Residents' perception of hydraulic fracturing and their engagement in hydraulic fracturing in Lethbridge, Fox Creek, and Rosebud, Alberta, Canada

by

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ABSTRACT

Alberta has been dependent upon oil and gas extraction for over a hundred years, resulting in a particular set of political-economic conditions. Up to date, 93 percent of all the conventional oil in Alberta has been extracted. Therefore, to maintain resource rents, unconventional sources of oil and gas, previously considered too uneconomical to develop, have dominated production. Unconventional gas, including shale and coalbed methane, can only be accessed with a drilling technique involving horizontal, multi-stage, hydraulic fracturing, called fracking for short. In Alberta, over 80 percent of new wells drilled today are fracked, and there has been a growing record of resulting environmental and health problems. Among the more vivid of impacts is seismic activity. In Fox Creek for example, scientists confirmed that volume and geological factors account for ~96% of the variability in the induced earthquake rate near Fox Creek.

Health impacts have also raised alarm. For over a decade, the residents of another small town, Rosebud, sought recourse from the provincial government for the contamination of water wells, also believed to be the result of fracking. The scientific record has corroborated these concerns, with several studies finding significant water quality, and ecological and human health impacts as a result of fracking. With increasing evidence of negative impacts from fracking, understanding public perspectives on fracking and the engagement of residents in political activities to express their views are fundamental. Applying a social capital approach, which has generated a substantial body of research indicating that trust, networks and self-efficacy play important roles in civic engagement, this research aims to explore the impact of these three social capital attributes on resident perspectives and engagement in fracking opposition activities in Lethbridge, Fox Creek, and Rosebud, Alberta, with the use of survey research methods.

Results of local residents' perspectives on fracking and level of engagement in fracking were explored using a household survey of residents in Lethbridge (n=184), Fox Creek (n=29), and

Rosebud (n=13), three regions in Alberta where fracking has either been undertaken or proposed. Participants completed a questionnaire that measured their trust levels in different information sources and media related to fracking as well as in government representing local interest in fracking. In addition, residents' social networks, self-efficacy, and concerns for the negative impacts of fracking, factual knowledge about fracking, and socio-demographic information were also included in the survey.

Similar to findings of other emerging technologies, our logistic regression results suggested that males were more likely to support fracking. Trust and factual knowledge about fracking were also positively associated with fracking support. However, trust was expressed differently toward specific government organizations across the three study sites, signaling the importance of local historical context to fracking attitudes. I found social capital, including trust and self-efficacy, and concerns for the impacts of fracking, all strongly predicted social engagement in fracking in the three study sites. Annual household income, education, and working in the energy sector also shaped residents' participation in fracking. Furthermore, trust in particular institutions influenced personal and collective engagement differently. These findings reaffirm that residents' responses to fracking are strongly shaped by local community context. The political-economic context defined by Alberta's historic role as a petro-state nonetheless shapes the nature of political mobilization and affects the trust and efficacy of residents. Institutional trust had the strongest effect on shaping local residents' perspectives on fracking, even when controlling for gender, income, factual knowledge about fracking, and sector of employment. However, levels of institutional trust toward a set of specific government entities varied substantially by location, suggesting that historical experiences with those entities with respect to fracking development strongly influenced local residents' trust, and this in turn affected their attitudes toward fracking.

PREFACE

This dissertation is an original work by Duyen Truong. I developed the survey questions, conducted the literature review, designed the survey instrument for this study as well as for model input data and model runs, and conducted data analysis and interpreted results. Dr. Debra J. Davidson was the supervisory author and was involved with designing of the research, model development, modelling supervision and manuscript composition. Dr. John R. Parkins involved with concept formation, data modelling, data analysis and manuscript editing.

Chapter Three was published in the journal *The Extractive Industries and Society* as Truong, D, J.R. Parkins, and D.J. Davidson, "Context matters: Fracking attitudes, knowledge and trust in three communities in Alberta, Canada" in September 2019.

Chapter Four has been revised for resubmission to the journal *Society and Natural Resources* as Truong, D, J.R. Parkins, and D.J. Davidson, "What shapes public engagement in fracking?".

Only when the last tree has died, and the last river been poisoned, and the last fish been caught will we realize we cannot eat money.

- Cree Indian Proverb

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My deep gratitude goes to my parents for being my emotional strength throughout this period. Finally, special thanks to my husband and two sons; without their emotional and mental support my journey would not have been the same.

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Chapter 1. Introduction and objectives

1.1. Introduction

Hydraulic fracturing (commonly called fracking) is a drilling technique, first introduced in the US, that involves pumping hydraulically pressurized liquid consisting of water, silica, and chemicals deep into the earth's surface to fracture solid substrates containing natural gas (or oil) such as shale, to release the trapped thermo-genic gas. The increasing use of fracking in extracting unconventional oil and gas resources since the early 2000's has generated intense legal, political, and environmental debates, especially in response to a growing record of scientific evidence of significant environmental and social impacts, including in particular seismicity (Ellsworth, 2013; Fischetti, 2012, Schultz, Atkinson, Eaton, Gu, & Kao, 2018) and water contamination (Coram, Moss, & Blashki, 2014; Finkel & Hays, 2013; Korfmacher, Jones, Malone, & Vinci, 2013). Concern has centered on the quantity and types of chemicals used in the hydraulic fracturing process. However, in many places, chemical disclosure is either not mandatory (E.g. Cramer, 2016; Elgin et al., 2012; Haas et al., 2012; Vann et al., 2014) or not sufficient for citizens, journalists, and regulators due to the limited information provided (Cramer, 2016). While the volume of empirical research on fracking attitudes internationally has grown considerably of late, there remains a need to focus attention on local contexts in which fracking takes place, given the high degrees of variability in factors affecting attitudes toward development at the local scale. Because local residents bear a disproportionate share of the impacts, ensuring their concerns are understood and factored into decision-making is paramount.

The Province of Alberta is a focal point for oil and gas development in Canada, and the industry continues to support a substantial share of revenues and employment. With conventional reserves of natural gas largely depleted, fracking has been expanding rapidly. Previous province-wide studies (Axsen, 2014; M. Thomas et al., 2017) have found that a majority of Albertans

support fracking for shale gas and oil, based on the expected economic benefits from resource extraction. However, little research has been conducted to date that focuses on perspectives toward fracking at the local level, especially among residents in fracking development zones in Alberta.

The strong support expressed by many Albertans for oil and gas development in this province has been attributed in part to narratives that define these resources as a key element of what has been termed "the Alberta Advantage," a term broadly capturing the benefits of being an Albertan, living in a province with a resource-rich, business friendly environment with low taxes, and low unemployment (Adkin, 2016). The benefits of a resource-rich province, however, are also associated with social and ecological problems resulting from high-volume of resource extraction (Coram et al., 2014; Davidson, 2018; Finkel, 2013; Korfmacher et al., 2013; Schultz et al., 2018; Warner, Christie, Jackson, & Vengosh, 2013; Willow & Wylie, 2014).

At the time I started this study to explore local residents' perspectives on fracking in Alberta, the only studies towards Albertans' perspectives on fracking were conducted at the provincial level. These previous studies do not capture the variation in attitudes toward fracking among Albertans, variation that may be strongly influenced by local context.

1.2. Objectives of the study

To fill this gap, I explore the perspectives of local residents about fracking in the Hamlet of Rosebud, the Town of Fox Creek, and the City of Lethbridge—three regions of Alberta where fracking has occurred or been proposed. I also examine levels of social and political engagement focused on fracking among local people, and what factors shape that engagement. The results of this research address the following research questions: "What are residents' perspectives regarding fracking in their regions? In what ways do local contextual factors shape local residents' perspectives on fracking? What factors are associated with their engagement in

fracking opposition activities?" To answer these questions, telephone and online surveys were employed to collect data from a sample of 226 adults living in Lethbridge, Fox Creek, and Rosebud. These locations were chosen because they are all located in regions subject to intensive fracking development in recent years, and yet are characterized by highly varying economic context and histories related to fossil fuel development.

The City of Lethbridge is the fourth largest city in the province with a population of 92,730 (Statistics Canada, 2016b) and hosts a mixed economy with services and post-secondary education. Therefore, the economy of Lethbirdge has remained stable throughout the city's history. According to Statistics Canada Census Profile 2016, females accounted for 50.9% of Lethbridge population. The average age of Lethbridge residents was 39.7 with female averaging 39.1 and males averaging 37.1 years of age. The average household income was $90,537 per year (Statistics Canada, 2016b). Results from the 2018 Lethbridge Study Public Opinion Poll showed residents were progressive on policy but conservative at the polls (Mahoney, 2018). In 2019, 101482 people have chosen Lethbridge as their homes showing the increasing in the population of this city and making Lethbridge the third largest city in Alberta, and the Major Chris Spearman believed that the growth would continue (Ferris and Roulston, 2019).

Lethbridge city was the first municipality in Alberta to oppose fracking by passing an official resolution on November 13, 2012 to prevent oil and gas drilling within city limits (Patterson, 2013). The City Council reaffirmed its opposition to fracking in an official statement issued on September 16, 2013 when GoldenKey Oil publicly announced its intentions to pursue fracking within the city limits of Lethbridge (No Drilling Lethbridge, 2017a). This decision coincided with actions taken by No Drilling Lethbridge, a small local organization, which collected 11,000 signatures on a petition presented to the Alberta Energy Regulator (AER) to request a ban on drilling for oil and gas in Lethbridge. This petition was tabled in the legislature in March 2015

and shortly thereafter Goldenkey Oil retracted its application to frack for oil in Lethbridge (No Drilling Lethbridge, 2017a). Lethbridge government and citizens opposed the oil exploration project of Goldenkey Oil company in Lethbridge due to concerns about the environmental effects of fracking activities and the lack of transparency regarding corporation ownership, extent of the mineral license, history of non-compliance, water sourcing, and consultation with Lethbridge city council (Josefina AT, 2015).

Fox Creek, on the other hand, is a small town with a population of 1970 (Statistics Canada, 2016a). According to Statistics Canada Census Profile 2016, females accounted for 54% of Lethbridge population. The average age of Fox Creek residents was 35.1 with female averaging 34.5 and males averaging 35.7 years of age. Most inhabitants at Fox Creek were above the low-income cut-off with the average household income of $135,271 per year. Within the period from 2001 to 2016, the population of Fox Creek was declining at a rate of 1.04% per year (Statistics Canada, 2016a).

Fox Creek town is considered an oil-hub, highly dependent upon the oil and gas industry. The revenue from oil and gas companies accounts for about 95 percent of the district's total revenue, and it was $77 million in 2018 (Riley, 2019). In Fox Creek, the Kaybob assessment area has experienced the most development with 197 gas wells and 11 oil wells drilled as of the end of December 2015 (Preston, Garner, Beavis, Sadiq, & Stricker, 2016). Fox Creek is also the location of Alberta's first earthquakes found to be associated with fracking activities, with some over 4.0 on the Richter scale (Schultz et al., 2018). The magnitude 4.8 quake on January 12, 2016 forced a shutdown of extraction activities by Repsol Oil and Gas site in Fox Creek (Braken, 2016). A study published in the journal *Science* noted a sharp increase in the frequency of earthquakes near Fox Creek, Alta., began in December 2013 in response to fracking and further confirmed that earthquakes in Fox Creek are linked to fracking operations (Schultz et al., 2018). However, this

has not slowed down drilling activities in Fox Creek. Although some residents expressed their concerns about the increase in frequency and magnitude of earthquakes in their communities (Giovannetti, 2015), up to now, there has been no organized response to fracking from people in this town.

Rosebud, an even smaller community, with 85 people (Statistics Canada, 2016c), is an agricultural, theatre, arts and music community located in Wheatland County, in South-Central Alberta. According to Statistics Canada Census Profile 2016, females accounted for 47% of Rosebud hamlet population. The average age of Rosebud residents was 41.3 with female averaging 40.6 and males averaging 42 years of age. The average household income in Rosebud was $66,304 per year. Within the period from 2006 to 2016, the population of Rosebud was declining at a rate of 20.1% per cent (Statistics Canada, 2016c).

Rosebud sits on part of the Horseshoe Canyon Coal reserve, which includes a 50,000 acres deposit of unconventional gas (Nikiforuk, 2015). Between 2000 and 2002, Encana and Calgary-based MGV, both energy companies, drilled and fracked several hundred experimental wells to determine the most economical way to take methane out of the Horseshoe Canyon Coals (Nikiforuk, 2015). In 2003, many farmers signed new gas well leases with Encana in anticipation of economic benefits. However, dozens of Rosebud residents soon thereafter flooded the Regulator with complaints about compressor noise, increase in traffic levels, and insufficient consultation about the coalbed methane fracking activity, but little appeared to change (Nikiforuk, 2015). There was no organized response to fracking from the residents of Rosebud; however, one of Rosebud's residents, Jessica Ernst – a biologist and former oil field consultant, filed a Statement of Claim in 2007 against Encana for contaminating her water well and other wells in her community (Nikiforuk, 2017). She further filed a claim against Alberta Environment, now called the Alberta Energy Regulator (AER), for failing to properly investigate the

groundwater contamination. The multi-million-dollar lawsuit of Jessica Ernst, started in 2011, was ultimately rejected by the Supreme Court in January 2017 for the reason that she can't sue AER over alleged violations of her Charter rights, because the AER is given immunity by provincial legislation, but the case drew international attention and local sympathy (The Canadian Press, 2015).

The data collection methods of this study were reviewed and approved of by the University of Alberta Research Ethics Board before data collection began, with the application ID number of Pro00065714. The survey was implemented from September 7 to October 25, 2016 by the polling firm Research Now, using a questionnaire which was designed to measure key factors that were expected to predict perspectives toward fracking and engagement in fracking activities, including trust in information sources, trust in government and government bodies, factual knowledge about fracking, social networks, engagement in fracking opposition activities, self-efficacy, concerns about the effects of fracking, and socio-demographics. The survey questionnaire consists of closed-ended questions using five-point Likert scales, open-ended questions, and partly-open-ended questions. It takes between 12 to 15 minutes to complete the survey questionnaire for both web-based and telephone respondents.

The collected voices from people who live in fracking areas contribute a unique understanding of citizens' engagement and their perspectives on fracking in the three selected sites. Understanding and sharing the views of local affected people is very important for the development of suitable policies regarding unconventional resource exploration in those areas. This study is critically important for researchers, environmental practitioners, and scholars who are interested in communicating about residents' engagement in fracking. Moreover, policymakers will better understand local residents' perspectives on fracking projects in the three study sites in order to tailor relevant fracking development policies for these locations and to

begin to understand the variability in attitudes about fracking across the province. Further, this study aims to extend previous research by exploring the relationship between public engagement and social capital in the resource development field, particularly in oil and gas extraction via fracking.

The dissertation is organized into five chapters, as follows:

Chapter one (the introduction chapter) provides general information about objectives of the study and outline of the dissertation.

Chapter two presents a systematic review of public perspectives about fracking in the US, Canada, and other places. Building on the existing literature on the public perceptions of fracking, I apply a systematic review approach to further explore the perceptions of fracking among different survey groups including residents, landowners, and government officers, as well as perceptions elicited from nationwide samples of residents. Factors that have been found in previous empirical studies to shape public perceptions of fracking are presented. Using the PRISMA flow diagram, I selected 41 empirical papers in English about perceptions of fracking that were published between 2008 and 2018. These studies revealed the variation in perceptions among publics toward fracking, tending toward higher support among those who perceive benefits outweighing risks associated with fracking operations (Considine, Watson, & Blumsack 2010; Hultman et al. 2011; Crowe et al. 2015). Others who have indicated direct experience with the social and environmental costs of fracking were more likely to oppose fracking development in their communities (Davidson 2018; Eaton & Kinchy 2016; Willow & Wylie, 2014). However, this record of research suggests that public perceptions of fracking have had little impact on government decisions in applying this technology in their communities (Eaton & Kinchy 2016; Willow & Wylie, 2014; Sher a& Wu, 2018; Yu, Huang, Qin, & Chen, 2018).

Chapter three explores fracking perspectives on local residents and factors shaping their perspectives about fracking by using survey data (n=226) from a sample of residents in the three communities including Lethbridge, Fox Creek, and Rosebud, Alberta, Canada, each of which has experienced unique political-economic relationships with the oil and gas industry. Our logistic regression results (r^2=.51) suggest that trust and factual knowledge about fracking are positively associated with fracking support. Notably, in a high energy-dependence community, residents express strong support despite concern for the impacts of fracking; and trust is expressed differently toward government organizations across the three study sites, signaling the importance of local context to fracking attitudes.

Chapter four, using the same survey data above, investigates factors that shape public engagement in fracking opposition activities by investigating the relationships between public engagement and many factors that may affect citizen participation, including trust, networks, self-efficacy, and concerns for the impacts of fracking. Social capital attributes, including trust and self-efficacy, and concerns for the impacts of fracking, were found strongly predict social engagement in fracking in the three study sites. Annual household income, education, and working in the energy sector also shape citizens' participation in fracking. Furthermore, trust in particular institutions had different levels of influence on personal and collective engagement.

Chapter five provides a discussion of the research findings and their relevance for scholarship and policy. It also offers future research suggestions for scholars who are interested in social responses to fracking and public engagement in shale gas extraction after presenting its contribution to the field of research in public perspectives and engagement of fracking.

Chapter 2. Public perspectives on shale gas development via hydraulic fracturing technique, a systematic literature review

2.1. Introduction

The discovery and production of shale gas, a natural gas found within shale formations, started in the US (M. Thomas et al., 2017). The first shale gas formation was discovered in 1821 in the organic-rich Devonian shale in the Appalachian basin, and millions of dollars have been spent in the exploration of the geological and geochemical nature of organic shale formations since the 1970s (Fanchi, 2018). Shale gas, in fact, is globally distributed, present in various geographical locations. Up to now, the US has played a leading role in shale gas production, producing 16.54 trillion cubic feet in 2016, and US annual production is expected to reach 33.4 trillion cubic feet by 2050 (Wang, 2019). Recently, many other countries have begun producing their own shale gas reserves, including, Canada, China, several European countries, Russia, and Lybia (M. F. Smith & Ferguson, 2013).

Shale gas production via fracking has received both public support and opposition. Proponents argue that shale gas production reduces future dependency on imported oil/gas, which ensures national energy security (Considine et al., 2010; Hultman et al., 2011). Many also argue that shale gas is a cleaner energy source compared to coal burning, and can serve as a "bridge" to a lower carbon economy (Jenner & Lamadrid, 2013). Economic benefits including jobs, local taxes, royalties from leasing lands, and local economic improvement are the main focus of both local peoples and authorities considering shale gas development in their community (Crowe et al., 2015). On the other hand, many citizens have expressed concerns, and many of their concerns have been substantiated by scientists who have provided evidence of significant impacts from fracking, including water contamination (Coram et al., 2014; Korfmacher et al., 2013), induced

seismicity (Ellsworth, 2013; Fischetti, 2012; Schultz et al., 2018), and social and health problems (Davidson, 2018; Korfmacher et al., 2013; Warner et al., 2013; Willow & Wylie, 2014).

In recent studies, coalbed methane hydraulic fracturing wells were found to be associated with petroleum hydrocarbon-derived contaminants [benzene, toluene, ethylbenzene, and xylenes (BTEX)] which returned to the surface as flowback, or migrated into shallow groundwater (Ferrar et al., 2013; Gregory et al., 2011; Meszaros et al., 2017). BTEX are listed as priority pollutants by the United States Environmental Protection Agency (USEPA) under the Clean Water Act (USEPA, 2012). Canada has a standard for petroleum hydrocarbon in soil only (CCME, 2008). Studies confirmed that BTEX contaminates drinking water (Peng et al., 2015), poses human health risks (Carpenter, 2016; Parker et al., 2014), and generates adverse ecological consequences such as physiological alterations in fish embryos (Adeyemo et al., 2015), and decreases in chlorophyll content in algae (Peng et al., 2015).

