THE UNIVERSITY OF MAINE

Public Perceptions of Metallic Mineral Mining in Maine
Research Summary Report of Preliminary Results

To

The Joint Standing Committee on Environment and Natural Resources

By
Andrew Morgan
Dr. Sandra De Urioste-Stone

2017

Center for Research on Sustainable Forests

SSi maine's sustainability solutions initiative. Senator George J. Mitchell Center

NIWR

School of Forest Resources • University of Maine

Table of Contents

List of Tables

List of Figures

Executive Summary

As new locations for mining activities are sought, some regions with limited recent metallic mineral mining (MMM) history and expertise find themselves grappling with the issues which surround mining activities. Since 2012, Maine found itself in this situation after renewed interest in one of the state's largest metal containing deposits spurred the legislature to revise its MMM laws. Now in 2017, the debate continues demonstrating the importance of a social license to operate. A social license refers to the acceptance or approval of mining operations by local communities and other stakeholders, who can affect the profitability of those operations. This public acceptance or social license to operate, is influenced by risk perceptions, trust in governance structures, and weighing of benefits over costs. With multiple mining bills introduced during the 128th legislative session, gaining an understanding of the public's risk perceptions on MMM in the state is both timely and important.

It is the aim of this study to examine Maine residents' perceptions of metallic mineral mining and to provide further data to inform the current policy debate. Researchers have sought to identify major debate themes utilizing publicly available secondary data including public hearing testimonies and newspaper articles between 2012 and 2017. A mail survey was also implemented to gather opinions from a wider audience of Maine residents. A total of 501 residents from across the state responded to this survey.

Preliminary analysis of the secondary data identified several topics that have been prominent concerns for stakeholders. These topics include: water quality, mining on public lands, human and wildlife health, financial assurance, site closure and reclamation, potential impacts to existing industries, mistrust in mining organizations and also the state government. Survey participants expressed similar concerns. 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. Likewise, the majority of survey participants (64%) agreed that a metallic mineral mine would be harmful to the local natural environment and over half (54%) of participants believed nature based tourism would decrease as a result of a potential local mine.

Over three quarters (78%) believed employment opportunities would increase. However, the majority of survey participants (63%) agreed that the negative impacts of MMM outweighed the benefits.

Acknowledgements

The authors would like to acknowledge Dr. John Daigle, Dr. Jean MacRae, Dr. Amanda Olsen, and Lydia Horne, for help with survey design and question development. This study is supported by the National Institutes for Water Resources administered through the Senator George J. Mitchell Center, the Center for Research on Sustainable Forests and the USDA NIFA, McIntire Stennis project ME041504.

About the Authors

Andrew Morgan is a Graduate Research Assistant in the School of Forest Resources at the University of Maine. Born and raised in Maine, he is currently pursuing a MS in ecology and environmental sciences where he focuses on the human dimensions of natural resources. He earned his B.S. in Parks, Recreation and Tourism from the University of Maine. Andrew has been responsible for much of the data collection, study design, analysis, and reporting for this study.

Dr. Sandra De Urioste-Stone is Assistant Professor of Nature-based Tourism in the School of Forest Resources, University of Maine, USA. She earned a BA in ecotourism, MS in resource recreation and tourism, and PhD in natural resources with emphasis on conservation social sciences. Dr. De Urioste-Stone has done extensive work on sustainable tourism, community-based tourism, human dimensions of biodiversity conservation, and sustainable development (including adaptation to global changes, food security, and community-based public health interventions). She has had experience working for environmental NGOs and universities in Central America. She has focused extensively on promoting knowledge to action approaches to science.

1. Introduction

1.1. Background and Relevance

The demand for metal products, largely due to growing global affluence compels society to extract more raw metals from the earth. As new locations for mining activities are sought, some regions with limited recent metallic mineral mining (MMM) history and expertise find themselves grappling with the issues which surround mining activities. Since 2012, Maine found itself in this situation after renewed interest in one of the state's largest metal containing deposits spurred the legislature to revise its MMM laws. A long sometimes heated and continuing debate has followed among a relatively small set of stakeholders. However, with no metallic mining in the last 40 years Maine lacks experienced professionals and there has been few mining experts involved in this policy development process. Additionally, unknown are the widespread views from the general Maine population.

An increasingly important concept for the mining industry is what is known as a social license to operate. A social license 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). It has been well documented that public acceptance of mining activities are critical for their profitable operation (Zhang & Moffat, 2015; Zhang et al., 2015; Suopajrvi et al., 2016). This public acceptance or social license to operate, is influenced by risk perceptions, trust in governance structures, and weighing of benefits over costs (Zhang & Moffat, 2015; van der Linden, 2015). With multiple mining bills introduced during the 128th legislative session, gaining an understanding of the public's risk perceptions on MMM in the state is both timely and important.

A social license to operate metallic mines is particularly important in this context because Maine is a "home rule" state where the local municipalities have much authority over land use policy (Richardson, 2008). Reflective of this reality, the most recent proposed mining rules from the Maine Department of Environmental Protection (2016) are explicit in explaining that the rules, an official permit to mine, nor the statute "prevent a municipality from regulating…mining or reclamation activities" which includes "regulating the routes, hours, and weights of transportation of…mining-related materials on public streets and roads in order to protect the public health, safety, and welfare" (p. 11). Thus if the local municipality is opposed to the mine then they could create restrictions that could negatively affect its profitability. The lack of a social license can affect mining profitability in other ways, such as protests, public outrage, creating a negative image, law suits, etc.

In a 2015 article, researchers Airong Zhang and Kieren Moffat, studied public acceptance of mining activities in Australia and found that residents were not willing to compromise their environmental concerns even if they recognized that mining created many benefits. They also found that confidence in governance structures 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 governance was perceived to be weak, acceptance level significantly decreased even for those residents with low environmental concerns.

Risk perception studies have been applied on numerous topics and contexts, such as, global climate change (van der Linden, 2015; Mase, Cho, & Prokopy, 2015) and tourism (De Urioste-Stone, 2016) to name a few. However, comprehensive risk perception models have not been applied to the topic

of mining. There are several qualitative studies that give great insight into community conflicts in regard to permitting a single mine (Hutchins et al., 2007; Campbell & Roberts, 2010; Gibson, 2006) but none to a policy debate that covers an entire state or region. Other studies have focused on gold mining and its impacts on the environment and livelihoods in developing countries (Kumah, 2006; Bryceson & Jonsson, 2010; Kitula 2006). These studies give some useful insights for mining in Maine since many of the potential sites are predominately in rural locations. Additionally, most of the studies concerning some type of public perception of mining have been in areas with an already established mining industry. Therefore this study is unique in that it applies a risk perceptions model to the topic of mining in an area which has little recent experience and expertise in the metallic mining industry.

1.1.1. Study purpose

It is the aim of this study to examine Maine residents' perceptions of metallic mineral mining and to provide further data to inform the current policy debate.

2. Methodology

2.1. Study Objectives

The objectives of this study are to (1) Track the evolution of the mining policy debate since 2012, (2) Better understand the perceptions and acceptance levels of Maine residents, (3) Determine the barriers that have prevented approval of the rule revisions and the conditions required for approval, (4) Provide information to policy makers to aid in their deliberations concerning metallic mineral mining in Maine.

2.2.Study Design

Data has been collected between January 2016 and March 2017 using a mixed methods approach, with both qualitative and quantitative research components.

Component 1—Content Analysis of Secondary Data: Throughout the research qualitative data was collected which included public hearing testimonies and newspaper articles. Testimonies were acquired through the Maine legislature and Board of Environmental Protection websites. News articles are predominantly from the Bangor Daily News and the Portland Press Herald. A qualitative content analysis was conducted on these testimonies and news articles using NVivo 11, a software that assists in such qualitative analysis.

Component 2—Resident mail-survey: Survey instruments were mailed to Maine residents beginning in July 2016. Up to two replacement questionnaires were sent and up to one postcard reminder to those who did not respond by set dates. Responses were recorded and analyzed in IBM's Statistical Package for the Social Sciences (SPSS).

