Social Perspectives on Hybrid Poplar Biofuels in the Pacific Northwest: Structuring Stakeholder Viewpoints and Analyzing Media Content

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Abstract

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For scientists, policymakers, and stewards of this earth, it is critical to find ways to recognize human interdependence with life on this planet and live within the boundaries which preserve the balance of global systems. In this research, I provide knowledge about stakeholder perspectives on the development of a new biofuels industry in the Pacific Northwest. In order to support constructive policy dialogue and program implementation, policymakers, natural resource managers, and communication specialists need to understand how citizens make sense of and contribute to the discourse surrounding environmental issues. A direct way to gain access to meaningful social perspectives is through examining stakeholders' social discourse. I used Q-methodology to examine stakeholder discourse and a grounded interpretive mixed methods analysis to examine online discourse on the social media site Twitter. Social discourse is often chaotic and difficult to access for purposes of policy analysis. Q-technique and grounded

interpretive approaches are both well-suited to systematically structuring social discourse so it can be useful for policymakers in designing effective policy outcomes. Stakeholders included: farmers and growers; refinery, fuel, and/or energy producers; energy associations; bioenergy companies; labor unions; investment companies; research institutions; and advocacy organizations. In addition, I identified relevant information for policymakers about the biofuels issue public, social discourse, and communication structure found in the Twittersphere. Results from the three studies echo other researchers' findings that social perspectives surrounding biofuels are quite complex. Findings from the two Q-studies indicate frame flexibility across stakeholders: individual stakeholders held multiple perspectives, and some even held conflicting ones. Overall sentiment of the tweet-based biofuels discourse was largely positive, with 60% of the issue public viewing biofuels positively and 16% viewing them negatively. However, sentiment was mixed for four of the six stakeholder groups. Some of this complexity may be explained by the overarching finding that there are distinct micro-discourses existing within the broader biofuels discourse. Priming any particular aspect of this discourse may influence how stakeholders conceptualize biofuels development issues. Ultimately, this kind of clarity is crucial to facilitating a constructive policy dialogue, rather than one in which people unwittingly speak past each other.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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DEDICATION

For River.

1. INTRODUCTION

Humanity is facing an unprecedented crisis, a crisis of both biophysical and social global earth systems. If we are to bravely turn toward this for our collective good, we need to reconsider the old ways of doing business (Steffen et al., 2015). Humans are arguably predominant drivers of environmental change on this planet (Steffen et al., 2007); therefore, as scientists, policymakers, and stewards of this earth, it is critical to find ways to recognize our interdependence of life on this planet and live within the boundaries which preserve the balance of global systems (Sachs & Ki-Moon, 2016). Society needs clarity around those boundaries and shared goals in order to work together to attain them (Kanie & Biermann, 2016). However, the divide around how to steward our resources at a planetary level is staggering, especially when climate change is brought into the discussion. Climate change is one of this nation's polarizing issues and perhaps the most challenging environmental problem we have faced to date (Bliuc et al., 2015; Hofman, 2011; Fisher, Waggle, & Leifeld, 2013; Gardiner, 2006; Braman et al., 2012; Leiserowitz et al., 2001; McCright, & Dunlap, R. E., 2011; O'connor, Bord, & Fisher, 1999). In the old policy world, positivist approaches to planning and the best available science directed decision-making and policy creation, at least in theory (Fischer & Forester, 1993). Yet, as the debate of climate science shows, relying on the best available science to guide the navigation of planetary boundaries is no longer possible.

How do policymakers and natural resource planners deal with such polarized ways of understanding the world? Society needs to be able to have civil discourse and constructive policy dialogue in order to develop constructive alternatives (Fischer & Forester, 1993).

But how is this possible in such a divided context? How do we as a society have a dialogue with ourselves? In Greek, dialogue literally means *dia*, "through," and *logos*, "meaning," and taken together, *shared meaning* (Bohm, 1996). But, when different words can mean the same thing, and the same words can mean different things, how does one reach shared meaning? Further, how does one arrive at shared meaning within oneself, integrating narratives from competing value systems?

There are no easy answers to these questions; however, in light of them, several scholars in the policy-planning and natural resource management fields have suggested a turn toward more reflective approaches to policy analysis as a means to better plan in such a complex environment (Dryzek, Fischer and Forester, 1993; Gregory et al., 2012; Healey, 2006; Rydin, 2003). Though these authors have proposed several more reflective forms of policy analysis, including communicative planning, collaborative planning, discursive democracy, and structured decision-making, the unifying element between these approaches is the creation of policy that meaningfully honors subjective human values. In these systems, agendas, institutional identity, and latent values are of equal or greater importance for decision-making than inputs based purely on administrative rationality.

In this dissertation, I describe how arriving at shared meaning is important in order to determine constructive future directions for living in balance with our world. Policymakers, program managers, and communication specialists need to understand how citizens and stakeholders are making sense of issues, as well as how this constituency contributes to and shapes the discourse surrounding environmental issues (Addams and Proops, 2002; Bohm, 1996; Hajer, 1995; Litfin, 1994; Rydin, 2003). A direct way to do this is through examining stakeholders' social perspectives. For the purposes of this study, I define social perspectives as a system of

values, beliefs, attitudes, and emotions that make up the collective cognitive schema for how people view the world.

I analyze the cognitive and narrative structures underlying stakeholder perspectives on sustainable energy development in the Pacific Northwest in order to support decision-making toward identifying the socially acceptable alternatives. In-depth knowledge of social perspectives help researchers find effective policy alternatives and determine a given project's social feasibility (Burdge, 2004). Even if future natural resources management utilizes all the best available science to create economically viable, environmentally sound, and technologically possible policy, it will likely fail upon implementation if it is not socially acceptable (Wüstenhagen et al., 2007). The specific focus for the following chapters is to present my analysis of social perspectives about the development of hybrid poplar-based biofuels in the Pacific Northwest. This research aligns with the UN Sustainable Development Goal #7 of developing affordable clean energy, and might serve as a model for seeking deeper clarity around the boundaries for our global earth systems, including the diverse values and unique boundaries inherent in human systems.

Thus, my research task is threefold: to identify and honor people's diverse values and ways of knowing the world; to analyze the potentially unconscious sources of approval and concern that lie outside of personal identity, institutional affiliation, or professional agenda; and to determine areas of more conscious concern in order to find which agendas may resonate with deeper pre-existing discourses. Achieving these three goals will help address the sustainable energy challenge by reframing perceived conflicting discourses through the lens of shared meaning, thereby facilitating constructive dialogue about future directions that align with planetary boundaries and support healthier social and environmental global systems.

People express their perspectives both through intrapersonal communication—that is, private reading, writing, and thinking—and through interpersonal communication, in person through everyday talk, and especially in the age of the Internet, through various online media such as emails, blogs, and websites. When people communicate their perspectives in the public sphere, these perspectives shape the social discourse (Cox, 2013; Glynn et al., 2004). That said, this kind of public sphere discourse is chaotic and often inaccessible to decision-makers, especially in the early stages of the development of an environmental problem (Hannigan, 2006). Without systematic scrutiny, the raw forms of these communications offer little direction for management and policy. I seek to address this deficit by structuring these social perspectives in a way that can be used constructively for implementing socially acceptable policies, programs, and projects.

In natural resource management and policymaking in general, researchers tend to assess social "climate" through public opinion surveys, interviews, and discourse analytic approaches. However, such methods often fail to capture the gap between stakeholder's stated opinions and the acceptability of a policy or program after implementation (Wüstenhagen et al., 2007). Although a number of factors are responsible, this gap can partially be explained by the unstructured and transient nature of people's opinions, as well as the inability of survey and interview research to enable participants to ground or structure opinions while considering multiple perspectives (Asah et al., 2012a; Stephenson, 1953). Furthermore, resources are finite, and decision-makers must make real-world tradeoffs among many different alternatives (Asah et al., 2012a, Asah et al., 2012b). Most survey research and interview approaches do not provide the opportunity for stakeholders to prioritize and consider salient issues holistically and systematically.

It is not enough for policymakers to consider general social perspectives in applying reflective approaches to policy analysis and planning. It is critical that the right perspectives be brought to the bear on the issue. Thus, any inquiry into the social feasibility of a policy or program must include people who might be influential in its development (Rogers, 2010; Shindler et al., 2004). This is especially important for place-based phenomenon like environmental issues to avoid the *Not-In-My-Back-Yard* (NIMBYism) effect (Jenssen, 2010; Van der Horst, 2007). Therefore, public opinion is important for providing broad context for environmental planning, but it is often not specific enough to provide the depth of knowledge needed by policy analysts to facilitate constructive policy dialogue and region-specific planning efforts (Burdge, 2004). Therefore, I focus my observations on key stakeholders and specifically engaged publics, including potential political actors, rather than focusing on the general public at large.

The purpose of this study is to provide knowledge that will facilitate decisions and outreach efforts aimed at rendering hybrid poplar biofuels more politically, socially, and culturally acceptable among different stakeholder groups and communities, thus facilitating a more constructive direction for planning and managing the region's sustainable energy future. In service to this aim, I systematically analyzed and structured the active social discourse of biofuels to reveal meaningful characteristics of subjective thought. I examined social discourse within two major spheres of social communications: small group interpersonal settings and the online social media site, Twitter. These sources represent two important domains of public sphere communication. Additionally, they provide access to the key stakeholders and engaged publics most likely to influence social attitudes on the development of biofuels in the region. Two different approaches guide the analysis: Q-technique and a grounded interpretive mixed methods analysis. Q-technique

and grounded interpretive mixed methods analysis are both well-suited to systematically structuring social discourse so it can be most useful for anticipating and managing social perspectives.

Several key concepts underlie and provide justification for my approach to examining social perspectives about biofuels in the Pacific Northwest. First and foremost is the link between the development of social perspectives, communication, and cognition. My research is designed to investigate communications about biofuels, and then draw insight about the intrapersonal and interpersonal cognitive constructions of the parties involved.

Next, I present the importance of discourse and framing, then discuss implications for the social acceptability of biofuels. Since several concepts such as framing and discourse have been defined and applied differently, depending on the research tradition, I also provide clarity around how I define and apply these concepts. I follow this with a brief history of the development of bioenergy in the United States and conclude with a review of the relevant literature on of the social perceptions of biofuels.

1.1 Communication, Cognition, and Constructing Social Perspectives

Communication constitutes the shared process of making meaning undergone by individuals and society. As individuals develop their own perspectives and influence the development of social perspectives, these communications shape the active and dynamic process of social acceptability (Shindler et al., 2004; Brunson et. al, 1996). This process is termed *consciring,* suggesting that any *thought* we have is *communicable*, or able to be communicated (Stephenson, 1978). In addition, for a given thought, there is a universe of possible

communications expressing those ideas, known as a *concourse* (Stephenson, 1980a). For example, the full set of communication that has ever existed and ever will exist about biofuels is called the biofuels concourse. Q-technique and its methodology offer a quasi-qualitative means of examining prominent themes in concourses (Stephenson, 1953).

The biofuels concourse develops through communication as people strive to make sense of new environmental and technological activities. The biofuels concourse is not new: online conversations started trending about biofuels production in the United States by 2004. Hybrid poplar and second-generation biofuels (cellulosic-based feedstock) first became a topic of discussion in 2006 (Google Trends). Conversations about biofuels are diverse and expressive, with some people hailing biofuels as "sky's kind of the limit" and "very exciting" (Grass, 2012) and others calling them "just plain immoral" (Novista, 2007) or an "enormous risk" (Petermann, 2011).

In Q-methodology, the correlation and factor analysis of the themes present in the biofuels concourse represent the *schema*, or underlying structure of social perspectives around this issue (Brown, 1980; Stephenson, 1980b). In other approaches to examining social perspectives such as ethnographic content analysis, the frequency of themes denotes social issue salience and provides insights into collective priorities (De Munck, 2009). Thus, through the study of communication occurring in the public sphere, this study is able to access socially held values, beliefs, and attitudes regarding biofuels; in short, social-psychological frames of understanding and preference. However, in order to give adequate structure to and understand relevant social-psychological frames regarding biofuels, they need to be grounded in the social discourse produced by stakeholders and engaged publics.

1.2 Discourse, Social Discourse, and Policy Dialogue

The study of communication as a philosophical and methodological approach is quite broad. Therefore, it is helpful to narrow the focus to consider communication within the context of discourse. Discourse refers to a grouping of ideas, concepts, and categories which give meaning to some topic of interest (Hajer, 1993). Brown (2014) suggested that a discourse is actually a more linear story-like subset of communication contained within the broader concourse. There is also the notion of "dominant" discourses, also known as *D*iscourses with a capital *"D"* (Gee, 2014). Dominant *D*iscourses emerge out of analyzing the conversations taking place between actors in the public sphere (Gee, 2014). They represent the highest-level themes or narratives that appear in conversations. The actual conversations and communication itself is referred to as social *d*iscourse, or discourse with a little *"d"* (Addams & Proops, 2000; Gee, 2014). Cognitively, discourses refer to the substantive points where people become aware of their thinking, as compared with concourses which relate more to more unconscious transitive thinking (Brown, 1980). For this reason, some researchers advocate for Q-methodology as an approach to social *d*iscourse analysis (Addams and Proops, 2000; Stainton-Rogers 1997-1998). Hence, analyzing social discourse can provide a platform for understanding the structure of stakeholder subjectivity toward biofuels.

Social acceptability is important from a practical standpoint because it determines how feasible future biofuels policies, programs, and projects will be to implement. Again, it is through the study of stakeholder social *d*iscourse about biofuels that researchers are able understand the underlying proxies of social acceptability. Literature from the policy field supports this approach (Dayton, 2000; Dryzek, 1993; Rein & Schon, 1993; Fischer & Gottweis, 2012; Focht & Lawler, 2000). Post-positivist policy analysts suggest that competing ideas expressed through

communication shape the perception of an issue; this is the "*argumentative turn"* in policy analysis, indicative of the more reflective policy approach previously described (Fischer & Gottweis, 2012).

In this research, I advocate for a more constitutive role for communication. I add to that a normative proposal to honor shared meaning in policy analysis, supporting collaborative deliberation rather than adversarial in the vein of *communicative planning* (Healey, 2006). The process of communication permits society to share in the social construction and definition of biofuels as the social process reciprocally shapes how individuals frame and define biofuels for themselves. Analyzing discourse in this way accesses a real-time co-construction of ideas, rather than revealing underlying passive structures. Thus, I approach this research through the examination of 'discourse' as a constitutive policy *d*iscourse for the purpose of organizing knowledge that can be used to facilitate a policy dialogue supporting shared meaning and the creation of constructive direction for the development of biofuels in the region.

1.3 Discourse, Framing, and Psychological Discourse Analysis

Social discourses are the stories that, shared, collectively construct a picture of reality, while framing is the process through which individuals or groups tell these stories. Discourses frame how people view the world (Boykoff, 2012). The telling of these stories through a particular lens shapes the individual and collective interpretation of them. Thus, any examination of the biofuels concourse as constitutive policy *d*iscourse should consider how discourse is framed.

Entman (1993) has argued that *framing* unifies the study of communication. *Frames* are mechanisms which mark the salience of different aspects of communication (Entman, 1993). The

aspects that are made salient either consciously or unconsciously denote preferences and priorities for the individual or social group engaged in communication. These contribute to the development of individual psychological cognitive frames (Cantrill, 1996) and also social frames (Benford & Snow, 2000).

In Q-methodology the different constellations of individual viewpoints which make up each perspective taken holistically are the social-psychological frames, which I also refer to as social perspectives. At an individual level, as the participant engages in a Q-sort they are creating their individual frame for how they understand the issue by examining communication about the issue presented via the Q statements. The participant consciously prioritizes some aspects of that communication over others as they engage in the sorting process. Once all of the individual viewpoints are factor analyzed, groupings of social frames emerge from the analysis. In this way Q-methodology provides a detailed quantitative approach to enable participants to generate frames for their individual viewpoints and subsequently allows researchers to access their associated social-psychological frames.

In other approaches to examining social discourse, frames are identified through counting the frequency of themes or exploring theme content in other ways to assess issue salience. This is perhaps the more common approach to analyzing individual and social frames. In policy analysis, for example, *policy discourse* can be analyzed in terms of specific *policy frames* regarding preferences for addressing policy problems (Dayton, 2000). In the policy arena, however, there is a split between scholars who view discourse as constitutive versus structural (Fischer & Gottweis, 2012), a split that may stem from misunderstandings about the definition of framing.

A key distinction about frames is that they can be both cognitive and interactional (Dewulf et al., 2009). Frames are interactional in the sense that competing frames are used by different stakeholder groups to influence the interpretation and construction of specific discourses about biofuels. This definition for framing is more in alignment with traditional communication scholarship (Entman, 1993). However, communication is also cognitive because it contributes to the formation of individual perceptions and the development of deep psychological structures known as schemata (Cantrill, 1996; Judd & Kulik, 1980; Markus, 1977). This interpretation is in alignment with the psychological definition of framing (Dewulf et al., 2009).

Policy scholars often apply frame analysis as a structural approach for examining broader universal themes and *D*iscourses. They often apply methods such as critical discourse analysis or Foucauldian style discourse analysis to examine discourse associated with past and ongoing policy issues (Wiggins & Potter, 2008). However, discourse surrounding future policy proposals and the development of specific management alternatives requires a more context-specific approach. A social-psychological lens to discourse analysis provides the necessary level of detail and has been successfully applied in the environmental field to support conflict management (Asah et al., 2012a; Asah et al., 2012b; Mazur & Asah, 2013). Approaches to planning that consider both the cognitive and interactional elements of framing social *d*iscourse are relatively rare in the field of environmental planning, but hold much promise for the future.

1.4 A Brief History of Bioenergy Development in the US

The production of bioenergy sources such as ethanol and bio-diesel has existed in the United States for some time, but it has only been in the last decade that other alternative bioenergy

sources have come to prominence (Dirks et al., 2012). After the passing of the Renewable Fuels Standard in 2005, Congress passed the "Energy Independence and Security Act 2007" which required 36 Billion gallons of bio-based fuel ethanol be produced by 2022. Half was expected to come from woody-based sources (US Congress, 2007). At the time the act was passed, second-generation bioenergy sources did not exist. Second-generation biofuels are cellulosic-based rather than sugar-based and can be made of anything from algae to switchgrass (Dirks et al., 2012). Today, second-generation producer plants are slowly increasing in number. Bio-ethanol production takes place mainly in the North Central and Midwest United States (Ethanol Producer Magazine, 2017), with newer plants emerging in the Pacific Northwest and Southeast (Figure 1). The Pacific Northwest still imports the majority of its ethanol from outside the region. In 2011, the USDA NIFA funded the development of advanced second-generation bio-based diesel, gasoline, and renewable jet fuels across the Pacific Northwest (Figure 2).

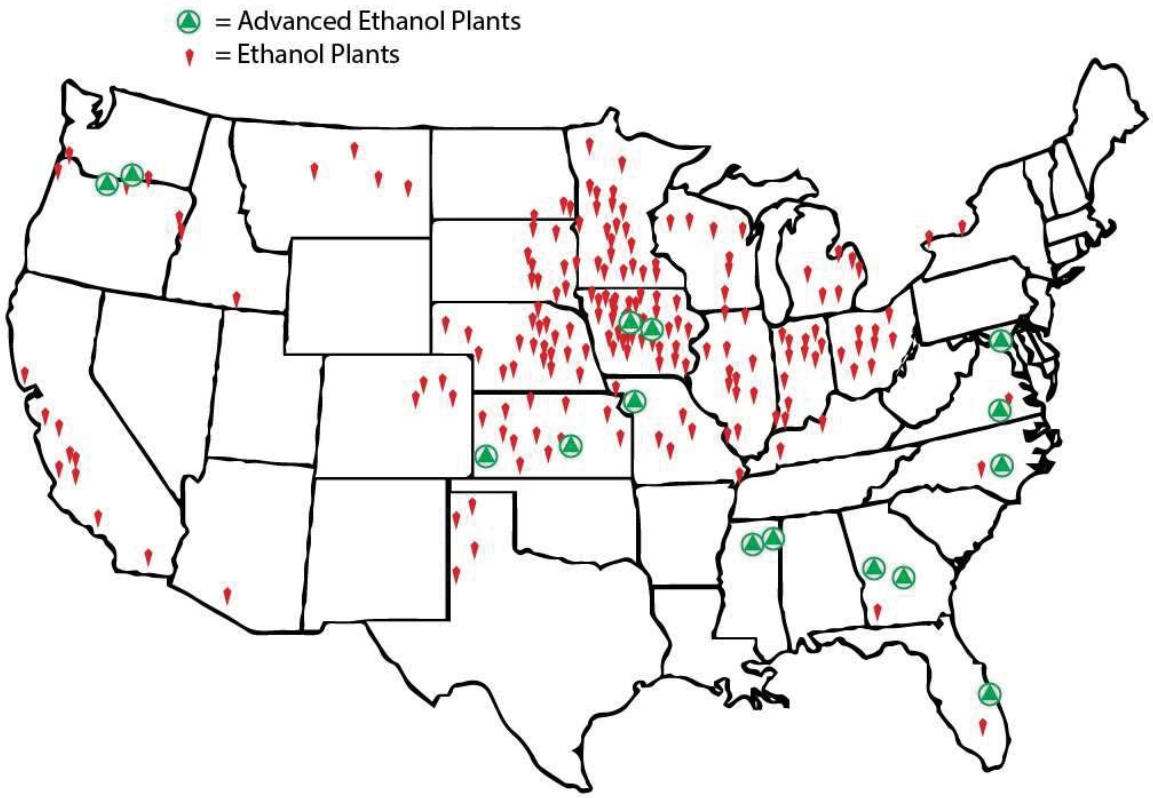

Figure 1. Map of ethanol plants and advanced ethanol plants. Map based on Ethanol Producer Association's Fuel Ethanol Map 2017.

