnson, 2017). While the first metal mines in Montana were concentrated around the town of Butte, prospect miners poured into the adjacent Silver Bow Valley to mine gold and silver ore (Hoffman, 2001). Multiple thick copper veins were discovered shortly thereafter, propelling Butte and the surrounding mining districts to the pinnacle of the mining industry (Loomis, 2017).

At this time, mining was the primary driver of the economy in Montana. Butte became known as the "richest hill on Earth" (Hoffman, 2001). Towns nearly doubled in size overnight with the arrival of an influx of prospective miners. There were riches to be found with the arrival of the mining industry, whether one was a prospector or a mine owner. However, with such a boom in an extraction industry came the threat of widespread and catastrophic environmental impacts.

During the earlier years of mining in Montana, regulations preventing environmental contamination were scarce to nonexistent. Mining companies could extract the desired material at the lowest cost possible and dump the mining waste back into nearby water bodies, polluting the water for human and animal consumption, with no fear of reprisal or punishment from governing bodies. As many booming mining towns were located near water sources, the effects

of mining contamination quickly became an issue as activities increased to supply the demand during World War II. As Americans became more conscious of the health of their environment and waters, legislation began to be enacted that would delegate the Clean Water Act and other paragon environmental statutes. This legislation protected water resources from the majority of impacts from current mining activities, but potential contamination from mines that had been abandoned, or sites where mining activities once occurred but "acceptable mine closure and reclamation did not take place or was not complete" was under no such constraints (What are abandoned, 2012).

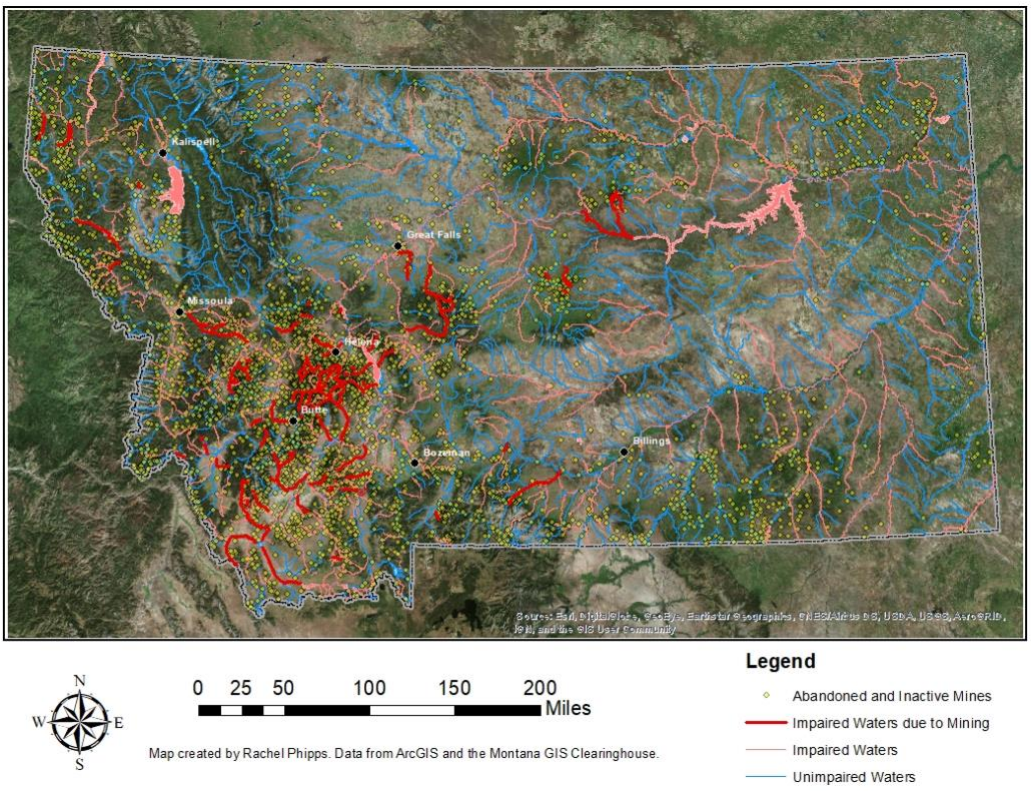

Figure 6.3 *Montana surface water impairments and their proximity to abandoned mines. Rachel Phipps. October 2017. Data retrieved from the Montana GIS Clearinghouse.*

This map (Figure 6.3) was created to show the waterways of Montana and their proximity to abandoned mines. The yellow dots represent abandoned mines. The red waterways, as

described in the map legend, depict waterways that are classified as “impaired” under Section 303 (d) of the Clean Water Act due to the effects of mining operations, such as acid mine drainage, leakage from mine tailings, and other degradation that has resulted from hardrock mining. Section 303 (d) requires states to submit Water Quality Assessment reports every two years. These reports describe the condition of the state’s waters and an analysis of the extent to which the waters are meeting the accepted water quality standards. If the standards are not met for one or more parameters, the waterway is classified as impaired (303(d) and 303(b), 2016).

Of the 37,775 total miles of waterways in Montana, shown in blue, 13,301 miles are listed as impaired, which is approximately 35.2% of the total. Of those impaired waters, 1,423 miles are classified as impaired due to mining. This represents about 10.7% of the impaired waterways, and 3.8% of all major waterways in Montana. This illustrates the magnitude of the problem right in our backyard. These are the lakes and rivers we live along and recreate in; this is a critical issue that directly affects Montanans who interact with our surface waters.

There is no doubt that mining operations have the potential to degrade water quality. However, that is dependent on many constituents of the individual mining operation. Specifically, the type of ore being mined, additional chemicals added to the water solvent, the history and age of the mine, and standard environmental practices in place in the state of operation are the principal controlling factors (Land-Use Practices, 2004). Despite the fact that on a global scale mining operations use a small percentage of the total available freshwater, the effects of the mining industry’s activities are ubiquitous when discussing impairments of adjacent and downstream water sources.

Water and Mining Regulation

The first step in addressing Montana’s mining legacy is to locate and assess abandoned mine sites actively degrading surface water quality. Federal and state regulation has a hand in maintaining the integrity of water resources through two federally-established acts: the Clean Water Act (CWA) of 1972, which is enforced mostly by states under the Environmental Protection Agency (EPA), and the Surface Mining Control and Reclamation Act of 1977 (SMCRA).

The purpose of the Clean Water Act (CWA) is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters” (Clean Water Act, 1972). Under the

CWA, the state is obliged to classify water bodies and set appropriate water quality standards. If the water body does not meet the established standards, the water body must be listed as "impaired" and a total maximum daily load (TMDL), an amount of input a particular pollutant can receive without exceeding set standards, must be declared (Clean Water Act, 2002). Various aspects of the CWA are intended to protect drinking water quality and to assess sources of pollution. Without the implementation and enforcement of the CWA, the resultant water quality degradation that could occur would not only pose potential risks to human and environment health, but could negatively impact natural aesthetics and recreation opportunities.

The Surface Mining Control and Reclamation Act of 1977 was the first major federal legislation to address mining contamination. The Act diverts funds into a reclamation fund for abandoned mines before and after 1977 and requires mining operators to provide a detailed plan for reclamation before mining has commenced. SMCRA is largely responsible for administering funding for reclamation projects provided through federal grant programs derived from a tax on coal of $0.12 per ton of underground material and $0.28 per ton of surface material mined. As of 2011, $7.2 billion has been used to reclaim around 295,000 acres of hazardous abandoned mines throughout the United States (Superfund State Unit, n.d.). Under SMCRA reclamation sites can only receive federal funding if there is truly no responsible party.

The modern environmental movement in the 1960's emphasized protection and efficient management of the natural environment, which was heavily endorsed by social activism (Superfund State Unit, n.d.). The demand for federal and state regulation on mining industries in particular resulted in the 1980 drafting of what is commonly known as 'Superfund Act', or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (Superfund State Unit, n.d.). This act imposed a tax on chemical and petroleum industries that provides funding for remediating hazardous and waste deposits when liability or the responsible party cannot be identified, and established provisions and requirements in regards to abandoned sites.

Although federal funding was available for the remediation of abandoned mines, it wasn't until 1989 when Montana legislature instituted the Environmental Quality Protection Act, which gave the Montana Department of Environmental Quality legal authority to investigate, find liable persons, and carry out the cleanup of hazardous material, similar to the provisions of CERCLA. State Superfund sites that oversee the cleanup of abandoned mine sites do so under

the Comprehensive Environmental Cleanup and Responsibility Act (CECRA) that follow the provision and requirements of CERCLA.

