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Risk Perceptions of Metallic Mineral Mining in Maine

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RISK PERCEPTIONS OF METALLIC MINERAL MINING IN MAINE

By

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An Abstract of the Thesis Presented
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As society's need for metals increases more mining locations will likely be sought. Maine contains 10 known significant metal deposits but there are currently no active metal mines. Interest in developing one of these deposits prompted legislative changes to the metallic mineral mining (MMM) law and rules to be pursued. Social license to operate (SLO) or the acceptance of mining activities by communities plays an increasing role in the siting and profitability of mining activities. This study broadens the application of SLO to the context of a statewide policy debate. Appropriate policy development for MMM needs to consider the views of residents and their risk perceptions toward this type of mining activity being conducted in the state. This thesis aims to measure Maine residents' risk perception and acceptance levels of MMM in order to inform a current statewide policy debate. Using a mixed methods approach, this study implemented a qualitative case study and a quantitative resident mail survey (N = 501). The case study dove into the context of the debate and used qualitative content analysis (QCA) to identify the positional stances of stakeholders and the major themes that have been most prominent throughout the debate. Opposition to the proposed rules has been the principal stance from stakeholders. The QCA resulted in four prominent themes from this debate: water permeates everything, using experiences and examples, inadequate rules, and mistrust. The qualitative results show that, counter intuitively, pushing to get a bill passed can actually hinder the fulfillment of the bill's

purpose. The quantitative study investigated the risk perceptions of Maine residents to MMM in their state and explored the social-psychological constructs that explain risk perception levels. This study also examined the utility of a risk perception model originally developed for the topic of climate change on an additional natural resource topic. Results from the hierarchal regression analysis show that the full risk perception model is able to explain over 80% of the variance in risk perceptions with significant predictors being knowledge of impacts to local assets, normative factors, biospheric value orientations, and level of trust in certain information sources. This thesis concludes with a convergence of the findings from both the qualitative and quantitative components. Predominantly congruent with each other these findings demonstrate the advantage of a mixed methods approach in studying contemporary social-natural resource issues.

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LIST OF ABBREVIATIONS

AMD: Acid Mine Drainage

BEP: Board of Environmental Protection

BDN: Bangor Daily News

CCRPM: Climate Change Risk Perceptions Model

DEP: Department of Environmental Protection

LD: Legal Document

MAPA: Maine's Administrative Procedures Act

MMM: Metallic Mineral Mining

MRPM: Metallic Mineral Mining Risk Perception Model

NGO: Non-Governmental Organization

NIMBY: Not in My Backyard

NRCM: Natural Resources Council of Maine

PPH: The Portland Press Herald

QCA: Qualitative Content Analysis

SLO: Social License to Operate

SPSS: Statistical Package for the Social Sciences

CHAPTER 1

INTRODUCTION

Metal mining is a global commodity industry whose products are necessary for modern society. It is also one of the largest sources of land and water pollution (U.S. Environmental Protection Agency, 2017a). The industry is fraught with issues and risks that range between technical engineering challenges and societal risks to and from surrounding communities. A further challenge is that of temporal-spatial differences with the costs and benefits of mining. The majority of benefits, mainly in the form of economic benefits, are dispersed beyond local operations (companies, tax revenues, etc.) and accrue only during the time a mine is operational. The costs tend to be borne by local communities and can remain for long after operations cease (Campbell & Roberts, 2010; Zhang & Moffat, 2015). Because of these issues, some mines experience intense opposition to their operations from residents. When a new mine is proposed these issues also emerge as part of the permitting debate and can hinder the actualization that a mine will be developed. Appropriate government policy development can facilitate the reconciliation of these conflicts (Prno & Slocombe, 2012; Zhang & Moffat, 2015). To do so, the social risks and risk perceptions of residents need to be accounted for and understood (Dogaru, et al., 2009; Prno & Slocombe, 2012).

This thesis aims to measure Maine residents' risk perception and acceptance levels of metallic mineral mining (MMM) in order to inform a current statewide policy debate. This debate began in 2012 after there was renewed interest in mining some of Maine's metal deposits. A full description of this debate is given in chapter 2. Maine is challenged with limited knowledge and experience in this industry and thus also lacks an understanding of the risk perceptions toward MMM held by the public. Current research on public perceptions or other

social contexts of mining have occurred in establish mining regions and either focused on individual mines (Campbell & Roberts, 2010; Hutchins, Walck, Sterk, & Campbell, 2007) or the mining industry throughout an entire country (Zhang & Moffat, 2015; Zhang et al., 2015). Therefore, this research can have important contributions to both the state of Maine and the current literature on metal mining and risk perceptions.

1.1. The Historical and Geological Context of Metallic Mineral Mining in Maine

Maine has a long if not extensive history with mining in general, one that few residents are aware (Lepage, Foley, & Thompson, 1991). Sand, gravel, and stone quarries are the most prevalent sites (both now and in the past). Metallic mineral mining has a more limited history and there are no active metal mines currently. Volcanogenic massive sulfide deposits are distributed throughout the state (Figure 1.1) and are associated with volcanic belts stretching from the New Hampshire-Quebec border, through northern Maine and into New Brunswick, and along the coast. Geologically and chemically similar deposits have been successfully mined in both New Brunswick and Vermont. These deposits are attractive as mines because the hydrothermal processes involved in their formation concentrate valuable ore minerals including copper, zinc, lead, gold, and silver; however, they are also very high in sulfur as well as heavy metals that can be damaging to the environment and human health (Marvinney, 2015).

Commercial metal mining operations occurred periodically throughout the 1800's and the early 1900's including a lead mine in Lubec, the Katahdin Iron Works (now a state historic site), and a short mining boom from 1879 to 1882 (Lepage et al., 1991). After nearly 50 years of no metal mining, a few operations were started in the 1960's in Hancock County. The last of these mines closed in 1977 and with it the last metal mine operated in Maine (Lepage et al., 1991). Limited experience in the industry continued through exploration activities but after new rules

were implemented in 1991, these activities also dwindled. Renewed interest in a deposit in Aroostook County has brought the topic back to the surface. Since 2012, the future of MMM in Maine has been a policy debate within the state government. The extent of history and experience with MMM in Maine could be summed up thus: small mining booms in the 1800's, a few legacy mines that closed in the 1970's, some exploration activities, and a several years of policy debates.

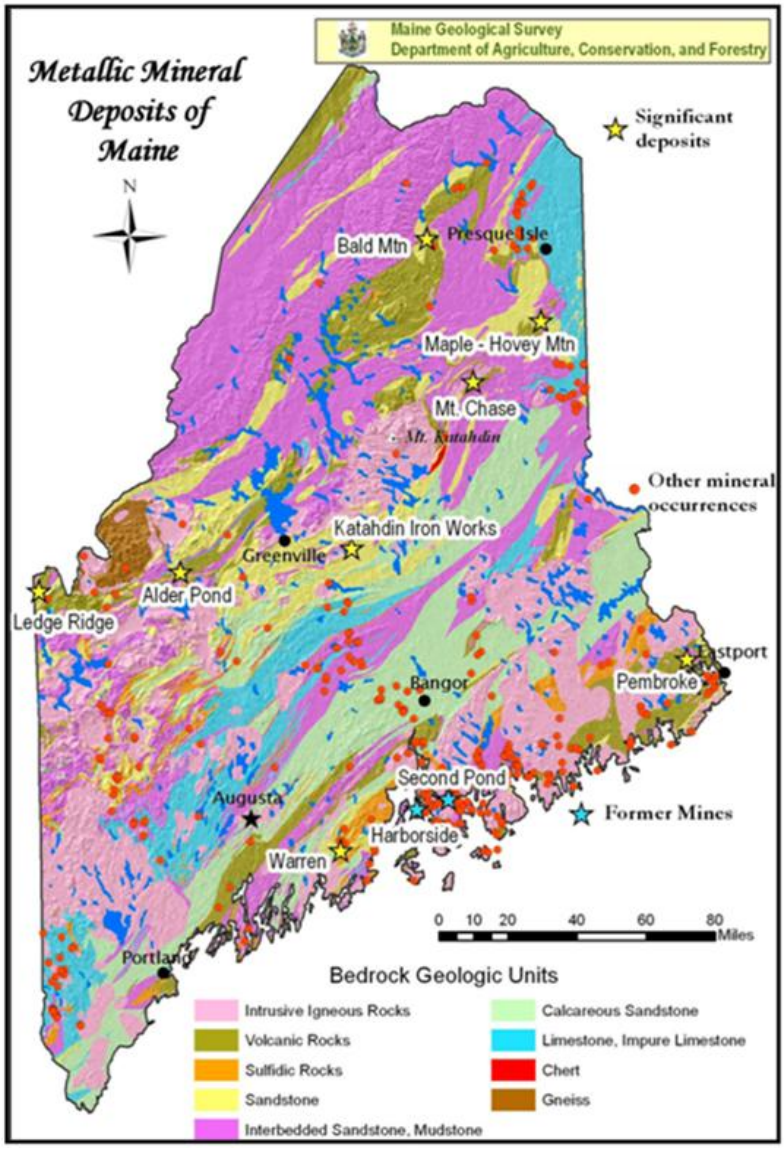

Figure 1.1. Metallic mineral deposits of Maine Map (Maine Geological Survey, 2013).

1.2. Mixed Methodology

This study implements a mixed methods approach utilizing a three component convergent research design (Creswell, 2015). Mixed method approaches aim to capitalize on the strengths of both qualitative and quantitative approaches by integrating and comparing the two within the scope of one study (Creswell, 2015). The qualitative component (Chapter 2) is a case study using qualitative content analysis on public hearing testimonies and news articles about the MMM policy process. The quantitative component (Chapter 3) comprises a resident mail survey designed to capture the risk perceptions of Maine residents toward MMM in Maine. The survey design was informed by some initial qualitative data and a pilot online survey conducted during a spring 2016 environmental attitudes and behaviors course at the University of Maine. This pilot survey is not dealt with directly in the scope of this thesis project. Both components ran concurrently with each influencing the other during the data collection and analysis stages. The final component (Chapter 4) involves the integration of the findings from both the qualitative and quantitative components into a combined conclusion of lessons learned.

1.3. Theoretical Framework for Risk Perception Model

The risk perception model developed through this research is an adapted version of the Climate Change Risk Perceptions Model (CCRPM) developed by van der Linden (2015). According to Thouez and Singh (1984), attitudes and behaviors can only be understood through psychological processes. "Psychometrics is the study of the operations and procedures used to measure variability in behavior and to connect those measurements to psychological phenomena" (Furr & Bacharach, 2014, p. 10). Based largely on this theory of psychological measurement, van der Linden's (2015) framework combined different social-psychological constructs that have been demonstrated in the literature to predict risk perceptions, into one

comprehensive model. These constructs include cognitive, experiential, socio-cultural, and socio-demographic factors. Our model (Figure 1.2), the metallic mineral mining risk perception model (MRPM) also uses these constructs with the addition of a trust construct (Mase, Cho, & Prokopy, 2015). The following provides a description of these different constructs used in our model and their influence on risk perceptions.

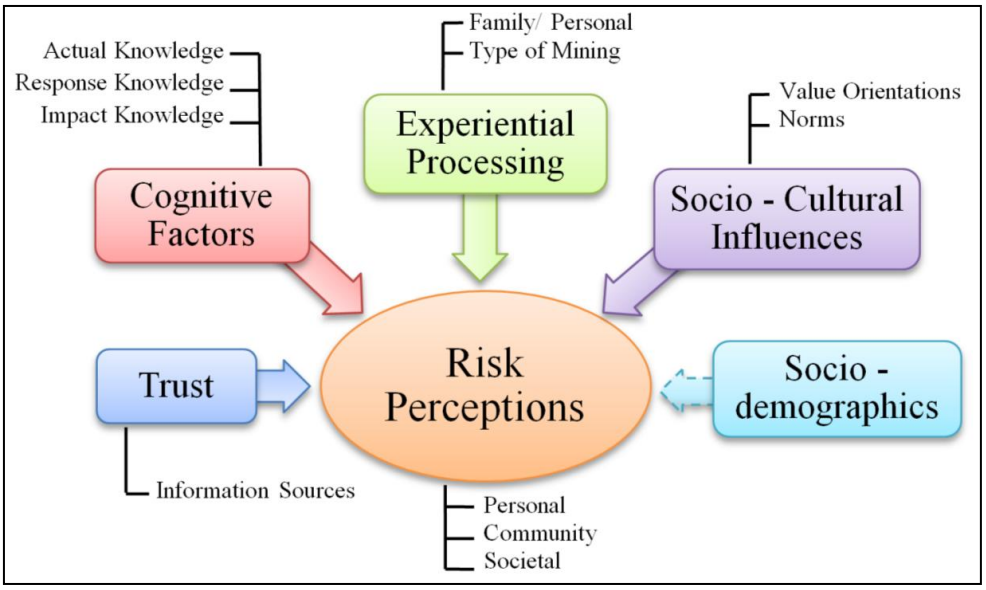

Figure 1.2. Metallic mineral mining risk perception model adapted from van der Linden (2015).

1.3.1. Risk Perceptions

Risk is uncertainty about an event or activity coupled with the possible severity of outcomes (Riesch, 2013). In addition, there are differences between an individual's personal and societal risk perceptions. For example, van der Linden (2015) found that knowledge was a significant predictor only for societal risk whereas personal experience and egoistic value orientations were only significant predictors of personal risk. Other concepts (e.g., gender, social norms) predicted both types of risk. Societal risk in this context is associated with the state of Maine overall.

Community risk is an added type of risk perception to the model. This type of risk is important to distinguish from personal and societal because mining costs tend to be disproportionately borne by the local communities whereas the benefits are dispersed throughout society (Campbell & Roberts, 2010). Community risk is also unique because of the "not in my backyard" (NIMBY) phenomena. NIMBY is the "opposition to the siting of locally undesirable land uses…which present unusually high risks" to the local community or natural environment (Kelly, 2011). NIMBYists are not necessarily opposed to land uses like mining they just don't want them near their home (Kelly, 2011). Thus by including community risk along with personal and societal risk, variability can be measured. For example, if community risk is high while personal and societal risk is low then the NIMBY phenomena may be present.

1.3.2. Cognitive Factors

In order for the role of knowledge in risk perceptions to be detected, different forms of knowledge should be utilized (Kaiser & Fuhrer, 2003; van der Linden, 2015). The MRPM measures three interrelated cognitive factors: actual, response, and impact knowledge about metallic mining in Maine. These differ slightly from the original model with the use of actual knowledge instead of cause knowledge.

The following is an example of how knowledge can influence risk perceptions. When people lack prior knowledge, their attitudes can shift with any new information received (Slovic, Fischhoff, & Lichtenstein, 1982). Heberlein (2012) calls these weak attitudes opinions because they lack cognitive structure. Given the novelty of the MMM topic in Maine, measures have been added to ascertain if respondents have heard of the topic prior to taking the survey and if so, what sources did this information come from. If a respondent has not heard of the topic before

then the survey is their first encounter with MMM. This should be able to explain any inconsistencies with their responses throughout the survey.

1.3.3. Experiential Processing

"Attitudes based on direct experience are better developed. They have more beliefs, they're more stable, and they have stronger affect" (Heberlein, 2012, p. 26). Personal experience is also connected with heuristics which are mental shortcuts. People often process information about complex risk issues by linking them with past experiences or vivid examples from specific events (Mase et al., 2015). Therefore, if someone has prior experience with mining activities they will associate and evaluate the current MMM issue through those experiences and tend to have stronger attitudes associated with the topic.

1.3.4. Socio-Cultural Influences

The CCRPM utilized broad value orientations to explain risk perceptions. Vaske (2008) distinguishes between value orientations and values which "transcend situations, issues and objects" (e.g., honesty) (p.24). Value orientations, though guided by values, are "patterns of direction and intensity among basic beliefs" which "reflect our thoughts about specific objects or issues" (Vaske, 2008, p. 25). According to van der Linden (2015) three broad value orientations are relevant for environmental issues. These are egoistic (i.e., caring for one's own wellbeing), socio-altruistic (i.e., caring for others), and biospheric (i.e., caring for nature) value orientations (van der Linden, 2015).