The Advanced Hardwood Biofuels Consortium, a USDA NIFA funded initiative, focused on developing wood-based biofuels from fast-growing hybrid poplar and willow sources, thus, my focus on hybrid-poplar-based biofuels and second-generation bioenergy (Advanced Hardwoods Biofuels Northwest, 2017).

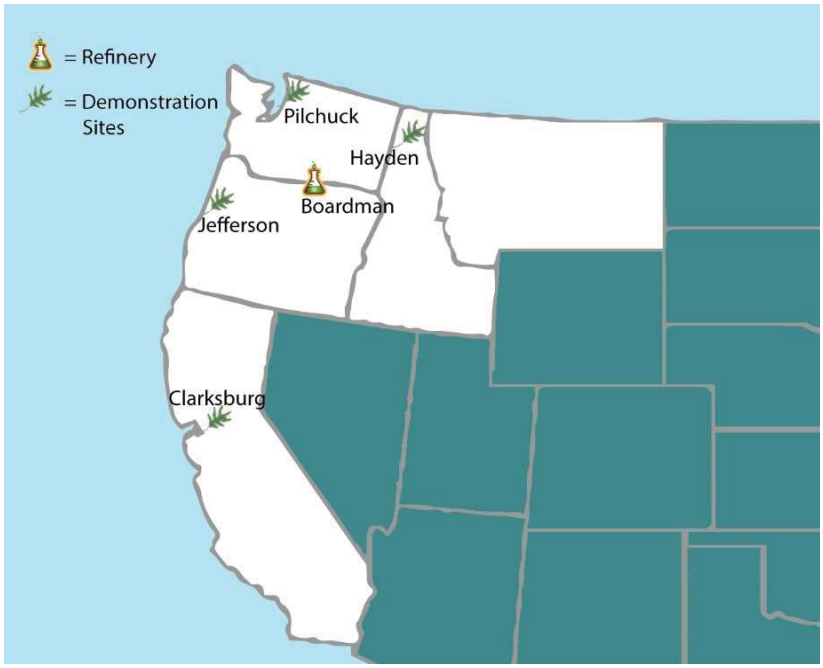

Figure 2. Map of the Advanced Hardwood Biofuels Northwest Hybrid-Poplar Demonstration Grow Sites and the Boardman Advanced Ethanol and Bio-Chemical Plant

1.5 Previous Research on Social Perceptions Of Biofuels

Because polarized social perspectives contribute to the development of *wicked problems* later, it is important to examine the framing of biofuels in the social discourse in order to address these perceptions as they evolve (Balint et al., 2011; Rittel & Webber, 1973). This is especially important as some researchers have already characterized biofuels as a wicked problem in United States and Europe (Fast & McCormick, 2012). Additionally, scholars have found that opinions about biofuels are extremely variable and depend on the scale of the study and the type of "public" examined (Halder et al., 2015). Public opinion of biofuels in the United States, although markedly less polarized than the international sphere, is still evolving (Delshad & Raymond, 2013).

Mixed findings about public opinion over time may indicate a need for more intensive studies to identify emergent themes and underlying belief structures. Intensive studies focus on the intensity of opinion and the degree to which theoretical soundness may lead to practical action (Thompson, 1966). Although studies related to social perceptions of biofuels and bioenergy have been increasing since 2006, the majority of studies on social perceptions are broad-based public opinion research conducted via traditional survey methods (Delshad & Raymond, 2013; Halder et al., 2015, Radics et al., 2015). Few have focused on intensively analyzing stakeholder framing of the biofuels social discourse for policy analysis.

A review of the literature on social perceptions of biofuels revealed that 79% of studies on social perceptions of biofuels and bioenergy focused exclusively on public opinion surveys (Radics et al., 2015). Moreover, although focus group research is increasing, data are not organized and presented in a way that makes obvious the best policy alternatives, or process for dialogue. Although these studies do provide beneficial knowledge about major themes in the biofuels discourse, they have limited application for evaluation and management of stakeholder perspectives.

Furthermore, though several content analyses have also been conducted, the source focus has been almost exclusively news media, particularly national news media and excludes direct user generated content (Delshad & Raymond, 2013; Kim et al., 2014; Sengers et al., 2010; Sovacool, 2014; Wright & Reid, 2011). While media plays a prominent role in shaping the development of political attitudes and social communication, it does not singlehandedly shape them (Cappella & Jamieson, 1996; Hertog, & Fan, 1995). Hearing directly from stakeholders who might be impacted more directly is critical for place-based environmental planning and policy analysis (Jenssen,

2010; Van der Horst, 2007; Shindler et al., 2004). Thus, studying discussions produced by engaged stakeholders and the relevant issue public provides a more direct measure of the underlying attitudes, beliefs, and values which drive social acceptability.

Region-specific analyses of stakeholder discourse have primarily been limited to the Southeast, North Central, and Midwest United States (Halder et al., 2015; Radics et al., 2015; Selfa et al., 2011). There are some notable exceptions to this, however, though they either lack the broader regional focus needed to assess development of biofuels in the Pacific Northwest (Singer, 2013; Stidham and Brown, 2011), or they are limited to forest biomass feedstock sources (Moroney, 2015). By focusing on intensive analysis of stakeholder discourse frames about biofuels in the Pacific Northwest, this research contributes to developing region-specific policy recommendations where place-based environmental decision-making requires a localized context (Shindler et al., 2004).

1.6 Research Objectives and Questions

In the second chapter of this dissertation, I focus on two related but distinct aspects of the biofuels concourse. A concourse is the universe of possible communication that exists for a topic (Stephenson, 1978). The biofuels concourse I propose to examine is grounded in interpersonal expressions which occurred both in focus group interviews and online media such as newspapers, blogs, and websites. Here, I seek to address the question: *What frames do stakeholders use to express perceived problems with wood-based cellulosic biofuels?*

In my third chapter, I address the research question*: What frames do stakeholders use to express concerns or benefits associated with wood-based biofuels?* I analyze the stakeholder

perspectives on biofuels expressed by leaders of energy associations, labor unions, different farm and grower associations, environmental and community advocacy groups, investment companies, research institutions, and policymakers.

In the fourth chapter of my dissertation, I conducted a grounded interpretive mixed methods analysis consisting of both algorithmic and emergent approaches to target a broader sub-set of the population, sometimes known as the issue public, engaged in social discourse about biofuels on Twitter. The issue public for a particular issue are citizens who pay particular attention to that issue, engage more frequently with information and communication about an issue, and are more likely to influence the outcome of policies (Key, 1961). It represents a narrower swath of potentially important political actors than the general public. In this chapter, I examine perspectives that allow for comparisons with findings that emerge from the Q-study. As such, I use the same concourse that I used to develop the Q-samples as the basis for the interpretive mixed methods analysis's initial coding scheme. In the coding scheme, I consider three areas for the sample of the tweets concourse: questions about the tweet text, users, and structure of the tweets. I analyze tweets produced by individuals; industry representatives such as business owners, energy associations, and machinery operators; news organizations; environmental and community advocacy groups; and others.

The specific research questions I address in this research are: *1) What are the salient themes present in the biofuels social discourse? 2) What is the sentiment associated with specific themes? 3) What types of communication are most prevalent in the biofuels social discourse? 4) What is the relationship between sentiment, salient themes and certain stakeholder groups or account types? 5) What is the format/structure of the tweets in the biofuels social discourse?*

1.7 Summary of Methods

1.7.1 *Q-methodology*

Q-methodology is the best approach for this research for several reasons. First, the structure it provides for stakeholder perspectives helps identify groups of stakeholders associated with each perspective. Second, Q-methodology distinguishes areas of agreement and disagreement, as well as the relative magnitude of how strongly stakeholders agree or disagree with a given perspective (Brown, 1980). Third, Q-methodology is ideal for working with natural resource management issues because of the forced-choice practice that sorting imposes on stakeholders. The tradeoffs Q-sort participants must make to determine their actual perspectives while considering the views of other stakeholders mimic real-world natural resource management issues, where resources are limited and tradeoffs occur (Asah et al., 2012a; Asah et al., 2012b). Hence, results from Q methodology are readily useful in guiding policymakers' choices about issue prioritization, program development, and communication.

1.7.2 *Grounded Interpretive Mixed Methods Analysis*

A grounded interpretive mixed methods analysis of the Twittersphere is a complementary approach to Q-methodology because it provides additional and more diverse sources of data about the relative importance of themes and communication attributes associated with social discourses about biofuels. Analysis of social media data via this approach draws from emerging methodology coming from the computer informatics field and makes use of exploratory, interpretive and quantitative analysis (Maddock et al., 2015; Palen & Anderson, 2016; Starbird et al., 2015).

Twitter is an ideal digital source for accessing the opinions of the issue public because Twitter users tend to be more interested in specific issues than the general public (Matsa and Mitchell, 2014). In addition, accessing the broader issue public through Twitter allows for the emergence of unanticipated stakeholders and, subsequently, perspectives that the Q-methodology snowball sampling approach may miss. Researchers can also explore the level of influence individual accounts may have on the social discourse empirically by observing online actions such as "mentions" and "retweets". Furthermore, these actions provide another measure of issue salience produced directly by Twitter users.

Another strength of this approach is that it facilitates both extensive and intensive analysis of the subject matter. Observing trends in "mentions" and "retweeting" of biofuels social discourse, for example, may provide clues as to the relative direction and diffusion of future opinions. Tracking these trends allows researchers and decision-makers to anticipate both emergent attitudes and preferred modes of communication as the policy issue evolves over time. Lastly, a grounded interpretive mixed method approach also provides essential knowledge for strategic communication, such as which communication channels, such as websites, radio or video, might be best to target for strategic outreach efforts.

1.8 Dissertation Structure

In the following sections, I first present a discussion of the theoretical framework, rationale, and relevant literature supporting my dissertation, then discuss methodology and analyses. Each chapter is presented as a standalone document with its own introduction, methods, analyses, results, and conclusion. Together, these chapters will advance new concepts and applications in

the study of social perspectives for natural resource management. This research will also contribute practically by providing region-specific recommendations for decision-makers, resource managers, and communication specialists, which can be used to help inform and manage the developing social perspectives around hybrid poplar biofuels in the Pacific Northwest.

2. STAKEHOLDER PERSPECTIVES ON PROBLEMS WITH HYBRID POPLAR BIOFUELS IN THE PACIFIC NORTHWEST

2.1 INTRODUCTION

With the impacts of climate change on the horizon, region-specific adaptations to mitigate its effects and address its causes are critical (IPCC, 2014). Low-carbon energy alternatives such as biofuels provide one such option for the future (Creutzig et al., 2015). Nationally and internationally, however, early attempts to produce biofuels, especially corn-based ethanol, have fomented public backlash and obscured the space for developing alternative options (Pilgrim & Harvey, 2010; Halder et al., 2015; Tomei & Helliwell, 2016). Given the increasing complexity of environmental problems such as sustainable energy production, as well as the increasingly polarized political climate, how can policymakers best steward our resources while also managing conflict arising from diverse lives, values, and beliefs?

The United States has a history of addressing environmental conflicts through the courts, in public hearings, as part of the political process, and more recently through collaboration (Wondolleck & Yaffee, 2000). These approaches have worked to varying degrees for different environmental conflicts; however, the best approach to dealing with these kinds of challenges is to engage in more effective environmental planning and decision-making practices which explicitly include conflict early in the project proposal and development process (Burdge, 2004; Gregory et al., 2012). In order to bring forth biofuels as sustainable energy alternatives, one must take the time to understand the perspectives of stakeholders who may influence this new energy source's development. This is especially important because biofuels already have an associated

history of conflict (Pilgrim & Harvey, 2010; Tomei & Helliwell, 2016). Decision-makers need to carefully assess, anticipate, and proactively address biofuels' perceived problems rather allowing these perceptions to become barriers to developing constructive policy outcomes.

Interpersonal exchanges in the public sphere through social media, online news forums, public meetings, and small group discussions are excellent sources for collecting data on stakeholder perspectives about potential problems with biofuels. However, these expressions provide only a snapshot of transient, fluctuating thought, and are not readily available in forms that are directly useful for decision-making and outreach efforts (Stephenson, 1988/1989). In other words, opinions expressed in the public sphere are examples of interpersonal unstructured subjective thought (Asah et al., 2012a). Furthermore, stakeholders often express preferences without adequate consideration of other viewpoints relative to their own. Examples of structuring subjective thought include clearly delineating areas of agreement and disagreement, identifying the magnitude of those disagreements, identifying areas where perspectives share common ground, and clear articulation of latent underlying beliefs and values (Stephenson, 1988). Most people do not have such a differentiated view of their own thoughts unless they are preparing to sit down to a negotiations table, and even then they are subject to a host of heuristic biases that sometimes prevent the arrival at constructive outcomes (Bazerman, M. H., & Moore, 2008). Consequently, it is difficult to discern which problems stakeholders prioritize and to what extent people with different stakes agree or disagree with their perspectives' key issues. Making these perspectives useful for decisions and other outreach efforts that seek to enhance social acceptability requires understanding the underlying structure of those perspectives.

At the heart of environmental conflict lies the challenge of clearly defining the problem a given measure seeks to address (Balint et al., 2011); therefore, examining biofuels problem framing, or conflict frames (Benford & Snow, 2000), helps researchers to understand the structure of social perspectives on biofuels. Thus, the dual focus of understanding the structure of a perspective with a specific focus on perceived problem frames facilitates providing decision-makers with effective recommendations for program implementation and strategic outreach efforts. In this study, I propose using a quasi-quantitative approach known as Q-methodology to structure stakeholder perspectives about the perceived problems associated with the development of cellulosic biofuels in the Pacific Northwest. My research question is: *What frames do stakeholders use to express perceived problems with wood-based cellulosic biofuels?* In the following sections I present this work's rationale and significance, relevant literature on social perceptions of biofuels and previous research conducted on problem framing, and my research design. In my results section, I present a description for each perspective emerging from the analysis, a detailed comparison between the perspectives, and an intra-perspective stakeholder comparison. I discuss how policymakers and natural resource planners can apply each of these results in order to prioritize and address perceived problem areas. I conclude with a discussion of connections to the international biofuels debate as well as further insights into intra-perspective stakeholder comparison.

2.2 Rationale and Significance

There are several ways to examine the structure of environmental problem frames. Q-methodology provides a unique approach to quantifying different elements of problem frames

through the investigation of the social discourse constructing the frame. Frames are communication devices that make some aspects of communication more salient and others less so (Entman, 1993). Social *d*iscourse frames how we perceive experience (Boykoff, 2012). Discourses collectively construct a picture of reality, while frames shape our interpretation of this picture by highlighting and de-emphasizing various elements. Framing as a worldview is a radical departure from more positivist approaches to decision-making (Fischer & Forester, 1993). Policy analysts have recently transitioned toward using *policy frames* and *policy discourse* as a foundation for approaching environmental planning (Dayton, 2000; Fischer & Gottweis, 2012). These frames are interactional in nature: different stakeholder groups use competing frames to influence the interpretation and construction of a specific discourse about social issues (Dewulf et al., 2009; Glynn et al., 2004; Hannigan, 2006). However, because communication is also cognitive, frames contribute to the formation of individual and social perspectives (Cantrill, 1996; Dewulf et al., 2009; Stephenson, 1980a).

Environmental issues undergo a number of concurrent phases as they evolve through social discourse (Hannigan, 2006). Because this process of social perspective formation is ongoing, it is important for policy analysts to consider biofuels problem framing to identify places where frames are discordant to better facilitate policy dialogue and constructive outcomes (Benford & Snow, 2000; Dayton, 2000). This helps policymakers anticipate and preemptively address issues, mitigate social impacts, and support overall social acceptance of the policy, program, or development (Burdge, 2004). Environmental researchers have used Q-methodology as an application of frame analysis to successfully managed environmental problems and conflicts (Asah et al., 2012a; Asah et al., 2012b; Danielson, 2014; Mazur & Asah, 2013; Webler et al. 2009). Moreover, researchers

following this approach for environmental problem framing have arrived at constructive outcomes in local and regional cases (Asah et al., 2012a). Q-methodology can identify frames and support the reframing of conflicts that once seemed intractable, thereby supporting the creation of policies and programs that all stakeholders support—or at least tolerate. Thus, it is important for policy analysts to examine frames specifically relating to the development of potential problems with biofuels in order to support effective policy dialogue and Q-methodology is uniquely suited to the task.

2.3 Literature Review

2.3.1 *Social Acceptability of Biofuels in the United States*

In spite of a recent increase in studies related to social perceptions of biofuels and bioenergy (see Halder et al., 2015 for a review), studies that focus on systematic structuring of stakeholder discourse for policy analysis are comparatively rare. The majority of studies on social perceptions are broad-based public opinion research conducted via traditional survey methods (Delshad & Raymond, 2013; Radics et al., 2015). Moreover, although focus group research is increasing, data are not organized and presented for policy makers in a way that makes obvious the best policy alternatives, or process for dialogue.

Although, several content analyses relating to biofuels have also been conducted, the source focus has been almost exclusively news media, particularly national news media and excludes direct user generated content (Delshad & Raymond, 2013; Kim et al., 2014; Sengers et al., 2010; Sovacool, 2014; Wright & Reid, 2011). Hearing directly from stakeholders who might

be impacted more directly is critical for place-based environmental planning and policy analysis (Jenssen, 2010; Van der Horst, 2007; Shindler et al., 2004).

Region-specific analyses of stakeholder discourse have primarily been limited to the Southeast, North Central, and Midwest United States (Halder et al., 2015; Radics et al., 2015; Selfa et al., 2011). There are some notable exceptions to this, however, they either lack the broader regional focus needed to assess development of biofuels in the Pacific Northwest (Singer, 2013; Stidham and Brown, 2011), or they are limited to forest biomass feedstock sources (Moroney, 2015).

By focusing on systematic structuring of stakeholder discourse of biofuels framed as potential a problem in the Pacific Northwest, Chapter 2 directly bears on decision-making about wood-based biofuels in the region. This is important for developing region-specific policy recommendations where place-based environmental decision-making requires a localized context (Shindler et al., 2004). By using Q-methodology to analyze regional stakeholders' framing of social discourse, this study makes a unique contribution to the literature on social perceptions of biofuels.

2.3.2 *Systematic Structuring of Social discourse around Perceived Problems*

Q-methodology provides access to underlying belief structures that form the basis of the developing social perspectives, and presents this data in a way that is easy to access for policy analysis. As such, it is an excellent approach for understanding stakeholders' perspectives about biofuels. Q-methodology improves upon traditional survey research because it does not allow participants to consider their views on a subject in isolation (Brown 1980). Q-methodology

requires participants to make decisions that simulate realistic trade-offs which may be useful for decision-making which often requires prioritization of goals. Q-methodology requires participants to consider their decisions within the context of all available options so that they are able to structure their own beliefs accordingly, often revealing latent or unknown preferences that are difficult to uncover using other methods (Asah et al., 2012a and b). As such, it documents robust attitudes relevant to the real world. Q-methodology is also unique in the policy arena in that it focuses on emergent perspectives, rather than considering demographic segmentation qualities like political affiliation or industry stakeholder association as the sole source for understanding stakeholder preferences and interactions (Cuppen et al., 2010).

Systematic structuring of stakeholder discourse using Q-methodology seeks to identify predominant perspectives about biofuels, in addition to generating knowledge about which stakeholders express particular perspectives. In-depth structure is created by clearly delineating nuanced areas of agreement or disagreement at a very fine scale of cognitive differentiation while also providing the relative magnitude of stakeholders' opinions on each of those areas.

Furthermore, the forced tradeoffs inherent in Q-methodology create robust findings as to how participants prioritize issues, a crucial element in guiding policy and communication. Because biofuels are still an emerging technology in natural resource development, Q-methodology is particularly suited to exploring stakeholders' views of it. Such early insights can help ensure that policymakers propose policies and programs that align with perceptions of benefits, address concerns, and demonstrate compatibility with existing localized culture and belief systems (Rogers, 2010).

2.4 Research Design

The first step in Q-methodology is generating a concourse of statements that represents the dominant themes present in conversations about biofuels taking place across the region (Figure). I used a mixed methods approach to develop the concourse, conducting a qualitative thematic analysis of online news sources and utilizing regional focus group data from a concurrent study on stakeholder perceptions of biofuels. The thematic analysis included user-generated content and direct statements generated by stakeholders engaged in online news articles, blogs, and websites. I employed purposeful sampling to collect statements online (Krippendorff, 2012). The geographic focus used local, regional, and national news sources, which I located through online Google searches that used the following search terms: *biofuel(s)*, *bioenergy*, *biomass*, and *renewable*. I continued sampling news sources until reaching saturation in the occurrence of themes, which resulted in a total of 981 statements. I then cross-referenced statements and compared them against focus group data, which added additional statements to the set and ensured that regional views were explicitly included. I selected statements from focus group data after reviewing 32 focus groups and research conversations for unique themes.