2.2.1. Survey Sampling

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 mailing the questionnaire (Fig. 1). The sample consisted of 2,573 valid addresses. Similar to Zhang and Moffat (2015) this study oversampled strata 1 and 2 with 830 and 839 addresses

respectively to insure adequate number of responses from areas which have the greatest potential to be directly influenced by mining activities.

Stratum one consists 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 impact.

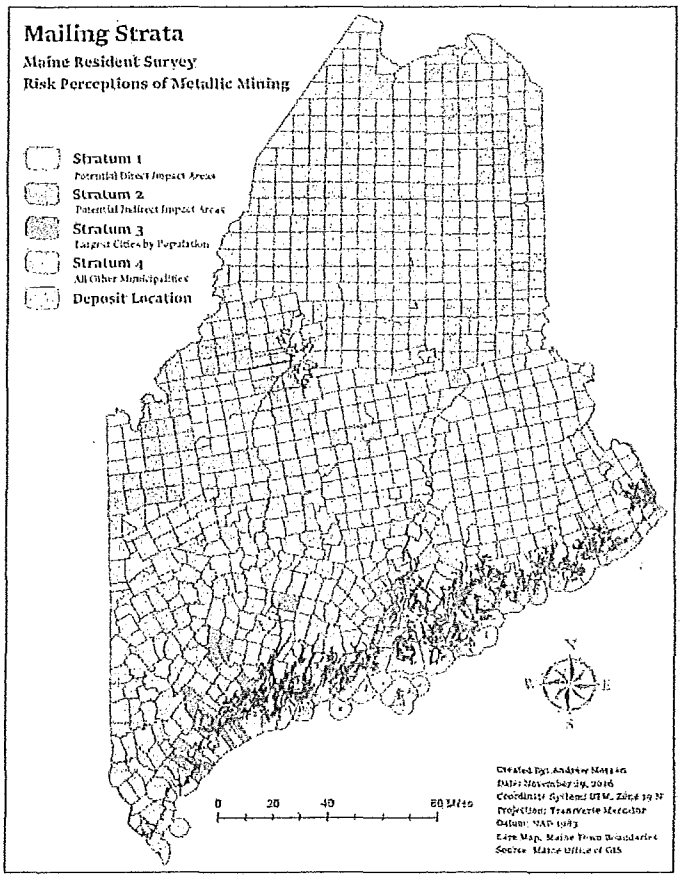

Figure 1. Map of sampling strata for mail survey of Maine residents.

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.

2.2.2. Questionnaire Design and Implementation

The mail questionnaire was designed using an adapted version of van der Linden's (2015) socio-cultural risk perceptions model. Our questionnaire utilizes knowledge, experience, socio-cultural, trust and socio-demographic constructs to determine risk perceptions which in turn influences acceptance levels. For more information on the theoretical framework please see Appendix A. The surveying period began July 2016 and ended in March 2017. The questionnaires were sent to the addresses determined in the sampling design with a cover letter and a prepaid return envelope. 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.

2.3.Quality Control

2.3.1. Pre-Testing

An online pilot survey was developed and implemented as part of an environmental attitudes and behaviors course in the School of Forest Resources during the spring 2016 semester. Based upon the results of this pilot survey changes were made to make questions easier to understand and ensure we received an adequate response rate before implementing the mail survey.

2.3.2. Response Rate

The response rate for the mail survey was 19.5% (501 out of 2,573). We do not have phone contact information of participants so we are unable to follow up with any of those who did not respond to our survey. However, responses from those who responded after the final contact have been shown to be similar to non-respondents (Armstrong & Overton, 1977). Therefore, we will be comparing responses between those who responded to the mail survey after the first mailing with those who responded after the final contact.

3. Results

3.1. Qualitative Data

Knowing that this committee has been involved throughout this policy process we only offer a brief synopsis of our results from our qualitative content analysis. Over the past five years only introduced bills (LD 1302, LD 1324, LD 1059, and the original version of LD 750) that sought to strengthen the 2012 Metallic Mineral Mining Law received more support than opposition (Fig. 2). In Figure 3, the positions of all the testimonies and written comments given to the Board of Environmental Protection on the most recent proposed Chapter 200 rules are displayed. The opposition was overwhelmingly dominant with 486 opposed while only three supported and two testified neither for nor against the rules. No testimonies from the most recent public hearing held on March 20, 2017 have been analyzed.

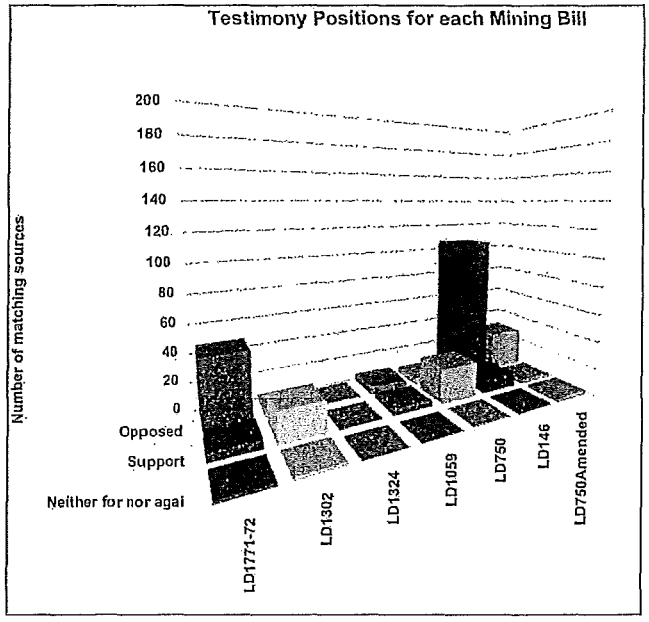

Figure 2. Positions of testimonies for several bills related to metallic mineral mining.

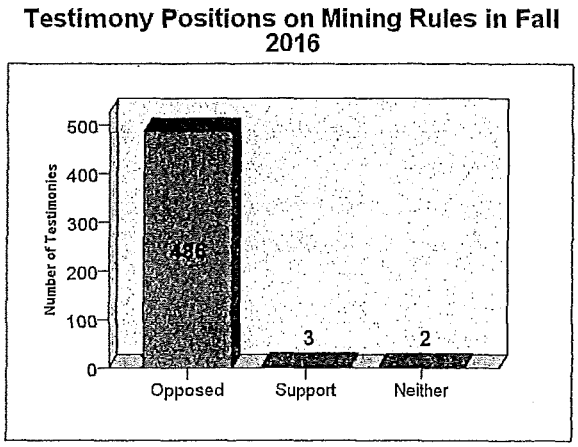

Figure 3. Position of testimonies and written comments on proposed Chapter 200 rules submitted to BEP during Fall 2016.

Figure 4 displays the most frequent words within all the testimonies and news articles. The size of the word indicates its prevalence. Several major areas have been dominant and most consistent over time as barriers to rule approval. These barriers topics are displayed in Table 1.

Figure 4. Word cloud showing the most frequently used words in testimonies and news articles from 2012 through 2016.

Table 1. Themes identified as major barrier topics that have prevented approval of past mining rules.

Major Barrier Topics
▪ Water quality
▪ Mining on public lands
▪ Human & wildlife health
▪ Financial assurances
▪ Site closure & reclamation
▪ Potential impacts to existing industries
▪ Mistrust in mining organizations
▪ Mistrust in state government

3.2.Resident Mail Survey

A total of 501 individuals responded to the mail survey. The mail survey was voluntary therefore participants could skip questions if they desired. Non-responses for each question were not calculated in percentage totals. The following results give the exact number of responses (N) for each question. These results reflect descriptive results only.

3.2.1. Demographics (residence, place of origin, gender, age, education)

General demographic characteristics from respondents are presented in Table 2 along with comparisons with census data and Maine 2016 voter registration data. Just over half of the respondents were female (51.9%) which is nearly identical to 2010 Census data. The mean age of all participants was 58.3 (as a requirement, all participants were 18 years or older). A higher percentage (52.9%) of participants have a Bachelor's degree or higher than the overall Maine population (28.4%). 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.