Public perspectives on fracking operations, to some extent, directly affect the energy policies of a country. As a result of anti-fracking movements, for example, fracking has been banned in Germany, France, South Africa, Bulgaria, Luxemburg, Romania, and Switzerland. Several sub-national jurisdictions, including some in Canada, have also established moratoria or bans on fracking. In the US, the states of Vermont, Pennsylvania, and New Mexico have established moratoria on fracking. Fort Collins, Boulder, and Lafayette, all in Colorado, have banned fracking, and at least 100 Counties in New York State have done so (No Drilling Lethbridge, 2017b). In Canada, Quebec and Newfoundland and Labrador banned fracking in 2013; Nova Scotia and New Brunswick issued moratoria on fracking in 2014. All of these restrictions are in large part the outcome of mobilized public opposition to fracking in those areas (Sherwood, 2015; The Canadian Press, 2013). Anti-fracking activities were well organized in places where fracking was banned. However, in many other jurisdictions, fracking continues to take place

despite the expressed concerns of residents (e.g. Davidson, 2018; Willow, 2014). Level of public support for fracking, to some extent, can be expected to influence energy development policy. Therefore, understanding what drives public support and opposition toward fracking is a crucial area of research. The rapidly increasing scale of fracking globally has triggered a significant controversy over the benefits and negative impacts of the technology (G. L. Theodori, Luloff, Willits, & Burnett, 2014). Public pressure is being placed on governments around the world to either prohibit the process or develop and enforce policies and regulations that protect the environment and communities from risks associated with this technology. Scientists have argued that public engagement in the policy development process coupled with independent scientific research (Jackson et al., 2014) could equip governments with better information regarding the perceived risks and benefits of technologies such as fracking, resulting in stronger and more widely accepted policies and regulations (Shaw et al., 2015).

In this paper, I present the findings of a systematic review of research that has been conducted to date on public perspectives on fracking. I first describe the systematic review methods used, then discuss the findings of the reviewed articles. The findings will include public perspectives on fracking among different survey groups such as residents, landowners, and local leaders. I then present factors identified in these studies that shape public perceptions of fracking, before providing future research suggestions and conclusions.

2.2. Methods

2.2.1. Search strategy

A search strategy was developed to identify empirical studies, based on observed and measured phenomena and generalized knowledge from actual experience, about public perspectives on fracking published in the English language between November 2008 to November 2018. I limited the search to studies that were published in the last ten years to ensure

the contemporary relevance of findings to current political, economic, and environmental conditions. I used the following literature databases: Agricultural & Environmental Science Collection; Environment Complete; Web of Science; Sociological Abstract; Jstor; and Theses and Dissertations Global in the database of the University of Alberta. Searches were conducted on title, abstract and/or keywords as per the capacity of each database, using the following terms: 'hydraulic fracturing' or 'fracking' or 'shale gas' and public 'perspectives' or 'perception' or 'attitudes' or 'opinions' or 'responses' or 'support'. Also, I used similar search terms to identify potentially relevant grey literature from Google Scholar, Canadian Newsstream, and websites of government and non-governmental organizations. I adopted PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), a flow diagram for inclusion, an evidence-based analytical tool relying upon a minimum set of items for reporting in systematic reviews and meta-analyses in reporting systematic reviews of public perspectives on shale gas development via hydraulic fracturing technique.

PRISMA was presented by a group of 29 participants, including review authors, methodologists, clinicians, medical editors, and a consumer to address conceptual and practical advances in the science of systematic reviews by using a four-phase flow diagram (figure 2.1) (Moher et al., 2009). PRISMA was expected to help authors improving the reporting of systematic reviews and meta-analyses. PRISMA is very popular in producing systematic review and meta analyses of studies that evaluate healthcare intervention (Liberati et al., 2009). However, the general concepts and topics covered by PRISMA are all relevant to any systematic review study (Moher et al., 2009).

From 854 returned research results that included numerous nonrelevant literature and research on a wide range of topics and fracking, I aimed to focus on public perceptions of fracking for shale gas and oil globally. I included articles that were directly related to public opinions,

attitudes, or perceptions about fracking for both oil and gas in the review without differentiating between the two in the analysis because the reviewed papers often provide no clear distinction. Thus, by using PRISMA flow diagram, I ended up with 41 empirical papers about the perceptions of fracking published between 2008 and 2018 for this systematic review (figure 2.1). Among these 41 empirical papers, eight were studies involving a qualitative approach, including the collection of data by interviews and observations using a variety of research methodologies such as ethnography, grounded theory, phenomenology, interpretive description, and case study. Thirty-one studies were quantitative, involving the collection of quantifiable data which were then subject to statistical, mathematical, or computational analysis. Two studies used mix methods to gather both qualitative and quantitative data to answer research questions (See Figure 2.1).

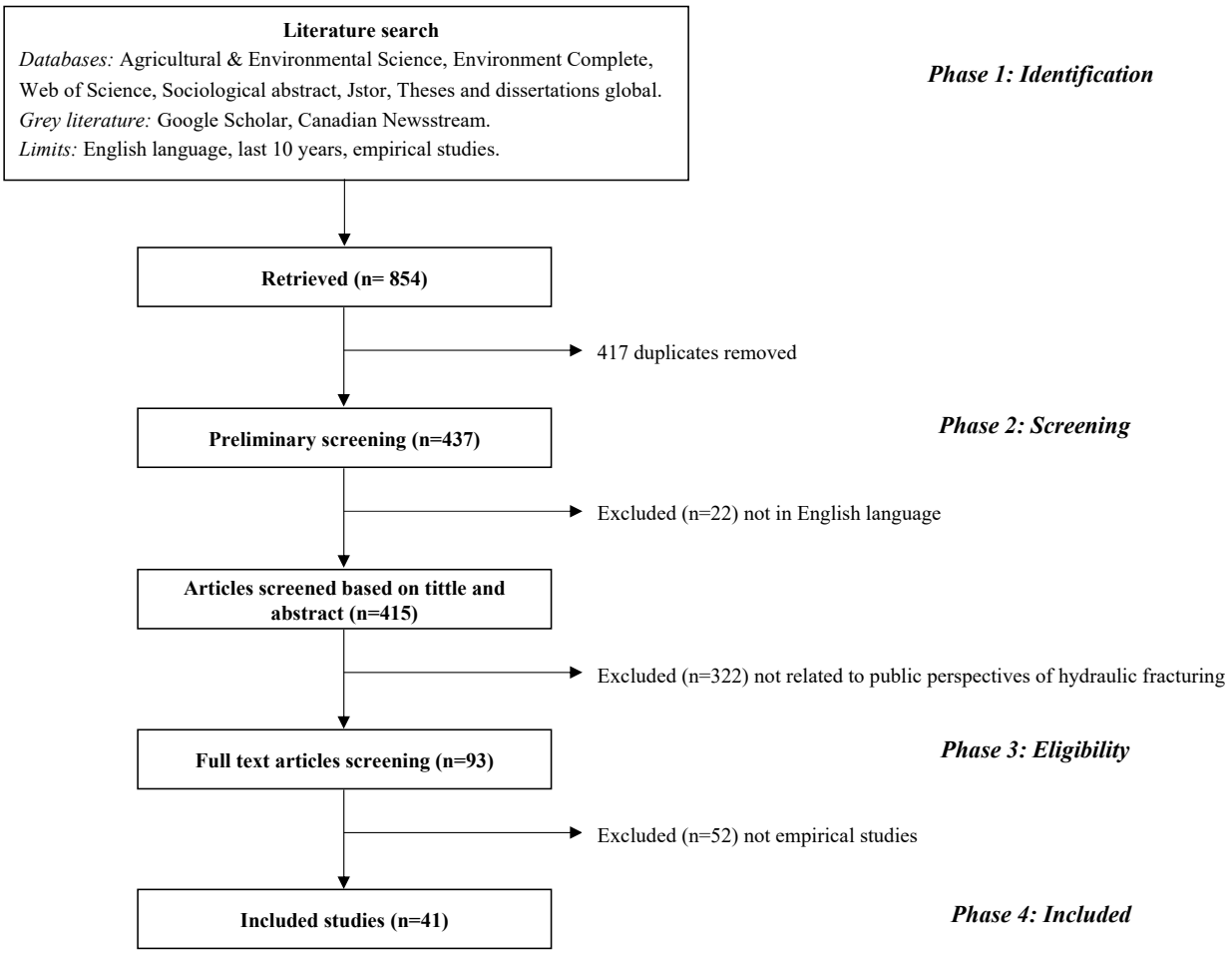

Figure 2.1. Flow diagram of search strategy used for generation of database included in systematic review.

2.2.2. Inclusion/exclusion criteria

All empirical papers from electronic searches were imported into Mendeley Library. Mendeley is a citation management tool that assists with the collection and organization of citations, as well as the insertion of citations into documents and format bibliographies. Mendeley has citation styles that match popular journals and allows authors to choose specific citation style options. After duplicates and non-English papers were removed, I conducted an initial screening to eliminate obvious nonrelevant references. Then I screened the abstracts and full texts of remaining papers and removed those which were not about public perspectives on hydraulic fracturing or not

empirical papers. I confirmed my screening and selection with my supervisor, to produce the final set of 41 studies for further analysis.

2.3. Findings

In this section, I focus on two themes. First, I present the evidence from empirical papers about public perceptions of fracking development in US, Canada, and international countries, concentrating on the responses from residents, landowners, and local leaders in fracking areas, as well as responses from nationwide resident samples. Second, I identify factors that shape public perceptions of fracking by reviewing the articles summarized in Table 2.1.

Table 2.1. Characteristics of included empirical studies

Author, year	Method of study*	Year of study	Place of study	Sample size
Eaton & Kinchy, 2016	1	2009	Pennsylvania, US	16
	1	2014	Saskatchewan, Canada	60
Malin, 2013	1	2011	Pennsylvania, US	47
Ladd (Anthony E.Ladd), 2013	1	2012	Louisiana, US	35
Willow, 2014	1	2012	Ohio, US	31
Kreuze, Schelly, & Norman, 2016	1	2015	Michigan, US	49
Sher & Wu, 2018	1	2015	Sichuan, China	17
Zilliox & Smith, 2017	1	2015	Colorado, US	24
Davidson, 2018	1	2016	Alberta, Canada	12
Crowe et al., 2015	2	2013	Illinois & Kentucky, US	16
Shaw et el., 2015	2	2014	Canada nation-wide	85
Theodori, 2009	3	2006	Johnson county, Texas, US	301
	3	2006	Wise county, Texas, US	299
Stedman, Jacquet, & Fiteau, 2012	3	2009	Pennsylvania, US	1916
Kriesky et al., 2013	3	2011	Pennsylvania, US	1301
Jacquet, 2012	3	2011	Pennsylvania, US	1028
Boudet et al., 2014	3	2012	US nation-wide	1061
Boudet et al., 2016	3	2012	US nation-wide	618
Brown et al., 2013	3	2012	Pennsylvania & Michigan, US	415
	3	2012	Pennsylvania, US	424
Davis & Fisk, 2014	3	2012	US nation-wide	765
Stoutenborough, Vedlitz, & Liu, 2015	3	2012	US nation-wide	1525
Axsen, 2014	3	2013	Canada nation-wide	2628
Ceccoli, 2018	3	2013	US nation-wide	1489
Ciuk & Yost, 2016	3	2013	Pennsylvania, US	446

Author, year	Method of study*	Year of study	Place of study	Sample size
Clarke et al., 2016	3	2013	US nation-wide	1000
Alcorn, Rupp, & Graham, 2017	3	2014	Ohio, Penn, Texas, US	1373
Evensen & Stedman, 2016	3	2014	Pennsylvania, US	1625
Howell et al., 2017	3	2014	US nation-wide	853
Mayer, 2016	3	2014	Colorado, US	322
Sarge et al., 2015	3	2014	US nation-wide	250
Stedman et al., 2016	3	2014	UK nation-wide	3800
	3	2014	US nation-wide	1625
Withmarsh et al., 2015	3	2014	UK nation-wide	1457
Arnord, Darrer, & Holahan, 2018	3	2015	Utica, Eastern Ohio, US	388
Choma et al., 2016	3	2015	US nation-wide	412
Edwards, 2018	3	2015	US nation-wide	911
Howell, 2018	3	2015	UK nation-wide	1745
Christenson, Goldfard, & Kriner, 2017	3	2016	US nation-wide	2000
Costa et al., 2017	3	2016	Spain nation-wide	704
Guenther & Joubert, 2018	3	2016	South Africa nation-wide	310
Lachapelle, Kiss, & Montpetit, 2018	3	2016	Canada nation-wide	2012
O'Connor & Federicks, 2018	3	2016	British Columbia & New Brunswick, Canada	2004
Yu et al., 2018	3	2016	Sichuan, China	730
Pierce et al., 2018	3	2017	US nation-wide	1042

** 1. Qualitative method, 2. Mixed method; 3. Quantitative method.*

2.3.1. Public perceptions of shale gas development

This section includes the perceptions of publics in the US and Canada as well as perceptions of people from other countries about shale gas development via fracking, based on the 41 empirical papers selected for the review.

2.3.1.1. Voices from the US and Canada

Studies on public perceptions of shale gas exploration using fracking technology have been mostly conducted in the US. Only a few publications from Canada, UK, and China have been added to the field. Up to now, the US is still the world's largest producer of natural gas, with two-thirds of their wells being drilled with fracking (Perrin, 2016). Among thirty publications about public perceptions of fracking in the US and Canada, eight of them focused on Pennsylvania, location of the Marcellus field, the largest shale gas play in the US, which extends throughout

much of Pennsylvania and West Virginia, reaching also into large sections of New York and Ohio (Eaton & Kinchy, 2016). A smaller set of studies have been conducted on perceptions of fracking in regions where the Utica, Haynesville, Antrim, Albany, and Barnett Shale plays are located (all in the US). In Canada, most of the studies conducted to date were based on data collected from Alberta, British Columbia, and Saskatchewan, the only Canadian provinces where fracking is taking place. Internationally, several papers about public perceptions in the UK, China, South Africa, and Spain are also included in this review.

As shown in Figure 2.2, the frequency of studies on shale gas development using fracking technique and residents' perceptions has significantly grown since 2015, illustrating the growing interest in this field.

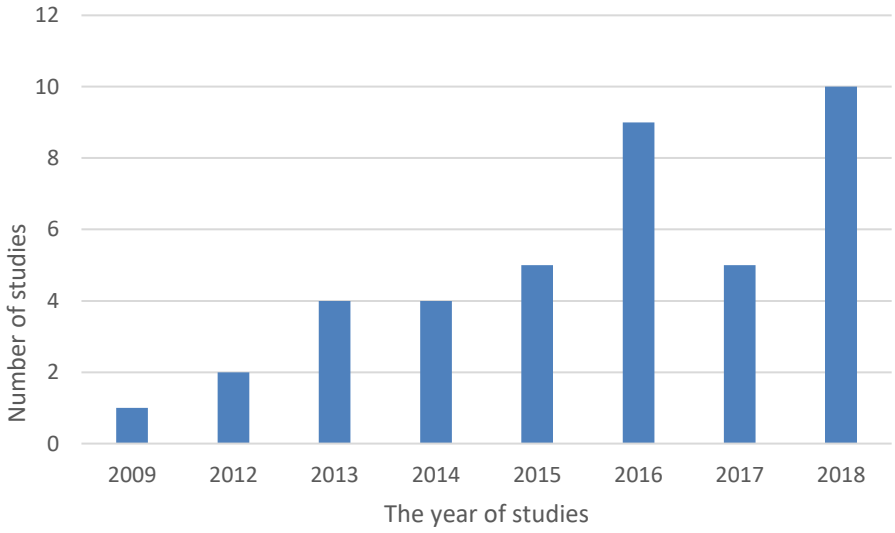

Figure 2.2. Number of empirical studies towards public perspectives on shale gas development via fracking, by the year of study

In this section, I group the voices of residents in the US and Canada into four categories: the voices of landowners who live in or near fracking zones, the voices of local residents who live in or near fracking zones, the voices of nationwide residents (non-local residents), and the voices of authorities about fracking.

Landowners who live in the area with underlying shale gas deposits have different perspectives toward fracking. Based on their economic positions with respect to the energy industry, they either support or oppose fracking operation in their communities. Jacquet (2012) described how landowners in Bradford counties and the Armenia Mountains in northern Pennsylvania, an area which was at the early stage of shale gas development at the time of the study, were encouraged by industry to sign contracts with gas companies in exchange for lucrative signing bonuses, annual lease payments, and the promise of large royalty payments. Those with natural gas leases were more likely to have positive attitudes towards fracking, since they received economic benefits from shale gas operations. At the earliest stage of shale exploration, most of the landowners believed that fracking would bring more economic benefits than costs to themselves and their communities (Jacquet, 2012; Nikiforuk, 2015). These landowners acknowledged that to enjoy the economic benefits; they would have to accept the risks associated with energy development. Furthermore, at such an early period of development, residents did not have first-hand experience with the impacts of fracking, even if they were aware of them (Eaton & Kinchy, 2016; Malin, 2014), and thus their support was decline once experiences with negative impacts mount (Jacquet, 2012; Nikiforuk, 2015). Similar to Jacquet's study, the majority of landowners in Bradford, Susquehanna, and Washington Counties, Pennsylvania, were found to be highly supportive of fracking for shale gas, attributed to the expected economic benefits, with some even expressing that "environmental concerns were based on irrational opinions, not facts" (Malin, 2014, p. 22-3). Other citizens in this study indicated awareness of environmental problems related to fracking but, viewing the decision with a cost-benefit framework, considered the impacts as a necessary cost that would be self-monitored by local landowners (Malin, 2014). In contrast, landowners who lived in the area, previously dominated by farming, wood products production, and service industries, expressed their

grievances regarding the negative impacts of fracking on their land uses and public health since shale gas exploration began in their communities. For instance, landowners from Saskatchewan (Eaton & Kinchy, 2016), Eastern Ohio (Willow, 2014), and Southern Alberta (Davidson, 2018, Nikiforuk, 2015) witnessed environmental degradation in terms of water and airborne contamination. However, given that fracking activities persisted in these places despite the expression of residents' concerns, many research subjects indicated that they felt ignored (Davidson, 2018; Eaton & Kinchy, 2016; Willow, 2014). Many fracking opponents, however, have not mobilized against fracking activities in their communities due to a feeling of powerlessness (Davidson, 2018; Eaton & Kinchy, 2016; Sher & Wu, 2018; Willow, 2014), and the lack of organizational capacity or political opportunities (Eaton & Kinchy, 2016). These residents felt powerless to confront challenges they might have in fighting against shale gas development, as their governments expressed strong support for the economic benefits of shale gas production via fracking (Eaton & Kinchy, 2016; Nikiforuk, 2015). Disempowerment was routinely reported in communities, where people were no longer be able to determine what took place in their property and living environment, with existing or potential environmental hazards (Davidson, 2018; Eaton & Kinchy, 2016; Nikiforuk, 2015; Willow, 2014). These rural landowners either expressed their grievances individually by making police reports or confronting the workers of oil and gas companies (Eaton & Kinchy, 2016), remained silent (Eaton & Kinchy, 2016; Malin, 2014), or relocated (Willow, 2014).