State funding for remediation is dependent upon the identification of responsible persons. If the responsible person is not found, federal grants may be acquired under SMCRA and CERCLA. However, if liable persons are identified, the Controlled Allocation of Liability Act (CALA) is a voluntary process that allows those responsible to petition for allocation of liability as an alternative to provisions included in CECRA. The CALA provides another choice for persons who may have obtained a mining claim and do not have the resources or money that are required for clean up (Superfund State Unit, n.d.). The state Superfund site designation process includes six major actions over the span of 12 or more years. The CECRA and the CALA are administered by the Montana DEQ in partnership with private and state agencies throughout the risk assessment, feasibility and remedial action portions of the process. The cleanup and remediation that occurs at designated sites as a result of the Superfund process benefits human and environmental health by responding to the active release and presence of vestigial contaminants in the waterways.

Case Study: Jefferson River Metals Project

The Jefferson River watershed encompasses over 700 square acres near Whitehall, Montana. Big Pipestone Creek, east of Whitehall, originates as the headwaters of the watershed in Twin Bridges, Montana. There are five waterbody segments that flow into the Jefferson before reaching Three Forks, Montana, where the Jefferson converges with the Madison River. The bedrock geology of this region formed billions of years ago during the cooling of metamorphic rock (specifically gneiss and schist) with intrusions of igneous batholith, about 100 million years ago (Livers, 2014). This geologic formation is responsible for hosting rich metal deposits across southwestern Montana, and many of these deposits are still being mined today.

The Silver Star Mining District was the inaugural mining locale in the Jefferson River area, beginning operations in the 1800s and producing great quantities early on, but ending production in 1910. Today, mining operations take place in the Whitehall District with the Golden Sunlight gold mine, established in 1980, at the forefront (Cooke City TMDL, 2011). According to the United States Geological Survey (USGS), water quality monitoring clearly brings to light the elevated presence of metals in the Jefferson River, and has linked the pollution

to the previous activities of abandoned and inactive hard rock mining and placer operations (Livers, 2014).

The priority areas for reclamation in the Jefferson watershed are Little Whitetail Creek, Whitetail Deer Creek, and Big Pipestone Creek. Between the Little Whitetail Creek watershed and the Big Pipestone watershed there are about 35 abandoned mine properties, abandoned most often for being "unproductive" (Abandoned Mine Lands, n.d.). However, even unproductive mines contain adits and steep features that expose previously-buried rocks and minerals to the surface, producing toxic discharge. Rivers in western Montana are no stranger to heavy metal and arsenic pollution. Vast reaches of the Jefferson River are listed as "impaired" pursuant to the CWA, due to elevated levels of arsenic, copper, dissolved aluminum, lead, iron, and zinc (Livers, 2014).

Like many metals, arsenic-containing compounds can pose a serious risk to human health. Long exposure to the metal can cause serious health issues, including cardiovascular issues and cancer of the lung, bladder, skin, and kidney (The Facts on, 2012). Reduced arsenic in the form of arsenate (AsO_4^{3-}) is toxic to organisms because the chemical structure resembles phosphate, and as phosphate is used by cells to create ATP (a compound that represents energy in organisms) and to send signals from cell to cell, arsenic can replace phosphate and consequently disrupt energy production and block cell signals (Erraguntla et al., 2013). Another form of the element that poses a risk to human health is arsenic penta-sulfide. When this compound is introduced to the body, there is a high possibility of arsenic binding to a specific enzyme on a cysteine amino acid instead of sulfur compounds. This substitution causes the enzyme to malfunction and reproduces the abnormalities which make cells cancerous (Saha et al., 1999).

These metal and metalloid impairments likely originate from the close proximity of many abandoned mines to the Jefferson River. Over 100 years of intensive mining have produced many abandoned mine sites that are sources of contamination making its way into the Jefferson. This contamination has drawn the attention of Governor Bullock, who in cooperation with the Montana DEQ formulated the Jefferson River Metals Project Area TMDLs and Water Quality Improvement Plan (Livers, 2014). The main goal of this project was to improve the water quality by lowering TMDLs, directly requiring reclamation of the abandoned mine sites leaking heavy metals into the water.

Case Study: Soda Butte Creek Reclamation

Cooke City is a small town in southwestern Montana that was established as a mining town in the early 1900s to support the New World Mining District's mining operations. Between 1934 and 1953, the McLaren Mill processed gold and copper ore, polluting Soda Butte Creek as byproducts of the mill entered runoff and eventually ended up in the creek (Saha et al., 1999). Among other mining processes, the McLaren pit is attributed to being the main source of pollution. The construction of the Beartooth Highway in 1936 helped fuel the McLaren Mill's processing of gold and copper from the New World Mining District. With the Beartooth Highway, trucks filled with raw ore no longer had to commute through Yellowstone National Park (Axline, 2016). Despite redirection of the stream into the McLaren tailings pit, pollutants had been measured downstream of the dam as early as 1960. The Yellowstone fires of 1988 caused alarm among managers of the Yellowstone River, as increased runoff from vegetation loss could have caused the rudimentary tailings dam to collapse and vast amounts of contaminants from the tailings to pollute the Yellowstone River downstream. As a result, the tailings site in Cooke City was deemed an Emergency Response Action Site by the USEPA in 1988. In 1996, the U.S. government purchased the mining district from Crown Butte Mining, Inc. and allocated $22.5 million for reclamation within the district. In 1999, the USDA Forest Service submitted an Implementation for Restoration Plan after extensive data collection and engineering work.

Soda Butte Creek was of particular interest to the reclamation of the mining district, as the creek flows into the Yellowstone River and failure of the McLaren pit dam would cause a contaminant catastrophe downstream. In 2010, the tailings behind the dam were excavated and mixed with lime to raise the pH. The excavated tailings, totaling 120,000 yards, were spread over a repository site, mixed with lime, and topped with topsoil and compost. Water from the pit was drained and treated on-site and 2,000 linear feet of the stream channel was reconstructed to its historic position. The slopes were revegetated following the reconstruction. After implementation, the availability of metals in the water and excavated tailings was reduced to acceptable levels. On top of successfully reducing metal availability, the construction of the project was complete ahead of schedule.

Conclusion

While the benefits of clean water and a healthy environment may be hard to quantify, the importance of clean water to human health, communities, and ecosystems cannot be overlooked. There is no doubt that the mining industry has improved the comforts and utilities of modern communities, but addressing the impact of abandoned mining operations will be crucial in safeguarding water resources in the future. Without the implementation and enforcement of federal and state regulations, water quality degradation will result in risk to human and environment health, but could also negatively impact natural aesthetics and recreation opportunities. It is critical that those who recreate and work in and with Montana's waterways are informed about the quality of their water and where impairments are originating from. An educated public will be more likely to care about reaching and maintaining acceptable water quality levels in streams and lakes that have been degraded by abandoned mining operations, and may play a hand in shaping surface water regulations and abandoned mine regulations in the years to come.

6.4 Environmental Impacts and Mining Practices in the U.S. and globally

Zachary Gigone

Over the past decades as the understanding of our environment has increased, the number of U.S. mining regulations have also greatly increased. The number of federal mining regulations has more than tripled since the 1960's, helping to reduce the impacts of mining on the landscape, and our air and water. The increasing amount of regulation, however, has also increased the cost of metal mining domestically, leading many companies to increase production in countries with less regulation.

Metal plays a major role in our lives, and the increasing ubiquity of technology such as smartphones has greatly increased demand for metals such as copper, gold, and silver. The average American uses 1398 lbs of copper in their lifetime for uses such as house wiring, cars, and electronics.

Due to this massive demand, copper and other metal mining has greatly increased in South American countries such as Peru. Copper production in the country has more than tripled since

1990, and is continuing to increase each year. Production of other metals such as gold has dramatically increased within the country as well.

In 1992, the Peruvian government introduced the General Mining Law, which requires environmental reviews and permitting for any new mine operating within the country. However, lack of enforcement and widespread corruption have decreased the effectiveness of these laws and led to many illegal, unregulated mines in the Amazon watershed. Gold is mined from many alluvial deposits in the rainforest, which involves the use of large amounts of mercury that can end up in nearby waterways and bioaccumulate in the ecosystem. Mercury pollution has reached such a level that certain regions of the country declared a state of emergency in 2016 due to health risks. A small scale gold mine releases about 1.3 lb of mercury into the ecosystem per 1 lb of gold produced. The mercury used for these extractions is in elemental form, but when released into the ecosystem, it is methylated into the organic form, which is much more toxic to wildlife. Cyanide is also often used in the extraction, and regulations on its monitoring are often not enforced. Although both materials are also used for extraction in the U.S. as well, they are much more heavily regulated here, and less likely to be released into the environment.