Risk perceptions are also influenced by interaction with other people and social structures (Joffe, 2003; Kasperson, et al., 1988). Norms are one of the most useful and powerful concepts in social psychology (Heberlein, 2012). A key distinction between norms and attitudes is that

norms come with sanctions or punishments (Vaske, 2008; Heberlein, 2012). Descriptive norms are behavioral regularities (Heberlein, 2012); they are "what most people are doing" (Vaske, 2008, p. 27). Injunctive norms are "what people should or ought to do in a given situation" (Vaske, 2008, p. 27). These two norms are categorized as social norms where the punishments are administered by others. Personal norms represent an individual's belief system, carry an individual sense of obligation, and have internal sanctions (Heberlein, 2012).

1.3.5. Trust

Though not originally a component in the CCRPM, van der Linden (2015) suggests that trust factors would be useful additions. This study thus incorporates a trust in information sources component similar to what Mase et al. (2015) added to the Social Amplification of Risk Framework. When a person feels that an information source shares similar values, is consistent with initial beliefs, and has the public's best interest in mind that source is trusted more; while conversely, information from sources that they feel do not meet those standards are rejected (Mase et al., 2015; Slovic et al., 1982).

1.3.6. Socio-Demographics

Gender and political affiliation were the only socio-demographic factors that influenced risk perceptions with the CCRPM. Other factors such as income, education, and age had no significant effect on risk perceptions (van der Linden, 2015). This lower explanatory property is reflected in figure 1.2 with a dotted outline on the socio-demographics arrow. These socio-demographics are still important because they act as control factors and allow evaluation of how well the sample reflects the population.

1.4. Research Paradigm

I am conducting a study on risk perceptions of MMM in Maine using a mixed methods approach. This approach utilizes both quantitative and qualitative methods in order to build upon the strengths of each and create a more complete picture of the phenomena being studied. Reflective of this approach I hold a pragmatist paradigm toward research. As a pragmatist, I focus on multiple methods and sources of data collection and the practical implications of my research (Creswell, 2013).

The ontological assumption is that reality is what is practical or useful and, epistemologically; this reality is gained by utilizing many different research tools (Creswell, 2013). My axiological assumption is that I will discuss both the relevance of my own values but especially that of the study participants (Creswell, 2013). Methodologically, I am utilizing mixed methods to study the topic within its real-world context and using inductive logic where the analysis may change as more details unfold (Creswell, 2013).

1.5. Researcher-as-Instrument

A researcher (whether qualitative, quantitative, or in my case both) should recognize that no matter how objective they try to be that the researcher is doing the final interpretation. In other words, a researcher's beliefs and attitudes can influence the findings and interpretations (Ely, Vinz, Downing, & Anzul, 1997). When this is recognized up front, a researcher can be more transparent to themselves and others. By understanding the context (both of yourself as the researcher and that of the research topic) and being aware of this knowledge throughout the process, a researcher can take steps to overcome biases while also discovering things that may remain hidden if context is not understood (Flick, 2002). This section is an attempt at this

transparency for others to understand how I as the researcher view myself within the context of this research topic and the filters I use.

Born and raised in Maine, my childhood contains memories exploring gem mines in Oxford County. These mines created scars in the landscape but as a kid I was unaware of this. To me they were places of adventure where I could pretend to be an archeologists digging for fossils and where moose would sometimes come to lick the exposed minerals. In recent years I lived in the Old Town area and have been blessed to extend my outdoor experience to northern and Downeast Maine, areas that have many of the significant metallic deposits in the state. Those deposits have the potential to provide jobs for residents in these rural areas. As a husband and a father of three young children I understand the necessity of adequate employment opportunities.

Professionally I have sought training in outdoor recreation management and conservation sciences. Recognizing that the choices we as humans and society make significantly impact the environment, I am currently focusing on the human dimensions of natural resources. I recognize our right to utilize the natural resources God has given us (note that utilize does not merely imply economic gain but also for other purposes such as enjoyment, etc.). However, these resources are to be used "with judgment, not to excess, neither by extortion" (The Church of Jesus Christ of Latter-day Saints, 1831). We are to be good stewards of this earth.

My research paradigm is pragmatic (i.e. open to using what works best for a given problem) (Creswell, 2013). This paradigm choice is a result from noticing that decisions in life are hindered by our adherence to one theory, ideology, or stance that we cannot even hear what someone else with another view is saying. For instance, political polarization comes partly from

one party screaming ‘jobs, jobs, jobs’ and another yelling the ‘environment’; arguments go nowhere when both sides try hollering over each other.

My stance is similar to Gifford Pinchot; “Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run.” So I ask - will metallic mines in Maine achieve this? As it stands right now I don’t think so. Now don’t get me wrong, I am not outright saying that metallic mineral mining should not occur and nor am I saying it should. I’m saying it depends. It depends largely on the state government in creating appropriate rules. It comes down to risk management. Safeguards must be in place and enforced. The benefits of a mine will be as long as the mine is operational. If done wrong, the negative impacts can last for generations.

I am not a big advocate for government regulations in general. I believe when we over rely on regulation we are trying to pass off our own responsibility, a sentiment shared by Aldo Leopold (1949). When are regulations necessary then? I believe that they are necessary when the freedom of others is grossly impaired. During this research I have discovered that metal mining can, has, and often does result in large negative impacts to those outside the mine. Only in instances where a mine was held to a high standard were the positive and negative impacts more balanced. It is better for one company to be restricted than an entire region’s freedom be diminished.

1.6. Organization of Thesis

This introductory chapter has expounded upon the antecedents to this research. This thesis is further comprised of two articles intended for scientific publication. Chapter two has been submitted for publication in Resources Policy, an international scientific journal on issues

involved with any type of mining. This article is the qualitative component of the full mixed methods study. It is a case study that describes the context and uses qualitative content analysis to determine the major themes from the metallic mineral mining debate within the state government. It investigates how the idea of a social license to operate can be broadened to apply to a policy development context. The chapter concludes with lessons that could be useful for other regions that may be developing policy to direct metal mining activities for the first time.

Chapter three is an article that will be submitted in the near future to Society and Natural Resources Journal. As the quantitative component, this chapter utilizes a resident mail survey to capture the risk perceptions of the general Maine population toward metallic mineral mining in the state. Using the adapted risk perception model presented earlier (Figure 1.2) this study investigates the constructs that predict risk perceptions through the use of multiple hierarchical regression models.

The concluding chapter forms the convergence of the qualitative and quantitative components of this mixed methods study. By combining findings from both the debate that occurred in the public square and the perceptions from a sample that is representative of the general Maine population the level of congruence between the two are displayed. This convergence allows for a more complete research picture where general lessons are presented and implications for future research are discussed.

CHAPTER 2

DEBATING METALLIC MINERAL MINING IN MAINE: THE RELEVANCE OF SOCIAL LICENSE TO OPERATE IN A STATEWIDE POLICY DEVELOPMENT CONTEXT

2.1. Chapter Abstract

As new locations for metal mines are sought, some regions with limited experience with metal mining find themselves grappling with the issues that surround these activities. In 2012, Maine, USA found itself in this situation when renewed interest in some of the state's largest metal containing deposits spurred the legislature to pass a new metallic mineral mining law in less than two months. This paper illuminates the subsequent five year debate that has ensued since the introduction of the 2012 bill. Available research concerning public debates on mining have been in areas with an already established mining industry and most focused on particular mine sites. The present study differs in that it covers a state-wide policy debate in a region with very little experience with metal mining. This case study uses qualitative content analysis to identify the positional stances of stakeholder groups and the major themes that have been most prominent throughout the debate. Four themes were identified from this debate: water permeates everything, using experiences and examples, inadequate rules, and mistrust. Rushing a bill through in less than two months created mistrust, confusion and unforeseen problems with wording, definitions, etc. Natural resource dependent regions like Maine may not necessarily be opposed to developing metal mining operations so long as they feel regulatory frameworks adequately ensure protection of existing resources (i.e. water, other industries, etc.). Counter-intuitively, strict and clear regulations that reflect the values of local residents might actually

lead to a more efficient approval process. Maine provides a good example for other areas that may be facing this controversial issue for the first time and need to develop appropriate policy.

2.2. Introduction

The demand for metal products, largely due to growing global affluence, compels society to extract more raw metals from the earth. Natural resource dependent regions with existing metal ore deposits are inclined to look to mining as an option for improving the economy. However, many are skeptical of metallic mineral mining's (MMM) ability to provide economic benefits to local communities and others are likewise concerned about the environmental damage that can occur. If those concerns are not addressed properly then MMM operations will likely fail to gain a social license to operate (SLO) because of intense opposition. A SLO refers to the "acceptance or approval of mining operations by local communities and other stakeholders, who can affect the profitability of those operations" (Zhang et al., 2015). While research on social license has focused primarily on local stakeholders involved with permitting or operating individual mines, the concept equally applies to a larger context of MMM policy development for an entire state because government policy development constitutes an initial step in the SLO process and can facilitate or hinder future debates on individual mining operations (Prno & Slocombe, 2012; Zhang & Moffat, 2015).

This is the case of Maine, USA, which in 2012 began the process of changing its MMM policies. With limited experience with modern MMM and facing renewed interest in some of the state's largest metal containing deposits, the state legislature pass a new MMM law in less than two months. This paper identifies the themes that have been prominent during the resulting five year debate and demonstrates the relevance of an SLO in a statewide policy debate context.

2.2.1. Background

Solomon, Katz, & Lovel (2008) argue that the social context of mining is broader than just local mining communities and that research needs to delve into this broader context. Yet research concerning public debates on mining has primarily focused on community conflicts involving the permitting or operation of a single mine (Hutchins, Walck, Sterk, & Campbell, 2007; Campbell & Roberts, 2010; Gibson, 2006) but none to a policy debate that covers an entire state or region. Additionally, these studies are usually in geographic regions/communities with an already established mining industry. Campbell and Roberts (2010) demonstrate that pro- and anti-mining stakeholders rarely shift their positions. Rather than working together to reach consensus, these two opposing sides spend their resources on trying to convince those who are undecided about a mining project. Hutchins et al. (2007) found that both sides attempted to use science to support their arguments as well as phraseology directed to elicit an emotional response. In contrast, conflict resolution can be achieved by involving local stakeholders in decision making and focusing on contributing to long-term sustainability of host communities (Gibson, 2006).

Public perceptions play a significant role in these types of debates. The perception of negative impacts from metal mines can create challenges for the mining industry even if scientific studies provide evidence that those perceptions are unfounded (Younger, Coulton, & Froggatt, 2005; Prno, 2013). Using scientific studies and language can actually cause more conflict if the information source is not trusted (Gallois, Ashworth, Leach, & Moffat, 2017; Suopajarvi et al., 2016; Mase, Cho, & Prokopy, 2015). However, even if trust is established the risks can still be deemed too high (Holley & Mitcham, 2016). When additional economic activities (i.e. existing industries such as nature-based tourism and agriculture) are closely tied to

the natural environment just the perception of negative impacts from mining are enough to affect the 'clean' image that these industries depend upon. As Younger et al. (2005) demonstrated, the presence of a commercially harvested resource played the most important role in the decision to continue water treatment at a closed mine because of the occasional discoloration of the nearby waterways. Even in areas that generally accept mining there can still be very strong concern about environmental contamination (Suopajarvi et al., 2016; Zhang & Moffat, 2015). In northern Russia and Scandinavian countries (areas that share similar northern wet climates and resource dependent industries as Maine) strongest environmental concern came from areas with pre-existing natural resource dependent industries like reindeer herding and nature-based tourism (Suopajarvi et al., 2016). Therefore, Younger et al. (2005) concluded that physical science investigations must be coupled with studies on the social context for appropriate decision making.

Governments can also shape how people perceive the mining industry and affect the likelihood of an SLO being granted (Prno & Slocombe, 2012). For instance, strong political support for mining can sometimes contribute to locals feeling powerless (Suopajarvi et al., 2016). Zhang & Moffat (2015) found that confidence in government played a significant role in residents' level of acceptance. Environmental concerns were offset and level of acceptance increased if residents perceived that there were strong regulations and the government had the ability to hold the mining industry accountable. Conversely, when government was perceived to be weak, acceptance level significantly decreased even for those residents with low environmental concerns (Zhang & Moffat, 2015). When governments actually weaken environmental laws in the hopes of generating economic benefits from mining the result can be the opposite with non-realized economic gains for the local communities alongside increased

pollution (Essah & Andrews, 2016; Zhang & Moffat, 2015). Therefore, government must play a key role in ensuring mining increases the sustainability of local communities as companies are unable to fully achieve that on their own (Essah & Andrews, 2016). In order to increase sustainability, financial resources need to flow from a mine to local communities (Fordham, Robinson, & Blackwell, 2017). Governments can help by repurposing tax revenues from a mine into the communities for capacity building and trainings that promote business start ups unrelated to a local mine (Essah & Andrews, 2016). Laws and regulations can direct companies to adopt more sustainable practices that can result in lasting positive benefits for the host communities and ecosystems, such as mandating public involvement as part of the permitting process (Fordham et al., 2017; Holley & Mitcham, 2016).

2.2.2 Case of Maine

Though Maine has some MMM history, there has been no metal mining in the state for over 40 years. When metal mining rules were implemented in 1991, MMM exploration in the state ceased as some called the rules a moratorium on mining because of how restrictive they were. These restrictions included separate and redundant permitting processes through two state agencies, baseline monitoring on 24 specific factors, no discharge allowed to groundwater and site reclamation to original condition (Bernard, 2013). In 2012 however, one of Maine's largest landowners, J.D. Irving, Limited, a Canadian based company, expressed interest in mining a metal ore deposit they owned on Bald Mountain in northern Maine (Figure 2.1). A new MMM bill was soon introduced that aimed to streamline the permitting process. This bill was introduced late in the 125th legislative session and passed in less than two months, an incredibly short time especially for a bill of this nature.

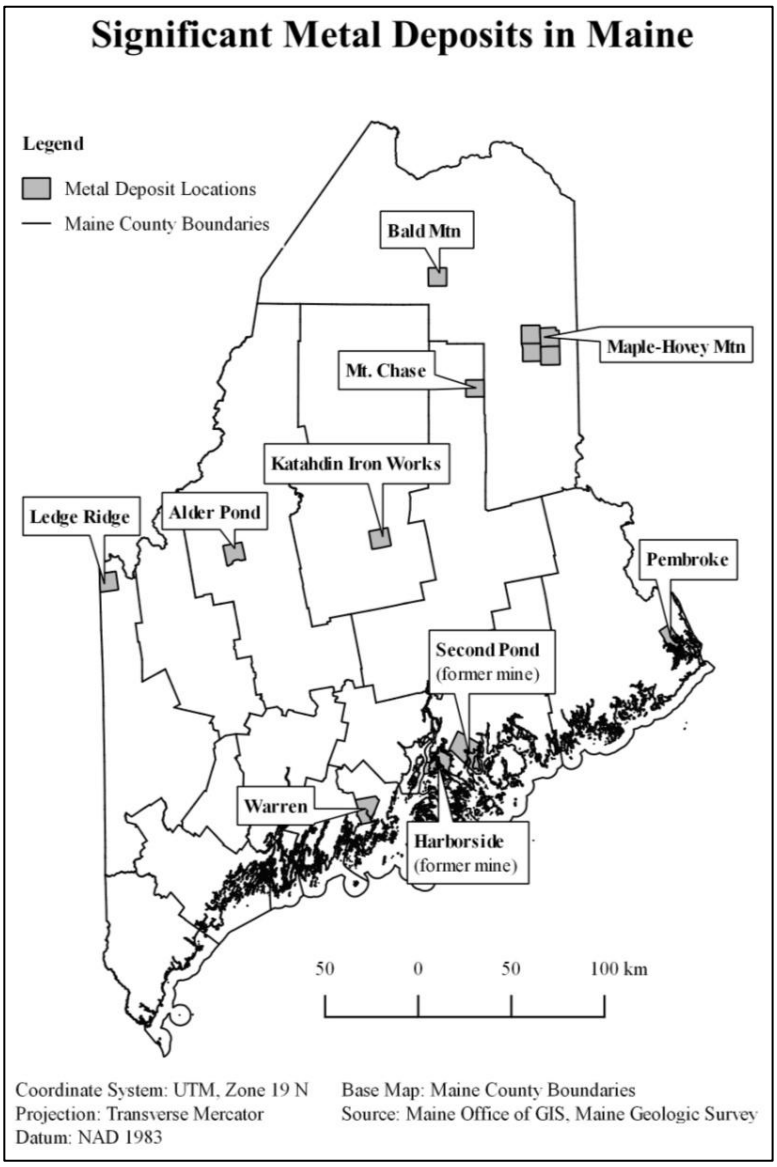

Figure 2.1. Map showing locations and names of the 10 known significant metal deposits in the state of Maine.