Local residents of the fracking areas in the US and Canada have different perspectives toward fracking. Residents in a community where fossil fuel exploration was more mature held more positive views about the contributions of shale gas operations to their communities than people who lived in places where there were fewer drilling activities, even though those residents may nonetheless have concerns about water contamination associated with fracking operations (G.

Theodori, 2009). For example, the majority of the local residents near Philadelphia (Evensen & Stedman, 2016; Jacquet, 2012; Kriesky et al., 2013), Northwestern Ohio (Alcorn, Rupp, & Graham, 2017; Arnold, Farrer, and Holahan, 2018), Michigan Basin (Kreuze, Schelly, & Norman, 2016), Texas (Alcorn et al., 2017), and New Brunswick (O'Connor & Fredericks, 2018) tended to view hydraulic fracturing activities as important to their state economies, although they expressed concerns about the risks associated with fracking. In contrast, residents included in study samples in New York (Evensen & Stedman, 2016), Northern Tier Pennsylvania (Eaton & Kinchy, 2016), Eastern Ohio (Willow, 2014; Willow & Wylie, 2014), Southern Alberta (Davidson, 2018, Nikiforuk, 2015), and British Columbia (O'Connor & Fredericks, 2018) opposed shale gas development due to its associated risks, or due to the lack of respect of authorities to local residents' concerns about the impact of fracking on social and ecological values while making decisions on shale development projects (Shaw et al., 2015). The local peoples included in these studies expressed similar feelings of helplessness and distrust in authorities due to their failure to respond to fracking concerns in a manner expected. Importantly, the interaction between the local culture and economic relationships to the industry facilitated the corrosion of communities (Davidson, 2018, p. 206).

Regarding studies based on national population samples, (See Table 2.2), among 11 US national surveys and polls about public attitudes of fracking from 2011 to 2017, less than half of nationwide respondents supported this drilling technique. On the other hand, in the YouGov National Survey conducted by Stedman and colleagues in 2014, 58.9% of respondents supported fracking. However, the level of support or opposition to fracking of the American population was inconsistent; indeed, it differed greatly even across studies conducted in the same year. Additionally, a high percentage of respondents in the US national studies (i.e. primarily respondents who do not reside in fracking regions) were undecided when asked about their

perspectives on fracking. This was indicated most strongly in Boudet's study in 2014, which showed 58% of respondents were ambivalent about fracking. As mentioned by Boudet, American populations were largely unaware of fracking and they did not know or were undecided about whether to support or oppose it (Boudet et al., 2014). In Canada, Lachapelle et al. (2018) used an online national survey conducted in 2016 of 2,012 adult Canadians to investigate public perspectives on fracking. The results showed that the mean value of support for fracking in this nationwide Canadian sample was 3.97 (level of support or opposition to fracking was measured using a-ten-point scale from "0" = "strongly oppose" to "10" = "strongly support"). Perceptions of fracking were found to vary widely by province in this study, with relatively low public support in Quebec, and significantly higher public support in the Prairie provinces of Alberta, Saskatchewan, and Ontario (Lachapelle et al., 2018, p. 640).

Table 2.2. Public perspectives on shale development using fracking technique, results from US nationwide surveys.

Author, year	Year of study	Method of study	Sample Size	Mean	Perspectives on fracking (%)		
					Supported	***Opposed***	***Undecided***
Edwards, 2018	2011	March # 2, 2011 CBS News Poll (landline & cellphone)	1022	-	47.6	37	15.4
Boudet, 2014	2012	Climate Change in the American Mind Survey (online)	1061	-	22	20	58
Davis & Fisk, 2014	2012	Nationwide Austin Energy Poll (landline & cellphone)	764	-	45	40	15
Ceccoli, 2018	2013	Pew Research Center National Survey (landline & cellphone)	1215	-	45.2	47.4	7.4
Clarke et al., 2016	2013	Cornell National Social Survey (landline & cellphone)	500	2.4[1]	-	-	-
Stedman et al., 2016	2014	YouGov National Survey (online)	1625	-	58.9	24.5	16.6

Author, year	Year of study	Method of study	Sample Size	Mean	Perspectives on fracking (%)		
					Supported	***Opposed***	***Undecided***
Sarge et al., 2016	2014	MTurk Survey (online)	250	-	22	47	31
Howell et al., 2017	2014	GfK Group National Survey (online)	853	4.5[2]	-	-	-
Choma et al., 2016	2014	MTurk Survey (online)	412	3.6[3]; 2.3[4]	-	-	-
Christenson et al., 2017	2016	YouGov National Survey (online)	2000	-	33	37	30
Pierce et al., 2018	2017	MTurk Survey (online)	1042	-	48.9	34.3	16.8

[1]: Support for fracking was measured by the scale of "1" = "Strongly oppose" to "4" = "Strongly support"
[2]: Support for fracking was measured by the scale of "0" = "Do not agree at all" to "10" = "Agree very much"
[3]: Fracking risk attitudes were measured by the scale of '1'= strongly disagree to '5'=strongly agree
[4]: Fracking economic attitudes were measured by the scale of '1'= strongly disagree to '5'=strongly agree

The voices of authorities about fracking were the center of several studies. For instance, Kreuze and colleagues (2016) conducted a qualitative analysis of the perspectives and concerns of local authorities in Crawford and Barry counties in Michigan. Crawford County has high volume fracking (HVF) wells and the most wells in the state, whereas Barry County does not have any HVF wells, but many oil and gas leases have been signed (Kreuze et al., 2016). Although these two counties have differences in levels of HVF activities, local authorities of these counties shared expressions of a lack of power that local authorities have in making decisions or regulations of HVF activities in their communities. In fact, they expressed concerns about the high volume of water used in fracking and water contamination associated with drilling practices. They further expressed their frustration and sense of powerlessness, because their concerns were not accounted for in regulatory decision making by other governing bodies with jurisdiction over approval of fracking wells, the location of wells, and regulations of the related activities of the wells (Kreuze et al., 2016). In the study by Crowe et al. (2015), local leaders in the New Albany Shale Basin in Southern Illinois and Northwest Kentucky showed a split in their views of shale development in the region. While a split existed, over half (10 out of 16) favored the introduction of fracking for shale oil and gas in their communities, with the expectation of

economic benefits. These leaders also framed the public views of fracking for oil and gas as a benefit to their communities. On the contrary, four leaders expressed opposition to fracking due to potential environmental and social threats including water contamination, seismicity, housing costs and shortages, demands on social services, and crimes. The remaining two leaders were undecided due to lack of information about the issue. Although leaders' perceptions of shale development in this region were not completely similar, these leaders shared common views about public attitudes toward shale development based on expected economic benefits. They anticipated that local residents would support fracking for shale oil and gas because of the economic benefits from this industry and residents' familiarity with fossil fuel extraction in their communities. These leaders' perceptions of the public attitudes of fracking, however, were not in alignment with public response about fracking. In fact, survey data of that study showed that about half of the community members believed that fracking for shale gas and oil should not be encouraged due to environmental impacts. This difference may originate from the lack of public hearing about shale development since one of the leaders emphasized that there hadn't been any public forum or anything like that about shale development and fracking in the regions where major shale plays were located (Crowe et al., 2015).

2.3.1.2. Voices from residents of other countries

Whitmarsh and colleagues (2015), using a national survey, found considerable ambivalence about fracking for shale oil and gas among the public in the UK, but respondents indicated a greater awareness of potential risks than benefits (Whitmarsh et al., 2015). In another national survey conducted in the UK a year later, Howell found 36% of respondents supported fracking for shale gas, while 32% were opposed in a national sample. However, at the local level, only 22% of local residents supported the development of shale gas, while 45% were opposed (R. A. Howell, 2018). Another online survey conducted in the UK in 2014 showed that 44% of UK

respondents supported fracking for shale oil and gas, and 27% were opposed (Stedman et al., 2016).

In a national survey conducted in Spain, half of the participants opposed fracking for shale gas, and the opposition was higher in communities that were closer to shale development sites (Costa, Pereira, Góis, Danko, & Fiúza, 2017). The majority of participants (53.6%) stated that there was not enough information to have a reliable opinion on fracking for shale gas, 68.7% of them suggested more studies were needed, and 49% indicated that their opinion could change in response to the results of further research on environmental impacts of this drilling technique (Costa et al., 2017).

In 2015, to investigate local perspectives on fracking in Sichuan province in China, Sher and Wu (2018) interviewed local villagers in Xinchang township, where the first fracking well in China was drilled in 2010, and in Jiaoshi township where the largest scale of fracking for shale gas production existed. Results showed local people reported economic and social benefits from fracking via leasing land, increasing jobs for local people, and improving local infrastructures. However, respondents expressed concerns about water contamination, air pollution, and noise of drilling activity. Despite the negative impacts of fracking, local villagers all indicated support toward fracking for shale gas due to both economic benefits and government interventions. They stated that they did not feel that they could oppose fracking for shale development project, because "it was a government project and they did not want political pressure as well as bad experiences in protesting the government" (Sher & Wu, 2018, p. 639). Through the online survey in 2016, Yu et al. (2018) describe a different story about local responses to fracking in the Sichuan Basin, China. 61.1% of the respondents strongly believed that fracking for shale gas improved the local economy, while 86% of them reported negative impacts of fracking, including water contamination, noise pollution, and geological disruption. Based on their views of shale gas

development impacts, 36.6% of respondents opposed fracking for shale gas in their community (Yu et al., 2018).

2.3.2. Factors shaping public perceptions of fracking

2.3.2.1. Perceived benefits and risks

Through the 41 articles included in this study, perceived risks and benefits were the most prevalent drivers of support or opposition to fracking. Those who had higher risk perceptions of fracking were less likely to support it, while having higher benefit perceptions was associated with greater support (Edwards, 2018; Howell et al., 2017).

Economic improvement was the most commonly reported perceived benefit of shale gas development, including such expectations as boosting local economies by creating more job opportunities, increasing local and state tax revenues and housing values and benefiting local businesses (Edwards, 2018; Howell et al., 2017); and on the personal level bringing lucrative signing bonuses to landowners, and increasing their incomes through annual lease payments and royalty payments (Ladd, 2013; Sarge, Vandyke, King, & White, 2015). A number of respondents also expressed support on the basis of expected benefits that would accrue at the macro-level, including the prospect of increased domestic oil and gas production contributing to a reduction in dependence on energy importation and contributions to national energy security (Jacquet, 2012; Ladd, 2013). Others viewed fracking as a 'cleaner' option leading to overall reductions in air pollution since natural gas has been depicted as a cleaner energy source by reducing CO2 emissions in comparison to coal burning (Ladd, 2013).

Negative environmental and social impacts were the main perceived risks associated with fracking (Davidson, 2018; Jackson et al., 2014; Nikiforuk, 2015; Schultz et al., 2018; Willow, 2014). Growing awareness of negative impacts from fracking has been raising concerns, particularly regarding water use and water contamination, which were the most cited

environmental impacts. Other problems of concern to members of the public in these studies included air pollution, ecological system disturbance, and the increase in frequency and magnitude of seismic events (Davidson, 2018; Eaton & Kinchy, 2016; Ellsworth, 2013; Howell, 2018; Schultz et al., 2018; Willow, 2014). Additional concerns related to fracking included local impacts such as traffic, road safety, noise, and light pollution (Ladd, 2013; G. Theodori, 2009). Participants also spoke of persistent fear of future exposure to negative impacts of fracking (Davidson, 2018; Willow, 2014).

2.3.2.2. Issue awareness

Issue awareness or familiarity with fracking was found to be correlated with public perspectives on fracking operations in different ways at different locations. In the US, familiarity with fracking has been found to be associated with lower levels of support in some studies (Choma, Hanoch, & Currie, 2016) and opposition in others (Boudet et al., 2014). In the UK, familiarity with fracking was found to be positively associated with support (Andersson-Hudson, Knight, Humphrey, & O'Hara, 2016; Stedman et al., 2016). In contrast, Howell (2018) found that respondents who had more knowledge about fracking were more likely to hold negative beliefs about fracking than were less knowledgeable respondents (R. A. Howell, 2018, p. 728). In Canada, Lachapelle et al (2018) indicated that the negative effect of issue familiarity on public perspectives toward fracking was significantly more negative in the province of Quebec, a place with limited experience with oil and gas development and overwhelmingly negative media coverage of fracking (Lachapelle et al., 2018). In contrast, the effect of issue familiarity was significantly more positive in Saskatchewan. This study was consistent with previous research that had documented more positive media coverage of this issue in the Canadian Prairies (Olive, 2016). Self-reported issue familiarity was associated with significantly less support in a national online survey in Canada conducted by Leger research firm (Lachapelle et al., 2018).

2.3.2.3. Proximity

The Not In My Back Yard phenomenon (NIMBY) is a characterization of residents opposing proposed development in their communities (Swofford & Slattery, 2010). However, studies on public perspectives on fracking using proximity have revealed significant variation in opinions across regions. For instance, several studies disclosed that residents living in areas of intense drilling activity were more supportive of drilling than residents who lived in places where fewer drilling activities had been done, especially landowner-supporters who directly received income from drilling activities on their property, through leasing and royalty payment (Jacquet & Stedman, 2013). In contrast, at the national level, few of the studies that examined the relationship between public responses to fracking and proximity to fracking operations found those who lived closer to the development had greater support for fracking (Clarke et al., 2016; Howell et al., 2017). In addition, Clarke et al. (2016) found that as distance increased, the difference between conservative support and liberal opposition became larger, with moderates and conservatives becoming more supportive while liberals remain their level of opposition to fracking (Clarke et al., 2016). These above findings were largely generated from the use of quantitative methods. Nevertheless, conducting in-deep interviews with the local residents in intense fracking areas, scholars found different stories about the relationship between proximity and social perceptions of drilling. For example, social scientists have provided evidence that many local landowners and residents in the US and Canada strongly opposed to drilling activities in their living areas due to the negative environmental and social impacts associated with fracking to which they and their families had been directly exposed (Davidson, 2018; Willow, 2016; Zilliox & Smith, 2017).

2.3.2.4. Socio-demographic factors

Gender and political ideology have been found to be correlated with public perspectives toward fracking development. Women have been consistently found to be somewhat less supportive of hydraulic fracturing than men (Boudet et al., 2014; Davis & Fisk, 2014; E. L. Howell et al., 2017). Political conservatism predicted lower risks associated with fracking and tended to predict support for fracking, while political liberalism has been associated with perceptions of higher risks of this technology, and thus liberal survey respondents in several studies were more likely to oppose this technology (Boudet et al., 2014; Clarke et al., 2016; Davis and Fisk, 2014; Sarge et al., 2015; Christenson et al., 2017). The positive relationship between conservative political ideology and support for fracking was found to be stronger in states with higher poverty rates (E. L. Howell et al., 2017).

2.4. Conclusions and future research suggestions

I conducted a systematic review of 41 empirical research articles in English published from 2008 to 2018, focusing on public perspectives on shale development via fracking in the US, Canada, and other countries. The prevalence of studies focused on the US and to a lesser extent Canada on public perspectives on fracking is perhaps justified, since these nations have been at the forefront of shale development using fracking drilling technique. Within the US, scholars have expressed a greater interest in the Marcellus Shale Play which is located in Pennsylvania, than other shale plays. The smaller set of studies about public attitudes of fracking in Canada indicate many similarities to US studies in the ways that publics respond to fracking. Other reviewed studies conducted in other countries contribute to a comprehensive understanding of public attitudes about fracking globally. Broadly, the story of public perspectives on shale development via fracking technique is about two issues: the perceptions of risks versus benefits of fracking and the level of direct exposure to fracking's impacts.

The perceptions of risks versus benefits of fracking operations are varied through different shale development phases (Jacquet, 2012). At every period of the drilling operation, from the pre-development to the peak of development, and to the decline periods of shale operations, local people have experienced different types of economic, social, and environmental impacts associated with fracking. However, among 41 reviewed empirical papers, there was not a single study that measured changes in local perspectives during the life span of a shale development project. Therefore, it would be beneficial to use longitudinal research designs that allow scholars to be able to thoroughly investigate changes in residents' responses to fracking operations in their communities. Results from this type of research could provide unique insights into the evolution of local perspectives about shale development.

The level of direct exposure to fracking's impacts shapes the local perspectives on fracking operations. For example, Albertans were found to be highly supportive of shale gas development in national surveys (Axsen, 2014; Olive, 2016) that used representative samples. However, those who experienced impacts of fracking firsthand expressed high levels of concern toward fracking, as distrust of local authorities who failed to address those concerns (Davidson, 2018; Nikiforuk, 2015). A similar story was found in Ohio, where local people strongly opposed fracking due to its associated risks to their livelihood and health (Alcorn et al., 2017; Eaton & Kinchy, 2016; Willow & Wylie, 2014). Also, the wide variation in responses of the participants in many US nationwide surveys toward fracking operations even in the same year of study was noted. This variation might be the result of differences in the method of study. Although both quantitative and qualitative methods offer their own merits, most of the evidence of local opposition to fracking was found in studies using in-depth interviews, the method that sought out interviewees with particular perspectives. Therefore, the story of public attitudes about fracking should be told through both qualitative and quantitative methods to fully explore local voices of fracking.

The 2010 US Gasland documentary film contributed to the growth of global anti-fracking movements; according to one source, the film led to the formation of over 100 local anti-fracking groups globally (Admin Fracking News, 2014). Anti-fracking mobilization successfully prevented fracking in some regions in Canada including Quebec, New Brunswick, Lethbridge, Nova Scotia, and Yukon Territory, and New York State and several municipalities and counties in the US (Admin Water Docs, 2018). These anti-fracking groups played an important role in preventing oil and gas drilling within their regions. However, while not the focus of the current review, there would appear to be relatively little research being conducted on the effects of these anti-fracking groups on social and political responses to fracking. Therefore, further research about the impacts of anti-fracking-networks/groups on social and political responses toward shale gas development, especially in high-volume fracking areas, is suggested.

The literature shows a difference in the levels of support for and opposition to shale development via fracking across regions within the US and Canada. Even within one region, local attitudes toward fracking can be highly varied. For example, residents in Northwestern Ohio (Alcorn et al., 2017) and Bradford County in the North of Pennsylvania (Jacquet, 2012) expressed strong support for fracking . On the other hand, residents of Eastern Ohio (Willow, 2014) and Northern Tier Pennsylvania (Eaton & Kinchy, 2016) strongly opposed fracking in their communities. A number of papers also highlight the degree to which acceptance of fracking risks can be associated with a wide range of values and beliefs (Boudet et al., 2014; Christenson et al., 2017), and the perceived distribution of risks and benefits (Davidson, 2018; Ladd, 2013; Willow & Wylie, 2014), which suggests the critical importance of local context in shaping public views of fracking in a particular location or nation. Research should therefore include comparative studies of different local contexts to further explore factors associated with public acceptance (or rejection) of fracking.

I find general similarities between Canada and the US in terms of local residents' responses to fracking where shale oil and gas extraction has had a negative effect on pre-existing local livelihoods. People living in these areas tended not to have previous experiences with the oil and gas industry. In other words, they are engaged in farming, production of wood products, or providing various services. After shale extraction was introduced to their regions, many of these local peoples were exposed to first-hand experiences with fracking impacts, particularly water contamination and health problems (Davidson, 2018, Eaton & Kinchy, 2016; Nikiforuk, 2015; Willow & Wylie, 2014). The common responses of these people toward fracking was grievance regarding unexpected negative impacts to in their environment, families and communities (Davidson, 2018; Willow, 2014). These people share feelings of powerlessness when they feel their concerns about the impacts of fracking are not addressed. They also express their distrust in government authorities, who did not respond to local people's concerns about fracking in a manner expected (Davidson, 2018; Eaton & Kinchy, 2016; Nikiforuk, 2015; Willow & Wylie, 2014). Local peoples have the right to have their voices about fracking heard and to have opportunities to engage in the decision-making process related to shale operations in their communities, since they are not only in some cases the direct beneficiaries of energy projects, but also the potential victims of environmental and technological risks related to fracking.

