NATURAL RESOURCES, COMMUNITY ENGAGEMENT, AND POLICY: USING INTERDISCIPLINARY METHODOLOGIES TO STUDY COMPLEX POLICY QUESTIONS

By

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ABSTRACT

NATURAL RESOURCES, COMMUNITY ENGAGEMENT, AND POLICY:
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The new frontiers of environmentalism will be played out in combined human and natural spaces. Sustainability is not possible in a world where communities struggle for basic survival—people will prioritize fuelwood over pandas, homes over fish habitat, and agriculture over forests. Natural resource scientists and managers are not new to the idea that human communities can be solutions as well as problems. The last few decades have marked new inroads in collaborative (co-) management with mixed results, in large part because the standards of what makes good community engagement in the natural resources arena are still being decided. This research hopes to serve as an early bridge to link natural resource scientists with community engagement scholarship, a field dedicated to working with communities to develop long term, sustainable solutions to human problems. For community-engagement scholars, who often work on small scales with specific programs and projects, this research can serve as an advancement of thinking about engagement in a larger management scale.

In Chapter 1, I use a content analysis technique to help to bridge the language divide between these two fields. This chapter attempts to overcome the first hurdle in interdisciplinary research: helping researchers from different disciplines understand each other. The chapter successfully uses an iterative methodology to uncover some of the most common terms being used in natural resources fields to describe community engagement initiatives,

starting only with the name of a field of interest and a term already familiar to community engagement scholars.

In Chapters 2 and 3, I move from theory into practice. In Chapter 2, I combine the risk ladder from natural resources human dimension research with the Q-sort, a methodology designed in the field of psychology for comparing various issues against each other. The result is the Riley Risk Ladder, which allows for the quantitative measurement of multiple costs and benefits from both the probability and magnitude dimensions of risk in addition to qualitative data collected during the interview. In Chapter 3, I use the Riley Risk Ladder in a group setting which has the possibility of collecting similar data with a lower investment of time and resources. This chapter explores how conducting the interview in a group setting changes what sorts of results can be seen and discusses what mechanisms can be put in place to reduce confounding group dynamics such as groupthink, social desirability, and anchoring.

Finally, Chapter 4 takes the interview data back to the stakeholders, reaching out in partnership to the stakeholder groups that participated in the original interview work. It explores the process of working with partners to develop a set of research questions, and takes a look at some of the obstacles of bridging the divide between partners from typically natural science backgrounds and working with social science data.

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INTRODUCTION

It can be argued that the environmental movement in the United States began with Yellowstone National Park, set aside in 1872 by President Ulysses S. Grant (National Park Service, 2018), soon followed Theodore Roosevelt who set aside approximately 230 million acres of public land during his presidency. Roosevelt is considered a "conservationist president" (National Park Service, 2017). "Conservation" is a philosophy which advocates for the wise use of nature by humans, as opposed to "preservation," which promotes protecting land from human use—a philosophy promoted by Roosevelt's contemporary John Muir (Westover, 2016). Despite their differing philosophies, both conservationists and preservationists of the period approached the issue in the same way: setting aside protected land to avoid overuse by humans.

The 1950's and 60's demonstrated the wisdom in protecting land from human overexploitation as populated landscapes were doused in DDT and other chemicals that had serious impacts on human and animal health (Carson, 1962). In the late 1960's Lake Erie was declared dead In 1969, The Cuyahoga River was on fire (Rotman, 2017). Human spaces had become toxic to living things. With the passage of new environmental laws such as the Clean Air Act and Clean Water Act and the creation of the Environmental Protection Agency, a new wave of environmentalism crossed the country which focused on environmental health as it relates to human health, rather than resource use. New standards were created for human industrial waste in human spaces to protect human lives.

Both of these previous eras of environmentalist thought continue to exist today, with battles continuing over protected land (Eilperin, 2018) and new challenges developing with environmental contamination (Bridge Magazine, 2016; Gardner & Ellison, 2018). But we are

also faced with new trials as human population continues to increase and more and more demands are placed on our natural resources. In the United States, an uneasy truce has been drawn between the human and natural worlds, with natural spaces defined by a lack of human settlement and human spaces defined by their built environment. With a landscape carved up into “people” areas and “no people” areas, we begin a new chapter of environmental history, played out in the disputed territory between and among these two spaces.

The demands of our ever-increasing human population will not shrink any time soon and they are currently being played out on the landscape. Rural America, traditionally the interface between human and natural spaces, is shrinking as people move to more urbanized landscapes (Wilson, 2018). Many are also leaving behind rural pastimes such as hunting and fishing which in turn is reducing the conservation funding that comes from license sales for those activities (U.S. Department of the Interior, U.S. Fish and Wildlife Service; and U.S. Department of Commerce, U.S. Census Bureau, 2016). Meanwhile, suburban sprawl is on the rise as an increasing human population brings with it unsustainable standard of living expectations and a slow but steady encroachment into what was previously considered nature-only spaces (Peterson, Peterson, & Liu, 2013).

The new frontiers of environmentalism will be played out in combined human and natural spaces. Navigating that space will require scientists to do more interdisciplinary work than ever before. It will require that those concerned with the environment and natural resources to reach out to communities to develop compromises that meet the needs of people while protecting the environment that they share with the natural world. Sustainability is not possible in a world where communities struggle for basic survival—people will prioritize

fuelwood over pandas, homes over fish habitat, and agriculture over forests (Liu, et al., 2007). The wellbeing of our natural environment is intrinsically linked to the wellbeing of its human communities, just as human wellbeing is linked to the health of our environment.

Natural resource scientists and managers are not new to the idea that human communities can be solutions as well as problems. The last few decades have marked new inroads in collaborative (co-) management, in which natural resource managers reach out to human communities in partnership (Plummer & Fitzgibbon, 2004), as well as new efforts in stakeholder engagement around decision-making (Schusler & Decker, 2002). The results have been mixed, in large part because the standards of what makes good community engagement in the natural resources arena are still being decided (Yandle, 2003; Reed, 2008). This is precisely where collaborations between natural resource scientists and scholars of community engagement can be most effective.

This research hopes to serve as an early bridge to link natural resource scientists with community engagement scholarship, a field dedicated to working with communities to develop long term, sustainable solutions to human problems. Because human problems are intrinsically linked to environmental problems, such an intellectual partnership could advance thinking and progress in natural resources co-management. For community-engagement scholars, who often work on small scales with specific programs and projects, this research can serve as an advancement of thinking about engagement in a larger management scale.

In Chapter 1, I use a content analysis technique to help to bridge the language divide between these two fields. Content analysis is defined as “a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of

coding" (Stemler, 2001). This chapter uses this methodology to overcome the very first hurdle in interdisciplinary research: helping researchers from different disciplines understand each other. Oftentimes moving from one discipline to another, with all its jargon and insider speech, is like learning a new language. How do you even know what questions to ask? The chapter successfully uses an iterative methodology to uncover some of the most common terms being used in natural resources fields to describe community engagement initiatives, starting only with the name of a field of interest and a term already familiar to community engagement scholars.

In Chapters 2 and 3, I move from theory into practice. One of the difficult leaps for natural resource scientists to make when working with people is the need to rely on qualitative research, which can seem frustratingly subjective for natural scientists. Unfortunately, prior to this research, the quantitative methods for understanding the perception of risk, in particular the risk ladder, are limited to the evaluation of a single risk of which the objective risk is already known. This is extremely limiting in discussions around natural resource use, usually policy discussions, which must account for multiple hypothetical costs and benefits, for many of which an objective risk could not be calculated.

In Chapter 2, I combine the risk ladder from natural resources human dimension research with the Q-sort, a methodology designed in the field of psychology for comparing various issues against each other. The result is the Riley Risk Ladder, which allows for the quantitative measurement of multiple costs and benefits from both the probability and magnitude dimensions of risk. In addition, the qualitative data collected during the interview can be sorted into a small number of topics which can then be broken down quantitatively to

see how belonging to different stakeholder groups influences an individual's interest in certain topics.

In Chapter 3, I use the Riley Risk Ladder in a group setting rather than conducting individual interviews which has the possibility of collecting similar data with a lower investment of time and resources. This chapter explores how conducting the interview in a group setting changes what sorts of results can be seen and discusses what mechanisms can be put in place to reduce confounding group dynamics such as groupthink, social desirability, and anchoring.

Finally, Chapter 4 takes the interview data back to the stakeholders, reaching out in partnership to the stakeholder groups that participated in the original interview work. It explores the process of working with partners to develop a set of research questions, and takes a look at some of the obstacles of bridging the divide between partners from typically natural science backgrounds and working with social science data.

As the frontier of natural resource sciences is increasingly focused on the intersecting role of human and natural systems, it is more important than ever for natural resource scientists to make inroads into the social sciences and prioritize expertise in community engagement. Working with communities to find sustainable solutions at the intersections of human and natural environments is the next frontier in environmental science. Through this research, it is my hope that new doors can begin to open between natural resources scientists and community engagement scholars.

CHAPTER 1: TRANSLATING DISCIPLINES: USING CONTENT ANALYSIS TECHNIQUES TO BUILD A COMMON LANGUAGE BETWEEN NATURAL RESOURCE FIELDS AND COMMUNITY ENGAGED SCHOLARSHIP

Riley, Betsy, Triezenberg, Heather, Diane Doberneck. *In review*. Translating Disciplines: Using Content Analysis Techniques to Build a Common Language between Natural Resource Fields and Community Engaged Scholarship.

Abstract

Effective communication is key to interdisciplinary work. Each field, however, has its own unique terminology or jargon that can make communication across disciplines difficult. This research seeks to develop a method for researchers to bridge disciplines by using content analysis software NVivo to search existing research articles for key words and phrases. This research starts with a phrase used by community engagement scholars plus the inclusion of a term describing the new discipline in order to identify existing research articles. These articles were downloaded, a key word search run, and the key words and phrases identified. Using the top identified phrase, the process was run again three times. The final results identify the top five words and phrases that are used in the natural sciences to describe community engagement work: co-management, adaptive co-management, adaptive management, social-ecological system, and collaborative management.

Introduction

While community engagement scholarship exists as its own distinct discipline, the practice of outreach and engagement—working with communities to solve practical problems, exists across a wide variety of fields. Researchers in community engagement have struggled for decades to come up with common definitions to describe the work being done, dating back to Barbara Holland's 1999 paper in which she laments: "A confusing myriad of terms has arisen, and the rhetoric of public service is not clear to everyone. . . . [T]he lack of clear and comparable definitions and terms…constrain[s] faculty involvement and . . . make[s] effective documentation and evaluation difficult." In their 2010 paper, Doberneck, Glass, & Schweitzer discuss the wide variety of terms that are used across disciplines, some of which, such as

"bench to bedside interface" in health and medical fields and "civic literacy" in the social sciences would scarcely be recognized by community engagement scholars as being a related scholarship practice.

The lack of common definitions can cause problems when trying to work on an interdisciplinary team. Every field has its own terminology, built up through years of scientific progress conducted within isolated disciplinary silos, much like the concept of "scholarship of engagement" has changed in community engagement circles over the past few decades (Sandmann, 2008). Sometimes the terms that these disciplines develop to describe their outreach or engagement work are completely unfamiliar, such as the case of "bench to bedside interface" described above (Doberneck, Glass, & Schweitzer, 2010). Other times the terminology can sound similar, but the practices behind them can be profoundly different, as Sherry Arnstein broke out so eloquently in her "Ladder of Citizen Participation" in which she describes the term "citizen participation" being used for project ranging from manipulation of local citizens to total citizen control (Arnstein, 1969). Kenneth Boulding (1956) perhaps put it best in his General Systems Theory when he laments: "One wonders sometimes if science will not grind to a stop in an assemblage of walled-in hermits, each mumbling to himself words in a private language that only he can understand."

While a set of common definitions across disciplines is still elusive, it is possible to search within disciplines to determine what terms are currently being used and what sorts of methodologies are attached to them—effectively, to translate between disciplinary languages. This research is an exploratory effort to bridge the terminology between one set of disciplines (the natural resource sciences) and community engagement scholarship. By creating a

rudimentary translation, it is hoped that natural resource scholars and community engagement scholars can communicate across their respective fields more effectively, which can lead to more interdisciplinary efforts in the future. By using a replicable methodology, it is hoped that scholars wanting to make other disciplinary jumps have a starting point for developing their own translations.

Research Questions and Design

This research methodology builds on earlier work done in content analysis, a methodological field which relies on the identification of key terms and the calculation of the frequencies in which those terms appear in the selected texts in order to answer research questions (Krippendorff & Bock, 2008). The use of key words is especially important because it is the main way that natural science researchers and community engagement scholars search for existing research, and it is the first place a breakdown in communications may occur. But how do you know what key words to look for when you're not familiar with the discipline?

The field of natural resources was chosen because 1.) it is my, the author's, personal area of expertise, so I would know whether the final results reflect my own disciplinary knowledge, and 2.) natural resources fields have a long history of trying to engage people in conservation, since natural systems are so often affected by human systems. This research attempts to answer the questions:

1. What terms are currently being used within the variety of natural resources fields as it relates to community engagement activities?
2. What methods correspond to these terms?

Methods

Searches were conducted using the Web of Science database, accessible through Michigan State University. Articles which were not accessible through Michigan State University's library were not included. Articles which presented images of the text that were not readable by a screen reader were eliminated. Finally, articles which were not in English were excluded. The article's publication dates ranged from 2007-2017. These dates were chosen in order to determine what terminology is being used currently in the field.

Finally, each article was skimmed manually before it was downloaded to ensure it contained information related to natural resources. This process eliminated numerous articles from the medical field, particularly in later rounds when search terms had overlap. To address these research questions, I used content analysis, a research method for studying documents and communication artifacts to reveal patterns in communication, in a replicable and systematic way. The content analysis was run using QSR International's NVivo 11 Software on the entirety of the content in the chosen articles. NVivo 11 recognizes individual words in PDFs and allows researchers to search these documents for specific words and phrases. The software includes a function for identifying variations of words as well, such as identifying "engagement" and "engaged" as the same root word.

This study uses an iterative approach to the keyword search, starting with a single phrase and then using the results of that search to inform the next round of keyword searches. The starting phrase was "stakeholder engagement," followed by "fisheries" and later "forestry" to narrow the search focus on two example natural resource fields, discussed more in the next

section. This field-specific narrowing was only done in the first round. Each round of keyword searches has four steps, as follows:

- Step 1: Perform a keyword search using a chosen search phrase using the Web of Science database (how the keywords were chosen are described below in each round).
- Step 2: Run a Word Frequency Query on the resulting articles to identify most commonly used words with the intent of using these words to identify common phrases.
- Step 3: Run a Text Search Query on the most commonly used word or words to create a Word Tree to identify commonly used phases
- Step 4: Use the most commonly used phrase(s) to repeat these steps.

Once three iterations of this process were complete, a text search was run on all articles from all rounds to determine the total usage of the terms in all articles. From these results, the top five words were identified and a short literature review was conducted to determine how these terms were being used in the current natural resources literature.

Results

Round 1

Round 1, Step 1 began with a phrase which community-engaged scholars would recognize and combined it with a natural resource field of interest. For this research, the phrase "stakeholder engagement" was used as a recognized community engagement phrase, but other phrases could also have been used, such as "community engagement" or "public outreach." The objective was to start with a term familiar to the discipline conducting the search. In this instance, the search was conducted as a community engagement scholar interested in natural resource sciences.

To narrow the search results to natural fields, the search terms “fisheries” then “forestry,” respectively, were included as key words in the search in addition to the term “stakeholder engagement” in order to focus the search results on articles in natural resource fields. The term “fisheries” was used to link to natural resource research in aquatic systems, and the term “forestry” to link to research in terrestrial systems. The final search results included fisheries and forestry research, but also included research in coastal management, protected areas, wildlife management, and coral reefs, indicating the terms were successful in identifying natural resource research more broadly than these two fields.

Round 1 revealed 204 relevant sources were identified through the search of Michigan State University Web of Science database. These articles were downloaded, then uploaded to NVivo 11. In Step 2, a Word Frequency Search was conducted to identify which words were used the most often in the articles. Words which could not be reasonably linked to both community-engaged research or natural resource management were eliminated. Words which were field specific, such as “fisheries” or “coastal” were also eliminated (see Table 1.7 for more detail on eliminated words). These eliminations were determined by two independent researchers and their final choices discussed until agreement was reached. The NVivo search function grouped stemmed words into a single category (e.g. “participate,” “participant,” “participated,” etc.). The results of the search are presented in Table 1.1.

Table 1.1: Top five engagement- or management-related words in Round 1

Word	Frequency (#references)
Management	13,131
Stakeholder	8,007
Use	6,691
Community	6,638

Table 1.1 (cont'd)

Development	5,790

The presence of "stakeholder" in the top five list is not surprising, given the initial search terms. If this term had been the most frequently used term, both the first and the second term would have been used going into Step 3 (as happens in Round 2). Instead, the term "management" was the focus.

Because terminology regularly involves both an adjective and a noun (e.g. "stakeholder engagement," "local decision-making") a second search was run on the top result, in this case the term "management." Inputting the term "management" into the "Text Search Query" feature in NVivo 11 allowed the creation of a word tree, which showed how often different terms were used before and after the term "management" within the literature.

The results were again sorted to select only for those terms which applied to community-engaged scholarship and/or natural resource management. In this case, however, it became apparent that more than a frequency search was required, due to the presence of *niche terms* and *coincidental terms.* Niche terms are phrases with high frequency but only a small number of source articles, often discussing a niche concept or idea. Coincidental terms are phrases which happen to be used in multiple articles, but only a small number of times, suggesting coincidental rather than purposeful use. To identify only the terminology used commonly in natural resource fields, niche and coincidental terms were controlled for by 1.) eliminating all terms that were used in less than 5% of source articles, and 2.) taking the average of the remaining terms and eliminating any term which was used less than two times on average in the applicable source articles.

The results were then filtered for terms whose meaning encompassed both some form of community engagement and natural resources management. Terms which featured only community engagement ideas, such as "community-led," as well as terms which included only natural resource management ideas, such as "fisheries management" were noted, but not included in the final list. A longer discussion of these terms is made later in this chapter.

The final results of the search are presented in Table 1.2.

Table 1.2: Results of Round 1, Step 2

Term	Number of Sources	Number of References	Average References/ Source	Frequency Score (#sources*#references)
Co-management	63	1085	17.22	68,355
Adaptive management	49	494	10.08	24,206
Ecosystem-based management	33	112	3.39	3,696
Adaptive co-management	23	138	6	3,174
Collaborative management	12	27	2.25	324

The results of Round 1 show that the word "management" was used more frequently than any other term in the studied terminology. Of the uses of the word "management," the term "co-management" had the highest score and was selected for the keyword search in Round 2.

Round 2

The three steps were run again, this time using the term "co-management." No additional terms were used (such as "fisheries" and "forestry" in Round 1). The search results using this search term were already sufficiently focused on natural resource fields including

protected area management, wildlife management, and coastal management among others. In Step 1, 635 articles were downloaded which met the criteria discussed in the methods section. In addition, replicate articles from Round 1 were eliminated. The remaining articles were uploaded into NVivo 11 for analysis. For Step 2, a Word Frequency Query was run again, using the same techniques in Round 1 to narrow results, with the top highest frequency words shown in Table 1.3.

Table 1.3: Top five engagement- or management-related words in Round 2

Word	Frequency (#references)
Management	60,675
Community	25,548
Government	18,906
Use	17,535
Local	16,103

It is natural here that the word "management" is most frequently used, since the original search data was based off both "management" and "co-management." In order to expand the results, Step 3 was completed twice this round, creating two word trees: one for "management" (in case other word phrases appeared using these terms) and one for "community," to see if a single phrase could be identified as having the highest score.

Because of the high number of articles this round, the NVivo software experienced significant difficulty in creating word trees to encompass all possible results. For this reason, 212 articles (every third article, selected in alphabetical order by author name), were selected on which to run the two word trees. Phrases from both the "management" and "community" trees which were applicable to natural resource management and/or community-engaged scholarship were noted and a text search was run on them to determine their prevalence

within the entirety of the 635 articles. The term “co-management,” which was the basis of the search in Round 2, was considered only if included in a larger a phrase.

The results of the two word trees are in Table 1.4.

Table 1.4: Results of Round 2, Step 2.

Term	Number of Sources	Number of References	Average References/ Source	Frequency Score (#sources*#references)
Adaptive co-management	232	1709	7.37	396,488
Adaptive management	233	696	2.99	162,168
Community-based management	149	337	2.26	50,213
Collaborative management	148	304	2.05	44,992
Ecosystem-based management	88	343	3.90	30,184
Local management	116	249	2.15	28,884
CBNRM*	53	454	8.57	24,062
Joint management	55	190	3.45	10,450
Participatory management	66	145	2.20	9,570
Self-management	39	210	5.38	8,190
Community-based co-management	63	126	2.00	7,938

*Acronym for term “Community-Based Natural Resource Management”

While skimming the articles to ensure their natural resource content, an instance was identified in which authors defined a term, then used an acronym in its place for the remainder of the document. This was the case with “CBNRM” or “Community-Based Natural Resource Management.” The full term was eliminated from consideration because the term was used, on average, less than twice per article. As seen by the popularity of the acronym, this is most likely because after its first use, the acronym was then the primary method of referencing this

concept within the article. Where identified, an effort was made to include the acronyms in the frequency calculations, but the work was not comprehensive. While this presented a problem for correctly evaluating the frequency of word use, many of the terms presented here, when used in a keyword search by community-engaged scholars interested in finding related work, will still allow these works to come up, as the full phrase is often used at least once in the abstract and/or the keywords of these articles.