When community involvement is combined with strict regulation and constantly advancing technology, metal mining can be done in ways that reduces its environmental impact. One example of a mine that has taken such measures is the Stillwater mine in the Beartooth mountains. In 2000, local citizens, and the Northern Plains Resource Council created a legally binding 'Good Neighbor Agreement' in conjunction with the operators of the mine. This agreement means that residents of nearby communities have a say in the practices carried out by the mine, and aims to preserve the water quality and way of life of the many farmers and ranchers in the area. This document sets water quality standards that are higher than those set by the state, as well as implementing monitoring of nearby rivers. Additionally, the use of a tunnel boring machine replaces some of the need for explosives, reducing the amount of groundwater pollution that can occur from such practices. Although every metal mine certainly has an impact on the landscape, as well as acid mine drainage and other pollution, this agreement and use of new technology is a major step in encouraging more socially responsible mining.

As our society's demand for metals such as copper increases, it is important to understand that an increasingly large amount of this demand is met from sources that are largely unregulated and can have much larger impacts on the environment. People want cheap access to technology,

and the materials to make these devices is often met from the cheapest possible source. It is therefore important for consumers and policymakers to understand that there are negative consequences of our appetite for technology. Manufacturers will continue to source their materials from the lowest cost source unless they are pressured by consumers and regulators to make more socially responsible choices.

6.5 National and International Economics

Paul Hegedus

Technology Metals

The technological boom of the late 20th and 21st century in the computer, electronics, and high technology fields has led to a growing reliance by humans on these advanced products. The increased consumption of technology in the modern age is creating a parallel dependence on the minerals required to build the innovative technology society craves. Everyday products use minerals mined from the earth; 66 different minerals are used in the average computer, but focusing on copper alone, 50 pounds of copper are embedded in a gasoline automobile, 150 pounds of copper are required for an electric automobile, and a 0.5 ounces of copper is in each mobile phone (Copper - a metal, 2016; Mineral Commodity, 2017). The metals used in these products, 'technology metals', are essential to our production of technology, and include zinc, aluminum, copper, lithium, silver, gold, and more rare elements (Dennehy, 2015; Izatt, 2016). The United States consumption of technology metals has increased in the last decade, reaching 3.59 million tons of copper per year, while we only produced 1.41 million tons of copper in 2016 (Mineral Commodity, 2017; Scarce Supply, 2017). This high demand both domestically and internationally, causes supply risks, as these minerals are being mined faster than they are being recycled back into the lithosphere, causing future shortages. This is especially true for more rare minerals that are produced as natural byproducts of other processes, but will eventually affect the less vulnerable metals like zinc, aluminum, and copper.

Technology metals are dispersed geologically around the globe, and extraction is dependent on the country's level of investment for the resource. Metals are mined in developed and developing countries alike, although government policy and regulation dictates mining

practices, and production and can vary between nations. Rare earth metals commonly used in technology are mined almost exclusively in China (90%), followed by the United States (3.6%), with Russia, Australia, India, Vietnam, and Brazil producing the remaining 6.4% (Scarce Supply, 2017). Lovely et al. (2011) found that increases in technologies are correlated with increases in regulations that affect small companies disproportionately more than large companies. Regulations can have an impact on commercial welfare due to the economic implications related to the commodity. According to Riveiro (2008), to preserve the commercial welfare of a community, an optimal level of regulation must consist of free trade or export subsidies for a resource, because enforced environmental regulations will decrease industry incentive in the area. The ideology behind economic regulation on mineral production and trade is that production will occur where extraction is cheapest, and when there are less regulations guiding extraction techniques, methods that take less time and have fewer resources dedicated to containment of pollutants will yield cheaper results. However, when the cost of extraction decreases, there is a strong economic benefit to selling the cheaply acquired copper internationally at a higher price. The higher prices in the more developed countries are due to environmental regulations that limit domestic production The developed countries with more stringent regulations that reduce environmental degradation due to mining, shift the environmental burden of mineral production to countries with less environmental regulations that have lower costs to comply with. This results in a lower cost of extraction, reducing incentives to sell the copper domestically, and instead selling the copper to the developed nations. This results in the developed countries retaining environmental sustainability and consumption of copper, while developing countries experience environmental degradation and economic degradation as the income to mining companies is not recycled into the local economies (Cole et al. 2003). Environmental justice is the notion that environmental problems shift to other geographic areas due to environmental regulations implemented to prevent that degradation in the original area. This transfer can occur because of many factors such as economics, policies and regulations, political climate, and social standards, however findings support that the more stringent regulations are, the more trade in environmental goods occurs (Sauvage, 2014). The shifts of environmental harm to areas with fewer environmental regulations can be explained through the economic benefits of actions through less expensive extraction methods that result in lower mineral prices.

Not only providing the materials needed for everyday life, mining is a massive ephemeral economic influx for communities and plays a large role in national economies (Griffith, 2013). The mining of rare earth elements and technology metals is considered 'hard rock mining', as the minerals of interest are generally in solid deposits. The link between the mining and technology industries is inseparable globally, as mining products are fundamental for the technology industry. However, the environmental damage inflicted by the mining process cannot be ignored, nor can the amount of minerals being consumed. Thus, the increased demand sprouts a need for regulations that sustain mineral resources for continued use in future technology industries. An optimal level of regulation is needed for countries to keep the economic benefit of the hard rock mining industry while balancing the amount of environmental damaged by the industry practices, all without increasing regulations above a threshold that results in a loss of competitive advantage (Naito et al. 2009; Li, 2012). This threshold of regulation coincides with environmental justice, as logical economic thought results in mining in areas where extraction is possible, or where the benefits outweigh the consequences, usually due to the lack of regulatory action. This leads mining companies to shift business to areas with less regulation and thus less consequence for cheap extraction methods, automatically increasing profits.

Detriments of Mining

The detriment to ecosystems bears a burden on society that can manifest years beyond the economic benefit of the damaging activity. Mining of all types leave an imprint on a landscape beyond just the massive EPA Superfund sites; and while the tech industry promotes 'green' responsibilities, the industry is one of the largest consumers of chemical and mineral products, resulting in environmental degradation and human harm (Byster et al. 1999). Abandoned and hazardous sites cost the taxpayers millions of dollars in cleanup, while companies held liable for reclamation are facing increasingly higher costs in regard to regulations on environmental standards, due to the cost to comply with environmental regulations: about $184 billion USD per year in the United States in 2003 (Cole et al. 2003) and likely has reached higher costs by 2017. However, regulations in industrialized countries are increasing because the tradeoff between environmental regulation and productivity is more significant for small companies, however negligible for large companies who can take over the production from small companies. The financial burdens and risk of mining with the numerous regulations and the liability for cleaning

up post production is becoming increasingly difficult for smaller companies to bear, while having less effect on large mining corporations (Lu, 2010; Sanchez-Vargas et al. 2012). The tradeoff between regulation and productivity leads to arguments by Heffron et al. (2017) that energy justice, similar to environmental justice, is occurring when companies in developing countries with fewer regulations pick up the slack in production from smaller companies in developed nations that can't afford to continue production due to regulations.

Copper mining is one of the most environmentally harmful of all the technology metals, yet is highly valuable in the telecommunications, technology, automotive, and many other industries because of its metallurgical properties. In addition to its importance, copper is widely distributed across the globe and at non-threatened levels of availability. The availability of copper, as calculated by Dudka et al. (1997), alludes to the theory by Lu (2010) that as demand for copper continues, the mining of copper is likely to intensify and occur wherever copper is available. The necessary forethought on the diminution of copper availability across a global scale requires plans for this occurrence. If action is taken to extract copper reserves now, in a cost effective and environmentally efficient way that decreases environmental degradation, societies can maximize returns in developing countries while their resources are still available by decreasing restoration costs with environmentally efficient methods. This approach would be beneficial in that if experiments can lead to practices that extract developed countries' reserves after developing countries have exhausted theirs, the time taken to find an efficient method and the coinciding inefficient extractions will have occurred already, maximizing efficient economic extraction of the resource when reserves worldwide are waning because of decreased restoration costs with the advanced methods. This intellectual framework casts aside the 'not in my backyard' approach and introduces a 'my backyard, my rules' mindset and requires a global attitude in favor of less damaging production and extraction methods.