Chapter 3. Context matters: Fracking attitudes, knowledge, and trust in three communities in Alberta, Canada

3.1. Introduction

In recent decades, the development of technological advances in horizontal multi-stage hydraulic fracturing - a method of extracting unconventional oil and gas reserves by injecting a pressurized mixture of silica, water, and chemicals that fractures the hard rocks and shale to release oil and gas from shale - has generated controversy across North America, Australia, China, and other countries where fracking has emerged. Supporters of this technique, known in short as fracking, claim that fracking offers energy security and large economic benefits in the form of employment and tax revenues for local communities (Considine et al., 2010; Hultman et al., 2011; Jackson et al., 2014). However, research has produced an increasing evidence base of fracking's negative social and environmental impacts, raising concerns about water use and contamination (Coram et al., 2014; Korfmacher et al., 2013), air quality and greenhouse gas emissions (Jackson et al., 2014; Litovitz et al., 2013; Roy et al., 2014), ecological system disturbance (Sawyer et al., 2013; Trexler et al., 2014), increasing seismic events (Ellsworth, 2013; Kerr, 2012; Schultz et al., 2018), and health impacts (Warner et al., 2013).

Canada is one of the world's largest producers of energy (Natural Resources Canada, 2017) including an estimated 30.8 trillion cubic meters of natural gas, although 72% of this is trapped in shale, primarily located in Alberta and British Columbia (National Energy Board, 2017), which requires fracking in order to access it. In Alberta, more than 10,000 wells have been fracked since 2008, and the provincial government has been promoting expansion of this industry (Natural Resources Canada, 2017). Fracking for natural gas is just one feature of the energy industry in the Province, however Albertans have enjoyed the fruits of oil production for over a century, affecting everything from government decision-making to regional culture, such that some

commentators refer to the province as a 'petro-state' (e.g. Adkin, 2016; Davidson et al., 2011; Taft, 2017). Since the beginning of the 21st century, the Athabasca oil sands have dominated the sector, contributing to a near-continuous growth in production volume over the past 20 years (Alberta Government - Economic Dashboard, 2019). Although the proportion of provincial revenues from energy have declined during this period, they still make up a substantial share of 11 percent (Alberta Annual Report, 2019).

Given this historical context, I might anticipate strong public support for fracking, despite the concerns regarding the health and environmental impacts of fracking that have been raised elsewhere. However, Canada, including Alberta, has been subject to relatively limited research on public perceptions of fracking. In one recent nation-wide study, Lachapelle and colleagues (2018) found widely varying levels of support within Canada, with respondents in the Prairies notably more supportive (Lachapelle et al., 2018). Another study examining public perspectives on fracking development showed that most Albertans supported unconventional fossil fuel development, including fracking (Axsen, 2014). However, even in a province with such a strong historical relationship with the oil and gas industry, attitudes toward fracking may vary widely, particularly given the localized nature of impacts. One earlier qualitative study did reveal that some local citizens exposed to the impacts of fracking have expressed concerns similar to those expressed by residents elsewhere (Davidson, 2018). Moreover, municipalities can play an influential and yet varied role in policy responses to the environmental and health risks from fracking (e.g. Larkin et al., 2018). An emphasis on the local scale is thus relevant not only in order to unpack what I expect to be significant regional variations in perceptions but also because such localized expressions of concern may have a substantial influence on municipal-level policy responses.

I sought to capture a wide variation in local context in our selection of three communities for this study. The City of Lethbridge is the fourth largest city in the province with a population of 92,730 (Statistics Canada, 2016b) and hosts a mixed economy with services and post-secondary education. This city was the first municipality in Alberta to oppose fracking by passing an official resolution on November 13, 2012 to prevent oil and gas drilling within city limits (Patterson, 2013). The City Council reaffirmed its opposition to fracking in an official statement issued on September 16, 2013 when GoldenKey Oil publicly announced its intentions to pursue fracking within the city limits of Lethbridge (No Drilling Lethbridge, 2017a). This decision coincided with actions taken by No Drilling Lethbridge, a small local organization, which collected 11,000 signatures on a petition presented to the Alberta Energy Regulator (AER) to request a ban on drilling for oil and gas in Lethbridge. This petition was tabled in the legislature in March 2015 and shortly thereafter Goldenkey Oil retracted its application to frack for oil in Lethbridge (No Drilling Lethbridge, 2017a). Lethbridge government and citizens opposed the oil exploration project of Goldenkey Oil company in Lethbridge due to concerns about the environmental effects of fracking activities and the lack of transparency regarding corporation ownership, extent of the mineral license, history of non-compliance, water sourcing, and consultation with Lethbridge city council (Josefina AT, 2015).

Fox Creek, on the other hand, is a small town with a population of 1970 (Statistics Canada, 2016a). This town is highly dependent upon the oil and gas industry. The revenue from oil and gas companies accounts for about 95 percent of the district's total revenue, and it was $77 million in 2018 (Riley, 2019). In Fox Creek, the Kaybob assessment area has experienced the most development with 197 gas wells and 11 oil wells drilled as of the end of December 2015 (Preston, Garner, Beavis, Sadiq, & Stricker, 2016). Concerns have also been raised in recent years about the implication of methane – a potent greenhouse gas commonly leaked intentionally

flared in natural gas production. A study published earlier this year in the journal BiogeoSciences posited that methane from shale gas may have bigger implications for the climate change than previously thought. Additionally, Fox Creek is also the location of Alberta's first earthquakes found to be associated with fracking activities, with some over 4.0 on the Richter scale (Schultz et al., 2018). The magnitude 4.8 quake on January 12, 2016 forced a shutdown of extraction activities by Repsol Oil and Gas site in Fox Creek (Braken, 2016). A study published in the journal *Science* noted a sharp increase in the frequency of earthquakes near Fox Creek, Alta., began in December 2013 in response to fracking and further confirmed that earthquakes in Fox Creek are linked to fracking operations (Schultz et al., 2018). Although some residents expressed their concerns about the increase in frequency and magnitude of earthquakes in their communities (Giovannetti, 2015), this has not slowed down drilling activities in Fox Creek. Up to now, there has been no organized response to fracking from people in this town.

Rosebud, an even smaller community, with 85 people (Statistics Canada, 2016c), is an agricultural, theatre, arts and music community located in Wheatland County, in South-Central Alberta. Rosebud sits on part of the Horseshoe Canyon Coal reserve, which includes a 50,000 acres deposit of unconventional gas (Nikiforuk, 2015). Between 2000 and 2002, Encana and Calgary-based MGV, both energy companies, drilled and fracked several hundred experimental wells to determine the most economical way to take methane out of the Horseshoe Canyon Coals (Nikiforuk, 2015). In 2003, many farmers signed new gas well leases with Encana in anticipation of economic benefits. However, dozens of Rosebud residents soon thereafter flooded the Regulator with complaints about compressor noise, increase in traffic levels, and insufficient consultation about the coalbed methane fracking activity, but little appeared to change (Nikiforuk, 2015). There was no organized response to fracking from the residents of Rosebud ; however, one of Rosebud's residents, Jessica Ernst – a biologist and former oil field consultant,

filed a Statement of Claim in 2007 against Encana for contaminating her water well and other wells in her community (Nikiforuk, 2017). She further filed a claim against Alberta Environment for failing to properly investigate the groundwater contamination. The multi-million-dollar lawsuit of Jessica Ernst, started in 2011, was ultimately rejected by the Supreme Court in January 2017 for the reason that she can't sue AER over alleged violations of her Charter rights, because the AER is given immunity by provincial legislation, but the case drew international attention and local sympathy (The Canadian Press, 2015).

Given the expectations for expansion of fracking activities and the noted variation in community response to fracking in Alberta, exploring the drivers of public perceptions about fracking is well warranted. Albertans' perspectives regarding oil and gas development are undoubtedly shaped by their regional economic and historical context, with expectations of high levels of support and tolerance for the environmental impacts of these development activities. Our study was motivated by two research questions: (1) What are the public perspectives on fracking in regions where fracking is operating or will be operated? (2) In what ways do local contextual factors help shape these attitudes? In response to these questions, I used a hierarchical multiple regression model to examine the roles of gender, employment in the oil and gas sector, geographical location, trust in government and government bodies, and factual knowledge about fracking as predictors of attitudes toward fracking in Lethbridge, Fox Creek, and Rosebud. Our findings highlight the relevance of local histories and economic context to environmental concern, and support for fracking.

3.2. Literature review

Many factors can influence the formation of personal perspectives on fracking. In this section, I focus on previous studies of fracking perceptions, highlighting research regarding the influence of proximity, knowledge, trust, and sociodemographic variables.

Published studies tend to show a relatively ambiguous relationship between proximity to fracking and public perceptions (Batel and Devine-Wright, 2015). Jacquet (2012) found no relationship between the two, while others found living closer to energy development to be associated with increased support (Boudet et al., 2014). Evensen and Stedman (2016) found that beliefs about specific impacts were strongly linked to perceptions of local shale gas development (Evensen and Stedman, 2016). These variations in perceptions could be attributed at least in part to locally-expressed discourses, ideological values, and local experiences (Swofford and Slattery, 2010).

Familiarity with fracking is another factor that has been found to be correlated with perceptions of this technology. People are more likely to oppose risks that are perceived to be unknown (Boudet et al., 2014). Limited knowledge of the process of fracking and its impacts creates uncertainty about whether to support or oppose fracking (Boudet et al., 2014). Findings regarding the influence of familiarity, however, are inconsistent. Some studies have found knowledge or familiarity to be positively associated with opposition (Boudet et al., 2014; Choma et al., 2016; Howell, 2018; Stedman et al., 2016), while other studies particularly those conducted in the U.K., find the opposite (Anderson, 2010; Stedman et al., 2016). Lachapelle, et al. (2018) found that in Canada the effect of knowledge and familiarity on public perceptions of fracking varied by region. At the national level, familiarity with fracking was associated with less support, but in some provinces, including Alberta, familiarity with fracking was linked to increasing support (Lachapelle et al., 2018).

Trust is another important factor in public perceptions of industrial activities like fracking. Trust in a given institution tends to be positively associated with support for the decisions made by that institution (Hetherington, 1998). Trust in government institutions is related to satisfactory experiences with government bodies (Thomas, 1998), and “congruence between citizens'

wishes/expectations and government policy or the way in which government functions" (Bouckaert & Van de Walle, 2003:338). Public trust in government institutions is consequently important for the social license of resource development projects (Gross, 2007). With respect to activities that are associated with risks, social scientists have found that high levels of trust are associated with lower concern (Siegrist et al., 2003). Smith and colleagues (Smith et al., 2013) also confirmed that individuals with higher levels of general trust toward authorities tended to not get involved in natural resource development issues, as they trust governing bodies to do the right thing.

Governmental bodies in some cases may be losing the trust of public, however, due to a perceived decline in accountability. Although trust levels in Canada have been less subject to inquiry, public trust in government has been in long term decline in other regions (Bovens & Wille, 2008; Van de Walle et al., 2008). Declines in political trust were well documented in the U.S. in particular: the percentage of Americans who trusted their government to do the right thing was 75% in 1958, but just 21% in 1994, and 18% in 2017 (Pew Research Center, 2017). Trust in government also varies depending on one's education, age, household income, and economic circumstances (Hudson, 2006). This decline in trust could be observed in relation to energy development. The lack of trust in the competence of the U.S. Department of Energy, for example, led to public rejection of a high-level nuclear waste repository in Nevada (Kunreuther et al., 1990). Local residents in Colorado considered the Colorado Oil and Gas Conservation Commission (COGCC) to be "too closely align[ed] with the oil and gas industry" to be trusted with the safe regulation of that industry (Mayer, 2016:751), depicted by some as the "fox guarding the henhouse" (Opsal & O'Connor Shelley, 2014:575).

Several socio-demographic factors have also been found to influence perspectives on fracking. Women are more likely than men to express concern for the potential risks associated with

emerging technologies (Bullock & Vedlitz, 2017; Whitmarsh et al., 2015; Yu et al., 2018), and this has been the case for studies of perceptions of fracking as well. For example, Boudet and Willits found that in the U.S. women are less likely to support fracking (Boudet et al., 2014; Willits et al., 2016). Similarly, women in the UK are less likely than men to support shale gas extraction (Andersson-Hudson et al., 2016; Whitmarsh et al., 2015). A recent study conducted in China has produced similar results (Yu et al., 2018). In one study, minorities were found to be more strongly opposed to the operation of natural gas, coal, nuclear, and wind power facilities within 25 miles of their homes (Ansolabehere & Konisky, 2009).

The relationships observed between age, education attainment, and concerns about industrial risks have been less consistent and may express differently by type of energy development (Boudet et al., 2014). Education has been found to be related to awareness of fracking and support in some studies (Boudet et al., 2014, 2016; Pierce et al., 2018), and opposition in others (Arnold et al., 2018; Jacquet, 2012). Older respondents tend to show higher support for fracking (Boudet et al., 2014; Yu et al., 2018) while younger respondents tended to oppose this technology (Jacquet, 2012).

The effects of income level are similarly inconsistent, with higher incomes being associated with opposition to fracking in some cases (Jacquet, 2012), and support in others (Boudet et al., 2014; Pierce, et al. 2018). The source of income also matters, specifically the degree of dependence on the industry producing the risks. Studies have shown that people are less inclined to speak out against the oil and gas industry if their economic status is directly related to that industry (Malin, 2014). Jacquet (2012) notes that American landowners, who might receive direct benefits from energy projects in the form of rent payments and royalties, tended to support energy development. However, in Colorado, opinions about fracking operations were shown to be independent of the potential for private economic benefits to accrue (Mayer, 2016).

Word choice has also been found to have a notable effect on public attitudes. In particular, the terms *fracking* and *hydraulic fracturing* can elicit different reactions from different social groups. Research has illustrated that the term *fracking* elicits less support for natural gas extraction than a description of the process (Climek et al., 2013; Goidel et al., 2013), and *fracking* is associated with negative connotations (Evensen et al., 2014; Stoutenborough et al., 2016; Fahey, 2012). However, even though Stoutenborough and colleagues (2016) confirmed that *fracking* is associated with negative connotations, they argued that there is no general framing effect for using one wording over the other; but level of support and reaction to specific wording are influenced by the level of familiarity with the technique.

In general, with the exception of findings with respect to gender, previous research has generated widely divergent findings regarding the influence of socio-demographics, knowledge, and trust on residents' perception of energy development, potentially indicating that public perception of energy projects is a complex web of locally-contingent factors. This literature, in sum, implies the need for continued research, particularly at the local level.

3.3. Methods

3.3.1. Data collection

Our data collection methods were reviewed and approved of by the University of Alberta Research Ethics Board before data collection began. The data for this study were collected from a sample of 226 adults living in Lethbridge, Fox Creek, and Rosebud, via telephone and online survey. I chose these locations because they are all located in regions subject to intensive fracking development in recent years, and yet are characterized by highly varying economic context and histories in fracking. Based on the populations of these communities, the number of participants from each community varied widely with 184 participants from Lethbridge, 29 from Fox Creek, and 13 from Rosebud.

The survey was implemented from August 30 to October 25, 2016 by the polling firm Research Now. To ensure the quality of data collected, a "soft launch" for ten percent of the sample was conducted on August 30, 2016 to pretest the survey instrument. The full launch was initiated on September 7, 2016 after reviewing. Participants from Lethbridge were recruited from a representative panel of residents. Participants received an email from the polling firm to invite them to participate in the survey, and recruitment continued until a target sample of at least 180 was reached. When they agreed to participate, respondents received a unique login and password to ensure that only that respondent could complete the web survey. Because the polling firm does not have sufficient panel representation from small communities like Fox Creek and Rosebud, participants of these two communities were identified by computer-aided random digit telephone dialing, and the survey was conducted over the phone. Recruitment continued until minimum target samples in each municipality were reached. During the interview, trained interviewers explained the question-and-answer process to the respondents, read questions exactly as worded, let respondents provide non-directive answers, and recorded the answers. The survey questionnaire took between 12 to 15 minutes to complete for both web-based and telephone respondents. Table 3.1 (section 3.4.1) presents characteristics of the sample.

3.3.2. Survey design

The survey instrument was designed to measure key factors that were expected to predict attitudes toward fracking including trust in government and government bodies, factual knowledge about fracking, and socio-demographics. The survey instrument consisted of closed-ended questions using five-point Likert scales, open-ended questions that served to expand response options, such as the names of local organizations.

Trust, and factual knowledge about fracking are two key explanatory variables of interest. The trust category is presented in Table 3.2, and factual knowledge about fracking is presented in

Figure 3.2. To measure trust, respondents were asked about their levels of trust in information sources, in media, and in government (local, provincial, and Alberta Energy Regulator). Respondents were also asked to indicate whether their level of trust in the provincial government's ability to manage the impacts of fracking has changed since the last election, when the long-standing right-wing Progressive Conservative Party was replaced by the New Democratic Party.

Factual knowledge about fracking was operationalized using a set of six statements to gauge respondents' factual knowledge about fracking, including true or false statements regarding the fracking extraction process, pressure, water use in fracking, fracking technique, and the agencies responsible for the regulation of fracking activities. I then generated an index variable measuring total factual knowledge about fracking based on the sum of responses to all six knowledge items.

In the survey, the term 'hydraulic fracturing' was used in the introduction and stated that hydraulic fracturing is also called 'fracking'. Then the term 'fracking' was subsequently used for all questions in the survey, based on the expectation that participants were familiar with the term 'fracking' since they live in the areas where fracking has occurred or been proposed.

3.3.3. Data analysis

The dependent variable "fracking support" was recoded into a dummy variable with the two values: 0=does not support fracking (including all responses with the value of not at all support fracking), 1=support fracking (including all responses with the value from slightly support to extremely support). A large proportion of respondents (n=40) indicated they were undecided; these were not included in the regression analysis. This recoded dependent variable was used for binary logistic regression. All variables that were correlated with fracking support (Table 3.3) were entered into the regression model of analysis.

I first ran descriptive statistics on all variables. Then I examined the binary correlations between the dependent variable and independent variables as well as a series of interaction effects. Finally, in order to find predictors of fracking support, I developed a hierarchical multiple regression approach with three analytical models. The first model included socio-demographic and location variables only. The second model had additional variables related to trust. To the last model I added the index variable measuring total factual knowledge about fracking.

3.4. Results

3.4.1. Characteristics of the survey sample

In the survey sample, I gathered information about sex, age, income, and employment sector, as described in **Table 3.1**.