Round 1 and Round 2 had overlapping terminology. With the exception of the phrase "community-based management" which appeared in Round 1 as well but was eliminated as a coincidental term, the other top five terms in each round were identical, despite there being no overlap between the articles produced by each keyword search.

Round 3

The three steps were run again, this time using the term "adaptive co-management." In Step 1, only 52 articles were downloaded which fit the criteria outlined in the Methods section. Replicate articles from either Rounds 1 and 2 were eliminated. The remaining were uploaded into NVivo 11 for analysis. For Step 2, a Word Frequency Query was run again, using the same techniques as previous rounds to narrow results, with the top highest frequency words shown in Table 1.5.

Table 1.5: Top five engagement- or management-related words in Round 3

Word	Frequency (#references)
Management	5,064
Adaptively	2,732
Socially	2,010
Government	1,943
Community	1,916

The appearance of word derivatives of “management” and “adaptively” is not surprising, given then search phrase was “adaptive co-management.” In order to be exhaustive, Step 3 was completed three times this round, creating three word trees: one for “management” and one for “adapt” (in case other word phrases appeared using these two terms), and one for “social” to see if a single phrase could be identified as having the highest score. The final results of the three word trees are displayed in Table 1.6.

Table 1.6: Results of Round 3, Step 2.

Term	Number of Sources	Number of References	Average References/ Source	Frequency Score (#sources*#references)
Adaptive management	41	395	9.6	16,195
Social-ecological system(s)	38	351	9.2	13,338
Adaptive governance	23	192	8.3	4,416
Collaborative management	20	72	3.6	1,440
Community-based natural Resource management (including CBNRM)	11	114	10.4	1,254
Management network(s)	7	31	4.4	217
Social-ecological resilience	9	22	2.4	198
Management right(s)	5	38	7.6	190
Adaptive collaborative management	9	21	2.3	189
Community-based management	4	18	4.5	72
Fisheries co-management	5	10	2.0	50
Network management	5	10	2.0	50

Due to the rapid decrease in the total number of articles moving from Round 2 (n = 635) to Round 3 (n = 52), it was determined that the analysis was approaching saturation and that additional iterations would likely not yield a high number of new articles. The total number of articles from all three rounds (n=891) was a sufficiently high sample size to continue to the next phase of the analysis.

Eliminated Words

As noted earlier, there were multiple terms which were eliminated from consideration as a search term despite being neither niche nor coincidental, including some terms with very high overall scores for frequency of use. These were terms which referred to *only* natural resource management *or* community engagement or outreach, but not both. While these terms were not suitable as keyword terms because they were not specific enough to return the desired results, community-engaged scholars may find them useful in their own searches. For this reason, the total source and frequency results of the applicable words were calculated from the results of all three rounds (Table 1.7).

Table 1.7: Example terms eliminated from key word consideration.

Term	Number of Sources	Number of References	Average References/ Source	Frequency Score (#sources*#references)
Terms with no clear tie to community engagement and/or outreach				
Resource management	686	4,164	6.07	2,856,504
Natural resource management	464	1,688	3.64	783,232
Environmental management	439	2,141	4.88	939,899
Forest management	218	2,465	11.31	537,370
Coastal management	236	1,415	6.00	333,940
Terms with no clear tie to natural resource management				
Community members	282	975	3.46	274,950
Local community	276	769	2.79	212,244
Community participation	149	308	2.07	45,892
Community-level	174	356	2.04	61,944
Community engagement	88	412	4.68	36,256
Terms with no clear tie to community engagement and/or outreach OR natural resource management				
Risk management	64	313	4.89	20,032
Conflict management	27	92	3.41	2,484

Words were eliminated because they applied to EITHER community-engagement and/or outreach OR natural resources management, but not both. All terms met criteria for being non-niche and non-coincidental. Details of terms which appeared in both all three rounds are combined totals.

Top Words

All the non-coincidence, non-niche words were run through a text search which included the combined articles from all three rounds. The final words and their scores are show in Table 1.8.

Table 1.8: Relevant words from all 3 Rounds.		
1st Discovered	Term or Phrase	Final Score
Round 1	co-management	12,843,672
Round 1	adaptive co-management	766,800
Round 1	adaptive management	501,120
Round 3	social-ecological system	415,410
Round 1	collaborative management	72,360
Round 2	community-based management	58,765
Round 1	ecosystem-based management	56,792
Round 3	community-based natural resource management (NOT including CBNRM)	41,160
Round 2	local management	36,448
Round 3	use management	36,424
Round 2	CBNRM	33,002
Round 2	joint management	13,728
Round 2	participatory management	13,040
Round 2	self-management	8,988
Round 3	social-ecological resilience	8,949
Round 2	community-based co-management	8,128
Round 3	adaptive collaborative management	1,736

Of the top five words, four were originally uncovered in the first round. While Rounds 2 and 3 revealed a substantial number of additional terms, in this case it appears as though a single round was sufficient to find the majority of the most commonly used terms. Additional research testing this methodology in other fields could reveal to what degree additional rounds past the first add methodological value.

The top five words, once identified, were analyzed to determine how they are being used. First, a comparison was completed which looked at how word use has changed over the last decade. A cross-tabulation was completed comparing these top five words to publication year (Figure 1). The references to “co-management” were filtered to remove instances of “adaptive co-management” to avoid double-counting.

The results show that four of the five search terms (the exception being “co-management”) are very closely linked, suggesting that these terms are often used in the same

discussions. The term "co-management" in contrast, seems to have experienced a rising popularity throughout the last decade, with a decrease starting in 2016. It nevertheless remains the most commonly word throughout natural resources outreach engagement literature.

Translating the Terms

Finally, the articles were analyzed to determine how words were being defined and used. This was done by conducting a literature review on the articles which were identified in NVivo as using the term. What follows are brief overviews from these articles explaining how the terms have been used and are being used in the natural resource fields over the last decade.

Co-management and Collaborative Management

"Co-management" is an abbreviation for "collaborative management" according to some authors (Plummer & Baird, 2013). The term has been used broadly throughout the literature to describe a wide array of governance arrangements. Zulu (2013) provides a good overview, including perhaps the best definition through their quote of Yandle (2003): Co-management is "a spectrum of institutional arrangements in which co-management responsibilities are shared between the users (who may or may not be community-based) and government." This definition covers a variety of co-management "arrangements," from the institutionalized shared governance policies of the European Marine Strategy Framework and the U.S. National Ocean Policy (Maier, 2014) to 100% government control with the community forced into "guerilla gardening" arrangements with nearby protected areas (Hung, 2017). In Zulu's (2013) overview, he provides one conceptual model for how to think about co-management (adapted from Plummer & Fitzgibbon, 2004) which includes ideas around private

property rights, the role of crises, and required aspects of the necessary relationship between local people and government institutions.

As seen in the reviews of the other top terms in the next sections, co-management is an older theory in the natural resource fields and as such, is the subject of debate around its effectiveness. Much of the recent literature on the topic stresses the mixed success that co-management has experienced (see (KimDung, Bush, & Mol, 2016); Linke & Bruckmeier, 2015; and/or Levine, 2016 for a few examples).

Adaptive Co-management

Hasselman (2017) provides a great historical overview of the history and differences between the terms "adaptive management," "adaptive co-management," and "adaptive governance." Adaptive co-management combines two management traditions: collaborative management and adaptive management. Plummer & Baird (2013) use the following definition: "a process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, on-going, self-organized process of learning by doing." In their review of the literature, Whaley & Weatherhead (2016) identified five policy categories for adaptive co-management, which include (paraphrased) 1.) understanding the functionality of the resource, 2.) making a plan for change and uncertainty, which are inherent features of natural systems, 3.) managing for improving the resilience and adaptive capacity of the system (including the social system), 4.) promoting participation across multiple social scales, and 5.) recognize that management will be long term and develop iterative processes that can improve with new learning.

Adaptive Management

The intellectual forbearer of adaptive co-management, adaptive management was first proposed in 1978 as a process for integrating ecological and social dimensions in early stages of policy design. Intrinsic in this design is the idea of a series of iterative policies based on scientific experiments, in which each iteration of the policy produces new information which helps to inform future polices (Hasselman, 2017). Adaptive management has come under fire, however, for only being possible in a subset of natural resource problems. In their adaptation of Peterson et al. (2003), Allen & Gunderson (2011) identify the necessary conditions for effective adaptive management as situations with high uncertainty (creating the potential for learning) and high controllability (allowing for precise manipulation which allows for scientific conclusions). In their review, Aceves-Bueno et al. (2015) identify inadequate system monitoring and low stakeholder buy-in as two of the most cited reasons for adaptive management failure.

Social-Ecological System

Gonzalez et al. (2008) define a social-ecological system as "an ecological system that is intricately linked with or affected by one or more social systems." However, the term is used so frequently in the field that many authors do not bother to define it, assuming that its meaning is understood. It is often used in conjunction with other terms, including "social-ecological system resilience" (Krasny, Tidball, & Sriskandarajah, 2009; Bohensky & Mary, 2011), "socio-economic/ecological resilience" (Grafton, 2010) and a "complex socio-ecological system" (Gonzalez, Montes, Rodriguez, & Tapia, 2008; Beratan, 2007).

Discussion

The objective of this paper was to test a method for creating a linguistic gateway for outreach and engagement professionals to enter the world of natural resource sciences and management. The top terms reveal constantly evolving theories of human-environment interaction research within natural resource fields. Each term is shown to be used regularly with the field, and have exposed a complicated history of trial and error as natural resource scientists have struggled to develop methods to create sustainable human and natural systems.

The date range chosen for the articles (2007-2017) was designed to identify terms which are still in use today, assuming that someone who wanted to begin a collaborative effort with natural resource professionals would know what terms are currently in use. However, as the top five terms reveal, a broader date range would allow a more thorough understanding of how the theory of community engagement and outreach has progressed in the field. In natural resources, this progression has included a melding of ideas between cooperative management or co-management, the theory that management should be done with involvement from stakeholders (Zulu, 2013), and adaptive management, the theory that management can be designed to answer scientific questions in order to answer questions that can make management better in the future (Hasselman, 2017). Understanding the history of how terms and theories have evolved throughout time can benefit those hoping to do interdisciplinary work by helping them to identify the theoretical foundations behind their partner's ideas, and can help collaborators work with partners who may span multiple generations of training.

The broad use of the term "co-management" across the literature suggest that, at its heart, the term is not a well-defined concept. It is not surprising that new theories have grown

from it. This term is being used to describe the European Marine Strategy Framework (Maier, 2014), with its extensive, formal processes. At the same time, it is being used to describe a "guerilla gardening" effort as citizens rebel against 100% government control of a protected area (Hung, 2017). These disparate concepts indicate that the definition of co-management may be too fluid or too broad to be useful on its own in putting together community-engaged natural resource projects and research. Partners who hope to integrate the concepts of co-management should take time to determine what they mean when they use that term for their activities in order to ensure everyone is on the same page.

Finally, while this research is designed to find the most common terminology in the field and therefore only focused on the most commonly used words and phrases, it could be useful to look into the other terms uncovered through the search process and the concepts they represent. Even if they are not in common usage now, they could identify thought leaders in the field or perhaps good ideas that didn't quite gain traction. Researchers who are interested in using this methodology to build connections between disciplines could well benefit from doing a more exhaustive review of the identified literature and the terminology it contains in order to build a deeper understanding of the field's history and theories.

Conclusion

This research was conducted using an extremely broad field (natural resources), guided only in the first round by subfield terms to focus results ("fisheries" and "forestry"). Within this field are numerous subfields, all of which have their own long histories of terms, methods, and the inevitably trial-and-error of the scientific process. While far from comprehensive, it is my hope that the results of this paper can serve as a jumping-off point for collaborations between

the natural resource sciences and community engagement scholars. For those interested in other types of collaborations, I hope that this extension of content analysis methodology will allow a place to start in building up a common language for future interdisciplinary work.

CHAPTER 2: THE RILEY RISK LADDER: COMBINING THE RISK LADDER WITH Q-METHODOLOGY TO MEASURE RISK PERCEPTION IN COMPLEX POLICY QUESTIONS

Abstract

The Riley Risk Ladder is derived from traditional risk ladders used in fisheries and wildlife (Riley & Decker, 2000a) and a psychology interview technique called Q-methodology (Ramlo, 2016). It creates a method for researchers to gain a more comprehensive understanding of how complex issues are being perceived by key stakeholders in situations where multiple risks exist, even when an objective measure of these risks is infeasible or impossible to calculate. In this chapter, I conduct 39 interviews with stakeholders on all sides of the Michigan aquaculture debate, a high uncertainty political conflict ongoing in the state at the time of this research. The results show that the technique is successful in identifying differences in how stakeholder group affiliation influences perception of risk and, through a content analysis of the interview data, how group membership can influence the salience of certain topics over others. By understanding how risks are being perceived, researchers, extension specialists, and policy makers can improve their outreach and communication methods on controversial policy issues.

Introduction

The risk ladder concept has been in use in natural resources and environmental fields since at least the past three decades (D.J.Moschandreas & Chang, 1994; Riley & Decker, 2000a; Keller, 2011). Variations of this ladder are used by researchers in a variety of ways, the two most common being the measuring of risk perception (Riley & Decker, 2000a; Logar & Brouwer, 2017) and evaluating risk communication (Keller, 2011; Lipkus & J.G.Hollands, 1999). The ladder helps to quantify risk in an objective way by comparing a certain phenomenon to other known risks.

To date, however, the use of risk ladders has been focused on a single risk and usually a risk that has already been quantified in some way, such as the possibility of risk of cancer after radon exposure (Lipkus & J.G.Hollands, 1999) or the possibility that a baby could be born with Down syndrome (Hess, Visschers, Siegrist, & Keller, 2011). Little research, however, has been done to expand the capabilities of the risk ladder to encompass perceptions regarding uncalculated or, in cases with high uncertainty around multiple variables, unknowable risks. The present study uses an expanded risk ladder technique to evaluate participant perception of 1.) multiple risks simultaneously, and 2.) risks which are not objectively quantifiable. The Riley Risk Ladder is derived from a psychology technique called Q-methodology (Ramlo, 2016), and it creates a method for researchers to gain a more comprehensive understanding of how complex issues are being perceived by key stakeholders in situations where multiple, unknowable risks exist. By understanding how risks are being perceived, researchers, extension specialists, and policy makers can improve their outreach, engagement, education, and communication methods on controversial policy issues.

The Need for Better information on Complex Policy Issues

Environmental risks are often difficult to evaluate effectively, and even more so when the risks involved are hypothetical—a new factory in a state would have very different risks based on its location, its size, the technology that it's using, and the regulations that are put into place. Policy makers are often asked to make decisions based on perceived risk not only for a hypothetical factory, but sometimes entire hypothetical industries. While risk assessments could be done for each scenario, the scale necessary for some projects are cost prohibitive and policy makers are forced to make decisions without perfect information. They must weigh

multiple costs and benefits in order to make a decision they feel is the best choice for their constituents.

In the absence of perfect information, policy makers rely on stakeholder groups. These stakeholder groups must decide whether a policy option is good or bad for them based on their perception of how the costs and benefits will affect them. Like the policy makers, however, stakeholder groups in most cases must work off their perception of risk, rather than objective risk assessments. Because stakeholder perceptions are therefore driving policy making, these perceptions themselves warrant study, regardless of the objective risks which drive them.

Expanding the Risk Ladder

Risk perception was chosen as the focus area for this research because it has been identified as a key aspect in Wildlife Stakeholder Acceptance Capacity models (Riley & Decker, 2000b) as a main component of the acceptance capacity that a population has for a certain risk, sometimes interpreted as a "tolerance" for risks (Inskip, Carter, Riley, Roberts, & MacMillan, 2016). An individual or societal acceptance capacity for a risk is a function of both the perceived costs and benefits of certain risks, and it indicates what level of that risk an entity is willing to accept (Riley & Decker, 2000b).This model of risk perception as integral to acceptance capacity has been tested in multiple cultural contexts with consistent results (Riley & Decker, 2000a) (Sakurai, Hiroto, Matsuda, & Maruyama, 2014) (Smithem & Mazzotti, 2008) and has been used successfully in educational contexts as well (Skupien, Andrews, & Larson, 2016).

The research used a mixed-method approach which blends two well-established scientific techniques: the risk ladder and the Q-sort, or Q-methodology. This method (described below) was chosen because of its ability to most fully answer each research question.

Understanding *what* exists requires a systematic, quantitative approach to information gathering: counting the stakeholders and ranking the issues. Attempting to understand the *why* of stakeholder perceptions, however, is a question that can be answered most simply by qualitatively asking it to stakeholders.

The Risk Ladder

As described above, the risk ladder attempts to quantify an individual's feelings about how risky a particular event might be relative to other risky events. This traditional risk ladder combines the two elements of risk (probability and magnitude) to measure where on the ladder a research participant would rank a single risky phenomenon in relation to other risky events of known quantity (such as climbing Mount Everest or flying with a commercial airline). In traditional risk ladders, participants rank probability while the magnitude (usually death or another negative outcome) remains constant.

However, such a method has limitations when trying to rank multiple risks, particularly risks which are not easily comparable to a single standard (such as death). To compensate for this shortcoming, this research broke the risk ladder into multiple scales to allow participants to rank the probability of an event separately from its magnitude.

Q-methodology

While the risk ladder provides a method of quantifying risk perception, it is most commonly used for assessing a *single* risk and has not been tested before with multiple risks. As such, additional research was done to find a method with a sound scientific foundation for allowing this expansion of the risk ladder. That method was the Q-sort. The Q-sort, or Q-methodology, has been used in the social sciences, particularly psychology, since the 1930's

and involves working with participants to sort and rank their feelings around particular issues or questions (Ramlo, 2016). The Q-sort resembles the Likert scale methodology in that a scale is often used which ranges from low to high in some measure. Unlike the Likert scale, however, which only allows a single item to be ranked, a Q-sort involves multiple items (usually displayed on cards) which a participant can rank relative to other items, moving the cards around freely until a single final ranking is determined using all the cards. This ranking process is done as part of an interview, in which the researcher discusses with the participant why they have made their ranking choices

Working from Q-methodology research, this study turned each of the 20 "risks" (defined as an event which has a probability and magnitude and is inclusive of both costs and benefits) into their respective cards, which a participant can pick up, move around, and arrange during an interview. The scale that was used was the multiple risk ladders. The Q-sort's interview format allows the researcher to ask questions of the participant as the research progresses in order to establish not only the quantitative placement of each of these topics on the scales, but *why* that participant has made that choice, allowing a deeper understanding of the underlying reasoning for the decisions.

The Case of Michigan Aquaculture

The issue of Michigan aquaculture was chosen as a research topic due to its prominence in policy discourse at the time this research was conducted. Michigan's water resources have an estimated capacity to produce $1-5 billion worth of commercial seafood annually (Weeks, Colyn, Boersen, & Knudson, October 2014), yet Michigan imports 90% of its seafood (Rudolph, 2017), including from countries with lax environmental, health, and labor laws (Food and

Agriculture Organization, 2016). Much of Michigan's water remains off-limits for seafood production due to the fear and suspicion currently surrounding aquaculture. Michigan's natural places have made a slow and painstaking recovery after centuries of overexploitation and industrial dumping. For decades, Michigan has sought compromises between what it is able to produce and a clean, healthy environment. That ability to compromise has reached a stalemate with fish farming. Since 2011, lawsuits have been filed, legislation introduced (Ellison, 2017), expert panels have come and gone, and millions of dollars have been offered and turned down (Department of Agriculture and Rural Development, Department of Environmental Quality, Department of Natural Resources, March 9, 2016).

Much of the research in the area focused on answering objective scientific questions around the feasibility of aquaculture in Michigan waters (Department of Agriculture and Rural Development, Department of Environmental Quality, Department of Natural Resources, March 9, 2016). This research looks at the human element driving policy, focusing on how different stakeholder groups perceive risk. The goal of the study was to use this expanded risk ladder to determine if differences exist between stakeholders with regards to aquaculture costs and benefits and if so, whether understanding these differences could offer insights into new outreach and communication techniques.

Methodology

Materials

Three scales were created on which participants placed cards. The first, a probability scale, showed 0% at the bottom labeled "Is impossible/couldn't happen." At the top was 100% and labeled "Will happen." In the middle, a 50% range was labeled "A toss-up (50/50 chance of

happening).” Two magnitude scales were developed—one for costs and one for benefits—and also ranged from 0% to 100%, with the cost scale labeling 0% as “No effect on Michigan fisheries/economy” and 100% labeled “Total collapse of Michigan fisheries/economy.” The benefit scale labeled 0% as “No people/fish in Michigan will benefit” and 100% as “All people/fish in Michigan will benefit.” These scales can be found in Appendix D. Participants were asked to rank each cost and each benefit along the appropriate ladders.