The 2012 MMM law provided a general framework for and mandated that the Maine Department of Environmental Protection (DEP) write new rules that complied with the law. Since then, each iteration of the MMM draft rules has been rejected by the legislature. Subsequent MMM bills introduced with the aim of strengthening the environmental protections within the 2012 law likewise either failed to pass the legislature or the veto power of the governor.

This renewed interest in mining metals in Maine came during a time when metal prices were at their highest since before the great recession. However, since 2012 prices of many metals, including gold, silver, and copper (all present in the Bald Mountain ore body) have experienced a decreasing trend (The World Bank, 2017; Karl & Wilburn, 2017). Copper, for instance, went from a high of $7,955 real USD per metric ton in 2011 down to $5,152 real USD per metric ton in 2016 (The World Bank, 2017). It is interesting to note that early on J.D. Irving, Limited and other mining proponents were prominent stakeholders but have likewise diminished their presence over the course of the debate.

It has been an opposite pattern with opponents. The rapidity with which the 2012 law was passed meant there were not many residents even aware of its existence. Prominent environmental groups and a few legislators with the most recently closed metal mining sites in their districts were the first responders. Environmental groups, led by The Natural Resources Council of Maine (NRCM), quickly banded together and steadily garnered more support. In later years they provided template emails and encouraged people to use these to submit comments during times when the state government was taking public comments.

Of primary concern from opponents is metal mining's potential to generate toxic pollutants. Maine's known concentrations of metal ore are contained within volcanogenic massive sulfide deposits (Maine Geological Survey, 2013). When exposed to water and oxygen the sulfide minerals react to produce sulfuric acid which dissolves and mobilizes heavy metals. Mining activities bring these minerals to the surface and increase the reactive surface area, greatly accelerating acid formation and heavy metal leaching. Other common pollutants from MMM, such as arsenic, are also produced. These dissolved pollutants are known by most as acid mine drainage (AMD) while some mining proponents may use the term acid rock drainage (Hutchins et al., 2007). The U.S. Environmental Protection Agency (2000) estimated headwaters of over 40 percent of Western watersheds were contaminated by mining activities. Skousen, Sextone, & Ziemkiewicz (2000) also estimated 20,000 km of U.S. waterways have been contaminated by AMD. Metal mining specifically is the nation's number one industry polluter, comprising 37% of all toxic releases by industries in 2015 (U.S. Environmental Protection Agency, 2017a). As a very wet state with many rivers and lakes the potential for AMD is a viable concern for human and environmental health in Maine.

On the other hand, the economic and potential social benefits are not to be ignored. In a state whose economy is largely tied to natural resources extraction/use (Brookings Institute, 2006), the potential for metal mining related jobs is especially significant at a time when many of the state's sawmills have closed leaving behind a large employment gap to fill (Viola, 2015). J.D. Irving's subsidiary, Aroostook Resources, was created to pursue the possibility of mining the deposit they own on Bald Mountain in Aroostook County. They estimated a mine here could produce 300 direct and 400 indirect jobs, as well as, $120 million in state and local tax revenue (Bernard, 2013). Aroostook County has the highest unemployment rate in Maine, which as of

December 2016 was at 5.5% compared to the USA at 4.7% (Maine Department of Labor, 2017). During the time of Aroostook Resources' economic predictions, Aroostook County's unemployment rate was near 10% (Bernard, 2013). However, some opponents say that mining would threaten industry that already exists such as fishing, tourism, and agriculture (Mountain & Bolstridge, 2016). With the state's known significant deposits lying either under headwaters of major watersheds or along the Downeast coastline, the risk to water quality, human health, the surrounding ecosystems, and existing industries seem to conflict with the need for economic development in these mainly rural areas.

2.2.3. Study Purpose

This research is the qualitative component of a larger mixed methods study looking into resident risk perceptions of MMM in Maine. In this paper we identify the main themes or debate topics that have emerged during the five year (2012-2016) MMM policy issue in Maine. We also identify the key stakeholders participating in the policy debate and their positional stance towards the main themes. Our aim was to identify the main concerns that have hindered approval and understand how social license to operate can apply to a metal mining policy development context.

2.3. Material and Methods

This study utilized a single holistic case study methodology (Yin, 2014) combined with qualitative content analysis (Mayring, 2000; Bengtsson, 2016; Hsieh & Shannon, 2005). A case study delves into a contemporary issue within its real world context (Yin, 2014). Central to case studies is the case description which allows a reader to begin to make their own conclusions because it is a factual depiction of the events and context of the study topic (Gagnon, 2009; Merriam, 2002). Qualitative content analysis (QCA) is a method that is both systematic and

flexible in describing the meaning of qualitative data. It analyzes data in its context and has the ability to reduce large amounts of text data (Schreier, 2014; Kaefer, Roper, & Sinha, 2015). Therefore, QCA was an ideal method for this stage of the research where hundreds of testimonies and news articles were identified, explored, and analyzed.

2.3.1. Data Collection and Management

Data collection included the identification and compilation of publicly available documents such as testimonies and news articles. Testimonies from each MMM public hearing conducted by the legislature between the years of 2012-2016 were downloaded from the Maine state legislature website. This website provides public information on bills introduced, public hearings and testimonies for each legislative session. The Maine Board of Environmental Protection (BEP) website was also used to collect all testimonies and written comments on the fall 2016 draft MMM rules written by the Maine DEP. In all, 780 testimonies and written comments were collected.

The collection of news articles followed the same time frame as the testimonies, 2012-2016. A total of 58 news articles were collected. Most articles came from the two prominent newspapers in the state, Bangor Daily News (BDN) (30) and The Portland Press Herald (PPH) (6). These articles were found with each website's search engine utilizing the search terms, "metallic mineral mining in Maine", "metal mining in Maine", and "Bald Mountain". All additional articles were found using the same search terms with Google. Additional article sources in Maine included Central Maine News, Maine Public Broadcasting Network, Sun Journal, Fiddlehead Focus, Pine Tree Watch Dog, University of Maine, Fox News Bangor and WABI. Some out-of-state sources also covered the Maine MMM issue. These included articles from The Boston Phoenix, CBC News, Wiley Environmental Science Backyard Blog,

Huffington Post, New Brunswick Media Co-op, and the Wall Street Journal. When available, online comments attached to news articles were also captured and used in analysis.

These data were imported, stored, coded, and analyzed in NVivo 11 Plus© software. Testimonies were classified by month, year, legal document, government entity hosting the hearing, position, type of testifier (resident, organization, etc.), and by Maine county if applicable. Newspaper articles were classified by month, year, outlet source (BDN, PPH, other in Maine, other out-of-state), author/reporter, and the public hearing if applicable (Kaefer et al., 2015). This classification scheme was an important preparation for conducting more in-depth analysis through the use of matrix queries that helped determine patterns among stakeholders groups and positional changes over time (Bringer, Johnston, & Brackenridge, 2006; Robertson, 2008).

2.3.2. Ethical Considerations and Trustworthiness Strategies

Steps were taken to anonymize individual residents so as to not cause unwanted attention and dissuade future participation in political debates. The dependability, confirmability, and transferability of this research was ensured through using only publicly available data thereby allowing others the ability to utilize the same methods with the same data. To address credibility, triangulation of methods (Creswell, 2013; Yin, 2014) was conducted between testimonies and news articles, and between source types (e.g., government, organization, individuals) to determine the level of congruence.

2.3.3. Data Analysis

A multi-level coding scheme was used (Kaefer et al., 2015; Miles, Huberman, & Saldaña, 2014). The first level of coding began by using word frequency and text search queries, as well

as, using NVivo's auto coding capabilities. The software searched through the project's database, automatically coded, and returned the most prominent category nodes and the child-nodes. These child nodes are In Vivo codes—codes in the participants' own language (Miles et al., 2014). Using open coding (Miles et al., 2014), each node generated was opened, references were checked within the source document for appropriate context (Blair, Weible, Heikkila, & Evensen, 2016), and further categorized in a new nodes folder.

Pattern coding, grouping the categories into larger themes, constituted the second coding level (Miles et al., 2014). Matrix queries were then conducted on the different time periods in order to capture the evolution of the policy process. As suggested by Miles et al. (2014) we made occasional use of numbers to help check for bias and the robustness of interpretations.

2.4. Results and Discussion

The following results reflect the positions of residents and organizations who have participated in public hearings and the news articles that have covered the debate. These should not be construed to necessarily represent the Maine population as a whole. The generalization to the entire population is addressed in a different stage of this research.

In general, stakeholder positions did not change throughout the course of the debate with opposition being the prominent stance. Over the past five years only bills that sought to strengthen the 2012 Metallic Mineral Mining Law received more public support than opposition. Each submitted revision of the rules received primarily opposition from testifiers at public hearings. For the most recent draft rules in fall of 2016, the opposition was overwhelmingly dominant with 486 opposed while only three supported and two testified neither for nor against the rules.

Some of the key concerns referenced in the documents are: impacts to water quality, financial assurances, uncertainty about mining on public lands, human and wildlife health concerns, catastrophic disasters, site closure and reclamation, and potential impacts to existing industries. Proponents stressed the economic benefits and that modern mining technologies and techniques could alleviate the issues expressed by opponents. This research highlights four themes that have been prominent in the debate: water permeates everything, using experiences and examples, inadequate rules, and mistrust.

2.4.1. Water Permeates Everything

Maine is a very wet state, with over 32,000 miles of rivers and streams, 6,000 lakes and ponds, and 42 inches of average annual rainfall (Maine Department of Inland Fisheries and Wildlife, 2016; Maine Geological Survey, 2012). Reflective of its prevalence in the state, the topic of water has permeated nearly all facets of this policy debate. The potential of AMD contaminating water sources has influenced the debates revolving around other topic areas such as financial assurances, site closure and reclamation among others. For instance, AMD could impact human and wildlife health, the quality of public lands, and existing industries that depend upon clean water. MMM was seen as an enormous threat to clean water, which one online comment affirmed, "is our most abundant and precious asset" (dogfight2, 2016). Indeed many perceived clean water to be one of Maine's best assets. They attributed clean water with economic value, quality of place, human health, and associated it with Maine's overall identity. Utilizing NRCM's email template to emphasize this point, 211 people submitted written comments during the fall of 2016 with the following statement:

> As Mainers, we depend on clean water to support our tourism, fishing, hunting, and recreation industries. Not only does our clean water directly and indirectly support thousands of jobs across the state, it is a part of our way of life (Ch200, 2016).

2.4.2. Using Experiences and Examples

Due to the close of the last metal mines in the 1970's and the cessation of MMM exploration in the early 1990's, Maine lacks the experience and knowledge of having active metal mines. However, in processing new risks, people often use whatever experience or knowledge is available to them (Mase et al., 2015). Even if they are not recent, experiences or knowledge that have vivid negative consequences can become dominant in processing information (van der Linden, 2015). Many who have testified express high risk because of their experience with Maine's two most recent metal mines, one of which is a superfund site (U.S. Environmental Protection Agency, 2017b), though both are commonly labeled as such. Others have looked to experiences with metal mines elsewhere. Both used these experiences to highlight MMM's history of environmental damage that negatively impacts water, wildlife, and the economy while sometimes leaving the public to pay for the cleanup costs, as illustrated by the following two quotes:

> I live in the Blue Hill Peninsula area, the site of 2 Super Fund sites...Although both mines are quite old, 35+ years, they continue to be toxic necessitating monitoring and clean up funds borne by the taxpayers...These two sites illustrate the devastating history of mineral mining...it damages the environment and when the mine is played out, the mess is left behind. (Female, LD1772, 2014).

> I have observed mines and mining operations on three continents and in many countries. What too many have in common are the contaminated waters, decimated fish populations, polluted air and destroyed landscapes left behind. Those consequences elsewhere — and in Maine — should be enough to convince Maine residents that they don't want a new mining operation here that could endanger the wildlife, fishery, forestry and recreation areas that are this state's proven assets (Kircheis, 2014).

Since the closure of Maine's two metal mines there have been many environmental regulations like the Clean Water Act as well as advances in technology. Therefore, supporters say that this is not a reasonable comparison because of the age of these sites.

> This reputation stems for the most part from unregulated mining which pre-dated the EPA or the DEP but the legacy of fear about mining persists and in the present case, is being exaggerated by those individuals and groups who clearly are anti-mining, at least for Maine (Male, LD1772, 2014).

Yet, opponents continually called upon proponents to cite good examples of metal mines. At each instance they struggled to do so. Opponents did not have any difficulty citing bad examples, which were almost always of open pit mines and tailings ponds. They especially capitalized on two high profile examples of catastrophic metal mine failures that occurred during this time frame: the Mount Polley mine in British Columbia and the Gold King mine in Colorado. Mount Polley was an active modern copper and gold mine whose tailings pond dam was breached in 2014 and led to the four square kilometer tailings pond being emptied into the nearby creeks and lakes. The Gold King mine is a superfund site that the U.S. EPA was working on cleaning when a massive spill occurred in 2015 leading to the nearby Animas River turning bright orange. These two examples highlighted opponents fears and provided additional evidence of metal mining's potential for environmental disasters.

> The mining industry claims that modern mining is different, that they can now control pollution and reclaim mining sites to their former beauty. That is simply not true. I point to the Mount Polley Mine disaster last year in British Columbia, a "modern" mine that had a massive tailings pond failure (Resident, LD146, 2015).

Even if mining operations continue to get better, the negative perception is likely to still pose a challenge (Prno, 2013; Younger et al., 2005). The long history and examples of pollution, disastrous spills, and negative effects on local communities provide ample fodder for people to use in processing the pros and cons of mining in future debates. Each new mine failure from

anywhere in the world only aids people's ability to quickly link metal mining with vivid negative experiences or examples. Figuring out a way to overcome that image is a great challenge that faces the entire mining industry since the examples used were not just from metal but other forms of mining as well.

2.4.3. Inadequate Rules

The areas of concern and the examples of mining disasters were all used to demonstrate the weaknesses within the MMM draft rules and by extension the 2012 statute. In essence, much of the opposition comes from views that the mining risks are too high and the rules are inadequate to reduce that risk. Perceived inadequacies in the rules include but are not limited to: allowing discharge into groundwater within the mining area, unclear definitions, vague standards like "reasonable assurance" and "to the extent feasible", the allowed proximity to water bodies and public lands, leaving mining on public lands in question, and insufficient required financial assurances to protect Maine taxpayers from clean up costs.

Many believe policy makers have pushed for weaker rules while the testimonies have been disproportionally calling for stronger ones (see Table 2.1). However, some, especially DEP have argued that the rules cannot be any stronger because they have to fit within the framework of the 2012 statute. This has displayed the problem caused by the rapid passage of a law concerning an unfamiliar topic and without sufficient public or professional input. During the public hearing held by BEP on the proposed rules in September 2016, the deputy commissioner of DEP, stated: "What we're hearing today is a great deal of opposition to the law. Unfortunately, we do not have the power to change the law. What we have to do is change the rule" (Tremble, 2016). The DEP communications director has added these comments:

> [The DEP] cannot exceed or act contrary to its rulemaking authority and other state laws... department does not have the ability to fully address these concerns without statutory changes by the Legislature (Brino, 2016).