Table 2. Demographic characteristics of residents who responded to the mail survey. N=501.

Demographic Characteristics	N	%	Census Data[1]	ME 2016 Voter Registration[2]
Gender				
Male	235	48.1	49	
Female	254	51.9	51	
Age in years				
Mean	58.3 yrs			
Education				
Less than high school	9	1.8	8.7	
High school	75	15.3	33.6	
Some college	90	18.4	20.1	
2-year degree	57	11.7	9.3	
Bachelor's degree	147	30.1	18.3	
Master's degree or higher	111	22.8	10.1	
Political Affiliation				
Democrat	140	29.9		32%
Republican	125	26.7		27%
Independent	173	37		36%
Other	30	6.4		5%

Note 1. Gender data from 2010 Census. Education data from 2014 Census estimates. No average age was found for Maine population 18 years and older. All census data obtained from https://www.census.gov/quickfacts.

Note 2. Data obtained from Statewide Registered and Enrolled Data File from http://www.maine.gov/sos/cec/elec/data/. Unenrolled was used to calculate independents. Green and Libertarian were used to calculate other category.

As a result of oversampling strata 1 and 2, over 30% of respondents were residents in Aroostook (18%) or Hancock (15%) counties (Fig. 5). Cumberland County was third with 13% while Oxford and Sagadahoc counties only comprised 1% each.

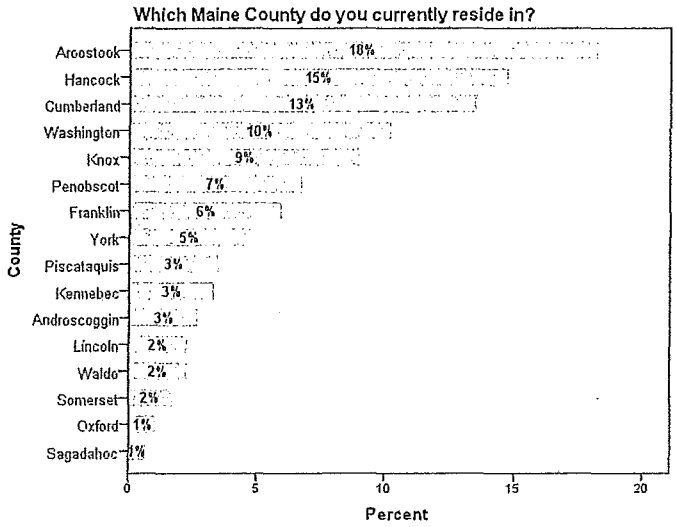

Figure 5. Percentage of respondents from each Maine county. N=501.

3.2.2. Profile (Experience, Knowledge, and Community)

The questionnaire asked questions related to a participants experience with any type of mining, knowledge about metallic mineral mining in Maine, and questions about their own community. Table 3 displays the results from a few experience and knowledge questions. The vast majority (83%) had no personal or family experience with any type of mining. Approximately 40% incorrectly thought that there were currently active metal mines in the state while nearly two thirds (63.5%) had not heard about the MMM discussion occurring in the state prior to participating in the survey. Of those that did have prior knowledge, three quarters (74%) got their information from newspapers and over two thirds (68%) from local TV/radio news outlets.

Table 3. Answers to experience and knowledge related questions.

Experience & Knowledge Survey Questions	N	%
Q1. Experience with any type of mining?	477	Yes = 17 No = 83
Q2. Currently active MMM in ME?	403	Yes = 39.2 No = 52.1 I Don't Know = 8.7
Q4. Prior knowledge of MMM discussion?	485	Yes = 36.5 No = 63.5

Figue 6 shows results for the question that asked a participant's level of agreement to the statement "I am concerned about my community's ability to attract young people." A quarter (26%) strongly agreed with this statement. In all, 75% had some level of agreement to this statement. Nearly identical results are displayed in Figure 7 with 76% expressing some level of agreement to the statement "limited job opportunities have caused the departure of people who lived in my community."

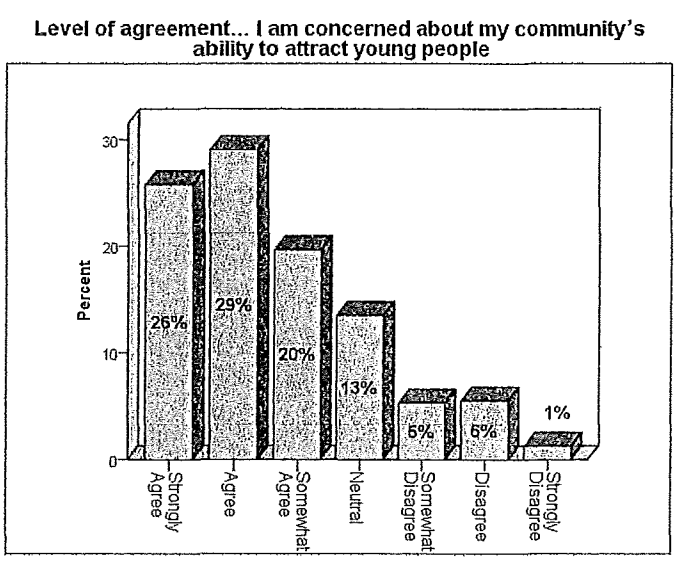

Figure 6. Respondents' level of agreement with the statement "I am concerned about my community's ability to attract young people." N=489.

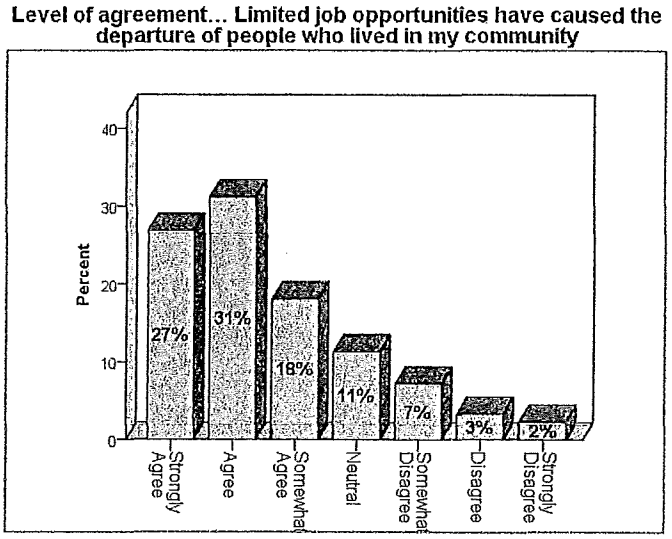

Figure 7. Respondents' level of agreement with the statement "Limited job opportunities have caused the departure of people who live in my community." N=488.

For the statement " people in my community are typically supportive of resource extraction jobs", 7% strongly agreed, 48% either agreed or somewhat agreed (Fig. 8). Even more had some form of

agreement (87%) that 'people in my community are typically supportive of jobs in the tourism industry (Fig. 9).

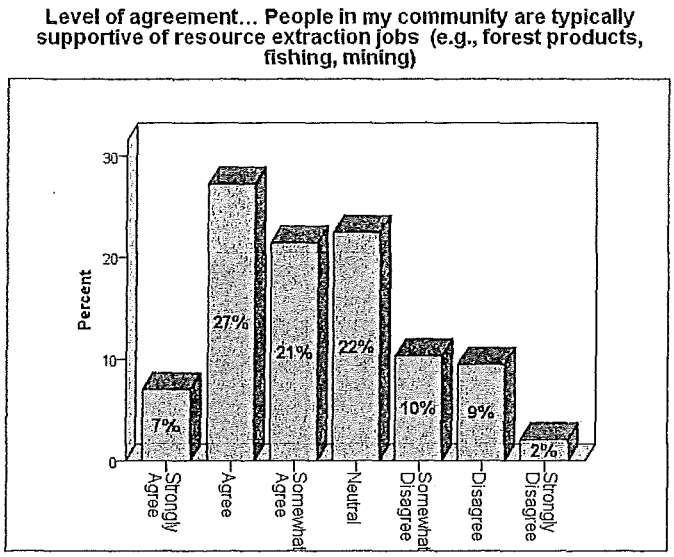

Figure 8. Respondents' level of agreement with the statement "People in my community are typically supportive of resource extraction jobs." N=485.