Table 3.1. Sample characteristics (n=226) with population averages based on last Census (Statistics Canada 2016a, b,c)

Unit %

Variables	Categories	Lethbridge	Fox Creek	Rosebud
Age group (years of age)	18-34	16.3	0	0
	35-50	17.9	24.1	15.4
	51-69	47.9	48.3	69.2
	>=70	17.9	27.6	15.4
Average age		55.6	57.7	56.6
Census average age (2016)		**39.7**	**35.4**	**41.3**
Female		66.9	22.2	69.2
Census average percentage of female (2016)		**49**	**54**	**47**
Working sector	Agriculture	5.5	0	7.7
	Business	8.8	0	0
	Education	13.8	10.7	7.7
	Health	11.6	3.6	15.4
	Forestry	0	7.1	0
	Energy industry	3.9	32.1	7.7
	Other	34.8	28.6	46.2
Annual household income (CAD)	<40,000	19	17.9	7.7
	40,000 – 64,999	21.8	10.7	23.1
	65,000 - 89,999	17.3	10.7	15.4
	90,000 - 124,999	13.4	32.1	23.1
	>125,000	14	17.8	0
	Not stated	14.5	10.7	30.7
Census average annual household income (CAD) (2016)		**90,537**	**135,271**	**66,304**

For descriptive purposes, the age variable was divided into four groups. Group one included participants from 18 to 34 years. Group two included participants from 35 to 50. Group three included participants from 51 to 69, and group four consisted of participants from 70 and over. I did not have participants from the younger age group in Rosebud, which is likely a function of the lower sample size in this community. Overall, however, the ages of participants do not depart from the average ages in these three locations. The participation rate of women did, however, with higher than average female participation in Lethbridge and Rosebud, and lower in Fox Creek.

Almost half (49.9%) of respondents from Fox Creek earn $90,000 (before tax) or above, while those numbers in Lethbridge and Rosebud are 27.4% and 23.1%, respectively (**Table 3.1**). These differences appear to reflect the widely varying average household incomes across the three municipalities. Respondents from Lethbridge represent a diversity of occupational sectors, while the largest percentage of respondents from Fox Creek work in the energy industry (32.1%), and the majority of respondents from Rosebud work in art and public services (46.2%). Other working sectors include food services, transportation, entertainment and recreation, constructions, arts, and other services. Data representing municipal-level occupation sector statistics are not shown due to differences in occupational categories used by Statistics Canada.

3.4.2. Knowledge, trust, and support for fracking

All participants responded to the question regarding support for fracking. 17.7% do not know/ undecided; 5.8% extremely support; 8.8% support quite a bit; 14.6% moderately support; 13.7% slightly support; and 39.4% do not support at all. The level of support for fracking varied by area, with 79% of Fox Creek participants indicated moderate and extreme support compared to 26% of Lethbridge respondents. Only 8% of Rosebud respondents were moderately or extremely supportive (Figure 3.1).

The level of support for fracking varied in the three communities (Figure 3.1). In Fox Creek, an industry town in which a high proportion of men work in the oil and gas sector, 20.8% of respondents expressed extremely high support, and an additional 31% indicated quite a bit of support for fracking. Notably, support in this community was high despite high levels of familiarity with the harmful effects of fracking. Fox Creek has been subjected to three earthquakes since 2015 with one at a Richter scale magnitude of 3.8, and two additional events that were both 4.4 on the Richter scale. Fracking operations ceased in January 2016 in response to one of these, and a stop order was still in place at the time our survey was conducted from August to October 2016. However, in Rosebud, the site of heated controversy over the impacts of fracking, not one single participant expressed extremely or quite a bit of support, while only a small portion (1.8%) of respondents from Lethbridge showed extremely high support for fracking in their area.

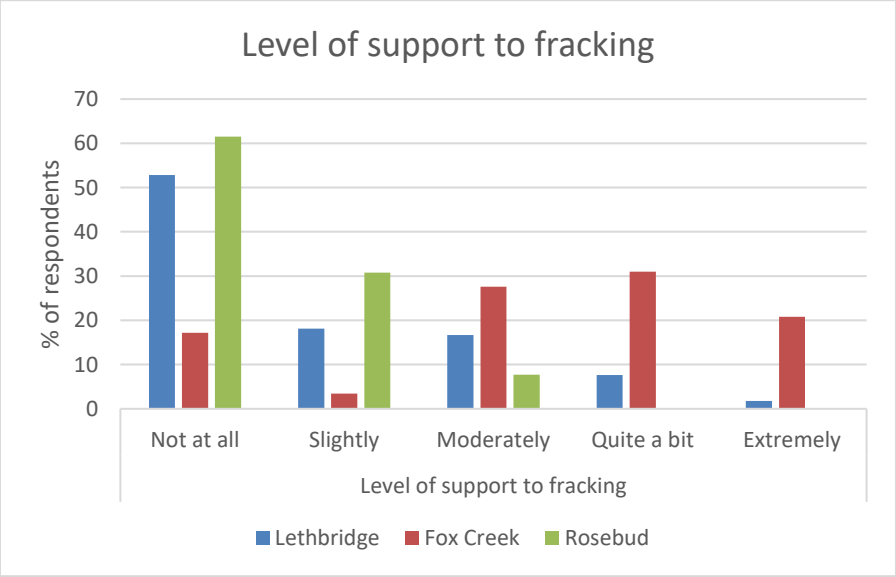

Figure 3.1. Level of fracking support, by three study sites

All 226 respondents answered the six knowledge statements. 8.4% answered all six items incorrectly; 88.5% provided correct responses to the fracking process question; 36.3% provided

correct responses to the fracking pressure question; 58% provided correct responses to the fracking methods question; 30.5 % provided correct responses to the question regarding water use for fracking; 46.5% provided correct responses to the question regarding technology used in fracking; and 38.5% knew that AER is the primary regulatory authority over fracking development in this province. Across the three study sites, participants from Fox Creek indicated the highest level of factual knowledge about fracking (Figure 3.2).

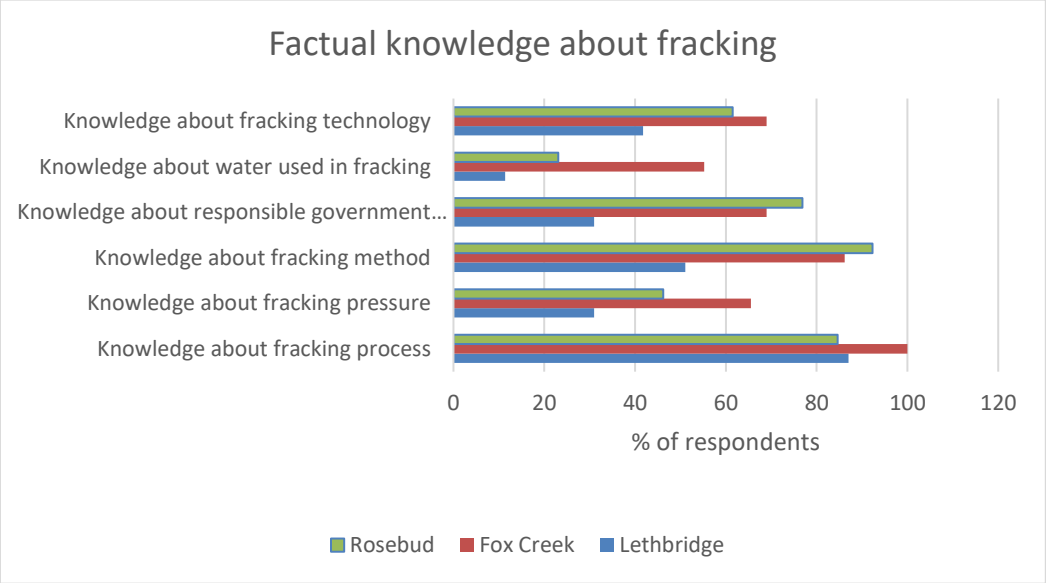

Figure 3.2. Factual knowledge about fracking, by three study sites

Table 3.2 describes participants' trust levels, with four noteworthy insights. First, scientists were ranked as the most reliable source of information related to fracking. The least trusted information source was from politicians, particularly for residents of Fox Creek and Rosebud. Second, respondents placed greater trust in the internet and personal communication than news media. Third, there was a great difference in trust in government among participants. Rosebud expressed considerably lower levels of trust in local government than respondents from Lethbridge or Fox Creek, while participants from Fox Creek expressed the highest level of trust in the AER. The majority of participants from Rosebud, on the other hand, had low trust level in

AER, while trust in this agency among Lethbridge residents was moderate. A majority of participants from Fox Creek also reported that they believed that local government (92.6%) and the AER (96.3%) represented their interests regarding fracking in and near their community. More than half of participants from Fox Creek (65.5%) reported that their trust in the provincial government's ability to manage the impacts of fracking has decreased since the last election when the New Democratic Party (NDP) was elected.

Table 3.2. Percentage levels of trust in information source, in media, and in government by three study sites (n=226).

Variable	Category	Lethbridge	Fox Creek	Rosebud
Trust in information source				
From scientists	Low	14.1	32.1	18.2
	Moderate	33.6	28.6	18.2
	High	52.3	39.3	63.7
From government	Low	56	67.9	61.5
	Moderate	34.7	25	38.5
	High	9.3	7.1	0
From politicians	Low	74.3	85.7	84.7
	Moderate	22.4	14.3	15.3
	High	3.3	0	0
Trust in media				
Traditional media	Low	37.5	39.2	46.2
	Moderate	40.6	46.4	38.4
	High	21.9	14.3	15.4
Internet and world wide web	Low	39.1	51.8	38.5
	Moderate	41	29.6	38.4
	High	19.9	18.6	23.1
Personal communication	Low	39.9	20.6	23.1
	Moderate	39.2	34.5	61.5
	High	20.9	44.9	15.4
Trust in government				
Local government	Low	36.3	25.9	72.8
	Moderate	35.5	37	27.2
	High	28.2	37.1	0
Provincial government	Low	42.5	42.9	75
	Moderate	39	35.7	16.7
	High	18.5	21.4	8.3
Trust in Alberta Energy Regulator	Low	35.4	22.2	92.3
	Moderate	48.5	25.9	7.7
	High	16.1	51.9	0

3.4.3. Bi-variate correlations between demographics, knowledge, trust, and support

Table 3.3 shows correlations and interaction effects between outcome variable (fracking support) and explanatory variables (social-demographic variables, trust, and factual knowledge about fracking). Living in Fox Creek and working in the energy sector were found positively associated with fracking support, while being female, living in Lethbridge, and having annual household income below $40,000 were negatively associated with fracking support. These correlations were all statistically significant. Five out of six variables measuring factual knowledge about fracking were positively associated with fracking support and most of them were significant at the .01 level. The aggregated factual knowledge about fracking variable was positively associated with fracking support, $r=.314$, $p<.01$, as were most of the individual knowledge items. The specific knowledge item regarding fracking pressure was not statistically correlated with fracking support, therefore, it was excluded in the correlation table. The correlations between trust in information items were mostly negatively associated with fracking support, except the trust in information related to fracking from AER, which had a positive correlation with fracking support.

Next, I created interaction effect variables between gender and social demographics; between gender and trust variables in order to test the existence of these interactions and the scale of these effects (Table 3.3). The direction of interaction effects between female and location; female and income; and female and trust were all in the same direction as the main effects of these variables. For example, the additional effect on support if a person was female and lived in Lethbridge was -.293, but if she lived in Fox Creek, the additional effect was .135; the main effects of these two locations were -.252 and .309, respectively. Similarly, additional effects on fracking support was negative if a respondent was female and trusted information related to fracking from NGOs, the worldwide web, and the provincial government.

The correlation between fracking support and variables measuring trust appeared in the opposite direction. Particularly, the additional effects on fracking support was positive if a respondent was male and trusted information related to fracking from NGOs, the worldwide web, and the provincial government, while in the main effects those relationships were negative. The correlation between these interaction effects and outcome variables were all statistically significant (Table 3.3).

Table 3.3. Correlations between explanatory variables and fracking support (n=170)

Explanatory variables	**Fracking support**
Socio demographics	
Female	-.268***
Lethbridge	-.252***
Fox Creek	.309***
Work in energy sector	.261***
Annual household income below $40k	-.168*
Independent variables	
Factual knowledge about fracking process	.173**
Factual knowledge about fracking method	.304**
Factual knowledge about water use in fracking	.182**
Factual knowledge about technology use in fracking	.250**
Factual knowledge about government body in charge of fracking	.159*
Total Factual knowledge about fracking	.314**
Trust in information related to fracking from NGOs	-.191**
Trust in information related to fracking from Worldwide web	-.164*
Trust in information related to fracking from provincial government	-.158*
Trust in information related to fracking from Alberta Energy Regulator	.350***
Trust in provincial government changed since the last election	-.268***
Interaction effects	
Female*Lethbridge	-.293***
Female*Fox Creek	.135*
Female*annual household income below $40k	-.181**
Female*trust in information related to fracking from NGO	-.262***
Female*trust in information related to fracking from Worldwide web	-.265***
Female*trust in information related to fracking from provincial government	-.214**
Male*Fox Creek	.246***
Male*work in energy sector	.233***
Male*age group 2 (35 to 50 years of age)	.188**
Male*trust in information related to fracking from NGO	.229**
Male*trust in information related to fracking from Worldwide web	.250***
Male*trust in information related to fracking from provincial government	.171*
Male*trust in information related to fracking from Alberta Energy Regulator	.315***

** Coefficient is significant at the 0.05 level (two-tailed).*
*** Coefficient is significant at the 0.01 level (two-tailed).*
**** Coefficient is significant at the 0.001 level (two-tailed).*

3.4.4. Regression results predicting fracking support

Since our outcome variable was a dichotomous variable, I used binary logistic regression in the model to test the probability of support for fracking. In the hierarchical logistic regression model (Table 3.4), I first entered demographics (gender and location), then added trust, factual knowledge about fracking, and interaction effects. Interaction-effect variables did not show any statistically significant association with the fracking support variable; thus, they were left out of the final models. Non-responses were treated as missing data, and removed from the analysis, leaving a total sample for the regression of 136.

Table 3.4. Results of logistic regression predicting determinants of fracking support (n=136)

	Model 1 Socio-demographics			**Model 2 Trust**			**Model 3 Knowledge**		
	B	**SE**	**OR**	**B**	**SE**	**OR**	**B**	**SE**	**OR**
`Variable									
Constant	1.918**	.657	6.807	1.732	1.401	5.654	.499	1.516	1.647
Socio-demographics									
Female	-.552	.384	.576	-.461	.481	.631	-.418	.495	.659
Male (excluded)									
Lethbridge	**-1.753****	.665	.173	**-1.757***	.791	.173	-1.515	.810	.220
Rosebud	**-2.726****	1.056	.065	-2.252	1.322	.105	-2.177	1.325	.113
Fox Creek (excluded)									
Working in energy sector	1.229	.873	3.419	1.189	1.084	3.285	1.013	1.099	2.753
Trust variables									
Trust in information source related to fracking from									
Scientists				-.157	.230	.854	-.183	.236	.833
Government				.486	.429	1.597	.345	.447	1.412
Politicians				.210	.416	1.234	.486	.438	1.626
Trust in media									
Traditional media				-.039	.332	.962	-.220	.357	.803
Internet sources				**-.649***	.322	.522	**-.6568***	.323	.519
Personal communication				.023	.271	1.023	.031	.281	1.032
Trust in government									
Local government				-.007	.307	.993	-.021	.318	.980
Provincial government				**-1.028****	.343	.358**	**-1.003****	.348	.367

	Model 1 Socio-demographics			Model 2 Trust			Model 3 Knowledge		
	B	**SE**	**OR**	**B**	**SE**	**OR**	**B**	**SE**	**OR**
Alberta Energy Regulator				**1.360*** **	.370	3.897	**1.405*** **	.374	4.075
Total factual knowledge about fracking							**0.385***	.171	1.470

Nagelkerke R² of model 1= .215; of model 2= .485; of model 3= .518.
** Coefficient is significant at the 0.05 level.*
*** Coefficient is significant at the 0.01 level.*
**** Coefficient is significant at the 0.001 level.*

The results of Model 1 showed that living in Lethbridge and Rosebud ($p<.01$) was significantly negatively associated with fracking support. The addition of variables in Model 2 offers a notable increase in explanatory value from Model 1, increasing the Nagelkerke R^2 from .215 to .485 (Table 3.4).

In Model 2, living in Lethbridge ($p<.05$), trust in internet information sources ($p<.05$), trust in provincial government ($p<.01$), and trust in AER ($p<.001$) all had statistically significant associations with fracking support (Table 3.4).

In Model 3 I added total factual knowledge about fracking, increasing our R^2 to .518. In this full model, geographical location was no longer statistically significant. The directions of the three variables that were significantly associated with fracking support in Model 2 were unchanged in Model 3. The predictive values of trust variables were largely consistent across Model 2 and Model 3, while the association between total factual knowledge about fracking and fracking support became positively significant ($p<.05$) in Model 3 (Table 3.4). I found correlations between factual knowledge about fracking and education level ($.208^{**}$); between factual knowledge about fracking and working in energy sector ($.146^{*}$). However, when I added these two variables along with education level and occupation in the energy sector in the regression model, no statistically significant relationship was found. Therefore, in our model, these two variables were not included.

3.5. Discussion and conclusions

The respondents in this study overall expressed wide-ranging levels of support for fracking, with considerable differences between the three study sites. Levels of support found in Lethbridge, Fox Creek, and Rosebud were all considerably lower than what was found in province-wide studies (Axsen, 2014; Thomas et al., 2017). Higher support in Alberta would be expected, given the history of economic dependence of this province on oil and gas development, and the extent to which this history has influenced Alberta's cultural and political character. Yet, more than half of respondents in Lethbridge and Rosebud did not support for fracking at all. Even in Fox Creek where employment dependence on the industry was highest, 17.2% of respondents did not support fracking.

Factual knowledge about fracking was found to be positively associated with support, as might be expected considering knowledge is likely to be positively associated with either working directly in this sector or having close friends or family members who do. This association was in line with previous studies related to fracking and perceptions in the UK (Andersson-Hudson et al., 2016; Stedman et al., 2016).

Delving more deeply into attitudes toward fracking in this province, however, requires looking more closely at the local level. This analysis highlights the extent to which local context matters more than many structural variables commonly attributed to attitudes toward environmental risks from fracking. Additionally, institutional trust had the strongest effect in our full model, even when controlling for gender, income, knowledge, and sector of employment. As indicated in our descriptive statistics, however, levels of institutional trust toward a set of specific government entities varied substantially by location, suggesting that local historical experiences with those entities with respect to fracking development strongly influenced local resident trust, and this in turn affected attitudes toward fracking.

As level of trust in the current provincial government increased, support for fracking declined. In contrast, the higher the level of trust in the AER, the more likely a resident was to support fracking. These findings may reflect the fact that the AER has largely remained unchanged in structure and function since its inception under the previous, conservative government, and continues to be a regulatory body dominated by energy industry interests despite the election of the NDP leadership since that time. Rural communities across Alberta express lower levels of support for the NDP than their urban counterparts, and this likely influenced community-level institutional trust in the current provincial government, under NDP leadership. Trust in the current provincial government was not particularly high in any of our three communities, but it was particularly low in Rosebud, Alberta, as was trust in the AER. This small area experienced several difficult years during which residents sought relief from the provincial government for contamination of water wells as a result of nearby natural gas development, without success. In Fox Creek, by contrast, an area highly-dependent upon (male) employment in oil and gas development, residents were inclined to distrust the provincial government but expressed the highest level of trust in the AER. They expressed high levels of support for fracking, despite direct experience with some of its more vivid impacts. Respondents in the small city of Lethbridge, where residents previously were sufficiently concerned about the impacts of fracking that they successfully prevented well drilling within the city limits, had a level of trust in the provincial government comparable to Fox Creek residents, but with lower trust in the AER.