Twenty cards were developed to be placed on the scales, with ten cards listing the potential costs of an expanded Michigan aquaculture industry and the other ten cards listing the potential benefits. Card content was designed based primarily on publicly available media and reports published with regards to aquaculture in Michigan. For the cost cards, data were collected primarily from source material created during the previous year’s open discussions on the prospect of net-pen aquaculture in the Great Lakes. While this research did not focus on net-pens, many of the issues raised, particularly in the report by a state designated Science Panel (Anderson, et al. October 2015), were applicable to inland aquaculture systems as well, including concerns about nutrient loading into surface waters, disease risk, and escapees. Additional concerns were identified through online news reports, particularly surrounding an ongoing legal case between anglers and an aquaculture farmer in northern Michigan (Ellison 2016) (VanAmeyde 2016), as well as content published by an anti-aquaculture organization in Ontario, Canada (Georgian Bay Association n.d.). In addition to reiterating concerns addressed by the Science Panel, these sources included more social or economic considerations, including concerns about dropping property values around aquaculture installations, and loss of tourism dollars due either to the visuals created by aquaculture or the farms’ expected effects on

recreational fishing. The primary source material for the benefit cards was the Michigan Sea Grant funded 2014 Integrated Assessment on the topic (Colyn, et al. 2014), but other sources included the Michigan Aquaculture Association website (Michigan Aquaculture Association 2011-2016) and the Northern Ontario Aquaculture Association website (Northern Ontario Aquaculture Association 2016). Cards included a title (outlined in Table 2.1) and an explanation below it more fully outlining the argument which the title represented. The back of the cards were blank. The complete card sets can be found in Appendix C.

Once the initial cards were compiled, they were reviewed by academic experts for content and clarity and submitted to the Michigan State University Institutional Review Board (MSU IRB #i053833) along with a semi-structured interview outline. Study participant recruitment depended heavily on the stakeholder group involved and is described in more detail in Section 2.5: Sample Population.

Table 2.1: The Negative and Positive Risks Commonly Associated with Michigan Aquaculture Development

Negative Risks (Costs)	**Positive Risks (Benefits)**
Nutrient Loading	Improve Recreational Fishing
Fish Disease	Improve Wild Stocks
Invasive Species	Competitive Edge
Escapees	Increase Tax Revenue
Habitat Degradation	More Michigan Jobs
Reduced Tourism	Better Food Security
Reduced Property Value	Good Example Site
Legal Flood Gates	High Quality Fish
Management Challenges	More Sustainable Protein
Reduced Cultural Value	More Local Fish

Interview Structure

Pilot testing was completed with six participants which resulted in revisions to ensure content validity and understandability. For the final version, participants were randomly selected to look first at the cost cards or the benefit cards. Each set of cards were placed in front of them in turn so that they could see all the cards at once, and time was allowed for the participant to look over the cards and consider them. At this time, the interviewer answered any questions about card content. Once all the questions were answered, the interviewer asked the participant to rank the cards in terms of how likely they were to happen if inland, private aquaculture was to expand in Michigan and have the participant think more about how the issues on the cards ranked against each other in terms of probability. The probability scales were used first, followed by the magnitude scales, an order determined through the pilot testing.

If not offered during the placement process, the researcher would follow up with the participant regarding each placement and why participants made the choice to rank as they did. Once all the cards were placed, the researcher removed all the cards and placed the second set of cards in front of the participant in the same way, allowing the participant to see all the cards at once and the ranking began again. After the second round, the cards and the scale were removed and the first set of cards were once again placed before the participant, after being mixed up from the previous ranking. The ranking process then began again for the magnitude of these events if they did occur (described as “how good/bad it would be if this did happen”). The process was done for both scales and both sets of cards.

No limitations were made on the participants' desires to move cards around once they were placed. Participants often moved cards around the scale before settling on a ranking that they were comfortable with. The final ranking was recorded by the researcher in handwritten interview notes.

Once all card placement rounds were complete, the researcher asked a final open-ended question to determine if there were any other thoughts that the participant had and wanted recorded. Then the interview was complete.

All interview notes were hand written during the interview in order to protect the privacy of participants. No audio recording device was used. After the interview, these notes were typed up and sent back to the participant for review to ensure correctness. If the interviewee had corrections, these were made and included in the final notes.

Study Area

Interviews were conducted throughout the state of Michigan, including 6 from the Upper Peninsula and 29 from the Lower Peninsula (2 commercial fishers fished in Michigan waters but considered their home base to be either outside Michigan or held no particular allegiance to either peninsula). An effort was made to ensure all regions of the state were represented by at least one interview.

Sample Population

Interview participants were selected using stratified, purposive sampling from the target stakeholder groups identified in the introduction. Where possible, sampling was done using objective databases from which participants were selected, such as the list of licensed aquaculture farmers in the state of Michigan, which is provided publicly by the Michigan

Department of Agriculture and Rural Development, or online searches of local tourism locations such as fly shops or fishing lodges. In cases where such databases were less readily available, such as Michigan angler groups, individuals involved in Delta County economic development, and affiliates of Michigan tribes, a combination of snowball sampling and random sampling was used, as described below in the breakdown of each stakeholder group.

Interviews were conducted between June 2017 and June 2018. Four interviewees who initially agreed to be interviewed were unable to find a convenient time. No interviews were turned down because of disagreement with the content.

Anglers

An angling category was included to represent current stakeholder interests with regards to current fisheries. This was a natural category to include as angling groups have played a large role in Michigan to shape the conversation around aquaculture. An effort was made to reach out to individuals involved in angling organizations in Michigan and a few interviews were collected using this method. However, the majority of the interviewees in the "angling" category include individuals from other categories who also reported angling in their free time. To ensure that the group contained more serious anglers, only those who either belonged to an angling organization (n=7) and/or who reported fishing at least once a week (n=15) were categorized as an "angler" (n=5 that belonged to both categories for a total of 17 interviews). Some members of angling organizations reported not being anglers themselves, but were nevertheless included in this category (n=2).

Aquaculture Farmers

Aquaculture farmers have the highest potential to be affected by changes in aquaculture policy. New aquaculture policies will affect their efforts to farm fish and, if new regulations bring in new aquaculture farmers, they may face increased economic competition. The Michigan Department of Agriculture and Rural Development maintains a list of all licensed aquaculture farmers in the state of Michigan. This list was used to identify farmers for interviews. It quickly became apparent, however, that the list had problems, including instances in which the phone number listed was not correct, and in some cases, addresses lead to locations with no obvious aquaculture facility in place. It was also very common to contact individuals who had farmed in the past but were not currently farming (often due to economic reasons) despite maintaining a license. Discussions with local experts revealed that fewer than five farmers were currently operating at a large, commercial scale. Interviews were therefore conducted with farmers who were currently farming, and those who were not currently farming, but who had maintained their facilities and licenses.

Commercial Fishers

Commercial fishers could be affected by an expanded aquaculture industry both through an increase in the supply of fish that such an expansion would mean, as well as potential environmental impacts that many fear an expanded industry could mean. All interviews with commercial fishers were conducted at the Michigan Fish Producers Association Annual meeting, which took place in Traverse City in January 2018. I was invited to the meeting by Association leadership who was supportive of the project. Interviews were conducted either through snowball sampling (those who had done the interview sent others to speak with me)

and through random sampling (the researcher approached commercial fishers and asked if they would be willing to do the interview).

Delta County Residents

Delta County residents were included due to the need for a stakeholder group that could represent those who might benefit economically from an expanded industry. Delta County was chosen because it had a higher than average percentage of licensed aquaculture farmers. In addition, a recently rejected plan for aquaculture expansion would have permitted the creation of an offshore facility in Delta County. While this research did not focus on offshore aquaculture, there was a higher than normal likelihood that residents of this county had given critical thought to the issue of aquaculture in their county and the affects it could have on them. This perspective was critical for the group to represent those who had potential to be affected by aquaculture expansion, rather than current stakeholder groups. Any individual who belonged to another group, but that resided in Delta County, MI, was included in this group. In addition, efforts were made to involve members of economic development organizations who had been involved with the cancelled offshore aquaculture proposal.

Fish Wholesale

Interviews with fish processors were conducted because this group had the potential to benefit from an increase in the supply of fish that would come with an expanded aquaculture industry. The idea for including them is that unlike other types of Michigan industries, fish wholesale distributors would see an increase in business just by increasing the number of fish they process, regardless of where the fish came from. Ultimately, interviews included four wholesale processors and distributors and one individual with a processing facility which

processed fish from multiple sources. Two interviews were conducted onsite at an interviewee's business, and three were conducted at the Michigan Fish Producers Association Annual meeting where wholesalers were in attendance.

Michigan Tribal Affiliates

Michigan tribes are regularly brought up in the aquaculture controversy. Due to their treaty rights, tribes may have the legal ability to pursue aquaculture separate from the state's overall aquaculture policy. Tribes were contacted directly to see if they were interested in participating (one tribe agreed). Otherwise, members of other groups were asked if they were affiliated with a tribe and, if so, were included in this group. While some tribal affiliates were also tribal members, some interviewees in this category worked for a tribe in their Natural Resources department, but were not tribal members themselves.

Regulators

Regulators have been deeply involved in the aquaculture debate, particularly those in the Michigan Quality of Life departments (the Michigan Departments of Natural Resources, Environmental Quality, and Agriculture and Rural Development). These people have powerful voices when it comes to decision making around aquaculture and they, more than any other group, have to listen to and think about the costs and benefits of an expanded industry because they have to make decisions regarding the best interests of those they serve. Included in this group were individuals who worked at the state, local, or tribal level and who had specific decision making or regulatory power over aquaculture decisions. Interviewees were identified based on their experience working on the issue, although several regulators were also part of other categories that were interviewed.

Tourism Industry Representatives

A key stakeholder perspective against the expansion of the aquaculture industry has to do with tourism. There has been a great deal of discussion that the aesthetic or environmental impacts of an expanded aquaculture industry will negatively impact the angling tourism industry across the state. Members of this group included fishing lodges and fly shops, as well as others whose business depends on angling tourism. An effort was made to include only those tourism industry members whose products or services were related to angling specifically, and not other aspects of the tourism industry. This group was sampled at random by identifying location in Michigan with a prominent inland angling tourism industry, then either walking into shops to ask for an interview or calling ahead to schedule an interview (usually in the case of lodges). In a few cases members of other groups also did work related to angling tourism.

Interview Overview

A total of 39 interviews were conducted between June 2017 and June 2018. The final breakdown of stakeholders is listed in Table 2.2. It should be noted that some stakeholders belonged to more than one group, so the total number of interviewees will not sum to 39.

Table 2.2: Number of Interviewees by Stakeholder Group	
Stakeholder Group	**Number of Interviewees**
Anglers	16
Aquaculture Farmers	9
Commercial Fishers	6
Delta County Residents	5
Fish Wholesale	5
Michigan Tribal Affiliates	8
Regulators	11
Tourism Industry Representatives	7

Post-Interview Communications

All interview notes were typed up and sent back to participants, either through via email or paper copies through the mail. Each participant was encouraged to send back any notes, corrections, or comments. Mailed copies included a blank page labeled "Corrections or Comments" and a stamped envelope with the researcher's address for sending the page back.

Any notes that a participant made were included in the official notes for that interview. In order to protect the privacy of participants, all identifying information was redacted from these documents.

Each participant was also sent a one-page (front and back) overview of the results of the study. This was emailed or mailed to participants depending on contact information.

Data Analysis

Quantitative Analysis

Using Stata statistical software, the means were calculated by stakeholder group for both sets of cards (costs and benefits), which were broken down again into the three measured

elements: probability, magnitude, and overall risk (see Appendix A for a complete accounting). The individual card means were then averaged with the other cost or benefit cards, respectively, to create six final scores to be used as dependent variables, listed below:

1.) pcost: Overall probability of something bad happening
2.) pben: Overall probability of something good happening
3.) mcost: Overall magnitude if something bad happened
4.) mben: Overall magnitude if something good happened
5.) rcost: Overall risk score (probability x magnitude) of benefit cards
6.) rben: Overall risk score (probability x magnitude) of cost cards

These aggregate scores were then run through a multiple regression to determine how belonging to a certain stakeholder group predicted participant perceptions of aquaculture costs and benefits. The multiple regression format was chosen because the overlap between stakeholder groups (some commercial fishers were also anglers, some farmers also lived in Delta County, etc.) made a more categorical analysis unreliable.

Qualitative Analysis

The interview data were analyzed using content analysis, in which themes were identified based on how participants responded to questions and participant responses sorted according to these themes.

Results

Descriptive Statistics

Using the six overview variables, basic descriptive statistics were obtained (Table 2.3).

Table 2.3: Descriptive Statistics of Overview Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
pcost	0.457	0.223	0.010	0.845
pben	0.596	0.180	0.271	0.900
mcost	0.413	0.259	0.030	0.835
mben	0.541	0.281	0.003	0.995
rcost	0.260	0.229	0.001	0.741
rben	0.376	0.230	0.003	0.830

Overall Perceptions of Costs and Benefits

Once the regression was run, using the overview variables as dependent variables, significant correlations were found for nearly all stakeholder groups, with the exceptions of tribal affiliates and Delta County residents, which did not reach or approach significance for any of the overview variables.

Table 2.4: Coefficients of Multiple Regression

Stakeholder group	pcost	pben	mcost	mben	rcost	rben
Angling organization member	0.178 (0.036)	-0.245 (0.001)	0.215 (0.058)	-0.349 (0.017)	0.234 (0.005)	-0.299 (0.005)
Angler fishes at least weekly	-0.091 (0.099)	0.027 (0.534)	-0.215 (0.058)	-0.062 (0.507)	-0.207 (<0.000)	-0.021 (0.749)
Tribal affiliation	0.141 (0.049)	-0.107 (0.060)	-0.022 (0.811)	-0.225 (0.066)	0.055 (0.404)	-0.161 (0.067)
Delta County resident	-0.094 (0.213)	0.044 (0.462)	-0.071 (0.479)	0.065 (0.611)	0.017 (0.805)	0.037 (0.683)
Aquaculture farmer	-0.111 (0.218)	0.059 (0.404)	0.061 (0.612)	0.049 (0.749)	0.050 (0.550)	0.084 (0.443)
Fish wholesale	-0.111 (0.242)	0.139 (0.071)	-0.029 (0.820)	-0.023 (0.888)	-0.027 (0.762)	0.085 (0.466)
Commercial fisher	0.183 (0.071)	-0.226 (0.007)	0.307 (0.026)	-0.245 (0.154)	0.351 (0.001)	-0.233 (0.062)
Tourism industry representative	0.185 (0.040)	0.006 (0.927)	0.231 (0.055)	0.015 (0.920)	0.268 (0.002)	0.007 (0.949)
Regulators	-0.115 (0.157)	0.041 (0.518)	-0.042 (0.697)	-0.066 (0.630)	-0.053 (0.478)	0.005 (0.960)

p-values in parentheses. Values where $p < 0.10$ have been highlighted.

Coding Results

A content analysis produced 18 general areas which were representative of the comments made by study participants (Appendix B). The mean was calculated to determine how often each stakeholder group referenced a topic on average. The results are shown in Table 2.5.

Table 2.5: Coding Determined through Content Analysis. Mean number of references by stakeholder groups.

Code	Angler Org Members	Angler Fish Weekly	Tribes	Delta	Farmer	Whole-sale	Comm-ercial	Tourism	Regulator
Aquatic Environment	3.57	4.53	4.88	5.40	5.56	4.80	2.50	3.28	3.45
Aquatic Organisms	2.28	3.20	3.88	3.40	4.00	2.20	2.83	2.00	2.64
Business Revenue and Costs	2.00	3.07	3.00	4.40	5.11	4.40	1.83	1.71	2.64
Competitive Marketplace	2.14	2.87	3.75	4.20	3.89	4.80	3.33	1.71	2.73
Economic Market	2.86	4.40	5.88	6.00	5.11	5.40	4.67	3.14	5.00
Facility	2.86	4.27	6.00	6.20	7.22	5.20	3.33	2.00	4.82
Fish	2.71	4.07	5.25	5.00	5.89	3.80	3.83	3.43	3.64
Fish Product	1.71	2.93	4.00	3.80	4.44	3.20	3.17	2.29	2.73
Human/ Environment Interaction	2.00	3.53	5.00	3.00	5.78	2.20	3.17	2.57	3.91
Industry Logistics	3.00	4.87	4.63	3.60	4.78	5.60	2.50	2.00	4.82
Information	1.57	3.13	3.13	5.60	4.33	5.40	3.00	2.43	4.18
Michigan Effects	5.43	4.80	5.50	5.40	6.22	4.40	3.50	4.57	5.09
Politics	2.57	2.47	2.38	3.60	3.33	3.20	2.50	3.29	1.55
Regulations	3.43	5.73	8.63	9.20	7.56	9.00	5.00	3.14	7.18
Site	2.29	3.33	3.50	3.80	3.22	5.20	2.00	2.43	3.63
Social	4.00	4.40	6.00	4.00	6.56	6.40	4.00	4.14	5.36
Tourism	2.71	3.20	2.50	2.80	3.78	3.60	2.00	3.29	3.18

Code with highest average response per stakeholder group has been highlighted.

Stakeholder Breakdown

Anglers

Anglers who self-reported being members of an angling organization rated significant in all 6 measures. Belonging to an angling organization consistently influenced perceptions of costs as higher and benefits as lower. These anglers ranked the probability of costs as 17.8%

higher than other groups, the magnitude of the costs as 21.5% higher, and the overall risk of aquaculture costs to be 23.4% higher. They ranked the potential benefits of aquaculture as 24.5% less probable, a 34.9% lower magnitude, and overall 29.9% than other groups. The top code that anglers discussed was the effects (positive, negative, and neutral) that an expanded aquaculture industry may have on the state of Michigan.

In contrast, being someone who self-reported fishing at least once weekly (regardless of membership status in an angling organization) negatively influenced perception of costs, ranking these their probability 9.1% lower than other groups (although this score was only significant at the p=0.10 level), their magnitude 21.5% lower, and their overall risk as 20.7% lower than other groups. The most common topic of conversation among this stakeholder group was regulations (positive, negative, and neutral).

Tribal Affiliates

Tribal affiliates ranked similar to members of angling organizations, ranking the probability of costs as 14.1% higher than other groups, and the benefit cards as lower, at 10.7% lower probability, 22.5% lower magnitude, and 16.1% lower in overall risk. However, they did not differ significantly in their perception of the magnitude of costs, resulting in their overall risk perceptions of the cost cards as not reaching a significant difference. The most common topic discussed among the tribal affiliate participants was regulations.

Fish Wholesalers

Belonging to the fish wholesaler category largely did not result in significant differences, with the exception of the perception of the probability of benefits, which was ranked 13.9%

more likely. These interviewees focused regulations most often on average during their interviews.

Commercial Fishers

Like anglers and tribal affiliates, commercial fishers differed from other groups in their perception of costs, at 18.3% higher probability, 30.7% higher magnitude, and 35.1% higher risk overall. In addition, commercial fishers rated the probability of benefits as 22.6% lower than other groups, but did not rate the magnitude of benefits as significantly different. However, low ratings in probability scores resulted an overall lower perception of benefit risk in the amount of 23.3%. The primary topic discussed by commercial fishers was regulations.

Tourism Industry Representatives

Whiles the tourism industry generally agreed with other groups in their perception of the benefits, they differed across the board with regards to cost: they rated the costs as being more probable (by 18.5%), of higher magnitude (23.1%), and overall riskier (26.8%). In their interviews, they discussed social considerations most often on average.

Table 2.6: Coefficients of Multiple Regression

Stakeholder group	**pcost**	**pben**	**mcost**	**mben**	**rcost**	**rben**
Delta County resident	-0.094 (0.213)	0.044 (0.462)	-0.071 (0.479)	0.065 (0.611)	0.017 (0.805)	0.037 (0.683)
Aquaculture farmer	-0.111 (0.218)	0.059 (0.404)	0.061 (0.612)	0.049 (0.749)	0.050 (0.550)	0.084 (0.443)
Regulators	-0.115 (0.157)	0.041 (0.518)	-0.042 (0.697)	-0.066 (0.630)	-0.053 (0.478)	0.005 (0.960)

Findings of No Significance: Delta County Residents, Aquaculture Farmers, and Regulators

Membership in these three groups did not predict, overall, how individuals felt about Michigan aquaculture. The three groups echoed each other in their top topic, regulations,

discussing this topic more on average than any other. A lack of significant difference in itself is a result from a communications standpoint, as it indicates that agreement might exist between groups with regards to their perception of risk. This does not mean that these stakeholder groups agree on all issues—the dependent variables used as in the regression are overview variables, designed to provide a snapshot into how groups perceive costs and benefits generally. A further breakdown of how these scores might differ can be found in Appendix A.

Discussion

The results also show that many of the current communication topics coming from certain groups may not be the most compelling arguments. A good example of this is the general disbelief among all stakeholder groups that aquaculture facilities are likely to improve wild stocks (low probability scores). This has been a large selling point among aquaculture farmers, since exactly these results have been reported around the net pens in Canada. These results indicate that this message isn't being well received across the board, regardless of it happening in other areas of the Great Lakes.