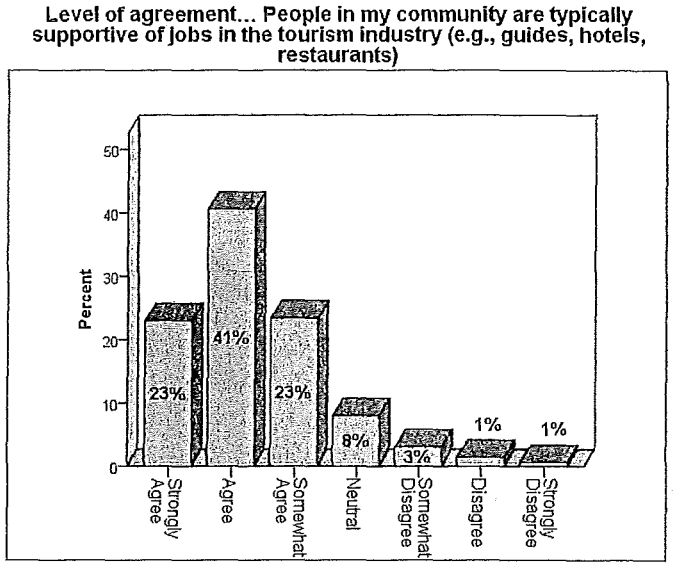

Figure 9. Respondents' level of agreement with the statement "People in my community are typically supportive of jobs in the tourism industry." N=488.

3.2.3. Trust in Information Sources and Strategies

This section displays the results of questions that asked about how much participants trusted different sources for more information on MMM and how much they believed certain strategies would reduce negative environmental impacts of MMM. Trust in newspapers and local news outlets were nearly identical with 52% and 50% having some level of trust (Fig. 10 & 11).

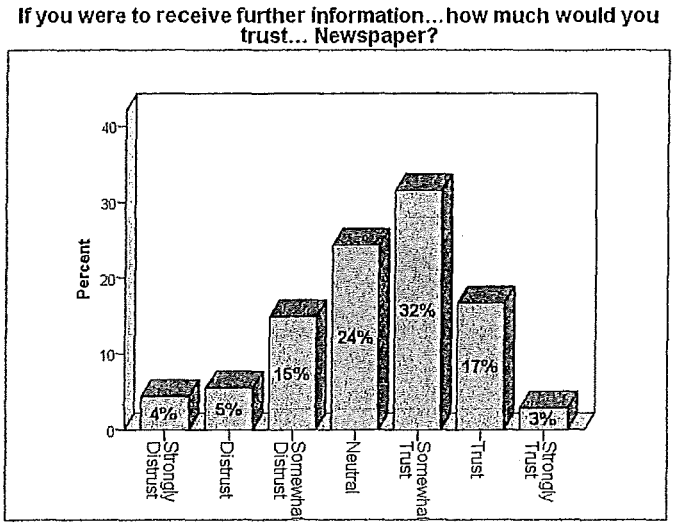

Figure 10. Respondents' level of trust for receiving further information on MMM from newspapers. N=457.

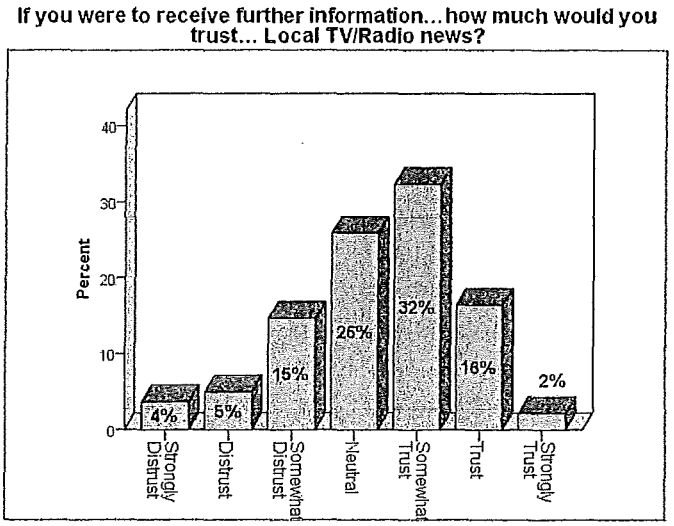

Figure 11. Respondents' level of trust for receiving further information on MMM from local TV/radio news. N=464.

The large majority (84%) had some level of trust in scientists/researchers as information sources (Fig 12). Conversely, 23% somewhat trusted or trusted mining organizations and only 3% expressed strong trust (Fig. 13).

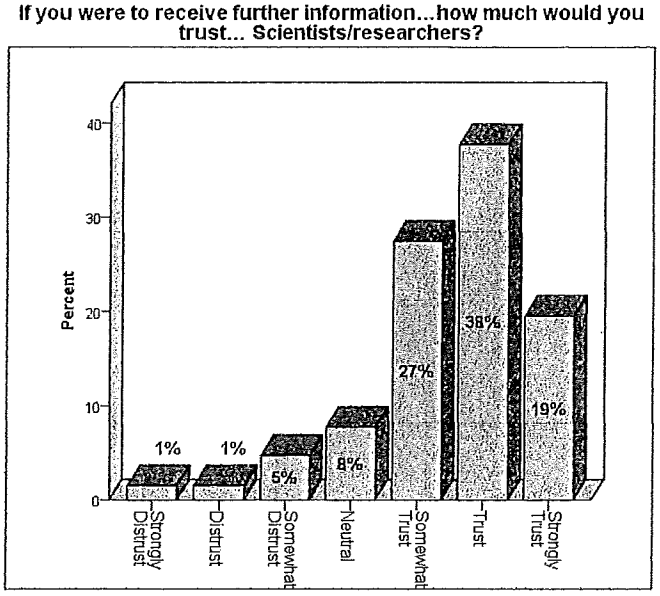

Figure 12. Respondents' level of trust for receiving further information on MMM from scientists/researchers. N=467.

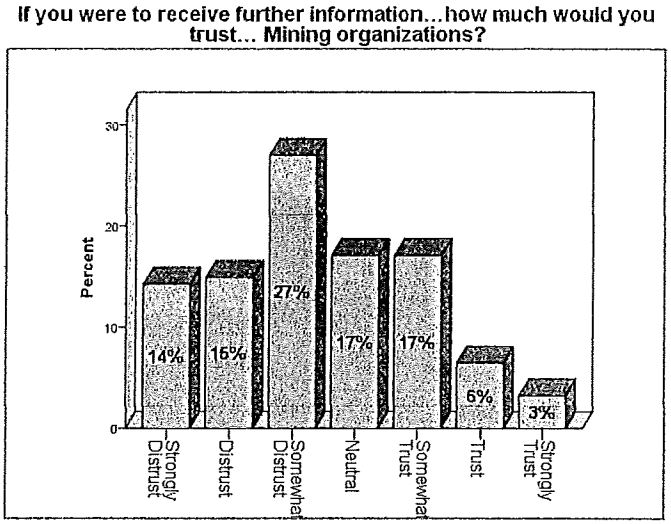

Figure 13. Respondents' level of trust for receiving further information on MMM from mining organizations. N=463.

Economic development organizations were trusted slightly more than mining organizations (Fig. 14) with 27% trusting or somewhat trusting, and only 3% strongly trusting them as future information sources on MMM. Figure 15 shows that 43% somewhat trusted or trusted conservation organizations while just 7% strongly trusted them.