This study will focus on the economic implications to the technology industry due to hard rock mining regulations in the United States, specifically through the analysis of the geographic origin of copper and practice of copper extraction in 1900 and the present day. Historical perspective will be gained through the lens of case studies that cover the topics of environmental regulation and trend in economics in the copper industry. Brunel et al. (2013) evaluate regulation stringency through time through case studies, taking into account cost-benefit impacts. Economic analysis over time will be generated through a benchmark focus on the Butte and Anaconda

copper industry in the late 1800's to late 1900's before declines in the local industry. Local, national, and international data for historical perspective were taken from around 1900 or as close to that date possible. Present day analysis utilized modern data on the copper industry as well as regulations and in the temporal frame of the proposed Black Butte Copper Mine in Montana's Smith River watershed.

Historical Context

Mining in Butte took off in 1882 when Marcus Daly began shipping copper down the Clark Fork River to his smelter in Anaconda. At this time, the Butte mining district produced 9 million pounds of copper per year from underground mining before increasing production by 250% the next year. In the 1950's, open pit mining dominated Butte's metal extraction and the legendary Berkeley Pit began to take form. The mine has since dwindled since the 1970's, and Anaconda's smelter has been abandoned, leaving the country's largest Superfund site in its place (Butte Montana, 2011). The destructive legacy and rich history of hard rock mining has left a confused weariness in Montanans about the development of new mines. The desire to preserve recreation and natural aesthetics drive resistance to the proposed Black Butte Copper Mine (Solomon, 2015), while the proposed mine would be predominantly underground; they would drill for copper, cobalt, and silver and implement state of the art reclamation practices to minimize environmental impacts (Proposed Black, 2015).

The key assumptions for this review are that the Butte/Anaconda system is representative of the mining practices in the United States as a whole in 1900, and that the Smith River mine is a depiction of a modern mining method. The methods used in Butte during the 1900's are still used in developing and developed countries today, however with the lack of thought given to the ecological consequences of the industry remaining in developing countries without environmental regulations.

The goal of this study is to conceptualize the economic implications of geographic mining displacement due to environmental regulations on the U.S. technology industry. The goal will be assessed under two objectives. The first objective is to assess the effect of regulations on the technology metals mining industry in the United States, through the analysis of the mining industry practices, production and regulations, and international copper trends. The second objective will be to assess regulatory impact on the technology industry in the United States

through analysis of the relationship between the mining and technology, origin of copper and price, and trends in the price of copper over time. Due to the increase in reliance on technology and the demand for copper, it is expected that the mining and technology industry will show a dependent relationship that has increased since 1900.

Implications of regulations on technology metals mining

Mining practices have advanced over the past century in the mechanical innovation used in the mining of minerals. Prior to the 1900's, common mining practices around the world included underground mining consisting of tunneling with picks and shovels as well as blasting with dynamite, and placer mining of superficial deposits, consisting of the excavation of rock. Open pit mines became common in the mid 1900's, and require the removal of topsoil from a site, the removal of rock to sort through for the mineral of interest, and the storage of those spoils on site. The development of techniques such as open pit mining was the industry response to decreasing resource availability and less rich deposits where pioneering engineering solutions are needed to maximize the efficiency of extraction of the mineral (Calcutt, 2001). Open pit mines such as the Berkeley Pit are seen as the typical mine for most, due to the prominent surficial degradation, and are still found in the United States as well as across the world, however are kept to stringent reclamation standards for refilling, regrading of the landscape, and revegetation. The mining practices around 1900 had no consideration of potential environmental damage, and in Butte, spoils from underground as well as open pit mining were cast aside with little afterthought, as they were considered waste not worth the investment or effort to move or treat (Gammons et al. 2006). Modern mining practices apply rigorous approaches to minimize the ecological disruptions to an ecosystem through the activities of mineral extraction. The proposed Black Butte Copper mine will use state of the art measures to prevent impacts to water quality, habitat, recreation, and other key natural interests in the Smith River watershed. To preserve water quality, the tailings will be stored in an anoxic container, reducing toxicity, and all wastewater will immediately be pumped through a reverse osmosis plant and returned to the groundwater, in situ. Additionally, to minimize aboveground effects, overburden will be mixed with a cement slurry in situ, and used to fill in decommissioned mine shafts as mining progresses

(Commitment to, 2016). The Black Butte Copper mine is proposed to be a modern example of underground mining in a rich copper deposit where open pit mining is unnecessary and extreme.

There are other modern methods of mining besides underground, placer, and open pits. Solution mining pumps chemicals into the rock to dissolve the minerals in what is called pregnant leachate, which is then collected for treatment. The benefits are faster start-ups timelines for companies, lower capital, and operating costs. Solution mining is only effective for superficial deposits as the leachate must be effectively collected, and as containment efficiency decreases significantly with depth. This method is essentially the same as the hydrometallurgical processing methods for mined ore in the other methods where leach solution dissolves the minerals and the leachate is collected (Copper: Technology, 1988; Evolutionary and, 2002).

Regulations affecting the hard rock mining industry were scarce until the 'green revolution' of the 1960's and 1970's. In the United States, the first mining law written was in 1866 concerning lode mining (non superficial deposit mining), and passed under the title of *"An Act Granting the Right-of-Way to Ditch and Canal Owners Over the Public Lands, and for Other Purposes"* (Placer Act), allowing exploitation on public land with the intent to deliver patents (Lacy, 1995; Seymour, 2004; EPA's National, 1997). In 1870, the Placer Act was written to include placer mining (surface deposit mining) in a different patent category than lode mining (Seymour 2004). This led to the General Mining Law of 1872 that expanded the leasing and exploitation of minerals on federal lands in the United States, which was the only legislation pertaining to hard rock mining until the Surface Resources and Multiple Use Act (SMRCA) of 1955, which regulated actions made under leased mineral permits, although had no regulatory action on environmental degradation (Seymour, 2004; EPA's National, 1997). The General Mining Law of 1872 went under review from 1964 to 1970 by the congressional Public Land Law Review Commission that concluded legislation reform of the law could not realistically be achieved (Seymour 2004). No environmental regulation affected the hard rock mining industry until the National Environmental Policy Act (NEPA) of 1969 that created a standard procedure for assessing environmental degradation potentially caused by mining projects.

International regulations were just as scarce and regulations varied drastically between nations (Lacy 1995). However, regulations both domestically and abroad have increased dramatically since the 1970's. Soon after NEPA, the Clean Air Act of 1970 was implemented to regulate the emission of airborne pollutants and contributed to future considerations in the

mining industry. Three acts in the next seven years further restricted the hard rock mining industry. The Resource Conservation and Recovery Act of 1976 had a large regulatory effect on the hard rock mining industry, as it introduced regulations on the release of solid hazardous waste such as mine tailings; the Clean Water Act of 1977 regulated pollutant discharge into waterways and continues to affect acid mine drainage treatments in the mining industry; and the Toxic Substance Control Act of 1977 controlled which chemical substances and solutions can be used in mining and refining of metal ores, specifically impacting the use of chemical leachates for refining (Lacy, 1995; Seymour, 2004; EPA's National, 1997). The Federal Land Policy and Management Act of 1976 dictates that federal lands must take into account multiple uses that have sustainable yields, validating mining claims whilst deeming more areas less available to mining in prioritization of other uses (Seymour 2004). In 1980, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was passed, which allows the government to take and remediate any site that has been exposed to hazardous substances. CERCLA is a sweeping regulation with broad powers based off of the loose term of 'hazardous substance.' The act is especially significant because it held polluters liable for cleanup costs for the first time, created clean up budgets and emergency funds, and allows for the declaration of emergency status for sites (Lacy 1995, Seymour 2004). Since 1980, the number of federal regulations relating to hard rock mining has increased to at least 26 (Table 6.4.1), significantly more than in 1896 (EPA's National, 1997; H.R. 322, 1993; H.R. 2262, 2007).