Nevertheless, the results show that despite the rhetoric, there is quite a bit of agreement among stakeholders, particularly regarding the overall costs of Michigan aquaculture. Where disagreement does exist with regards to costs, it's often a difference of opinion regarding how likely an event is to occur versus how bad it could be if it did occur. For communications and outreach professionals, this result can help to direct messaging to stakeholder groups to better communicate on the issues that these groups find the most pressing.

It is hoped that this research can provide a novel methodology to offer greater insight into the perceptions of risks of Michigan aquaculture, as well as other hot button, high conflict issues within the natural resources world and beyond. But offering greater insights into beliefs around multiple, otherwise unknowable risks, better communication is possible between groups and there is more potential for mutually beneficial solutions to complex problems.

CHAPTER 3: A COMPARISON ANALYSIS OF USING THE RILEY RISK LADDER METHODOLOGY WITH GROUPS VERSUS INDIVIDUAL INTERVIEWS

Abstract

The Riley Risk Ladder was successful in helping to understand how membership within a stakeholder group can influence an individual's perception of the potential benefits and costs of Michigan aquaculture, a complex policy question with uncertain risks. One of the disadvantages of the methodology, however, is the costs associated with collecting the data. This chapter tests the Riley Risk Ladder in a group setting, which has the potential to collect similar data at lower costs. The results indicate that such data collection is possible, but that certain precautions have to be accounted for in the discussion design to avoid group dynamic constraints that could influence overall results, including groupthink, social desirability, and anchoring.

Introduction

The Riley Risk Ladder was designed to fill a gap in the existing methodological landscape between the need for precise, quantitative information surrounding risk perception and the need to measure a range of potential risks that influence complex policy decisions. The method allows for a deeper understanding of how the benefits and costs of a policy decision are being understood by the stakeholders involved, and it does so in a non-confrontational way that makes it useful for aiding in high-conflict policy issues.

The disadvantage of the methodology, however, is the amount of time and resources required to do interviews with multiple individuals from every relevant stakeholder group. This chapter tests the idea of using the Riley Risk Ladder as a group workshop, which has the potential to decrease the amount of time and overall resources needed for data collection.

Group Dynamics

The change from individual interviews to a group workshop brings into play group dynamics which can be both helpful and harmful for the group decision making process. By relying on each group member's respective expertise, groups have the potential to make more informed judgements about risk than an individual might. However, the introduction of group dynamics to the methodology also means the introduction of group biases that could lead to less accurate results.

One potential obstacle for group research is the issue of social desirability. Research has shown that in instances in which the questions are being asked reflect a clear "socially desirable" answer, participants will choose that answer even if it is not a true reflection of their feelings (Lavrakas, 2008). These sort of questions can involve questions of bigotry, such as race or sex (An, 2015) or criminality (Sugarman & Hotaling, 1997). The issue of social desirability is less well researched with regards to policy issues, but it's likely to play a role, particularly in high conflict policy issues. When tensions are high around a policy issue, expressing an unpopular opinion could lead to sharp social backlash not unlike that described by social desirability theory.

Another potential barrier to accurately collecting data through a group workshop is groupthink, the phenomenon in which group members will choose to protect relationships and support group cohesiveness over thinking about critically about facts (Aronson, Wilson, & Akert, 2007). For almost all of the stakeholder groups interviewed, there are individuals who have been more involved in Michigan aquaculture discussions than others, lending them an air of expertise to other group members who have been less involved. In addition, objective risks

cannot be measured with much clearer guidance of what Michigan aquaculture would entail, making the final "answers" to the interview questions inherently subjective. If a disagreement were to arise, a participant has the option to think that it's simply a difference of opinion anyway, and choose to protect their relationship with the other group member rather than create an argument.

Using the Riley Risk Ladder in a group setting has the potential to tap into both social desirability and groupthink mentalities. While an individual in the general public may have no strong preferences around aquaculture, those who have been parties to the Michigan discussions, public meetings, and public comments will know that there are many strong feelings on the issue in these circles. Particularly with ongoing lawsuits and legal battles, there could be considerable pressure from within groups to stick to particular talking points that their group or organization has endorsed, either as a form of public compliance (conforming to a group's opinion even if your personal opinions are different) (Aronson, Wilson, & Akert, 2007) or because regular exposure to one set of opinions has influenced member thinking.

Ultimately, it is not possible to determine perfectly whether individual interviews or group interviews are more effective at getting the "truth" of risk perception. To do so would require there to be a correct or better answer to how people perceive risk, which is not possible for research such as this which looks at a real world policy issue with uncertainties. Instead, this work will compare the results of the group work with the average results obtained through interviews with the same stakeholder group members to see if there is consistency in results and, if not, whether the differences in results can be explained.

Research Question

This chapter seeks to test the Riley Risk Ladder in a group setting. Because of the high costs and resources necessary to do individual interviews across multiple stakeholder groups, changing the methodology to work for group settings could potentially result in faster, less expensive data collection. The research questions for this chapter are:

1. Can the Riley Risk Ladder be used effectively in group settings?
2. If so, what tradeoffs exist in terms of data quality?

Methods

Research Participants

Regulators and agency representatives from the Michigan Quality of Life agencies were willing to partner with the author for this section of the research. These agencies were the Michigan Departments of Agriculture and Rural Development, Environmental Quality, and Natural Resources, and were all tasked with providing guidance and, in some cases, decision making with regards to Michigan aquaculture development. A total of five participants were scheduled to be at the meeting and four ultimately participated, with the fifth being sick the day of the workshop.

It was determined that this group was at high risk of experiencing both the social desirability and groupthink phenomenon. The agencies that these members belonged to had made multiple public statements on the topic of Michigan aquaculture and many members had been active in public meetings, public comments, and other events which required them to interact with stakeholders on this controversial topic. These experience would have made it clear that opinions on the topic had the potential to evoke strong responses. In addition, those

individuals who attended more of these meetings or events could be perceived as having greater expertise than others in the group, which could lead to group members deferring to their opinions. Finally, the positions that participants held in these organizations were also their jobs rather than a hobby, potentially putting more pressure on members to conform to their agency's stance on the subject.

Meeting Logistics

The objective of this chapter was to develop a method for using the Riley Risk Ladder with fewer costs and resources than can be done with individual interviews. For this reason, certain constraints were imposed on the meeting, including limiting the time to one hour, which was a typical interview length and which also matched the typical length of a meeting that an organization may hold during the work day.

To work within this time constraint and also allow time for disagreement and discussion, it was determined that participants would be broken into groups which would allow them to sort the cost and benefit cards at the same time. To facilitate this, projectors were placed on two separate walls onto which the scales were projected. In addition, both the probability and magnitude scales were projected simultaneously. Participants were given two of each card to put on each scale. Participants were broken into two groups of equal size and allowed to choose whether they wanted to look at the cost cards or the benefit cards first. After the cards were placed by both groups, we then went through both sets of cards as a full group and the participants who did the ranking described to others why they made the placements they did. They were allowed to move the rankings in accordance with the larger group if they chose.

Breaking into two groups had an added benefit of addressing, to some extent, concerns around groupthink. By splitting up participants with more expertise, it was hoped that participants who might have otherwise deferred to those they considered more "expert" would have a chance to participate and influence results.

Results

Aggregate scores, or overview variables, were calculated for each of the cost and benefit scores, respectively, for probability, magnitude, and overall risk using the same process described in the last chapter, in which the scores for each card were averaged to create six aggregates scores. These scores included the average probability rankings of all benefit cards, the average magnitude rankings of all benefit cards, the average risk scores (probability x magnitude) of all benefit cards, and then these same three scores for the cost cards. These overview variables were then compared against the same scores that were calculated for the individual interviews as described in the last chapter, allowing a direct comparison between how cards were ranked, on average, in individual interviews versus the group workshop (Figure 1).

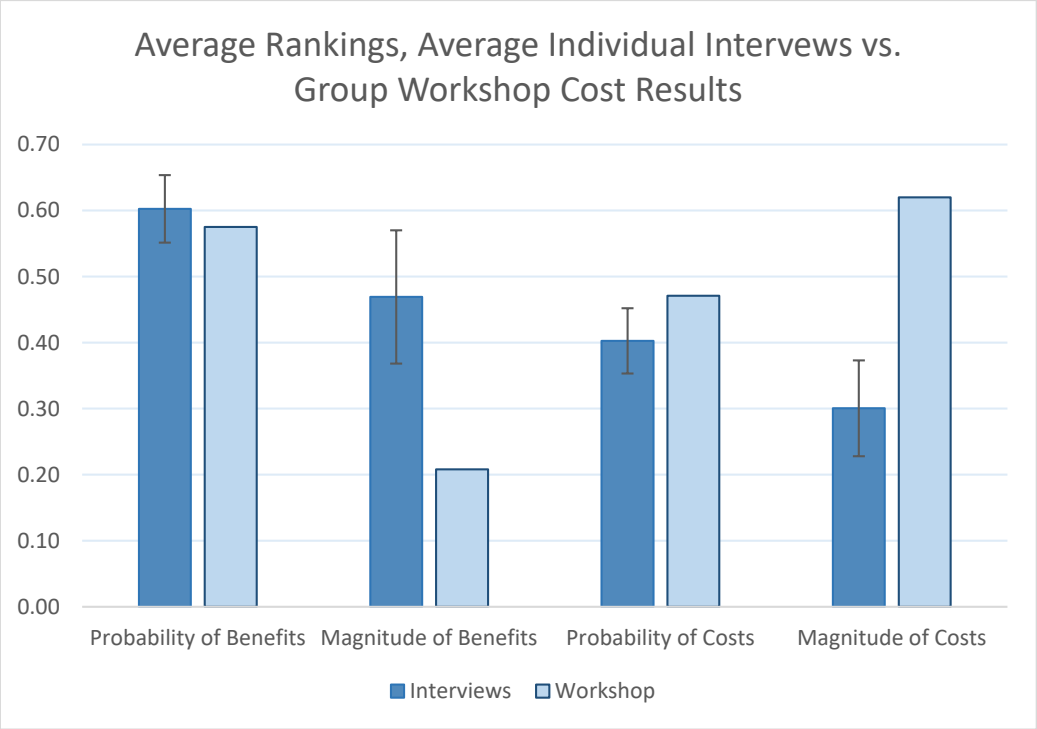


Figure 3.1. Overview Variable Rankings: Average Individual Interviews vs. Group Workshop Cost Results

Figure 3.1 shows that the primary differences between how cards were ranked in interviews versus the group workshop lie with perception of risk magnitude, with both the average probability of costs and the average probability of benefits being similar regardless of research methodology. To better understand what aspects of magnitude were causing the difference, similar graphs were created showing how the average score of regulators to each of the benefit (Figure 2) and cost (Figure 3) cards compared to how regulators ranked these scores as a group.

These figures show a consistently lower magnitude score awarded benefits, and a consistently higher magnitude score given to costs across all cards. For the benefit cards, the largest differences were seen with the “Competitive Edge,” “Improved Recreational Fishing,” “Increased Tax Revenue,” and “More Michigan Jobs” cards. The cost cards show the group

workshop very consistently ranking costs as higher for all the cards, with the possible exception of “Escapees,” which has a very close score within the error bar, and “Reduced Property Value” which is the only instance of the group participants ranking a cost card lower than individual participants did on average.

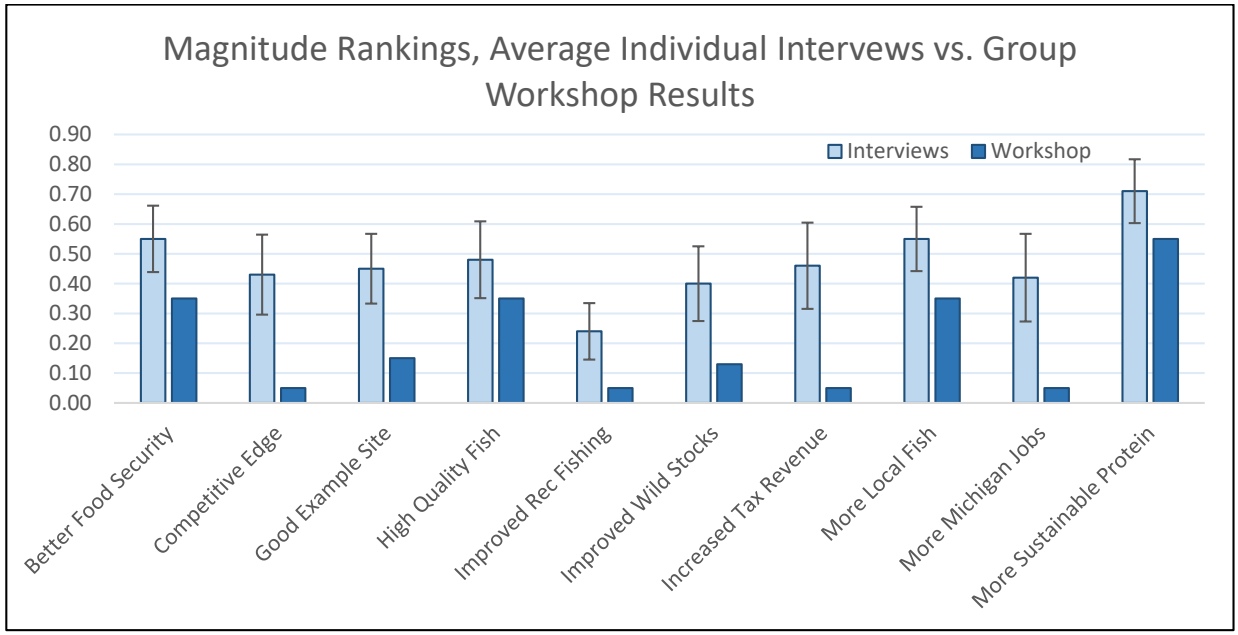


Figure 3.2: Magnitude Rankings, Average Individual Interviews vs. Group Workshop Results

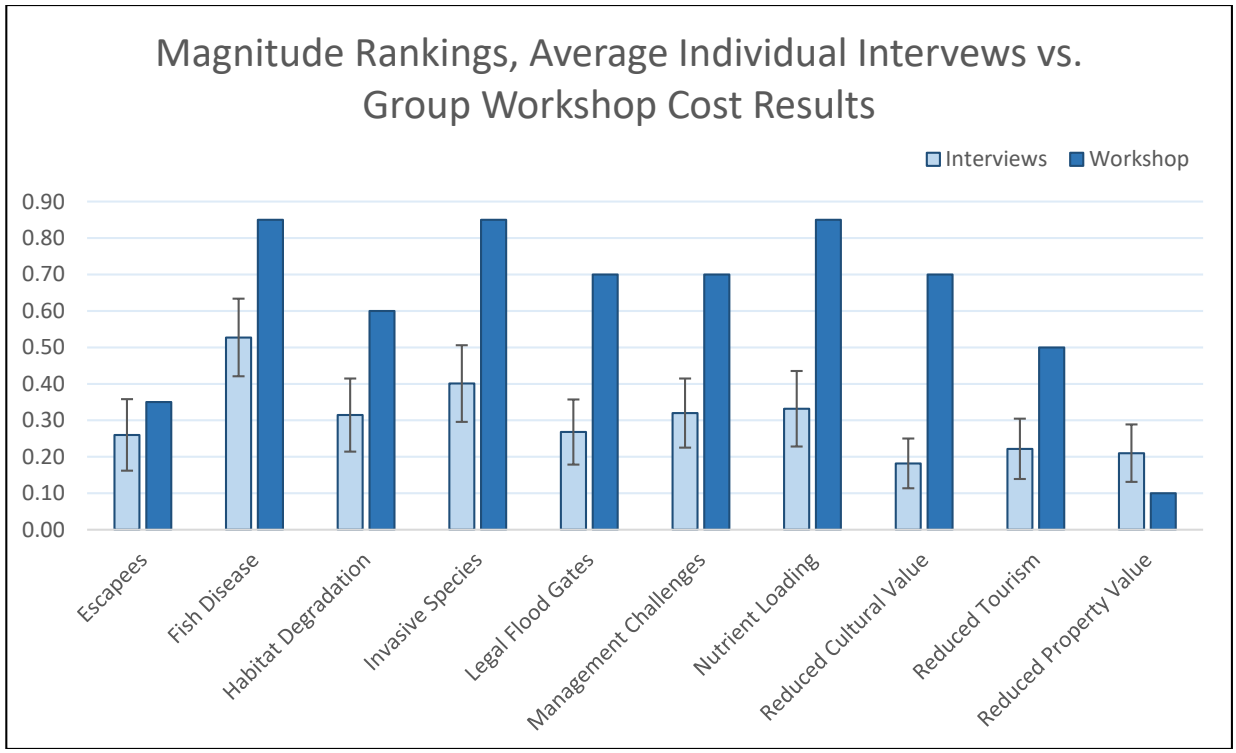


Figure 3.3: Magnitude Rankings, Average Individual Interviews vs. Group Workshop Cost Results

In order to account for the time gap between when the interviews were conducted and the date of the group workshop, the facilitator simply asked participants if they could think of any events that occurred in this intervening time that might influence their perceptions of risk. The group members brought up the legal dispute which had recently been resolved (with the anglers buying out the fish farmer, so it did not have clear winners or losers) which could influence their perception of items such as the "Legal Flood Gate" card. In addition, they discussed the implications of the recent Per- and polyfluoroalkyl substances (PFAS) outbreaks in the state which had required their departments to take action. They speculated that the recent contamination of the water table may influence how they think about items such as nutrient loading which relate to water contamination. Ultimately these items did not rank too differently from other cost magnitude cards (which were all ranked higher by the group than by

individuals in interviews), so it likely that the interviews and the group workshop were conducted close enough together in time to avoid major shifts in risk perception.

Discussion

While the appropriate data were collected in the group workshop, there were several limitations to using the Riley Risk Ladder with groups. Due to difficulty of one facilitator moving back and forth between each group, it was not possible to obtain good notes on why regulators made the rankings that they did. The planned discussion, as each group explained to the other why they ranked the way they had, was not as talkative as anticipated, with the questions being very targeted to one or two cards and not allowing a full view of the reasons behind all the card rankings. Future research could improve this situation by bringing an additional facilitator so that notes can be taken for each group during the initial ranking, when the group members are talking to each other about each card in turn.

In addition, the expertise of the group itself may have played a role in the score differences. Many regulators at these state agencies have master's degrees and regularly use scientific research in the course of their work. One limitation of the magnitude scales was that they were treated very differently by participants depending on whether they thought critically about how many people, numerically, were in the state of Michigan and how that corresponded to the percentages on the scale, and by those who ranked the magnitude scores with more of a gut feeling about how good or bad a card might be if it happened. This phenomenon, called "numeracy," has been discussed at length in the literature on risk ladders and is known to cause differences in scoring depending on numeracy levels (Keller, Siegrist, & Vixxchers, 2009). It could be seen with some regularity in individual interviews in which

participants would remark on how even low percentages on the magnitude scales still meant hundreds of thousands of Michiganders.

Due to the difficulty described above in a single facilitator obtaining clear qualitative data from both groups, it was not clear from the final interview notes where the regulators fell in terms of numeracy, although the notes from individual interviews indicate that at least some regulators demonstrated a high numeracy. However, if regulators in this group were prone to ranking lower due to feeling as though even low numbers represented large numbers of people (as was discussed in individual interviews), it would have been expected that both cost and benefit cards would have been ranked lower. Instead, benefit cards are ranked lower and cost cards are ranked higher, indicating that they may be correctly reflective of magnitude perception and not a difference in numeracy.

Conclusion

The research shows mixed results with regards to the utility of the Riley Risk Ladder in a group setting. The closeness of the average probability scores for both cost and benefit cards between the average interview data and the group data indicate that moving from individual interviews to a group setting could result in similar data for a smaller investment of time and resources. However, the clear differences in perception around cost and benefit magnitude respectively tell another story, with group rankings different than averaged individual scores in consistent ways.

It should not be ruled out that social desirability or groupthink influenced the final results. Indeed, the consistency with which all benefit cards are ranked as lower than average individual scores and almost all cost cards are ranked higher than average individual scores

suggests a social phenomenon at play, possibly an anchoring bias in which participants start with a number and then base their other decisions on it, even if it is particularly high or low. In other words, where the participants placed the first card in both cases may have influenced where they placed other cards. New research suggests that an anchoring bias can present in groups, and particularly in groups which are behaving cooperatively to find an answer together (de Wilde, Ten Velden, & De Dreu, 2018), which was the case in this research. Additional research should be conducted in order to determine whether the anchoring bias is in play and, if so, whether structuring the group discussion differently could help mitigate its effects.

In addition, future research could benefit from the addition of at least one other facilitator, which could aid in the qualitative portion of the Riley Risk Ladder which was not fully used in this group setting. Another option would be to expand the length of time for the workshop to allow for a more thorough discussion between the groups around why they ranked the way they did. More time for discussion could also reduce concerns about groupthink, as participants may have been responding to a time crunch in their decision not to push back against their colleague's rankings.

Ultimately, the group meeting was a mixed success with potential to think critically about future restructuring to make it more successful. It's likely that such a restructure will involve a longer period of time going through the cards, which can increase the resources required to conduct the methodology, as well as making scheduling a workshop more difficult. However, even with the time and resources dedicated to longer sessions and more energy spent with scheduling, the total time commitment will be much less than individual interviews,

making it a potentially viable alternative to researchers without the resources to conduct full interviews with stakeholders.