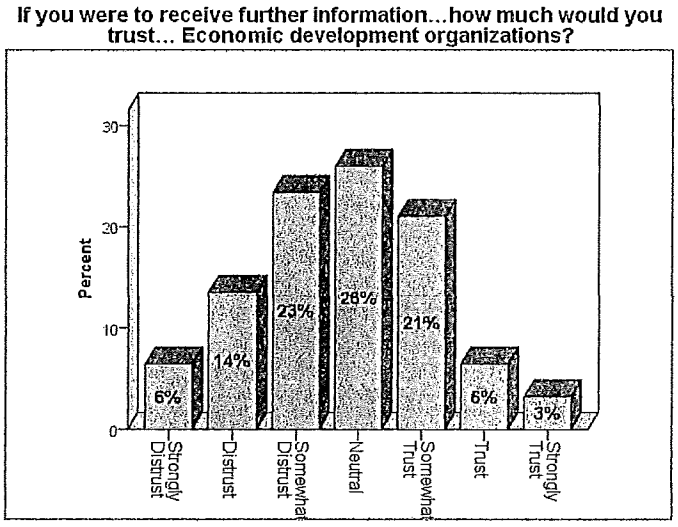

Figure 14. Respondents' level of trust for receiving further information on MMM from economic development organizations. N=466.

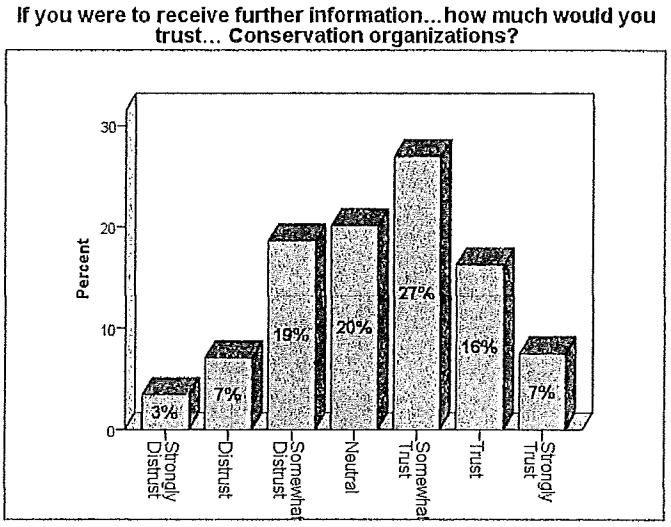

Figure 15. Respondents' level of trust for receiving further information on MMM from conservation organizations. N=467.

Both the state government and federal government (Fig. 16 & 17) only had a quarter of participants have some level of trust in them as information sources on MMM.

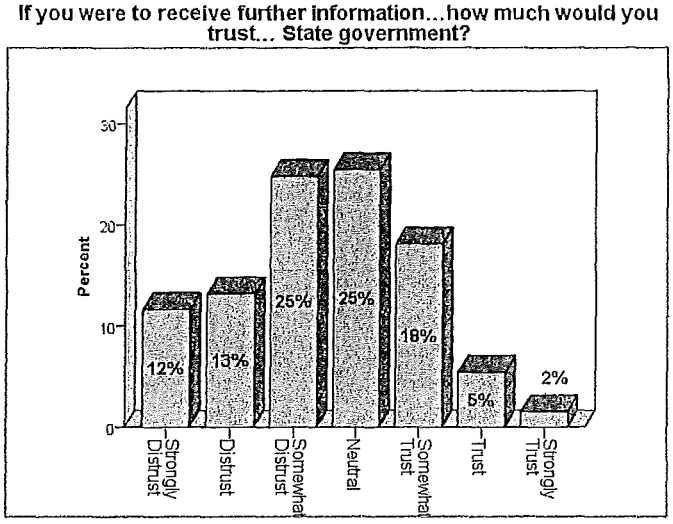

Figure 16. Respondents' level of trust for receiving further information on MMM from the state government. N=464.

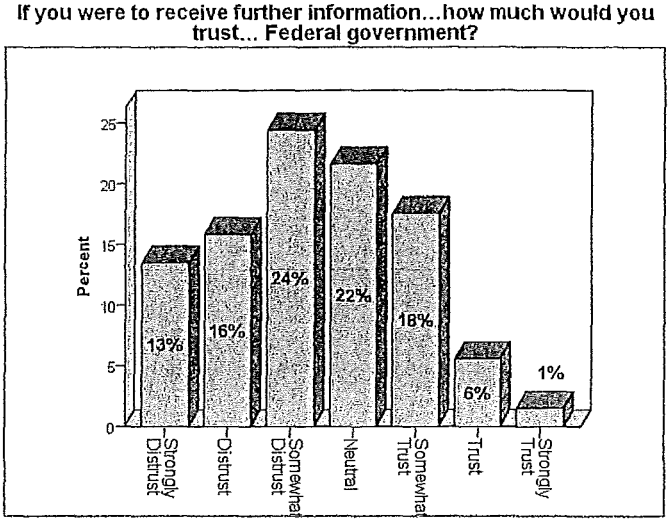

Figure 17. Respondents' level of trust for receiving further information on MMM from the federal government. N=467.

Yet, 86% and 85% believed that water quality regulations and oversight by Maine Department of Environmental Protection would reduce negative environmental impacts of MMM in Maine respectively (Fig. 18 & 19).

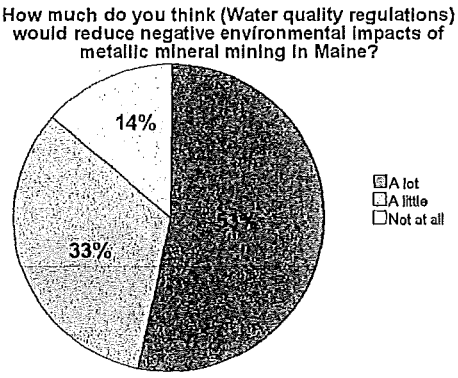

Figure 18. How much respondents' thought water quality regulations would reduce environmental impacts of MMM in Maine. N=462.

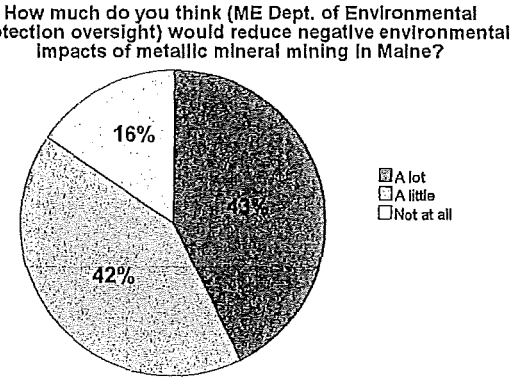

Figure 19. How much respondents' thought DEP oversight would reduce environmental impacts of MMM in Maine. N464.

Conversely, in Figures 20 & 21 over one-third (39% and 36%) believed that environmental monitoring and upfront financial assurances by private mining companies would not reduce negative environmental impacts.

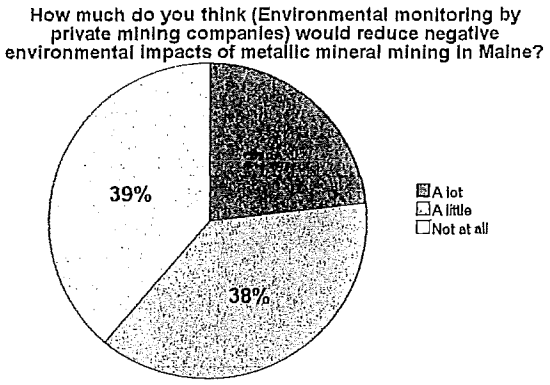

Figure 20. How much respondents' thought environmental monitoring by private mining companies would reduce environmental impacts of MMM in Maine. N=462.

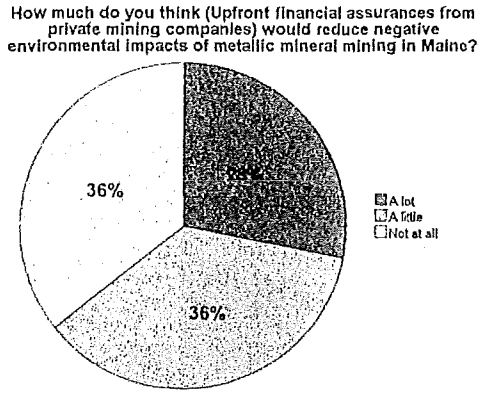

Figure 21. How much respondents' thought upfront financial assurances from private mining companies would reduce environmental impacts of MMM in Maine. N=459.