Frustration has also mounted as the interval lengthens between the passage of the 2012 law and the approval of the rules. Not just opponents but companies with mining interests also share the frustration.

> The fact that the State has passed a new metallic mining law, however failed to adopt pertinent rules in essence creates a moratorium, or at the least the basis for a lengthy litigation battle if someone were to apply for a permit (Aroostook Resources, LD 750, 2015).

Table 2.1 displays additional evidence on the perceived inadequacy of the rules by highlighting representative quotes within three nodes – weak mining rules, need protective rules, and lack of experts. These quotes stress that the proposed rules are too weak to protect Maine's existing resources, calls for stronger rules that include clear language, and a few have pleaded for more unbiased expert input into the rule making process.

Table 2.1. The number of references and representative quotes by year on the inadequacy of the mining rules by node. Quotes are organized chronologically by year and the number displayed above each quote is the number of references coded within that node from that particular year.

Nodes	2012-2013	2014	2015	2016
Weak mining rules	6	12	57	620
	"2,000 people signed a petition submitted by Maine Conservation Voters expressing opposition to weak mining rules" (Lynds, 2013).	"Despite overwhelming public comment in favor of stronger and more protective rules...the overall direction of these changes is to make the rules substantially less protective" (Conservation Organization, LD1772, 2014).	"To risk our precious natural resources with weak mining rules is unacceptable" (Female, LD 146, 2015).	"I am very concerned that these weak rules would allow mining corporations to pollute our water and harm our woods and wildlife for centuries" (211 written comments used this phrase).
Need protective rules	9	14	32	13
	"A region where economic development, whether industrial or recreational must be subject to stringent rules" (Male, LD 1059, 2013).	"I am not opposed to the extraction of metallic minerals in Maine, but am committed to rigorous oversight, with tough, clear and effective rules that are vigorously enforced" (Male, LD1772, 2014).	"We need very protective and clear rules that will help prevent the type of problems that have plagued communities, taxpayers and the environment near mines across the country. These rules are neither protective nor clear" (NRCM, LD 146, 2015).	"I hope you will do everything in your power to establish strong mining rules that will protect Maine's amazing water resources. The proposed rules are not strong enough" (Female, Ch 200, 2016).
Lack of experts	2	2	1	1
	"The task of designing rules now that really will be adequate for the future will take more expertise and time than this committee has available in these few weeks" (State Representative, LD 1853, 2012).	"The current language has no scientific basis and provides no clear guidance for how a mining company might be expected to develop and defend its monitoring plan" (Male, LD 1772, 2014).	"14 committee members and Maine's legislature, without sufficient factual knowledge taken into consideration, should not be making this decision..." (Tuttle, 2015).	"demand that the statute be fixed under expert guidance of a multi disciplinary expert panel free of all political, agency and mining lobby influences" (NGO, Ch 200, 2016).

2.4.4. Mistrust

Others have expressed opposition partly due to the mistrust they have in the state government. As suggested by Mase et al. (2015), mistrust in government in this case has also presented a significant barrier to rule adoption and intensified the public response. This mistrust has stemmed from the involvement of J.D. Irving, Limited in the initial push for a new mining law and their relationship with the state legislator who sponsored the bill. For example, NRCM stated:

> These rules are the result of JD Irving's stated desire to mine at Bald Mountain. The sense of urgency that has surrounded this rulemaking over the course of the past two years — the sense that Maine needs new mining rules is also a JD Irving creation (LD 1772, 2014).

Additional sources of mistrust include the rapidity of the passage of the 2012 law, little initial public input, suspected non-compliance with Maine's Administrative Procedures Act (MAPA), resubmitting rules that were alleged to be the same as the rules that were rejected the year before, and the appearance of weakening rules while public input was calling for stronger ones. In essence, as Prno & Slocombe (2012) cautioned, enough questionable practices occurred that de-legitimized the entire process. Table 2.2 displays people's mistrust in the state government through representative quotes within four nodes – irresponsible mining rules, current state administration, MAPA non-compliance, and resubmitting rejected rules.

Table 2.2. The number of references and representative quotes by year about mistrust in the state government by node. Quotes are organized chronologically by year and the number displayed above each quote is the number of references coded within that node from that particular year.

Nodes	2012-2013	2014	2015	2016
Irresponsible mining rules	4	4	22	119
	"Maine Legislature in 2012 rushed through a law requiring the DEP to write new, less-stringent mining rules for the whole state" (Tapley, 2013).	"The proposed changes to mining regulations constitute careless, even reckless, gambling with our long-term safety and prosperity for the sake of short-term profit" (Private Business, LD1772, 2014).	"It is clear that the overall intent of these metallic mining rules is to relax regulations on the metallic minerals mining industry" (16 written comments used this phrase, LD146, 2015).	"The past two years, thousands of citizens and many local organizations said "NO" ...and defeated these irresponsible mining rules" (111 written comments used this phrase).
Current state admin.	5	2	0	115
	"[The Governor] and his cronies want to say 'screw clean water, we need ten jobs for ten years'" (Earthling3, 2012)	"It is impossible to overstate the arrogance in the agency's responses to precautionary testimony in the record" (Resident, LD1772, 2014).		"For the third year in a row, the [Current] Administration is pushing weak mining rules that attack our clean water and land" (111 written comments used this phrase).
MAPA non-compliance	1	11	16	2
	"In light of the improprieties on the part of Maine DEP, and considering the devastating damage that would be allowed under the permissive rules proposed by the agency, I contend that the mining law enacted in 2012 must be repealed" (Spear, 2013).	"The Department of Environmental Protection... did not follow administrative procedural rules that require a ten-day public comment period" (State Representative, LD1772, 2014).	"I understand that LD 750 ...demands that the rejected metallic mining rules comply with Maine's Administrative Procedures Act" (Resident, LD 750, 2015).	"MAPA specifically requires that DEP affirmatively seek best knowledge and science applicable to all rulemaking, even routine technical rules. DEP has not satisfied that standard for many many years now. It is not meeting this standard in this reckless rule" (NGO, Ch 200, 2016).
Re-submitting rejected rules	0	0	22	9
			I speak in opposition to L.D. I46, a bill that contains verbatim the same mining rules that were rejected by the legislature last year (Female, LD 146, 2015).	"My comments on the "revised" mining rules...are almost identical because the rules are almost identical" (Male, Ch 200, 2016).

Similar to Suopajarvi et al. (2016) residents were also skeptical of information from the mining industry. Trust in information sources can play a significant role in how residents determine the level of risk involved in different activities (Mase et al., 2015). This mistrust was connected with metal mining's history of negative environmental impacts. As one resident exclaimed, "the mining industry does not have a very good or honest track record in this country!" (Resident, Ch200, 2016). Despite claims by mining proponents that advancements in mining technology can limit environmental impacts, opponents were not convinced. Speaking about a public forum held in northern Maine concerning the possibility of mining on Bald Mountain, one resident stated, "environmental risks were explained away with propaganda about technical advances that will assure drinking-quality water will leave the mining site" (LD1302, 2013). The word propaganda was used partly because these claims failed to be followed up with adequate examples of where this technology has been successful.

2.5. Conclusions

While there are many aspects of this debate that are unique to Maine, there are some general lessons that could be applied in other situations. With no recent history of metal mining, Maine can specifically provide a good example for other areas that may soon be faced with this controversial issue for the first time and need to develop appropriate policy. Trying to rush a bill through created mistrust and confusion. Counterproductively, it actually contributed to making the approval process longer, more difficult, and with stronger opposition. The length and reoccurring nature of the debate has led to increasing frustration from all sides. Governments need to recognize their role in SLO - that policy development is a first step in many towards successful mining operations. If the first step is hard the rest of the process is shaky at best. As also argued by Prager (1997), companies interested in mining should strive to earn a social

license to operate from the very beginning by recognizing this first step in the process and not merely using SLO as a reactionary tool to address threats (Owen & Kemp, 2012; Parsons, Lacey, & Moffat, 2014).

The rapid passage of a law also created unforeseen problems with wording, definitions etc. The resulting vague language and unclear regulations became a barrier for approval by many stakeholders. Those from each side of the discussion desired clear standards. Unclear rules have left the public with misgivings and interested investors with uncertainty about pursuing mining in this state. Natural resource dependent regions like Maine may not necessarily be opposed to developing metal mining operations so long as they feel regulatory frameworks adequately ensure protection of existing resources (i.e. water, other industries, etc.). Counter intuitively, strict and clear regulations that reflect the values of local residents might actually lead to a more efficient approval process for policies and an overall social license to operate.

2.5.1. Current Status of Debate

The timeframe of this project was from the debate's inception in 2012 through the end of 2016. However, nine more MMM bills were introduced during the 2017 legislative session. At the time of writing this paper, one bill was passed into law. This bill was drafted jointly between a senator, NRCM and DEP. It received support in the state legislature partly because it addressed the major concerns discussed in this paper, many of which could only be fixed by statute.

CHAPTER 3

RISK PERCEPTIONS OF METALLIC MINERAL MINING IN MAINE

3.1. Chapter Abstract

Although numerous studies have examined risk perceptions related to a wide range of issues, very few have been conducted on risk perceptions of metal mining. This study investigated the risk perceptions of Maine residents to metallic mineral mining in their state and explored the social-psychological constructs that explain risk perception levels. This study also examined the utility of a risk perception model originally developed for the topic of climate change on an additional natural resource topic. A resident mail survey (N = 501) was conducted using a stratified random sampling design. Results show that the full risk perception model is able to explain over 80% of the variance in risk perceptions with significant predictors being knowledge of impacts to local assets, normative factors, biospheric value orientations, and level of trust in certain information sources. Three separate dimensions of risk perception are also explored – personal, community, and societal. Differences and consistencies between these three dimensions are identified. The challenges of measuring risk perceptions in a region with limited firsthand exposure to the risk topic are discussed. The validity of the model is confirmed and its continued use and further adaptation in future research is encouraged.

3.2. Introduction

The risks associated with metal mining can be large and are frequently evaluated during policy development and industry risk assessments. However, perceptions of these risks by residents are seldom incorporated into such assessments (Amoatey, Famiyeh, & Andoh, 2017; Prno & Slocombe, 2012; Dogaru, et al., 2009; Prager, 1997). In spite of the growing research on

resident risk perceptions towards global and local issues that affect human health and well-being (noted below), few studies have specifically measured risk perceptions related to metal mining (Dogaru, et al., 2009; Zheng, et al., 2015). Yet, these studies didn't incorporate comprehensive risk perception models that utilize multiple constructs to predict levels of perceived risk. Risk perception models have been used and developed on a number of other natural resource based topics such as wildfire (Schulte & Miller, 2010), climate change (van der Linden, 2015; Mase, Cho, & Prokopy, 2015), nature-based tourism (De Urioste-Stone, Le, Scaccia, & Wilkins, 2016), and ecological risk based on a range of environmental hazards (Willis & DeKay, 2007). Research on metal mining has largely either focused on other social contexts (corporate social responsibility, social license to operate, economic impact, etc.) or the technical aspects of mining. As conflicts between metal mining and communities continue throughout the world, understanding how the public perceives the risk involved with such activities is important.

Results from prior studies suggests that people's risk perception associated with mining is a function of a range of explanatory factors, including resident attitudes, physical location of communities in relation to mining sites (Dogaru, et al., 2009), socio-cultural variables (Charles, et al., 2013), and economics (Charles, et al., 2013; Dogaru, et al., 2009). Further, research has shown age and gender were significantly associated with knowledge about the health effects and environmental impacts that may result from mining (Charles, et al., 2013). It was also found that an individual's occupation was associated with level of knowledge of health effects and risk factors resulting from mining activities (Charles, et al., 2013). According to Dogaru et al (2009), resident mining risk perceptions were determined by education, household income, residents' perceived change in water quality in the years prior to mining being closed, and source of water

pollution. With level of education for instance, residents with post high school education were seven times more likely to detect pollution than high school graduates (Dogaru, et al., 2009).

Differences in perceived costs and benefits of mining have been observed between residents based on proximity to a mine/mining regions, experience and level of involvement (Zhang & Moffat, 2015; Suopajarvi, et al., 2016; Zheng, et al., 2015). Proximity can influence risk perceptions because of aesthetic changes in landscape, experience with pollution, local memory (before and after a mine), noise, and impacts to existing industries (Suopajarvi, et al., 2016; Dogaru, et al., 2009). Proximity does not necessarily influence everyone the same way because of level of involvement with the risk activity. According to Zheng et al., (2015), the more involved a person was in private lead-zinc mining (mine owner, mine worker, or having an immediate family member who was either) the less risk perceived while those with no involvement with mining had significantly higher levels of perceived risk. These findings are based on smaller private operations owned by individual residents not companies, in an area with a long history (dating back to the 1600's) of mining and 80% of participants were involved in some way with mining. The more involved in mining a person is the more benefits (i.e. higher income) they might receive, which can lower risk perception (Tilt, 2006) and increase acceptance of the activity (Zhang & Moffat, 2015).

There are differences between how residents perceive risk and how industry or governments assess risk. While resident risk perceptions can be influenced by facts (i.e. scientific knowledge), other factors are often more prominent in the process (Thouez & Singh, 1984; Walker, et al., 2006; Younger, Coulton, & Froggatt, 2005). The mining industry and government look to quantify risk. Government does this by weighing the associated benefits and costs often through economic valuation and environmental impact assessment (Zhang & Moffat, 2015).

According to Amoatey, Famiyeh and Ando (2017) there is limited use of a sector-specific risk assessment model in the mining industry today. In general, the mining industry evaluates both the severity and frequency of threats and then ranks the risks from these threats based on their potential to increase project cost, project duration, and damage to the environment. Unacceptable risks are those threats that could cause a mine to shutdown (Amoatey et al., 2017).

However, Amoatey et al. (2017) argue for mining projects to do better at understanding the context, identifying and ranking risks, and creating mitigation plans to address the threats prior to the establishment of a mine. Social risks (Prno & Slocombe, 2012) should be considered in understanding the context and identifying threats (Amoatey et al., 2017). Context is especially important because though the factors that influence social risk are similar; their level of importance can vary among mining locations because of differences in cultural influences and governmental structures (Zhang et al., 2015). Thus, there is no one-size-fits-all solution which highlights the need for region specific research (Zhang et al., 2015). Prager (1997) argues for mining companies to include socio-cultural viability as part of their full feasibility studies when the ability to change plans is highest and the cost to do so is the cheapest. Franks and Vanclay (2013) suggest the use of Social Impact Management Plans as a means to incorporate the social risks into planning of mining operations. In essence, incorporating risk perceptions of the local communities and regional stakeholders can improve the effectiveness of industry risk assessments and governmental policy development (Dogaru, et al., 2009).

3.2.1. The Present Research

This study uses a modified version of a social-psychological model developed by van der Linden (2015) whose aim was to integrate and operationalize key constructs to help better explain risk perceptions. Utilizing climate change as the risk topic, his model explained 68% of

the variance in risk perceptions, which was more than any other study at the time. He also posited that his model could be useful in other types of environmental risk perception contexts. Thus this study aims to determine if his empirically tested model (applied to a global issue) will also work in the context of risk perceptions of metallic mineral mining (MMM) in Maine (a regional issue).