CHAPTER 4: FACILITATING COMPLEX POLICY DISCUSSIONS: USING COMMUNITY ENGAGEMENT TO TACKLE TOUGHER PROBLEMS

Abstract

Michigan aquaculture, or fish farming, has been a topic of intense debate in certain policy circles since at least 2011, sparking lawsuits, permitting approvals and postponements, and numerous regulatory starts and stops. While in many ways policy problems can resemble the same problems faced by smaller communities, the scale of wins and losses and the lack of prior relationships between stakeholders can make community engagement difficult. This research seeks to develop and test a methodology for creating community engagement opportunities amid policy conflicts. 39 one-on-one interviews were conducted with members of stakeholder groups who could be impacted by an expanded Michigan aquaculture industry. These interviews collected the traditional qualitative interview data and in addition, collected quantitative data related to how participants perceive the costs and benefits of Michigan aquaculture. After the data was collected individually, a group workshop was hosted with one stakeholder group in which research questions were developed (and later answered) using the interview data. The outcomes indicate the methodology shows promise in working on complex policy issues, as the data collected can be adapted to multiple research questions. In addition, the mixed methods nature of the research results in both quantitative and qualitative data that can be useful for all different types of community thinkers.

Introduction

Policy questions can be dangerous territory for researchers as policy decisions often have winners and losers, particularly when those decisions affect a lot of people such as those made at the state or federal level. Community engagement scholarship relies on listening, trust, and good faith, which are not always in large supply in the realm of power and politics. The

current mechanisms that many government agencies in the United States have in place for working with communities are primarily one-way communication such as public meetings, public comment periods, and news releases. Policy decisions can have major implications for the health and wellbeing of communities and the need for better community engagement is clear, but the scale of communicating with a constituency of millions is daunting.

Many laws and regulations can limit the ability of regulators to fully engage with the public and many of these restrictions are in place for good reason—to avoid the appearance of (or actual) political favoritism and corruption. Even researchers trying to work in the policy realm are not immune to being accused of having their own secret agendas, a phenomenon so common that books have been written to help scientist navigate their role (Piekle, 2007). And yet as scientists and researchers without vested interests in the outcomes of policy decisions, our roles can be powerful ones, particularly when paired with community engagement principles.

This research, through two phases, seeks to expand existing methodologies in an interdisciplinary way in order to provide higher quality community input into conflict-heavy, large scale policy decisions. It does so by first collecting data through one-on-one interviews with members of pre-identified stakeholder groups, allowing participants to discuss topics in a private setting without fear of reprisal from political opponents or feelings of pressure from political allies to conform with stated policy positions. In the second phase, is the interview responses and analysis are brought, de-identified, back to stakeholder groups to ask questions of the data which the researcher helps to answer.

Michigan aquaculture: The policy debate

While concentrated fish production facilities have existed in Michigan for decades in the form of government stocking for recreational fishing, the rise of privately-owned aquaculture facilities oriented towards commercial food production has raised alarm bells among many residents over the potential risks and benefits of expanding the practice in Michigan. In a state which prides itself on its tourism and sportfishing industries, this potential increase in industrial interests has been the source of concern and suspicion among the state's more traditional interest groups that rely on fishing and tourism. The question was framed for Michigan residents as anglers and tourism versus industry (Markey, 2018).

The current aquaculture policy debate began in 2011 when state agencies, the Michigan Departments of Agriculture and Rural Development (MDARD), Environmental Quality (DEQ), and Natural Resources (DNR) joined with aquaculture farmers in starting the Aquaculture in Michigan (AIM) Initiative (Michigan Department of Agriculture and Rural Development, n.d.). Aquaculture as an industry is still relatively new in the state, with regulatory frameworks such as the Michigan Aquaculture Development Act dating back to only 1996 (Michigan Legislature, 1996). Earlier laws focused on government aquaculture as a method for stocking game fish in public waters (Michigan Legislature, 1994), or on animal husbandry more generally (Michigan Legislature, 1988).

The AIM Initiative was designed to expand and support the Michigan aquaculture industry. New reports started coming out, including a Roadmap through Regulation (Colyn & Boersen, 2012) and an integrated assessment funded by Michigan Sea Grant in collaboration with Michigan agencies and the existing aquaculture industry. The integrated assessment

included a strategy for how Michigan could move forward with aquaculture and estimated Michigan has the ability to sustainably produce 400-500 million pounds of seafood annually—a $1 billion industry (Weeks, Colyn, Boersen, & Knudson, October 2014). Ultimately, the Michigan Aquaculture Association adopted Sea Grant's Strategy document as their own (Michigan Aquaculture Association, n.d.).

Included in that plan was a focus on three different potential types of Michigan aquaculture: 1.) indoor Recirculating Aquaculture Systems (RAS), 2.) outdoor flow-through raceways in inland areas, and 3.) offshore net-pen systems in the waters of the Great Lakes (Weeks, Colyn, Boersen, & Knudson, October 2014). All three of these systems in various forms were already in place in both the U.S. and Canadian waters of the Great Lakes region, both in privately-owned facilities or government stocking operations. The integrated assessment findings outlined offshore net pen operations as having the greatest potential for producing the most amount of fish at the lowest costs (Weeks, Colyn, Boersen, & Knudson, October 2014). By the end of 2014, interested companies approached the Michigan Quality of Life departments with two proposals for putting net pens into the Great Lakes (Department of Agriculture and Rural Development, Department of Environmental Quality, Department of Natural Resources, March 9, 2016).

While interested groups were putting together plans for a net-pen facility, resistance to the idea of Great Lakes aquaculture was slowly building in the recreational fishing and tourism industries. In March 2016 with the publication of their *Synthesis Report Regarding Net-Pen Aquaculture in the Great Lakes*, the Quality of Life agencies closed the discussion on net pens, citing too many environmental uncertainties, too much risk to existing industry, management

challenges, too small a return on investment, and a lack of regulatory authority (Department of Agriculture and Rural Development, Department of Environmental Quality, Department of Natural Resources, March 9, 2016). In addition to net pen concerns, which the Quality of Life agencies referred to as a "serious and potentially contentious matter" (Department of Agriculture and Rural Development, Department of Environmental Quality, Department of Natural Resources, March 9, 2016), a new lawsuit was filed in July 2014 concerning the proposed expansion of a flow-through system in the northern lower peninsula of Michigan. The next few years included a series of lawsuits against the farm which involved the president of the Michigan Aquaculture Association. Public meetings became more argumentative and trust began to deteriorate between all the parties involved.

The Michigan Stakeholder Communities

Before this project was designed, I spent time getting to know the community and what issues people were focusing on around Michigan aquaculture. This included attending the public meetings that the Quality of Life agencies held to receive input from interested stakeholders as well as meetings of the Michigan Aquaculture Association and tours of existing aquaculture facilities. I conducted informal interviews with recognized academic and agency experts in the field, as well as with a member of the consulting agency Originz, LLC which developed the Aquaculture in Michigan Roadmap through Regulation. As a Michigan Sea Grant Extension Graduate Fellow, she participated in a Michigan aquaculture siting project with agency partners which resulted in a guidebook to help those interested in starting their own aquaculture facility figure out where to site (Triezenberg, et al., 2018). She attended a course on Hazard Analysis and Critical Control Points (HACCP) in which she interacted with the fish

producer and processor community. She talked with charter boat operators, members of the existing recreational fishing tourism industry, on both Lake Michigan and on a Michigan river to discuss their thoughts about Michigan aquaculture. In addition to in-person interactions, I followed the formal reports issued by the agencies and the media attention given to the issue of Michigan aquaculture. The question of Michigan aquaculture expansion was covered in a variety of trade journals, but the general public was also engaged through discussions on public radio and popular news sources such as the Detroit Free Press and Bridge Magazine (an online, non-profit magazine focused on Michigan topics generally).

It was through these discussions that an understanding of who had a stake in the Michigan aquaculture industry began to form. Given the scale of the policy in question, which would affect communities across the state of Michigan, community engagement could only feasibly be accomplished on a dissertation scale by narrowing the focus of the work. Relevant stakeholder groups were identified by considering who was affected by Michigan aquaculture expansion and who was in positions of power to affect change, using the Rainbow Diagram from Chevalier & Buckles (2008). This identification process started with those who were at the center of the debate (aquaculture farmers, recreational fishers, and regulators) and widening in scope to include those who were not directly involved in the debate but who could be affected positively or negatively by an expanded industry. The final list of stakeholders included:

1.) Recreational fishers/anglers (n=17). Advocates from organizations representing this stakeholder group were leading the charge against Michigan aquaculture, both through lawsuits and their contributions to the public comments and meetings. Generally, this group considered aquaculture waste outputs (fish feces, excess feed,

and potentially disease) to be a threat to the wild fisheries they enjoyed. The group initially included all individuals who either 1.) self-reported fishing at least once a week on average, and/or 2.) self-reported belonging to an angling organization. Later analysis of the data considered these two attributes separately.

2.) Aquaculture farmers (n=9). This group, particularly through the Michigan Aquaculture Association, was the primary advocacy group advancing Michigan aquaculture. The focus of the debate concerned private growers producing commercially for food (rather than those raising bait for recreational anglers). However, only two commercial farms are currently in operation in Michigan. For this reason, this category was expanded to include farmers who had facilities which had previously been used to raise fish commercially and which could be restarted if the right market conditions presented themselves.

3.) Commercial fishers (n=6). While they did not engage regularly in the public processes, this group was considered a stakeholder both economically (more fish on the Michigan market could result in lower prices and competition) as well as ecologically (if the negative impacts predicted by angling industry representatives came to pass, the wild fish that commercial fishers catch could see populations reductions).

4.) Delta County Residents (n=5). Delta County is in Michigan's Upper Peninsula and was the potential site for an offshore aquaculture farm, which was strongly advocated for by the Delta County Economic Development Association. In addition, this county

has more aquaculture farmers registered with the state than any other county in Michigan.

5.) Fish Wholesale Producers (n=5). Wholesale businesses which process and/or buy and sell fish products would benefit from an increase of Michigan fish on the market, regardless of how it was being produced. In addition, farmed fish could be produced in more consistent amounts than wild catch, which would benefit most wholesale business models.

6.) Michigan Tribal Affiliates (n=8). Many stakeholders saw tribes as an unpredictable player. Since tribes are not subject to the same rules regarding natural resource use as other individuals in the state, there was potential for tribes to make their own decisions on whether to pursue offshore aquaculture independently of Michigan government agency decisions. Many of the net pens off the Great Lakes shoreline in Canada are currently run by Canadian tribes.

7.) Regulators (n=11). This group included individuals with political positions at the state, local, or tribal level who responded "yes" when asked if they had a voice in decision-making in their position. While regulators are confined to certain legal frameworks, they can serve as advisors to policy makers in determining what these legal frameworks look like, and ultimately make decisions about how laws are implemented through the passing and enforcement of rules and regulations.

8.) Tourism Industry Representatives (n=7). Preliminary dissertation research indicated that the threats posed to the Michigan tourism industry were some of the most salient potential costs to many stakeholders. The potential for ugly facilities,

unfortunate smells, and any pollution or disease that could come from aquaculture discharge were all discussed as impacting the Michigan tourism industry and most specifically the sportfishing industry. This research is careful to only include in this group individuals who are involved in the recreational angling economy, including fishing lodges and fly shops.

In addition to identifying stakeholders, it was necessary to determine how outreach and engagement should be conducted. Experience at public meetings and discussions with stakeholders made it clear that bringing different stakeholders together would be a difficult task and, considering the animosity between some stakeholders, may not be a productive use of time. A two-phase methodology was thus developed to ensure perception data was collected from representatives from all stakeholder groups while ensuring their anonymity.

Methods

Phase 1: Interviews with Stakeholders

The first phase of this research (conducted under IRB #i053833, approved 3/29/2017), 39 participants were interviewed using a mixed methods approach called the Riley Risk Ladder which collected data on how participants perceive the potential costs and benefits associated with a Michigan aquaculture expansion. These one-on-one interviews were collected between June 2017 and June 2018 and took approximately 1-2 hours per interview with some exceptions.

The interview format was chosen because:

1.) Pre-research revealed that most community members had well-formed opinions about many of the costs and benefits of aquaculture. Little education work would need to be done.

2.) Because aquaculture was a controversial policy topic, many interest groups had developed talking points. Interviews would allow focused questioning of individuals without concern that a single individual would guide the conversation back to the established talking points.

3.) Interviews allow participants to speak more freely, particularly if they disagree with their group's talking points, without fear of hurting their reputation in a larger group.

The interviews were conducted with each stakeholder group in accordance with the Riley Risk Ladder methodology discussed in the Chapter 3 that collected quantitative information in the form of scales which asked where participants would rank aquaculture costs and benefits according to their personal perception of their probability and magnitude. In addition, qualitative information was collected through the interview format. Once final interviews were complete, a one-page, two-sided document was mailed or emailed to every interview participant with a preliminary overview of the results (see Appendix E). This included a description of the entire interview process on one side and a breakdown of card rankings by stakeholder group on the other side. Rather than including specific numbers, results were color-coordinated, with higher ranked cards having a darker coloration than those with lower ranked cards. These rankings were determined by calculating a risk score (probability x magnitude) for each card for each participant. Then the average of these scores would be calculated for all

stakeholders which belonged to a certain category. Some stakeholders belonged to multiple categories. The overall score, then, was an indicator of how belonging to a certain group could influence an individual's thinking about different potential aquaculture costs and benefits.

The full results of the interviews can be seen in Chapter 2 of this dissertation.

Phase 2: The Group Workshop

At the conclusion of the interviews, researchers were left with a great deal of qualitative and quantitative data from which many additional questions could be answered. For phase 2, we approached our stakeholder groups to see if they would be interested in partnering in order to collaboratively come up with research questions that our data could help answer. For each stakeholder group, an individual was selected who could reasonably represent a leadership position. For that person, included with their one-page overview was an email invitation to continue with the research by contacting the researcher and determining a time to discuss. It was indicated in the email that the next phase of the research would involve small groups. While several individuals responded with interested, ultimately only one stakeholder group, regulators, were able to coordinate a group meeting.

In January 2019, the researcher met for one hour with a group of four regulators, all of which were involved in Michigan aquaculture rules and regulations. The workshop involved having participants work through the Riley Risk Ladder (using primarily the original interview methodology, see Chapter 4 of this dissertation for more details) as groups to come up with a collective decision of relative risks I then lead the group in a discussion of research questions using the Diamond of Participatory Decision-Making (Kaner, Lind, Toldi, Fisk, & Berger, 2014) which starts with brainstorming broad topics, then narrows the focus. By the end of the

meeting, the regulators had come up with three questions they were interested in, based on the data available. The topics included:

1.) A general overview of the data, to see where stakeholder groups stood relative to each other on each of the card topics.
2.) A comparison of how belonging to a stakeholder group could influence one's perception of the magnitude of the benefit cards. The regulators were interested in whether other groups ranked these scores as similar to themselves.
3.) More information on whether a particular stakeholder group had intragroup differences. During policy discussions, this stakeholder group always appeared to regulators to have a single message which they did not waiver from. Regulators were interested in seeing whether that message held up when talking to people one-on-one.

After the research questions were determined, I offered to keep lines of communication open in case they came up with more questions. Then I went back to the lab to try to find answers for the questions. Approximately one month later, the regulators received a 25-page report with the answers to their questions (Appendix F).

Discussion

Phased Research: Using that Extra Data

The original intent of this dissertation research was to create and test a method for collecting social data around a complex policy issue (Chapters 2 & 3). However, once those research questions were answered, there remained an enormous amount of data available that could answer numerous policy questions. Rather than come up with more researcher-driven

questions, we decided to reach out to the communities which had given their time to collect the data.

By going back to our research partners, we were able to ensure that the questions we asked of the data would be of direct use to the community. In addition, allowing our partners to help develop the questions (questions which we did not have the answer to until they were asked by our partners) it is clear that the results were compiled and presented solely in response to regulator questions and not because we were pushing our own agenda. This sort of distance, combined with our previous distance as university affiliates with no connections to other stakeholders in the debate, lends our results higher credibility than if they had been presented without context.

While it is generally true that community engagement scholars benefit in some ways from being outsiders without their own political agenda, this is especially true when working with stakeholders around a high-conflict policy issue. Because of this need to maintain a distance from the policy issue in question, it is unlikely that Phase 1 of this research could have been completed had certain stakeholder groups been more involved in the design of the research. On multiple occasions, either when planning an interview or, in one case, abruptly during an interview, participants would be very interested in who I was working for, who was funding my research, and whether I had any connections to the groups involved. One potential interviewee made it clear that if my funding came from specific sources that he would not be willing to speak with me. While these restrictions made finding funding for the research difficult, it had a clear advantage in helping participants feel comfortable speaking to me. Ultimately, as is discussed in the previous chapter, no participant who was approached

explicitly declined to talk to me, although there were several instances in which logistical issues prevented an interview.

The Social Scientist in a Natural Science Arena

During the first research phase, it became apparent that the role a social scientist could play wasn't well understood among stakeholder groups. While it's not clear to what extent this is true for policy questions in general, this research involved collaboration with regulatory agencies (in which many employees have master's degrees in the natural sciences) and policy questions which heavily revolved around ecosystem capacity and other natural science questions. As such, the policy question was regularly approached by stakeholders as an ecology and biology question rather than a social question. At best, it was approached as an information problem rather than a people problem, as evidenced by the work that regulators did consecutively with this research which involved making a guidebook with clearer instructions on how to navigate regulations, and the creation of an aquaculture siting guidebook which could be used to find hydrologically, ecologically, and economically viable locations for a new aquaculture facility.

In addition, because of the highly public nature of the Michigan aquaculture discussion, those heavily involved in the debate were already exposed to many perspectives on the aquaculture question. From some perspectives, this could seem like a complete understanding of the social tensions underlying the question. However, as the interviews revealed, perspectives within groups could be much more complex than they appeared by listening to public statements alone. The one-page overview of results thus served dual roles, both as a way of thanking participants for their time and to showcase what the results might add to

participant's current understanding of the social situation. During the discussion in Phase 2, regulators demonstrated an intuitive grasp of the usefulness of the research, asking targeted questions about how perceptions differed between groups, and whether perceptions within certain groups were more nuanced than the public facing statements of these groups appeared.

These sorts of questions are central to effectively understanding the reality of a politically charged question beyond the finely honed messages of organized groups. Community engaged scholarship and participatory action research are based in community empowerment and building capacity. Decision makers are constrained by resource limitations in doing their own engagement with their large constituencies and relying on lobbying groups has become a common way to shortcut deeper engagement activities. Many times policy debates, however, are determined by which organization has the most funding and/or the best organizing strategy. This is an area where community engagement scholars, as politically neutral and skilled in facilitation, can play a helpful role.

Ethical Considerations

We aspired to conform to the International Association for Public Participation's Code of Ethics (2017), and because of the nature of the research, some creative solutions were devised. There were difficulties inherent in the scale of what constitutes the public for a statewide policy, so steps were taken to identify those stakeholders with the highest likelihood of being influenced by aquaculture policy decisions and ensure that these groups had representation in the research. No individual who was interested in participating was turned down and, indeed, this policy resulted in the discovery of a stakeholder group—fish wholesalers—who had not been previously identified.

The principle of openness was weighed against our ethical responsibility to protect our participants and avoid further polarization. Policy questions can be emotionally charged because stakeholders face the prospect of gains and losses. Particularly with pending lawsuits between participants very interested in the latest science, there was a non-zero possibility that misuse of the data could change the balance of power among stakeholders. Our research was designed with this in mind, including our decision to conduct individual interviews rather than facilitate group discussions with all stakeholders together. In addition, we de-identified the data, which included taking handwritten notes only during the interview rather than recording audio which avoided collecting personally identifiable information. In addition, having the interviewer take notes reduced the likelihood that someone could identify a participant based on the words they used, further de-identifying the data. To ensure the notes were an accurate reflection of the participant's words, they were typed up and mailed or emailed back to the participant for comment. While a file with the participant's personal data was maintained (in order to contact them with the one-page overview of results, as well as to invite certain participants to join Phase 2, as described in a previous section), this data was kept on an encrypted drive on a password protected computer in a room that locks. All of this was explained to the participants before interviews, and portions were included in the consent form given to all participants before research began.

For Phase 2, there was some concern that participants might be interested in obtaining data on opposing stakeholder groups to use as leverage in the policy debate, which could increase polarization between communities. While there is no way to completely prevent this, it was made clear to partners at the beginning of the group workshop that the intent was to aid

in communications and outreach. The ultimate research questions that our regulator partners decided on were determined not to be a concern in this regard.

Participation in Group Workshops

It cannot be ignored that only a single stakeholder group followed through on their interest to do a group workshop and work with the data. However, this may have been an issue of timing and logistics rather than lack of interest. Two other well-organized stakeholder groups responded to the initial email invitation with interest, but coordinating a group meeting ultimately fell through. In one instance, the organization in question underwent a change in leadership with two long-time leaders retiring and finding a new position, respectively. The new leadership was interested, but had not been in Michigan during the bulk of the aquaculture debate and may simply not have developed the connections yet to organize a meeting. In the other instance, the contact had just suffered a non-trivial setback on a court case and may not have been up to organizing the meeting after the initial expression of interest.