3.2.4. Risk Assessment

This section displays results of questions that assessed participants' perception of the risks of MMM if mines were developed near their community and in Maine overall. Over half (59%) expressed concern if a metallic mineral mine were developed near their community (Fig. 22) and 64% expressed agreement that such a mine would be harmful to the local natural environment (Fig. 23).

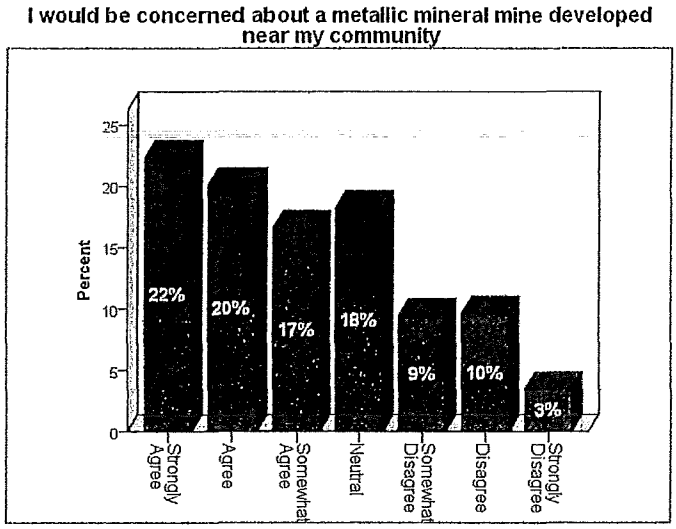

Figure 22. Respondents' level of agreement to the statement "I would be concerned about a metallic mineral mine developed near my community." N=487.

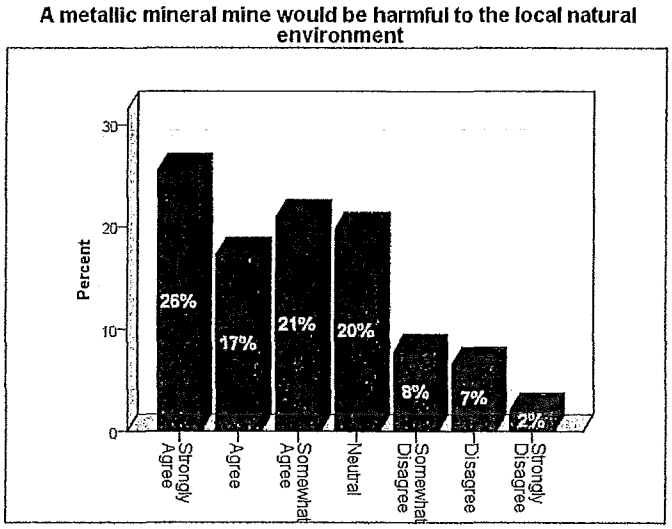

Figure 23. Respondents' level of agreement to the statement "A metallic mineral mine would be harmful to the local natural environment." N=486.

In Figure 24, a third (34%) agreed or somewhat agreed that a metallic mineral mine would be beneficial to their community. Only 6% strongly agreed with this statement.

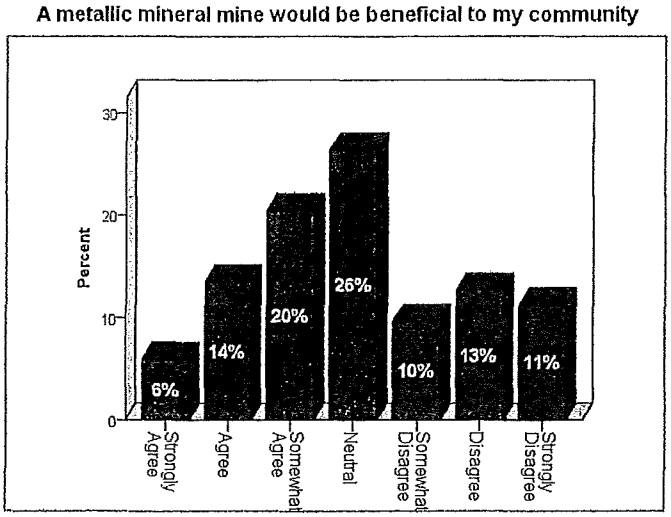

Figure 24. Respondents' level of agreement to the statement "A metallic mineral mine would be beneficial to my community." N=488.

In asking about mine development in Maine overall, 63% had some level of agreement that the negative impacts of MMM outweigh the benefits (Fig. 25). Only 17% expressed any disagreement to this statement. In Figure 26, 41% had some level of agreement to the statement that "metallic mineral mining would be harmful to Maine's natural environment" while a third (32%) were neutral towards the statement.

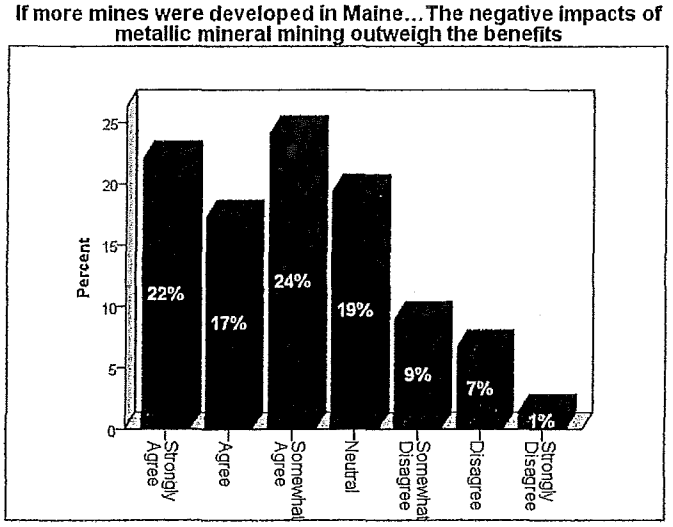

Figure 25. Respondents' level of agreement to the statement "the negative impacts of metallic mineral mining outweigh the benefits." N=480.

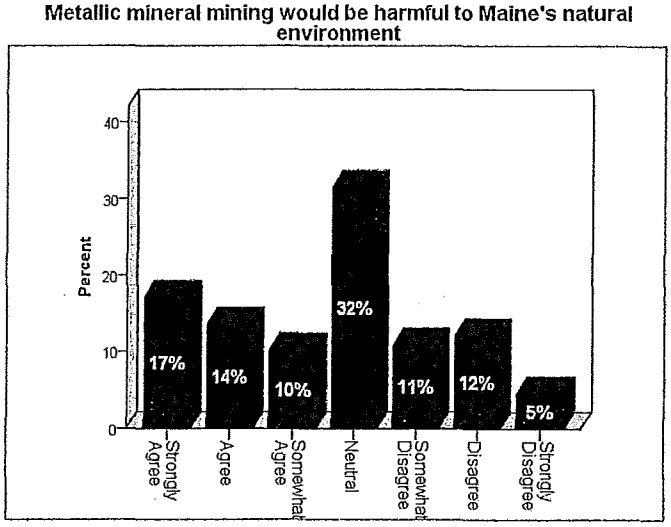

Figure 26. Respondents' level of agreement to the statement "metallic mineral mining would be harmful to Maine's natural environment." N=479.

Participants were also asked if they believed certain things would increase, decrease, or remain constant if a mine was developed near their community. In Figure 27, over half (53%) believed human health would decrease and 43% believed it would remain constant. Over two-thirds (69%) believed that fish and wildlife health would decrease (Fig. 28).

