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To frack or not to frack: Perceptions of the risks and opportunities of high-volume hydraulic fracturing in the United States

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ABSTRACT

Although proponents praise natural gas as a clean and abundant energy source, the varying impacts and uncertainties surrounding the process of extracting natural gas from unconventional sources, known as horizontal high-volume hydraulic fracturing (HVHF) or "fracking," have raised important concerns. This project explores public perceptions of the risks and beneficial opportunities associated with HVHF as recognized by the residents of two counties in Michigan, USA, one that currently produces natural gas by HVHF and one that does not. Through an analysis of media content related to HVHF in each case study site and interviews with stakeholders in both counties, this comparative study contributes to understanding the similarities in differences in perceptions of risks and opportunities in communities differently impacted by unconventional natural gas development, offering theoretical insight into the shared concerns and divergent perspectives among publics that have different experiences with HVHF, insight that provides new understandings of factors shaping community perceptions and means of improving environmental policy and water governance.

1. Introduction

Developments in high-volume hydraulic fracturing (HVHF) technology allow extraction of natural gas from unconventional sources. Proponents of HVHF argue for increased production of natural gas and praise HVHF as providing access to a clean and abundant energy source, while opponents question the many uncertain impacts to communities and the environment ([16,18,20,29,40,45,57]; see also Refs. [16,29,57,20]). HVHF is expanding so quickly that the long-term impacts to communities and the natural environment are not yet known [28,46,57,20]. While some of the benefits and risks of HVHF have been examined, controversies and misconceptions still exist [7,48,59]. Researchers emphasize the importance of conducting longitudinal studies and comparative studies to better understand perceptions and identify relationships or differences [10,31,48].

Most published work on public perceptions of HVHF in the United States focuses on Pennsylvania, New York, Texas, and Colorado [31,61]. This project identifies and characterizes perceptions of the risks and beneficial opportunities associated with HVHF as recognized by the stakeholders of two counties in the state of Michigan, USA, one that currently produces unconventional natural gas and one that does not (see Fig. 1). Using a comparative approach, this study assesses whether there are differences in the perceptions of the risks and benefits of HVHF associated with the presence of HVHF operations. Through a content analysis popular media sources and interviews with stakeholders, this study examines perceptions of risks and opportunities by comparing two communities that differ in their level of experience with HVHF operations. A grounded theory approach was used to develop and test hypotheses regarding the relationship between perceptions of the risks and opportunities associated with HVHF as expressed in popular media, compared to the perceptions expressed by stakeholders, and how perceptions of the risks and opportunities associated with HVHF differ in communities with differing levels of HVHF activity.

Findings indicate that the most commonly perceived risks among public stakeholders, those associated with impacts on water quantity and quality associated with HVHF, are similar to the risks commonly identified in popular media representations. In contrast, the opportunity for energy security, which is a common benefit expressed in popular media, is not identified by stakeholders as a significant opportunity provided by HVHF. Further, this research demonstrates that there are differences in perceived levels of concern between communities with differing exposure to HVHF; in

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this study, the community without current HVHF activity expressed more concern about the risks and identified fewer benefits of HVHF, suggesting that the presence of HVHF may open the doors to additional wells, as public opposition seems to lessen. However, stakeholders in both communities expressed significant concerns about the lack of public control over HVHF well decisions, indicating an issue of coalescence for community members, a shared concern that mobilizes opposition yet is not clearly articulated in the popular media. Throughout this paper, the term "stakeholder" refers to residents or individuals with involvement, authority, or influence within the county [43]. The term "community" refers to both the geographic (county boundaries) and the relational (professional relationship; e.g. individuals who work inside the county boundaries or individuals involved with organizations inside the county boundaries, but live outside of the county boundary) aspects of each community [36].

It was over a quarter century ago when modern society was identified as being characterized by risk [6]. Yet public perceptions of risk are not entirely shaped by objective or calculative considerations of risk [55,56]; perceptions of risk are shaped emotively, by existing images, associations, and other associated representations [33,34,7]. Perceptions of the risks and benefits associated with new energy technologies typically correlate with opposition of support at the individual and community scale [35]. However, there are multiple and competing perspectives when it comes to theorizing the role of cognition and culture in shaping risk perceptions [51]. In this study, we aim to offer insight into the community level factors that may contribute to collective understandings about the risks and opportunities associated with HVHF by examining communities with differing levels of direct experience with HVHF. We also aim to explore the relationships among risks and opportunities associated with HVHF as presented in scholarship literature, popular media, and stakeholder understandings; demonstrating the points of convergence and disjunction in the perceptions of risk among these sources and between communities offers opportunity for building theoretical knowledge about how to address public concerns about HVHF or how to mobilize communities against this extractive industry.

1.1. Methodology

This project is guided by a grounded theory methodology [13], with the goal of improving conceptual tools for understanding the factors shaping public perceptions of HVHF. This study followed an iterative approach to data collection and analysis, where each stage of research (including a review of existing scholarly literature, a content analysis, and interviews) contributed to further refinement of coding, analysis, and theory development through the collection of additional data. Corbin and Strauss [15] recommend that researchers using a grounded theory approach collect data from any source that will provide useful information or important insight. A variety of data sources were utilized, including academic qualitative and quantitative sources, government sources, and popular media sources. The coding scheme used for the popular media content was developed based on the key findings from the literature review, and the coding framework initially developed for analyzing interview transcriptions was based on the refined codes resulting from the content analysis. Thus, scholarship on the risks and benefits of HVHF was analyzed using an open coding approach; the themes that emerged from this process were used to initially guide analysis of public media content, and as new codes emerged during the coding process of the media content, they were used to analyze interview data. In addition, the content analysis allowed for a comparison across the three data source analyzed: academic literature, popular media content, and interviews. This study aimed to use comparative logic to refine conceptual understandings of how communities with differing levels of exposure to HVHF activities compare in terms of understanding the risks and opportunities associated with HVHF, and to compare perceptions of HVHF as presented in academic scholarship, popular media, and stakeholder discourse.

Corbin and Strauss [60] recommend using theoretical sampling until saturation is reached. This approach guided both the collection of popular media content and interview data. Potential interviewees were identified using theoretical sampling, which focused on finding individuals with the potential to provide new insights or perspectives. The initial interviewees were chosen due to either holding a public position or mention in the analyzed media content. Sampling continued by snowballing until interviewees provided consistent responses. Coding involved organizing the data, identifying the key themes and topics, and aggregating the information, and the coding scheme used in this study evolved in three stages, in response to the literature review, the content analysis, and the interviews, with each stage informing the analysis of the next. The findings presented in tables are reported using percentages to standardize across the different sample sizes.