While modern mines have many more federal regulations than at the start of the 20th century, they also must take state environmental regulations into account. The Black Butte Copper mine in Montana will have to comply with at least two more environmental quality laws as stated by the Montana Department of Environmental Quality; the Metal Mine Reclamation Act of 2015, and the Montana Hard Rock Mining Reclamation Act of 2006 (Hard Rock Mining, 2017). Internationally, mining policy in developed countries is similar to regulations in the United States, while developing countries lag in the amount of regulations and are generally less effective. In South Africa, a law requiring Environmental Impact Assessments is viewed as a 'token procedure' and a routine formality for mining companies rather than as a safety check to the mining industry. Exploitation of the law limits evaluation of safety risks associated with mines and results in lax regulation; 46 mines operated without valid water licenses in 2006 (Leonard, 2006). Other developing countries such as El Salvador have taken divergent

approaches to environmental regulation. Gold was discovered and mined by the Spanish in the 1500's and mining has continued locally at small scales since then. Production mines began in the 1940's and the industry increased in El Salvador in the 1980's and early 1990's after declines in the textile market. The majority of mining companies were of foreign origin, operating in the developing countries with little regulation and oversight. Mining boomed between 2002 and 2012 before threats to water quality and the environmental impacts of mining began to shape public opinion. In 2017, El Salvador voted to ban all hard rock mining in the country; 80% of the country opposed all mining after a Canadian multinational corporation invested $77 million USD (Collins, 2009; Dougherty, 2017).

The number of mines in the United States is difficult to estimate and not feasible to measure, as the records prior to 1979 contain a high amount of uncertainty. Almost as uncertain is the number of abandoned mines in the United States. Best estimates are about 161,000 abandoned hard rock mines in the western states and Alaska (Information on, 2011; Tilton et al. 2005). The decrease in number of hard rock mines in the United States from 1979 to 2015 follows an increase in the amount of regulations and stipulations mining companies needed to adhere to since then (Figure 6.4.1). This trend signifies that the mining industry has consolidated small operations into larger operations run by the larger corporations as production has increased over time. The increase in regulations occurs concurrently with an increase in the cost of copper production by over a dollar in the past few decades, as the increased regulations cause increased expense for the mining companies as more time consuming and careful methods of extraction are used to prevent environmental damage, as well as due to the financial burden of reclamation efforts after mining activities have ceased. Despite increases in regulations, the demand for copper necessitates mining activities, which have held a constant percentage of the United States gross domestic product (GDP), at 0.039% of the U.S. economy in 1896, and 0.036% of the United States economy in 2016 (Table 6.4.2). On the international scale, the production of copper in the United States was 0.00875% of the global GDP in 1896 while only 0.0063% of global GDP in 2016 (Table 6.4.3). The lower proportion of copper mining to the global GDP over the past century reflects the increase in mining regulations that have decreased the amount of copper mining occurring inside the United States compared to the rest of the world's production of copper. This is suggested by the decrease in the proportion of copper produced by the United States from 51% of global production in 1896 to 14.38% of the world supply in 2016,

with domestic production only exceeded by Chile, Peru, and China, respectively (Mineral Commodity, 2017). The environmental regulations affecting the sustainability of the nation's mineral resources have helped keep the contribution of copper mining to the national GDP constant over the past century. The increase in demand and consumption of copper resources however, has led to a production void that can only be met by copper production abroad, which potentially occurs without the same level of stringent environmental regulations found in the United States.

The increase in regulations in the United States has had relatively little effect on the presence of the hard rock mining industry in the nation's economy, however has resulted in the consolidation of mines and companies into large corporations that can weather the financial burdens of environmental regulation. The increase in regulations has led to the 'pollution hypothesis' that echoes the concept of environmental justice in that the increases in regulations in developed countries moves production to 'clean goods', while consumption of 'dirty goods' remains constant. 'Dirty goods' are considered those produced with significant amounts of pollution or ecosystem damage as a byproduct, while 'clean goods' are products sustainably produced. This causes production of 'dirty goods' to occur in developing countries where less regulations control environmental degradation and risks associated with mining (Lu, 2010; LaBelle, 2017). The increase in production of 'dirty goods' by developing countries for export to developed countries depletes the mining community of much of the associated revenue, resulting in economic poverty, compounding on their environmental poverty from unregulated mining practices (Bouzarovski et al. 2017). The United States has had a steady rate of consumption of copper for the past few decades, and while the production of copper has increased in the last century domestically as well as globally, the increase in regulations coincide with a decrease in the ratio of copper produced in the United States to the world (Table 6.4.3). For this reason Managi et al. (2005; 2009) argue that stringent environmental regulations cause disadvantages for nations and states, and that the trade from developed to developing nation results in increased pollution for both nations. The geographic shift of pollution from mining because of environmental regulations is onset by the economic regulations surrounding the minerals; regulations have shifted from control through taxes of the products to incentive based motivations on the industry, resulting in increased regulations on the domestic mining industry while enabling cheap imports and trade to satisfy domestic demand (Williams, 2012). This

causes no detriment on the product or amount imported itself, allowing unrestricted importation of the material for consumption and less pressure to regulate the mining practices utilized in obtaining the materials from international sources. Increasing regulations on copper extraction practices in the United States are affecting the distribution of copper production across the globe, imports by the United States, the cost of production of copper, and subsequently the price of copper to be used in the technology industry.

Effects of mining regulations on technology industry

The relationship between the metals mining and technology industries (Figure 6.4.2) supports the conclusion that the two markets are related, potentially because their relationship is driven by a dependency factor. The price of copper in 1896, adjusted for inflation, was $0.10 per pound while costing $2.20 per pound in 2016, highlighting the decrease in global availability of copper deposits, resulting in more expensive methods of extraction (Feliciano & Gonzalez, 2002; Weed, 1905; Edelstein, n.d.). The price of copper has increased dramatically over time supporting the increase in demand and expenditure to produce copper with increasing regulations and a dwindling amount of resources.

As previously mentioned, regulations have decreased the 'dirty goods' produced by developed countries but have not decreased their consumption of them (Lu, 2010), leading to the conclusion that 'dirty goods' are mined in less developed countries. The United States imported 34% of its annual copper supply from Chile, Canada, and Peru in 2016, with resulting prices per copper of $2.20 per pound for domestically produced copper, and $2.16 per pound for imported copper (Mineral Commodity, 2017; Burgess, 2016). This furthers supports evidence that the increase in regulations in the United States are driving up the cost of copper production, resulting in an increased price of copper on the market. The higher the price of copper for the technology industry, the higher will be the costs of technological products produced for societal consumption, positively influencing the technology industry.

Increasing regulations on hard rock mining in the United States over the past 40 years has led to an increased dependence on international copper imports for the growing technology industry as domestic copper production decreases. The effect of regulations on the technology industry filter down the supply chain of copper, to their effects on the mining practices and

economic burden of cleanup and remediation, leading to drivers on the origin of copper, which ultimately dictates the practice of extraction and the amount of environmental degradation. As the amount of available copper decreases globally, as environmental regulations become more stringent in the United States, as the number of environmental regulations globally grows, and as the price of copper continues to rise, the effect on the technology industry will be higher revenues for higher priced products that are invaluable for our society.

Discussion

The economic implications of environmental regulations infiltrate the supply chain of copper products in the United States, affecting multiple aspects of the mineral's economic life cycle. The increase in environmental regulations in the United States has changed the hard rock mining industry in the United States by decreasing the number of domestic mines and contributions to the world supply of copper. While the proportion of copper production to the United States GDP has remained constant over the past century, the cost of mining has increased, and mining companies have consolidated into large corporations capable of withstanding the financial responsibilities associated with hard rock mining in the modern age. The increase in regulations have led to more sustainable practices of mining, yet result in an increase in international dependence on copper by the United States because of the sustained need for consumption of copper in the technological industries. Future predictions of the copper market indicate that prices in copper will continue to rise with the compounded effects of increased regulation and depletion of available deposits for mining.

Consideration of the reclamation of mined lands in the United States is highly variable and poorly defined, ranging from $2 billion USD to $71 billion USD for all mines active and abandoned (Seymour, 2004). The cost of these estimates and the government liability of companies to these reclamation actions are routinely underestimated, resulting in taxpayer liability for the remediation of private mines; however, between 1997 and 2008, four government agencies, the Bureau of Land Management, the Forest Service, the Environmental Protection Agency, and the previously known Office of Surface Mining, invested $2.6 billion USD on reclamation of hard rock mines (Information on, 2011). The economic revenue of the technology industry from increased product prices will be offset by the massive sums of money that will be

needed to remediate and reclaim the mined lands across the country. The underestimation of costs associated with reclamation after mining leaves taxpayers accountable for the financial burden of cleaning up these mines, which takes away from the potential infusion of profits from the technology industry to citizens in the United States.