To achieve this, a household survey was conducted to assess residents' perceptions on opportunities and risks metallic mineral mining could pose to their quality of place assets. Close-ended questions and scales were developed using previously tested and reliable items (Brenkert-Smith, Dickinson, Champ, & Flores, 2013; Renn, Burns, Kasperson, Kasperson, & Slovic, 1992). This modified version of van der Linden's (2015) social-psychological model integrates cognitive factors (Helgeson, van der Linden, & Chabay, 2012), experiential processes (Brenkert-Smith et al., 2013), and socio-cultural influences (Sjöberg, 2000) to measure public risk perception associated with MMM in Maine. Cognitive factors measured (1) actual knowledge variables – correct knowledge on status of active metal mines and prior knowledge of the issue being debated in the state legislature; (2) response knowledge variables—mitigation, adaptation, and policy strategies associated with mining activities; and (3) impact knowledge variables—residents' understanding of potential positive and negative impacts of mining activities near their community. The experiential processing construct was operationalized using residents' personal experience with any type of mining. The socio-cultural influences construct measured (1) the perceived socio-economic status of respondents' communities; (2) descriptive and prescriptive social norms as well as a personal norm associated with metal mining in Maine; and (3) residents' broad value orientations.

In addition, van der Linden (2015) suggested that incorporating a trust construct into the model could improve its performance. Therefore, this study added a trust construct that measured residents' trust in information sources (Mase et al., 2015) regarding mining activities and its threats/opportunities. Socio-demographic factors such as gender, age, education level, household income, and length of residence in the area were also elicited.

There is an existing literature gap in how risk perceptions are assessed prior to close exposure with the risk activity. For example, most of the studies concerning some type of public perception of mining have been in areas with an already established mining industry or near recently closed mines. This study contributes to the literature in that it applies a comprehensive risk perceptions model to the topic of metal mining in an area which has little experience in the metallic mining industry (there have been no metal mines in the state of Maine for over 40 years). This research was conducted within the context of renewed interest in some of Maine's metal deposits and the resulting five year metal mining policy debate in the Maine state government.

3.3. Material and Methods

3.3.1. Sampling Design

Resident mailing addresses were obtained through InfoUSA and were selected using a stratified random sampling design. Based upon the 10 known significant metallic deposits in Maine, four strata were created for selecting the sample and mailing the questionnaire (Fig. 3.1). The sample consisted of 2,573 valid addresses. Similar to Zhang and Moffat (2015) this study oversampled strata 1 and 2 with 830 (32.3% of sample) and 839 (32.6%) addresses respectively to ensure adequate number of responses from areas which have the greatest potential to be directly influenced by mining activities.

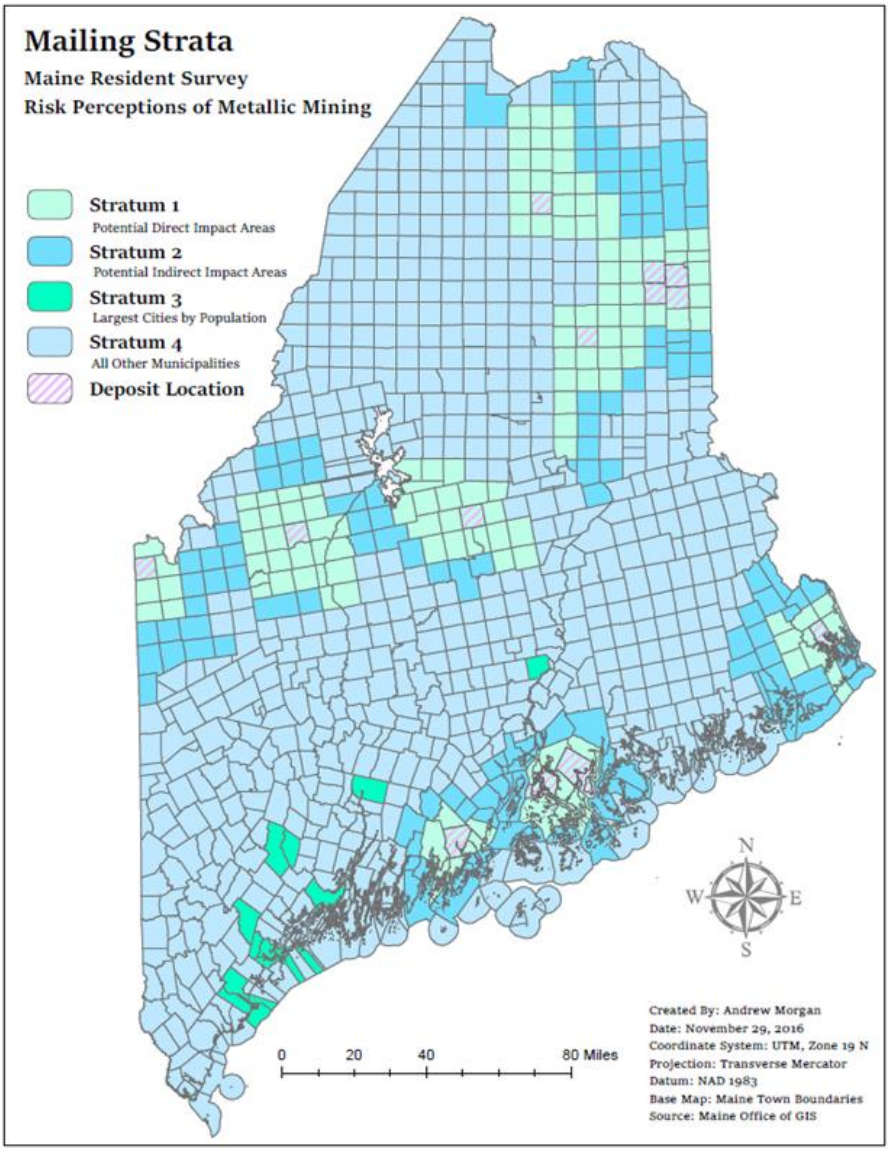

Figure 3.1. Map of sampling strata for mail survey of Maine residents.

Stratum one consisted of those communities that are in closest proximity to the deposits or that have the potential to be most directly influenced if a mine were developed. Potential negative impacts from groundwater, air, and noise pollution as well as positive economic impacts could affect communities in any direction. Potential surface water pollution can be transported farther distances by rivers and streams. A deposit's proximity to waterways and the size of those waterways determine the distance of the direct surface water impact.

Similarly, stratum two also revolves around the deposits but with fewer direct impacts. The largest determinants were both potential surface water pollution on larger waterways and being within a commutable distance (~1 hour) from the potential mine site. Stratum three is based upon the largest metropolitan communities in the state. Stratum four is the rest of Maine.

3.3.2. Questionnaire Design and Implementation

The mail questionnaire was designed and implemented by using Dillman, Smyth and Christian's (2014) Tailored Design Method. Survey instruments were mailed to Maine residents in 2016. The questionnaires were sent to the addresses determined in the sampling design with a cover letter and a prepaid return envelope. As an incentive, residents were informed that upon returning a completed survey they would be entered into a raffle to win one of three gift cards. One adult (whoever had the most recent birthday) from each address was asked in the cover letter if they would be willing to participate and instructions on how to do so. Up to two replacement questionnaires were sent and up to one postcard reminder to those who did not respond by set dates.

The survey was pre-tested with an online pilot questionnaire (N = 91) using the same stratified approach. Based upon the results of this pilot survey changes were made to make

questions easier to understand. The overall response rate for the mail survey was 19.5% (501 out of 2,573). The response rates per strata were as follows: stratum one, 20.6% (171 out of 830); stratum two, 18.8% (158 out of 839); stratum three, 16.7% (76 out of 454); and stratum four, 21.3% (96 out of 450). In survey efforts, it is important to address non-response bias. Previous work has shown that respondents who participated after the final contact are similar to non-respondents (Armstrong & Overton, 1977). Therefore, non-response bias was checked by comparing responses between those who responded to the mail questionnaire after the first mailing with those who responded after the final contact. Using Pearson's Chi-square test of independence no significant differences were found for gender (χ^2=2.282, 1 df, p=.131), age (χ^2=43.080, 58 df, p=.928), education level (χ^2=8.538, 7 df, p=.288), county of residence (χ^2=18.181, 15 df, p=.253), or sampling strata (χ^2=1.306, 3 df, p=.728).

3.3.3. Measures and Indices

Risk perception – To assess holistic risk perception a total of 12 measures were used based on a 7-point Likert-scale ranging from 1 (*strongly agree)* to 7 (*strongly disagree).* Participants were asked to indicate their level of agreement with statements about themselves, their community, and the state given the hypothetical situations of either a metallic mineral mine being developed near their community and anywhere else in Maine. Based on van der Linden's (2015) work, four indices were created, a holistic risk perception index using all 12 variables (α = 0.95), a personal risk index using three measures (α = .80), a community risk index using four measures (α = 0.87), and a societal risk index using five measures (α = 0.89).

Cognitive Factors – *Actual* knowledge was assessed with two yes/no items: "Are there currently active metallic mineral mines in the state of Maine" and "Prior to this survey, were you aware of the current discussion concerning metallic mineral mining in Maine?". Answers were

dichotomized to either correct (1) or incorrect (0) and then combined together. *Response* knowledge ($\alpha = 0.85$) was assessed with seven items that asked respondents to rate how much each strategy (e.g., water quality regulations, new technologies) would reduce negative environmental impacts of MMM in Maine (a lot, a little, not at all). Lastly, *impact* knowledge ($\alpha = 0.87$) was assessed with 10 items that asked respondents if they believed each quality of place asset (e.g., water quality, employment opportunities) was likely to increase, decrease, or remain constant if a mine was developed near their community.

Experience – Participants were asked if they had family history or personal experience with any type of mining. If a respondent answered yes, then they were given options of what that experience was (e.g., living near an active mine) and what type of mining (e.g., coal, precious metals). Respondents were also able to specify whether these experiences were in Maine, another U.S. state, or in a foreign country.

Socio-cultural influences – Both community description and norms indices were assessed on a 7-point Likert scale by asking respondents their level of agreement with four statements each. *Community description* ($\alpha = 0.82$) statements were about the socio-economic status of respondents' community. *Norms* ($\alpha = 0.88$) statements consisted of one statement measuring a prescriptive social norm, two statements measuring descriptive social norms, and one statement measuring a personal norm. Broad value orientations were assessed using the same measures and 9-point scale (recoded to be 1 = Of supreme importance, 9 = Opposed to my values) as van der Linden (2015). Three indices were created: *egoistic* ($\alpha = 0.75$), *altruistic* ($\alpha = 0.84$), and *biospheric* ($\alpha = 0.92$).

Trust – Level of trust in 11 information sources was assessed on a 7-point scale (recoded to be 1 = strongly trust to 7 = strongly distrust). We differentiated between information sources and created four indices: *News* ($\alpha = .084$), *Family/Friends* ($\alpha = 0.85$), and *Pro-mining Groups* ($\alpha = 0.81$) consisted of two sources each, while *Government* ($\alpha = 0.90$) consisted of three items (local, state, and federal). Scientist/researchers and conservation organizations were the two remaining information sources and were used individually in the analysis.

Socio-demographics – the socio-demographic information asked of participants included age, gender, ethnicity, education, income, employment status, political affiliation, Maine County of residence, and years lived in Maine.

3.3.4. Data Analysis

Survey responses were recorded and analyzed in IBM's Statistical Package for the Social Sciences (SPSS) version 23. Quality control through a double entry process was conducted on a random selection of 10% of the returned questionnaire which resulted in a data entry error rate of 0.09%. Descriptive statistics were calculated for all variables and nonparametric Kruskall-Wallis Tests were conducted to explore differences between strata on select variables. Spearman correlations were conducted and the above indices were created. Hierarchical multiple regression (van der Linden, 2015) analysis was used to determine the significance of predictor variables and amount of variance in holistic risk perceptions of metallic mineral mining explained by the before mentioned constructs.

3.4. Results

General demographic characteristics from respondents are presented in Table 3.1 along with comparisons with census data for the state and Maine 2016 voter registration data. Just over

half of the respondents were female (51.9%) which is nearly identical to 2010 Census data for Maine. The mean age of all participants was 58.3 (as a requirement, all participants were 18 years or older). Survey participants were more educated (52.9% have a Bachelor's degree or higher) as compared to the general Maine population (28.4% have a Bachelor's degree or higher). Participants' political affiliation mirrored very closely to that of the Maine population with 29.9% Democrat, 26.7% Republican, 37% Independent, and 6.4% other.

Inter-correlations of indices with holistic risk and descriptive statistics are presented in Table 3.2. All scale level variables were coded or recoded so that high values reflect higher risk. Therefore, a mean of 4.5 for holistic risk perception means that more respondents perceive a risk with metal mining than do not. Additionally, a mean of 2.4 for level of trust in scientists indicates that on average respondents fell between 'trust' and somewhat trust' making scientists the most trusted source for mining information.

Table 3.1. Select demographic characteristics of residents who responded to the mail survey as compared to Maine population data. N=491.

Demographic Characteristics	%	Census Data[1]	ME 2016 Voter Registration[2]
Gender			
Male	48	49	
Female	52	51	
Age in years			
Mean	58.2 yrs		
Length of Residence			
Mean	38.9 yrs		
Education			
High school or less	17	41.3	
Some college	18.4	20.1	
2-year degree	11.7	9.3	
Bachelor's degree	30.1	18.3	
Master's degree or higher	22.8	10.1	
Income			
Less than $25,000	18.5		
$25,000 - $34,999	10.4	Median	
$35,000 - $49,999	18.5	$49,331	
$50,000 - $74,999	19.2		
$75,000 - $99,999	16.3		
$100,000 or more	17.2		
Political Affiliation			
Democrat	29.8		32%
Republican	26.8		27%
Independent	36.8		36%
Other	6.6		5%

[1] Gender data from 2010 Census, education data from 2014 Census estimates, and income data is median household income 2011-2015 (U.S. Census Bureau). No average age was found for Maine population 18 years and older.

[2] Data obtained from Statewide Registered and Enrolled Data File (Maine Bureau of Corporations, Elections & Commissions, 2016). Un-enrolled was used to calculate independents. Green and Libertarian were used to calculate other category.

Table 3.2. Spearman intercorrelations and descriptive statistics of predictor variables and holistic risk.

	N = 471	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Actual Knowledge	(NA)															
2.	Response Knowledge	-.04	(.85)														
3.	Impact Knowledge	-.02	.32***	(.87)													
4.	Personal Experience	-.10*	.04	.05	(NA)												
5.	Community Description	.12**	-.22***	-.18***	.05	(.82)											
6.	Norms	-.01	.35***	.70***	.02	-.20***	(.88)										
7.	Biospheric Values	-.06	-.07	-.44***	.07	.00	-.42***	(.92)									
8.	Altruistic Values	-.07	-.01	-.30***	.00	-.05	-.26***	.76***	(.84)								
9.	Egoistic Values	.08	.04	.13**	-.02	-.12*	.16**	-.09*	-.02	(.75)							
10.	Trust – News	-.08	.07	-.01	-.08	.06	-.02	.15**	.23***	.07	(.84)						
11.	Trust – Fam/Friends	.01	.01	.02	.02	.05	.05	-.01	.03	.02	.20***	(.85)					
12.	Trust – Scientists	.01	.03	-.01	-.08	.09*	-.06	.21***	.29***	.00	.37***	.20***	(NA)				
13.	Trust – Pro-mining	.07	.29***	.55***	-.06	-.11*	.57***	-.30***	-.15**	.13**	.19***	.11*	.22***	(.81)			
14.	Trust – Conservation	-.00	-.05	-.26***	-.07	.11*	-.31***	.42***	.39***	-.05	.37***	.17***	.39***	.01	(NA)		
15.	Trust – Government	-.04	.23***	.21***	-.05	-.03	.19***	.00	.11*	.12*	.37***	.13**	.34***	.45***	.32***	(.90)	
16.	Holistic Risk Perceptions	.04	.30***	.82***	.02	-.17***	.81***	-.51***	-.33***	.13**	-.02	.05	.01	.64***	-.30***	.21***	(.95)
	Mean	NA	NA	3.22	NA	5.14	4.36	3.15	3.30	6.60	3.59	3.25	2.47	4.40	3.57	4.45	4.51
	SD	NA	NA	0.62	NA	1.34	1.24	1.60	1.54	1.53	1.20	0.97	1.19	1.35	1.46	1.27	1.27

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. Cronbach's alpha scale reliabilities are shown along the diagonal.