The content analysis consisted of reviewing 63 popular sources. Sources include national news articles, state news articles, local news articles, letters to the editor, blogs, websites, articles, and reports. The publication dates of these sources range from April 1998 to January 2015. The timeframe of these publications covers dates prior to any HVHF operations in Michigan up to current publications at the time of analysis. The media content included in the analysis was found through Internet keyword searches regarding HVHF in Michigan, and in the two specific counties studied here (Crawford and Barry Counties), specifically searching the counties' local newspapers' websites using key word searches related to HVHF; following up by searching topics or organizations mentioned in articles and on relevant social media group pages; and following links on websites to explore associated media content. The analysis involved categorizing the sources according to their publication type and using the themes identified in the academic literature on public perceptions of HVHF to code the discourse in each article. The analysis was completed before analyzing interviews; contributing to the iterative nature of building a conceptual understanding based on comparative study logic.

This study includes a total of 31 semi-structured interviews, thirteen interviews in Crawford County, sixteen interviews in Barry County, and two interviews with individuals knowledgeable about HVHF across Michigan and in both case study counties. These interviews took place between November 2014 and February 2015. Participants were identified through Internet searches and snowball sampling, and contacted by email or phone. They were informed of the study's purpose and that the interview would be completely confidential. To maintain confidentiality, names have been changed to pseudonyms throughout this paper, and information regarding the specific organization or sometimes the kind of organization each individual represents has to be left out of this presentation of results in order to protect participant confidentiality.

The first set of interviews was with public officials and leaders of both governmental and non-governmental organizations or businesses. The particular organizations, agencies, businesses, and officials were chosen because of their positions as representatives of residents, their role as decision-makers, their involvement in HVHF discussions, and their knowledge about the positive and negative changes that have or may take place in these counties related to HVHF. Participant recruitment continued on through snowball sampling. During interviews, participants were asked about community perceptions by being prompted to think more broadly about their communities rather than just about themselves and specifically asked about perceptions, opinions, and awareness among

Table 1
Awareness levels and opinions of HVHF held by the American public.

Study	Awareness Level	Opinion
[26]	45% were very or somewhat aware of fracking as an issue	–
[49]	29% had heard a lot about it	52% support
	37% had heard a little about it	35% oppose
	37% had heard nothing about it	
[7]	9% had heard a lot about it	58% did not know whether they supported or opposed of HVHF
	38% had heard "a little" or "some" about it	
	35% had heard nothing about it	

residents of their communities. This study reached saturation with a relatively few number of interviews due to respondent redundancies in articulating their perceptions of the risks and benefits associated with HVHF and their discussion of the decision-making process, as described below. The remainder of the paper follows the sequencing of the research process, first discussing HVHF as presented in scholarly work before turning to the specific case study sites and the findings from the content analysis and interviews, finally concluding with a summary of how this research contributes to conceptualizing perceptions of the risks and benefits associated with HVHF in ways that can improve both public outreach regarding extraction and mobilizing public opposition against it.

2. Public perceptions of HVHF

Natural gas supplies 27% of total electricity generation in the United States [64] and 22.5% of total electricity generation globally [27]. Annual production of natural gas has increased greatly since 2000 [23], with predictions that it will triple within a decade. Allowing for such growth is the production of unconventional natural gas (e.g. tight shale, tight sand, and coal bed methane) [23,30,48]. Although many supporters argue that natural gas drilling and production technologies have been utilized since the 1940s, new horizontal drilling methods to obtain unconventional gas have expanded only in the last decade [59]. The process involves techniques that differ from conventional wells, in that the wells typically reach thousands of feet deeper, utilize horizontal drilling methods, use much larger volumes of water,[1] and inject larger amounts of fracture fluid [9,17].

Some expressed benefits of HVHF include an abundant supply of natural gas, lower energy prices, lower carbon dioxide emissions, local economic development, an opportunity for growth for the chemical industry, and new jobs [29,40,59]. The local economic benefits from HVHF are often considered short-term benefits because of the short operation life of many wells. The beginning stage of natural gas production yields high volumes, but production quickly declines, with some wells already complete within 12–18 months of production. Although HVHF brings economic benefits during the production phase, it possibly leaves long-term consequences that offset the benefits [14]. In addition, previous studies indicate that majority of the economic benefits are realized out-of-basin (by the companies), while the majority of long-term environmental and health costs are realized in-basin. The spatial and temporal disparities between in-basin costs and out-of-basin benefits are an important, yet under examined aspect of environmental governance as it relates to hydraulic fracking and community decision-making [47].

Potential risks associated with HVHF include technological complexities and risks of poor operating practices, degradation to the environment, contribution to climate change, displacement of renewable energy sources, social opposition, increased seismicity and earthquakes, uncertainties in predicting profitability, and harms to public health from water pollution, air pollution, and the release of radiation [59]. Small et al. [57] also identify risks to employees during operation of the well pad, effects on public health and ecosystem health, socioeconomic and community effects, and the possibility for cumulative impacts. Furthermore, over 650 of the products used during HVHF are comprised of at least "one or more of 29 chemicals that are (1) known or possible human carcinogens, (2) regulated under the Safe Drinking Water Act for their risks to human health, or (3) listed as hazardous air pollutants under the Clean Air Act" [65]; 1). Noise from trucks, drilling, generators, and other well pad operations can also disturb nearby residents [1]. The industry is associated with a boom and bust cycle, creating rapid socioeconomic changes in a community and involving many social impacts to the residents [52]. The influx of newcomers can change social structure and community identity, which can lead to increased stress, tensions, disagreements, and an overall reduced quality of life [7,52].

The risk of contamination to both groundwater and surface water sources from the flowback water represents another major concern. The flowback water contains high levels of salts, metals, chemicals, organic compounds, and radioactive materials [23,30,50]. In Michigan, approximately 37% of the fracture fluid returns to the surface, where it is temporarily stored in enclosed, steel tanks until disposal through deep well injection. Reports of increase seismic activity from underground injection and worries about the potential migration of gases from flowback water have raised criticism of this disposal method [17,30].

HVHF is exempt from key provisions in several federal laws, including the Safe Drinking Water Act (SDWA), Clean Air Act (CAA), Clean Water Act (CWA), Solid Waste Disposal Act (SWDA), Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Emergency Planning and Community Right to Know Act (EPCRA), and the National Environmental Policy Act (NEPA) [8,24]. These federal exemptions place responsibility to regulate the natural gas industry on states [46]. In Michigan, oil and gas companies are exempt from the State's Water Withdrawal Statute (Part 327). Natural gas companies using HVHF in Michigan do not have to disclose the chemicals used in their fracture fluid until 60 days after the well has been completed [17]. This raises important concerns over how to handle potential spills, illness from contamination, and how to determine what wastewater treatment method should be used [25,65].

States hold the responsibility to regulate the industry, but often lack the capacity to do so. For example, Michigan currently has 30 inspectors responsible to oversee 25,000 active wells [58]. In New York, 31 inspectors were responsible for more than 125,000 wells [62]. The BLM records for 2009–2012 reveal that four of every ten high-priority wells located on public land, half of the wells on public lands in South Dakota, and one out of every six wells on public lands in Pennsylvania went uninspected [66].