Increasing metal mining regulations in the United States can be seen as a necessary evil in regards to economic benefit in the long term. The United States has the means and is on the trajectory of implementing environmental regulations that can substantially shift the methods used in copper and mineral mining. Projects like the Black Butte Copper Mine that utilize modern methods in attempts to reduce environmental impacts may result in long term profits for the technology industry and United States GDP. More stringent regulations that require mining companies to develop less environmentally damaging methods will only occur with public support for increased regulations. There is the assumption that mining companies currently possess the technological and financial means to develop extraction and production methods that will lower the environmental effects of their practices, however with the ability to outsource metals, there stands no benefit for investing in new mining technologies. When mining is done more efficiently and with fewer environmental risks, the costs associated with the mine clean up are much lower than for those at inefficient mines, which has the potential to offset the investment and production costs of more environmentally conscious mines. The cost of reclamation tends to become the largest expenditure in the mining process and decreasing this will result in decreased prices for copper. When global reserves for copper and other technology metals run low, there will be a public acceptance of mining wherever possible to provide the technology metals that our society depends on, and fewer regulations to maximize this extraction will be tempting. However reclamation and restoration of mine sites will always be a priority for developed countries, especially after essential mining occurs close to home. A shift in public perception may help mitigate future damage and degradation, while still yielding the same economic returns and technological supplies. Additionally, investment in efficient and environmentally conscious methods of copper mining may boost the industry as innovations and advancements are made in the mining sector.

Investing in less damaging mining processes in developed countries now will not only improve public perception of domestic mining, decrease the cost of domestic copper and reduce environmental damage elsewhere, but mitigate future degradation of ecosystems when mining to

sustain the demand of technological metals is forced to occur in developed countries. A value on environmental health and sustainability now and the implementation of stringent and efficient regulations to mitigate this damage is essential to reduce the impacts of this necessary industry.

Figures and Tables

Table 6.4.1. Examples of U.S. regulations affecting hard rock mining, the year passed through legislature, and significance to the industry

U.S. Environmental Regulations on Hard Rock Mining

Act Name	Year	Significance to Mining
*Placer Act**	1866	Allowed for explorationfor minerals on plublic lands with the intent of patent delivery
Lode Law	1870	Put lode mining patents in a separate category from placer mines
General Mining Law	1872	Expanded the leasing and exploitation of mineral resources on federal lands
USFS Organic Act	1897	Protects continued use and sustainable considerations of forest resources like minerals
Rivers and Harbors Act	1899	Restricts dumping of waste into navigable waters of the U.S.
Surface Resources and Multiple Use Act	1955	Restricts land use activities under mineral leases to pertain to land use actions related to minerals
Multiple Use and Sustained Yield Act	1960	Agencies must manage resources for sustainable yields in future and must balance activities such as mining with others
National Historic Preservation Act	1966	Prevents mining in areas of cultural or historical significance
Wild and Scenic Rivers Act	1968	Restricts mining in designated riparian ecosystems
National Environmnetal Policy Act	1969	Potential mines must undergo an assessment process for potential environmental damage
Clean Air Act	1970	Regulates emissions of airborne pollutants
Coastal Zone Management Act	1972	Prevents mining along coast
Endangered Species Act	1973	Restricts mining permits and leases in areas inhabited by species listed under the act
Resource Conservation and Recover Act	1976	Regulations on the release of solid hazardous waste eg. Mine tailings
Federal Land Policy and Management Act	1976	Federal lands must manage mineral resources sustainably, and balance mining activities with other land uses
National Forest Management Act	1976	More rigorous planning decisions about activies such as mining
Mining in the Parks Act	1976	Closed National Parks to all mining
Clean Water Act	1977	Regulations on pollutant discharge into waterways
Toxic Substance Control Act	1977	Controls chemical substances and solutions used to extract minerals of interest from rock
Comprehensive Environmental Response, Compensation, and Liability Act	1980	Gives government the right to take and remediate sites and hold polluting party accountable
Fish and Wildlife Conservation Act	1980	Prevents destruction of fish and wildlife habitat
Farmland Protection Policy Act	1981	Prevents agriculturally significany land from being converted to non agricultural uses eg. Mining
Inidian Mineral Development Act	1982	Included tribal governments in decisions on mineral resource management
Hard Rock Mining Reform Act	1993	Imposes royalties, restricted requirements for mineral patents and leases
Hard Rock Mining and Reclamation Act	2007	Modified requirements for mineral leases and patents

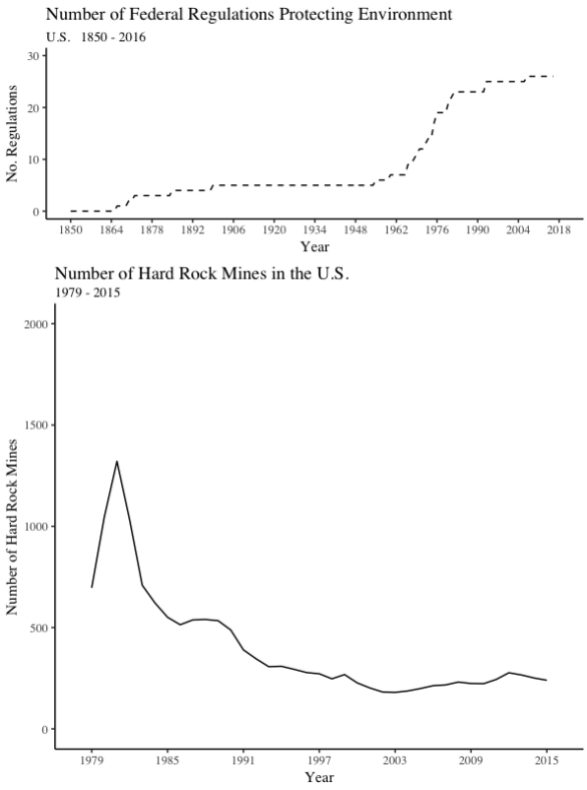

Figure 6.4.1. *The number of environmental regulations affecting hard rock mining in the U.S. from 1850 - 2016 (top). The number of hard rock mines in the United States from 1979 – 2015 (bottom)*

Table 6.4.2. *The GDP in USD of the U.S. copper industry, the total GDP of the U.S. and world, and the percent of GDP contribution by the U.S. copper industry in 1896 and 2016.*

Copper Industry Relation with Economy

Year	**1896**	**2016**
GDP of Cu Industry (Millions USD)	98	6,800
Total US GDP (Billions USD)	249	18,570
Total Global GDP (Billions USD)	1,120	107,500
Cu Industry % of US GDP	0.039	0.036
Cu Industry % of Global GDP	0.00875	0.0063

Table 6.4.3. *The amount of copper produced from mining in the United States, the percent of copper production contributed to the world production in the U.S., and number of regulations in 1896 and 2016.*

Regulations and Copper Production in the U.S.

Year	**1896**	**2016**
Copper Production (Millions Metric Tons)	0.095	1.41
Percent of World Supply	50.9	14.38
Number of Regulations	4	26

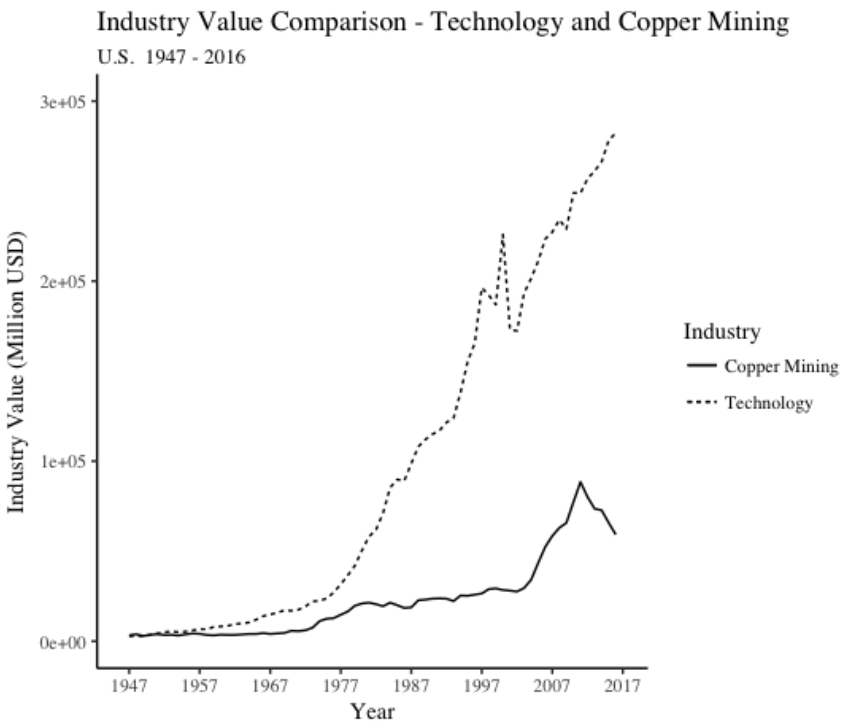

Figure 6.4.2. *The industry value in million USD of the computer and electronics (Technology) industry, and the copper mining industry in the U.S. from 1947 to 2016*

6.6 A Small Third World Country with a Conscience

Jeremy Ditto

Many nations value their environment over possible monetary compensation. A case study is the recent victory by the nation of El Salvador over the OceanaGold mining company regarding the mining of metals. El Salvador decided that the clean water was more important than money from metal mining.