It should be noted that the regulator group which was ultimately able to host the workshop was arguably the best organized of all the stakeholders, was in the same city as the researcher, and had a history of collaboration with Michigan State University. This suggests that participation may have been a factor of ease of organizing rather than lack of interest. Future research using this method or similar methods may benefit from additional effort expended to plan a group workshop much farther in advance, or to work with events that groups have already scheduled so that participants don't have to make an extra trip.

Conclusion

Policy questions can have powerful implications and as such can be complex and emotional for the people involved. The communities in these discussions are numerous and can even be in conflict, making more traditional engagement strategies extremely difficult. Furthermore, those in decision making positions may underestimate the need for community engagement and try to solve social problems with natural science solutions. There is a pressing need to scale up community engagement techniques to aid in finding policy solutions.

In many ways, a policy problem is very much like a traditional community's problem, just on a larger scale. Tradeoffs have to be made and there will be winners and losers. There will be points that everyone agrees on and points that people disagree on. There are players who are easy to bring to the table and those that take more effort to reach out to. The difference is that the tools for tackling policy problems in a community-engaged way have been underdeveloped.

This research does not propose to have found a perfect solution. In many ways, the lack of community engagement in the design of Phase 1 can be seen as a community engagement failure, since decisions about what data to collect, how to collect it, and what questions to ask were taken outside of community hands. On the other hand, the question of aquaculture benefits and costs was a question developed entirely by the community and was the subject of intense public debate long before this research was developed. In the policy realm where all interpersonal connections are suspect and everyone's motivations questioned, the methodology outlined in this research could offer a compromise.

APPENDICES

Appendix A: Breakdown of mean responses by stakeholder group (Total Risk, Probability, and Magnitude)

Card	Score Type	Member of Angling Group	Fish at Least Once a Week	Aqua-culture Farmer	Comm-ercial Fisher	Delta County	Fish Whole-saler	Tribal Affiliate	Regul-ator	Tour-ism
Average Benefit Rankings										
Better Food Security	Total Risk	0.088	0.450	0.797	0.418	0.727	0.824	0.516	0.474	0.208
	Probability	0.375	0.693	0.878	0.767	0.800	0.910	0.800	0.740	0.483
	Magnitude	0.221	0.623	0.911	0.527	0.910	0.890	0.608	0.545	0.393
Competi-tive Edge	Total Risk	0.253	0.350	0.399	0.235	0.363*	0.250	0.141	0.250	0.481
	Probability	0.614	0.677	0.772	0.433	0.700	0.560	0.506	0.555	0.729
	Magnitude	0.380	0.497	0.550	0.392	0.738*	0.538	0.311	0.432	0.621
Good Example Site	Total Risk	0.243	0.410	0.505	0.360	0.765	0.550	0.330	0.382	0.369
	Probability	0.536	0.657	0.639	0.560	0.900	0.810	0.543	0.678	0.593
	Magnitude	0.429	0.574	0.675	0.458	0.790	0.720	0.401	0.446	0.607
High Quality Fish	Total Risk	0.073	0.307	0.518	0.067	0.368	0.650	0.258	0.260	0.192
	Probability	0.243	0.437	0.633	0.167	0.440	0.770	0.350	0.400	0.350
	Magnitude	0.226	0.466	0.733	0.450	0.660	0.830	0.445	0.480	0.521
Improved Recreation-al Fishing	Total Risk	0.016	0.164	0.284	0.083	0.388	0.254	0.138	0.134	0.147
	Probability	0.186	0.340	0.400	0.175	0.750	0.570	0.194	0.345	0.371
	Magnitude	0.079	0.300	0.511	0.300	0.520	0.420	0.228	0.245	0.221
Improved Wild Stocks	Total Risk	0.110	0.283	0.372	0.005	0.217	0.494	0.055	0.130	0.139
	Probability	0.300	0.447	0.511	0.050	0.340	0.680	0.150	0.309	0.364
	Magnitude	0.300	0.440	0.750	0.183	0.760	0.670	0.350	0.405	0.407
Increased Tax Revenue	Total Risk	0.197	0.326	0.607	0.177	0.427	0.655	0.375	0.451	0.250
	Probability	0.508	0.671	0.878	0.492	0.940	0.860	0.806	0.825	0.458
	Magnitude	0.407	0.470	0.706	0.468	0.430	0.730	0.418	0.464	0.486
More Local Fish	Total Risk	0.217	0.415	0.799	0.243	0.664	0.804	0.404	0.457	0.271
	Probability	0.586	0.693	0.911	0.325	0.840	0.950	0.644	0.755	0.557
	Magnitude	0.376	0.542	0.872	0.342	0.740	0.850	0.500	0.548	0.464
More Michigan Jobs	Total Risk	0.204	0.274	0.379	0.177	0.487	0.364	0.265	0.422	0.546
	Probability	0.558	0.743	0.783	0.492	0.820	0.920	0.800	0.825	0.817
	Magnitude	0.226	0.332	0.494	0.485	0.532	0.442	0.279	0.418	0.516
More Sustainable Protein	Total Risk	0.248	0.567	0.717	0.380	0.770	0.902	0.442	0.541	0.469
	Probability	0.442	0.723	0.794	0.542	0.840	0.980	0.694	0.736	0.650
	Magnitude	0.421	0.710	0.900	0.567	0.930	0.920	0.581	0.709	0.571
Average Cost Rankings										
Escapees	Total Risk	0.373	0.092	0.070	0.797	0.007	0.144	0.185	0.102	0.436
	Probability	0.533	0.418	0.339	0.883	0.120	0.490	0.538	0.373	0.720
	Magnitude	0.564	0.233	0.183	0.892	0.096	0.274	0.245	0.260	0.600
Fish Disease	Total Risk	0.606	0.257	0.225	0.802	0.219	0.188	0.327	0.280	0.675
	Probability	0.693	0.400	0.351	0.883	0.240	0.260	0.560	0.430	0.750
	Magnitude	0.771	0.590	0.600	0.883	0.450	0.470	0.513	0.527	0.857
Habitat Degrad-ation	Total Risk	0.466	0.158	0.075	0.278	0.027	0.126	0.242	0.196	0.595
	Probability	0.807	0.483	0.203	0.538	0.250	0.210	0.707	0.544	0.800
	Magnitude	0.627	0.287	0.278	0.592	0.104	0.354	0.431	0.315	0.721
Invasive Species	Total Risk	0.497	0.163	0.089	0.75	0.075	0.137	0.293	0.196	0.516
	Probability	0.643	0.321	0.160	0.750	0.140	0.260	0.513	0.309	0.671
	Magnitude	0.686	0.487	0.572	0.875	0.470	0.300	0.466	0.401	0.714
Legal Flood Gates	Total Risk	0.304	0.187	0.335	0.505	0.461	0.133	0.240	0.121	0.571
	Probability	0.708	0.477	0.459	0.650	0.570	0.280	0.488	0.336	0.790
	Magnitude	0.414	0.318	0.417	0.675	0.524	0.254	0.397	0.268	0.657

Card	Score Type	Member of Angling Group	Fish at Least Once a Week	Aqua-culture Farmer	Comm er-cial Fisher	Delta County	Fish Whole-saler	Tribal Affiliate	Regula tor	Touri sm
Average Cost Rankings, *cont.*										
Manage-ment Challenges	Total Risk	0.486	0.311	0.312	0.517	0.380	0.198	0.227	0.205	0.532
	Probability	0.764	0.717	0.531	0.875	0.540	0.440	0.744	0.659	0.857
	Magnitude	0.592	0.372	0.378	0.575	0.414	0.344	0.270	0.320	0.607
Nutrient Loading	Total Risk	0.643	0.251	0.098	0.605	0.001	0.276	0.294	0.193	0.702
	Probability	0.864	0.603	0.287	0.733	0.130	0.390	0.650	0.554	0.843
	Magnitude	0.721	0.377	0.267	0.808	0.054	0.564	0.388	0.332	0.807
Reduced Cultural Value	Total Risk	0.230	0.061	0.060	0.477	0.036*	0.034	0.208	0.103	0.251
	Probability	0.421	0.313	0.244	0.608	0.363*	0.110	0.538	0.400	0.443
	Magnitude	0.392	0.139	0.188	0.558	0.090	0.180	0.306	0.182	0.420
Reduced Tourism	Total Risk	0.287	0.072	0.009	0.035	0.000	0.026	0.018	0.076	0.209
	Probability	0.486	0.192	0.041	0.075	0.000	0.090	0.066	0.145	0.521
	Magnitude	0.501	0.149	0.072	0.317	0.010	0.190	0.114	0.222	0.353
Reduced Property Value	Total Risk	0.233	0.064	0.005	0.262	0.001	0.078	0.021	0.092	0.151
	Probability	0.486	0.203	0.100	0.408	0.040	0.310	0.138	0.255	0.414
	Magnitude	0.409	0.142	0.050	0.367	0.020	0.190	0.101	0.210	0.334

*Indicates less than 5 responses to this question (n=4 in both cases). Participant chose not to respond.

All scores were calculated by taking the average of each group's individual scores.

Appendix B: Coded variables identified in Content analysis of qualitative Riley Risk Ladder interviews

Business Revenue and Costs	Factors which can influence the viability of an aquaculture farm as a business, including taxes (as they relate to business expenses), government subsidies, crime, usefulness of byproducts, water access, and general comments on the feasibility of Michigan aquaculture farms. NOT larger economic drivers like supply and demand.
Competitive Marketplace	A competitive economic marketplace, including competition between aquaculture farmers, with other fish producers, other industries, and comparisons between political jurisdictions.
Aquatic Environment	References to the water itself and aquatic habitat--water quality (contamination, nutrient load), water quantity, water sourcing, use, etc.
Facility	References to the types of facilities, specific characteristics of facilities, facility best practices. NOT siting/location or discussions of the industry more broadly (which are their own category).
Fish	Discussion of live fish themselves, including the value of certain species versus others, certification or vetting of fish, fish diet, naturalized/native/hybrid/invasive/stocked fish, and fish genetics.
Information	Discussion of past or ongoing scientific research (information collection), a need for more or better information, or instances in which past access to information may have resulted in better (or more expected) outcomes. Also includes references to past experience being used to inform current opinions.
Industry Logistics	References to the existing or planned Michigan aquaculture industry, including the size of the industry, what sort of species might be raised, beliefs around interest in entering the industry, and beliefs around proper training and expertise needed by fish farmers. NOT siting or facility-specific information (which are their own categories).
Michigan Effects	Discussion of local, regional, or statewide concerns specific to Michiganders. This includes Michigan job creation, local availability of products, the spread of money through the economy (including discussion of how to use taxes raised through aquaculture), and non-market values derived from Michigan wild places.
Aquatic Organisms	Non-fish organisms (fish are their own category) which live in aquatic ecosystems, including invasive species, plants, and disease.
Politics	References to political theories and/or speculations, including perceptions of litigation, public vs. private water use, and the motivations of political leaders and regulators in their decision making. NOT references to specific regulations or regulatory needs (their own category below).
Fish Product	Discussion of fish (wild or farmed) as a product to be consumed, including qualities of the product such as taste, its healthy qualities (benefits, protein, & contamination), freshness (speed to market), and overall quality, but also details of the product's life cycle including distribution, shelf life, product consistency, and product seasonality.

Regulations	Instances in which regulations are discussed--existing regulations, needed regulations, how regulations are implemented, how regulations change across jurisdictions, etc.
Site	Suggestions that participants had regarding characteristics of the site selected, including discussion of the surrounding area or region, the cultural significance of a location, the perception of a site, hydrological requirements, etc.
Social	Aspects of risk which are social in nature, including opinions around aesthetics, cultural norms, ethics around society and stewardship, perceptions, and motivations (or suspected motivations) for actions.
Tourism	A discussion of tourism in Michigan--existing, different types, the effects of certain actions on tourism, etc.
Economic Market	Instances in which the larger economic drivers of aquaculture (as food) are discussed, such as supply and demand (where fish come from and where they go, as well as quantity), pricing, markets, and consumer preference.

Appendix C: Cost and benefit cards used in Riley Risk Ladder interviews and group workshop

← **Nutrient Loading** Nutrients will leave aquaculture systems and enter the natural environment, increasing the risk of algal blooms and eutrophication.	← **Fish Disease** Diseases will move from aquaculture fish to wild fish, hurting the health of wild fish.
← **Reduced Tourism** The negative aesthetic and environmental consequences of aquaculture facilities will result in fewer tourists coming to Michigan.	← **Invasive Species** Invasive species will be released from aquaculture facilities, either through the farmed fish escaping or through aquatic hitchhikers.
← **Escapees** Aquaculture fish will escape from facilities and breed in the wild, outcompeting wild fish or causing contamination of wild genetic lines that make the next generation of wild fish unable to survive.	← **Habitat Degradation** Habitat for Great Lakes fish and wildlife will be degraded due to the construction and operation of aquaculture facilities, including more human traffic in these areas.
← **Reduced Cultural Value** Even if they have no environmental impacts, aquaculture facilities will negatively impact culturally important lakes and streams because these facilities are industrial buildings in naturally wild locations.	← **Reduced Property Value** Aquaculture facilities are ugly and people will not want to look at them, which could result in a drop in nearby property values.
← **Management Challenges** One Great Lakes state, province, or tribe will make decisions about aquaculture without the consent of the others, which will hurt shared management of the resource.	← **Legal Flood Gates** Allowing one private aquaculture facility in public waters will open the flood gates to more facilities, beyond the ability of regulators to protect the environment.

Improved Recreational Fishing

Aquaculture facilities improve recreational fishing opportunities around them, as nutrients that leave these systems help to build (or rebuild) ecosystems which are currently nutrient poor.

Good Example Site

If one aquaculture facility is allowed to be built beyond what is currently allowed, regulators will see that aquaculture can be safely pursued and other facilities will soon be permitted.

Increased Tax Revenue

The presence of new aquaculture businesses will lead to more taxes going to local governments for municipal services.

More Michigan Jobs

Aquaculture facilities will bring aquaculture jobs to Michigan in production and processing

More Sustainable Protein

Aquaculture seafood can be produced with a smaller environmental footprint than other types of meat production, so it will be possible to feed more people more sustinably.

More Local Fish

More aquaculture facilities in Michigan means that more fish will be produced locally and made available to those interested in eating locally produced food.

Better Food Security

Michigan's food security will be improved due to producing more farmed fish here, and we won't have to import as many fish.

Improved Wild Stocks

Producing farmed fish to meet the ever-increasing human demand for more seafood will take pressure off wild fish populations and allow them to rebuild.

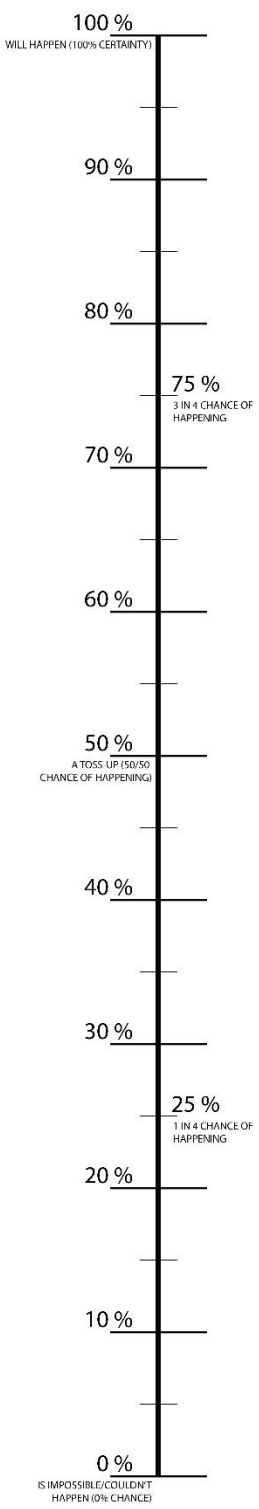
High Quality Fish

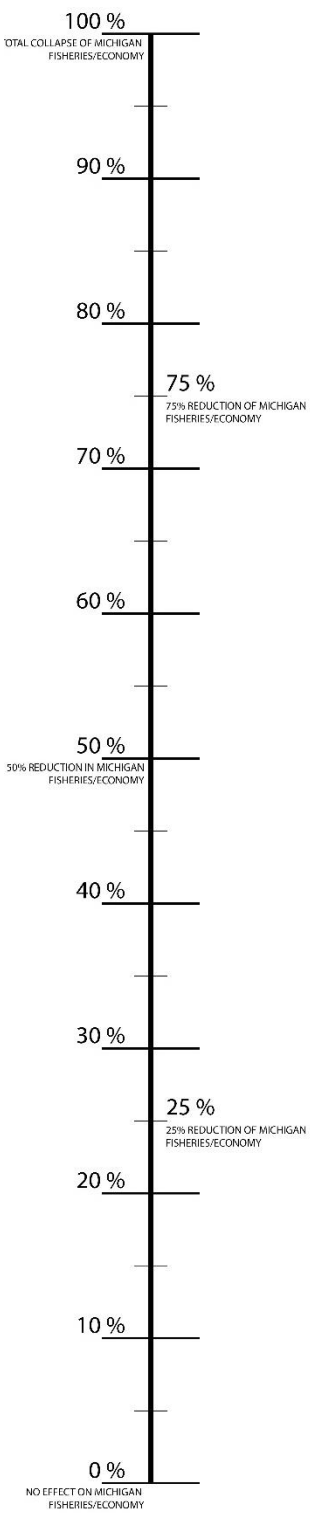
Fish grown in aquaculture facilities will be fresher and of higher quality than wild fish because farmers raise them for quality and get them more quickly to stores.

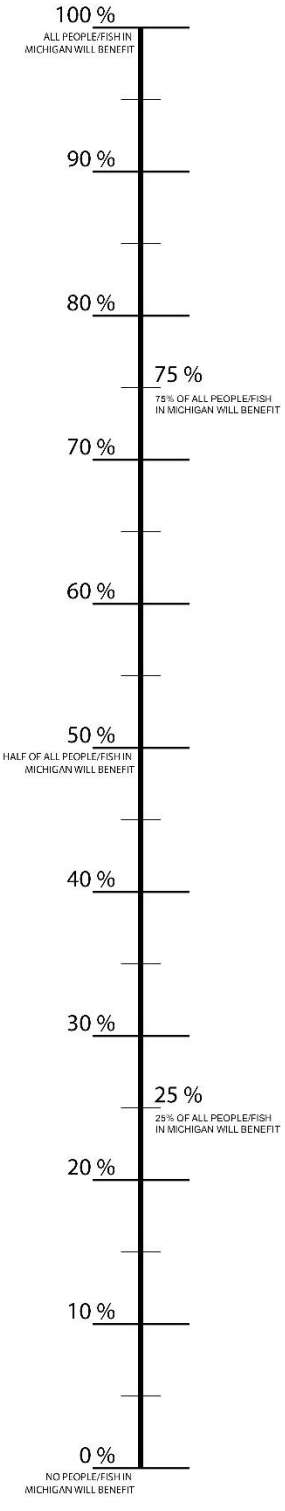
Competitive Edge

One Great Lakes state, province, or tribe will make decisions about aquaculture before others decide, giving them a competitive edge in the future industry.

Appendix D: Probability and magnitude scales used in Riley Risk Ladder interviews and group workshop







Appendix E: One-page (front and back) overview of preliminary results sent to participants at the completion of interviews

How Risky is Michigan Aquaculture?

From June 2017-June 2018, PhD Candidate Betsy Riley traveled across Michigan to talk to Michiganders about the potential goods and bads of Michigan aquaculture. Her interviews focused on groups who would be most affected by aquaculture expansion in the state.

Why Did You Do This Research?

The question of whether Michigan should pursue an expanded aquaculture industry has been ongoing for years. A great deal of science has been done, but people understand that science differently. The purpose of the research was to determine how individuals understood risk, and whether various groups understood aquaculture risks differently.

What Did You Ask?

Using existing information from the news and group websites, we filtered out ten potential problems that stakeholders worried about if aquaculture were to expand. We also identified ten potential benefits that could come with an expanded industry. Betsy then asked participants to think about each item from two dimensions: how likely each item was to happen if aquaculture expands in Michigan, and how good or bad it would be for Michigan if each item did happen. These two scores were multiplied together to get the results you see on the back of this page.

Who Did You Talk To?

Using currently available information, we identified eight stakeholder groups that we thought would be most affected by an expanded aquaculture industry. The full list is at the top of the table on the back of this page.

Who Was Right?

There are no right or wrong responses to these questions, since the actual costs and benefits of aquaculture in Michigan are likely impossible to fully calculate. Instead, we asked people what was most important or pressing to them, as a way of focusing the conversation.

Questions or Comments? You can email me at bril@msu.edu. Research is IRB #i053833

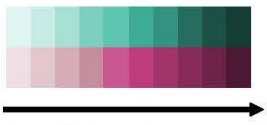
What Did We Find?

This table shows how each benefit and cost is ranked by each of the different stakeholder groups. It can be read this way:

The number beside the stakeholder group name shows how many interviews were conducted with members of that group. Many people belong to more than one group. The information here can be thought of as, "if you identify with a category, how does that aspect of your life shape your perception of these costs and benefits?"