The rapid expansion of HVHF makes it difficult to fully understand the potential impacts [46,20]. The current status quo allows for the technology to be employed and assumed safe until proven

[1] Vertical well use approximately 500,000 gallons of water to fracture. Horizontal wells use approximately 2–7 million gallons of water to fracture [9,17,68].

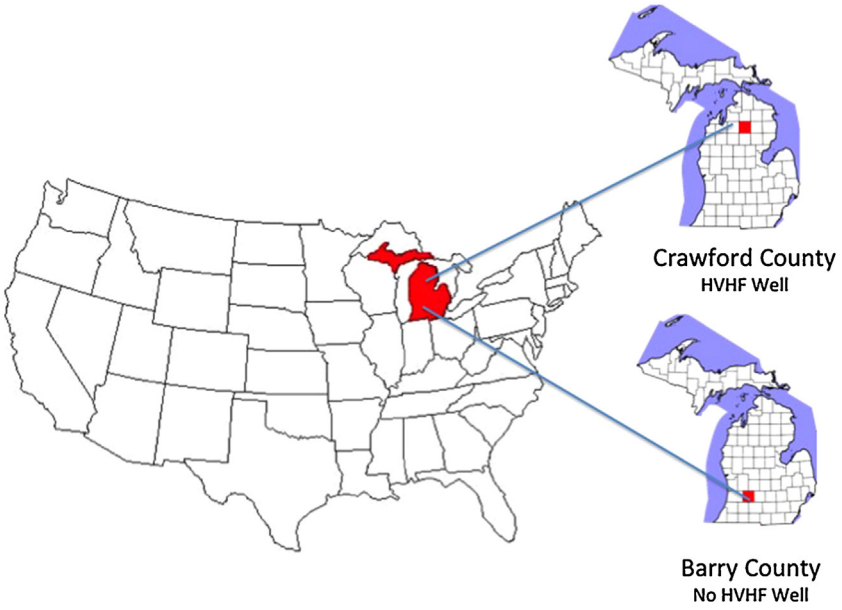

Fig. 1. Map of study counties in Michigan, USA.

otherwise [12]. Freudenburg and Alario [21] argue, "capitalist societies collectively produce wealth that is concentrated in private hands" (p. 150), drawing attention to the unequal distribution of costs and benefits in the American economic system. Those concerned with HVHF argue that the state is placing the interests of the industry before environmental and public health Davis and Hoffer [16]. Adopting the precautionary principle would require proof that HVHF is safe before continuing to employ the technology, thus providing great benefits to communities and ecosystems [12].

HVHF embodies a highly controversial topic, often with very extreme opinions, but how knowledgeable are Americans about it? Table 1 displays the findings from three studies that either polled or surveyed the American public, asking them their awareness level of HVHF and whether they support or oppose HVHF. The studies indicate overall low awareness as well as divided or uncertain opinions about the process. Impacts to water quality and support for tighter regulations were the two most prominently shared responses.

Stakeholder perceptions of the impacts of HVHF fall into three main categories: social, economic, and environmental [31,61]. A public perception survey in New York and Pennsylvania revealed that perceptions differed based on how residents viewed their relationship with the natural environment. Residents who thought of the natural environment in terms of the usable services it provides perceived lower risks from HVHF, whereas residents who believe humans are interconnected with the natural environment perceived higher risks. In responses to the survey, 58% of respondents believed the negative impacts of HVHF can be avoided and only 22% of respondents believed remediation is possible if negative impacts do arise [14].

Another study compared perceptions in two Texas counties, one that has a more established natural gas industry with one that has a less established natural gas industry. Of the 30 items listed in the survey, respondents perceived 24 of them as negative social or environmental impacts. The increase in truck traffic was the most commonly shared negative impact in both counties. Perceptions in the two counties differed regarding other impacts listed in the survey, suggesting that residents in counties with differing levels of natural gas development view potential impacts differently [61].

Research suggests that popular media acts as a main source of information for the public, and thus strongly influences public opinion [16,21]. Industry also plays a role in how the public understands and views HVHF [21,25]. The portrayal of potential risks and benefits may shape the way the residents perceive the risks and benefits [29].

The existing literature on HVHF suggests that the issue is highly contentious, with strongly divisive public perceptions of risks and benefits. It also suggests that issues of energy security and the benefits of domestic energy production, in addition to local economic benefits, may shape positive perceptions of HVHF, while concerns about environmental risks especially to water may be the primary public concern. Further, previous studies demonstrate the need for comparative work examining differences in public perceptions in communities with differing levels of exposure [10,31,48]; this study aims to address that gap in understanding public perceptions of HVHF. Further, the state of Michigan is relatively understudied when it comes to understanding public perceptions of HVHF, yet is a potentially important region for the HVHF industry. Thus, this research also focuses on building conceptual understandings in a developing region for HVHF activity.

3. Case study research sites: Crawford County and Barry County, Michigan

Within the U.S. State of Michigan, Crawford County and Barry County were chosen for this study due to differences in levels of HVHF activity, along with being relatively similar demographically and environmentally. Both counties share histories with extractive industries, but they are distinctly different in that Crawford County has a HVHF well and is located in the region with the most wells, whereas Barry County and it's surrounding counties do not have a HVHF well. All of the interviewees were aware of the well operations in Crawford County. The presence and awareness of HVHF in and around Crawford County and the lack of HVHF but similar awareness of the potential for HVHF in and around Barry County were the factors of interest for comparing these two counties.

The case study counties also share similar characteristics. Both are characterized as rural counties, with fewer persons per square mile than the Michigan average of 175 people per square mile [63]. These counties economically rely on recreational tourism. Both counties contain predominantly Caucasian, aging populations, and share conservative voting choices. Barry County has slightly

higher average income levels, marginally lower unemployment and poverty, and the county is more populated than Crawford County.

Crawford County is in the north-central portion of Michigan's Lower Peninsula (see Fig. 1). The 2010 county population was 14,704, with a population density of 25.3 people per square mile [63]. About 70% of Crawford County's land area is publically owned lands. The county offers a variety of recreational activities, such as fishing, hunting, snowmobiling, and boating, which generate income for the local economy.

The Au Sable River flows through Crawford County and represents a vital part of the community, economy, and the HVHF debate. The river contains many different branches, but the "Holy Waters" is the main stream of the river. Another important part of Crawford County's identity is Camp Grayling, the largest military installation east of the Mississippi River and largest National Guard training site, which provides many jobs to the area.

Marathon Oil Corporation owns and operates the HVHF well in Crawford County. The well began producing in 2013 [39], and required 15,810,735 gallons of water to complete. The well is still producing natural gas and is Michigan's largest producing well [19,38].

Barry County, the second study site, is located in the southwest portion of Michigan's Lower Peninsula. The county is a rural area situated between three metropolitan areas. The 2010 county population was 59,173, with a population density of 106 people per square mile [11,63,4]. Less than 10% of the land area is public land (Barry County Equalization Department, personal communication, February 13, 2015).