El Salvador is a small country on the Pacific coast of central America. To put this in perspective, the entire country of El Salvador is around 5% the size of the state of Montana which covers 147,040 miles. The population of El Salvador is 6 times that of Montana: 6,090,646 in El Salvador versus 1,043,000 in Montana. Hence, the density of El Salvador is 100 times greater than that of Montana: 761 persons per mile in El Salvador, as compared to 7 in Montana. Most Salvadorans live in cities such as the capital San Salvador (Canadian Mining, 2009).

El Salvador, like Montana, has had an agricultural economy for many generations. While metal mining has had a small place in El Salvador's history, .4% GDP agriculture has been the main use of natural resources. Cacao, indigo, cotton and coffee have been the major sources of income. To date coffee is the main cash crop of El Salvador, but due to the growing population there are fewer acres of arable land to cultivate for coffee (Canadian Mining, 2009).

As of 2006 mining played a very small part in the economy of El Salvador and only controlled 0.4% of the GDP (Canadian Mining, 2009). There is a small and active mining community of Salvadorans considered artisans who hand dig mines and process minerals for survival (Fernandez, 2017). Gold mining could be a major boom for the country and its people. It is estimated that beneath the city of San Isidro, El Salvador there are 1.2 million ounces of high purity gold and 7.2 million ounces of silver. According to APMEX, a precious metal seller, the value of gold in 2017 is $1,306 and silver is $17.50 per ounce which is $1.57 billion in gold and $126 million in silver (APMEX Investments, 2017). This would be a substantial sum for an impoverished third world country with a GDP of $26.8 billion (El Salvador GDP, 2017).

In 2001 large foreign owned mining companies began exploring for gold in El Salvador. One of the companies, Pac Rim Cayman, was granted an exploratory permit to search for gold in the area around Cabanas, which is located in the watershed of the Lempa River.

The Lempa River is one of the few remaining unpolluted rivers in the country and supplies half of El Salvador's drinking water (Canadian Mining, 2009).

In 2005 El Salvador's government denied Pac Rim's license request to begin open pit mining near the town of San Isidro, stating that Pac Rim had not met all the legal requirements for the permit (Malkin, 2016). Pac Rim a Canadian-Australian mining company filed a lawsuit for $314 million against the government of El Salvador, for the loss of expected profits from the mine (Malkin and Malkin, 2017). This suit was filed with the International Center for Settlement of Investment Disputes (ICSID), a division of the World bank. In 2013, the ICSID ruled unanimously in favor of El Salvador stating that Pac Rim had never acquired any rights to mine (Malkin, 2016).

In 2017 the Salvadoran government decided to completely ban large scale metal mining in the country. Water is the first victim of mining and the people of El Salvador rallied to protect theirs with the mining ban. In many small towns, the citizens organized local ballots to show solidarity in the movement to ban mining (Moore, 2017). According to Dr. Molly Todd, a scholar specializing in Salvadoran history, with the help of many non-governmental organizations (NGOs), elections were held in small towns and local citizens were encouraged to vote their conscience on mining. Overwhelmingly these elections said no to mining. Elections were held in small towns to tell the Salvadoran government that vida (life) is more important than gold. Voters walked for miles, rode horses and bikes to make their voices heard (Todd, 2017).

In a historic decision, a very poor nation put their health and environment in a priority over money, in this case gold and silver. Socially we see that these people have values that outweigh wealth. It should be noted that this ban did not come without a cost. Between 2009 and 2011 as Pac Rim was requesting a permit to mine, there were five anti-mining activists murdered and some showed signs of torture. As of 2014 none of the perpetrators have been brought to justice and petitions are being filed for investigations into possible links to Pac Rim (Cabezas, 2014).

Social impacts

It is said that the first thing to suffer in mining is water. Even with today's more modern mining techniques unintended pollution can occur and enter a water table. Mercury and other toxic chemicals can be released in accidents. A typical gold mine uses 24,000 gallons of water per hour, roughly the same amount of water used by a Salvadoran family in 20 years (Achtenberg, 2011). Clean water is precious, especially in a global south country that doesn't have the water purification facilities of countries in the global north.

Preserving clean water is a positive ramification of the ban, but what are the negatives? El Salvador is an extremely impoverished nation. It is questionable what the influx of dollars to the Salvadoran economy would be as an estimated 3% of mining profits would be paid to El Salvador in the form of taxes. The National Round Table against Mining claims that very few Salvadorans have the mining expertise needed to be hired to work (Achtenberg, 2011). But large-scale mining by a Salvadoran company, possibly government run could provide much needed revenue and help feed a hungry nation.

Under the new ban on metal mining, the small scale artisanal miners will be barred from mining even at the micro scale they work. Unfortunately, it is common for these miners to use mercury and other chemicals to separate minerals from tailings and have even less of the ability to keep the watersheds clean. These low wage people will have to find different ways to survive.

As scientists, we should recognize that over the long term the artisanal miners have and will continue to pollute waterways on a small scale. The United Nations estimates that 1,000 tons of mercury are released into the environment every year by artisanal miners processing gold and other minerals. Using mercury in industrial mines has been halted but acid mine drainage becomes the largest polluter as well as environmental damage from surface mining, which, according to Dr. Molly Todd was the method Pac-rim proposed to use in the Lempa River valley (Todd, 2017).

To conclude, I feel that the Salvadorans made a noble choice based on facts and emotions. Provided the ban is enforced, some Salvadorans will need to find other ways to support themselves. According to Dr. Todd, the Salvadoran government is considering methods to retrain and offer financial support to those affected by the ban. The precedent set by the country is the largest gain of this entire saga. It is my hope that other nations will take notice and consider life over gold.

Another consideration is that metals have become a daily fact of life to many humans. Especially in the global north we drive cars and use cell phones with little consideration to where the metals came from that these products are made of. Should we mine these metals in our own country where we have better control of environmental and social issues and pay for that control, or should we exploit other nations and environments for less expensive conveniences?

6.6 The Social Response to Mining in America

Kelsey Wallisch Simon

The mining industry has a long history of causing rifts and divides in local communities and internationally. Mining leases are often from public land entities, and therefore strike a nerve with the many people who may use the land for their own benefit, people who live in the area, or those who are concerned with environmental conservation.

"Not in My Backyard," often referred to as NIMBY, is defined by Thornton and Tizard (2010) as, "a negative cognitive-affective reaction expressed through behavioral opposition to changes that are perceived to have undesirable personal consequences." In discussing mining operations, specifically new exploration for future mining sites, this is a common and strong response by the American public, especially near the proposed site, but it is not always the only type of response. Why is mining so often met with disapproval and where is the miscommunication rooted from the mining industry? The psychology of NIMBY and other social responses have been observed in different case studies for different industries, but we will explore how this can be applied to the mining industry.

An interesting example of challenging and divided social responses surrounding the mining industry is reflected in a proposed copper mine in northern Minnesota near the Boundary Waters Wilderness Area. While this mine is proposed to be an underground and less-invasive mine versus an open pit, it will be located in the watershed and on the edge of the wilderness area where a sensitive and complex hydrologic system extends into Canada. The northern half of Minnesota is remote, with little industry to support the economy other than tourism, and therefore many individuals in the area are very supportive of the new job opportunities and the boost in economy that are part of the development of a new mine. While their vested interest in

the economy is supportive of the mine, other Minnesotans have contrasting feelings. Their vested interest is strongly held for some, in their favorite vacation spot and others in the beautiful and sensitive ecosystem; they predominantly oppose the mine.