I used an inductive, iterative approach for coding that resulted in the development of salient themes (Saldana, 2012). From these themes, I constructed a Q-sample focused on statements about biofuels that were presented explicitly as problems (Appendix A-2). I define problems as a perceived present harm, ill or cost. The use of Fisher's experimental variance design principles maximized within-theme variance, minimizing the number of statements required to represent the concourse fully in the Q-sample (Stephenson, 1953). The final Q-sample contained 43 statements about biofuels framed as a problem or cost (Table 1). Some of the main themes included in the Q-

sample were *Economic, Environment, Social-Psychological, Logistics, Politics and Policy,* and *Social Justice*, as well as others (Appendix A-3). In keeping with Stephenson's (1953) suggestions on the subject, I made very few changes to the original verbatim quotes taken from the online and interview sources.

Following completion of the Q-sample, I selected the sample of persons (P-set) to take the Q-sort. I identified key stakeholders through a Google search of online organizations and entities, as well as through recommendations by participants following a link-trace snowball sampling approach (Handcock & Gile, 2011). Stakeholders were selected for inclusion if they were participating in the development of biofuels in the Pacific Northwest (Washington, Oregon, Idaho, Montana, California), if they had the potential to be impacted by the development of biofuels in the region, and if they were leaders of organizations or active in institutions that might influence the development of biofuels in the region (i.e.; CEOs of industry, leaders of non-profits, lead researchers, and government officials). I then classified stakeholders as members of energy associations and utility companies, labor unions, farmer or grower associations, cattle associations, dairy farmer associations, environmental organizations, community advocacy organizations, investment companies, research institutions, or government (Appendix A-3). The study also asked stakeholders to provide their own classification, additionally offering an opportunity to select "other" and explain their selection to ensure accuracy.

The design of the P-set in a Q-study is as important as designing the sort itself; Fisher (1966) provides guidance for both. Though it can be difficult to anticipate in advance what influences might lead to differences in perspectives, I carefully selected stakeholders with a range of attributes likely to represent a breadth of possible regional perspectives on wood-based biofuels.

Given the wide geographic scope of the study, I elected to host the study online, contacting stakeholders via email and utilizing a free open source software program called Flash Q to deliver the Q-sorts to participants. The first invitation round was used to gauge participant interest and instill commitment. Each participant received as many as three email invitations to assess their initial willingness to participate. Once participants committed to partaking in the study, up to three follow-up emails provided reminders to participants who expressed interest. Once participants completed the Q-sort, they received a final thank you email. Excluding invalid email addresses, the response rate was 39%, the cooperation rate was 87%, and the final completion rate was over 61%, culminating in a total of 49 completed Q-sorts[1].

In a Q-study, the ratio of statements to people is more important than the response rate for determining the robustness of the study (Stephenson, 1953). Researchers frequently use the ratio of one participant for every three statements as a benchmark of robustness (Webler et al., 2009). Beyond this general guideline, practitioners recommend ensuring the P-set includes enough individuals to differentiate the emerging perspectives (Brown, 1980). I read related literature and familiarized myself with industry practices and careers in order to develop a list of potential stakeholders for the P-set.

I sent my initial email invitations soliciting interest in May 2014, and the final Q-sort was complete by January 2016. A link in the invitations and subsequent reminders directed stakeholders to the study website, where they reviewed and agreed to the consent form. From there,

[1] These numbers include response, cooperation, and completion rates from the advocacy, industry, and tribal stakeholder groups. Response rate information for the research and government stakeholders was not recorded in a way that is easily accessible and was not included in these estimates. I expect the inclusion of these groups will reduce the response rate.

participants entered the Flash Q interface that presented them with a virtual deck of 43 cards containing problem statements about biofuels. First, stakeholders placed cards into three piles according to whether they agreed, disagreed, or felt neutrally toward the statement. The next screen contained a grid and instructions asking stakeholders to arrange the statements with the items most agreed and disagreed with first. This provided context as participants arranged other statements according to level of agreement (McKeown and Thomas, 2013). The grid was based on a 10-point scale (-5 to +5) with disagree and agree at either end of the continuum and a normal distribution shape (Figure). A forced choice distribution required participants to prioritize issues they were more polarized around at the ends of the distribution and place statements that they held more neutrally in the middle. This allowed for comparison across the intersubjective neutral point, or distensive zero, among participants, which in turn enabled easier contrast of consensus and conflicting views later in the analysis (Stephenson, 1953). After the initial arrangement of cards on the grid, stakeholders clicked to the next screen, which asked them to double-check that the grid represented their views on the issue fully. From there, the study asked participants to explain their reasons for sorting the cards at the extreme ends of the continuum by typing in a comment box on the next screen. Finally, a short survey asked participants questions about socio-demographics and allowed them to comment on the study (Appendix A-5). This knowledge is helpful for drawing comparisons between stakeholders and interpreting perspectives.

I analyzed the resulting 49 sorts using a specialized statistical software, PQMethod, version 2.35, which was developed specifically for analyzing Q-study data (Schmolck, 2014). The first step in the analysis is to correlate all 49 sorts. The correlation matrix is then subjected to a centroid factor extraction resulting in un-rotated factors. The selection of which factors to retain and rotate

in the final step of this process often requires some level of judgment (Watts & Stenner, 2012; Webler et al., 2009). I used Varimax rotation to analyze the factors because I had no theoretical reason to believe the factors might be correlated (Stephenson, 1953; Brown, 1980). After rotation, I retained factors if they appeared distinct from other perspectives, if the spread of the factors was "simple, clear and stable," and where positive inter-standpoint associations were less than 0.5 (Watts & Stenner, 2012; Webler et al., 2009).

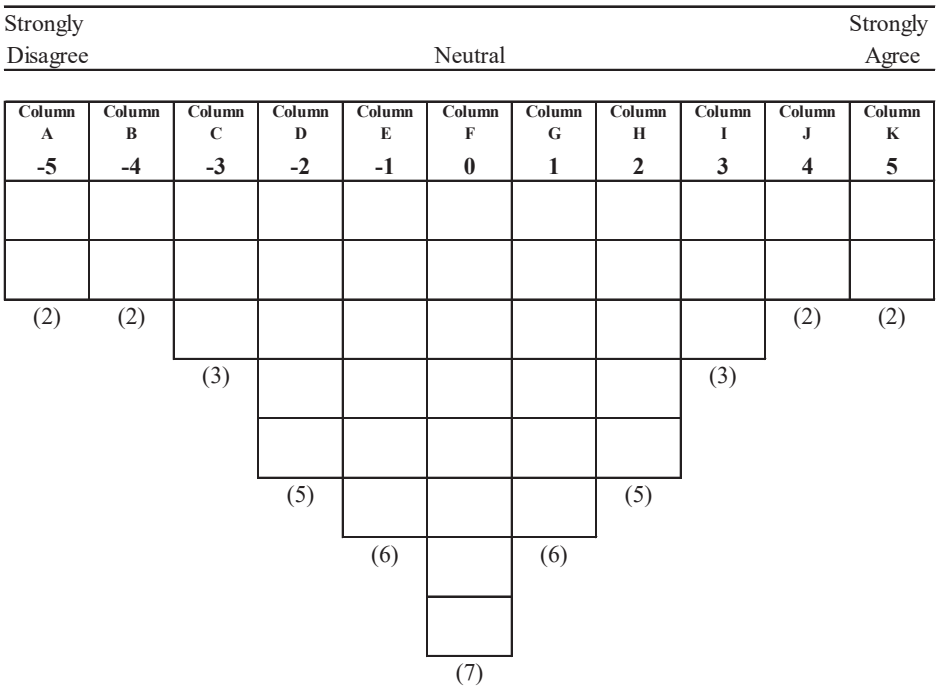

Figure 3. Ranking and Structure of the 43 Q-sort Statements

2.4.1 *Data Limitations*

Online Q-sorts impose some limitations. First, conducting the sorts online may have made it more difficult for participants who are less familiar with digital technology to conduct the sort.

That said, given participants' high-level positions in industry, the relatively basic computer technology required likely did not pose too much of a barrier. The second limitation has to do with the software used for this study, which could have been more user-friendly in its design. Finally, although an effort was made to include all relevant stakeholder types in the study, it is possible key stakeholders may have been missed, such as rural policy actors or those who are averse to interacting with online media such as email. However, this study went to great lengths to attempt to include the broadest possible spread of potential perspectives and opinions. Care was also taken to include at least five stakeholders for each larger stakeholder subset in the analysis.

2.5 RESULTS

Three unique perspectives emerged from the factor analysis of the 49 Q-sorts. They will be referred to primarily as the *Political Social Will Perspective*, the *Compatibility and Capacity Perspective*, and the *Supply and Communication Perspective*. Combined, these frames make up 41% of the total variance found in conversations about perceived problems associated with the development of biofuels in the Pacific Northwest. In the following discussion, I outline each of these perspectives in detail and provide a description of each one. Each perspective's level of agreement or disagreement with each of the 43 statements is presented in Table 1. The Z-score for each statement is ranked in association with each perspective to provide more detailed information about the relative differences (Asah et al., 2012a, Asah et al., 2012b).

Table 1. Q-sample Statements and Z-score Ranking

Q-sample of statements addressing potential perceived problems associated with the development of biofuels. Z-scores are normalized deviation from the mean for each perspective. Statements which share consensus across all three perspectives are bolded. Those with "*" are calculated by PQ-method and are statistically consensus to the 0.05 level with "*" and 0.01 with "**"

#	Statement	Political Social Will Perspective	Compatibility and Capacity Perspective	Supply and Communication Perspective
1	A big challenge for developing wood-based biofuels is the infrastructure.	1.72	1.2	-0.55
2	Biofuels means burning food; it is just plain immoral. **	**-2.19**	**-1.94**	**-1.81**
3	Logistics right now is the challenge for developing wood-based biofuels, not the bio maximum.	**1.34**	**0.43**	**-0.01**
4	Wood-based biofuels are not economically feasible.	-0.5	0.93	0.87
5	There is no way wood-based biofuels can compete with the massive, century-old fossil fuels business.	-0.82	0.21	0
6	The problem with growing wood-based biofuels is the water is already all spoken for, every drop is measured.	-0.42	-1.23	0.75
7	The limiting factor for wood-based biofuels is the economics of hauling very low value material very long distances.	**1.48**	**1.57**	**1.96**
8	We don't have the capacity to make enough wood-based biofuels to have an impact on petroleum needs in the US.	-0.71	1.05	1.14
9	Wood-based biofuels cannot meet EPA air quality standards.	**-0.96**	**-0.01**	**-0.3**
10	There is not enough land to grow food and wood-based biofuels crops, given the explosive growth in population.	-0.69	0.36	-0.41
11	The biofuels that are added to gasoline now are clogging up fuel ports and gumming up engines.	-0.95	1.12	-1.16
12	There is no such thing as a successful, green military.	-0.33	0.54	-0.07

13	Wood-based biofuels deplete and destroy soils, permanently removing nutrients and microbes.	-0.37	-0.9	0.44
14	You get a slight savings in greenhouse-gas emissions with wood-based biofuels, but not much.	-0.75	0.43	0.61
15	The problem with growing wood-based biofuels is the ability to get the water rights.	0.49	-1.06	0.87
16	The biggest problem is lack of information; all we get are slogans and propaganda.	**1.09**	**0.08**	**1.48**
17	Any wood-based biofuels crop that takes two years to get a paycheck is a draw on cash that a lot people cannot stand.	**-0.33**	**-0.03**	**-0.83**
18	The one bad thing about making wood-based biofuels, is it puts pressure on other industries that have nothing to do with growing feedstock.	**-0.06**	**-0.24**	**-0.67**
19	Wood-based biofuels cause significant air pollution that threatens public health.	-1.56	-0.34	0.24
20	There is no sustainable way to replace fossil fuel with wood-based biofuels at the scale they are used in the US.	**0.34**	**0.78**	**1.56**
21	The biofuels industry is setting itself up as completely separate; it is not integrated with agriculture or forestry. *	**0.09**	**-0.18**	**-0.43**
22	The problem with wood-based biofuels is that they have invest so much money it is just completely unrealistic.	-0.87	0.61	0.24
23	The problem is knowing when to stop shoveling funds into the public trough so the industry can live or die of its own economic vitality.	**-0.08**	**1.41**	**1.57**
24	I think that the real challenge with developing wood-based biofuels is that we have this glut of natural gas in the market.	**0.9**	**1.83**	**1.71**
25	Greed is the problem; if biofuels starts making money, it may become socially and environmentally destructive.	0.03	-1.04	-1.09
26	Wood-based biofuels has accelerated peak phosphorus, which means once our phosphate supplies are depleted global agriculture will collapse.	-0.58	-0.52	0.14

27	Farmers have no incentive to take on the risks of changing technologies; there is no policy bridge to help make the transition.	1.52	0.75	-0.12
28	We lack the political will to develop wood-based biofuels because of the controlling power of industries who own our government.	2.01	0	-1.45
29	I think government has failed us in developing biofuels; they are looking for what plays well with the press and polls.	1.15	-0.98	-0.8
30	The biggest problem with developing wood-based biofuels is enforcement; there are a lot of loopholes and they can't checking everything.	**-0.23**	**-0.41**	**-0.93**
31	Nothing is going to happen with wood-based biofuels with the EPA being against everything; paralysis by analysis.	-0.2	1.46	-2.16
32	Wood-based biofuels encourages human rights abuses related to land access and usage.	**-0.48**	**-2.01**	**-0.6**
33	Marginalized communities are the first and most impacted by polluting and exploitative industries, including wood-based biofuels.	0.83	-1.17	-0.45
34	You have to show that wood-based biofuels is actually going to happen or nobody is going to take it seriously.	**1.65**	**1.35**	**0.67**
35	The biggest problem with developing wood-based biofuels is probably public perception.	1.34	-0.35	-1.41
36	My problem with biofuels is that you are creating gasoline; it produces the same pollution that fossil fuels does.	-1.29	0.35	0.09
37	The problem is with breakthroughs in technology, this project could be outdated in a week.	-1.03	0.17	0.04
38	Wood-based biofuels feedstocks are heavily chemically fertilized and sprayed with dioxin-like herbicides.	-0.65	-1.22	0.35
39	No one wants to live next to the noise, and trucks you get with wood-based biofuels industrial activity.	0.29	-0.5	-0.04

40	The greatest challenge currently facing wood-based biorefineries is the absence of readily available, cost effective feedstock.	**1.09**	**-0.02**	**1.92**
41	Big industry sucks money out of the community and then the whole thing is over and gone; the same is true for wood-based biofuels.	0.51	-2.3	-0.89
42	The Pacific Northwest cannot compete with other regions of the US or North America to produce biofuels at a lower cost. **	**-1.02**	**-0.6**	**-0.64**
43	They are trying to save the world by creating wood-based biofuels, but they end up burning more fuel because there is not as much energy in it.	-0.81	0.41	0.16

Table 2. Stakeholder Loadings on Each Perspective

Stakeholder loadings for each of the 3 perspectives on perceived problems associated with the development of hybrid poplar biofuels in the Pacific Northwest. Sorts with an "X" indicate Q-sorts which are considered defining Q-sorts (Q-sorts that closely represents the perspective). While all significant values marking stakeholder agreement (+) or disagreement (-) with a perspective have been bolded.

Stakeholders	Stakeholders' level of agreement or disagreement[a] with each standpoint		
	Political Social Will Perspective	Compatibility and Capacity Perspective	Supply and Communication Perspective
Community Advocate 1	0.14	**-0.48**	**0.39**
Community Advocate 2	**0.54X**	0.22	-0.05
Community Advocate 3	**0.59X**	0.12	0.10
Community Advocate 4	**0.70X**	0.12	0.19
Community Advocate 5	**0.73X**	0.01	0.02
Environmental Advocate 1	**-0.31**	-0.09	**0.39**
Environmental Advocate 2	-0.13	-0.14	**0.56X**
Environmental Advocate 3	-0.11	0.23	**0.68X**
Environmental Advocate 4	0.27	0.27	**0.56X**
Environmental Advocate 5	**0.50**	**0.51**	0.11

Environmental Advocate 6	**0.46X**	0.08	-0.21
Environmental Advocate 7	**0.58X**	0.29	-0.19
Environmental Advocate 8	**0.68X**	-0.02	0.03
Environmental Advocate 9	**0.70X**	-0.19	0.27
Government Agency Official 1	0.07	0.03	0.22
Government Agency Official 2	0.13	0.09	**0.59X**
Government Agency Official 3	0.28	**0.52X**	0.21x
Government Agency Official 4	**0.46**	0.29	**0.43**
Government Agency Official 5	**0.73X**	-0.10	0.26
Government Agency Official 6	**0.80X**	-0.05	-0.10
Native American Stakeholder	0.18	0.06	**0.55X**
Cattle Rancher	0.02	**0.74X**	0.21
Economic Development Professional 1	-0.10	0.23	0.22
Economic Development Professional 2	**0.45X**	0.16	0.013
Economic Development Professional 3	**0.65X**	-0.25	-0.13
Energy/Association Representative 1	**0.43X**	-0.03	-0.04
Energy/Association Representative 2	**0.64X**	**0.31**	0.08
Energy/Association Representative 3	**0.75X**	0.13	0.16
Forester 1	-0.12	**0.47X**	0.14
Forester 2	0.09	**0.60X**	0.28
Forester 3	**0.52**	**0.48**	-0.06
Grower 1	0.03	0.23	**0.53X**
Grower 2	0.12	**0.74X**	**0.36**
Grower 3	0.25	**0.73X**	-0.02
Grower 4	-0.10	-0.11	0.07
Labor Union Representative 1	0.04	**-0.58X**	0.25
Labor Union Representative 2	**0.73X**	-0.13	0.04
Producer/Association Representative 1	**0.45**	**0.38**	0.04
Producer/Association Representative 2	**0.49**	**0.54**	0.14
Other	**0.54X**	0.17	0.20
Bioenergy Researcher 1	-0.23	**0.40**	**0.40**
Bioenergy Researcher 2	0.04	**0.31**	0.24
Bioenergy Researcher 3	**0.35**	0.03	**0.42**
Bioenergy Researcher 4	**0.54**	0.16	**0.41**
Bioenergy Researcher 5	**0.55X**	0.22	0.11
Bioenergy Researcher 6	**0.76X**	0.24	0.06
Bioenergy Researcher 7	**0.38**	**0.36**	**0.33**
Bioenergy Researcher 8	**0.62X**	-0.03	**0.30**
Total # of stakeholders in agreement:	**28**	**14**	**15**
Total # of stakeholders in disagreement:	**1**	**2**	**0**

% Explained Variance	**22**	**11**	**9**

[a] Loading on a standpoint requires $P < 0.05$ probability. Significant loading = (1.96) *1/√N where N = # of statements. Loading scores = ± 0.30 are significant.

2.5.1 *Perspective 1: The Political Social Will Perspective*

Distinguishing Themes: Politics, logistics other than the bio-maximum, and public perception are the main problems. Human health and environment are not priority problems.

This perspective expresses strong concern with the lack of support in the political environment for biofuels (#28) and blame government as one of the reasons it has not been more successful (#29), citing that they are more *"concerned with their survival, not spending time really understanding issues and building consensus.*" They are also concerned about the influence of industry on political will with one defining stakeholder suggesting that *"the fossil fuel industry has a strong influence and...is bent on extracting and profiting on those resources."* Another defining stakeholder on the *Political Social Will Perspective* refers to the fossil fuels industry as a *"global monster."* Similarly, these stakeholders mention that there is no support for farmers taking on new risks because of the lack of policy bridges to help in the initial transition phase (#27). Another problem that these stakeholders identify is the more material challenge of logistics (#3, #7) and infrastructure (#1), rather than being constrained by the cost of development (#22). One defining stakeholder explained it:

> *"I believe we have enough of the bio-materials which are otherwise going to waste in the current system(s), it's just a matter of figuring out the logistics in order to create viable, sustainable, economical systems, likely at a much more localized level than the current fossil fuel industry is working. If communities were producing and providing their own energy locally it would be a very different world, and that is possible it's just a matter of sorting it out"*
>
> - *Environmental Advocate, Political Social Will Perspective*

They are concerned about the practicality of actually getting a reliable supply of feedstock going (#40), rather than the possibility of a bio-maximum that would prevent enough supply once it was established (#3). Stakeholders with this perspective also view as problematic the managing of public perception and public understanding of biofuels (#35). As one defining stakeholder explains, *"just the statements [in this Q-sort], many which are quite ridiculous, go to show that the public neither understands [and] in fact often does not care to understand, how biofuels work and what options might be feasible."* This may explain why they rank items #34 (demonstrated feasibility) and #16 (access to reliable information) so highly, suggesting that there needs to be a demonstration of biofuels' feasibility or "nobody is going to take it seriously."