These findings add up to a complex portrait of the local perceptions of fracking development. The collective voices from participants of the three study sites contributed a unique understanding of local people's perspectives on fracking activities in their communities. The underlying message is clear, and likely resonant regardless of the type of development in question: political conflicts over development may have less to do with the structural identities of

citizens and more to do with the unique local histories and cultures that define current community relationships with those industries which makes province wide generalization and policy making difficult.

Chapter 4. What shapes public engagement in fracking?

4.1. Introduction

Local public dialogue is critical to effective environmental governance (Diduck & Sinclair, 2002; Gastil & Dillard, 1999), and public engagement is an essential feature of a democratic society, facilitating policy decisions that are more likely to reflect public interests (Parkins et al., 2017). These objectives are often more principle than practice, however, and this is particularly the case with respect to managing the social and environmental risks of fossil fuel development in jurisdictions that are economically and culturally linked to such development. To further complicate matters, oil and gas development today increasingly entails the extraction of unconventional fossil fuel reserves, that entail equally unconventional risks. Fracking, for example, has generated heated public opposition, in some cases resulting in moratoria or bans across several countries, in response to concerns about the health and environmental risks involved. Fracking, or horizontal, multi-stage hydraulic fracturing, refers to a method of extracting oil and gas trapped in shale and other solid substrates, by injecting a mixture of silica, water, and chemicals under very high pressure.

In Canada, natural gas shale is widely distributed across the Provinces of British Colombia, Alberta, Saskatchewan, Quebec, and the Maritimes (Chong & Simikian, 2014). Since 2008, more than 10,000 wells have been fracked in Alberta, and the provincial government has been promoting its expansion (Ministry of Energy, 2018). The Canada Energy Regulator (formerly called National Energy Board) projects that shale gas will have reached 28% of total gas production in Canada by 2035, assisted in part by efforts to phase out coal and replace it with natural gas (touted to be less greenhouse gas intensive) as well as expected increase in demand due to the construction of liquefied natural gas facilities (LNGs) in British Columbia. Albertans

thus have already experienced some impacts from fracking and will likely see the impacts of increased fracking in the future.

The Province of Alberta produces a significant amount of fossil fuels in addition to natural gas, particularly from the Athabasca oilsands—the world's third largest reserve of oil (in the form of bitumen)—and large coal reserves. Scholars have characterized Alberta as a 'petro-state,' in which the government privileges the priorities of the energy sector. Residents who raise concerns about the social and environmental consequences of fossil fuel extraction are often dismissed as 'un-Albertan' (Adkin, 2016; Davidson, & Gismondi, 2011; Shrivastava & Stefanick, 2012), a style of neo-liberalizing discourse observed in other fossil fuel production zones (Mercer, De Rijke, & Dressler, 2014). Petro-statism is a particular instance of place-based social identity, which may be a central feature of responses to high risk industrial activities such as fracking, and to public engagement in general (Luke, Rasch, Evensen, & Köhne, 2018). Alberta is thus an important context in which to explore how residents respond to fossil fuel-based energy development activities, but also an important context to enhance our understanding of factors associated with public engagement.

As might be expected, previous studies conducted at the national or provincial scale show that Albertans are supportive of unconventional fossil fuel development than people in other provinces (Axsen, 2014; Lachapelle et al., 2018). Importantly, national and provincial-scale polls fail to capture the potential for wide divergences in perspective at the local level. One recent study highlights the relevance of scale, finding notable departures in findings from analyses of attitudes to fracking conducted at the national, state, and local scales (Evensen & Stedman, 2016; Luke, 2017). Such polling can promote the erroneous depiction of widespread agreement among a citizenry. Resistance can nonetheless be observed in Alberta, in the form of petitions, lawsuits, and environmental protest events. For instance, residents of Lethbridge started a grassroots

organization called No Drilling Lethbridge, that called on the Alberta Government to ban drilling for oil and gas in that city. Jessica Ernst – a biologist, former oil field consultant, and resident of Rosebud, Alberta, gained international notoriety for her legal fight against an energy company and the provincial government, for contaminating her water well and other wells in her community as a result of nearby fracking activities. Recent events may also influence public support, including the attribution of seismic events in Fox Creek, Alberta that were attributed to fracking (Schultz et al., 2018). Also noteworthy is the historical but short-lived win of the left leaning New Democratic Party after 40 years of consistent Progressive Conservative Party rule in the provincial election in October 2015. The newly named United Conservative Party has since reclaimed control of the legislature, in 2019.

This study seeks to explore the extent of public engagement in fracking among a sample of residents in Rosebud, Fox Creek, and Lethbridge, all located near fracking activities in Alberta. Public engagement is driven by many factors, but social capital may be particularly relevant. Few studies of public engagement in fracking have focused on social capital, however. As such, this study analyzes the relationship between public engagement and three aspects of social capital found to be particularly strong predictors of environmental engagement previously: networks, trust, and self-efficacy (Edwards, 2010; Kirkby-Geddes, King, & Bravington, 2013). Below, I offer a brief review of empirical studies of attitudes toward fracking, and then discuss previous research on the three social capital themes explored in this study. This is followed by sections describing our methods and results, and discussion of the implications of our findings.

4.1.1. Attitudes toward fracking

Empirical study of public attitudes toward fracking has increased considerably over the past decade. While I only touch briefly on this research record here, there are a number of excellent reviews available (M. Thomas et al., 2016), including a recent special issue (Evensen, 2018).

Importantly, studies conducted in many regions have found mixed levels of support, with higher expressions of support often linked to expected community economic benefits, or in the case of some landowners, direct economic benefits (Jacquet, 2012; Luke, 2017; Malin, 2014). Other factors found to be correlated with support include familiarity with the technology (Andersson-Hudson et al. 2016; Boudet et al. 2014; Stedman et al. 2016). Men are also often found to be more supportive of hydraulic fracturing than women (Boudet et al., 2014; Davis & Fisk, 2014; Howell et al., 2017), and political conservatism has been correlated with lower perceived risks and higher support for fracking (Boudet et al., 2014; Clarke et al., 2016; Davis & Fisk, 2014; Edwards, 2018; Luke, 2017). Local support is by no means universal, however; many local residents have expressed strong concerns regarding environmental and health impacts, and for many, feelings of frustration and powerlessness (Davidson, 2018; Eaton & Kinchy, 2016; Willow & Wylie, 2014). Even among residents who do not necessarily oppose the technology, the perceived fairness of the decision-making process is a critical component of support (Shaw et al., 2015).

4.1.2. Social networks

Social capital has long been considered an important facilitator for social engagement. There are several attributes and types of social capital, but in this study, I focus on three, beginning with social networks. Participation in networks offers individuals access to resources, particularly knowledge, while also contributing to those networks, leading to the enhancement of wellbeing for all participants. They are particularly relevant to democratic decision-making, including in environmental realms (Ingold, 2017). This occurs through several mechanisms, but importantly, social networks foster norms of generalized reciprocity (Putnam, 2000), which contribute to higher levels of civic participation (Ki-Choon Song, 2013), and foster democratic values (Zhang, Johnson, Seltzer, & Bichard, 2010). In other words, networks are a constituent of social capital,

and also serve to reinforce the virtues of social capital, including cooperation, because they enable communications that are candid and crosscutting (Fisher & Hamilton, 1996; Putnam, 2000).

Network analysts focus on network centrality and structure, including network degree and network range. Degree describes *frequency* of interactions, important to information dissemination, social pressure, and attitude formation. Range describes the *diversity* of interactions—the number and location of networks with which one is connected (Burt, 1980)—and the information exchanged in those interactions, which may be important for more complex cognitive processes such as identity formation (Tindall, 2002), social mobility (Lin & Dumin, 1986), and open-mindedness (Putnam, 2000). Having ties to people across diverse networks implies that one is more likely to obtain multiple sources of information, opinions, and evaluations about issues and events (Putnam, 2000; Tindall, 2002). Repeated interpersonal interactions provide the basis for group solidarity, which enables collective action (Collins, Neal, & Neal, 2014). In this study, I tested whether the density and diversity of social networks enhances the likelihood of engagement.

4.1.3. Trust

Trust is a key element in public engagement. Increased levels of reciprocity and mutual trust lead to increases in communication, and turn out to motivate collective action (Willis, 2012). Trusting relationships among stakeholders encourage collaboration, openness, and more effective governance (Parkins et al., 2017). The nature of relationships among community members, state and industry have a significant influence on publics' granting of social license to operate, or in cases of grievance, its withdrawal (Luke, 2017; Luke et al., 2018). Like networks, the relationship between trust and social capital is reciprocal. Trust encourages engagement, and

engagement in turn contributes to empathy, and ultimately strengthens social capital (Hays, 2012; Nooteboom, 2007).

While the concept of trust encompasses both general trust and skepticism (Poortinga & Pidgeon, 2003), in this study, the role of general trust in public engagement in energy issues is the focus. General trust describes one's perceived competence, caring, fairness, and openness on the part of decision-makers (Parkins et al., 2017). Higher levels of generalized trust in government agencies have been associated with citizen engagement in public affairs (Uphoff, 2000). When governmental agencies appear to prioritize social needs, have more efficient administrative processes, and exhibit capacity to implement policy, citizens are much more likely to participate in public affairs, abide by laws and express trust towards government (Edwards, 2010). Trust in government is expected to be negatively associated with engagement in fracking opposition activities, particularly given Alberta's economic dependence upon the oil and gas industry, and the strong provincial government support for this industry.

4.1.4. Self-efficacy

Self-efficacy, referred to as confidence in one's personal capacity to influence one's environment (e.g. Young, 2020), is another critical factor contributing to personal motivations for engagement. Self-efficacy has long been considered to be a necessary prerequisite for public engagement (Bandura, 1977): individuals who believe their voices are heard and their opinions are taken into account, particularly by authorities, are far more likely to engage. Although self-efficacy is believed to be cultivated early in the life course (Gecas, 1989), prior experiences in collective activities can also elevate or attenuate efficacy, which may affect motivations for subsequent political engagement (Valentino, Gregorowicz & Groenendyk, 2009; Bandura, 1997). Members of the public may be encouraged to participate if they feel they can make a valuable contribution (Diduck & Sinclair, 2002), or they have a strong sense of responsibility toward

improving their community (Bandura, 2001). However, in communities where power and influence is concentrated among a small minority, as is often the case in rural, resource-based communities, people are less likely to feel sufficiently empowered to engage in public affairs (I. M. Young, 2002). Drawing from these previous studies, I expect to see a positive association between perceived self-efficacy and engagement.

4.2. Methods

In order to explore the willingness of Alberta residents in our selected communities to engage in organized activities regarding fracking, data was collected via telephone and online survey from a sample of 226 adults living in three highly diverse local communities. The first community is the City of Lethbridge (population 96,828), an economically diverse city in southeastern Alberta in which Lethbridge University is a centerpiece. Fracking has occurred in southeastern Alberta, but in 2013, Goldenkey Oil applied for a license to begin a fracking operation within the City Limits. A local resistance group was quickly mobilized, and the company's application was withdrawn in 2014. Rosebud is also in southeastern Alberta, an older agricultural community that has experienced significant declines in that activity, and now sustains a population of just 87. There was no organized resistance to drilling for natural gas in this community, until many residents began to notice health effects that they attributed to a sudden decline in well water quality in the early 2000's. The concerns expressed by many Rosebud residents at that time were disregarded, resulting in the disintegration of what were previously complacent relations with the Provincial government. Fox Creek, finally, is in northern Alberta (population 1,720) and is heavily reliant on oil and gas production. Community residents have experienced several seismic events attributed to nearby fracking activities in recent years, some of which were severe enough (over 4.0 on the Richter scale) to trigger a stop work

order by the government. To date these events have not transpired in organized opposition to fracking in Fox Creek.

The survey was implemented from the 30th of August to the 25th of October 2016 by the polling firm Research Now. This firm recruited participants from Lethbridge using random-digit dialing and an online survey. Due to difficulties obtaining email addresses of people living in Fox Creek and Rosebud due to their small populations, participants of these communities were surveyed by telephone, with the same front matter, questions and response options as the online survey instrument. The questionnaire took between 12 to 15 minutes to complete. Based on the populations of these communities, the number of participants from each community varied widely with 184 participants from Lethbridge, 29 from Fox Creek, and 13 from Rosebud.

Although the sample sizes of the two smaller communities are quite small, the resulting dataset allows for statistical comparisons between these distinctive communities. The sample is described further in **Table 4.1**. Most respondents are female (57.5%) and over 50 years old (68.1%) as reported in Table 4.2. Women account for 51% of the provincial adult population and the average age is 48 years (Statistics Canada, 2016d), thus the participants of this survey are slightly older and more female than the provincial population. In terms of annual household income, 45.1% of respondents earn more than $65,000, compared to the average income of Albertans in 2015 of $62,778 (Statistics Canada, 2016d). Regarding the occupation of participants, 31.2% of respondents from Fox Creek work in the energy sector, with 3.9% of Lethbridge respondents, and 7.7% of Rosebud respondents in the same occupation.

Table 4.1. Sample characteristics (n=226) with population averages based on last Census (Statistics Canada 2016a, b,c) Unit %

Variables	Categories	Lethbridge	Fox Creek	Rosebud
Age group (years of age)	18-34	16.3	0	0
	35-50	17.9	24.1	15.4
	51-69	47.9	48.3	69.2
	>=70	17.9	27.6	15.4
Average age		55.6	57.7	56.6
Census average age (2016)		**39.7**	**35.4**	**41.3**
Female		66.9	22.2	69.2
Census average percentage of female (2016)		**49**	**54**	**47**
Working sector	Agriculture	5.5	0	7.7
	Business	8.8	0	0
	Education	13.8	10.7	7.7
	Health	11.6	3.6	15.4
	Forestry	0	7.1	0
	Energy industry	3.9	32.1	7.7
	Other	34.8	28.6	46.2
Annual household income (CAD)	<40,000	19	17.9	7.7
	40,000 – 64,999	21.8	10.7	23.1
	65,000 – 89,999	17.3	10.7	15.4
	90,000 – 124,999	13.4	32.1	23.1
	>125,000	14	17.8	0
	Not stated	14.5	10.7	30.7
Census average annual household income (CAD) (2016)		**90,537**	**135,271**	**66,304**
N		**184**	**29**	**13**

To measure engagement in fracking opposition activities, a series of variables were utilized. The items used to measure engagement were taken from the Energy Literacy Survey with attribution to the original creators of the scale (Comeau, Beckley, Parkins, & Stedman, 2015). The list of engagement activities in resistance to environmental impacts of fracking included nine items, but after initial factor analysis, two domains was settled on. These two subsets of engagement reflect activities that involve personal and collective engagement. I then aggregated the measures to generate a *personal engagement index* based on the mean of three activities (donate money to support environmental event(s), communicate with government officials, and communicate concerns to oil and gas companies). Similarly, three items are aggregated to

generate a *collective engagement index,* including signing a petition, attending public protest(s), and discussing personal viewpoints about fracking with family, friends, and neighbors.

For the social capital items, I referred to the General Social Survey Cycle 27 from Statistics Canada, designed to measure social capital and public engagement in Canada, and added additional survey items of my own. The survey included 13 trust items, referring to media, information sources, local and provincial government, and the Alberta Energy Regulator (AER), the government body responsible for overseeing energy development. For network measures, the survey included items measuring respondent membership in local and non-local organizations. Respondents were also asked which organizations they were most active in, and time spent in organization participation. Next, perceived self-efficacy was measured with the statement "I have a strong influence in making this community a better place to live." Then participants were asked "How concerned are you about harmful effects of hydraulic fracturing in and near your community?" Most of these items were measured with 5-point Likert scales. Finally, the analysis includes standard socio-demographic variables for age, gender, education, annual household income, geographical location, occupation in the energy sector, and the length of time participants lived in that community, based on previous research indicating that place identity strongly affects the degree to which local people express concern about health and environmental risks associated with industrial development or large-scale land use change (Jacquet & Stedman, 2014; Luke, 2017; Short & Szolucha, 2019).

4.3. Findings

Descriptive statistics for the total sample and all measures are summarized below in Table 4.2. As noted, 38.1% of respondents self-reported being a member of a local group or organization, while participation in non-local groups or organizations was lower, at 23%. Respondents'

average self-reported efficacy is 2.95 out of 5. Over a quarter of respondents (25.7%) believe they have a strong influence in making their communities a better place to live, while 42.5% of them are not sure about their efficacy in their communities.

Table 4.2. Descriptive statistics for variables used in bivariate analysis and OLS regression model, reported as Likert scale responses from 1 (not at all) to 5 (very often), unless otherwise noted.

Variable	%[1]	Mean[2]	SD	Min	Max	N
Personal engagement	-	1.75[3]	0.81	1	4.67	117
Collective engagement	-	2.38[4]	0.84	1	4.67	117
Trust information sources related to fracking provided by scientists	-	3.52	1.11	1	5	188
Trust information sources related to fracking provided by government		2.25	0.92	1	4	191
Trust information sources related to fracking provided by politicians		1.8	0.85	1	4	193
Trust information sources related to fracking provided by NGO		2.65	1.01	1	5	190
Trust information sources related to fracking provided by Newspapers, magazines, and TV		2.75	0.75	1	5	203
Trust information sources related to fracking provided by Internet		2.76	0.93	1	5	201
Trust information sources related to fracking provided by personal communication		2.84	1.01	1	5	195
Trust local government		2.83	1.03	1	5	173
Trust provincial government		2.55	1.05	1	5	181
Trust Alberta Energy Regulator		2.72	0.98	1	5	170
Trust change since the last provincial election		2.64	1.12	1	5	179
Local network	38.1					
Non-local network	23.0					
Solidarity		4.23	0.94	1	5	216
Self-efficacy	25.7	2.95	0.98	1	5	219
Concern about harmful effects of fracking	35.0	2.84	1.35	1	5	207
Female	57.5					212
Working in energy sector	7.5					222
Education (post-secondary)	77.9					221
Annual household income more than CAD 65,000	45.1					226
Age (over 50 years old)	68.1					226
Live in the community from 10 years and above	75.7					
Geographical location						
Lethbridge	81.4					226
Fox Creek	12.8					226
Rosebud	5.8					226

[1]: Percentage of respondents attending local and non-local networks.
[2]: Trust variables were measured by 5-point Likert scale of 1=lowest, 2= slightly, 3= moderately, 4=quite a bit, and 5=highest.

[3]: These values represent the mean of the three categories of engagement aggregated (donate money, communicate with government officials, and communicate with oil and gas companies). The total lowest value of the aggregate is 1, and the highest value is 4.67, on a scale where 1 = Not at all, to 5 = Very often.
[4]: These values represent the mean of the three categories of engagement aggregated (sign petition, attend public events, and discuss viewpoints about fracking). The total lowest value of the aggregate is 1, and the highest value is 4.67, on a scale where 1 = Not at all, to 5 = Very often.

Engagement is further disaggregated to the community level and by type of activity in Table 4.3. Nearly half (43.8%) of respondents indicated involvement in at least one engagement activity. This may be higher than actual engagement levels due to response bias, as people with higher levels of concern may be more likely to participate in surveys. As expected, those activities that required lower investments of resources, such as discussing personal views about fracking with friends and neighbors, have higher rates of participation, at 67.5%, 77.3%, and 91.7% of respondents from Lethbridge, Fox Creek, and Rosebud, respectively. Communicating with concerns about fracking to oil and gas companies received the lowest participation rates of respondents from Lethbridge (13.3%) and Fox Creek (22.7%).