Benefit Rankings

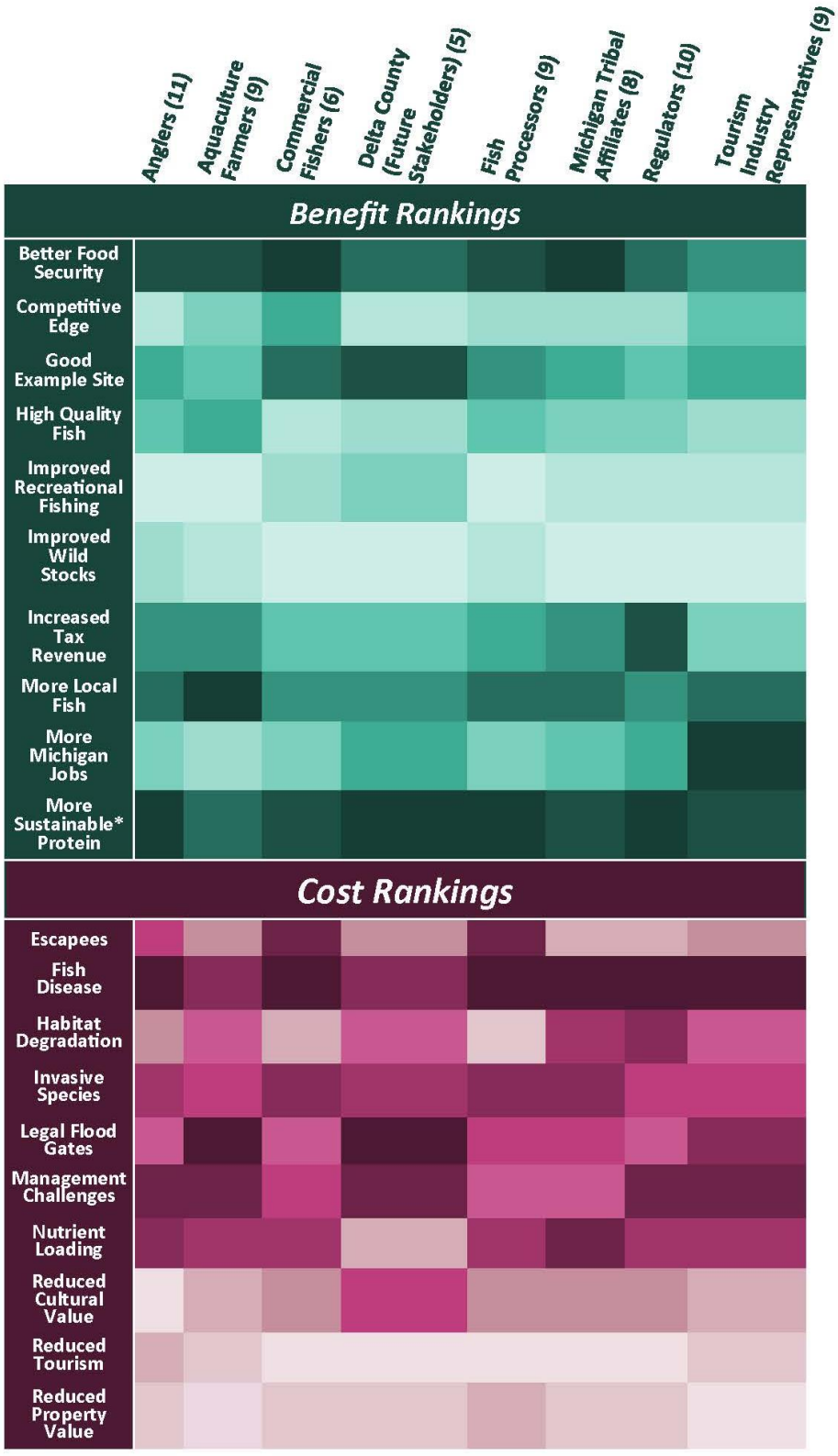
More likely to happen and better for Michigan



More likely to happen and worse for Michigan

Cost Rankings

*"Sustainability" was not defined in the research question. Each respondent interpreted "sustainability" in their own way.



Questions or Comments? You can email me at bril@msu.edu. Research is IRB #i053833

Appendix F: 25-page report sent to regulators with responses to co-developed research questions

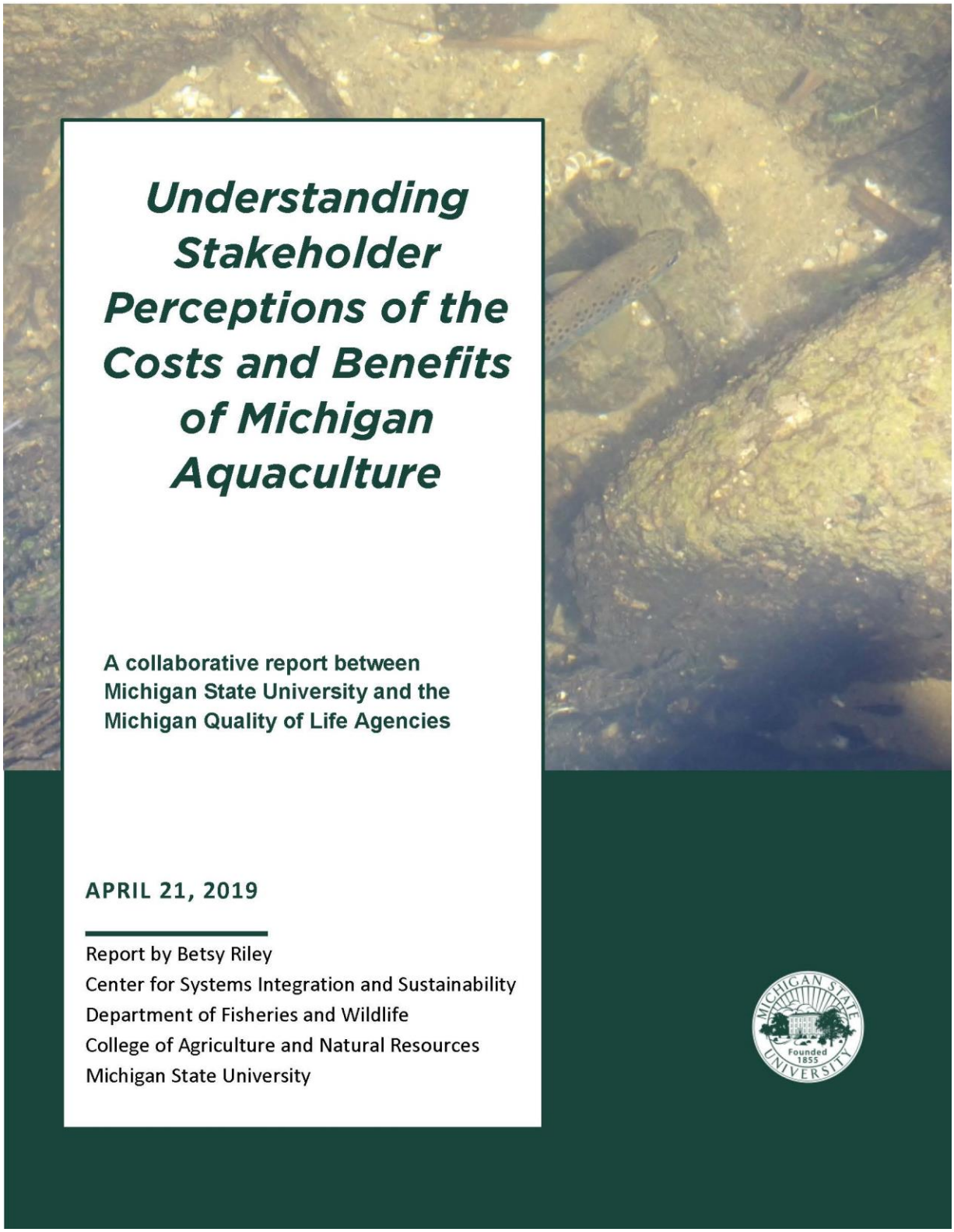


Table of Contents

This report was completed as part of the community engagement portion of Betsy Riley's dissertation research, for the completion of her PhD from Michigan State University Department of Fisheries and Wildlife. It will be included as an appendix in the applicable dissertation chapter, and will also be shown as part of her Portfolio Project for the Graduate Certification in Community Engagement. It is otherwise intended only for her research partners in the Michigan Quality of Life agencies and may be used by them as they deem useful.

Acknowledgements

I would like to thank my advisors, Drs. Heather Triezenberg and William W. Taylor and my committee members, Drs. Diane Doberneck and Dana Infante, and Mark Rey. I'd like to express my deep appreciation for the Michigan State University Graduate Certification in Community Engagement program, including Dr. Doberneck, for their incredible work helping me understand community engagement and improve my skills as a community engagement scholar. Thank you to the MSU Fisheries and Wildlife Department for the funding to complete the program, as well as MSU Extension for providing the materials and software I needed to complete my work. Thank you to Michigan State University for my University Distinguished Fellowship award.

I would like to thank my research participants for giving me their time and attention for what sometimes turned into very long interviews! I'd also like to thank them for the trust that they put in me by offering me their honest assessment of where we stand with Michigan aquaculture and their hopes for the future. Through this report and, hopefully, future community engagement efforts, I hope to retain that trust.

I would also like to thank my community partners at the Michigan Quality of Life agencies who took the time to come up with these research questions. My interviews were long. I collected a lot of data. But you took the time sit down with me, understand my research, and come up with some research questions that we could explore together. I hope this report is useful.

Background

Where did this report come from?

From June 2017-June 2018, Betsy Riley, a University Distinguished Fellow and PhD candidate at Michigan State University, traveled across the state of Michigan collecting interviews as part of her dissertation work (MSU IRB #i053833, approved 3/29/2017). She completed 39 interviews with aquaculture stakeholders ranging from members of the angling tourism industry, to aquaculture farmers, to commercial fishers and more.

Once the interviews were collected, Riley created a one-page overview of her preliminary results. She identified leadership among the different stakeholder groups that she spoke to and sent them this one-page overview along with an invitation: Are you interested in learning more? This report is a response to that invitation by the Michigan Quality of Life agencies.

What does the interview data look like?

Interview Method

Interviews included asking participants to rank their perceptions of ten potential aquaculture costs and ten potential benefits according to probability (how likely the event was to happen) and magnitude (how good/bad it would be if the event did happen). This created a database which could be analyzed quantitatively. In addition, participants were asked to discuss why they ranked in the way that they did. This created qualitative interview data which could help explain why participants ranked the way they did. Data were coded using thematic analysis to identify how often certain topics came up per interviewee, which could then be extrapolated to the larger stakeholder group(s) they belonged to.

Who was interviewed?

Interviewees were chosen according to their membership among certain stakeholder groups which Riley, in collaboration with her committee and other recognized aquaculture experts through Michigan State University, identified as having a stake in the future of Michigan aquaculture. The groups were as follows:

Anglers

Angling organizations have played a large role in Michigan to shape the conversation around aquaculture. This group is currently using the lake and stream resources which have the potential to be impacted by Michigan aquaculture. Interviewees from this group were split across two categories: those who are members of angling organizations, and those who go fishing at least once a week (some interviewees belonged to both groups).

Aquaculture Farmers

Aquaculture farmers have the highest potential to be affected by changes in aquaculture policy, both through because policy affects own efforts to farm fish and by the potential for increased competition if new policies support expansion of the industry in the state. However, discussions with local experts revealed there to be fewer than five practicing aquaculture farmers in Michigan operating at a large, commercial scale for food consumption. In order to protect the privacy of interviewees, all stakeholder groups required a minimum of five interviews so that responses cannot be linked to the interviewee. For this reason, interviews were conducted with farmers who were currently farming, and those who had previously farmed and who maintained their facilities so could resume under appropriate circumstances.

Commercial Fishers

Commercial fishers could be affected by an expanded aquaculture industry both through an increase in the supply of fish that such an expansion would mean, as well as potential environmental impacts that many fear an expanded industry could mean.

Delta County Residents

This group was included due to the need for a stakeholder group that could represent those who might benefit economically from an expanded industry. Delta County was chosen because it had a higher than average percentage of licensed aquaculture farmers. In addition, a recent plan for aquaculture expansion would have permitted the creation of an offshore facility in Delta County had offshore facilities been allowed. While this research did not focus on offshore aquaculture, there was a higher than normal likelihood that residents of this county had given critical thought to the issue of aquaculture in their county and

the affects it could have on them. Any individual who belonged to another group, but that resided in Delta County, MI, was included in this group. In addition, efforts were made to involve members of economic development organizations who had been involved with the cancelled offshore aquaculture proposal.

Fish Wholesale Distributors and Processors

Interviews with fish wholesale distributors were conducted because this group had the potential to benefit from an increase in the supply of fish that would come with an expanded aquaculture industry. Unlike other types of Michigan industries, fish wholesale distributors would see an increase in business just by increasing the number of fish they work with, regardless of where the fish came from.

Michigan Tribal Affiliates

Michigan tribes are regularly brought up in the aquaculture controversy. Due to their treaty rights, tribes may have the legal ability to pursue aquaculture separate from the state's overall aquaculture policy. Tribes were contacted directly to see if they were interested in participating (one tribe agreed). Otherwise, members of other groups were asked if they were affiliated with a tribe and, if so, were included in this group (n=2). While some tribal affiliates were also tribal members, some interviewees in this category worked for a tribe, but were not tribal members themselves.

Regulators

Regulators have been deeply involved in the aquaculture debate, particularly those in the Michigan Quality of Life departments (the Michigan Departments of Natural Resources, Environmental Quality, and Agriculture and Rural Development). This group more than any other group, has to listen to and think about the costs and benefits of an expanded industry because they have to make decisions regarding the best interests of those they serve. Included in this group were individuals who worked at the state, local, or tribal level and who had specific decision making or regulatory power over aquaculture decisions.

Tourism Industry Representatives

There has been a great deal of discussion that the aesthetic or environmental impacts of an expanded aquaculture industry will negatively impact the angling tourism industry across the state. Members of this group included fishing lodges

and fly shops, as well as others whose business depends on angling tourism. An effort was made to include only those tourism industry members whose products or services were related to angling specifically, and not other aspects of the tourism industry.

What questions were asked?

20 total cards were placed before participants representing ten benefits and ten costs commonly associated with the potential expansion of the Michigan aquaculture industry. Each card contained a header and a full explanation, as described below. Each of these cards were ranked on separate scales indicating a participant's perception of the probability (likelihood) and magnitude (how good or bad the card might be to Michigan) of each card with regards to an expanded Michigan aquaculture industry. Participants were asked to consider the question under a current Michigan scenario, with all current and potential regulations and natural resources, rather than best or worst case scenarios.

Benefit Cards

The following benefits were discussed and ranked during the interview. The list below describes the content on the cards, including the description:

Better Food Security
Michigan's food security will be improved due to producing more farmed fish here, and we won't have to import as many fish.

Competitive Edge
One Great Lake's state, province, or tribe will make decisions about aquaculture before others decide, giving them a competitive edge in the future industry.

Good Example Site
If one aquaculture facility is allowed to be built beyond what is currently allowed, regulators will see that aquaculture can be safely pursued and other facilities will soon be permitted.

High Quality Fish

Fish frown in aquaculture facilities will be fresher and of higher quality than wild fish because farmers raise them for quality and get them more quickly to stores.

Improved Recreational Fishing
Aquaculture facilities improve recreational fishing opportunities around them, as nutrients that leave these systems help to build (or rebuild) ecosystems which are currently nutrient poor.

Improved Wild Stocks
Producing farmed fish to meet the ever-increasing human demand for more seafood will take pressure off wild fish populations and allow them to rebuild.

Increased Tax Revenue
The presence of new aquaculture businesses will lead to more taxes going to local governments for municipal services.

More Local Fish
More aquaculture facilities in Michigan means more fish will be produced locally and made available to those interested in eating locally produced food.

More Michigan Jobs
Aquaculture facilities will bring aquaculture jobs to Michigan in production and processing.

More Sustainable Protein
Aquaculture seafood can be produced with a smaller environmental footprint than other types of meat production, so it will be possible to feed more people more sustainably.

Cost Cards

The following costs were discussed and ranked during the interview. The list below describes the content on the cards, including the description:

Escapees
Aquaculture fish will escape from facilities and breed in the wild, outcompeting wild fish or causing contamination of wild genetic lines that make the next generation of wild fish unable to survive.

Fish Disease
Diseases will move from aquaculture fish to wild fish, hurting the health of wild fish.

Habitat Degradation
Habitat for Great Lakes fish and wildlife will be degraded due to the construction and operation of aquaculture facilities, including more human traffic in these areas.

Invasive Species
Invasive species will be released from aquaculture facilities, either through the farmed fish escaping or though aquatic hitchhikers.

Local Flood Gates
Allowing one private aquaculture facility in public waters will open the flood gates to more facilities, beyond the ability of regulators to protect the environment.

Management Challenges
One Great Lakes state, province, or tribe will make decisions about aquaculture without the consent of the others, which will hurt shared management of the resource.

Nutrient Loading
Nutrients will leave aquaculture systems and enter the natural environment, increasing the risk of algal blooms and eutrophication.

Reduced Cultural Value

Even if they have no environmental impacts, aquaculture facilities will negatively impact culturally important lakes and streams because these facilities are industrial buildings in naturally wild locations.

Reduced Property Value
Aquaculture facilities are ugly and people will not want to look at them, which could result in a drop in nearby property values.

Reduced Tourism
The negative aesthetic and environmental consequences of aquaculture facilities will result in fewer tourists coming to Michigan.

What is in this report?

After the preliminary data was distributed, Riley was invited to lead a discussion with members of the Michigan Quality of Life agencies who work with Michigan aquaculture. This group was self-selected. At this group discussion, participants went through the interview again as a group, then discussed what questions came to mind. Three research questions were ultimately determined, which Riley was asked to analyze further. These questions are:

1.) Is there an updated version of that one-page overview?

2.) How did stakeholders rank the magnitude of the potential aquaculture benefits?

3.) Were there differences within the angler group in how potential costs and benefits were percieved?

This report discusses each of these questions in turn using the available interview data.

An Updated Overview

Since the first one-page overview, containing preliminary data, was sent out, a few changes have been made to how group membership is determined. The following differences exist between the original one-page and the overview in this report:

- The “processors” group has been removed. It was determined that many participants who identified as a processor processed only their own fish. This defied the original intent of the category, which was to identify individuals for whom more fish on the market generally would be welcome.

- A “wholesaler” category has been added in order to capture the idea behind the original “processor” group. This group includes business representatives who have a monetary incentive to want more Michigan fish on the market, regardless of where the fish came from. These interviews were collected at the same time as the other interviews when an opportunity presented itself. However, several interview results were left out of the original one-page because these interviewees did not fit into the previous categories.

- The “tourism representative” category has been refined to include only those individuals who worked exclusively in the recreational fishing industry, rather than allowing participants to self-identify as being part of the tourism industry.

- The “angler” category has been split between those who belong to an angling organization and those who fish at least once a week. There are unique individuals in each category, as well as some participants who belong to both categories.

- The original version of the one-page overview contained only color variations and did not include the numerical representations.

- This version of the one-page uses shading to show rankings among all groups, rather than within-group rankings.

Figure 1: An updated version of the one-page overview of results

What Did We Find?

This table shows how each benefit and cost is ranked by each of the different stakeholder groups. The number beside the stake-holder group name shows how many interviews were conducted with members of that group. Many people belong to more than one group. The information here can be interpreted as, "if you identify with a category, how does that aspect of your life shape your perception of these costs and benefits?"

Benefit Rankings

More likely to happen and be better for Michigan

More likely to happen and be worse for Michigan

Cost Rankings

*"Sustainability" was not defined in the research question. Each respondent interpreted "sustainability" in their own way.

	Angling organization (7)	Weekly Angling (15)	Aquaculture Farmers (9)	Commercial Fishers (6)	Delta County Representatives (5)	Fish Wholesalers (5)	Michigan Tribal Affiliates (8)	Regulators (11)	Tourism Industry Representatives (7)
Benefit Rankings									
Better Food Security	.09	.50	.80	.42	.73	.82	.52	.48	.21
Competitive Edge	.25	.35	.40	.24	.36	.25	.14	.25	.48
Good Example Site	.24	.41	.51	.36	.77	.55	.33	.38	.37
High Quality Fish	.07	.31	.52	.07	.37	.65	.26	.26	.19
Improved Recreational Fishing	.02	.16	.28	.08	.39	.25	.14	.13	.15
Improved Wild Stocks	.11	.28	.37	.01	.22	.49	.05	.13	.14
Increased Tax Revenue	.20	.33	.61	.18	.43	.66	.38	.45	.25
More Local Fish	.22	.42	.80	.24	.66	.80	.40	.46	.27
More Michigan Jobs	.20	.27	.38	.17	.49	.36	.26	.42	.55
More Sustainable* Protein	.25	.57	.72	.38	.77	.90	.44	.54	.47
Cost Rankings									
Escapees	.37	.09	.07	.80	.01	.14	.18	.10	.44
Fish Disease	.61	.26	.22	.80	.22	.19	.33	.28	.68
Habitat Degradation	.47	.16	.08	.28	.03	.13	.24	.20	.60
Invasive Species	.50	.16	.09	.75	.08	.14	.29	.20	.52
Legal Flood Gates	.30	.19	.33	.51	.46	.13	.24	.12	.57
Management Challenges	.49	.31	.31	.52	.38	.20	.23	.21	.53
Nutrient Loading	.64	.25	.10	.61	.00	.28	.29	.19	.70
Reduced Cultural Value	.23	.06	.06	.48	.04	.03	.21	.10	.25
Reduced Tourism	.29	.07	.01	.04	.00	.03	.02	.08	.21
Reduced Property Value	.23	.06	.01	.26	.00	.08	.021	.09	.15

Updated February 2019

The Magnitude of Benefits

Regulators were interested in knowing how groups overall ranked the magnitude of benefits, or how good stakeholders thought it would be for Michigan if each of the different benefit cards were to happen. In particular, they were interested in comparing their own rankings at the group meeting with other groups. See the "Benefit Cards" section on pages 8-10 of this report for the full description of each card. For a full description of what individuals were included in the stakeholder groups, see the "Who was Interviewed" section on pages 4-8 of this report.