Like most controversial topics in our country, of course this becomes a political issue. During the Obama administration, there was an unprecedented decision to halt further exploration and proposals for the mine in the Boundary Waters. It was ruled as too great a risk and impact to the surrounding environment, and the area is considered especially sensitive due to the extensive hydrologic activity (Bjorhus, 2016). After the Trump administration came to power, the proposal was reopened and given an additional two years for an impact assessment and another public opinion period (Karnowski, 2017). This of course has become very controversial, particularly for the environmental activists. To only add to the controversy, The Wall Street Journal reports the owner of the mining company also owns the property Ivanka Trump is renting in Washington DC, leaving a possible conflict of interest in the case (Maremont, 2017).

NIMBY reactions and other socially divided responses are most strongly dependent on the individual's vested interest in the proposed change in their life (Thornton and Tizard, 2010). The example in Minnesota illustrates this in the dividing controversy between protecting a sensitive ecosystem and providing a newly revived and healthy economy to a remote area. The arousal of NIMBY can be strong at first reaction and gradually decrease over time with acceptance of the change. The sensitivity toward a change may be subconscious but still present (Thornton and Tizard, 2010). This may explain the strong opposition of new mining operations in northern Minnesota. This area has a long history of mining and quarrying in the area as far back as the 1820's (Minnesota DNR, 2017).

There is obvious need for protecting the Boundary Waters, such that if there were a mining accident like an acid drainage spill, 2.3 million acres of public land alone, including land in Canada, would be affected (Forgrave, 2017). As an environmental scientist, I think it would be harmful to the environment, but there are other factors causing the social rift. While the mining would potentially bring jobs to the rural economy, the current local economy would likely suffer. This location is featured by National Geographic as one of the top places to visit in the world, and if mining operations damaged the ecosystem, the tourism would likely slow or even halt (Forgrave, 2017).

The campaigns of the opposing sides have a very different method of communication. If you venture to the Twin Metals Minnesota webpage, the company of the proposed mine, one small paragraph on the generic page discusses environmental impacts, stating that any operation will follow regulations (Twin Metals, 2017). They also link to powerpoints used for presentations that were given locally. The most recent talk given was more than two years ago, and the environment was discussed on one slide (Twin Metals, 2017). This gives a reader who was not present at the talk very little information from the vague bulleted list. Even their maps of proposed exploration and mining do not show a single body of water, keeping the illustration basic and generic.

In contrast, the largest Boundary Water advocacy group, Save the Boundary Waters, has a very different webpage. There is ambient background sounds of water and wind in the trees. There are interactive maps showing the potential damage across a massive waterscape. There are even pictures of children below the title reading, "What's at Stake?" (Rom, 2017). They depict a tragic scene the mine would create, describing what sounds like an open-pit mine with acres of tailing piles and storage (Rom, 2017), but Twin Metals discusses a closed and underground mine with cemented tailing stored safely underground or in offsite storage facilities (Twin Metals, 2017). Is this miscommunication from the Twin Metals LLC, or is Save the Boundary Waters overdramatizing the proposal? Could the methods of communication be driving the social divide further? Is it worth Twin Metals Minnesota effort to communicate their proposals to the other side of the fence?

Twin Metals claims their underground mine will be 99.9% safe against accidental spills, but many say this is still too risky for such a sensitive area (Forgrave, 2017). Mining technology has come a long way in safety and environmentally conscious methods, but it may not be enough for mines adjacent to important waterways. Twin Metals claims to not have any acids in their processing (Twin Metals, 2017), but sulfuric acid is a common byproduct of copper mining (Onello, 2016). In fact, while Twin Metals claims to have a positive track record, the *MiningTruth.org* claims sulfide mining has an almost perfect record for spilling and damaging the environment in some form. It seems there is a miscommunication and over dramatization from both sides of this controversial proposal.

Other mines in northern Minnesota are often open pit mines which are strikingly different mining methods. In just a visual sense, open pit mines look like apocalyptic wastelands,

much less considering what they can do to the surrounding groundwater and ecosystems. This is often how Save the Boundary Waters and other activists groups' convey mining, though it is not entirely an accurate picture of what Twin Metals plans to do. The company needs to be more explicit on their statistics and planning strategies for the public to understand this technology and the potential risks in full detail. Their scientific support from their webpage is very vague, and their fact sheet is basic in mining methods, whereas Save the Boundary Waters has over twenty-five Megabytes worth of scientific resources provided on their webpage.

Kris Reichenbach, the Public Affairs Officer at the Superior National Forest, explained that most of Twin Metals' outreach and communication has been kept local. They support the community by buying baseball uniforms and claiming the robust economy they create will keep the children home in their rural communities. Reichenbach also said Ely, Minnesota is referred to as "Ground Zero." While this is often known as the gateway to the Boundary Waters, it is also the place Twin Metals seems to focus their efforts. It seems their outreach and communications efforts nearly end at the local level, and they do little to fight for their cause at a large scale.

In contrast, an example of the environmentalist side is seen in an article from the New York Times. In our NIMBY reaction against mining, particularly for copper and referring to our entire country as our backyard, we often forget how much copper we all use on a daily basis. In 2004, *MineralsUK* estimated each person uses nearly a half ton of copper within their lifetime. We also forget we live in a country with Child Labor Laws, Environmental Regulations, and Public Opinion Periods. Many countries where mining is outsourced do not have such protection and privileges. If we continue to demand affordable minerals, we need to focus our efforts on compromising rather than fighting.

Rather than allowing these issues to become culturally dividing, we need to communicate to one another for a complete compromise for each scenario in the United States in contrast to El Salvador. We need to remember that our happiness is not a win-lose basis, but rather we need to come to agreement where our curvy and grey shaded line is located between a necessary economy and a healthy environment. We need to transition from a "Not In My Backyard" attitude to a "My Backyard, My Rules" as a more compromising mind frame.

6.7. Conclusion

In this section, we have seen the impact that regulation has on mining in the US and abroad. Historical examples from Butte, and modern examples in countries like Peru and El Salvador have shown the drastic effects that mining can have on the environment and the health of people who are impacted by its effects. With increasing demand for metals, it is important as scientists, and consumers, for us to consider where our metals come from and the impact that the extraction has on the environment and global economy.

7. Final Summary and Conclusion

The implications of environmental regulations impact us all directly and indirectly. Mandates and incentives are powerful tools, using them in tandem doubles the power. This increased power will be necessary as we navigate the climatic and political landscape stretching out into the future.

As fires increase in frequency and intensity, the risk to human establishments and land managed for specific purposes also increases. Through regulation, the public has involvement in revision of forest plans, and have a role in supporting the management of forests to decrease detrimental effects of fires. The causes of increased wildfires are many and include environmental factors such as drought and temperature, however there are still numerous wildfires started anthropogenically each year. In Montana, over one fourth (28%) of our wildfires are human caused and typically attributed to out of control campfires (Figure 3.2). As population and demand on public land increases, the need to practice fire responsibility becomes equally important as involvement in forest planning and management.

Increased species extinctions across trophic levels is observed with changing climate conditions. The ESA is a valuable and powerful tool for the preservation of species, such as the grizzly bear and sage grouse. However, it would be incorrect to assume the ESA doesn't need improvement. Lack of sufficient funding is a serious problem; furthermore, available funding may be better focused on the listing process and managing populations before threats to their existence becomes critical. Funding should also be allocated to follow-up studies on populations, which are crucial for assessing the effectiveness of tools and determining prioritization in the future.

Hardrock mining practices that obtain minerals degrade ecosystems throughout the world, yet demand for natural resources is incessant. Historical examples from Butte, MT, and modern examples in countries like Peru and El Salvador evidence the drastic effects mining can have on the environment and impacts on human health. With increasing demand for metals, it is crucial that we, as scientists and consumers, consider the source of products and the impact extraction has on the environment and the global economy. Manufacturers will continue to utilize materials from the lowest cost source, unless pressured by consumers and regulators to make socially responsible choices.

Although industries such as mining are drivers of the economy, so are environmental regulations. Internalizing external environmental costs is not only a good idea in the case of greenhouse gas emissions, but for other global environmental problems such as overfishing and biodiversity loss. Regulation of products and practices with environmental impacts carries high capital costs; however, regulation is one of the biggest drivers of environmental responsibility across industry. While some say that the environment is too important to leave to markets, the opposite is true -- the environment is too important to leave out of markets.

As budding environmental scientists, we recognize the complicated role of regulation for managing our environmental impact. Trained as biologists, ecologists, geospatial professionals, soil and water scientists, and restoration scientists, we carry responsibility to meaningfully engage in the conversation of environmental management. In future workplaces and academic endeavors, we commit to make ethical considerations of our work and communicating science that is both approachable and relevant.

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