The hierarchical multiple regression analysis yielded four models (Table 3.3). Personal experience with any type of mining was not a significant predictor in any of the regression models run in this analysis. Therefore, in order to have a higher sample size for the regression models, it was removed from analysis, models were rerun without it, and it is no longer reported on in these results.

Model 1 established a baseline with socio-demographic attributes. Only age ($p < 0.01$) and gender ($p < 0.001$) were significant predictors of holistic risk perception, explaining 3.5% of the variance (F (2, 468) = 9.51, adj. $R^2 = 0.035$). Therefore, older age and being female is associated with higher risk perceptions of metallic mineral mining.

Model 2 added the three cognitive factors to determine if they explained the variance in risk perceptions any more than age and gender. Actual and response knowledge were significant predictors at the $p < 0.05$ level with impact knowledge being a significant predictor at the $p < 0.001$ level. Adding these three factors explained an additional 59.5% of the variance in holistic risk perception (F_{change} (3, 465) = 251.59, Δ adj. $R^2 = 0.595$). In other words, having higher actual knowledge, belief that implemented strategies would not reduce negative environmental impacts, and belief that quality of place assets would decrease if a mine were developed near one's community were all associated with increased holistic risk perceptions. Age and gender were no longer significant predictors in models 2 – 4.

Table 3.3. Holistic risk perception of metallic mineral mining regression model results.

Independent variables	Socio-demographics	Cognitive factors	Socio-cultural influences	Trust in Information sources
	Model 1 (ß)	Model 2 (ß)	Model 3 (ß)	Model 4 (ß)
Age	0.14**	n.s.	n.s.	n.s.
Gender	0.17***	n.s.	n.s.	n.s.
Actual Knowledge		0.07*	0.05*	n.s.
Response Knowledge		0.07*	n.s.	n.s.
Impact Knowledge		0.76***	0.39***	0.34***
Community Description			n.s.	n.s.
Norms			0.51***	0.43***
Biospheric Values			(-) 0.16***	(-) 0.14***
Altruistic Values			n.s.	n.s.
Egoistic Values			n.s.	n.s.
News Outlets				n.s.
Fam/Friends				n.s.
Scientists				0.06*
Pro-Mining				0.21***
Conservation Organizations				(-) 0.06*
Government				n.s.
N	471	471	471	471
Adj. R^2	0.035	0.630	0.792	0.817
Δ adj. R^2		0.595	0.163	0.027
F_{change}	9.51	251.59	73.73	11.46
df1, df2	2, 468	3, 465	5, 460	6, 454

Note: Dependent variable is holistic risk index. Entries are standardized beta coefficients; *p < 0.05, **$p < 0.01$, ***$p < 0.001$ (n.s. = not significant).

Model 3 determined the additional explanatory power of socio-cultural influences beyond socio-demographics and cognitive factors. Norms and biospheric values were significant predictors of holistic risk perceptions and explained 16.3% more of the variance (F_{change} (5, 460) = 73.73, $p < 0.001$, Δ adj. $R^2 = 0.163$). The more participants presumed others would not think highly of them if the participant had a job at a mine and that other people thought that MMM would have negative impacts in Maine the higher their risk perceptions of MMM. The more a participant disagreed that MMM fit with their perception of the Maine identity the higher their risk perception. Also, the weaker the biospheric value orientations of an individual the weaker their risk perception of MMM. Altruistic and egoistic broad value orientations were not significant predictors of risk.

Model 4 examined the change in explanatory power when trust in information sources was added with the other three constructs. Scientists ($p < 0.05$), conservation organizations ($p < 0.05$), and pro-mining groups ($p < 0.001$) were the sources of information that were significant predictors of risk, explaining an additional 2.7% of the variance (F F_{change} (6, 454) = 11.46, Δ adj. $R^2 = 0.027$). Therefore, decreased trust in scientists and pro-mining groups as sources of information was associated with increased risk perceptions while increased trust in conservation organizations as a source of information was associated with increased risk perceptions of MMM.

In this last model the significant predictors of risk perceptions of MMM in Maine were impact knowledge ($p < 0.001$), norms ($p < 0.001$), biospheric broad value orientations ($p < 0.001$), and the three information sources listed above – scientists, pro-mining groups, and conservation organizations. These predictors in total explained 81.7% of the variance in holistic risk perception (adj. $R^2 = 0.817$).

As demonstrated by van der Linden (2015) risk can have a multi-dimensional structure. Therefore, holistic risk perception is also divided into three separate measures – personal risk, community risk, and societal risk. Three separate regressions were run using the same variables from the final holistic risk regression model (Table 3.4). Between these three models, there were differences in age, actual and response knowledge, scientists, conservation organizations, and government variables. (1) Age, actual knowledge, and conservation organizations were significant predictors for societal risk but not for either personal or community risk. (2) Response knowledge and government were significant predictors for personal risk but not for either community or societal risk. (3) Scientists were significant predictors for personal and societal risk but not for community risk.

Impact knowledge, norms, biospheric broad value orientations, and pro-mining groups were consistent in their predictor strength and significance among all three types of risk perceptions. Overall, the amount of explained variance was very similar between the three models; 73.8% for personal risk (F (16, 454) = 84.13, $p < 0.001$, adj. R^2 = 00.738), 73% for community risk (F (16, 454) = 80.49, $p < 0.001$, adj. R^2 = 00.73), and 74.4% for societal risk perceptions (F (16, 454) = 86.44, $p < 0.001$, adj. R^2 = 00.744).

Table 3.4. Comparison of significant predictors between personal, community, and societal risk perceptions.

Independent variables	Personal Risk	Community Risk	Societal Risk
Age	n.s.	n.s.	(-) 0.08**
Gender	n.s.	n.s.	n.s.
Actual Knowledge	n.s.	n.s.	0.06*
Response Knowledge	(-) 0.05*	n.s.	n.s.
Impact Knowledge	0.30***	0.34***	0.31***
Community Description	n.s.	n.s.	n.s.
Norms	0.44***	0.42***	0.38***
Biospheric Values	(-) 0.14**	(-) 0.12**	(-) 0.14**
Altruistic Values	n.s.	n.s.	n.s.
Egoistic Values	n.s.	n.s.	n.s.
News Outlets	n.s.	n.s.	n.s.
Fam/Friends	n.s.	n.s.	n.s.
Scientists	0.07*	n.s.	0.06*
Pro-Mining	0.20***	0.17***	0.21***
Conservation Organizations	n.s.	n.s.	(-) 0.11**
Government	(-) 0.08*	n.s.	n.s.
N	469	471	471
Adj. R^2	0.738	0.730	0.744
F	84.13	80.49	86.44

Note: Entries are standardized beta coefficients; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ (n.s. = not significant). Bolded variables have differences between models.

3.5. Discussion

This study investigated the risk perceptions of Maine residents to metallic mineral mining in their state and explored the social-psychological constructs that explain risk perception levels. This study also examined the utility of a risk perception model originally developed for the topic of climate change on an additional natural resource topic. This utility was confirmed with the models' ability to account for 81.7% of the variance in holistic risk perceptions of metallic mineral mining by Maine residents. Overall, the majority of participants perceived some level of risk involved with MMM. Older age and being female were associated with higher holistic risk perceptions, though they explained very little (3.5%) and their significance did not remain after controlling for other factors. In addition, gender was not significant in any of the other dimensions of risk while being younger was associated with societal risk. This limited and inconsistent explanatory power of socio-demographic characteristics falls in line with the risk research as a whole (van der Linden, 2015). Therefore, socio-demographics in this study primarily served as a control in our regression models and maintained the ability to compare to the study population.

3.5.1. Proximity

Contrary to evidence in other studies (Dogaru, et al., 2009; Suopajarvi, et al., 2016; Zhang & Moffat, 2015), our sampling strata, based on proximity to potential mine sites, was not a significant predictor in risk perceptions. However, this likely has more to do with the lack of experience and ore deposit location not being an adequate substitute for an actual mine. To check further on this, participants were regrouped based upon proximity to the closed (over 40 years ago) legacy mines, the deposit in northern Maine that is of current interest, and the rest of Maine. Through the use of a nonparametric Kruskall-Wallis test with pairwise comparisons there was

some evidence (p<.05) that there are differences in holistic risk perceptions between participants in proximity to the legacy mines and rest of Maine. However, these experience areas didn't produce significant predictors and were dropped from the regression analysis. Given the sample size for each stratum, a lack of statistical power may also be a cause of proximity's insignificance in this study.

3.5.2. Cognitive Factors

Unlike van der Linden (2015), cognitive factors were not assessed based on right or wrong (except for actual knowledge) but on believed effectiveness of strategies and impacts. Because of the lack of consensus in the literature/experts and the fact that each mine situation is different, the ability to determine right or wrong answers in this study was not possible. Actual and response knowledge were initially significant predictors but they dropped out by the final holistic model. Actual knowledge was a significant predictor for societal risk and response knowledge was significant for personal risk though both had low explanatory power.

However, impact knowledge was the second most influential and consistent predictor across all types of risk processing. Therefore, the belief one has about the impacts to quality of place assets that could occur if a metal mine was developed near one's community has strong influence on the level of risk that is perceived. Cognitive factors, including impact knowledge, in van der Linden's (2015) study did not account for as much of the variance as impact knowledge did here. They were also not significant predictors for personal risk (van der Linden, 2015). As van der Linden (2015) noted, the knowledge measures were more generally related to society given the topic of climate change whereas the MMM issue is more localized. Therefore, impacts from MMM may be easier to discern and relate to one's own wellbeing. This could explain the greater importance of impact knowledge for risk perceptions of MMM in Maine.

3.5.3. Socio-Cultural Influences

This study confirms the importance of socio-cultural influences on risk perceptions. Norms are powerful influences in people's lives (Heberlein, 2012) which were reaffirmed in this study with normative factors being the single most influential predictor in holistic risk perceptions. Therefore, the influence of what other people think concerning employment or the potential impacts related to MMM is a key factor as a person processes the risks involved. Likewise, participants' own personal norms of place identity and whether MMM fits with that identity influences risk perceptions. Survey respondents' perception of the Maine identity is likely related to pro-environmental views since they had high (1 = Of Supreme Importance) biospheric value orientations ($\bar{x}$ = 3.15) and lower egoistic value orientations ($\bar{x}$ = 6.60). Ultimately, norms were consistently the most influential predictor across the separate dimensions of risk implying their importance in risk processing at all levels.

The community description index, which assessed participants' views on the socio-economic status of their community, was not a significant predictor for any dimension of risk. This implies that the need for economic development may not be as influential in assessing the desirability of metal mining as is commonly depicted by some information sources. Broad value orientation results were consistent with van der Linden (2015) as biospheric value orientations were the only significant predictor of risk. They were also consistent in their significance and level of influence throughout the other dimensions of risk. Therefore, the stronger one holds biospheric values as guiding principles in life the stronger the perceived risks associated with MMM. Altruistic and egoistic broad value orientations were also not significant predictors of risk – same as van der Linden (2015). Since some biospheric and altruistic as well as some altruistic and egoistic variables were positively correlated with each other, future studies should

consider reconfiguring the altruistic and egoistic scales to better reflect and differentiate the concepts they are trying to measure. Overall, the socio-cultural construct explained the most variance in risk perceptions which was also the case in van der Linden's (2015) study.

3.5.4. Trust in Information Sources

Consistent with Mase et al. (2015), scientists and researchers were the most trusted source for future information on MMM with 84% of participants expressing some level of trust. In addition, trust in state government for future information on MMM was low (25% had some level of trust). Therefore, scientists may be able to play a role as intermediary on controversial issues by providing information to which a wary public may be receptive. A caution though is that scientists need to be alert to using language for the lay person and unaffiliated scientists (i.e. not being connected with stakeholder or government entities) may be the most successful (Gallois, Ashworth, Leach, & Moffat, 2017). However, though level of trust in scientists was a significant predictor, the amount of variance it explained was minimal. Level of trust in government was only significant for personal risk and again minimally influential.

An important implication for level of trust is for the mining industry itself. After normative influences and impact knowledge, level of trust in pro-mining groups (mining companies and economic development organizations) as information sources was the next most influential and consistent explainer of risk perceptions. Decreased trust in pro-mining groups as sources of information was associated with increased risk perceptions. This presents evidence of the importance of mining companies gaining the trust of residents and the benefits to those companies if they are able to do so. Though establishing trust is not an automatic guarantee that perceived risks will disappear (Holley & Mitcham, 2016). It presents a great opportunity and challenge for the industry as a whole. The results also showed that increased trust in conservation

organizations as a source of information was associated with increased risk perceptions of MMM.

3.5.5. Study Limitations

This study presented challenges in implementing risk perception in an area that lacks firsthand knowledge and experience with the risk topic. Some of these challenges have been discussed in regards to measuring cognitive and experiential factors. Another limitation of this study is that it didn't capture the personal affect component well which was the largest single predictor of risk in van der Linden's (2015) original model. Future research could examine methods to better capture risk perceptions prior to a risk event happening.

With no mining for 40 years, there is little public familiarity or interest in mining-related issues in the state and so we anticipated receiving a small response rate. Thus we opted to conduct a larger mixed methods study to support the findings from the mail survey. The 19.5% response rate is small enough that certain groups in the population may not be adequately represented. In determining the representativeness of the survey, the participants' demographics for gender and political party are nearly identical to that of the Maine population while average age, income, and education are higher.

3.6. Conclusion

This study presented additional evidence for the validity of using a risk perception model that incorporates multiple constructs such as knowledge, socio-cultural influences, and trust. Socio-demographics, though not consistent in their explanatory power in this model should always be included as a control and maintain the ability for inference to a larger population. While experience was also not a significant predictor in this study, the authors acknowledge the

difficulty in operationalizing this construct in a context where experience is inherently lacking. Given that the majority of mining research has been conducted in more established mining locales, future research should seek to fully incorporate this construct.

The full holistic risk perception model used in this study was able to explain over 80% of the variance. Likewise, for the each of the three separated dimensions of risk (personal, community, and societal) over 70% of the variance in risk perceptions was explained. It is recommended that van der Linden's (2015) model be further adapted and tested in future research on risk perceptions of metal mining and other natural resource topics.

CHAPTER 4:

MIXED METHODS CONVERGENCE

This thesis research utilized a mixed methods approach to understand the context of the issue, identify major debate themes, and measure risk perceptions of residents toward metallic mineral mining in Maine. This final chapter is the integration of the lessons learned from each component of the research in order to form a more complete picture and build upon the strengths of each methodology (Creswell, 2015). The four major themes derived from the debate were water permeates everything, using experiences and examples, inadequate rules, and mistrust. The most consistently significant predictors of residents' risk perception of MMM in Maine were norms, impact knowledge, biospheric value orientations and level of trust in certain information sources including pro-mining organizations and scientists.

The influence of stakeholder organizations should be taken into consideration when analyzing debates in the public square. Evidence from the qualitative study displayed considerable influence from two stakeholder organizations, the Natural Resource Council of Maine and J.D. Irving, Limited, with NRCM remaining the most consistently influential organization in regards to recruiting Maine citizens. How much of the debate themes represent the concerns of residents and how much is reflective of the success of an organization's campaign? The author proposes the degree to which the major themes from the debate reflect the opinions of the general population of Maine may be assessed by comparing them with the results from the quantitative mail survey.

4.1. Negative Impacts to Water and Other Resources – Impact Knowledge and Socio-cultural Influences

Survey participants expressed similar concerns to those expressed in testimony. These concerns include negative impacts of MMM to water quality, local environment, human health, and existing industries. In the debate residents and other stakeholders considered the potential negative impacts of MMM to be extensive enough to demand stronger rules. This coincides with the regression results which show impact knowledge to be the second most influential predictor of risk perceptions. The more residents believe that a metal mine developed near their community would negatively impact quality of place assets, the higher their risk perceptions of MMM. A fair number of survey respondents (40%) thought that a metallic mineral mine would be beneficial to their community and over three quarters (78%) believed employment opportunities would increase. However, the majority of survey participants agreed that the negative impacts of MMM outweighed the benefits (63%). Likewise, the majority of survey participants believed that human health (53%), fish and wildlife health (69%), and water quality (67%) would decrease if a metallic mineral mine were developed near their community.