According to this perspective, our region is not a constraining factor for increased cost to biofuels (#42). Instead, as one defining stakeholder suggested:

> *"…an "all of the above" approach is needed. Some biofuels may be produced in the Southeast, but many can also be produced and used in the Northwest. All corners of the US should be looking at their biomass resources and asking how to create fuels locally, or at least regionally."*
>
> - *Citizen, Political Social Will Perspective*

Stakeholders loading onto this perspective did not agree that air quality standards (#9), environmental, or human health risks (#19) were a problem. They also did not view compatibility with existing technology as a problem (#11). Further, stakeholders with this perspective disagreed strongly that biofuels produce the same kind of pollution as fossil fuels (#36). Of note, different stakeholders interpret "pollution" differently. Some of the defining stakeholders interpret this to

literally mean emissions, others are considering potential benefits to forest health, and still others are considering the carbon cycle.

Finally, one of the most strongly disagreed with statements for this stakeholder group was that the burning of fossil fuels also means the burning of food. In summary, problems associated with biofuels for these stakeholders appear to be not so much focused on issues of human health, or environmental wellbeing, but rather the logistics, politics, public perception and understanding.

The majority of advocacy stakeholders, both community and environmental, loaded onto this perspective, with the exception of three environmental advocacy stakeholders (Table 2). Notably, the three defining stakeholder researchers also loaded onto this perspective. Other defining sorts loaded onto this perspective include two government stakeholders, as well as a diverse mix of industry stakeholders focused on economic development, labor, and energy association interests.

2.5.2 *Perspective 2: The Compatibility and Capacity Perspective*

Distinguishing Themes: Existing status quo, analysis paralysis, transportation, and compatibility are the top problems. Politics, social justice, and environment are not priorities.

Stakeholders who load onto the *Compatibility and Capacity Perspective* are worried about the barriers to entry from the existing status quo, analysis paralysis, transportation, and compatibility. They are strongly concerned that the amount of natural gas in the market might make it impractical for alternatives like biofuels to be financially competitive (#24). As described by one defining stakeholder*, "its relatively low price has made the potential return on investment*

for biofuel lower...putting a brake on interest in that investment." And although economic feasibility in general is only a medium priority area of concern for these stakeholders (#4), they specifically do not want to see money wasted in developing fuels that will not be successful (#23) especially when they are unsure if there is capacity to produce the supply needed to meet US fuel demands (#8).

With reference to statement #8, there appears to be divergent interpretations for the concept of capacity. Some stakeholders were specifically referencing the cost of creating refineries that could produce enough supply, while another stakeholder commented that they felt like capacity referred to a forest's ability to be productive enough to sustain supply. Stakeholders on the *Compatibility and Capacity Perspective* also hold a specific concern about the practical challenge of balancing transportation costs when hauling low-value material to the refinery (#7). On this point, defining stakeholders reference a variety of associated transportation challenges, including the movement of water as part of this process, the energy inputs needed, and the cost of log hauling. One stakeholder explained:

> *"Log hauling in [our area] is quite expensive. Just getting wood to a loading spot on a road is also quite expensive. We do have competitive markets for woody material that won't make lumber or plywood, so any biofuel process will need to be able to pay its way out of the woods to a processing facility and doing so with an equal value of wood chips which go into our pulp mills."*
>
> *- Forestry, Compatibility and Capacity Perspective*

Further, they are strongly concerned with compatibility challenges with biofuels harming engines of vehicles and machinery (#11), as well as compatibility issues with other existing infrastructure (#1). Two major themes defining stakeholder sorts point to uncertainty about technology and capital costs of building the infrastructure as being the main explanations for

prioritizing this as an issue and uncertainty about technology. One government agency official put it this way:

> *"The infrastructure is a major investment. There's uncertainty about raw material supply and cost that dampens that investment. Also, it's not clear what will be the most effective technological route from biomass to fuel. Part of the infrastructure is also the delivery systems."*
>
> - *Government Agency Official, Compatibility and Capacity Perspective*

These stakeholders are also deeply concerned with regulatory barriers, specifically noting that too many regulations can prevent innovations from going forward and result in *analysis paralysis* (#31). Interestingly, they do not view regulatory barriers as political barriers, since they disagree with the notion that "government has failed us" (#29) and they are neutral toward the statement that government lacks political will (#28).

These stakeholders do not view greed as being a problem in the development of biofuels and don't see the industry as becoming socially and environmentally destructive (#25). Although these stakeholders are cautious about the economic impacts of biofuels, they do not seem to view the industry as depleting monetary resources from local communities (#41) or otherwise exploiting them (#17). An exemplifying quote from one of the defining grower stakeholders clarifies that:

> *"Big industry generally does not "suck money out" of communities but rather brings money in. It may or may not be sustainable over the long term vs. a short-term phenomenon, but even if so, it still helps communities in the short term."*
>
> - *Grower, Compatibility and Capacity Perspective*

Further, the *Compatibility and Capacity Perspective* stakeholder group in general does not view biofuels as the source of human rights abuses (#19), or contributing to the food versus fuel

moral dilemma (#2). One stakeholder from a defining sort described it, *"This may be a concern in other parts of the world - I have no data - but it's not in the US or Canada."*

Providing further insight into environmental sustainability, the *Compatibility and Capacity Perspective* stakeholders don't think water access or negotiating water rights (#15) is a problem. They are not concerned it will damage soil (#13), or that chemical sprays or fertilizers are problematic (#38). To summarize, stakeholders holding the *Compatibility and Capacity Perspective* appear less focused on issues of politics, social justice, and the environment, but more focused on challenges surrounding the existing status quo, analysis paralysis, transportation, and compatibility.

The most prominent stakeholders comprising this perspective are the growers, a self-identified stakeholder group composed mainly of farmers, foresters, and tree farmers (Table 2). All but one of the defining grower sorts are included in this perspective. The *Compatibility and Capacity Perspective* also includes a cattle rancher who was invited to ensure related agricultural operations and industries were invited. Though this study included only one rancher, it is intriguing that this participant's sort loaded with the other growers'. Additionally, this perspective also includes one government stakeholder as well as the only defining polar statement by a labor union stakeholder, loading at -0.58 (Table 2).

2.5.3 *Perspective 3: The Supply and Communication Perspective*

Distinguishing Themes: Priority problems include barriers to entry from the existing status quo, availability of supply, and information. Regulations, politics, perception, and compatibility are not priorities.

Stakeholders holding the *Supply and Communication Perspective* are concerned about the barriers to entry from the existing status quo, availability of supply, and information. The narrative for the *Supply and Communication Perspective* begins very similarly to the *Compatibility and Capacity Perspective*. Stakeholders that load onto the *Supply and Communication Perspective* are concerned about the barriers to entry from the existing status quo. They are strongly concerned about the "glut of natural gas" in the market and its impacts for alternative fuels (#24). Although economic feasibility in general is also a medium priority area of concern (#4), as in the *Compatibility and Capacity Perspective*, the *Supply and Communication Perspective* stakeholders specifically care that subsidies are not wasted on an unsuccessful industry (#23).

This is especially important given their uncertainty with the capacity to produce the amount of fuel needed to meet US demand (#8). By capacity, *Supply and Communication Perspective* stakeholders may be referring to challenges with supply, both in terms of navigating scale (#20) as well as producing a reliable stream of feedstock for production (#40). A defining sorter describes concerns over supply as "*Tough to get the material needed to handle the demand if fossil fuels disappeared."* Infrastructure was a common theme in participants' comments about statement #8, with one defining sorter explaining, *"Population and energy demand is much greater than the infrastructure to handle the demand."* Another concern which emerged exploring the comments for this perspective was potential regionally scoped differences among stakeholders' expectations about biofuels supply. For example, one defining sort stakeholder from Idaho shared:

> *"I answered this question specifically from the [standpoint] of wood based biofuel availability on state and federal land in southern Idaho, where [feedstock] supply is relatively low, growing conditions are drier and less [accommodating] for rapid feedstock replenishment, species selection is limited and marginal, and as such travel distances would need to be very long. Compared to natural gas and*

> *oil, which travel in the most energy efficient method possible, through pipelines, and the low cost of natural gas, this is not a realistic and financially sustainable effort in southern Idaho."*
>
> - *Dairy Farmer, Supply and Communication Perspective*

As in the *Compatibility and Capacity Perspective*, stakeholders with the *Supply and Communication Perspective* are concerned with hauling low-value material long distances (#7); however, their comments reveal that they appear to focus more on cost and energy efficiency. An example from one *Supply and Communication Perspective* defining sort shares, *"Wood, while offering the potential as a sustainable feedstock for fuels and chemicals, is not energy dense."*

Unlike the *Compatibility and Capacity Perspective*, stakeholders on the *Supply and Communication Perspective* do not see compatibility as a supply issue, or as a problem at all (#11). One defining sort stakeholder described, *"A huge fraction of gasoline at the pump already contains bio-ethanol— this is a tested and proven technology. Cars are still running fine."*

Lastly, *Supply and Communication Perspective* stakeholders are particularly concerned with the lack of trustworthy information (#16). Interestingly, despite this concern, and especially with the framing that "all we get are slogans and propaganda," they strongly disagree with the *Political Social Will Perspective* that public perception is a problem (#35). This may again point to a regional or placed-based difference in perspectives. A defining stakeholder from a rural community suggested, *"Public perception where I am from, and especially in rural communities, appears largely in favor of wood-based biofuels."*

One of the pivotal points distinguishing this perspective is strong disagreement about political will (#28). Stakeholders on the *Political Social Will Perspective* believe political will is one of the biggest problems facing the development of biofuels, stakeholders with the

Compatibility and Capacity Perspective feel neutrally, and stakeholders with the *Supply and Communication Perspective* feel strongly it is not a problem. Here are two quotes comparing defining stakeholders who embody the main themes for this statement for the two perspectives based on their comments:

> *"This is the crux of the problem... big oil is not held accountable for the damage they do, and big oil-funded republicans fight against anything perceived as environmental, we will never get to a sustainable system."*
>
> *– Researcher, Compatibility and Capacity Perspective*

> *"Industries do not own our government."*
>
> *– Researcher, Supply and Communication Perspective*

That being said, *Supply and Communication Perspective* stakeholders still believe that the government has failed in supporting the development of biofuels (#29). Yet they do not seem to be painting the challenge as a political problem, but rather a regulatory problem, in direct contrast to the *Compatibility and Capacity Perspective*. They strongly feel that "analysis paralysis" is *not* a problem (#31). Defining sort comments reveal several major themes that may explain this discrepancy: that it isn't the EPA's fault, economic feasibility is more to blame, or Congress is more at fault. One defining stakeholder put it, "*Most regulatory [agencies] are [captured] by the industries they are supposed to regulate."* In other words, it is more likely the EPA would support this industry than hinder it. Moreover, the *Supply and Communication Perspective* stakeholders don't see closing loopholes or enforcing regulations as being a problem either (#30).

Like the other perspectives, stakeholders associated with the *Supply and Communication Perspective* strongly express the view that biofuels are not morally wrong and do not contribute to

rising food costs (#2). However, unlike the other perspectives, *Supply and Communication* stakeholders feel more neutrally toward environmental concerns such as water (#6), chemical inputs (#38), or soil degradation (#13). They also feel more neutrally toward social justice issues (#33, #32) and human health (#19). In summary, stakeholders holding the *Supply and Communication Perspective* are not focused on regulation, politics, perceptions, and compatibility as problems, but rather barriers to entry from the existing status quo, availability of supply, and quality of information.

This perspective is characterized by the inclusion of the last three environmental advocacy stakeholder sorts (Table 2). Additionally, the single tribal stakeholder, one government stakeholder, and the one other defining grower stakeholder loaded onto this perspective.

2.5.4 *Comparison Between Perspectives*

There are several approaches for systematically comparing across perspectives. These include a comparison of computed consensus, moderate consensus, non-consensual non-controversial, and contentious areas. These areas involve comparisons between individual statements and their positive and negative associations with each perspective. Additionally, inter-perspective comparison is beneficial for examining comparisons more broadly across the entire perspective. Computed consensus statements indicate no significant difference between any of the views. In practice, these are the areas of shared agreement that might be used to help build from. Though much can be learned from statistically significant areas of agreement and disagreement, there are still levels of agreement and disagreement that might occur in even if not statistically determined. These areas represent potential points of compromise across perspectives and are

determined through a visual inspection of positive and negative statement loadings on perspectives. I refer to these as moderate agreement or disagreement areas. Non-consensual non-controversial areas occur when not all statements are associated with a perspective with the same positive or negative valence: however, the points of disagreement are neutral and thus also represent potential places for compromise. I define contentious areas as instances where statements are associated with another perspective nearly one standard deviation from the mean in opposition of another perspective.

2.5.4.1 Computed Consensus Areas

Of the three perspectives, there were four areas that were identified as Q-consensus statements (Table 1). The first statement shared (#2), "*Biofuels means burning food,"* is ranked among the most disagreed-with statements for all three perspectives (Z-scores of -2.19, -1.81, -1.81 respectively). Another consensus statement refers to the regions' ability to compete with the nation for production of fuels (#42). Both statements are statistically non-significant to the 0.01 alpha level, though the priority ranking for statement #42 is relatively low with the exception of the *Political Social Will Perspective* (Table 1). All three perspectives also strongly agreed with the statement that the limiting factor in biofuels is the economics of hauling low-value feedstock long distances (#7). Similar to statement #2, this appears to be a pivotal statement where all perspectives have ranked this among their most strongly agreed-upon problems. A fourth consensus area is around biofuels developing in coordination with other industries (#21). This statement, while shared, is not ranked a high priority among all three perspectives, which indicates a shared neutral statement. These last two areas of consensus are statistically non-significant at the 0.05 alpha level.

2.5.4.2 Consensus Areas of Moderate Agreement & Disagreement

Of the three perspectives, there are several areas where perspectives moderately agree, including the challenge of the current amount of natural gas flooding the market making it difficult for alternatives to compete (#24). Another such theme is the problem of information (#16) and a concern that slogans and propaganda are obscuring more reliable sources. There is also moderate agreement that replacing fossil fuels may not be sustainable in the US, considering the scale of use (#20). Additionally, all three perspectives somewhat agree that in order for people to take wood-based biofuels seriously, a feasibility demonstration is necessary (#34). All areas of modest agreement contain at least one, if not two, highly ranked statements, indicating that this as an important priority to focus on for policy making and program development.

Areas where perspectives share a moderate consensus of disagreement span a diversity of unique themes, with over half representing highly ranked statements. These include concerns over the ability to meet air quality standards (#9), concerns over the ability to enforce regulations (#30), and concerns that biofuels are the source of social justice problems (#32). These areas are not viewed as problematic by stakeholders. Other less pressing areas of moderate disagreement include concerns over putting pressure on other industries (#18) and concerns that the startup cost and time for farmers growing wood-based feedstock might be too much (#17).

2.5.4.3 Non-Consensual Non-Contentious Areas

In several cases, only one viewpoint prioritizes an issue or concern, whereas the others hold more neutral attitudes, albeit while still expressing clear viewpoints. These single or double-perspective concerns offer more opportunities for compromise and for strategic communication.

Understanding these points of neutrality can guide policymakers in proactive strategies for accommodation and conflict management.

There were two areas where the *Political Social Will Perspective* cared strongly while the other perspectives remained more neutral. The first area considers the challenges farmers face attempting to transition to biofuels without having incentives to take on new risks (#27). The *Political Social Will Perspective* strongly ranks this as a problem whereas the *Compatibility and Capacity Perspective* ranks it as a modest problem and the *Supply and Communication Perspective* feels more neutrally. Another area important for the Political Social Will Perspective is the disagreement with biomaximum being a challenge for biofuels development. For the *Political Social Will Perspective*, rather than biomaximum, logistics are viewed as a barrier (#3). The *Compatibility and Capacity Perspective* and the *Supply and Communication Perspective* do not prioritize this issue as highly. A third item that is strongly important to the *Political Social Will Perspective* and the *Compatibility and Capacity Perspective* is the challenge of a readily available feedstock (#40) for biofuels development. Finally, the *Supply and Communication Perspective* is uniquely polarized around the issue of biofuels being a passing fad that will be quickly outdated (#37), disagreeing strongly with this statement while the other perspectives consider it less of a priority.

The *Compatibility and Capacity Perspective* only ranks one other area beyond 1 standard deviation and that is item #23 referring to concern over subsidizing biofuels. This is shared with *the Supply and Communication Perspective*. Both the *Compatibility and Capacity Perspective* and the *Supply and Communication Perspective* feel strongly that this is a high-priority problem, while the *Political Social Will Perspective* feels quite neutrally toward it. The *Compatibility and*

Capacity Perspective and the *Supply and Communication Perspective* also feel strongly that greed is not an important problem for biofuels development (#25), both negatively sorting it beyond one standard deviation from the mean, whereas the *Political Social Will Perspective* is neutral on this point.

2.5.4.4 Main Areas of Contentious Disagreement

Although there are at least a dozen areas with varying levels of moderate disagreement, there are a number of strongly conflicting rankings. The Q-sort results highlight seven main areas of contentious disagreement. This study identifies areas of contentious disagreement by going through each statement systematically, considering the variance across all three perspectives, and singling out disagreements with opposing Z-score rankings of close to one standard deviation from zero.

Due to the complexity of the issue, these three perspectives' overlapping areas of agreement and disagreement defy a simple summary. There does not appear to be a pattern around how these perspectives strongly disagree with items. The following are general areas of strong contention among at least two of the three perspectives: supply, compatibility, water, politics, regulation, social justice, and public perception.

In the first contentious area, issues relating to supply are ranked as a problem (#8). The *Compatibility and Capacity Perspective* feels it is a strong priority (Z-score = 1.05), and so does the *Supply and Communication Perspective* (Z-score = 1.14); however, the *Political Social Will Perspective* feels opposite (Z-score = -0.71). For issues of compatibility (#11), the Compatibility and Capacity Perspective feels strongly (Z-score = 1.12) that biofuels will gum up engines and destroy to vehicles, whereas the *Political Social Will Perspective* and the *Supply and*

Communication Perspective feel strongly opposite (Z-scores of -0.95 and -1.16 respectively). The *Supply and Communication Perspective* (0.87) also prioritized access to water rights (#15, #6) as a problem, though the *Compatibility and Capacity Perspective* feels that it is not (Z-score = -1.06) and the *Political Social Will Perspective* feels more neutrally toward it.

Politics proves to be a very dividing theme. Lack of political will due to the controlling powers of big industry (#28) is prioritized as a problem by the *Political Social Will Perspective* (Z-score = 2.01) and treated neutrally by the *Compatibility and Capacity Perspective* (Z-score = 0.00). However, the *Supply and Communication Perspective* strongly disagrees that big industry is the source of the problem (Z-score = -1.45). The *Compatibility and Capacity Perspective* joins the *Supply and Communication Perspective* in agreeing that governmental failures (#29) are not a relevant concern, whereas the *Political Social Will Perspective* strongly ranks government failure as a salient problem, though not so much as politics, (#28, 1.15). Clear preferences emerged among perspectives around regulations (#31) as being distinct from politics as a potential problem. For example, although the *Compatibility and Capacity Perspective* stakeholders feel neutrally to opposite that politics are a problem (#28), they do view regulations as being a priority (Z-score = 1.46). Stakeholders loading onto the *Supply and Communication Perspective*, however, maintain a consistent view that politics and regulations are not priority issues, disagreeing with a Z-score ranking of -2.16.

Social justice issues regarding the exploitation of marginalized communities are viewed as a problem by the *Political Social Will Perspective* based on their 0.83 Z-score ranking, where the *Supply and Communication Perspective* feels neutrally and the *Compatibility and Capacity Perspective* feels strongly that it is not a problem (#33, Z-score = -1.17). Lastly, public perception

is viewed as a problem (#35) by the *Political Social Will Perspective* with a Z-score of 1.34 where the *Supply and Communication Perspective* feels strongly it is not a problem (Z-score = -1.41) and the *Compatibility and Capacity Perspective* ranked it more neutrally.

Table 3. Table with Inter-perspective Correlations
Inter-perspective correlations resulting from the Q-sorting of perceived problems associated with biofuels development in the Pacific Northwest.

Perspective	*Political Social Will Perspective*	*Compatibility and Capacity Perspective*	*Supply and Communication Perspective*
Perspective 1	1.00		
Perspective 2	0.22	1.00	
Perspective 3	0.15	0.37	1.00

2.5.4.5 Inter-perspective Comparisons

The inter-perspective correlations are presented in Table 3, indicating the level of conflicting (-1) or consensus (+1) perspectives that exist for the biofuels Q-sample. Areas where there is high positive correlation between perspectives suggest agreement on predominant issues, though definite priorities still exist. Areas with strong negative correlations indicate a polarization of perspectives. The results from this research suggest that overall, there are no deeply held conflicting perspectives, but rather variations in specific positions within the perspectives. The high correlation between the *Compatibility and Capacity Perspective* and the *Supply and Communication Perspective* is perhaps not surprising.

2.5.5 *Intra-perspective Stakeholder Comparisons*

A tremendous amount of variability exists across perspectives within stakeholder groups, though there do appear to be clear patterns for grouping some stakeholders, most notably the advocacy and grower stakeholders. One strength of Q-methodology is that it is able to provide insights about flexibility of stakeholders regarding the viewpoints that they hold and also point out inconsistencies in their beliefs or values. This study finds that 16 of the 49 stakeholders with significantly loaded sorts (or about 33%) hold multiple perspectives about biofuels (Table 4).