Table 4.3. Sample percentages engaged in fracking opposition activities by study site and engagement type

Study sites	Collective engagement			Personal engagement		
	Sign petition	Attend event	Discuss viewpoint	Donate	Communicate gov. officer	Communicate industry
Lethbridge	63.9	24.1	67.5	24.4	22.9	13.3
Fox Creek	27.3	27.3	77.3	13.6	36.4	22.7
Rosebud	66.7	33.3	91.7	8.3	33.3	41.7

Table 4.4 elaborate on participants' trust levels. Three points stand out. First, scientists are ranked as the most reliable information provider about fracking across all three communities. The least trusted information provider was politicians. Second, trust in personal communication was rated higher than other information sources such as traditional media and internet sources. Third, there are large differences in trust in government among participants. Rosebud expressed considerably lower levels of trust in all three government entities than respondents from Lethbridge or Fox Creek, while participants from Fox Creek expressed the highest trust in the AER, the provincial regulatory agency responsible for overseeing energy development. Trust in the AER among Lethbridge residents was moderate.

Table 4.4. Level of trust in information source, in media, and in government in percentage (N=226).

Variable	Trust level	Geographical locations		
		Lethbridge	*Fox Creek*	*Rosebud*
Trust in information sources				
From scientists	Low	14.1	32.1	18.2
	Moderate	33.6	28.6	18.2
	High	52.3	39.3	63.7
From government	Low	56.0	67.9	61.5
	Moderate	34.7	25.0	38.5
	High	9.3	7.1	0
From politicians	Low	74.3	85.7	84.7
	Moderate	22.4	14.3	15.3
	High	3.3	0	0
Trust in media				
Traditional media	Low	37.5	39.2	46.2
	Moderate	40.6	46.4	38.4
	High	21.9	14.3	15.4
Internet sources	Low	39.1	51.8	38.5
	Moderate	41.0	29.6	38.4
	High	19.9	18.6	23.1
Personal communication	Low	39.9	20.6	23.1
	Moderate	39.2	34.5	61.5
	High	20.9	44.9	15.4
Trust in government				
Local government	Low	36.3	25.9	72.8
	Moderate	35.5	37.0	27.2
	High	28.2	37.1	0
Provincial government	Low	42.5	42.9	75.0
	Moderate	39.0	35.7	16.7
	High	18.5	21.4	8.3
Alberta Energy Regulator	Low	35.4	22.2	92.3
	Moderate	48.5	25.9	7.7
	High	16.1	51.9	0

The bivariate analysis in Table 4.5 explores the direct relationships between key variables. In this table, trust information sources is an index based on the sum of 4 variables measuring the level of trust in information sources related to fracking provided by scientists, politicians, government, and NGOs; trust in media is an index based on the sum of 3 variables measuring the level of trust in fracking information provided by 3 channels including traditional (TV, magazine, newspaper), internet, and personal communication; trust in government is an index based on the

sum of 2 variables include trust in local and provincial government; and trust in the Alberta Energy Regulator (AER).

Regarding personal engagement, the first notice is that overall trust in information providers bears a positive correlation with personal engagement (.277). Also, consistent with the hypothesis, networks are positively correlated with personal engagement (.238 and .223). Self-efficacy also has a positive association with personal engagement as expected (.275). Regarding collective engagement, trust in information providers and trust in media are positively correlated with collective engagement (.210 and .461). As hypothesized, self-efficacy and concern are positively correlated with collective engagement (.199 and .481). The relationship between trust in government and engagement is in the expected direction (negative), though not statistically significant. No link between concern level and personal engagement is found, but concern has a strong relationship with collective engagement. This difference will be explained in the discussion section below.

Table 4.5. Bivariate relationships between engagement, trust, network, self-efficacy, concern, and correlation with social capital variables (N=226)

Correlates	Personal engagement	Collective engagement	Trust information	Trust media	Trust government	Local network	Non-local network
Trust information	0.277**	0.210**	1				
Trust media	0.196	0.461**	0.461**	1			
Trust government	- 0.059	- 0.063	0.310**	0.190*	1		
Local network	0.238**	0.033	- 0.046	-0.083	- 0.059	1	
Non-local network	0.223*	0.073	0.045	0.017	- 0.124	0.568**	1
Self-efficacy	0.275**	0.199*	0.202**	0.066	0.217**	0.174**	0.137*
Concern	0.157	0.481**	0.212**	0.160*	- 0.093	0.026	0.035

**Correlation is significant at the 0.05 level (2-tailed)*
***Correlation is significant at the 0.01 level (2-tailed)*

Moving to the regression results presented in Table 4.6, two separate models are presented for the two dependent variables: personal and collective engagement in fracking opposition activities. Because of missing values, the sample size is reduced (n = 92) and therefore the

number of predictor variables is limited in order to increase the number of observations and degrees of freedom. As such, several variables related to trust and demographics are not included in the final model. The hierarchical Ordinary Least Squares regression models for these outcome variables are organized by first entering social capital variables including networking, trust, self-efficacy, and concerns about the harmful effects of fracking. These predictors are then followed by a series of demographic variables (income, education, time living in the community, employment sector, and geographical locations). The dependent variables include respondents who did not participate in any activity (1 = Not at all) as well as those who participated frequently in all activities (5 = Very often).

Results in Model 1 are somewhat consistent with Table 4.5, with positive associations between personal engagement and self-efficacy (.256), as well as trust in information providers (.332), consistent with our hypotheses. Annual household income is positively linked to personal engagement, while working in the energy sector is negatively so. The effects are stronger for all four determinants of personal in comparison to collective forms of engagement.

In Model 2, I explore relationships between collective engagement and key explanatory variables. Here I see a pattern similar to results in Table 4.5, where trust in media (.299) and concern are positively associated with collective engagement (.391). Among demographic variables, again income is positively associated with collective engagement while higher education (university degree and above) is negatively so for both personal and collective engagement. In Model 2, the effect of working in the energy sector was not pronounced any more, which may in fact reflect Alberta's 'petro-state' status, a status that suggests that many Albertans identified strong with. Regression results in Model 2 suggest that when respondents trust media, are concerned about the effects of fracking, and have annual household income over

$65,000, they are more likely to be engaged in collective fracking opposition activities, and when they have higher education, they are less likely to engage.

Overall, higher education and income were found to shape personal and collective engagement in fracking opposition activities. The results support my expectation that perceived self-efficacy is positively associated with personal engagement in fracking opposition activities (.256 $p<.05$). The hypotheses that membership in networks is positively associated with public engagement, and trust in government is negatively associated with public engagement, are not supported.

Table 4.6. Results of OLS regression with standardized coefficients predicting determinants of personal and collective engagement in fracking opposition activities (N=92).

Independent variables	Personal engagement (Model 1)	Collective engagement (Model 2)
Constant	0.502	0.454
Social capital variables		
Local network	0.070	0.016
Non-local network	0.100	0.022
Trust information sources	0.332*	-0.015
Trust media	-0.056	0.299*
Perceived Self-efficacy	0.256*	0.116
Concern	0.133	0.391***
Demographic variables		
Annual household income >$65k	0.366***	0.231*
Education (BA and above)	-0.238*	-0.199*
Living in the community from 10 years and above	-0.168	0.052
Working in energy sector	-0.240*	-0.097
Fox Creek	0.058	-0.191
Rosebud	-0.005	-0.034
Adjusted R^2	0.26	0.33
N	92	92

** Significant coefficient at the 0.05 level*
*** Significant coefficient at the 0.01 level*
****Significant coefficient at the 0.001 level*

4.4. Discussion

This study examines factors that predict public engagement in fracking - a recently developed technology used to extract unconventional oil and gas resources that is the subject of increasing public scrutiny and concern. I focus on a particular context, a petro-state, in which the likelihood

for participation in collective action to resist fossil fuel development would be considered to be particularly low. Low levels of public engagement in extractive zones is particularly worrisome; considering the significant environmental and climatological consequences of these activities, public scrutiny and engagement in management decisions may be among the most important means of countering the environmental destructive potential of such activities. However, even within this regional context, associated with a strong historical allegiance to fossil fuels, I found that residents have widely divergent perspectives, shaped at least in part by their local community context, and these factors influence the likelihood for public engagement.

The findings from this study warrant further research, particularly given the small sample sizes—an inevitable feature of conducting research on small communities. Several key results are nonetheless noteworthy. First, the level of concern about the impacts of fracking was higher than anticipated given previous provincial studies (Axsen, 2014; Lachapelle et al., 2018). Results show that 75.1% of respondents from Lethbridge, 79.3% of respondents from Fox Creek, and 100% of respondents from Rosebud expressed at least some level of concern about the negative effects of fracking. While response bias may be at issue, what is clear is that support for enhanced extraction within a petro-state is far from uniform, with pockets of deep concern within some communities. While concern is not an effective predictor of personal engagement in resistance to fracking on its own, it does predict collective engagement in fracking opposition activities.

Second, participants were involved in fracking opposition activities at rates higher than expected: 43.8% of respondents participated in at least one activity, indicating that many residents of this petro-state are willing to express their concerns. In all the three study sites, participation rates were much higher for activities that required less investment of time and resources, but the fact that 37% of respondents are at least discussing their views about fracking with friends and neighbors indicates that such activities are receiving extensive citizen scrutiny,

as has been shown to be the case for other energy issues in Alberta (Parkins et al., 2017). The lower participation in activities requiring relatively higher investments in time and resources is not an unexpected result. Although previous studies highlight the complexity of associations between environmental concern and pro-environmental behaviors (Bamberg & Möser, 2007; Gifford & Nilsson, 2014), engagement in pro-environmental behaviors that require high levels of effort and resources are often found to be lower than activities that involve fewer resources and less personal effort (Parkins et al., 2017). Moreover, certain forms of personal engagement, such as communicating government officers or oil and gas companies, may be perceived to be a waste of time, even among concerned and efficacious individuals, within the context of a petro-province, in which state and corporate aversion to constraints on continued development is the norm (Adkin et al., 2017; Davidson, 2018). On the other hand, collective engagement activities such as discussing one's concerns with friends and neighbors, attending public events, or signing a petition expressing concerns about fracking, may be perceived as more impactful. Public engagement was not only driven by personal and social factors (Gifford & Nilsson, 2014) but also by the perceived satisfactory results of the engagement activities, emphasizing the importance of selection of measures in studies of environmental concern and behaviors.

Demographic variables including income, occupation in the energy sector, and higher education level all shaped public engagement in fracking resistance in our study sites, but gender and length of time living in the community were not significant. Annual household income over $65,000 was consistently positively associated with both personal and collective engagement, similar to previous studies (Perkins, Brown, & Taylor, 1996; Thompson, 1993). The relationship is likely more nuanced in this case, however: Alberta families have the highest median after-tax income in Canada (Workopolis, 2014), yet they do not necessarily express higher levels of political participation than citizens in other provinces. As expected, working in the energy sector

is negatively associated with personal engagement in fracking opposition activities. People are unlikely to criticize an industry that offers them direct economic benefits (Jacquet, 2012). Generally, dependence on a narrow set of economic sectors may lead to higher tolerance of the risks associated with those sectors, and hence a reluctance to express concerns. The effect of this predictor was not as strong as might have been expected, however. This could be interpreted to mean that in a petro-state, one does not have to necessarily work directly for that industry to have a strong sense of affiliation with it, in which case direct employment would not appear as a strong predictor of responses to the risks of fracking. Higher education was found to be negatively associated with both personal and collective engagement in fracking opposition activities.

Responses differed markedly across the three study sites, indicating the limitations of sociodemographic predictors alone. Respondents from Rosebud were more highly engaged in fracking opposition activities, while participants from Fox Creek were the least engaged. The regression results in Table 4.6 indicate no significant differences between communities, when controlling for other factors, but collective engagement is lower in Fox Creek. The lack of statistical significance here is likely a result of small sample sizes for these communities. These findings suggest that the decision to engage in fracking opposition activities may be shaped to a large degree by the economic and cultural character of the community. As has been well established in previous literature, place identity strongly affects the way local people respond to industrial development or large-scale use change, and each of these communities has a unique history, and political-economic relationship with the energy industry (Jacquet & Stedman, 2014; Luke, 2017; Short &Szolucha, 2019).

Among social capital variables, trust was expressed in particularly nuanced ways, with potential implications for future scholarship. While individuals certainly vary in their general dispositions to accord trust to government institutions, this study found high degrees of variation

in levels of trust accorded to the three government institutions of interest, highlighting the importance of historical relationships with specific state institutions. Considering the strong support for conservative parties, particularly in rural Alberta, the low levels of trust in the provincial government is not surprising, as the New Democratic Party was in power at the time of the survey, but trust in local government was also unexpectedly low. Most importantly, and particularly with respect to the Alberta Energy Regulator, trust levels also differed starkly across the three communities, each of which has a unique historical relationship with this institution. Of the 13 Rosebud residents in our study, not a single participant expressed high trust in the AER, or in local government. This extends to high distrust of information provided by the government and politicians about fracking.

Perceived self-efficacy also varied by community. Interestingly, respondents from Lethbridge reported much lower perceived self-efficacy (22%) compared to respondents from the much smaller communities of Fox Creek (44.8%) and Rosebud (46.2%), and yet Lethbridge hosted a local organization to oppose fracking. On the other hand, those who live in small communities can be expected to have higher degrees of interaction among community members. The regression results indicate that self-efficacy enhances personal engagement, similar to previous research findings that perceived power to influence outcomes can play a critical role in whether communities resisted industry development or not (Ergenc, 2014; Luke, 2017; Marcello & Perrucci, 2009).

The fact that social network participation was a significant predictor of personal engagement in the bivariate analysis, but not in the final model may reflect the possibility that organizational membership is strongly associated with education and income, both of which were significant, although in different directions, in the full model. It may also be the case that involvement in social networks alone is insufficient as a predictor of particular types of engagement activities.

Particularly, in this study, participants self-reported their memberships in charity or religious or recreational groups only. Even in Lethbridge, none of our respondent s were members of the No Fracking Lethbridge group. In rural, resource dependent communities, for example, frequent interactions with local organizations may be just as likely to sanction public engagement in fracking opposition as support it.

4.5. Conclusions

The results of this study suggest that concern about and engagement in resistance to the environmental impacts of fossil fuel development may be quite extensive, even within regions historically reliant on fossil fuel industries—so-called petro-states. However, the specific pathways through which those concerns emerge, and how residents choose to respond to those concerns, are strongly shaped by local community context. The residents of Lethbridge have not yet experienced directly the environmental impacts of hydraulic fracturing, although given the proximity of such activities in southern Alberta, and recent proposals to introduce such activities within their city limits, many residents would likely have been at least somewhat familiar with the risks associated with fracking. Residents of Rosebud and Fox Creek, on the other hand, have all experienced different forms of environmental impacts of fracking firsthand. In Rosebud, direct local economic dependence upon the oil and gas industry is relatively low, but the political experience of state and corporate indifference to expressions of concern very likely shaped responses to our survey. Residents of Fox Creek, on the other hand, who remain highly economically dependent upon oil and gas extraction, face considerable personal costs for public engagement in opposition activities, yet their personal experiences with impacts nonetheless have raised concerns.

This study offers unique insights into the pathways through which differences in trust and self-efficacy emerge. Even within a jurisdiction strongly shaped by a dominant political ideology,

institutional trust is allocated by residents according to personal and locally-specific histories with those institutions. And while the sample is too small to support generalizations, the higher degrees of self-efficacy expressed by residents of small, rural communities in comparison to the residents of an urban center certainly suggested for further investigation. Further study of public responses to the risks of energy development in extractive regions is strongly warranted, given the risks these residents face, and their potential to influence decisions over activities the impacts of which extend far beyond their jurisdictional boundaries. Regions where the oil and gas industries are mature and conventional reserves have been largely depleted will be increasingly reliant on unconventional sources of fossil fuels in order to sustain those economic sectors. The extraction of those unconventional sources, however, including gas and oil shale, heavy oil, and bitumen, has been linked to a growing scientific record of acute environmental impacts, in addition to increasing input costs, leading to increases in industry volatility in global commodity markets that are highly volatile to begin with. These conditions may result in the withdrawal of social license (Luke, 2017), even in regions where support has historically been quite high.

Chapter 5. General discussion and conclusions

This thesis makes contributions to the research fields of public perceptions about and engagement in fracking, focusing on local residents in Lethbridge, Fox Creek, and Rosebud, three communities located near fracking zones in Alberta, Canada. Our key finding is that regardless of demographic, socio-economic, and cultural differences among the communities, there are some common features among public perspectives regarding fracking evident in all three communities. Some members of local populations do not support fracking and are actively engaged in fracking opposition activities due to environmental concerns. Their likelihood of engagement appears to be influenced by economic, cultural, and institutional factors. However, our results showed that the level of support or opposition to fracking, and level of political engagement, differed markedly across the three study sites; and these differences are mostly attributed to the contextual factors. The latter can be classified into three main groups of factors: socio-economic relationship, institutional trust, and local cultural characteristics. All of them are interrelated, creating a complex and dynamic picture of local attitudes to fracking, which should be understood and considered in policy development at the municipal and provincial level.

5.1. Main findings of the study

In general, levels of support for fracking were considerably different among the three study sites. Levels of support found in Lethbridge, Fox Creek, and Rosebud were all considerably lower than what was found in province-wide studies (Axsen, 2014; Thomas et al., 2017). More than half of respondents in Lethbridge and Rosebud did not support for fracking at all. Even in Fox Creek where employment dependence on the industry was highest, 17.2% of respondents did not support fracking at all.

Engagement in fracking those opposition activities which require less investment of time and resources received a higher participation rate. On the other hand, communicating with government officials or oil and gas company representatives may be perceived by many to be a waste of time, even among concerned and efficacious individuals, within the context of a petro-province, in which state and corporate aversion to constraints on continued development is the norm (Adkin et al., 2017; Davidson, 2018).

The role of socio-economic factors is reflected in the association between the level of dependence of the local economy on the oil and gas sector, and individual perceptions of fracking. In particular, in the regions where the local economy largely depends on oil producing industries, is higher, the proportion of population who does not support fracking is less and the engagement in opposition to fracking activities is lower. For instance, 17.2% of respondents in Fox Creek, where employment dependence on the industry was highest, did not support fracking, while in Lethbridge, which has a diversified economy and a university, more than half of respondents did not support fracking at all. Analogously, the lower engagement into fracking opposition activities was reported from the communities with a high degree of economic dependence on the oil and gas industries (Fox Creek) and higher engagement where the economic influence of those industries was less (Rosebud, Lethbridge). Other socio-economic variables, such as annual household income, education, and employment in the energy sector, were also found to have a significant influence on citizen' participation in efforts to oppose fracking. Importantly, in regions with a high degree of economic dependence on oil and gas jobs such as Fox Creek, risk concerns and support for fracking are not necessarily inversely correlated: individuals in such communities can express support for fracking despite having concerns about the risks involved.

The other influential factor, which has the strongest effect on shaping local residents' perspectives on fracking together with their engagement in fracking opposition activities, is institutional trust. Notably, trust tin government, and in particular trust in the AER, differed starkly across the three communities. Among respondents in Rosebud, the level of trust was very low. None of the participants from Rosebud expressed high trust in the AER, or in local government. This extends to high distrust of information provided by the government and politicians about fracking. In this community the level of fracking support is relatively low (63% did not support fracking at all).

Our results showed a strong association between social capital and engagement in fracking opposition activities. Social capital, including trust and self-efficacy, in combination with concern for the impacts of fracking, strongly predict social engagement in fracking opposition in the three study sites. Institutional trust appears to have a polar effect on engagement, however. In some cases, a higher level of institutional trust was associated with higher engagement. For example, in Fox Creek the level of institutional trust was much higher compared to Lethbridge and Rosebud. The engagement of Fox Creek residents in attending events, discussing viewpoints about fracking, communicating with government officers and with industry was higher here than they appeared to be in Lethbridge. In contrast, respondents from Rosebud expressed their lowest trust in government among the three communities, and their engagement in fracking opposition activities was the highest.