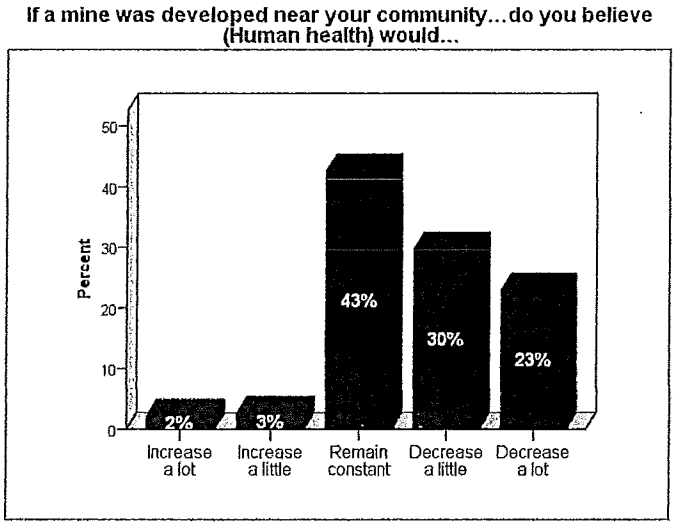

Figure 27. Perceived impact to human health of a potential mine near respondents' community. N=462.

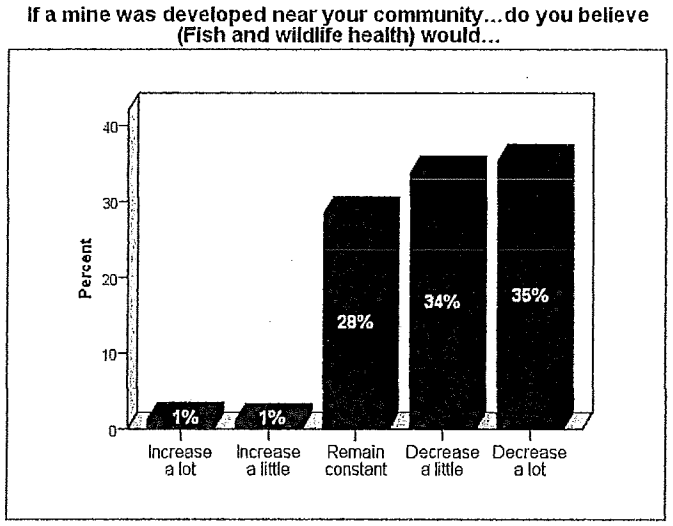

Figure 28. Perceived impact to fish and wildlife health of a potential mine near respondents' community. N=467.

Similarly, over two-thirds (67%) believed that water quality would decrease (Fig. 29). In Figure 30, over half (54%) believed that nature based tourism would decrease.

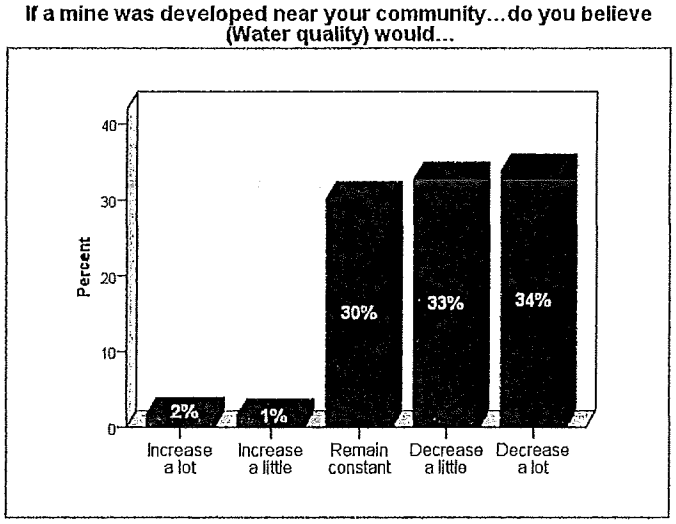

Figure 29. Perceived impact to water quality of a potential mine near respondents' community. N=467.

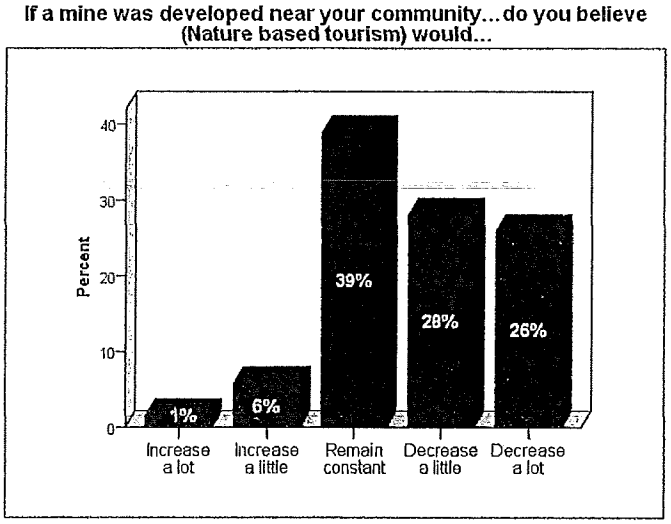

Figure 30. Perceived impact to nature based tourism of a potential mine near respondents' community. N=468.

In Figure 31, 78% believed employment opportunities would increase, however, the majority express there would be a little increase (62%). Yet, 44% believed that house/property values would decrease (Fig. 32).

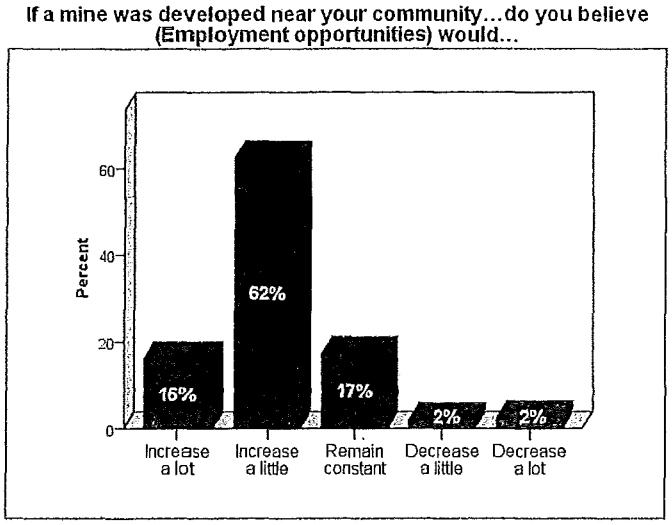

Figure 31. Perceived impact to employment opportunities of a potential mine near respondents' community. N=465.

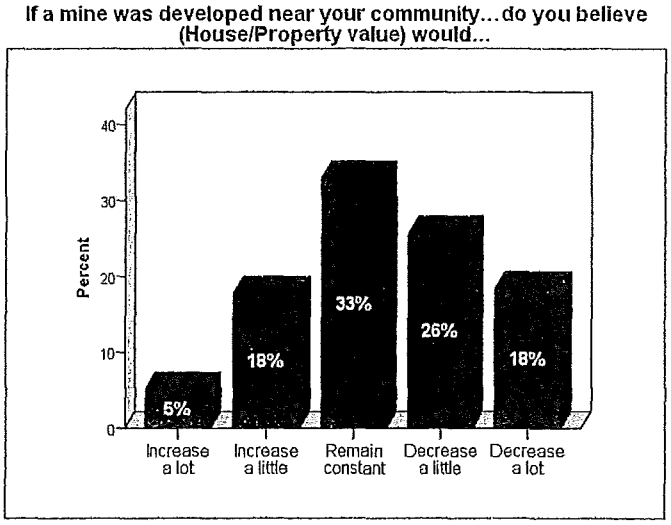

Figure 32. Perceived impact to house/property value of a potential mine near respondents' community. N=467.

4. Conclusions and Recommendations

Study Limitations and Considerations for Survey Results:

Given the 19.5% response rate, we caution on the conclusions as 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. The distribution of the counties in which participants resided also is different than Maine as a result of the deliberate sampling design to capture more residents within close proximity to deposits.