Table 4. Number of Stakeholders Associated with Each Perspective

Totals reflect cross-loading. The numbers in parenthesis in column one are the total number of stakeholders in that group; the negative numbers in parentheses throughout the rest of the table indicate the number of stakeholders who significantly disagree with that frame; the cut-off point for stakeholders' significant association with each frame was 0.37.

	Political Social Will Perspective	*Political Social Will Perspective* & *Supply and Communication Perspective*	*Compatibility and Capacity Perspective*	*Political Social Will Perspective* & *Compatibility and Capacity Perspective*	*Supply and Communication Perspective*	*Compatibility and Capacity Perspective* & *Supply and Communication Perspective*
Advocacy	**9(-1)**	**1**	**1(-1)**	**1**	**5**	**1**
Environmental	5(-1)		1		4	
Community	4		(-1)		1	
Government	**3**		**1**		**3**	
Industry	**10**	**1**	**9(-1)**	**4**	**2**	**1**
Related Industry	1		1			
Economic / Labor	3		(-1)			
Farmer / Grower	1		5		2	
Energy & Producers	5		3			
Researcher	**6**	**4**	**3**	**1**	**5**	**2**
Total	**28(-1)**	**6**	**14(-2)**	**6**	**15**	**4**

Participants with this degree of flexibility are found across all four stakeholder sectors, advocacy, government, industry, and researcher.

Both environmental- and community-focused advocacy stakeholders were predominantly associated with the *Political Social Will Perspective*; however, there was a notable group of three advocacy stakeholders uniquely associated with the *Supply and Communication Perspective* (Table 2). With the exception of two cross-loaded stakeholders, there were no advocacy stakeholders associated with the *Compatibility and Capacity Perspective*. Of these two cross-loaded stakeholders was actually negatively associated with the *Compatibility and Capacity Perspective*.

All five significant government agency officials' sorts loaded positively across their respective perspectives (Table 2). Only one government agency official cross-loaded between two perspectives, the *Political Social Will Perspective* and the *Supply and Communication Perspective*. One government official's sort was not significantly associated with any of the perspectives.

For industry stakeholders, meaningful divisions appeared to occur between the farmers, foresters, and growers in one group and the economic development professionals, labor union representatives, and energy associations in another (Table 2). Among the farmers, growers, and foresters, a clear preference seemed to emerge for the *Compatibility and Capacity Perspective*, with three uniquely associated sorts and two cross-loaded sorts making up that perspective. The *Compatibility and Capacity Perspective* has only one uniquely loaded sort, a grower. The *Political Social Will Perspective* included one cross-loaded forestry sort. Also, a grower who classified themselves in an "other" category produced a non-significant sort.

The economic development, labor, and energy association stakeholders loaded primarily on the *Political Social Will Perspective*. There is one cross-loaded energy association representative sort positively associated with the *Compatibility and Capacity Perspective* and also one labor union representative sort negatively associated with *the Compatibility and Capacity Perspective*. Of note here is that none of the energy association and economic development professionals load onto *the Compatibility and Capacity Perspective*. The two producer associations are evenly associated with *the Political Social Will Perspective* and *the Compatibility and Capacity Perspective*. One of the energy association representatives was found to be non-significantly associated with any perspective (Energy Association Representative).

Researchers were associated most strongly with the *Political Social Will Perspective*, with three defining researcher sorts loading uniquely onto that perspective. Three other sorts were cross-loaded with the *Political Social Will Perspective* and the *Supply and Communication Perspective*. All in all, the majority of researcher stakeholders were distributed across the *Political Social Will Perspective* and the *Supply and Communication Perspective*. The *Compatibility and Capacity Perspective* also had two researcher sorts associated with it, though they were cross-loaded with the others.

2.6 Discussion

Through the systematic structuring of stakeholder perspectives, we have insight into the emerging discourse surrounding the development of biofuels in the Pacific Northwest. This chapter has characterized each perspective, examined various levels of stakeholder agreement and disagreement, and provided insights about the flexibility of stakeholders regarding inter-

perspective and intra-perspectives. Overall, these findings are suggestions that biofuels, at least in the Pacific Northwest, are not a strongly contentious issue. In the US, the majority of environmental advocacy stakeholders have not taken an official stance on most forms of bioenergy, except to oppose burning whole trees for biomass (Schlossberg, 2016). Therefore, advance knowledge about what to expect from stakeholders is crucial to anticipating, and ideally preventing, the emergence of perceived polarized viewpoints as different groups vie for power in the issue-attention cycle of the arguably influential public (Glynn et al. 2004). In doing so, stakeholders can stay focused on the broader goal of finding constructive alternatives that address diverse needs and viewpoints.

A systematic structuring of stakeholder perspectives provides insight into the emergent discourse surrounding the development of biofuels in the Pacific Northwest. Studying these discursive frames highlight points of agreement, opportunities for compromise, and the specific priorities that stakeholder groups hold. Through Q-methodology, the findings are characterizations of several distinct perspectives that complicate traditional constructions of stakeholder group and demographic differences. Furthermore, it teases apart trends in stakeholders' inter-perspective and intra-perspective agreements and disagreements.

In advance of destructive conflict, analysts may gain clarity around specific problems and reframe them in terms of common ground, thus preventing deeply polarized discourse and supporting the development of effective alternatives. On a positive note, perspectives on biofuels in the Pacific Northwest share a large degree of common ground. Of the 43 themes accounted for by the Q-sort statements, all three perspectives shared some level of agreement on 15 issues, while

experiencing significant disagreements in only seven (Table 1). Furthermore, none of the three overall perspectives are polarized with the others (Table 3).

There are two main focal points for prioritizing which problems to address and manage. First, areas of agreement and partial agreement around non-controversial topics can be used to help design policies with a higher likelihood of social acceptance. There are 10 such areas out of the 43 themes accounted for by the Q statements. Secondly, addressing more controversial concerns—that is, those with strongly held polarized agreement characterized by Z-scores greater than one standard deviation from zero–is critical in order to prevent the development of future conflict around perceived opposing beliefs. Areas of modest disagreement help identify non-problem or lower priority concerns, and are therefore not included in this discussion of priority problems. Priority problem areas should be addressed first; more neutrally held concerns should be explored later, as they may provide important insight into knowledge gaps. These follow-ups remain important because more neutrally held areas can become points of future contention as the introduction of new knowledge changes participants' perspectives.

Therefore, the general approach should be:

1. Address "low-hanging fruit" non-controversial areas first to build trust and create a foundation of common ground to start from
2. Address controversial areas next to prevent conflicts from developing or worsening and create clarity and reframe before issue moves into problem formation cycle
3. Address neutral areas to investigate knowledge gaps

In the following section, I provide a discussion of priority areas for policymakers to address in order to help each perspective arrive at clarity around perceived problems with biofuels. I will present this from within each perspective, as well as across all perspectives.

2.6.1 *Priority Areas of Perceived Problems to Address*

A prominent concern expressed by stakeholders associated with all three perspectives was that the limiting factor for wood-based biofuels is the economics of hauling very low-value material very long distances (#7). The *Political Social Will Perspective,* the *Compatibility and Capacity Perspective,* and the *Supply and Communication Perspective* strongly agreed with this statement, with a Z-score of 1.48, 1.57 and 1.96, sig. respectively. As such, decision-makers should prioritize addressing public concern around this problem.

Another perceived problem is that the glut of natural gas flooding the market will make it difficult for biofuels to compete with other alternatives (#24). This is a high a priority area for the *Compatibility and Capacity Perspective* and the *Supply and Communication Perspective* (Z-scores = 1.83, 1.71, sig.), and stakeholders associated with the *Political Social Will Perspective* also showed strong agreement (Z-score = 0.90, sig.). One defining stakeholder put it thus: *"Natural gas prices are at a very low point. As long as they remain at this point, there is little incentive to research, or convert to other fuel sources whether they are fossil or renewable. It doesn't pencil out."* Because all three perspectives ranked this issue so highly, it is an important priority to address for clarification and co-learning. In other words, policymakers will have to engage perceived problems with competition, economic feasibility, and incentives for developing biofuels.

The other priorities to consider are ranked highly in two of the perspectives and held neutrally by one. These include concerns with taking biofuels seriously unless there is a demonstration such as a demonstration site or pilot program (#34), the amount of money that should be supporting or subsidizing the development of these fuels (#23), and how to sustainably meet demand for fuel (#20). Statement #20 is a little challenging to manage for because another related theme about the bio-maximum (#3) ranks exactly the opposite with two of the perspectives. The *Supply and Communication Perspective* feels most strongly that sustainability is a problem, while the *Political Social Will Perspective* does not; on the other hand, the *Political Social Will Perspective* feels most strongly that logistics is the challenge, while the *Supply and Communication Perspective* feels at most neutrally toward this statement. Operationally, there is a subtle difference between bio-maximum and sustainability, leading some participants to interpret statement #20 as a concern about sustainability of biofuels supply.

To further complicate things, when cost and ease of access to the feedstock is made salient (#40), the *Supply and Communication Perspective* strongly agrees with the *Political Social Will Perspective.* Consequently, policymakers should pay heed in designing policy to address challenges like these. As has been found in other studies examining perceptions and sensitivity to issue framing with energy, depending on which element is made salient, different levels of support for the policy or issue can result (Cacciatore, Scheufele, & Shaw, 2012).

Two statements stand out as *close to* neutral (Z-scores = 0.08 and -0.02), while the other two agree strongly (beyond one standard deviation) that the statements represent problems. These two issues are the cost and access of feedstock (#40), and the concern over information reliability (#16). The more neutral issue is *very* neutral, while the other perspectives agree strongly (beyond

1 standard deviation) that they are problems. Because the dissenting views are very neutral and the agreement views are very strong, policymakers must also prioritize these concerns; however, due to the low controversy, less time, money and resources may need to be expended to address the perceived problem.

In the examples presented above, those holding neutral viewpoints might still be amenable to putting energy into addressing the problem. In more controversial areas, though, a stakeholder who does *not* view an area as a problem may be hesitant to invest resources in solving or managing the issue. As such, care must be taken with the more controversial problem frames listed in the results. As discussed previously, politics (#28 and #29) prove to be a high-controversy issue that needs to be addressed with care. For roughly half of the seven high-priority controversies, the *Political Social Will Perspective* and the *Supply and Communication Perspective* are at odds with each other. The clearest example of this is the issue of political will (#28). This study did not collect demographic information about participants' political party identity, but this may be an informative area of future study, considering the divide between the *Political Social Will Perspective* and the *Supply and Communication Perspective* and the supporting evidence from recent research (Fung et al., 2014).

Ultimately, policymakers must emphasize to stakeholders that these seven high-controversy concerns are not a zero-sum game, and that one another's priorities can be fairly and equitably addressed, even though they are not priorities for all.

2.6.2 *International Biofuels Debate and Regional Implications*

In the broader international discussions of the biofuels debate, prominent themes center around the food versus fuel debate and indirect land use change (ILUC) (Pilgrim & Harvey, 2010; Tomei & Helliwell, 2016). In my initial examination of U.S,-centered discussions, I discovered that ILUC was associated primarily with international phenomena and thus represented more of a future concern than an existing problem in this country. I have included this theme as part of Chapter 3's analysis of benefits and concerns.

The food versus fuel debate, however, also became salient within the broader corn ethanol controversy in the U.S (Braustein, 2015; Tomei & Helliwell, 2016). I included it as part of this concourse for the development of the problems Q-sample statement set. Additionally, this research finds that all three perspectives strongly rejected the idea that biofuels were "burning food" (#2). Moreover, it was not just a strong preference, it was among the most strongly felt statements for all three perspectives (Z-score of -2.19, -1.94 and -1.81, sig. respectively).

Table 5. Comparison of Quotes from Defining Stakeholders

Comparison of quotes from diverse defining stakeholders across all three perspectives on statement #2, views on the food versus fuel debate.

Perspective	Defining Stakeholder Quote
Political Social Will Perspective	*"We waste millions of [pounds] of food annually as a nation. At least this is for a greater good." (Government Agency Official)* *"A successful food system requires a sustainable fuel system to grow and deliver the product. And we'll lose all our food crops if we don't get climate change under control." (Researcher)*

	"Purpose-grown energy crops such as willow, poplar, switchgrass, etc. are not food. Neither is bark-beetle infested forestry stock or construction waste." (Energy Association Stakeholder) *"We don't need to burn anything we could eat in order to make biofuels, nor [do] we need to sacrifice areas inclined to produce food in order to grow trees as sources for our biofuel" (Rural Environmental Advocate)*
Compatibility and Capacity Perspective	*"We don't eat trees or fiber from crop residue. We can grow adequate and reasonably priced food to feed the world if agriculture is allowed to utilize modern agricultural technology. Biofuels are the least of our problems." (Grower)* *"Our forests in the PNW generally grow on ground not suitable for farming or food production." (Forester)* *"The whole point of cellulosic biofuels is to use non-food feedstocks." (Producer Association Stakeholder)*
Supply and Communication Perspective	*"Research has shown serious impacts on commodity prices because of the distortions arising from the use of corn for ethanol, however wood based products do not necessarily fall into this same trap. Differences arise as well if you discuss whether the feedstock is sourced from public land or managed plantations. Increasing demand for phosphorus and fertilizer on feedstock plantations would have an impact on global food markets, however this would depend mostly on the scale of such operations." (Government Agency Official)* *"We should not use valuable farm land to plant [trees]" (Grower)* *"Many biofuels are not [consumable] by humans" (Environmental Advocate)*

If there was any doubt that the international discourse may influence these perspectives, it is clear that it did not influence them toward agreement based on the clear expression of

disagreement in the examples provided above (Table 5). Based on these findings, surprisingly, this is not a priority area that policymakers need to address or clarify in designing biofuels programs, other than perhaps to emphasize their understanding that it is not a problem. Undoubtedly, this does not mean they can design policies that promote "burning of food;" it just means that current stakeholders trust decision-makers not to do this. Interestingly, different stakeholder groups appear to have diverse reasons behind their agreement that this is not a problem.

It may be that the broader issue public who are not as directly involved in the development of biofuels may be less educated about the issue? Participants' comments indicate a high level of knowledge about this issue and the complexity.

2.6.3 *Further Insights on Intra-perspective Stakeholder Comparisons*

Though I do address some areas more specifically relevant to stakeholder groups, policymakers should select priorities based on the perspectives themselves, rather than the stakeholder group. As one can see from this analysis, nearly 30% of stakeholders hold more than one perspective (Table 4). There are no exclusive associations between specific stakeholder groups and certain perspectives, which is why Q-methodology is a fitting approach for this type of research. This finding might be viewed as positive because it indicates within stakeholder groups their flexibility around this frame.

It is also important for looking at demographic segmentation within specific stakeholder groups. Below, I discuss some possible causes for this segmentation within the environmental and community advocacy stakeholders, as well as within the researcher stakeholder group. This

diversity indicates that there are other factors beyond stakeholder association that may account for differences in perspectives.

Both environmental- and community-focused advocacy stakeholders were predominantly associated with the *Political Social Will Perspective*; however, there was a notable group of advocacy stakeholders uniquely associated with the *Supply and Communication Perspective* (Table 2). Upon closer inspection of stakeholder affiliations, it appears that a rural/urban divide may explain the differences. The advocacy stakeholders who are more community-focused appear to live and work in rural communities. The environmental advocacy stakeholders that load onto the *Political Social Will Perspective* all either live in an ecovillage community or belong to a rural regionally-focused environmental organization. A close examination of the *Supply and Communication Perspective* reveals that the environmental advocacy stakeholders defining this perspective are more urban-focused, either living and working in urban areas, or belonging to an organization whose mission focuses on urban areas. Additionally, the environmental stakeholder who cross-loaded positively with the *Supply and Communication Perspective* and negatively with the *Political Social Will Perspective* was a more urban-based participant. One stakeholder in his comments suggested, *"Public perception where I am from, and especially in rural communities, appears largely in favor of wood-based biofuels."* This may be due to the fact that rural communities are more isolated and rely more on themselves for being able to provide energy resources. Follow-up conversations with rural participants supported this hypothesis.

This suggests a need to extract a 4th factor using manual theoretical rotation to account for a new and possibly distinct rural stakeholder perspective. Alternatively, it may be that these groups share similar preferences, but when forced to prioritize issues of importance to them, their actual

interests outweigh their organization's priorities. However the advocacy group *No Biomass Burn*'s protests of the Seneca Sustainable Energy, LLC cogeneration facility in Eugene, Oregon provide evidence that such a viewpoint exists as a distinct perspective (Chirillo, 2013). This would represent a difference between stakeholders living in the areas where a refinery might be built and stakeholders living in more isolated areas that depended on local energy production. In considering the social impacts assessment literature, this is the difference between people who have a vested interest in seeing an industry develop and the potentially marginalized communities in urban industrial areas who are impacted at the local level (Burdge, 2004).

Another interesting example of within stakeholder differences can be seen by considering the researcher stakeholders. Researchers have loaded primarily on the *Political Social Will Perspective* or the *Supply and Communication Perspective*. Though the reason for this is a little less clear than with advocacy stakeholders, there is some evidence that political beliefs play a role. For example, a comparison between the *Political Social Will Perspective* and the *Supply and Communication Perspective* comments on whether industries own the government (#29) demonstrates a clear political difference between stakeholders:

> *"This is the crux of the problem... Big oil is not held accountable for the damage they do, and big oil-funded republicans fight against anything perceived as environmental, we will never get to a sustainable system."*
>
> *– Researcher, Political Social Will Perspective*

> *"Industries do not own our government."*
>
> *– Researcher, Supply and Communication Perspective*

However, as there is a lot of cross-loading between the two groups, distinctions between other themes are difficult to identify. That said, even for this single dimension the researcher stakeholder group highlights the diversity of opinions that can exist within a single sector. Thus, gaining clarity around the complexity of specific stakeholder beliefs may not be as helpful as considering the broader perspective due to the diversity of beliefs that are sometimes held within a single agency or stakeholder group. Further, while research on political identity may contribute greatly to analysts' understanding of the broader context for policy discourse, this results of this study can provide clarity on the diversity of subjective knowledge structures that exist within stakeholder groups.

2.7 Conclusion

As initially presented, the best way to manage environmental conflict is to thoughtfully design plans a-priori that will prevent the creation of new conflict and deeply polarized discourse later (Healey, 2006; Rydin, 2003). In order to do so, researchers and policymakers need to have as much clarity as possible about problem definitions. Effectively designed programs need to focus both on stakeholders' common ground and the differences in their deepest concerns—differences which stem primarily from divergent problem definitions, resulting from differing lived experiences. Anticipating these social perspectives can be particularly difficult, however, in cases where the industry is not yet present and early social influences have no existing models to base their opinions on. Additionally, early social influencers may form attitudes based on inaccurate, outdated, or media-exaggerated examples of attempts at first-generation biofuels industry or even a different industry all together (McCombs & Shaw, 1972). A specific example of this relevant for

the Pacific Northwest is the history of the failed pulp and paper industry in the region. In this instance, extension specialists from WSU reached out to farmers in the region encouraging them to grow poplar trees for a promising new paper industry. After the industry failed, a legacy of older generation farmers where left highly skeptical of growing tree-based crops. Examples like this point to the need for in-depth policy analysis that sufficiently explores stakeholders' experiences and worldviews. Concepts of environmental problems and communication around those concepts are often in flux (intra-personally and interpersonally), thus complicating the developing discourse. Such complexity makes it difficult to generate the knowledge that decision-makers need to discern effective alternatives for the greater good of society (Stephenson, 1988/1989). In addition to this process, stakeholder groups with differing definitions of the problem consciously compete to influence the developing policy discourse to align more closely with their organization or personal agendas (Boykoff, 2012; Hannigan, 2006). Thus, prior to developing new alternative energy industries such as wood-based biofuels, early issue identification efforts must explore the mental models of potential influencers in depth, searching across stakeholder groups to uncover in-depth knowledge about specific preferences and areas of disagreement about problem priorities. This study does just that in its analysis of stakeholder framing of biofuels as a perceived problem in the Pacific Northwest.

Q-methodology allowed for the identification and characterization of three predominant perspectives which exist about woody-based biofuels for the region. I have presented the priority areas for policymakers to address, noted the uniqueness of managing the developing policy dialogue for our region, and discussed insights into flexibility of stakeholders' perspectives and potentially important differences within stakeholder groups. These elements are essential to

developing clear recommendations for leaders in government and industry regarding the design, implementation, and communication about constructive directions for alternative energy in the Pacific Northwest.

3. STAKEHOLDER PERSPECTIVES ON BENEFITS & CONCERNS WITH HYBRID POPLAR BIOFUELS IN THE PACIFIC NORTHWEST

3.1 INTRODUCTION

It is critical to develop region-specific adaptations to help both mitigate climate change and address its causes (IPCC, 2014). Exploring and developing alternative energy sources represents an important potential pathway for ameliorating climate change (Creutzig et al., 2015). However, for a variety of economic, environmental, technological, and social reasons, alternative and renewable energy has achieved only moderate success in regards to social acceptability (Pasqualetti, 2011; Fast, 2013; Sovacool, 2009). Although each energy source appears to be associated with its own suite of challenges, in the Pacific Northwest, a great deal of research and has focused on the development of advanced or second-generation cellulosic fuels (Advanced Hardwood Biofuels). For cellulosic biofuels, international public outcry against early first-generation biofuels production attempts may threaten the development of new ventures (Pilgrim & Harvey, 2010; Halder et al., 2015; Tomei & Helliwell, 2016). The research I propose seeks to understand social perspectives, and thus the acceptability and feasibility, of establishing biofuels in the region. This knowledge will be useful for guiding policy proposal development and supporting decision-makers in developing effective alternatives.