No HVHF wells have been drilled in Barry County, but many oil and gas leases have been signed. The Michigan Department of Natural Resources (MDNR) 2012 state auction leased mineral rights under portions of public land to two oil and gas companies. Many private landowners in Barry County have also signed leases, scattered in various locations around the county. Barry County has a history with the oil and gas industry, as there are 26 conventional oil wells, three natural gas storage wells, and one brine disposal well in the county [42].

4. Results: shared concerns, key differences

Presenting findings from the content analysis, Table 2 displays the benefits of HVHF cited by the popular media sources and Table 3 displays the risks of HVHF cited by the popular media sources. Analyzed content identified jobs and revenue to the state and private landowners as the primary benefits of HVHF; domestic energy security was not a commonly identified opportunity. Importantly, although this content analysis included sources from both environmental groups and industry advocates and ranged from national to very local sources, it demonstrates that public portrayals of the risks of HVHF largely outnumber the presentation of benefits in the media, as over twice as many risks were mentioned overall.

Interview responses from both counties were similar in three important ways. First, respondents shared the perception that the large use of freshwater/large water withdrawals and risk of surface water, groundwater, or drinking water contamination are the primary risks associated with HVHF. Second, respondents shared a desire for more local authority to regulate HVHF in their communities. Third, stakeholders in both counties reported divided perceptions among community members.

Responses from these two counties differed in four primary ways. First, they identified different numbers of risks and benefits, as Crawford County (with HVHF) stakeholders identified 25 benefits and 58 risks while Barry County (without HVHF) stakeholders identified 19 benefits and 79 risks. Second, they differed in what they perceived as the primary benefit of HVHF, as Crawford County stakeholders identified jobs while Barry County stakeholders identified revenue to the state and private landowners. Third, they differed in terms of in their awareness levels of HVHF, as Crawford County stakeholders described mostly mixed awareness levels among residents and Barry County stakeholders described low awareness levels among residents. Finally, there were differences in level of involvement in discussions of ordinances, educational meetings, and participation in organizations, as fewer stakeholders in Crawford County described townships or groups organizing against HVHF than in Barry County. Table 4 presents the benefits mentioned by participants in each county, and Table 5 presents the mentioned risks.

A shared theme in the content analysis and the interviews is the lack of power local governments have to make decision or regulate HVHF in their communities. Local governments, organizations, citizens, and landowners feel powerless and frustrated that their opinions have no influence. The analysis suggested that there was more community activity and pushback in Barry County (which currently has no active HVHF wells) than in Crawford County. The limited local power was a key issue criticized by many of the articles, with suggestions that local governments should be given more authority in making decisions about approving new HVHF wells, the location of wells, and regulations of the associated activities on and off the well. Enacting zoning ordinances or police power ordinances are the only options local governments have to restrict or control HVHF in their communities, but these powers are limited in that they must not conflict with the state's statutes, and county ordinances override township ordinances [54]. Counties and townships are also prohibited from regulating "drilling, completion, or operation of oil or gas wells or other wells drilled for oil or gas purposes" and have no jurisdiction to issue "permits for the location, drilling, completion, operation or abandonment of such wells" [67,p. 4]. Thus, local power is limited to things such as controlling road use, truck size, lights, noise, and requiring bonds, and community stakeholders expressed frustration about this lack of local control in both print media and interviews. David, from Barry County, stated: "at local government level the only way (to prevent HVHF) is to put enough ordinances in place that its almost impossible for them (companies) to get through all of our hoops to drill." Keith, who works in a government position in Crawford County, remarked: "at the end of the day I think, people feel like, well you know what there's really nothing we can do about it, unfortunately."

Another key theme that emerged from both the content analysis and the interviews is the common claim that "fracking" has been occurring in Michigan for many years. This statement, typically made with no further explanation, wrongly portrays the HVHF process as no different than conventional hydraulic fracturing. The State of Michigan has had conventional hydraulic fracturing since 1952; however, according to reporting from the Michigan Department of Environmental Quality, HVHF has only been employed in the state since 2011 [37]. Some articles employed this frame as a way to dispel discussion of new or unique risks involved with HVHF, while other articles criticized this claim as misleading because there are differences between traditional hydraulic fracturing and HVHF. As a respondent from Barry County stated, "they have a way of presenting fracking as safe to the public and diminishing risks that we all, especially now, know to be potential risks. And I think that if the DEQ and DNR and state regulatory agencies would be much more upfront about the realistic risks, their credibility with the public would be improved."

4.1. Findings from Crawford County

While Crawford County interviewees identified jobs as the primary benefit of HVHF, some participants perceived economic

Table 2
Socioeconomic and ecological benefits of HVHF cited in the analyzed content.

Socioeconomic Benefits	Number of times cited	Percent
Jobs	13	18.6%
Revenue to the state and private landowners	13	18.6%
Increases economic revenue/Growth/Reviving industry	8	11.4%
Large reserves in U.S./Abundant supply/Reliable	7	10%
Energy security/Energy independence	7	10%
Increased U.S. production/Ability to produce formations previously unattainable	6	8.6%
Reduced energy costs/Affordable fuel	6	8.6%
Ecological Benefits	**Number of times cited**	**Percent**
Reduced CO_2 emissions/Cleaner burning fuel than coal/Clean fuel	5	7.1%
Step toward increased use of clean energy	3	4.3%
Decreases total number of wells that need to be drilled/Reduces surface development	2	2.9%

Note: The number of times cited row reflects the total number of times each benefit was cited. The percentage reflects the number of times each benefit was cited out of the total number of benefits cited (n = 70).

Table 3
Socioeconomic and ecological risks of HVHF cited in the analyzed content.

Socioeconomic Risks	Number of times cited	Percent
Harms human health/Reduced quality of life	14	8.3%
Decreases property values/Property rights issues	9	5.4%
Changed community/Cultural/Scenery/Potential for social and environmental justice issues	7	4.2%
Noise pollution/Light pollution/Flares	7	4.2%
Truck traffic/Road damage	6	3.6%
Potential to reduce economic viability/local businesses, tourism, and recreation	5	3%
Chemical non-disclosure	3	1.8%
Ecological Risks	**Number of times cited**	**Percent**
Large use of freshwater/Large water withdrawals	26	15.5%
Risk of surface water, groundwater, drinking water contamination	20	11.9%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	17	10.1%
Flowback/Wastewater storage and disposal	12	7.1%
Ecological health/Environmental concerns	12	7.1%
Surface spills/Underground leaks and migration of gas and/or chemicals	11	6.5%
Air pollution/Contribution to climate change	9	5.4%
Changed landscape/New Construction/Fragmentation	7	4.2%
Potential for earthquakes	3	1.8%

Note: The number of times cited reflects the total number of times each risk was cited. The percent reflects the number of times cited out of the total number of risks cited (n = 168).

Table 4
Benefits mentioned by interview participants.