As in other research (Suopajarvi, et al., 2016; Younger, Coulton, & Froggatt, 2005), it has been expressed both in testimony and by survey participants that negative impacts on the environment from MMM could potentially affect existing industries like tourism. While 55% of participants agreed that "people in my community are typically supportive of resource extraction jobs", even more participants (87%) agreed that 'people in my community are typically supportive of jobs in the tourism industry." Over half (54%) of participants believed nature based tourism would decrease as a result of a potential local mine.

For debate participants clean water was associated with Maine's identity. Approximately a quarter (26.7%) of survey participants agreed that MMM fit with their perception of the Maine identity while almost half (45%) disagreed. Survey respondents' perception of the Maine identity is also likely related to a clean environment since they had high (1 = Of Supreme Importance) biospheric value orientations ($\bar{x}$ = 3.15) and lower egoistic value orientations ($\bar{x}$ = 6.60). High biospheric value orientations were significantly associated with high risk perceptions.

4.2. Using Experiences and Examples – Experiential Processing

Due at least in part to the difficulty in measuring experience level in an area that is lacking, personal experience was not a significant predictor of risk perceptions in this study. However, it was still an influential component in the debate with residents drawing on experiences with Maine's legacy mines or experiences while living or traveling elsewhere. Additionally, residents and other stakeholders had an easy time pointing to vivid examples of bad mining practices or catastrophic failures. Events, experiences and industries are now connected globally, thus affecting each other and can be seen by people around the world through electronic devices. Therefore, people may not necessarily need direct firsthand experience because people use what is available to them, especially examples of vivid negative consequences when processing risk (Mase et al., 2015; van der Linden, 2015). Future research on risk perceptions of mining could draw on this concept of globally connected experiences in measuring the amount of influence experiential processes have on assessing risk.

4.3. Inadequate rules – Response Knowledge

Nearly two-thirds (63.5%) of survey participants had no prior knowledge of the debate occurring in the state government. Survey participants did, however, express that they believed that water quality regulations (86%) and oversight by Maine DEP (85%) would reduce negative

environmental impacts of MMM in Maine. However, response knowledge was not a significant predictor of risk after controlling for other constructs. Those who participated in the debate expressed opposition not necessarily to MMM itself but to the rules they deemed inadequate to allow appropriate oversight and mitigation of risks which is consistent with other research (e.g., Zhang & Moffat, 2015). Ensuring water quality regulations adequately enable DEP to restrict negative environmental impacts will play a critical role since nearly 40% of survey participants believed that environmental monitoring by private mining companies would not reduce these impacts at all.

4.4. Mistrust – Trust in Information Sources

Level of trust played a key role in both the debate and in measuring risk perceptions of Maine residents. Distrust in the state government was expressed because enough questionable practices occurred that de-legitimized the entire policy development process (Prno & Slocombe, 2012). As displayed by the survey results, scientists and researchers were the most trusted information source as well as a significant predictor of risk perceptions. Thus a lack of scientific experts involved in the policy process, as some expressed, likely contributed to stronger opposition and higher risk perceptions. Both debate and survey participants expressed distrust in the mining industry as a source of information. Debate participants' mistrust was connected with metal mining's history of negative environmental impacts despite claims that advancements in mining technology can limit those impacts. Only a quarter of survey participants expressed any level of trust in mining organizations as information sources. In addition, decreased trust in pro-mining organizations was significantly associated with increased risk perceptions, being the third single most influential predictor.

4.5. Conclusion

Overall, the findings from the two components are largely congruent, albeit with differing intensity levels. That being the level of opposition was higher for debate participants than survey respondents. Ultimately, many of the concerns expressed were similar for both components and the mean for holistic risk perceptions was towards the higher risk side. With the qualitative and quantitative components largely confirming the findings of each, more confidence can be given in the results and a more complete scope of inference can be made. Thus these findings have demonstrated the advantage of a mixed methods approach in studying contemporary social-natural resource issues.

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APPENDIX A: IRB APPROVAL

APPLICATION FOR APPROVAL OF RESEARCH WITH HUMAN SUBJECTS
Protection of Human Subjects Review Board, 114 Alumni Hall, 581-1498

PRINCIPAL INVESTIGATOR: Dr. Sandra De Urioste-Stone
EMAIL: sandra.de@maine.edu **TELEPHONE:** 207-581-2885
CO-INVESTIGATOR(S): Dr. John J. Daigle, '
FACULTY SPONSOR (Required if PI is a student):
TITLE OF PROJECT: "Mining in Maine: Characterization of Public Perceptions"

START DATE: 4/2/2016 ~~4/1/2016~~ **PI DEPARTMENT:** School of Forest Resources
MAILING ADDRESS: 237 Nutting Hall Orono, ME 04469-5755
FUNDING AGENCY (if any): Water Resources Research Institute
STATUS OF PI:
FACULTY/STAFF/GRADUATE/UNDERGRADUATE Faculty:

1. If PI is a student, is this research to be performed:

☐ for an honors thesis/senior thesis/capstone? ☐ for a master's thesis?
☐ for a doctoral dissertation? for a course project?
☐ other (specify)

2. Does this application modify a previously approved project? No (Y/N). If yes, please give assigned number (if known) of previously approved project:

3. Is an expedited review requested? Yes (Y/N).

SIGNATURES: All procedures performed under the project will be conducted by individuals qualified and legally entitled to do so. No deviation from the approved protocol will be undertaken without prior approval of the IRB.

Faculty Sponsors are responsible for oversight of research conducted by their students. By signing this application page, the Faculty Sponsor ensures that he/she has read the application and that the conduct of such research will be in accordance with the University of Maine's *Policies and Procedures for the Protection of Human Subjects of Research.*

03/18/16 Sandra De Urioste
Date Principal Investigator Faculty Sponsor

Co-Investigator Co-Investigator

****

FOR IRB USE ONLY Application # 2016-03-14 Date received 3/25/16 Review (F/E): E
Expedited Category: _____

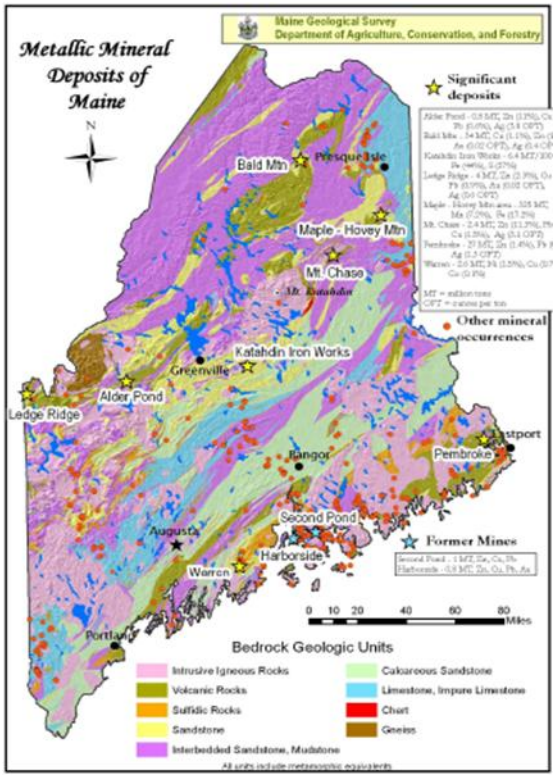
ACTION TAKEN:

X Judged Exempt; category 2 on 3/29/16 Modifications required? Y (Y/N) Accepted (date) 4/2/16
_____ Approved as submitted. Date of next review: by _____. Degree of Risk: _____
_____ Approved pending modifications. Date of next review: by _____. Degree of Risk: _____
Modifications accepted (date): _____.
_____ Not approved. (See attached statement.)
_____ Judged not research with human subjects

Approved to begin 4/2/16

APPENDIX B: SURVEY INSTRUMENT

Public Perceptions of Metallic Mineral Mining in Maine



Funding provided by:

Dear Maine Resident,

You are invited to participate in a research project being conducted by Dr. Sandra De Urioste-Stone, a faculty member in the School of Forest Resources at the University of Maine. Maine is currently exploring changes to metallic mineral mining legislation. The purpose of this research is to better understand your views toward metallic mineral mining and the associated benefits and risks. You must be at least 18 years of age to participate.

What you will be asked to do
If you decide to participate, you will be asked to fill out the following questionnaire, which will take approximately 15-20 minutes. You must be at least 18 years of age to participate.

Risks
Except for your time, there are no risks to participate in this study.

Benefits
While this study may have no direct benefit to you, this research will help us better understand resident views toward metallic mineral mining in Maine.

Compensation
By completing and returning this survey, you will be entered into a raffle to win one of three $50 Hannaford gift cards. Winners will be randomly chosen at the end of the survey period and the gift cards will be sent to the same mailing address used to send the survey.

Confidentiality
The survey responses will be confidential. Please do not write your name anywhere on the survey. The survey has an identification number for mailing and raffle purposes– your responses will be held in the strictest confidence; the key will be stored in a locked office for two years. The survey responses will only be published in summarized form, so your individual responses will never be revealed. All data will be kept in a password protected computer. Hard copy surveys will be destroyed after seven years.

Voluntary
Participation is voluntary. You may stop at any time or skip questions that you do not wish to answer. Returning the survey implies consent to participate.

Contact Information

If you have any questions about this study, please contact:

Dr. Sandra De Urioste-Stone
Assistant Professor
University of Maine
(207) 581-2885
sandra.de@maine.edu

If you have any questions about your rights as a research participant, please contact:

Gayle Jones, Assistant
Protection of Human Subjects Review Board
University of Maine
(207) 581-1498
gayle.jones@umit.maine.edu

Thank you for taking the time to complete this survey!

PART A. ***Mining involves the extraction and processing of raw materials from the earth. Given a long history of mining in Maine and across the country, we would like to know about any firsthand experience you may have with mining activities*****.**

1. Do you have any family history or personal experience with any type of mining?
(e.g., coal, gems, granite, gravel, metals, peat, etc.)

☐ Yes *(Please answer 1a & 1b)* ☐ No *(Skip to Part B, in page 4)*

1a. Your family history or personal experience with mining includes...

(Please check all that apply)	In Maine	In another U.S. State	In a foreign country
Having been employed at a mine	☐	☐	☐
Having a family member employed at a mine	☐	☐	☐
Living near an active mine	☐	☐	☐
Visiting near an active mine	☐	☐	☐
Participating in a mining advocacy program	☐	☐	☐
Participating in a group opposing mining	☐	☐	☐
Other (*Please specify*)	☐	☐	☐

1b. What type of mining was associated with your family history or personal experience?

(Please check all that apply)	In Maine	In another U.S. State	In a foreign country
Agricultural minerals *(e.g., peat, potash, etc.)*	☐	☐	☐
Coal	☐	☐	☐
Construction minerals *(e.g., gypsum, mica, etc.)*	☐	☐	☐
Industrial minerals *(e.g., salt, lime, boron, etc.)*	☐	☐	☐
Precious gemstones *(e.g., diamonds, etc.)*	☐	☐	☐
Semi-precious gemstones *(e.g., tourmaline, garnets, etc.)*	☐	☐	☐
Precious metals *(e.g., gold, silver, etc.)*	☐	☐	☐
Non-precious metals *(e.g., iron, copper, zinc, etc.)*	☐	☐	☐
Oil extraction	☐	☐	☐
Sand/Gravel	☐	☐	☐
Stone *(e.g., granite, dimension, etc.)*	☐	☐	☐
Other (*Please specify*)	☐	☐	☐

PART B. ***This part of the survey focuses exclusively on metallic mineral mining in Maine.***

- Metallic mineral mining involves the extraction of metal ore (e.g., copper, gold, iron, zinc, etc.) from the earth and the processing needed to concentrate those metals into usable commodities.
- Modern metallic mineral mines can create job opportunities by employing people to operate large facilities, equipment, and also building new infrastructure.
- As a by-product of the metal extraction process, large amounts of often toxic waste material is generated, which requires careful planning and treatment to prevent polluting the surrounding area. Any non-toxic waste material may be reused for other purposes such as building roads.
- Over the past few years the state government has sought to revise the laws and regulations that govern metallic mineral mining in Maine. Your responses are greatly appreciated and will help us understand Maine residents' opinions concerning this important subject.

2. Are there currently active metallic mineral mines in the state of Maine?

□ Yes □ No

3. Please indicate, to the best of your knowledge, how much you believe that each of the following items contributes to the demand for products derived from metallic mineral mining…

Items	*Please circle one response for each item below.*			
Cell phones, computers, etc.	Major contributor	Minor contributor	No contribution at all	Decreases demand
Construction	Major contributor	Minor contributor	No contribution at all	Decreases demand
Economic growth	Major contributor	Minor contributor	No contribution at all	Decreases demand
Improved recycling for electronics	Major contributor	Minor contributor	No contribution at all	Decreases demand
Jewelry	Major contributor	Minor contributor	No contribution at all	Decreases demand
Owning a car	Major contributor	Minor contributor	No contribution at all	Decreases demand
Recycling	Major contributor	Minor contributor	No contribution at all	Decreases demand

4. Prior to this survey, were you aware of the current discussion concerning metallic mineral mining in Maine?

□ Yes (*Please answer question 4a*) □ No *(Skip to question 5)*

4a. If yes, where did you gain your information? *(Please check all that apply)*

□ Newspaper *(paper or online)*
□ Local TV/Radio news
□ Family member
□ Friend
□ Scientists/researchers
□ Maine state government
□ Mining organizations *(e.g., Aroostook Resources)*
□ Economic development organizations *(e.g., Chambers of Commerce)*
□ Conservation organizations *(e.g., Natural Resource Council of Maine)*
□ Other *(Please specify)* _____

5. If you were to receive further information about metallic mineral mining in Maine, how much would you trust or distrust the following agencies, organizations, and groups?

Information Source	*Please circle one response for each source of information below.*						
Newspaper *(paper or online)*	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Local TV/Radio news	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Family members	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Friends	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Scientists/researchers	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Mining organizations	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Economic development organizations	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Conservation organizations	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Local government	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
State government	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Federal government	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust
Other *(Please specify)*	Strongly Distrust	Distrust	Somewhat Distrust	Neutral	Somewhat Trust	Trust	Strongly Trust

6. Please indicate your level of agreement or disagreement with the following statements about <u>your community and the people close to you…</u>

Statement	*Please circle one response for each statement below.*						
Good job opportunities are available to people who live in my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
I am concerned about people leaving my town to live elsewhere	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
People in my community are typically supportive of resource extraction jobs *(e.g., forest products, fishing, mining)*	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
I am concerned about my community's ability to attract young people	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Limited job opportunities have caused the departure of people who lived in my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
People in my community are typically supportive of jobs in the tourism industry *(e.g., guides, hotels, restaurants)*	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
People who are important to me would think highly of me for getting a job at a metallic mineral mine in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
People whose opinion I value think that metallic mineral mining may have positive impacts in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
People whose opinion I value think that metallic mineral mining may have negative impacts in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Metallic mineral mining would fit with my perception of the Maine identity	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

7. <u>If</u> a metallic mineral mine was developed <u>near your community</u>, please indicate your level of agreement or disagreement with the following statements about <u>yourself and your community</u>…

Statement	*Please circle one response for each statement below.*						
A metallic mineral mine would improve my current employment situation	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
A metallic mineral mine would be harmful to me	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
I would be concerned about a metallic mineral mine developed near my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
A metallic mineral mine would be beneficial to my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
I would support the development of a metallic mineral mine near my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
A metallic mineral mine would only have short-term economic benefits for my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
A metallic mineral mine would have long-term economic benefits for my community	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
A metallic mineral mine would be harmful to the local natural environment	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

8. <u>If</u> more metallic mineral mines were developed <u>in Maine</u>, please indicate your level of agreement or disagreement with the following statements...