Analyzing stakeholder perspectives in a way that is of direct utility for decision-making is vital. However, human thoughts are often in flux, and interpersonal exchanges provide only a snapshot of transient thought that may not provide the knowledge useful to decision-makers (Stephenson, 1988/1989). Inadequate consideration of other stakeholder perspectives and a lack

of structure can make stakeholder perspectives difficult to address and use to shape policy (Asah et al., 2012a). Discerning which issues stakeholders prioritize and the strength of their preferences about key issues provides valuable insight. The research described here seeks to understand the underlying structure of stakeholder perspectives, in order to provide knowledge decision-makers can use.

I hope to support constructive development of biofuels in Pacific Northwest by identifying the structure of socially held frames about biofuels to explore which are acceptable (Shindler et al., 2004), compatible with existing values, perceived as relatively beneficial (Rogers, 2010), and consequently resonate strongly with existing socially held frames surrounding environmental discourse (Benford &B Snow, 2000; Dryzek, 2005). Understanding the structure of how stakeholders frame biofuels' benefits and drawbacks will facilitate the provision of specific recommendations for decision-makers and provide a clear direction for strategic outreach efforts. In this study, I structure stakeholder perspectives about the development of cellulosic biofuels in the Pacific Northwest through the use of a quasi-quantitative approach known as Q-methodology.

My research question for Chapter 3 is: *How do stakeholders frame benefits and concerns with wood-based cellulosic biofuels?* In the following sections, I present the rationale and significance for this work, relevant literature on social perceptions of biofuels, previous research conducted on framing, as well as my research design. In my results section, I present a description of each of the perspectives emerging from the analysis, a detailed comparison between the perspectives and the intra-perspective stakeholder comparison. I discuss how each of these results can be applied by policy makers and highlight priority areas of benefit and concern to emphasize

or avoid. I conclude with a discussion of the importance of frame alignment and further recommendations for policy makers drawing from environmental discourse analysis.

3.2 Rationale and Significance

Q-methodology provides an intensive examination of the different ways discourses are framed, and thus facilitates structuring social discourse in a way that is useful for decision-makers (Addams, & Proops, 2000). Entman (1993) defines frames as communication mechanisms that make some aspects of communication more salient and others less so. There is a strong link between social discourse and discursive frames: discourses are the stories that collectively construct a picture of reality, while framing is the *way* these stories are told (Boykoff, 2012). Telling these stories through a particular lens shapes our interpretation of them. As a worldview, framing is a radical departure from more objectivist approaches to decision-making (Fischer & Forester, 1993). Policy analysts have only more recently transitioned toward using frames as a foundation for approaching environmental planning (Dayton, 2000; Fischer & Gottweis, 2012). These frames compete and interact as different stakeholder groups select the frames that will influence their interpretation and construction of particular discourses about social issues (Dewulf et al., 2009; Glynn et al., 2004; Hannigan, 2006). Research into conflict frames has variously conceptualized those frames as being primarily cognitive, primarily interactional (Dewulf et al., 2009), or both (Asah et al., 2012b). Because of the cognitive nature of communication, frames contribute to the formation of both individual and social perspectives (Cantrill, 1996; Dewulf et al., 2009; Stephenson, 1980a).

Q-methodology is one way to apply frame analysis which also supports the analysis of social discourse in natural resource management (Dayton, 2000; Focht & Lawler, 2000; Mazur & Asah, 2013; Martin & Steelman, 2004; Webler et al., 2009). Individuals begin the process of perceiving biofuels as socially acceptable by exploring intra-personally whether they view them as a social ill or a social benefit. This process becomes inter-personal as individuals interact with others, socially constructing the emergent frame together. Frame construction is part of the environmental problem formation cycle and includes a number of concurrent phases that affect the transformation of environmental issues through social discourse (Hannigan, 2006). Through frame analysis, it is possible to examine how an emerging issue such as biofuels is being framed in anticipation of how social perspectives of that issue might develop in the future. In planning for the successful adoption and diffusion of new technologies such as biofuels, it is important to assess the perceived level of risk and benefit, as well as compatibility with existing infrastructures (Rogers, 2010). These perceptions are observable through expressions of opinions, and are captured in the social discourse surrounding benefits and concerns for biofuels. Hence, this study examines how stakeholders frame the social discourse about the development of cellulosic biofuels in the Pacific Northwest as a concern or benefit.

3.3 LITERATURE REVIEW

3.3.1 *Social Acceptability of Biofuels in the United States*

In spite of a recent increase in studies related to social perceptions of biofuels and bioenergy (see Halder et al., 2015 for a review), studies that focus on systematic structuring of

stakeholder discourse for policy analysis are comparatively rare. The majority of studies on social perceptions are broad-based public opinion research conducted via traditional survey methods (Delshad & Raymond, 2013; Radics et al., 2015). Moreover, although focus group research is increasing, data are not organized and presented for policy makers in a way that makes obvious the best policy alternatives, or process for dialogue.

Furthermore, though several content analyses have also been conducted, the source focus has been almost exclusively news media, particularly national news media and excludes direct user generated content (Delshad & Raymond, 2013; Kim et al., 2014; Sengers et al., 2010; Sovacool, 2014; Wright & Reid, 2011). Hearing directly from stakeholders who might be impacted more directly is critical for place-based environmental planning and policy analysis (Jenssen, 2010; Van der Horst, 2007; Shindler et al., 2004).

Region-specific analyses of stakeholder discourse have primarily been limited to the Southeast, North Central and Midwest United States (Halder et al., 2015; Radics et al., 2015; Selfa et al., 2011). There are some notable exceptions to this, however, they either lack the broader regional focus needed to assess development of biofuels in the Pacific Northwest (Singer, 2013; Stidham and Brown, 2011), or they are more limited to forest biomass feedstock sources (Moroney, 2015).

By focusing on systematic structuring of stakeholder discourse of biofuels framed as a benefit or concern in the Pacific Northwest, Chapter 3 directly bears on decision-making in relation to poplar biofuels in the region, complementing the focus for Chapter 2. This is important for developing region-specific policy recommendations where place-based environmental decision-making requires a localized context (Shindler et al., 2004). By using Q-methodology to analyze

regional stakeholders' framing of social discourse, Chapter 3 makes a unique contribution to the literature on social perceptions of biofuels.

3.3.2 *Systematic Structuring of Social discourse around Benefits and Concerns*

Q-methodology provides access to underlying belief structures that form the basis of the developing social perspectives, and presents this data in a way that is easy to access for policy analysists. As such, it is an excellent approach for understanding stakeholders' perspectives about biofuels. Q-methodology improves upon traditional survey research because it does not allow participants to consider their views on a subject in isolation (Brown 1980). Just as natural resource management scenarios require prioritization of various goals and values, Q-methodology requires participants to make decisions that simulate realistic trade-offs. Q-methodology requires participants to consider their decisions within the context of all available options so that they are able to structure their own beliefs accordingly, often revealing latent or unknown preferences that are difficult to uncover using other methods (Asah et al., 2012a; Asah et al., 2012b). As such, it documents robust attitudes relevant to the real world. Q-methodology is also unique in the policy field in that it focuses on emergent perspectives, rather than considering demographic segmentation qualities like political affiliation or industry stakeholder association as the sole source for understanding stakeholder preferences and interactions (Cuppen et al., 2010).

In-depth structuring of stakeholder discourse using Q-methodology seeks to identify predominant perspectives about biofuels, in addition to generating knowledge about which stakeholders express particular perspectives. In-depth structure is created by clearly delineating

nuanced areas of agreement or disagreement at a very fine scale of cognitive differentiation while also providing the relative magnitude of stakeholders' opinions on each of those areas.

Furthermore, the forced tradeoffs participants experience while sorting Q-statements create robust findings for how participants prioritize issues, a crucial element in guiding environmental decision-making where resources are finite. Because biofuels are still an emerging technology in natural resource development, Q-methodology is particularly suited to exploring stakeholders' views of it. Such early insights can help ensure that policymakers propose policies and programs that align with perceptions of benefits, address concerns, and demonstrate compatibility with existing localized culture and belief systems (Rogers, 2010).

3.4 Research Design

Chapter 3 required a concourse of statements that represent the dominant themes present in regional conversations about biofuels. I used a mixed methods approach to develop the concourse: a qualitative thematic analysis of online news sources and direct user-generated statements from stakeholders engaged in online news articles, blogs, and websites; and a qualitative analysis of regional focus group data from a study taking place concurrently in our laboratory. I employed purposive sampling to collect statements online, focusing on local, regional, and national news sources (Krippendorff, 2012). I located sources using *biofuel*, *bioenergy*, *biomass*, and *renewable* as search terms, gathering 981 statements. I continued sampling news sources until I reached saturation in the occurrence of themes. After cross-referencing user-generated statements with the regional focus group data, I purposefully included more local stakeholder views by selecting additional focus group statements to add to the set.

I used an inductive, iterative approach to coding that resulted in salient themes focused on discussions of concerns and benefits of biofuels (Saldana, 2012). I used these themes to construct a sample of statements for use in the Q-sort, known as a Q-sample. I defined concerns as being a perceived future harm, perhaps worded less clearly than a problem placing direct blame (Appendix A-2). Benefits are perceived positive or beneficial associations with biofuels. Main themes that emerged from the analysis overlapped with those in Chapter 2, including *Environment*, *Social Psychological*, *Economic*, *Social Justice*, *Human Health*, *Food versus Fuel*, and others (Appendix A-4). Developing the Q-sample using Fisher's experimental variance design principles allowed me to maximize within-theme variance and thereby minimize the number of statements required to represent the concourse fully (Stephenson, 1953). The final Q-sample contained 49 statements, all of which framed biofuels as either a concern or benefit (Table 6). Again, I changed the original verbatim quotes taken from the online and focus group sources as little as possible (Stephenson, 1953).

In order to develop the sample of persons (P-set) to take the Q-sort, I used a Google search of online organizations and entities as the basis for a link-trace snowball sampling approach (Handcock & Gile, 2011). I included stakeholders I deemed likely to be influential in the development of biofuels in the Pacific Northwest based on three criteria: their participation in the development of biofuels, their potential to feel the effects of the changing biofuels industry, and/or their leadership activities in organizations and institutions that affect biofuels development (Rogers, 2010). Thus, stakeholders included CEOs of industry, leaders of non-profits, lead researchers, and government agency officials. In their intake surveys, stakeholders identified themselves as members of energy associations and utility companies, labor unions, farmer or

grower associations, cattle associations, dairy farmer associations, environmental organizations, community advocacy organizations, investment companies, research institutions, and government (Appendix A-4). In short, I selected regional stakeholders to represent the widest breadth of possible attributes and perspectives on cellulosic biofuels.

I hosted the study online to facilitate a wide geographic scope, contacting stakeholders via email and utilizing a free open-source software program called Flash Q to deliver the Q-sorts to them. Participants who agreed to take the sort received three follow-up emails as reminders, or fewer if they responded to the online Q-sort promptly. To complete the process, I sent emails thanking those who completed the Q-sorts. The approximate response rate of 53% to 287 Q-sorts that did not produce an error message indicating a bad email address produced a cooperation rate of 69%, with 64 completed Q-sorts; several people offered to complete additional Q-sorts. The completion rate for this sort was quite high at 91%[2]. In keeping with recommendations for this type of approach, I ensured that the ratio of statements to people exceeded 1:3 (Stephenson, 1953; Webler et al., 2009), and that the P-set included sufficient individuals to differentiate the emerging perspectives, thus establishing confidence in the results (Brown, 1980).

I began sending initial email invitations in May 2014; the final Q-sort for this chapter was completed in July 2016. The email directed stakeholders to the study website to review the consent form and confirm their consent for participation, after which the study participants entered the Flash Q interface. For the Benefits and Concern Q-sort, I presented 49 cards in a virtual deck of

[2] These numbers include response rate, cooperation rate, and completion rate from the advocacy, industry, and tribal stakeholder groups. Response rate information for the research and government stakeholders was not recorded in an easily accessible way and was not included in these estimates. I expect the inclusion of these groups will reduce the response rate.

benefit and concern statements about biofuels. First, stakeholders sorted according to whether they agreed, disagreed, or felt neutrally toward the statement; then they arranged the statements on a grid based on a 10-point scale (-5 to +5) (Figure). The procedure directing them to start with the items with which they most agreed or disagreed remained the same as in Chapter 2, with the same objective in providing context (McKeown and Thomas, 2013). As before, forced choice distribution had participants prioritize polarizing issues and place more neutral statements in the middle; this exercise supported the analysis of consensus and conflicting views, and allowed for comparison among different participants who had the same relative neutral point. After a review by participants of the placement of the cards, they were given the opportunity to explain their reasons for sorting the cards at the extreme ends of the continuum. The same socio-demographics and opportunity to comment on the study applied to Chapter 3 as applied to Chapter 2 (Appendix A-5). As before, I used this knowledge to draw comparisons between stakeholders and interpret their perspectives.

I analyzed the 64 sorts using PQMethod, version 2.35 (Schmolck, 2014). The process began with correlating all 64 sorts with each other. Then I subjected the correlation matrix to a centroid factor extraction, resulting in eight un-rotated factors. I followed several criteria in selecting which factors to extract and rotate (Watts & Stenner, 2012; Webler et al., 2009). Accordingly, I selected three factors using Varimax rotation, because I had no reason to believe they might be correlated (Stephenson, 1953; Brown, 1980). I retained factors with three key attributes: analysis suggested they were different from other perspectives; their spread was simple, clear, and stable; and the positive inter-standpoint associations were less than 0.5 (Watts & Stenner, 2012; Webler et al., 2009).

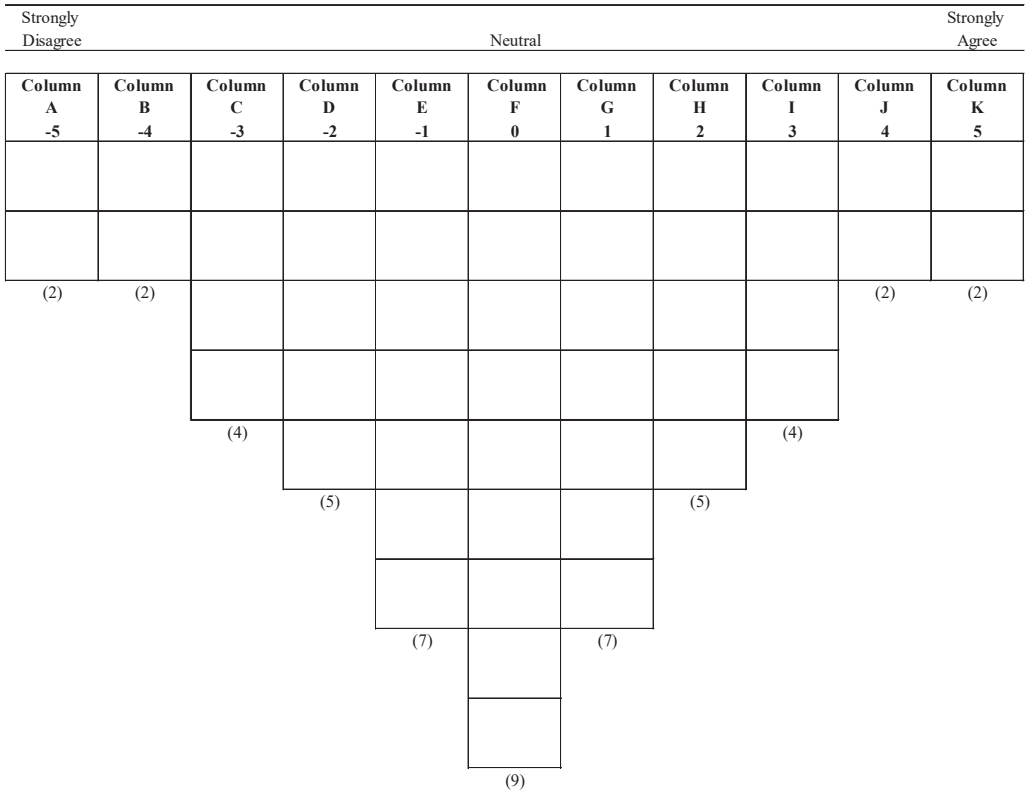

Figure 4. Ranking and structure of the 49 Q-sort statements

3.4.1 *Data Limitations*

The limitations I mentioned with respect to Chapter 2 apply to Chapter 3 as well, because of the similarity of the design: the use of digital technology, which could be difficult for some participants; the adequate, but not excellent nature of the software; and the possibility that there are other relevant stakeholder types that should have been included. However, this study went to great lengths to include the broadest diversity of potential perspectives. Care was also taken to include at least five stakeholders for each larger stakeholder subset in the analysis.

3.5 RESULTS

Three distinct perspectives emerged from the factor analysis of the 64 Q-sorts: the *Risk-Tolerant Optimistic Perspective*, the *Risk-Averse Environment-Focused Perspective*, and the *Skeptical Pragmatic Perspective*. Collectively, these three frames make up 49% of the total explained variance in conversations about general perspectives held toward biofuels (Table 6). In the following discussion, I outline each of these perspectives in detail and provide a narrative description for each one. The level of agreement or disagreement for each perspective is presented for each of the 49 statements in the sort in Table 6. The relative ranking for each statement is presented as a Z-score to provide more detailed information about the relative differences among perspectives (Asah et al., 2012a and b).

Table 6. Q-sample Statements and Z-score Ranking

Q-sample of statements addressing concerns and benefits of woody-based biofuels. Z-scores are normalized deviations from the mean for each perspective. Statements which share consensus across all three perspectives are bolded. Those with "*" are calculated by PQ-method and are statistically consensus to the 0.05 level with "*" and 0.01 with "**"

#	**Statement**	*Risk-Tolerant Optimistic Perspective*	*Risk-Averse Environment-Focused Perspective*	*Skeptical Pragmatic Perspective*
1	Wood-based biofuels will be carbon-neutral.	0.48	-2.18	0
2	It would be great to have trees instead of houses everywhere.	0.11	0.24	-0.93
3	As long as the wood-based biofuels refinery doesn't smell like a paper mill, I don't care where they put it.	**-0.04**	**-1.74**	**-0.66**
4	On the positive side, wood-based biofuels are renewable.	2.05	-0.34	2.27
5	Wood-based biofuels production will be labor intensive.	-0.4	-0.36	0.23
6	Creating a wood-based biomass supply chain for biofuels is vital to the economic development of rural areas.	1.02	-1.28	-0.04
7	We need the jobs, especially in the Pacific Northwest.	**1.03**	**0.2**	**1.14**
8	The sky's kind of the limit for wood-based biofuels; it's very exciting.	0.56	-1.62	0.06
9	You do get more energy from biofuels than you put in, so that's a benefit.	0.67	-0.76	-0.39

10	If the wood-based biofuels sites are large enough, they would provide habitat for different animals.	0.51	-1.59	0.31
11	Energy independence through the development of wood-based biofuels is critical to national security.	1.14	-1.38	-1.65
12	Feedstock for wood-based biofuels is so robust that if some of it gets out it might contaminate the environment.	-1.1	0.16	-0.59
13	Industry will not stop until all trees grown for biofuels are genetically modified, leading to an eco-catastrophe.	**-1.24**	**-0.2**	**-1.94**
14	Biofuels needs to make money.	**1.1**	**0.57**	**1.87**
15	The ecological consequences of large monoculture plantations will be bad even if it sited on marginal farm land.	-0.82	0.54	-1.31
16	Wood-based biofuels gives small forest owners more income to maintain their forest as a forest.	0.93	-0.66	1.1
17	Growing trees on the same plot and not cultivating them will stabilize the soil. *	**0.33**	**0.17**	**0.76**
18	We near the line of exploitation when forests are viewed for fuel potential rather than trees.	-0.84	1.1	-1.79
19	I don't want to see any natural forests sacrificed or converted into plantation forests.	0.14	2.07	-0.78
20	There has been little evaluation of the impact of drought on the supply of wood-based biofuels.	**0.08**	**0.4**	**0.78**
21	In reality, I don't know if wood-based biofuels are doable.	-0.72	0.83	1.24
22	It would be inappropriate to use crop land for wood-based biofuels production.	-0.53	0.8	-0.53
23	Because of their ability to slide into the existing infrastructure, wood-based biofuels have a huge cost advantage.	0.44	-0.58	-0.76
24	The development of wood-based biofuels would sustain continued research and teaching at universities.	0.76	-0.17	0.83
25	Wood-based biofuels are safe and there is no reason we cannot use more of them in our vehicles.	1.27	-0.56	0.5
26	There is an aesthetic that would be changed by bringing in poplar plantations; there would suddenly be walls instead of open space.	-0.67	0.09	-0.42
27	Wood-based biofuels will provide a tax base for local government to continue to support schools, roads and emergency services.	1.08	-0.22	0.9
28	Pollen could be an effect if hybrid poplar is grown; it might be an allergen source. *	-0.21	0.12	-0.32
29	I worry about communities completely losing control over what they want to see happening in their backyard.	-0.35	0.67	-0.35
30	I would hope that when developers communicate to the public about biofuels they are forthright and honest. **	**1.45**	**1.62**	**1.54**
31	I love the idea of a fuel that wouldn't make me feel guilty when I drive.	1.18	-0.05	-1.09
32	I am not in favor of the government subsidizing a biofuels industry that is not going to sustain financially.	-0.74	0.58	1.83
33	The hybrid poplar plantation system has been a failure and to continue it doesn't make sense.	-1	-0.22	0.17
34	I would like to be a part of something like wood-based biofuels that would be a solution.	1.42	-0.44	-0.04
35	If we replant the land with trees we are returning it to how it was a hundred years ago!	**-0.47**	**-1.86**	**-1.46**
36	I do not have faith in exploitive wood-based biofuels industries leading us to a sustainable future.	-1.23	1.4	1.34

37	If we fail to understand the ecological implications for wood-based biofuels, people and the planet will suffer.	0.76	2	-0.19
38	Everybody jumps on the bandwagon just because they can get funded, even when the research is still incomplete.	-0.47	0.66	0.87
39	I am afraid biofuels will not make any money because the company the producer might sell to may disappear or the market might crash. **	-0.12	-0.18	0.15
40	The wood-based biofuels industry is undeniably preferable to the fossil fuels industry.	1.72	-0.72	-2.11
41	We should keep the trees up in the forest and keep the farm land, farm land.	-0.73	0.59	0.24
42	Fads come fast and furious, and reactions to them can be ferocious; biofuels is just a passing fad.	**-1.65**	**-0.36**	**-0.01**
43	We are so busy trying to create wood-based biofuels, we haven't spent time to see whether we ought to.	-0.88	1.66	0.57
44	Biofuels plants might take up resources that could be devoted to exploring urban design instead of increasing car-based infrastructure.	-1.01	0.59	-0.36
45	If they are going to chop down whole fields every 2 to 3 years then it will destroy habitat that evolved for that period of time.	-0.96	0.77	0.29
46	For the folks advocating replacing gasoline, I am concerned about the conversion costs for my car to run on wood-based biofuels.	-0.97	-0.4	-0.19
47	With a wood-based bioenergy plant, you will need thousands of acres to keep it moving; you will create a monster.	-1.15	1.31	-0.49
48	Wood-based biofuels will be worse for the environment than the fossil fuels they are trying to replace.	-2.56	0.02	-0.24
49	I would like to see my children and grandkids have a more financially stable future, which wood-based biofuels would guarantee.	0.58	-1.28	-0.33

Table 7. Stakeholder Perspective Loadings

Stakeholder loadings for each of the three perspectives resulting from the Q-sorting of benefits and concerns for the development of woody-based biofuels in the Pacific Northwest. Sorts with an "X" indicate Q-sorts which are considered defining Q-sorts (Q-sorts that closely represent the perspective). While all significant values marking stakeholder agreement (+) or disagreement (-) with a perspective have been bolded.