Socioeconomic Benefits	Crawford County	Barry County
Jobs	46.2%	12.5%
Revenue to the state and private landowners	30.8%	37.5%
Increases economic revenue/Growth	46.2%	37.5%
Large reserves in U.S./Abundant supply/Reliable	7.7%	0%
Energy security/Energy independence	15.4%	6.3%
Increased U.S. production/Ability to produce formations previously unattainable	15.4%	6.3%
Reduced energy costs/Affordable fuel	15.4%	12.5%
Ecological Benefits		
Reduced CO_2 emissions/Cleaner fuel	15.4%	0%
Step toward increased use of clean energy	0%	0%
Decreases total number of wells that need to be drilled/Reduces surface development	0%	0%

Note: Crawford County (n = 13); Barry County (n = 16). The two interviews conducted with individuals operating at the state level are not included in this analysis.

growth and revenue as very minor benefits. Michael, from Crawford County, does not think there a trickle down effect for the broader community, explaining: "drilling companies like to take care of themselves. They have their own living areas, eating areas, they try to somewhat isolate themselves from the community anyways. I think the economic advantage to the community is minor." Two respondents said they were unaware of any portion of the taxes, lease revenue, or royalties being shared with the county. Although stakeholders identified economic benefits most frequently, they also questioned the real extent of the impact.

The most commonly perceived risks of HVHF in Crawford County are related to water, including concerns about the large use of freshwater/large water withdrawals and risk of surface water, groundwater, or drinking water contamination. Walter described HVHF as a "water destroyer." Doug stated that "fracking in Michigan requires massive amounts of water. . . it's the new fracking on steroids in Michigan." Bryan talked about the importance of the local river, which provides a renewable source of income to the

Table 5
Risks mentioned by interview participants.

Socioeconomic Risks	Crawford County	Barry County
Harms human health and safety/Reduced quality of life	7.7%	18.8%
Decreases property values/Property rights issues	15.4%	25%
Changed community/Cultural/Scenery/Potential for social and environmental justice issues	23.1%	18.8%
Noise pollution/Light pollution/Flares	30.8%	25%
Truck traffic/Road damage	61.5%	37.5%
Potential to reduce economic viability/local businesses, tourism, and recreation	23.1%	37.5%
Chemical non-disclosure	30.8%	12.5%
Ecological Risks		
Large use of freshwater/Large water withdrawals	84.6%	68.8%
Risk of surface water, groundwater, drinking water contamination	69.2%	68.8%
Use of chemicals and additives in HVHF fluid/Disposal of chemicals, drill cuttings, and drilling muds	23.1%	18.8%
Flowback/Wastewater storage and disposal	23.1%	31.3%
Ecological health/Environmental concerns	7.7%	31.3%
Surface spills/Underground leaks and migration of gas and/or chemicals	7.7%	37.5%
Air pollution/Contribution to climate change	15.4%	31.3%
Changed landscape/New Construction/Fragmentation	23.1%	25%
Potential for earthquakes	15.4%	12.5%

Note: Crawford County (n = 13); Barry County (n = 16). The two interviews conducted with individuals operating at the state level are not included in this analysis.

county: "we have to have our water and we have to think long-term. . . the river keeps this town going, no doubt."

4.2. Findings from Barry County

Like Crawford County residents, participants from Barry County questioned the long-term economic benefits of HVHF to the community. Many interview participants from Barry County said potential risks largely outweigh any potential benefits, with Jennifer sharing: "I would say that there is strong factual support for the claim that any short-term economic benefits would be vastly outweighed by the harm done to existing economic enterprises in Barry County." Also like Crawford County, risks to water resources were the most frequently mentioned concerns about HVHF. Someone in a government position explained that the biggest single risk is the "total destruction of the water" used to fracture the wells.

A key difference between Crawford and Barry County residents in terms of responses to HVHF is the amount of time local community members dedicate to the issue. Thirteen of the sixteen interview participants from Barry County said that concern about HVHF has taken time or resources away from their positions, affiliated establishments, and lives to become more involved. At least four new groups have formed in the community in response to the potential for HVHF; one organization filed a lawsuit against the state after leasing rights under public lands.

5. Discussion

Respondents in Crawford County perceived a greater number of benefits and slightly fewer risks to HVHF in their county than Barry County respondents, who perceived fewer potential benefits and a slightly greater number of risks, similar to other research that has also found that perceptions of potential negative and positive impacts associated with unconventional natural gas development vary among communities with dissimilar levels of development [61]. For example, respondents in both counties shared more similarities in what they perceived as getting worse and differed more in what they perceived as improving from the presence of HVHF operations in their counties. In addition, a comparative study of educator perceptions of the demographic, economic, and community impacts associated with HVHF revealed differences between communities with no or little development compared to communities with high development, finding that educators in areas with high levels of development were more likely to notice local changes such as increased economic benefits, increased inequality, demographic changes, and burdens to the communities' infrastructure [53].

Risks posed to water from HVHF activity was the primary concern cited in the analyzed popular media content, and stakeholders in both counties shared similar concerns regarding the potential impacts to water resources. Respondents in both counties perceived risks from the large use of freshwater/large water withdrawals and risks of surface water, groundwater, and drinking water contamination as the primary risks of HVHF. Similarly, two comparative studies in the Barnett Shale found that the large use of freshwater was a primary concern shared by respondents in counties with different levels of HVHF activity [2,61]. Furthermore, 69% of New Yorkers and Pennsylvanians aware of HVHF were concerned about HVHF impacts to water quality [26].

Stakeholders in both communities talked about two previous studies: a stream flow study by Michigan State University and a University of Michigan's Graham Institute's study of hydraulic fracturing in Michigan [3,5]. This finding itself suggests that stakeholders in both counties want to know more about HVHF. In addition, MSU's preliminary stream flow study revealed that there might be significant adverse effects from the water withdrawals used for HVHF on nearby surface waters. Based on the number of stakeholders and the number of popular media articles that discussed both studies, there is a clear public desire for a greater understanding of the potential effects of HVHF on water resources.

Stakeholders in both counties perceived a division between residents in support of and residents against HVHF. Two other studies [7,49] reveal a similar division in the broader American public. For example, Boudet et al. [7] found that 58% of Americans were unsure whether they were in support or in opposition to the HVHF process.

The extremely limited control local governments have regarding HVHF decisions and regulation in their communities was a shared source of frustration from respondents in both counties. A government official from Barry County shared, "unfortunately, it's out of local hands. We can only complain and add some road blocks." The disconnect between decision-making at the state level and consequences that are much more localized demonstrates important issues of scalar politics and environmental governance. Environmental issues do not stay within the political boundaries set by society [41], and the scale of the decision-making body often, and particularly in the case of HVHF, differs from the scale at which the environmental issues are being experienced [32]. Previous work suggests that environmental governance needs to include agencies, groups, and organizations across spatial, temporal, jurisdictional, and social scales to promote more just, fair, and robust oversight [44,32]; the findings reported here highlight the importance of

local control and participation in decision-making for communities currently or potentially experiencing the localized impacts of HVHF. One interviewee hit this point home when they shared: "we need gas and we need oil, but there should be some cooperation and consideration between the oil companies, the state, and small municipalities."