Next, investigating the factors influencing levels of institutional trust toward a set of specific government entities, our results showed that local residents' trust is strongly influenced by historical experiences with those entities with respect to management of fracking development, and these experiences in turn affected attitudes toward fracking. These findings have implications for policy making and opens new venues for future research.

This research contributes a unique understanding about the perspectives and engagement of local residents who live in fracked areas, toward fracking in their communities. However, this unique contribution has several limitations, arising primarily from sampling. Due to the large difference in the population scale among Lethbridge (population 92,730) (Statistics Canada, 2016b), Fox Creek (population 1,970) (Statistics Canada, 2016a), and Rosebud (population 85) (Statistics Canada, 2016c), the sample sizes differed greatly, including 184, 29 and 13 participants from Lethbridge, Fox Creek, and Rosebud, respectively. Although the participants, to some extent, represent the populations in their communities, the differences in sample size across the three study sites limit the generalizations that can be made regarding the results of this research. This limit could be addressed by further research in these regions using

5.2. Contribution of this study

The results of this study reaffirmed previous findings that residents of fracking zones are concerned about the harmful effect of fracking and opposed fracking in their communities, as shown in studies conducted in the U.S. (Willow, 2014; Malin, 2014), in Saskatchewan, Canada (Eaton & Kinchy, 2016), China (Sher and Wu, 2018), and in Southern Alberta (Davidson, 2018). Self-efficacy was found to enhance personal engagement. This result is similar to previous research which found that perceived power to influence outcomes can play a critical role in whether communities resisted industry development or not (Ergenc, 2014; Luke, 2017; Marcello & Perrucci, 2009). However, their level of engagement in fracking opposition activities is not significant enough to make any change in the energy development policy that reflects their interest due to their feeling of powerlessness (Davidson, 2018; Eaton & Kinchy, 2016; Sher & Wu, 2018; Willow, 2014). This reason might help to explain why I found out that respondents with higher levels of education are less likely to engage in fracking opposition activities. This is in line with a previous study conducted in Alberta, which showed “little evidence that views

expressed during public and expert consultations about climate change impacts were taken seriously in Alberta and it challenges environmental and social interests to influence environmental policymaking and limited the democratic potential of public engagement in energy sector." (Adkin et al., 2017, p. 304)

A unique contribution of this study is the finding of institutional trust that effects perspectives in fracking opposition activities. Institutional trust had the strongest effect in our full model, even when controlling for gender, income, knowledge, and sector of employment. As indicated in our descriptive statistics, however, levels of institutional trust toward a set of specific government entities varied substantially by location, suggesting that local historical experiences with those entities with respect to fracking development strongly influenced local resident trust, and this in turn affected attitudes toward fracking.

5.3. Future research and policy implications

Considering the importance of historical economic dependence on the oil and gas sector, future development of municipal and provincial policies governing oil and gas development should be prefaced by more in-depth inquiries into local attitudes. In some cases, where communities may have had negative experiences with government authorities, a substantial amount of effort may need to be invested in rebuilding trust, through providing opportunities for successful engagement with the sector. In all instances, the development of policy measures requires improved understanding of local economic, political, cultural and historical context. The political conflicts over development may have less to do with the structural and demographic identities of residents and more to do with the unique local histories and cultures that define current community relationships with those industries.

Institutional trust had the strongest effect on shaping local residents' perspectives on fracking. However, trust in the provincial government and trust in AER appeared to operate in opposite

directions in relation to support for fracking. In other words, those who trust in provincial government are more likely to oppose fracking. On the contrary, those who trust in the AER are more likely to support fracking. This evidence leads to the conclusion that trust in government can be institution-specific. The provincial government as a whole at any given point in time is strongly identified with the ruling party, and thus trust in this entity may be highly influenced by an individual's political affiliations. The AER, by contrast, is a bureaucratic organization that changed little over the course of recent election cycles, and trust in this entity may be significantly influenced by personal and community-level experiences with this agency and its employees. Given the small populations and unique histories of these communities, further empirical work is needed to investigate the interactions between institutional trust and local residents' perspectives on fracking in a broader range of social contexts.

The No Drilling Lethbridge group played an important role in raising public awareness in Lethbridge about the impacts of fracking. This group appears to have contributed to the retraction of Goldenkey Oil's application to frack for oil and gas in within this city's limits. As noted (Admin Fracking News, 2014), the 2010 US Gasland documentary film contributed to the growth of global anti-fracking movements, including the formation of over 100 local anti-fracking groups globally. These indications of the efficacy of political mobilization activities in generating public concern and changes in state and industrial decision-making are compelling.

Nevertheless, limited attention has been directed to date toward the study of the impacts of environmental groups on local people's awareness and perspectives on energy development, and other forms of environmental and health risk. Therefore, research on the impacts of anti-fracking networks/groups on public perceptions of shale gas development, especially in high-volume fracking areas, is warranted.

The perceptions of risks versus benefits of fracking can change over the course of different shale development phases (Jacquet, 2012) . At every period of the drilling operation, from the pre-development to the peak of development, to decline, and the stabilized periods of fracking operations, local people have experienced different types of economic, social, and environmental impacts associated with fracking. To date there have been no studies of changes in local perspectives during the life span of a fracking project in Alberta. Longitudinal research designs that allow scholars to be able to investigate thoroughly changes in residents' responses to fracking operations in their communities may be another valuable area of research. Results from this type of research will provide unique insight into local perspectives about fracking.

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APPENDIX

QUESTIONNAIRE EXPLORING LOCAL PERCEPTION OF HYDRAULIC FRACTURING DEVELOPMENT

To be conducted by telephone interview and as online written survey

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[This page will be added to the online survey] Thank you for taking the time to help us with our research project. The questions will require about 30 minutes of your time. The information collected today is focused on your perceptions of and responses to hydraulic fracturing (also called fracking) operations in and near your community. Your answers will help us to better understand the social impacts of and responses to fracking in local communities.

The information you provide is completely confidential and only used for this study. It will be presented in academic conferences and journals, and will contribute to the researcher's Ph.D. Thesis. Only the polling firm conducting the survey and the two researchers from the University of Alberta, have access to the survey data. All data will be treated as anonymous. Your personal information will be stripped from the survey itself after one week. However, if you would be willing to be contacted for a follow-up interview, your name and contact information will be collected. Once the follow-up interview completed, your identity will be stripped from the survey and kept in a separate file. The data will be kept in a secure location, and the names of participants will be kept in a separate file. All computer files containing data and any identifying information are password protected.

You have one week after we conduct the survey to decide if you would like to withdraw, or modify your answers to the survey questions by contacting the following number…….[polling firm number].

By agreeing to participate in the survey, you are indicating that you have understood the above information, and that you consent to participate in this study.

For more information regarding the study please contact the Lead Investigator's Supervisor: **Dr. Debra J. Davidson**, Professor, Department of Resource Economics and Environmental Sociology, University of Alberta. Email: debra.davidson@ualberta.ca. For questions regarding participant rights and ethical conduct of research, contact the University of Alberta's Research Ethics Office at (780) 492-0459.

A. Engagement with civic activities

Instructions: *Please indicate your engagement with civic activities in the past 12 months.*

Activities	Yes	No
1. Voted in the last city election.	1○	2○
2. Voted in the last provincial election.	1○	2○
3. Voted in the last federal election.	1○	2○

B. Networking

Instructions: *Below are questions that help us understand your social networks. Please answer each question to the best of your ability.*

Activities	Yes	No
1. Are you or someone in your household a member of any **local** group/organization?	1○	2○
2. Are you or someone in your household a member of any **non-local** group/organization?	1○	2○

3. If you answered "no" to both questions 1 and 2, go to question 7. If you answered "yes" to either or both of the two previous questions, in which of these groups/organizations are you most active in? (List up to three, starting from the most important one).

3.1 Name of group/organization 1. _____

Is this a local organization? **Yes** 1○ **No** 2○

On average, how many hours per month do you participate in this group? _____

3.2 Name of group/organization 2. _____

Is this a local organization? **Yes** 1○ **No** 2○

On average, how many hours per month do you participate in this group? _____

3.3 Name of group/organization 3.

Is this a local organization? **Yes** 1○ **No** 2○

On average, how many hours per month do you participate in this group? _____

4. Please tell us about the groups/ organizations in which you are most active in. **Are the group's members……**	**Group/ Org. 1**		**Group/ Org. 2**		**Group/ Org. 3**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
4.1 Mostly of the same extended family?	1○	2○	1○	2○	1○	2○
4.2 Mostly of the same religion?	1○	2○	1○	2○	1○	2○
4.3 Mostly of the same gender?	1○	2○	1○	2○	1○	2○
4.4 Mostly belong to the same political party?	1○	2○	1○	2○	1○	2○
4.5 Mostly have the same occupation?	1○	2○	1○	2○	1○	2○
4.6 Mostly from the same age group?	1○	2○	1○	2○	1○	2○
4.7 Mostly have the same education level?	1○	2○	1○	2○	1○	2○

5. How many close friends, immediate family members (e.g., living in the same household), and other people you know are there within the organization(s) in which you are most active in?

Close Friends _____ Immediate family members _____ Other people _____

6. (In the past three month,) how often did you talk with someone in these organization(s) about fracking or environmental issues?

	Never	**Once/ month**	**A few times/ month**	**Once/ week**	**A few times/ week**	**Don't know**
6.1 Group/ Organization 1	1○	2○	3○	4○	5○	9○
6.2 Group/ Organization 2	1○	2○	3○	4○	5○	9○
6.3 Group/ Organization 3	1○	2○	3○	4○	5○	9○

7. Please indicate whether or not you are a member of organizations that have expressed support for, or opposition to fracking, or know any members from these organizations.

	I am a member of		**I know member(s) of**	
	Yes	**No**	**Yes**	**No**
7.1 Organizations in support of fracking.	1○	2○	1○	2○

7.2 Organizations opposed to fracking.	1○ 2○ | 1○ 2○					

Instructions: *Below are questions that help us understand collaboration and participation in your community.*

8. In the past 12 months, how often have the residents in your community gotten together to talk about fracking issues?	**Never** 1○	**Rarely** 2○	**Sometimes** 3○	**Often** 4○	**Very often** 5○	**Don't know** 9○
9. If crisis such as a fire or flood occurs in your community, how confident are you that the members of your community would work together to respond to this crisis?	**Very low** 1○	**Low** 2○	**Medium** 3○	**High** 4○	**Very high** 5○	**Don't know** 9○
10. How satisfied are you in your ability to engage in decision-making in your local community?	1○	2○	3○	4○	5○	9○
11. How would you rate the spirit of participation among the residents of your community in regard to community issues?	1○	2○	3○	4○	5○	9○

12. To what extent do you agree or disagree with the following statements?

	Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**	**Don't know**
12.1 If I have a problem, there is always someone in the community willing to help me.	1○	2○	3○	4○	5○	9○
12.2 I am able to access the information that I want regarding community issues.	1○	2○	3○	4○	5○	9○
12.3 I am satisfied with information provided by the local media.	1○	2○	3○	4○	5○	9○
12.4 I have a strong influence in making this community a better place to live.	1○	2○	3○	4○	5○	9○
12.5 All adults in the community are given an opportunity to participate in community-level decision-making.	1○	2○	3○	4○	5○	9○

13. How long have you lived in this community?

Less than 1 year	**1 to 5 years**	**5 to 10 years**	**Over 10 years**	**All my life**
1○	2○	3○	4○	5○

C. Hydraulic fracturing development in the community and your participation

Instructions: *Below are questions that help us understand your familiarity with and involvement in efforts to influence decision-making regarding hydraulic fracturing in your community. Please answer each question to the best of your ability.*

	True	**False**	**Don't know**
1. Fracking is the process of drilling down into the earth and injecting chemicals, sand, and water at high pressure to release oil and gas that are trapped in solid materials like shale.	1○	2○	9○
Recent technology changes in hydraulic fracking development include:			
2. An increase in the level of pressure applied in the drilling process.	1○	2○	9○
3. The use of horizontal drilling methods.	1○	2○	9○
4. A reduction in the volume of water required	1○	2○	9○
5. None. The same process used today have been used for many decades.	1○	2○	9○

6. Please identify which of the following organizations have responsibilities for permitting and regulating the impacts of fracking (check all that apply).

Office of the Premier	The Federal government	The Alberta Energy Regulator	Local government	Ministry of environment	Don't know
1○	2○	3○	4○	5○	9○

7. Please indicate the frequency of your participation in the following activities related to opposition to fracking.

Type of activity	Frequency of activity					
	Not at All	Rarely	Sometimes	Often	Very often	Don't know
7.1 Donate/spend money to support environmental event(s).	1○	2○	3○	4○	5○	9○
7.2 Communicate with a government official regarding your concerns.	1○	2○	3○	4○	5○	9○
7.3 Write a letter to a newspaper regarding your concerns.	1○	2○	3○	4○	5○	9○
7.4 Communicate with the oil and gas company regarding your concerns.	1○	2○	3○	4○	5○	9○
7.5 Communicate with another organization regarding your concerns.	1○	2○	3○	4○	5○	9○
7.6 Sign a petition.	1○	2○	3○	4○	5○	9○
7.7 Attend publicly held protest event(s).	1○	2○	3○	4○	5○	9○
7.8 Attend meetings or public hearings sponsored by goverment or industry.	1○	2○	3○	4○	5○	9○
7.9 Discuss your views about fracking with family, friends, and neighbors.	1○	2○	3○	4○	5○	9○
7.10 Other forms of participation regarding environmental protection. Please specify. _____	1○	2○	3○	4○	5○	9○

8. Please indicate the frequency of your participation in the following activities related to support for fracking.

Type of activity	Frequency of activity					
	Not at All	Rarely	Sometimes	Often	Very often	Don't know
8.1 Express your support for fracking in public meeting(s).	1○	2○	3○	4○	5○	9○
8.2 Discuss your support for fracking with family, friends, and neighbors.	1○	2○	3○	4○	5○	9○
8.3 Other forms of activities in support for fracking. Please specify. _____	1○	2○	3○	4○	5○	9○

9. From which sources do you most frequently receive information about fracking.

Sources of information	Level of frequency				
	Never	Rarely	Occasionally	Frequently	Very frequently
9.1 Scientists	1○	2○	3○	4○	5○
9.2 Government	1○	2○	3○	4○	5○
9.3 Politicians	1○	2○	3○	4○	5○
9.4 Non-government organizations	1○	2○	3○	4○	5○
9.5 Friends & neighbors	1○	2○	3○	4○	5○
9.6 Local government	1○	2○	3○	4○	5○
9.7 Social media/Internet	1○	2○	3○	4○	5○
9.8 Oil and gas companies	1○	2○	3○	4○	5○

10. Please indicate the way you usually receive information related to fracking

Channels of information	Never	Rarely	Occasionally	Frequently	Very frequently
10.1 Newspapers, magazines, TV	1○	2○	3○	4○	5○
10.2 Social media/Internet	1○	2○	3○	4○	5○
10.3 Personal communication	1○	2○	3○	4○	5○

11. How concerned are you about harmful effects of hydraulic fracturing in and near your community?

Not at All	Slightly	Moderately	Quite a bit	Extremely	Don't know
1○	2○	3○	4○	5○	9○

12. If you indicated that you have concerns of fracking in the previous question, please list your top three reasons for concern in the spaces below.

12.1 _____

12.2 _____

12.3 _____

13. To what extent do you support hydraulic fracturing activities in or near your community?

Not at All	Slightly	Moderately	Quite a bit	Extremely	Don't know
1○	2○	3○	4○	5○	9○

14. If you indicated support for fracking in the previous question, please list your top three reasons for support in the spaces below.

14.1 _____

14.2 _____

14.3 _____

D. Trust

1. Please indicate your level of trust toward the information sources and channels related to fracking that you received.

Sources of information	Level of trust				
	Lowest	Slightly	Moderately	Quite a bit	Highest
1.1 Scientists	1○	2○	3○	4○	5○
1.2 Government	1○	2○	3○	4○	5○
1.3 Politicians	1○	2○	3○	4○	5○
1.4 Non-government organizations	1○	2○	3○	4○	5○
1.5 Friends & neighbors	1○	2○	3○	4○	5○
1.6 Newspapers, magazines, TV	1○	2○	3○	4○	5○
1.7 Internet, worldwide web	1○	2○	3○	4○	5○

1.8 Oil and gas companies	1○	2○	3○	4○	5○	

Level of trust

2. To what extent do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Don't know
2.1 The people in this community can be trusted.	1○	2○	3○	4○	5○	9○
2.2 The current local government represents my interests regarding fracking in and near my community.	1○	2○	3○	4○	5○	9○
2.3 The current provincial government represents my interests regarding fracking in and near my community.	1○	2○	3○	4○	5○	9○
2.4 The Alberta Energy Regulator represents my interests regarding fracking in and near my community.	1○	2○	3○	4○	5○	9○
2.5 I am satisfied that I have had the opportunity to express my views on fracking development in and near my community.	1○	2○	3○	4○	5○	9○
2.6 I believe that many members of my community have participated in making decisions regarding fracking development in and near my community.	1○	2○	3○	4○	5○	9○

3. How has your level of trust in the provincial government's management of the impacts of fracking changed since the last election?

Extremely decreased	Decreased	Unchanged	Increased	Extremely increased	Don't know
1○	2○	3○	4○	5○	9○

E. Social and demographic Information

Instructions: *Below are questions that help us understand who the findings of this study refer to. Please answer each question to the best of your ability. You can omit any question you prefer not to answer.*

1. What is your gender? **Male** 1○ **Female** 2○

2. What is your year of birth? _____

3. What is the highest certificate, diploma or degree that you have completed?

Less than high school	High school	Some college	Bachelor's degree	Above Bachelor's degree
1○	2○	3○	4○	5○

4. Were you born outside of Canada? **Yes** 1○ **No** 2○

5. If "Yes", when did you first arrive in Canada?

Less than 1 year	1 – 5 years	6 – 10 years	11 – 15 years	Above 15 years
1○	2○	3○	4○	5○

6. What is the ethnic or cultural origin of your parents? (Check all that apply)

Aboriginal	Asian	African	European	Latin American	Other, please specify
1○	2○	3○	4○	5○	_____

7. Do you have children?

Yes, they live at home	Yes, they live away from home	No
1○	1○	1○

8. In the past 12 months, what has been your job status?

1○ Employed or self-employed full-time 2○ Employed or self-employed part-time 3○ Out of work and looking for work

4○ Home-maker or caregiver
5○ A student
6○ Out of work but not currently looking for work
7○ Military
8○ Retired
0○ Unable to work

9. If you have been employed, in what sector do you work in?

1○ Agriculture
2○ Business
3○ Education
4○ Health
5○ Forestry
6○ Energy industry
7○ Other, specify 1. _____

10. In the previous year, approximately at what level was your ***total household income***?

0○ No income or loss
1○ Less than $40,000
2○ $40,000 to $64,999
3○ $65,000 to $89,999
4○ $90,000 to $124,999
5○ $125,000 or more
6○ Not stated
9○ Don't know

11. Is there anything else you would like to add regarding hydraulic fracturing operations in and near your community? If yes, please write your answer in the space below.

_____

_____

_____

_____

Would you be willing to participate in a follow-up interview? If so, please provide your name and contact information:

Name: _____

Contact information: _____

_____

Thank you for participating!