Stakeholders	Stakeholders' level of agreement[a] with each standpoint		
	Risk-Tolerant Optimistic Perspective	Risk-Averse Environment-Focused Perspective	Skeptical Pragmatic Perspective
Community Advocate 1	**0.52**	-0.17	**0.37**
Community Advocate 2	**0.59X**	0.04	0.14
Community Advocate 3	0.23	0.33	0.26
Community Advocate 4	**-0.42**	**0.70X**	-0.04

Community Advocate 5	-0.22	**0.63X**	-0.05
Community Advocate 6	0.25	**0.53X**	0.07
Environmental Advocate 1	-0.13	**0.61X**	0.23
Environmental Advocate 2	0.10	**0.59X**	-0.08
Environmental Advocate 3	**-0.37**	**0.81X**	-0.12
Environmental Advocate 4	-0.14	**0.87X**	-0.16
Environmental Advocate 5	-0.31	0.36	**0.50X**
Government Agency Official 1	**0.39**	**0.45**	0.25
Government Agency Official 2	**0.61X**	-0.34	**0.47**
Government Agency Official 3	0.31	0.18	0.33
Government Agency Official 4	**0.79X**	0.03	0.11
Government Agency Official 5	-0.06	**0.64X**	0.35
Government Agency Official 6	0.20	**0.37X**	0.08
Government Agency Official 7	**0.43X**	0.29	0.20
Government Agency Official 8	**0.58**	0.04	**0.55**
Government Agency Official 9	**0.52**	0.06	**0.48**
Government Agency Official 10	**0.57X**	-0.19	0.28
Government Agency Official 11	**0.80X**	-0.03	0.31
Government Agency Official 12	0.11	0.21	**0.42X**
Government Agency Official 13	**0.75X**	-0.19	0.23
Government Agency Official 14	**0.80X**	-0.22	-0.02
Cattle Rancher 1	**0.57X**	-0.23	0.28
Cattle Rancher 2	**0.59**	-0.16	**0.48**
Dairy Farmer 1	**0.68X**	-0.26	0.35
Dairy Farmer 2	-0.26	**0.54X**	0.22
Dairy Farmer 3	-0.14	0.17	**0.72X**
Forester 1	**0.56X**	-0.13	**0.57**
Forester 2	**0.73X**	-0.02	0.02
Labor Union Representative 1	**0.53X**	0.01	0.30
Labor Union Representative 2	0.0461	**0.51X**	-0.13
Economic Development Professional 1	**0.39X**	0.22	0.16
Economic Development Professional 2	**0.82X**	-0.17	0.08
Economic Development Professional 3	**0.39X**	0.22	0.16
Economic Development Professional 4	**0.82X**	-0.17	0.08
Economic Development Professional 5	0.36	0.23	0.33
Grower 1	0.35	-0.14	**0.39X**
Grower 2	0.15	0.32	0.21
Grower 3	0.22	0.05	**0.56X**
Grower 4	**0.58**	-0.08	**0.50**

Energy/Association Representative 1	**0.64X**	0.16	0.07
Energy/Association Representative 2	**0.43X**	-0.00	0.26
Energy/Association Representative 3	**0.72X**	-0.12	0.27
Producer/Association Representative 1	**0.72X**	-0.23	0.11
Producer/Association Representative 2	-0.03	0.35	-0.02
Producer/Association Representative 3	**0.47**	-0.06	**0.53**
Producer/Association Representative 4	-0.29	**0.57X**	0.21
Producer/Association Representative 5	**0.76X**	0.02	-0.02
Producer/Association Representative 6	**0.84X**	-0.12	0.19
Producer/Association Representative 7	**0.78X**	-0.10	0.25
Other	**0.45**	0.18	**0.58**
Researcher 1	**0.49**	-0.10	**0.44**
Researcher 2	**0.68X**	0.25	0.01
Researcher 3	**0.73X**	0.12	0.17
Researcher 4	**0.74X**	-0.02	**0.47**
Researcher 5	0.25	0.25	0.28
Researcher 6	**0.83X**	0.06	0.05
Researcher 7	**0.52X**	0.21	0.14
Researcher 8	**0.41X**	0.27	0.25
Researcher 9	**0.67X**	-0.27	0.35
Researcher 10	**0.63X**	0.13	**0.40**
Researcher 11	**0.66X**	0.15	0.04
Researcher 12	**0.73X**	-0.24	0.07
Total # of stakeholders in agreement:	**43**	**13**	**17**
Total # of stakeholders in disagreement:	**2**	**0**	**0**
% Explained Variance	**28**	**11**	**10**

[a] Loading on a standpoint requires $P < 0.01$ probability. Significant loading = $(2.58)*1/\sqrt{N}$ where N = # of statements. Loading scores = ± 0.37 are significant.

3.5.1 *Perspective 1: Risk-Tolerant Optimistic - "Taking Biofuels Seriously"*

According to the *Risk-Tolerant Optimistic Perspective*, stakeholders are most focused on the fact that wood-based biofuels are renewable (#4) and they represent a better alternative to the fossil fuels industry (#40, #48). One stakeholder described it as being "*infinitely better than fossil base*

carbon release." They view the environmental impacts to be negligible, or at least an acceptable tradeoff (#45, #12, #13, #36). One stakeholder emphasized this further by suggesting *"We need to get closer to the sun with each technology that we pursue for energy and chemical use and move away from pumping oil no matter what the environmental cost is*." Stakeholders holding this view are also not at all concerned with development of biofuels perpetuating the GMO industry. They either view it as not necessary for the development of biofuels, or not harmful if used correctly. One stakeholder put it simply, "*GMO is not necessary for biofuels and the fuels being researched are not going to create an eco-tastrophe. The eco-tastrophe is the status quo fossil fuel system."*

This perspective also focuses on benefits of biofuels in terms of national and local economic benefits (#6, #14, #27), and energy independence (#11). Biofuels, in short, "*needs to make money*" but should not be thought of as an "*instant cure-all*" as it will take time for the infrastructure to develop. Energy independence is also part of this perspective and is directly related to jobs and national security. In this perspective stakeholders view biofuels as part of the solution and they are interested in being part of it (#34). They don't view the poplar-based biofuels of the past as a failure (#33). They view biofuels as safe for use in vehicles (#25) and they are interested in finding ways to deal with their own guilt at using energy resources (#31). They don't think of the industry perspective as exploitative (#36) or as an unstoppable force (#47); however, they do want to be included in conversations by developers and industry (#30). Stakeholders with this perspective don't see biofuels as a passing fad (#42) and appear ready to accept it without too much undue concern. Multiple stakeholders defining this perspective mentioned that '*it's time to start taking biofuels seriously*.'

Although no perspective in this analysis presented itself as highly contentious, the *Risk-Tolerant Optimistic Perspective* is the most contentious of the three. It is the only perspective with significantly negative stakeholder loadings. Both disagreeing stakeholders are self-identified as either community or environmental advocates. On the other hand, the majority of stakeholders who identified as researchers (92%) significantly agreed with this perspective. To a lesser degree, government and industry stakeholders also significantly agreed with this perspective (Table 7).

3.5.2 *Perspective 2: Risk-Averse Environment-Focused –"The Veritable Monster"*

Stakeholders holding the Risk-Averse Environment-Focused Perspective are most concerned with the environmental risks of developing wood-based biofuels (#19, #37). One defining stakeholder described this by saying. "*We need more diverse native ecosystems with infrequent disturbance, not more monocultures with frequent disturbance*." And another defining stakeholder put succinctly, "*They are simply, monotonously ugly. They provide zero habitat for wildlife*." This also hints at an aesthetic concern for planting poplar trees, though this did not come through as a strong priority compared with other concerns. Stakeholders with the *Risk-Averse* perspective are also concerned about industry keeping in communication with the public and have little faith in industry not to exploit the environment (#30, #36). One of the reasons for this lack of faith may be due to the inherent complexity in the production of these types of fuels and the subsequent concerns about local impacts. As a defining sort stakeholder put it, "*Biofuels production from vastly different eco-regions means that the impacts will differ greatly and those impacts must be viewed in context with community values*." Along these lines, in addition to concerns about managing complexity and difficulties with communication, due to the volume of

feedstock required, there is also some sense that industry may create a "*veritable monster that cannot be stopped*" (#47). There is also a specific theme emerging around concern about "forests" being viewed as a resource and/or poplar tree farms as being a substitute for "natural" forest ecosystems (#19, #18, #35). This perspective is more Risk-Averse in general, and expresses a clear concern that not enough thought has been put into whether biofuels are the best alternative energy option to develop (#43).

In this perspective, biofuels are not seen as a solution or as an exciting venture (#8), nor are they viewed as providing economic benefits (#49, #6). In this perspective, national security is also not perceived as a benefit. Further, one of the most strongly disagreed-upon statements (#1) suggests that people with this perspective do not consider biofuels to be carbon neutral.

Stakeholder comments about infrastructure (#1) reveal that there are different reasons underlying the sentiment even though there is agreement it is a problem. Stakeholders suggest that carbon neutrality is the challenge, that the reliance on fossil fuels in the production process is the difficulty, or that the interconnectedness and broader reliance on fossil fuels in consumers' everyday lives poses the greatest problem. A defining Q-sort stakeholder suggests:

> *"This is functionally impossible with current infrastructure. Some amount of petroleum, or petroleum derived electricity, or other products will need to be used in production, even if you only count the fuel used to grow the grain to feed the cow that the production line worker eats."*

In another case, stakeholders may view biofuels as not being carbon neutral because of its association with biomass. As one defining stakeholder expressed it, "*The burning of biomass is not carbon neutral! It creates large amounts of CO2 and air pollutants that can lead to increased*

levels of smog and ozone." Or as the strongly agreed with statement #43 suggests, "*We are so busy trying to create wood-based biofuels, we haven't spent time to see whether we ought to."*

The majority of advocacy stakeholders load onto the *Risk-Averse Environment-Focused Perspective* (Table 7). This is true for both the community advocacy and the environmental advocacy stakeholder groups. There is more consistency within the environmental advocacy stakeholders, however, with all of them loading positively on the *Risk-Averse Environment-Focused Perspective* and only one strongly loading onto the *Risk-Tolerant Optimistic Perspective*. Though most of the government stakeholders loaded significantly onto the *Risk-Tolerant Optimistic Perspective*, several loaded significantly on the *Risk-Averse Environment-Focused Perspective*. Industry stakeholders presented themselves similarly to the government with a minority of them loading onto the *Risk-Averse Environment-Focused Perspective*.

3.5.3 *Perspective 3: Skeptical Pragmatic – 'I don't care how fuel makes me feel'*

The *Skeptical Pragmatic Perspective* is similar to the *Risk-Tolerant Optimistic Perspective*, in that this perspective focuses on the benefits of biofuels as being renewable (#4); however, it places a higher emphasis on the desire for it to make money (#14). Additionally, the stakeholders who loaded onto the *Skeptical Pragmatic Perspective* are far less interested in government aid or subsidies of any kind (#32). Stakeholders in this perspective are more concerned about industry being trustworthy (#30), and have concerns about it exploiting communities *and* the environment (#36). In fact, they are skeptical about the feasibility of biofuels in general (#21), and do not see it as preferable to the fossil fuels industry. As one defining sort stakeholder

suggested, "*There are good arguments for continued multiple uses of many types of fossil fuel. Unless wood based bio-fuel can compete on all levels it is not preferable."*

Stakeholders with this perspective do desire to see economic benefits resulting from developments in this industry (#7, #16). Stakeholders with this perspective are not as concerned with potential environmental impacts (#35, #18, #13); their comments suggest that it is not that they don't hold environmental values, but more than they do not believe biofuels will have negative impacts. One defining Q-sort stakeholder described, *"It's called tree farming. It has been done for centuries without harm to the environment."* In thinking about environmental impacts in their own lives, these stakeholders did not think of biofuels as a way to ease guilt about driving (#32). For instance, one stakeholder stated, *"I don't care about how biofuels make me feel."* This is in direct contrast to the *Risk-Averse Environment-Focused Perspective*, and highlights the pragmatic nature of the Skeptical Pragmatic Perspective. Moreover, this perspective also contrasts with the *Risk-Averse Environment-Focused Perspective* in viewing trees as natural resources (#35, #18). One stakeholder captured this well by saying, *"...most people I know, even those that express overwhelming enthusiasm for trees, are accustomed to living in houses*."

This perspective, though it captures the least overall percentage of stakeholder views, helps provide more insight into the complexity of different viewpoints. In the Discussion section of this paper, I elaborate in greater detail the multiple cross-loadings frequently occurring with the *Skeptical Pragmatic Perspective*. *Skeptical Pragmatic Perspective* also captures slightly more of the industry viewpoint than *Risk-Averse Environment-Focused Perspective*. Therefore, a finer scale examination of differences between industry stakeholder subgroups may be meaningful in explaining preferences priority concerns or benefits.

3.5.4 *Comparison Between Perspectives*

There are several approaches for systematically comparing across perspectives. These include a comparison of computed consensus, moderate consensus, non-consensual non-controversial and contentious areas. These areas involve comparisons between individual statements and their positive and negative associations with each perspective. Additionally, inter-perspective comparison is beneficial for examining comparisons more broadly across the entire perspective. Computed consensus statements indicate no significant difference between any of the views. In practice, these are the areas of shared agreement that might be used to help build from. Though much can be learned from statistically significant areas of agreement and disagreement, there are still levels of agreement and disagreement that might occur in even if not statistically determined. These areas represent potential points of compromise across perspectives and are determined through a visual inspection of positive and negative statement perspective loadings. I refer to these as moderate agreement or disagreement areas. Non-consensual non-controversial areas occur when not all statements are associated with a perspective with the same positive or negative valence. However, the points of disagreement are neutral and thus also represent potential places for compromise. I define contentious areas as instances where statements are associated with another perspective nearly one standard deviation from the mean in opposition to another perspective.

3.5.4.1 Computed Consensus Areas

Q-consensus statements indicate no significant difference between any of the views. Of the three perspectives, there were only two areas that were identified as Q-consensus statements (Table

6). All three perspectives shared the theme of trust and communication with developers being very important (#30). This statement was non-significant at the 0.01 alpha level. This was ranked as a high priority, with all three perspectives indicating a strong preference and each sort having a nearly 1.50 loading. The second area of agreement was statement #17, which stated that growing trees on the same plot and not cultivating them will stabilize the soil. There was neutral to medium priority toward this item (0.33, 0.17, and 0.76) with non-significance at the 0.05 alpha level.

3.5.4.2 Consensus Areas of Moderate Agreement & Disagreement

Though much can be learned from statistically significant areas of agreement and disagreement, there are still levels of agreement and disagreement that might occur in practice even without findings of statistically significant differences. These areas represent opportunities for compromise across the perspectives. There are several thematic areas where all three perspectives somewhat agree, including the need for jobs in the Pacific Northwest (#7). There was also mild agreement around the impacts of drought on the potential future supply of wood-based biofuels (#20), as well as some agreement around improving soil stability by planting trees in one area and not harvesting them (#17). Although these areas represent differences in ranking priority, they do represent important common ground for starting to build future agreements.

Areas where perspectives somewhat disagree include: the location of the refinery, due to concerns over smell (#3); implications for replanting of the land (#35); and whether biofuels are a passing fad (#42). Additionally, there is somewhat shared disagreement around the idea that genetically modified biofuels will lead to an eco-catastrophe (#13).

Finally, there was a neutral consensus around the notion that biofuels need to make money (#14). When faced with all the options for priorities around biofuels, none of the perspectives felt

particularly strongly about financial profitability, though this theme came out as a very important conscious priority in our research lab's focus groups. This highlights the strength of Q-method to force participants to consider many potential tradeoffs at once, thereby teasing out a more realistic sense of their values and priorities.

3.5.4.3 Non-Consensual Non-Confrontational Areas

Results indicate several unique areas of strongly held perspectives where only one perspective cares strongly and the others are more neutral. These represent further options for future compromise, as well as which benefits to highlight in communications targeting these stakeholders. While there are still clear preferences expressed by the other perspectives, indicating a certain caution may be appropriate in interpreting these results, these points of neutrality form a sound basis for policymakers to begin the process of compromise and accommodation.

Stakeholders associated with the *Risk-Tolerant Optimistic Perspective* feel strongly that biofuels are safe and ready to use with existing vehicles and infrastructure (#28, #23). Stakeholders with this perspective also feel that although feedstocks are robust, there is no concern about these crops being harmful to the environment (#12, #36, #45, #48). They also feel very strongly that investment in these fuels will not compromise the development of green infrastructure (#44). Successful communication with this perspective emphasize that biofuels are part of the solution (#34), and that past efforts with hybrid poplar have not failed and are still worth pursuing (#33).

The Risk-Averse Environment-Focused Perspective felt particularly strongly about limits to biofuels development being important (#8). They noted that caution should be used in researching future risks (#37) and developing design plans (#3). Stakeholders with this perspective also care very strongly about of the accuracy of biofuels' perceived environmental benefits,

expressing concerns that biofuels will neither provide wildlife habitat nor succeed in becoming carbon neutral. Risk-Averse Environment-Focused Perspective participants also feel strongly that biofuels are not necessarily sustainable for future generations. Although these areas are prioritized as benefits for the other perspectives they are not viewed as strongly beneficial, as this perspective views it as negative, thus care should be taken in emphasizing these benefits to stakeholders unless there is clarity around which perspective they hold. This may prove difficult, considering the high degree of crossover between different perspectives. Thus, given the concurrent skepticism and magnitude of preference inherent to the *Risk-Averse Environment-Focused Perspective*, as well as the general neutrality of other perspectives, it may be better for communication strategies to downplay these possible environmental benefits altogether.

The *Skeptical Pragmatic Perspective* only cared strongly about one area that was considered more neutrally by the other two perspectives. Participants who sorted for the *Skeptical Pragmatic Perspective* agreed strongly that large mono-culture crops like hybrid poplar plantations are not necessarily that bad (#15).