Key Findings and Recommendations:

- Most of the opposition expressed in testimony has been towards the law and rules that they perceive to be too weak.
- Survey participants expressed similar concerns to those expressed in testimonies. These concerns include negative impacts to water quality, local environment, human health, and existing industries.
- A large number of survey participants lacked of awareness or information. Approximately 40% incorrectly thought that there were currently active metal mines in the state while nearly two thirds (63.5%) had not heard about the MMM discussion occurring in the state prior to participating in the survey. Of those that did have prior knowledge, three quarters (74%) got their information from newspapers and over two thirds (68%) from local TV/radio news outlets.
  - In order to have more constructive public input on this and other policy topics, increased information may need to be given. Since newspapers and local news outlets were the most prominent sources of information, state government entities should utilize these channels for dispersion of information.
  - Scientists and researchers were the most trusted for future information on MMM (84% had 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 provide information to which a wary public may be receptive.
- Survey participants did, however, express that they believed that water quality regulations (86%) and oversight by Maine Department of Environmental Protection (85%) would reduce negative environmental impacts of MMM in Maine. Nearly 40% of survey participants believed that environmental monitoring by private mining companies would not reduce these impacts.
- 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 (87%) had some form of agreement 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.
- A fair number of survey respondents (40%) thought that a metallic mineral mine would be beneficial to their community, and over half (62%) believed employment opportunities would increase a little. However, the majority of survey participants agreed that the negative impacts of MMM outweighed the benefits (63%).

- The majority of survey participants (64%) agreed that a metallic mineral mine would be harmful to the local natural environment.
- 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.

5. Literature Cited

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research, 14*(3), 396-402.

Bryceson, D. F., & Jonsson, J. B. (2010). Gold digging careers in rural east Africa: Small-scale miners' livelihood choices. *World Development,* 38 (3), 379-392.

Campbell, G., Roberts, M. (2010). Permitting a new mine: Insights from the community debate. *Resources Policy,* 35, 210-217.

Creswell, J. W. (2015). *A Concise Introduction to Mixed Methods Research.* Thousand Oaks, CA: Sage Publications, Inc.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches.* (3rd ed.). Thousand Oaks, CA: SAGE Publications Inc.

De Urioste-Stone, S. M., Le, L., Scaccia, M. D., & Wilkins, E. (2016). Nature based tourism and climate change risk: Visitors' perceptions in Mount Dessert Island, Maine. *Journal of Outdoor Recreation and Tourism,* 13, 157-65.

Furr, R. M. & Bacharach, V. R. (2014). *Psychometrics: An introduction.* (2nd ed). Thousand Oaks, CA: Sage Publications, Inc.

Gibson, R. (2005). Sustainability assessment and conflict resolution: Reaching agreement with the Voisey's Bay nickel mine. *Journal of Cleaner Production,* 14, 334-348.

Hutchins, M., Walck, C., Sterk, D., & Campbell, G. (2007). Corporate social responsibility: A unifying discourse for the mining industry. *Greener Management International,* 52, 17-30.

Heberlein, T. (2012). *Navigating environmental attitudes.* New York, NY: Oxford University Press.
Joffe, H. (2003). Risk: From perception to social representation. *British Journal of Social Psychology,* 42(1), 55-73.

Kaiser, F. G., & Fuhrer, U. (2003). Ecological behavior's dependency on different forms of knowledge. *Applied Psychology: An International Review, 52*(4), 598-613.

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., & Goble, R. (1988). The social amplification of risk: A conceptual framework. *Risk Analysis.* 8(2), 177-187.

Kelly, J. (2011). NIMBY. In: Mulvaney, D. & Robbins, P. (Eds). *Green Politics: An A-to-Z Guide.* Thousand Oaks, CA: Sage Publications, Inc.

Kitula, A. G. N. (2006). The environment and socio-economic impacts of mining on local livelihoods in Tanzania: A case study of Geita District. *Journal of Cleaner Production,* 14, 405-414.

Kumah, A. (2006). Sustainability and gold mining in the developing world. *Journal of Cleaner Production,* 14, 315-323.

Mase, A.S., Cho, H., & Prokopy, L.S. (2015). Enhancing the Social Amplification of Risk Framework (SARF) by Exploring Trust, the Availability Heuristic, and Agricultural Advisors' Belief in Climate Change. *Journal of Environmental Psychology, 41,* 166-176.

Maine Department of Environmental Protection. (2016). *Metallic Mineral Exploration, Advanced Exploration and Mining* (06-096 Chapter 200 draft). Augusta, ME.

Richardson, B. (2008). Regional landscape conservation in Maine; best practices for enhancing quality of place. Maine State Planning Office, Augusta, ME.

Riesch, H. (2013). Levels of uncertainty. In: Roeser, S., Hillerbrand, R., Sandin, P., & Peterson, M. (Eds) *The Essentials of Risk Theory.* Dordrecht: Springer.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1982). Why study risk perceptions? *Risk Analysis,* 2(2).

van der Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *Journal of Environmental Psychology 41*,112-124.

Vaske, J. (2008). *Survey research and analysis: Applications in parks, recreation and human dimensions*. State College, PA: Venture Publishing, Inc.

Zhang, A., Moffat, K. (2015). A balancing act: The role of benefits, impacts, and confidence in governance in predicting acceptance of mining in Australia. *Resources Policy,* 44, 25-34.

Zhang, A., Moffat, K., Lacey, J., Wang, J., Gonzalez, R., Uribe, K...Dal, Y. (2015). Understanding the social license to operate of mining at the national scale: a comparative study of Australia, China and Chile. *Journal of Cleaner Production,* 108, 1063-1072.

Appendix A. Theoretical Framework

"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). Based largely on this theory of psychological measurement, van der Linden's (2015) framework focuses on linking attitudes to behavioral actions. Likewise, the metallic mineral mining risk perception model (MRPM) (Fig. 33) links attitudes with "behavioral action" which in this study's context is acceptance level of metallic mining.

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. 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.

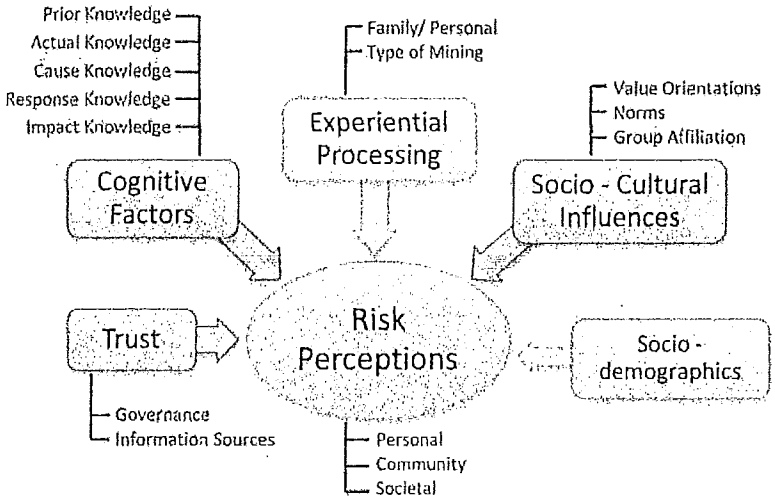

Figure 33. Metallic mineral mining risk perception model. (Adapted from van der Linden, 2015).

Community risk is an added component 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.

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). This study will measure five interrelated cognitive factors: prior, actual, cause, response, and impact knowledge about metallic mining in Maine. These differ slightly from the original model which distinguished between three types of knowledge: cause, impacts, and response.

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 et al., 1982). Heberlein (2012) calls these weak attitudes opinions because they lack cognitive structure. Given the novelty of the MMM topic in Maine, measures of prior knowledge 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.

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, p26). 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.

Socio-Cultural Influences

Van der Linden's model utilizes 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, socio-altruistic, and biospheric value orientations (van der Linden, 2015).

Risk perceptions are 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).

Trust

Though not originally a component of his model 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).

Trust is connected to confidence in governance structures which manage risks associated with activities like mining (Mase et al., 2015, Zhang & Moffat, 2015). "Loss of trust can increase risk perceptions, make a risk more unacceptable, and intensify the public response" (Mase et al., 2015, p. 168). Zhang and Moffat (2015) found that 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 governance was perceived to be weak, acceptance level significantly decreased even for those residents with low environmental concerns (Zhang & Moffat, 2015). Therefore a component to measure respondents' perceptions on the ability of different governance structures to reduce negative environmental impacts is also added to the model.

Socio-demographics

Gender and political affiliation were the only socio-demographic factors that influenced risk perceptions with van der Linden's model. 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 33 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.