Statement	*Please circle one response for each statement below.*						
The benefits of metallic mineral mining outweigh the negative impacts	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Metallic mineral mining would be harmful to Maine's natural environment	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Metallic mineral mining should occur in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Metallic mineral mining would only have short-term economic benefits in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Metallic mineral mining would have long-term economic benefits in Maine	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
The negative impacts of metallic mineral mining outweigh the benefits	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree

9. How much do you think that each of the following strategies, <u>if implemented</u>, would reduce negative environmental impacts of metallic mineral mining in Maine?

_____ is likely to reduce negative environmental impacts…	*Please circle one response for each strategy below.*		
Water quality regulations	A lot	A little	Not at all
Pre-site planning	A lot	A little	Not at all
ME Dept. of Environmental Protection oversight	A lot	A little	Not at all
Closure and site reclamation plan	A lot	A little	Not at all
New technologies for metallic mineral mining	A lot	A little	Not at all
Environmental monitoring by private mining companies	A lot	A little	Not at all
Upfront financial assurances from private mining companies	A lot	A little	Not at all
Other *(Please specify)*	A lot	A little	Not at all

10. <u>If</u> a metallic mineral mine was developed <u>near your community</u>, please indicate whether you believe that the following items would be likely to increase, remain constant, or decrease...

_____ is likely to…	*Please circle one response for each item below.*				
Nature based tourism	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Outdoor recreation	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Human health	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Fish and wildlife health	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Water quality	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Land pollution	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Noise pollution	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Human population	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Employment opportunities	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Rural development	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
House/Property value	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Infrastructure improvement	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Traffic	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Local tax revenue	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
State tax revenue	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Influence of state government	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot
Other *(Please specify)*	Increase a lot	Increase a little	Remain Constant	Decrease a little	Decrease a lot

PART C. ***This part asks you about your general values to life. This will give us a framework for studying Maine residents' attitudes and opinions related to metallic mineral mining.***

11. For each value listed below, please rate the extent to which you consider it to be a 'GUIDING PRINCIPLE IN YOUR LIFE':

Value	*(Please circle one response for each statement)*								
Wealth *(possessions, financial success)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Preventing Pollution **(***protecting natural resources)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Peace *(a world free of war and conflict)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Protecting the Environment *(preserving nature)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Social Power **(***control over others, dominance)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Helpful *(working for the welfare of others)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Authority *(the right to lead or command)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Social Justice *(correcting injustice, care for the weak)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Respecting the Earth *(harmony with other species)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Influential *(having an impact on people and events)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Unity with Nature *(fitting into nature)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance
Equality *(equal opportunity for all)*	Opposed to my values	Not important	Of little importance	Somewhat important	Important	Slightly more than important	Quite important	Very important	Of Supreme importance

PART D. ***This final section of the survey asks some background information about you. Your answers, as with all of the answers you provide, will remain confidential.***

12. Which Maine County do you currently reside in?

□ Androscoggin	□ Hancock	□ Oxford	□ Somerset
□ Aroostook	□ Kennebec	□ Penobscot	□ Waldo
□ Cumberland	□ Knox	□ Piscataquis	□ Washington
□ Franklin	□ Lincoln	□ Sagadahoc	□ York

13. How many years have you lived in the state of Maine?_____ years

14. What is your gender? □ Male □ Female

15. What is your ethnic background? *(you may select more than one)*

□ African-American	□ Native American
□ Asian-Pacific Islander	□ White
□ Hispanic	□ Other *(Please specify)*_____

16. What is your age? _____ years

17. What is the highest level of education you have completed?

□ Less than High school	□ 4-year college degree (BA, BS)
□ High school or GED	□ Master's degree
□ Some college	□ Doctoral degree (PhD)
□ 2-yr college degree (AA, AS)	□ Professional degree (MD, JD, etc.)

18. What is your current employment status? *(Please check all that apply)*

□ Part-time	□ Retired
□ Full-time	□ Unemployed, seeking employment
□ Self-employed	□ Unemployed, not seeking employment
□ Student	□ Unable to work

19. What is your current annual household income in US dollars before taxes?

□ Less than $10,000	□ $35,000 - $49,999
□ $10,000 - $14,999	□ $50,000 - $74,999
□ $15,000 - $24,999	□ $75,000 - $99,999
□ $25,000 - $34,999	□ $100,000 or more

20. What is your political affiliation?

□ Democrat	□ Independent
□ Republican	□ Other *(Please specify)* _____

21. Do you belong to any organizations related to conservation, tourism, recreation, or economic development?

□ Yes (*Please answer question 21a*) □ No (*Please skip to question 22*)

21a. If yes, for each category please list the organizations to which you belong.

- □ Conservation _____
- □ Tourism or Recreation _____
- □ Economic Development _____

22. Please feel free to add any additional comments regarding the topic of metallic mineral mining in Maine.

_____

_____

_____

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Thank you for participating in our survey!
Your responses are greatly appreciated

APPENDIX C: DESCRIPTIVE STATISTICS OF INDICES, MEASURES, AND ASSOCIATED VARIABLES USED IN REGRESSION MODELS

Table C1. Responses to actual knowledge measure and associated variables by percentage.

Actual Knowledge Measure	N	Both Correct	Half Correct	Both Incorrect
	484	18.8	42.1	39.0
Variables used		N	Correct	Incorrect
Are there currently active metallic mineral mines in the state of Maine? (Correct = NO)		404	52.0	48.0
Prior to this survey, were you aware of the current discussion concerning metallic mineral mining in Maine? (Correct = Yes)		484	36.4	63.6

Table C2. Mean for response knowledge index and responses to associated variables by percentage. N=491.

Response Knowledge Index	Mean 1.7		
Variables used			
How much do you think that each of the following strategies, if implemented, would reduce negative environmental impacts of metallic mineral mining in Maine?			
	A lot (1)	A little (2)	Not at all (3)
Water quality regulations	56.0	31.2	12.8
Pre-site planning	57.8	27.5	14.7
ME Dept. of Environmental Protection oversight	40.1	45.2	14.7
Closure and site reclamation plan	53.8	33.8	12.4
New technologies for metallic mineral mining	43.4	45.0	11.6
Environmental monitoring by private mining companies	21.8	41.5	36.7
Upfront financial assurances from private mining companies	26.5	40.3	33.2

Table C3. Mean for impact knowledge index and responses to associated variables by percentage. N=491.

Impact Knowledge Index Mean 3.2

Variables used

If a metallic mineral mine was developed near your community, please indicate whether you believe that the following items would be likely to increase, remain constant, or decrease...

	Increase a lot (1)	Increase a little (2)	Remain Constant (3)	Decrease a little (4)	Decrease a lot (5)
Nature based tourism	1.4	5.5	36.9	31.6	24
Outdoor recreation	1.4	5.1	49.3	24.4	19.8
Human health	2.0	2.4	40.1	34.2	21.2
Fish and wildlife health	1.2	1.0	27.1	37.7	33.0
Water quality	1.6	1.4	28.7	26.9	31.4
Employment opportunities	15.3	64.4	16.3	1.8	2.2
House/Property value	4.9	16.7	36.5	24.4	17.5
Infrastructure improvement	4.5	35.8	48.1	7.5	4.1
Local tax revenue	13.4	55.2	23.6	6.5	1.2
State tax revenue	11.6	54.6	27.7	4.7	1.4

Table C4. Responses to experience measure by percentage.

Experience Measure	N	Yes	No
Do you have any family history or personal experience with any type of mining?	477	17	83

Table C5. Means for trust in information sources indices, measures, and responses to associated variables by percentage. N=491.

Trust in Information Sources

If you were to receive further information about metallic mineral mining in Maine, how much would you trust or distrust the following agencies, organizations, and groups?

News Outlets Index Mean 3.6

Variables used	Strongly Trust (1)	Trust (2)	Somewhat Trust (3)	Neutral (4)	Somewhat Distrust (5)	Distrust (6)	Strongly Distrust (7)
Newspaper	2.6	15.5	36.5	22.6	13.8	5.1	3.9
Local TV/Radio News	2.0	15.5	36.3	24.4	13.8	4.5	3.5

Family/Friends Index Mean 3.2

Variables used	Strongly Trust (1)	Trust (2)	Somewhat Trust (3)	Neutral (4)	Somewhat Distrust (5)	Distrust (6)	Strongly Distrust (7)
Family members	4.7	24.2	30.3	34.6	5.1	0.2	0.8
Friends	2.6	16.7	37.5	34.8	6.3	0.8	1.2

Scientist Measure Mean 2.5

Scientists/Researchers	18.3	41.1	26.1	7.3	4.5	1.4	1.2

Pro-mining Index Mean 4.4

Variables used	Strongly Trust (1)	Trust (2)	Somewhat Trust (3)	Neutral (4)	Somewhat Distrust (5)	Distrust (6)	Strongly Distrust (7)
Mining organizations	3.1	6.1	16.1	16.1	31.4	14.1	13.2
Economic development organizations	3.1	6.1	20.0	29.9	22.2	12.8	5.9

Conservation Measure Mean 3.6

Conservation organizations	7.1	15.3	30.8	19.1	17.7	6.7	3.3

Government Index Mean 4.4

Variables used	Strongly Trust (1)	Trust (2)	Somewhat Trust (3)	Neutral (4)	Somewhat Distrust (5)	Distrust (6)	Strongly Distrust (7)
Local government	1.6	4.9	22.2	33.8	20.0	10.4	7.1
State government	1.4	5.1	17.1	29.7	23.4	12.4	10.8
Federal government	1.4	5.3	16.7	20.6	28.3	15.1	12.6

Table C6. Mean for community description index and responses to associated variables by percentage. N=491.

Community Description Index	Mean 5.1						
Variables used	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neutral (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
I am concerned about people leaving my town to live elsewhere (Reverse coded)	15.9	22.2	21.0	19.3	5.9	12.2	3.5
I am concerned about my community's ability to attract young people (Reverse coded)	25.5	29.5	19.6	13.4	5.3	5.5	1.2
Limited job opportunities have caused the departure of people who lived in my community (Reverse coded)	26.7	31.6	17.9	11.2	7.1	3.3	2.2

Table C7. Mean for norms index and responses to associated variables by percentage. N=491.

Norms Index	Mean 4.3						
Variables used	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neutral (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
People who are important to me would think highly of me for getting a job at a metallic mineral mine in Maine	4.1	7.9	7.3	43.6	10.2	15.2	11.4
People whose opinion I value think that metallic mineral mining may have positive impacts in Maine	3.1	11.2	12.8	45.0	8.6	10.6	8.8
People whose opinion I value think that metallic mineral mining may have negative impacts in Maine (Reverse coded)	9.4	5.1	8.4	44.8	8.4	5.1	1.8
Metallic mineral mining would fit with my perception of the Maine identity	2.2	9.0	15.5	28.9	14.5	14.7	15.3

Table C8. Means for broad value orientations indices and responses to associated variables by percentage. N=491.

Broad Value Orientations

For each value listed below, please rate the extent to which you consider it to be a 'GUIDING PRINCIPLE IN YOUR LIFE':

Bioshperic Index Mean 3.1

Variables used	Of Supreme importance (1)	Very important (2)	Quite important (3)	Slightly more than important (4)	Important (5)	Somewhat important (6)	Of little importance (7)	Not important (8)	Opposed to my values (9)
Preventing Pollution	16.1	23.0	22.4	6.1	22.8	7.5	1.0	0.4	0.6
Protecting the Environment	24.0	31.0	15.9	4.1	17.3	6.1	1.0	0.2	0.4
Respecting the Earth	25.7	26.9	14.3	4.1	21.2	5.7	1.0	1.2	0.0
Unity with Nature	16.3	23.2	17.7	4.3	23.0	9.4	3.7	2.2	0.2

Altruistic Index Mean 3.3

Variables used	Of Supreme importance (1)	Very important (2)	Quite important (3)	Slightly more than important (4)	Important (5)	Somewhat important (6)	Of little importance (7)	Not important (8)	Opposed to my values (9)
Peace	25.9	29.1	15.2	3.7	17.7	4.7	1.6	1.2	0.8
Helpful	9.8	24.4	21.6	5.9	21.4	12.0	2.0	2.0	0.8
Social Justice	14.5	21.6	20.0	6.3	22.0	9.4	3.5	2.2	0.6
Equality	21.2	31.8	11.2	2.9	22.2	5.5	2.4	2.2	0.6

Egoistic Index Mean 6.6

Variables used	Of Supreme importance (1)	Very important (2)	Quite important (3)	Slightly more than important (4)	Important (5)	Somewhat important (6)	Of little importance (7)	Not important (8)	Opposed to my values (9)
Social Power	1.0	2.4	3.7	1.6	7.7	8.8	31.0	24.2	19.6
Authority	0.6	3.1	5.9	3.3	18.3	22.6	24.8	16.7	4.7

Table C9. Means for risk indices and responses to associated variables by percentage. N=491.

Holistic Risk Index Mean 4.5							
Personal Risk Index Mean 4.7							
Variables used	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neutral (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
A metallic mineral mine would improve my current employment situation	4.1	7.5	7.1	25.3	7.5	24.4	24.0
A metallic mineral mine would be harmful to me (Reverse coded)	11.0	14.5	13.8	32.6	12.2	12.4	3.5
I would be concerned about a metallic mineral mine developed near my community (Reverse coded)	22.0	19.8	17.7	18.1	9.4	9.6	3.5
Community Risk Index Mean 4.4							
Variables used	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neutral (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
A metallic mineral mine would be beneficial to my community	5.9	13.4	20.4	27.1	9.6	12.4	11.2
A metallic mineral mine would only have short-term economic benefits for my community (Reverse coded)	9.8	14.5	16.9	36.0	13.6	7.7	1.4
A metallic mineral mine would have long-term economic benefits for my community	3.5	11.4	15.5	33.0	10.8	13.4	12.4
A metallic mineral mine would be harmful to the local natural environment (Reverse coded)	24.8	17.1	22.2	19.6	7.7	6.5	2.0
Societal Risk Index Mean 4.5							
Variables used	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neutral (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
The benefits of metallic mineral mining outweigh the negative impacts	3.3	11.4	13.2	29.9	13.8	14.5	13.8
Metallic mineral mining would be harmful to Maine's natural environment (Reverse coded)	21.4	16.7	26.3	18.9	8.8	6.5	1.4
Metallic mineral mining would only have short-term economic benefits in Maine (Reverse coded)	9.0	14.1	18.5	36.9	11.8	8.8	1.0
Metallic mineral mining would have long-term economic benefits in Maine	3.1	12.4	13.8	37.7	11.2	11.0	10.8
The negative impacts of metallic mineral mining outweigh the benefits (Reverse coded)	16.5	12.8	10.2	33.6	10.6	11.8	4.5

BIOGRAPHY OF THE AUTHOR

Andrew Morgan was born in 1988 in Portland, Maine. He earned his Maine General Education Diploma on January 2, 2007. In May 2016, he graduated from the University of Maine with a Bachelor's of Science in Parks, Recreation and Tourism. During his senior year he was awarded the Dwight B. Demeritt Award, the School of Forest Resource's highest student award, presented to the top senior as voted by the school's faculty. Andrew has worked the last four years as a research assistant for the Center for Research on Sustainable Forests, the Senator George J. Mitchell Center for Sustainability Solutions, and the School of Forest Resources where he has participated in a number of research projects. He has also interned with the New Hampshire Chapter of the Nature Conservancy where he conducted easement and ecological monitoring. He has extensive experience connecting young people with the natural world through other work and volunteer experiences including as a scoutmaster. Andrew is a student member of the International Association for Society and Natural Resources. He is a candidate for the Master of Science degree in Ecology and Environmental Sciences from The University of Maine in December 2017.