Yet while participants from both counties talked about the lack of local options for regulating HVHF, Barry County seems more active in terms of forming groups, holding public education meetings, and discussing possible ordinances. Two possible explanations exist for this difference in level of involvement by residents in the case study counties. This difference may be related to the presence of HVHF activity in Crawford County, but not Barry County. Like many other activities, the potential for new HVHF wells triggers strong not in my backyard (NIMBY) feelings in residents. Some scholars describe NIMBYism as a form of environmental grassroots activism with a focus on protecting public health [22]. This could be a factor explaining why Barry County residents are more actively involved in discussions to prevent HVHF operations from coming to their county; since there are no HVHF wells yet, country residents may feel more concerned one well will open the door for many wells to be drilled.

Another possible explanation involves the differences public lands and available jobs. In Crawford County, 70% of the land area is public, whereas less than 10% of the land area in Barry County is public. In addition, Crawford County was described as having few employment opportunities, and has slightly higher unemployment than Barry County. The HVHF well in Crawford County is located on public land, but HVHF wells in Barry County would most likely be located on private land. In Crawford County, there seems to be a strong desire for jobs, and residents see HVHF as offering job opportunities, without impacting privately owned land.

Stakeholders in both case study counties critiqued the claim Michigan Department of Environmental Quality (MDEQ) makes that "fracking" has been done for many years in Michigan, with little or no explanation of the differences between conventional and unconventional wells. This issue was also prevalent in the content analysis. David from Barry County discussed the industry's argument that the volume of water used in a typical HVHF well is the same as the amount of water the City of Kalamazoo uses each day, arguing in response: "well that's right, but it goes right back into the system. We use it again. You're pulling it out, filling it full of toxic chemicals, and injecting it down beyond the hydro-aquifers and it's gone." The MDEQ and the industry frame HVHF as something that has been done for a long time, likely in an attempt to diminish public concerns and opposition. A need exists for greater transparency for improved understandings of HVHF.

6. Conclusion

The findings indicate that counties with differing levels of HVHF activity share more similar perceptions of the primary risks associated with HVHF than perceptions of the primary beneficial opportunities from HVHF activities. Barry County reported more negative opinions and more active pushback in response to the potential for a HVHF well, indicating that communities without HVHF may be more resistant to local HVHF development than communities that already have HVHF. However, the communities were similar in the ways they discussed the primary risks and challenges associated with HVHF; interviewees in both community discussed risk to water as a central concern, corresponding to both scholarly and popular accounts of HVHF.

One of the three main theoretical contributions from this study relates to the discursive framing of the benefit of HVHF in terms of national security. This point is central in academic and industry descriptions of HVHF, but is not central in popular media accounts and is even less central to community stakeholders ask to thing about potential opportunities posed by HVHF; thus, those working to oppose HVHF do not need to bother spending time attacking this frame. The second main theoretical contribution is the fact that people feel powerless to contribute to decision-making across perspectives of risks and benefits, revealing a shared feeling among people with varying opinions on the technology. This highlights a shared demand for local governments to have more influence over HVHF decision, as the communities where operations occur are most closely experiencing the immediate changes from HVHF production. Stakeholders in both communities expressed frustration about the lack of local decision making power regarding HVHF. While this is not a direct risk of HVHF, it does represent a common concern for communities facing HVHF development. In this identified concern, this project speaks to the burgeoning literature on water governance and the politics of scale examining the power dynamics associated with in-basin and out-of-basin costs and benefits.This study contributes the emerging water governance and politics of scale literature [47], by providing a concrete example of disconnect between in-basin and out-of-basin costs and benefits and the power dynamics and politics associated with decision-making.

Lastly, this study theorizes that one well may potentially shift public perceptions, and may reduce challenges or opposition to any additional HVHF wells in that community. Crawford County respondents talked about fewer initiatives and groups working to prevent further expansion of the industry in their community; although they did not directly explain the lack of local mobilization, it is possibly due to the feeling that once one well is drilled, there is not much they can do to prevent another well from being drilled.

In addition to the above theoretical contributions, there were a few other important findings worth further discussion. Risks associated with the large water withdrawals and risks of water contamination were primary concerns revealed in the content analysis and shared by interview participants in both counties. Importantly, issues related to water destruction are often not considered in the cost and benefit process. State regulators need to consider this in HVHF regulation moving forward. This theme also offers a strong framing for groups interested in opposing HVHF development, regardless of whether the area already produces unconventional natural gas. Furthermore, stakeholders in both communities shared a concerned about the lack of authority held by local governments to limit or regulate HVHF. This also highlights an area for potentially improved regulatory policy, and a frame for opposing current HVHF activities. Finally, this research reveals the extent to which the statement that "fracking" has been done for many years in Michigan is commonly made, often with little or no explanation of how traditional hydraulic fracturing differs from HVHF (which, although it has been technically feasible for quite some time, has only been employed in Michigan since 2011). This claim may muddle public perceptions and obscure the potential risks involved in unconventional drilling processes.

A disconnect between the benefits of HVHF stressed by the industry and interest groups (energy independence and reduced CO2 emissions) and those perceived by the public (economic revenue, jobs, and revenue to state and private landowners) reveals a conceptual space for understanding public perceptions of HVHF that can be mobilized by both proponents and opponents. Arguably, it most centrally demonstrates a need for improved public education. However, the interview findings do support literature suggesting how influential the media can be on public perceptions, as jobs and revenue to state and private landowners were the primary benefits identified by both public media content and community participants.

One limitation to this work is that Crawford County has a larger percentage of public land area and is located much further from a metropolitan center than Barry County. One similarly comparative study found that community characteristics (e.g. population size, urban vs. urban, available transportation, infrastructure development) may have a stronger influence over stakeholder perceptions than level of activity or history with extractive industries [10]. Crawford and Barry Counties both have histories with extractive industries, but are different in terms of population density and proximity to urban centers, which may be a contributing factor for the differences in perceptions between the case study counties. Another limitation is that the small demographic differences between these two counties could explain why Barry County residents are more involved in this topic and why there are no HVHF wells in the county. The findings suggest that this study might be highlighting an environmental justice matter, where relative affluence influences a community's ability to resist environmental hazards.

Nevertheless, the comparative analysis presented here provides an understanding of community perceptions of HVHF and presents the key issues and concerns shared by both case study counties. Including both a content analysis and interview analysis provides a robust understanding of perceptions. In response to the limitations of this study, future comparative studies could evaluate counties with more similar socioeconomic demographics as well as dissimilar socioeconomic demographics to determine how influential these characteristics are in shaping perceptions. Furthermore, doing so would allow future researchers to further understand how different levels of HVHF activities among counties in the same state shape public perceptions, and what themes and concerns are similarly salient in different kinds of communities, focusing attention to other potential opportunities for mobilization.