Magnitude Rankings

Table 1 shows the average magnitude rankings of each stakeholder group for each card, as well as the final rankings decided on by the regulators during the group meeting. In addition, the table has been shaded according to the same convention as the one-page, with darker coloration indicating higher average rankings. Shading has been determined using all stakeholders, all cards, rather than ranking within stakeholder groups.

Stakeholders may belong to more than one stakeholder group. The results should be interpreted as how belonging to a certain group can influence perception of risk.

A regression was run on all of the interviewed groups to determine whether the differences shown in Table 1 are statistically significant. All findings of significance are indicated in the table with their p-values marked. The regulator group scores were not included in the regression due to large differences in data collection methods from the interview data. However, it is possible to make some observations.

Table 1: Average magnitude rankings by stakeholder group.

	Angling Organization Members	Weekly Anglers	Aquaculture Farmers	Commercial Fishers	Delta County Residents	Fish Wholesalers	Tribal Affiliates	Regulators (Individual Interviews)	Tourism Industry Representatives	Regulators (Group)
Better Food Security	0.22 (*p=0.003*)	0.62	0.91	0.53	0.91	0.89	0.61	0.55	0.39	0.35
Competitive Edge	0.38 (*p=0.086*)	0.50	0.55	0.39	0.74	0.54	0.31	0.43	0.62	0.05
Good Example Site	0.43 (*p=0.090*)	0.57	0.68	0.46	0.79	0.72	0.40	0.45	0.61	0.15
High Quality Fish	0.23 (*p=0.029*)	0.47	0.73	0.45	0.66	0.83	0.44	0.48	0.52	0.35
Improved Recreational Fishing	0.08 (*p=0.088*)	0.30	0.51	0.30	0.52	0.42	0.23	0.24	0.22	0.05
Improved Wild Stocks	0.30	0.44	0.75	0.18	0.76	0.67	0.35	0.40	0.41	0.13
Increased Tax Revenue	0.41	0.47	0.71	0.47	0.43	0.73	0.42	0.46	0.49	0.05
More Local Fish	0.38 (*p=0.074*)	0.54	0.87	0.34 (*p=0.016*)	0.74	0.85	0.50 (*p=0.089*)	0.55	0.46	0.35
More Michigan Jobs	0.23 (*p=0.046*)	0.33	0.49	0.49	0.53	0.44	0.28 (*p=0.052*)	0.42	0.52	0.05
More Sustainable Protein	0.42 (*p=0.004*)	0.71	0.90	0.57	0.93	0.92	0.58 (*p=0.020*)	0.71	0.57	0.55

The results show that overall, the regulators in the group meeting ranked each of the different benefit magnitude cards as lower than most other groups and is the lowest ranked value for 8 out of 10 cards. For some cards, specifically "Competitive Edge," "Good Example Site," "Improved Recreational Fishing," "More Local Fish," and "More Michigan Jobs," group regulator scores are lower than values from other groups which were rated as significantly lower than other stakeholder group scores.

Angler Opinions:
Organization Members vs. Weekly Anglers

Finally, regulators from the Quality of Life agencies were interested in determining if differences exist within the angler group as a whole. This section explores that question using both quantitative and qualitative data.

When the interview data were collected, participants were asked whether they self-identified as anglers and if they did, how often they fished. In addition, they were asked if they belonged to any angling organizations. Any participant who 1.) belonged to an angling organization and/or 2.) fished at least once a week was placed into the angling category, for a total of 17 angler interviews. 2 participants reported being part of an angling organization without being regular fishers.

However, early data analysis found relatively limited significant results, a surprising finding considering anglers have been one of the most vocal stakeholder groups in the Michigan aquaculture debate. The measures of significance that were found were not what could have been predicted based on pre-dissertation research and media commentary. Were anglers really so different than we imagined?

The question arose as to whether differences in opinion might exist between anglers that were part of an angling organization versus those who fished regularly. Subsequent data analysis determined that, indeed, this difference does exist, and that members of angling organizations hold perceptions around the costs and benefits of aquaculture which are much closer to their publicized statements than anglers who do not belong to an angling organization.

Benefit Cards

For every card and on all measures of probability, magnitude, and overall risk, members of angling organizations rated the benefits lower on average compared to those anglers who reported fishing at least once a week. Measures of significance (indicated through p-values in parentheses) are calculated using a full

regression with all stakeholder categories; however, only the results for anglers are shown here. Lower p-values indicate a stronger likelihood that the difference exists.

See the "Benefit Cards" section on pages 8-10 of this report for the full description of each card. For a full description of what individuals were included in the stakeholder groups, see the "Who was Interviewed" section on pages 4-8 of this report.

Table 2: Comparison between members of angling organizations and anglers who report fishing at least once a week, on questions of Michigan aquaculture benefits.

	Probability		**Magnitude**		**Overall Risk**	
	Angling Organization	Weekly Anglers	Angling Organization	Weekly Anglers	Angling Organization	Weekly Anglers
Better Food Security	0.38	0.69	0.22 (*p=0.003*)	0.62	0.09 (*p=0.060*)	0.50
Competitive Edge	0.61	0.68	0.38 (*p=0.086*)	0.5	0.25 (*p=0.064*)	0.35
Good Example Site	0.54	0.66	0.43 (*p=0.090*)	0.57	0.24	0.41
High Quality Fish	0.24	0.44	0.23 (*p=0.029*)	0.47	0.07	0.31
Improved Recreational Fishing	0.19 (*p=0.057*)	0.34	0.08 (*p=0.088*)	0.3	0.02	0.16
Improved Wild Stocks	0.30 (*p=0.058*)	0.45	0.30	0.44	0.11 (*p=0.090*)	0.28 (*p=0.048*)
Increased Tax Revenue	0.51	0.67	0.41	0.47	0.20	0.33
More Local Fish	0.59	0.69	0.38 (*p=0.074*)	0.54	0.22 (*p=0.074*)	0.42 (*p=0.083*)
More Michigan Jobs	0.56	0.74	0.23 (*p=0.046*)	0.33	0.20	0.27
More Sustainable Protein	0.44 (*p=0.002*)	0.72	0.42 (*p=0.004*)	0.71	0.25 (*p=0.003*)	0.57

For all aspects of the benefit cards, weekly anglers tracked closely with other groups, only approaching or reaching significance for their overall risk scores of "Improved Wild Stocks and "More Local Fish."

In contrast, members of angling organizations were significantly different by some measure on almost every benefit (the exception being "Increased Tax Revenue"). The primary differences in their perception of risk was in terms of the magnitude of benefits, which they rated consistently lower than other groups to a significant degree (see the breakdown of benefit magnitude responses in the previous section).

For three cards, members of angling organizations ranked the benefits to be less probable than other groups considered them. These groups are "Improved Recreational Fishing," "Improved Wild Stocks," and "More Sustainable Protein."

Cost cards

For potential aquaculture costs, members of angling organizations on average consistently ranked the probability, magnitude, and overall risk of potential Michigan aquaculture costs as higher than weekly anglers for all cards. Measures of significance (indicated through p-values in parentheses) are calculated using a full regression with all stakeholder categories; however, only the results for the two angler categories are shown in Table 3.

See the "Cost Cards" section on pages 10-11 of this report for the full description of each card. For a full description of what individuals were included in the stakeholder groups, see the "Who was Interviewed" section on pages 4-8 of this report.

Table 3: Comparison between members of angling organizations and anglers who report fishing at least once a week, on questions of Michigan aquaculture costs.

	Probability		Magnitude		Overall Risk	
	Angling Organization	Weekly Anglers	Angling Organization	Weekly Anglers	Angling Organization	Weekly Anglers
Escapees	0.53	0.42	0.56	0.23 (*p=0.001*)	0.37	0.09 (*p<0.001*)
Fish Disease	0.69	0.40 (*p=0.008*)	0.77	0.59	0.61	0.26 (*p=0.001*)
Habitat Degradation	0.81 (*p=0.019*)	0.48	0.63 (*p=0.099*)	0.29 (*p=0.009*)	0.47	0.16 (*p=0.022*)
Invasive Species	0.64 (*p=0.025*)	0.32 (*p=0.047*)	0.69	0.49 (*p=0.086*)	0.50 (*p=0.009*)	0.16 (*p=0.004*)
Legal Flood Gates	0.71	0.48	0.41	0.32 (*p=0.051*)	0.30	0.19 (*p=0.012*)
Management Challenges	0.76	0.72	0.59	0.37	0.49	0.31
Nutrient Loading	0.86	0.60	0.72 (*p=0.034*)	0.38 (*p=0.021*)	0.64 (*p=0.002*)	0.25 (*p=0.010*)
Reduced Cultural Value	0.42	0.31	0.39 (*p=0.016*)	0.14 (*p=0.007*)	0.23 (*p=0.040*)	0.06 (*p=0.050*)
Reduced Tourism	0.49 (*p=0.016*)	0.19	0.5 (*p=0.005*)	0.15 (*p=0.006*)	0.29 (*p<0.001*)	0.07 (*p=0.061*)
Reduced Property Value	0.49	0.20 (*p=0.100*)	0.41 (*p=0.026*)	0.14 (*p=0.057*)	0.23 (*p=0.046*)	0.06

Qualitative Results

The quantitative results above show how belonging to a stakeholder group can influence your perception of the costs and benefits of expanding the Michigan aquaculture industry. This section explores what sort of topics came up in interviews with participants.

In addition to placing the cards on the scales to obtain the quantitative results in the previous sections, Riley also took interview notes during her conversations with participants to determine why they made the ranking choices that they did. These interview notes were taken by hand, typed up, and then mailed or emailed back to participants to fact check and approve.

Once the interview notes were finalized, the thematic analysis was used for coding the interview data, a process which involved going through each interview and identifying common themes which resulted in a total of 147 unique codes. These codes were then further sorted into 16 broader themes (Table 4).

Table 4: The sixteen codes developed for the qualitative interview data based on thematic analysis.

Theme	Explanation
Business Revenue and Costs	Factors which can influence the viability of an aquaculture farm as a business, including taxes (as they relate to business expenses), government subsidies, crime, usefulness of byproducts, water access, and general comments on the feasibility of Michigan aquaculture farms. NOT larger economic drivers like supply and demand.
Competitive Marketplace	A competitive economic marketplace, including competition between aquaculture farmers, with other fish producers, other industries, and comparisons between political jurisdictions.
Aquatic Environment	References to the water itself and aquatic habitat--water quality (contamination, nutrient load), water quantity, water sourcing, use, etc.
Facility	References to the types of facilities, specific characteristics of facilities, facility best practices, and specific current facilities in operation. NOT siting/location (which are their own category).
Fish (Live)	Discussion of live fish themselves, including the value of certain species versus others, certification or vetting of fish, fish diet, naturalized/native/hybrid/invasive/ stocked fish, and fish genetics.
Industry Logistics	References to the existing or planned Michigan aquaculture industry, including the size of the industry, waste disposal practices, what sort of species might be raised, the industry's political struggles, beliefs around interest in entering the industry, and beliefs around proper training and expertise needed by fish farmers and overall best practices. NOT siting or facility types (which are their own categories)

Information	Discussion of past or ongoing scientific research (information collection), a need for more or better information, or instances in which past access to information may have resulted in better (or more expected) outcomes. Also includes references to past experience being used to inform current opinions.
Economic Market	Instances in which the larger economic drivers of aquaculture (as food) are discussed, such as supply and demand (where fish come from and where they go, as well as quantity), pricing, markets, and consumer preference.
Michigan Effects	Discussion of local, regional, or statewide concerns specific to Michiganders. This includes Michigan job creation, local availability of products, the spread of money through the economy (including discussion of how to use taxes raised through aquaculture), and non-market values derived from Michigan wild places.
Aquatic Organisms	Non-fish organisms (fish are their own category) which live in aquatic ecosystems, including invasive species, plants, and disease.
Politics	References to political theories and/or speculations, including perceptions of litigation, public vs. private water use, and the motivations of political leaders and regulators in their decision making. NOT references to specific regulations or regulatory needs (their own category below).
Fish Product	Discussion of fish (wild or farmed) as a product to be consumed, including qualities of the product such as taste, its healthy qualities (benefits, protein, & contamination), freshness (speed to market), and overall quality, but also details of the product's life cycle including distribution, shelf life, product consistency, and product seasonality.
Regulations	Instances in which regulations are discussed--existing regulations, needed regulations, how regulations are implemented, how regulations change across jurisdictions, etc.
Site	Suggestions that participants had regarding characteristics of the site selected, including discussion of the surrounding area or region, the cultural significance of a location, the perception of a site, hydrological requirements, etc.
Social	Aspects of risk which are purely social in nature, including opinions around aesthetics, cultural norms, ethics around society and stewardship, etc.
Tourism	A discussion of tourism in Michigan--existing, different types, the effects of certain actions on tourism, etc.

Please note that the final process of categorizing interview notes is still in progress and this section is preliminary. The next step in this process is to share the above codebook (Table 4) with another researcher to check for consistency in coding. The final results may use slight variations in these descriptions.

Angler data (n = 17) was than separated from the rest of the data and divided into two groups: 1.) members of an angling organization (regardless of angling activity) (n = 7), and 2.) participants who report fishing at least once a week and are not members of an angling organization (n = 10). A count was performed to determine how many participants in each group discussed a particular topic ("Participants" in Table 5), how many times these participants referenced that topic ("References" in Table 5), and what the average number of references were per participant, in order to account for unequal group sizes. The top three and bottom three topics were identified.

Table 5: Total number of participants who discussed a topic including, the number of times referenced, and average number of references, divided by group membership

	Members of Angling Organizations (n = 7)			**Anglers Who Fish At Least Weekly & Are Not Organization Members (n = 10)**		
Code	*Participants*	*References*	*Avg. Ref*	*Participants*	*References*	*Avg. Ref*
Aquatic Environment	7	25	**3.57**	9	53	5.30
Aquatic Organisms	5	16	2.29	10	39	3.90
Business Revenue & Costs	6	12	**1.71**	10	36	3.60
Competitive Marketplace	5	15	2.14	9	31	**3.10**
Economic Market	7	20	2.86	10	49	4.90
Facility	5	20	2.86	10	56	**5.60**
Fish (Live)	6	19	2.71	10	48	4.80
Fish Product	5	12	**1.71**	10	35	**3.50**
Human-Environment Interaction	6	14	2.00	10	43	4.30
Industry Logistics	7	21	3.00	10	56	**5.60**
Information	5	11	**1.57**	9	39	3.90
Michigan Effects	7	37	**5.29**	10	48	4.80
Politics	6	18	2.57	9	21	**2.10**
Regulations	7	23	3.29	10	68	**6.80**
Site	5	16	2.29	9	37	3.70
Social	6	30	**4.29**	10	58	**5.80**
Tourism	6	20	2.86	10	36	3.60

Table 5: Colors indicate the top three (green) and bottom three (red) topics discussed, on average, by group participants.

The results show similarities and differences in topics discussed based on membership. Some similarities include the presence of the "Fish Product" topic, or talking about fish as food, was ranked low for both groups. In addition, both groups ranked high with the "Social" topic, discussing things such as cultural norms or the ethics around an aquaculture expansion at least 4 times on average for each group. The groups differed, however, in which topic they discussed most often and which they discussed the least often.

Organization Members Most Common Topic: The Effects on Michigan

Angling organization members on average discussed their perception of the effects that Michigan aquaculture would have on Michigan more than any other category, an average of 5 times per interview. Within this category, the most often discussed topic was "Local" (mentioned 22 times across the 7 interviews) in which participants discussed their perceptions around the possibility of Michigan aquaculture having an effect on Michigan residents. The responses were 59% negative (beliefs that aquaculture would cause harm to local areas) and 27% positive (beliefs that aquaculture would help local areas). The remaining 14% were neutral responses.

Of the topics discussed, the availability of local fish was brought up in 59% of instances, followed by discussions of local taxes and the effects on the local tourism economy, both discussed in 18% of the references, respectively. The remaining 5% (n=1) was the effects on local property values. Below are representative examples of participant feelings on these topics.

Example Negative Responses

"They may have a better market in Jordan than Michigan and that's where the fish will go. At the state level, this card is highly optimistic."

"It [taxes] will never get to local government. The money will stay at the state level."

"This is almost a certainty. Like the Au Sable. It will reduce fisheries and angler trips up the river, and it will decrease the local economy. Anglers have choices—they could go all over the country and they'll choose to go to better fishing places."

Example Positive Responses

"They would definitely help small communities."

"This is a no brainer. Even though it's artificial, once it's established, we can raise the food here."

"Eating locally produced food could benefit small tourist communities. If people come here to eat it, it becomes part of the local culture. Especially with closed systems operations, like tilapia where they also sell the waste—that has potential."

Example Neutral Responses

"It depends on their [local communities'] tax situation, tax code, and local tax incentives whether local taxes will improve."

"Even those who can afford it—it's nice to buy it, but is it doing all that much for Michigan?"

Weekly Anglers Most Common Topic: Regulations

Weekly anglers on average discussed their perception of Michigan aquaculture regulations more than any other category, an average of almost 7 times per interview. Within this category, the most often discussed topic was "Government Hatcheries," mentioned 13 times across the 10 interviews. The responses were 46% negative (beliefs that hatcheries cause harm) and 38% positive (beliefs that hatcheries help). The remaining 16% were neutral responses.

Of the topics discussed, the management history of hatcheries was discussed in 38% of instances, followed by the role of hatcheries in public outreach in 31% of

instances and the public vs. private aspect of hatcheries as aquaculture facilities in 23% of instances. The remaining 8% (n = 1) was an expression of concern around the ethics of raising fish in a hatchery environment. Below are representative examples of participant feelings on these topics.

Example Negative Responses

"The salmon hatcheries brought in the disease. It was real bad."

"Farmers do a better job than the DNR. The DNR probably wouldn't pay farmers to stock. They have a good job and don't want to give that up. If the DNR paid farmers to stock, the industry would grow twice as fast."

"Hatcheries have always brought disease from farmed to the wild. But they're [hatchery fish] also released on purpose to the wild…Fish [wild and farmed] shouldn't ever meet each other."

Example Positive Responses

"We can limit it with sound policy and regulations dictating technology and sourcing of brood stock and eggs. Hatcheries have this now."

"Most people are attracted to aquaculture facilities. Every facility the state owns has an interpretive center and people come to see them."

"People want to go to fish farms. [They're] a tourist attraction if anything. Even state hatcheries used to let you in."

Example Neutral Responses

"I'm not sure, though, food is as simple as that. In [redacted] hatchery, there's a dietary deficiency that makes the fish grow differently than other fish. So they're fresher, but not higher quality."

"There are not a lot of private fish farms in Michigan…And state hatcheries are run in wild areas. I don't really think it will have a big impact on anything."

Discussion

This section is far from a comprehensive look at all the differences within the angling population, and due to the amount of data collected over the course of my interview work, certain decisions had to be made in how to narrow the results into useable pieces. It is my hope that this report can provide some groundwork for understanding where differences in angling populations might be found. The door remains open to my research partners who may feel as though this overview raises new questions that they are interested in exploring.

Conclusion

The true "risk" of Michigan aquaculture is impossible to calculate due to the enormous range of options around what such an expansion might look like. Nevertheless, policy makers and regulators must make decisions without perfect knowledge, basing these decisions off their best guess of what costs and benefits their decisions might bring. All stakeholders on this topic are faced with a barrage of information which they must sift through and use in combination with their own experiences to make up their minds about whether an aquaculture expansion is something they can support and, if so, what they think such an industry should look like. It is my belief, after sitting down with almost 40 interviewees from all places on the aquaculture spectrum, that each stakeholder group holds their own piece of the full story.

The purpose of this report was to explore the research questions developed in concert with my research partners at the Michigan Quality of Life agencies, using the interview data that I collected as part of my dissertation research exploring the differences in risk perception by stakeholder group around Michigan aquaculture. By answering these three research questions, regulators can glean a greater insight into often overlooked social component in policy discussions by

examining how perception of risk has affected the discussion around Michigan aquaculture. While the data collection portion of this research is over, it is my hope that the conversation is just beginning.

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