References

[1] J.L. Adgate, B.D. Goldstein, L.M. McKenzie, Potential public health hazards, exposures and health effects from unconventional natural gas development, Environ. Sci. Technol. 48 (15) (2014) 8307–8320.

[2] B.J. Anderson, G.L. Theodori, Local leaders' perception of energy development in the Barnett Shale, South. Rural Sociol. 24 (1) (2009) 113–129.

[3] Anglers of the Au Sable, Incidents Involving Water Shortages Caused by High Volume Water Withdrawals for Fracking., 2015, http://www.ausableanglers.org/ (accessed December 2014).

[4] Barry County Parks and Recreation Board, 2014–2018 Parks and Recreation Plan, 2014, http://www.barrycounty.org/ (accessed 12.02.15).

[5] N. Basu, A. Burton, K. Nadelhoffer, R. Zullo, J. Schwank, J. Wilson, K. Wolske, A. Hoffman, S. Gosman, B. Ellis, Hydraulic Fracturing in the State of Michigan Technical Reports, University of Michigan, 2013, Graham Sustainability Institute Integrated Assessment Report Series, 2 http://graham.umich.edu/knowledge/ia/hydraulic-fracturing/tech-reports (accessed 23.07.14).

[6] U. Beck, Trans Risk Society: Toward a New Modernity, Sage, London, 1992 (M. Ritter, Trans.).

[7] H. Boudet, C. Clarke, D. Bugden, E. Maibach, C. Roser-Renouf, A. Leiserowitz, Fracking controversy and communication: using national survey data to understand public perceptions of hydraulic fracturing, Energy Policy 65 (2014) 57–67.

[8] W.J. Brady, Hydraulic Fracturing Regulation in the United States: The Laissez-faire Approach of the Federal Government and Varying State Regulations, University of Denver, Sturm College of Law, 2012.

[9] S.L. Brantley, D. Yoxtheimer, S. Arjmand, P. Grieve, R. Vidic, J. Pollak, G.T. Llewellyn, J. Abad, C. Simon, Water resource impacts during unconventional shale gas development: the Pennsylvania experience, Int. J. Coal Geol. 126 (2014) 140–156.

[10] K.J. Brasier, M.R. Filteau, D.K. McLaughlin, J. Jacquet, R.C. Stedman, T. Kelsey, S.J. Goetz, Residents' perceptions of community and environmental impacts from development of natural gas in the Marcellus Shale: a comparison of Pennsylvania and New York Cases, J. Rural Soc. Sci. 26 (1) (2011) 32–61.

[11] Barry County Board of Commissioners, Budget, 2013, Retrieved from http://www.barrycounty.org/Reports_Permits/2013Budget.pdf (accessed January 2015).

[12] M.S. Carolan, The precautionary principle and traditional risk assessment, Organ. Environ. 20 (1) (2007) 5–24.

[13] K. Charmaz, Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis, Sage Publications, London: Thousand Oaks, CA, 2006.

[14] S. Christopherson, N. Rightor, How shale gas extraction affects drilling localities: lessons for regional and city policy makers, J. Town City Manag. 2 (4) (2012) 350–368.

[15] J. Corbin, A. Strauss, Grounded theory research: procedures, canons, and evaluative criteria, Qual. Sociol. 13 (1) (1990) 3–21.

[16] C. Davis, K. Hofffer, Federalizing energy? Agenda change and the politics of fracking, Policy Sci. 45 (2012) 221–241.

[17] B. Ellis, Hydraulic Fracturing in Michigan Integrated Assessment: Geology/Hydrology Technical Report, University of Michigan, 2013, Graham Sustainability Institute Integrated Assessment Report Series, 2(3). http://graham.umich.edu/knowledge/ia/hydraulic-fracturing/tech-reports (accessed 23.07.14).

[18] S. Entrekin, M. Evans-White, B. Johnson, E. Hagenbuch, Rapid expansion of natural gas development poses a threat to surface waters, Ecol. Soc. Am. 9 (2011) 503–511.

[19] FARWatershed, and respectmyplanet, Analysis of Michigan Department of Environmental Quality High Volume Hydraulically Fractured Well Completions and Applications, 2014, https://farwatershed.files.wordpress.com/2012/09/finalhvhf-chartanalysisupdate2.pdf (accessed 9.02.15).

[20] M.L. Finkel (Ed.), The Human and Environmental Impacts of Fracking: How Fracturing Shale for Gas Affects Us and Our World, Praeger, Santa Barbara, CA, 2015.

[21] W.R. Freudenburg, M. Alario, Weapons of mass distraction: magicianship, misdirection, and the dark side of legitimation, Sociol. Forum 22 (2) (2007) 146–173.

[22] N. Freudenberg, C. Steinsapir, Not in our backyards: the grassroots environmental movement, Soc. Nat. Resour. 4 (3) (1991) 235–245.

[23] K.B. Gregory, R.D. Vidic, D.A. Dzombak, Water management challenges associated with the production of shale gas by hydraulic fracturing, Elements 7 (2011) 181–186.

[24] R.A. Hammersley, K.E. Redman, Local government regulation of large-scale hydraulic fracturing activities, Mich. Bar J. (2014) 36–40.

[25] A. Hudgins, A. Poole, Framing fracking: private property common resources, and regimes of governance, J. Political Ecol. 21 (2014) 303–319.

[26] Infogroup/ORC, Fracking and Clean Water: A Survey of Americans. Conducted for the Civil Society Institute, 2010, http://www.civilsocietyinstitute.org/media/pdfs/122110%20CSI%20ORC%20NATIONAL%20FRACKING%20SURVEY%20REPORT%20FINAL1.pdf (accessed 13.09.14).

[27] International Energy Agency, Key World Energy Statistics, 2014, http://www.iea.org/publications/freepublications/publication/keyworld2014.pdf (accessed 14.08.15).

[28] M. Jacobson, R. Howarth, M. Delucchi, S. Scobie, J. Barth, M. Dvorak, M. Klevze, H. Katkhuda, B. Miranda, N. Chowdhury, R. Jones, L. Plano, A. Ingraffea, Examining the feasibility of converting New York State's all-purpose energy infrastructure to one using wind water, and sunlight, Energy Policy 57 (2013) 585–601.

[29] J.B. Jacquet, Review of risks to communities from shale energy development, Environ. Sci. Technol. 48 (15) (2014) 8321–8333.

[30] Y.K. Kharaka, J.J. Thordsen, C.H. Conaway, R.B. Thomas, The energy-water nexus: potential groundwater-quality degradation associated with production of shale gas, Procedia Earth Planet. Sci. 7 (2013) 417–422.

[31] A.E. Ladd, Stakeholder perceptions of socioenvironmental impacts from unconventional natural gas development and hydraulic fracturing in the Haynesville Shale, J. Rural Soc. Sci. 28 (2) (2013) 56–89.

[32] L. Lebel, P. Garden, M. Imamura, The politics of scale, position, and place in the governance of water resources in the Mekong Region, Ecol. Soc. 10 (2) (2005) 18.

[33] A. Leiserowitz, American risk perceptions: is climate change dangerous? Risk Anal. 25 (2005) 1433–1442.

[34] A. Leiserowitz, Climate change risk perception and policy preferences: the role of affect imagery, and values, Clim. Change 77 (2006) 45–72.

[35] S.H. Lesbirel, D. Shaw (Eds.), Managing Conflict In Facility Siting: An International Comparison, Edward Elgar Pub, Cheltenham, UK, 2005.

[36] D.W. McMillan, D.M. Chavis, Sense of community: a definition and theory, J. Community Psychol. 14 (1) (1986) 6–23.

[37] MDEQ, Five Facts About Hydraulic Fracturing, 2015, http://www.michigan.gov/documents/deq/Five_facts_about_HF_1_page_455379_7.pdf (accessed 12.07.14).

[38] MDEQ, High Volume Hydraulically Fractured Well Completion Active Permits and Applications, 2014, http://www.michigan.gov/documents/deq/high_volume_hydraulically_fractured_well_completions_for_map_July_2014_462731_7.pdf (accessed 9.02.15).

[39] MDEQ, Record of Well Drilling or Deepening, Office of Geological Survey, 2013, http://ww2.deq.state.mi.us/GeoWebface/GeoWebface/WF/039/60621_WF.PDF (accessed October 2014).

[40] Michigan House of Representatives. Subcommittee on Natural Gas, The Natural Gas Report on Energy and Job Creation, 2012, http://house.michigan.gov/sessiondocs/2011-2012/testimony/Committee6-4-24-2012.pdf (accessed June 2014).

[41] J. Meadowcroft, Politics and scale: some implications for environmental governance, Landsc. Urban Plann. 61 (2002) 169–179.

[42] B. Mitchell, Michigan oil and gas regulatory program, in: Presentation at the Environmental Issues in Barry County Meeting, Hastings, Michigan, February 22, 2015.

[43] R.K. Mitchell, B.R. Agle, D.J. Wood, Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts, Acad. Manag. Rev. 22 (4) (1997) 853–886.
[44] E.S. Norman, K. Bakker, C. Cook, Introduction to the themed section: water governance and the politics of scale, Water Altern. 5 (1) (2016) 52–61.
[45] Northeast Michigan Council of Governments, Crawford County Michigan Hazard Mitigation Plan, 2014, http://www.crawfordco.org/Hazard/Plan/Crawford%202014%20Hazard%20Mitigation%20Plan.pdf (accessed 9.02.15).
[46] D.W. North, P.C. Stern, T. Webler, P. Field, Public and stakeholder participation for managing and reducing the risks of shale gas development, Environ. Sci. Technol. 48 (15) (2014) 8388–8396.
[47] E. Norman, C. Cook, A. Cohen (Eds.), Negotiating Water Governance: Why the Politics of Scale Matter, Routledge, London, 2015.
[48] S.L. Perry, Addressing the societal costs of unconventional oil and gas exploration and production: a framework for evaluating short-term, future, and cumulative risk and uncertainties of hydrofracking, Environ. Pract. 14 (4) (2012) 352–365.
[49] Pew Research Center for the People and the Press, As Gas Prices Pinch, Support for Oil and Gas Production Grows, Pew Research Center Press, 2012, http://www.people-press.org/2012/03/19/as-gas-prices-pinch-support-for-oil-and-gas-production-grows/ (accessed January 2015).
[50] B.G. Rahm, J.T. Bates, L.R. Bertoia, A.E. Galford, D.A. Yoxtheimer, S.J. Riha, Wastewater management and Marcellus Shale gas development: trends drivers, and planning implications, J. Environ. Manag. 120 (2013) 105–113.
[51] S. Rippl, Cultural theory and risk perception: a proposal for a better measurement, J. Risk Res. 5 (2002) 147–165.
[52] K.A. Schafft, Y. Borlu, L. Glenna, The relationship between Marcellus Shale gas development in Pennsylvania and local perceptions of risk and opportunity, Rural Sociol. 78 (2) (2013) 143–166.
[53] K.A. Schafft, L.L. Glenna, B. Green, Y. Borlu, Local impacts of unconventional gas development within Pennsylvania's Marcellus Shale region: gauging boomtown development through the perspectives of educational administrators, Soc. Nat. Resour. 27 (4) (2014) 389–404.
[54] K.H. Schindler, Zoning and Police Power Ordinances Are Not the Same, and Should Not Be Mixed Together, Michigan State University Extension, 2014, http://msue.anr.msu.edu/news/ (accessed March 2015).
[55] P. Slovic, Perception of risk, Science 236 (1987) 280–285.
[56] P. Slovic, The Perception of Risk, Earthscan, London, 2000.
[57] M.J. Small, P.C. Stern, E. Bomber, S.M. Christopherson, B.D. Goldstein, A.L. Israel, R.B. Jackson, et al., Risks and risk governance in unconventional shale gas development, Environ. Sci. Technol. 48 (15) (2014) 8289–8297.
[58] Mark Snow, Policy and rules, in: Panel Discussion at the Fracking in Michigan Conference, Lansing, Michigan, December 3, 2014.
[59] B.K. Sovacool, Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracturing (fracking), Renew. Sustain. Energy Rev. 37 (2014) 249–264.
[60] A.L. Strauss, J.M. Corbin, Basics of Qualitative Research: Grounded Theory Procedures and Techniques, Sage Publications, Thousand Oaks, CA, 1990.
[61] G.L. Theodori, Paradoxical perceptions of problems associated with unconventional natural gas development, South. Rural Sociol. 24 (3) (2009) 97–117.
[62] I. Urbina, Regulation of Lax as Gas Wells' Tainted Water Hits Rivers, The New York Times, 2011, http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=all&_r=0 (accessed 20.07.14).
[63] U.S. Census Bureau, State and County QuickFacts, American FactFinder, 2014, http://www.census.gov (accessed 17.10.14).
[64] U.S. Energy Information Administration, Frequently Asked Questions, 2015, http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (accessed 14.08.15).
[65] U.S. House. House Committee on Energy and Commerce, Chemicals Used in Hydraulic Fracturing, 2011, http://democrats.energycommerce.house.gov/index.php?q=news/committee-democrats-release-new-report-detailing-hydraulic-fracturing-products (accessed February 2015).
[66] H. Yen, T. Peipert, Four in 10 higher-risk oil and gas wells in U.S. aren't inspected. 2014, June 15. The Washington Post (accessed 14.08.15).
[67] M.D. Zimmerman, Local regulation of oil and gas drilling and brine wells, in: Presentation at the Environmental Issues in Barry County Meeting, Hastings, Michigan, February 22, 2015.
[68] A.S. Ernstoff, B.R. Ellis, Clearing the waters of the fracking debate, Michigan J. Sustain. 1 (2013) 109–129.