Just as these results identify places for using one particular perspective to focus policymaking and communication strategies, they clarify areas where two of the perspectives felt strongly about the same thing, and the third felt neutrally. With one exception, these are similarities between the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective*. These shared perspectives include: the benefit of biofuels in providing a tax base for schools and other community services (#27), the perspective that biofuels help small forest owners (#16), and the fact that biofuels are a renewable energy source. Emphasizing these benefits in communications

and in prioritizing policies will help make biofuels more socially acceptable for these two perspectives, without excessively alienating the *Risk-Averse Environment-Focused Perspective*.

The one point of strong agreement between the *Risk-Tolerant Optimistic Perspective* and *Risk-Averse Environment-Focused Perspective* is the perceived importance of spending the time to thoroughly research and understand the risks of developing biofuels. Because this is a high-priority area of concern for both perspectives, it is a crucial point to address in program development, communications, and policymaking.

3.5.4.4 Main Areas of Contentious Disagreement

There were five main areas of contentious disagreement. These are found by going through each statement systematically and considering the variance across all three perspectives. Overlapping areas of agreement and disagreement between these perspectives are quite complex. In several cases, the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective* share agreement on a perception that diametrically opposes that of the *Risk-Averse Environment-Focused Perspective*. However, there are other areas where the *Risk-Averse Environment-Focused Perspective* and the *Skeptical Pragmatic Perspective* are in alignment, yet both oppose the *Risk-Tolerant Optimistic Perspective*. The *Risk-Tolerant Optimistic Perspective* and the *Risk-Averse Environment-Focused Perspective* are generally opposed to one another, agreeing largely on non-controversial perspectives such as the need for more research into future risks (#37). There is strong contention among at least two of the three perspectives on the importance of biofuels for national security, the viability of biofuels as an alternative to fossil fuels, the long-term sustainability of biofuels, the environmental impacts of biofuels, the human impacts of biofuels, and governmental support of biofuels development.

The first area of disagreement is on the importance of domestic biofuels production in support of national security (#11). The *Risk-Tolerant Optimistic Perspective* views bioenergy as a source for domestic fuel products that could be beneficial for national security while the *Risk-Averse Environment-Focused Perspective* and the *Skeptical Pragmatic Perspective* strongly disagree with this position. This may be related to two other places where both *the Risk-Averse Environment-Focused Perspective* and the *Skeptical Pragmatic Perspective* disagree with *Risk-Tolerant Optimistic Perspective*, including the viability of fossil fuels and doubt about the long-term future of biofuels (#36, #21, #40 and #49). Areas of disagreement around environmental impacts are another source of contention across these perspectives (#18, #19, #37).

The *Risk-Tolerant Optimistic Perspective* and *Skeptical Pragmatic Perspective* share only one point in opposition to the *Risk-Averse Environment-Focused Perspective*, and that is the matter of exploiting forests for fuel. Stakeholders associated with the *Risk-Averse Environment-Focused Perspective* perceive biofuels as being potentially exploitative of forests for fuel, while stakeholders holding the other two perspectives don't. Moreover, the *Skeptical Pragmatic Perspective* isn't as concerned as the *Risk-Averse Environment-Focused Perspective* about sacrificing wild forest lands, while the *Risk-Averse Environment-Focused Perspective* focuses very strongly on the point that this is an unacceptable sacrifice. Similarly, stakeholders holding the *Risk-Averse Environment-Focused Perspective* view biofuels as having the potential to spin out of control (#47), becoming a *"veritable monster*", while those holding the *Risk-Tolerant Optimistic Perspective* feel just the opposite.

There is also disagreement about the economic development of biofuels: perhaps predictably, stakeholders who loaded onto the *Risk-Tolerant Optimistic Perspective* feel that the

development of biofuels will be economically beneficial, while stakeholders who load onto the *Risk-Averse Environment-Focused Perspective* feel strongly it would be negative.

Another disagreement around human impacts relates to emotions and guilt. *The Risk-Tolerant Optimistic Perspective* feel that biofuels will help ease guilt around driving, and *stakeholders who load onto the Risk-Averse Environment-Focused Perspective* feel neutral on the topic, while the *Skeptical Pragmatic Perspective* strongly disagrees with this idea. Government subsidies are another contentious area between the *Risk-Tolerant Optimistic Perspective* and the *Risk-Averse Environment-Focused Perspective*. The *Risk-Tolerant Optimistic Perspective* supports government subsidies while the *Skeptical Pragmatic Perspective* suggests it should be able to stand up on its own.

3.5.4.5 Inter-perspective Comparisons

The inter-perspective correlations are presented in **Error! Reference source not found.**, indicating the level of conflicting (-1) or consensus (+1) perspectives that exist for the biofuels Q-sample. Areas with strong positive correlations between perspectives suggest agreement on predominant issues, though distinct priorities still exist. Areas with strong negative correlations indicate that perspectives are polarized.

Table 8. Table with Inter-perspective Correlations
Inter-perspective correlations resulting from the Q-sort of benefits and concerns for the development of biofuels in the Pacific Northwest.

Perspective	Risk-Tolerant Optimistic	Risk-Averse Environment-Focused	Skeptical Pragmatic
Perspective 1: Risk-Tolerant Optimistic	1.00		
Perspective 2: Environment-Focused	-0.29	1.00	
Perspective 3: Skeptical Pragmatic	0.19	0.21	1.00

The *Risk-Averse Environment-Focused Perspective* displays a negative correlation with the *Risk-Tolerant Optimistic Perspective*, but since that correlation is not very high, the polarization of viewpoints does not indicate the kind of intractable conflict seen in more "wicked" environmental issues (Balint et al., 2011, Rittel & Webber, 1973). This low correlation may indicate that biofuels are still not viewed as an environmental "issue" in the Pacific Northwest, whereas they might be in other regions.

The moderate polarization between the *Risk-Tolerant Optimistic Perspective* and the *Risk-Averse Environment-Focused Perspective* is not overly surprising, given the nature of their sentiments. However, what *is* interesting is that the *Skeptical Pragmatic Perspective* is positively correlated with both the *Risk-Tolerant Optimistic Perspective* and stakeholders who loaded onto the *Risk-Averse Environment-Focused Perspective*. On the surface, this perspective appears to represent a kind of ideological middle ground; upon deeper inspection, however, the *Skeptical Pragmatic Perspective* reveals itself to be unique, articulating similar or dissimilar conclusions that rely on distinctly different rationales.

3.5.5 *Intra-perspective Stakeholder Comparison*

There is a tremendous amount of variability within stakeholder groups regarding which perspective Q-sort participants load onto. A number of stakeholder groups hold multiple concurrent perspectives about biofuels, some of which are in opposition with each other. The strength of Q-methodology is its ability to provide insights about the flexibility of stakeholders' perspectives and to point out inconsistencies in their values and beliefs. This suggests that in most cases, research needs to target perspectives themselves, rather than presumed demographic types.

Overall, 15 of the 58 stakeholders with significantly loaded sorts (or about 26%) hold multiple frames (Table 9). This crossover exists across all four broad sectors of stakeholder type (Research, Government, Advocacy and Industry).

Table 9. Number of Stakeholders Associated with Each Perspective
Totals reflect cross-loading. The numbers in parenthesis in column one are the total number of stakeholders in that group; the negative numbers in parentheses throughout the rest of the table indicate the number of stakeholders who significantly disagree with that frame; the cut-off point for stakeholders' significant association with each frame was 0.37.

	Risk-Tolerant Optimistic Perspective	*Risk-Tolerant Optimistic Perspective* & *Skeptical Pragmatic Perspective*	*Risk-Averse Environment-Focused Perspective*	*Risk-Tolerant Optimistic Perspective* & *Risk-Averse Environment-Focused Perspective**	*Skeptical Pragmatic Perspective*
Advocacy	**2 (-2)**	**1**	**7**	**2**	**2**
Environmental	(-1)		4	1	1
Community	2(-1)	1	3	1	1
Government	**10**	**3**	**3**	**1**	**4**
Industry	**20**	**5**	**3**		**8**
Related Industry	6	3	1		3
Economic / Labor	5		1		
Growers	1	1			3
Energy & Producers	8	1	1		3
Researcher	**11**	**3**			**3**
Main Category Total	**43(-2)**	**12**	**13**	**3**	**17**

*Polar perspective

The *Research* stakeholder group loaded almost exclusively onto the *Risk-Tolerant Optimistic Perspective*, with the exception of three additional cross-loading sorts that shared the

Risk-Tolerant Optimistic Perspective and the *Skeptical Pragmatic Perspective* (Table 9). The cross-loading sorts between the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective* suggest that these stakeholders hold multiple perspectives about biofuels.

Government agency officials were predominantly associated with the *Risk-Tolerant Optimistic Perspective*, but as with the *Research* stakeholder group, they also had some cross-loading between the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective*. While the seven government agency officials loaded onto the *Risk-Tolerant Optimistic Perspective*, two agency officials loaded onto the *Risk-Averse Environment-Focused Perspective*. In addition, one government agency stakeholder held a pure the Skeptical Pragmatic Perspective loading. This suggests a degree of flexibility among agency officials in their views toward biofuels.

Advocacy stakeholders were mostly associated with the *Risk-Averse Environment-Focused Perspective*, but there were several cross-loading with the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective*. Additionally, at least one *Advocacy* stakeholder was associated purely with the *Risk-Tolerant Optimistic Perspective*, and another purely with the *Skeptical Pragmatic Perspective*. Stakeholders focused on community advocacy and those focused on environmental advocacy may have meaningful differences in how they frame and conceptualize benefits and concerns regarding biofuels. For instance, an analysis of cross-loadings reveals that community advocacy stakeholders appear more closely aligned with the *Risk-Tolerant Optimistic Perspective* than the environmental advocacy stakeholders.

Furthermore, there may be a rural/urban divide among the community advocacy stakeholders. Of the purely loaded stakeholders associated with the *Risk-Averse Environment-*

Focused Perspective, all three of them are associated with urban community advocacy organizations. Additionally, a stakeholder associated with urban community advocacy loaded significantly negatively onto the *Risk-Tolerant Optimistic Perspective*, whereas rural community advocacy organization stakeholders were all positively associated with the *Risk-Tolerant Optimistic Perspective*. One of the environmental advocacy stakeholders was also significantly negatively associated with the *Risk-Tolerant Optimistic Perspective*, further highlighting the potential division in rural community advocacy organizations and environmental advocacy organizations.

For the industry stakeholders, meaningful divisions seemed to occur between related industry, economic and labor stakeholders, growers, and energy and producer stakeholder groups. With the exception of one sort, the energy and producer stakeholders all loaded onto the *Risk-Tolerant Optimistic Perspective*. Further, the one cross-loaded energy and producer association sort was shared between the *Risk-Tolerant Optimistic Perspective* and the *Skeptical Pragmatic Perspective*. This is an indicator that for the most part, producers and energy associations hold the *Risk-Tolerant Optimistic Perspective* more rigidly. The exceptions are intriguing because the other two perspectives are more risk averse and more skeptical, respectively. However, these cross-loading sorts may be a reflection of doubt by the *Industry* stakeholders themselves as to the projected benefits and concerns surrounding the development of new biofuels.

Although I only had three stakeholders from farmer and grower associations to draw from for this sort, they stand out in comparison with the rest of the *Industry* stakeholders. All three farmer and grower stakeholders loaded onto the *Skeptical Pragmatic Perspective*, though one of these also cross-loaded with the *Risk-Tolerant Optimistic Perspective*. This appears to be unique

across all *Industry* stakeholders, especially given the perspective loadings. The only other *Industry* stakeholder that loaded onto the *Skeptical Pragmatic Perspective* was one of the related industry stakeholders.

The related industry stakeholder group was a mixture of dairy farmers, folks in forestry and natural resource management, and cattle ranchers. The goal with this group was to invite other related industry members to get a sense for where benefits and concerns may lie with them. These stakeholders are associated with a diverse spread of perspectives. Three of the stakeholders loaded onto the *Risk-Tolerant Optimistic Perspective*, one loaded onto the *Risk-Averse Environment-Focused Perspective*), and one loading is associated with the *Skeptical Pragmatic Perspective*. When including cross-loadings, three forestry stakeholders are loaded onto the *Risk-Tolerant Optimistic Perspective*; of these three, two are also cross-loaded with the *Skeptical Pragmatic Perspective*. The cross-loading for the cattle rancher associations also indicates a possible preference for the *Risk-Tolerant Optimistic Perspective*, with one stakeholder cross-loaded with the *Skeptical Pragmatic Perspective*. So, in general, across all the related industry they are associated mostly with the *Risk-Tolerant Optimistic Perspective* or the *Skeptical Pragmatic Perspective*.

3.6 DISCUSSION

This research systematically structures stakeholder perspectives in order to examine the emerging biofuels discourse in the Pacific Northwest. I have summarized each perspective and analyzed the differences between perspectives, including areas of stakeholder agreement and disagreement, points of consensus, and nuances of emerging inter-perspective and intra-

perspective flexibility. Just as in Chapter 2, these results suggest that biofuels are not a strongly contentious issue in the Pacific Northwest. Thus, this advance knowledge of stakeholder perspectives offers policymakers the opportunity to anticipate and constructively engage potentially polarizing disagreements before they become intractable "wicked problems." By improving the social acceptability of biofuels policies and programs, policymakers and stakeholders alike can focus on reframing issues in terms of common ground and addressing one another's diverse concerns.

Conducting this research in advance of overt conflict offers unique opportunities for finding areas of agreement shared between divergent perspectives. Of the 49 themes accounted for by the Q-sort statements, nine provided common ground that all three perspectives agreed upon, and only five contained significant disagreement. Because biofuels technologies are still emerging in the region, Q-methodology provides the opportunity for exploring the development of social viewpoints in advance of this new industry, helping to address future concerns and also highlight salient benefits.

In the first step of diffusion and adoption of innovative technological developments such as bioenergy, highlighting benefits and addressing areas of concern are key to helping ensure adoption, because they reveal public perceptions of the relative advantage of the new technology compared with other alternatives (Rogers, 2010). In the following section, I discuss each perspective that emerged from the analysis within the context of the relative advantages outlined by participants. I will present this from within each perspective (intra-perspective), as well as across perspectives (inter-perspective). Further areas of consensus and compromise represent prioritizations of relative benefit that can clarify important needs and values, improving the

likelihood of social acceptance for policy creation, persuasion, and targeted communication efforts around biofuels issues.

3.6.1 *Perceived Areas of Benefit to Avoid and Emphasize*

No area was statistically considered a consensus area of benefit across all three perspectives. Nonetheless, all three perspectives somewhat align around one perceived potential benefit: for the biofuels industry to provide much-needed jobs in the Pacific Northwest (7#). This was ranked strongly by both the *Skeptical Pragmatic Perspective* as well as the *Risk-Tolerant Optimistic Perspective*. While the *Risk-Averse Environment-Focused Perspective* ranked it more neutrally, but all three perspectives were either neutral or in agreement on this point. This represents an important benefit to emphasize in the development of policies around biofuels for the region, as well as in communications about programs during implementation.

Three other benefits should be highlighted in communications campaigns and discussions of proposed programs: renewable energy, strengthening the local tax base, and being part of a solution. Focusing on the fact that biofuels are a more renewable energy source (#4) is important. *The Risk-Tolerant Optimistic Perspective* and *Skeptical Pragmatic Perspective* both support this statement very strongly (Z-scores above 2), while stakeholders who loaded onto the *Risk-Averse Environment-Focused Perspective* oppose it but rank its importance more neutrally. Another benefit to highlight is the potential for the biofuels industry to strengthen the local tax base, thus creating revenue to support schools, roads, and emergency services (#27). The *Risk-Tolerant Optimistic Perspective* and *Skeptical Pragmatic Perspective* support this idea, while the *Risk-Averse Environment-Focused Perspective* only mildly opposes it, ranking its importance more

neutrally. Finally, the message that biofuels could be part of the solution (#34) may be more broadly embraced, or at least not strongly opposed, by all viewpoints. It should be highlighted with caution, however. While the *Risk-Averse Environment-Focused Perspective* ranked this statement more neutrally, it still had a Z-score of -0.44 for this group, meaning that strongly emphasizing it to holders of the other two viewpoints could alienate the *Risk-Averse Environment-Focused Perspective*. This is an area where follow-up interviews may help provide more clarity and direction.

As important as it is to know which benefit to highlight, it can also be helpful to know which benefits to avoid emphasizing. The other ten benefits in the concourse should be avoided in general communications, and care should be taken to develop policy decisions with specific perspectives in mind. For example, even though a benefit mentioned previously about creating a stronger tax base to support schools and emergency services was somewhat agreeable across perspectives, creating a biomass supply chain for wood-based biofuels to *revitalize economic development in rural areas* (#6) produced a more polarized response. Although Perspective 1 (*Risk-Tolerant Optimistic Perspective*) was supportive, Perspective 2 (*Risk-Averse Environment-Focused Perspective*) was diametrically opposed to it, and Perspective 3 (*Skeptical Pragmatic Perspective*) was neutral. This difference might be due to several reasons. For instance, "*biomass*" may be a trigger word with urban environmental and community advocacy stakeholders. Alternatively, the negative response may be because the benefit seems to be centralized around rural communities. Stakeholder comments do not provide clear clues to this beyond an apparent reaction to the word "vital," suggesting it is not "vital" and rural communities will find other uses

for the land to support themselves. Future research should investigate this polarized difference further, as it is an important point of clarity for developing this industry in the region.

Another benefit area to avoid emphasizing would be the rhetoric around energy independence and national security (#11). This is interesting because it tends to be one of the major themes present in news-mediated discourse around this topic (Wright & Reid, 2011). That said, it appears to be a very polarizing theme. Both Perspective 2 (*Risk-Averse Environment-Focused Perspective*) and 3 (*Skeptical Pragmatic Perspective*) show strong negative association with statement #11, while the *Risk-Tolerant Optimistic Perspective* is strongly in favor of this as a benefit (Table 6). The following quotes below provide an example of the diversity of views on this theme. The first two quotes are taken from within the same perspective, highlighting intra-perspective differences.

> *"Historically the US has purchased oil from some atrocious governments. Freeing ourselves from their fossil fuel handcuffs will have ripple effects from economic development to human rights. Even if we pay more for biofuels per gallon we'll save billions collectively in dealing with climate [refugees], unstable governments and military interventions."*
>
> *- Researcher, Risk-Tolerant Optimistic Perspective*

> *"The ability for a nation to produce its own energy and be more self sustainable is critical to national security. The less [dependent] we are on resources in other nations, the less ability others have to influence or direct how we as a nation choose to operate and move forward into the future."*
>
> *- Government Agency Official, Risk-Tolerant Optimistic Perspective*

> *"There are much more pressing issues to national security than this. This statement, to me, is [ridiculous]."*
>
> *– Related Industry, Skeptical Pragmatic Perspective*

Finally, despite the potential benefit of presenting renewable energy (#4) as an overarching benefit prioritized by all three perspectives, carbon neutrality (#1) should not be stressed. In the Q-sort results, this proved to be a very controversial topic, with the *Risk-Averse Environment-Focused Perspective* strongly opposing it (Z-score of -2.18, sig.).

3.6.2 *Perceived Areas of Concern to Address*

All three perspectives shared one major concern, which was the desire for trust and communication with developers (#30). The consensus between perspectives and the relatively high ranking (Z-score of 1.5, sig. and higher) indicate that this area should probably be prioritized by decision-makers. In any environmental initiative, communication with developers helps increase public support (Burdge, 2004; Structured Decision-making Book). Moreover, studies suggest that just inviting input into the process improves its social acceptability (Wondolleck & Yaffee, 2000). Thus, just as prior research seems to indicate, communication and trust prove to be a shared salient theme that stakeholders consciously prioritize above a plethora of other concerns. This suggests a strong need for focusing on this process element of production, both before and during development of biofuels in the region. Practically speaking, it underscores the need for a talented extension and strategic communications team.

Other concerns that were common in all of the perspectives include the smell of the refinery and the importance of location (#3), as well as concerns over the amount of area harvested and how it might transform the landscape in the future (#35). Policymakers should address these concerns proactively in planning, and communicate thoughtfully about them during project implementation. Given the history of NIMBY controversy associated with renewable wind energy

(D'Saouza & Yiridoe, 2014, 2007), this is an important area to address for biofuel energy development to be constructive for all parties, especially the local community contingent.

Finally, all three perspectives expressed varying degrees of concern that biofuels efforts make money (#14). This is particularly important in light of the specific history of regional extension agents in the Pacific Northwest visiting farmers and convincing them to grow poplar trees for the burgeoning pulp and paper industry. This left a number of growers with negative experiences, increasing local skepticism regarding future. Another common theme that emerged with multiple stakeholders defining each perspective, across all three perspectives, was the issue of economic viability. Sustainability as a theme is referenced within the context of economic viability repeatedly. This provides insight into broader interpretations of sustainability that policymakers should consider in communicating about biofuels for all three perspectives.

In addition to providing understanding into concerns agreed upon across all perspectives, Q-methodology provides insightful direction on which areas of concern are important to address for specific perspectives. For example, the *Risk-Averse Environment-Focused Perspective* specifically ranked the majority of strongly held concerns as priorities, while the *Skeptical Pragmatic Perspective* prioritized the last two main concerns. Based on its inter-standpoint negative ranking, the *Risk-Averse Environment-Focused Perspective* demonstrates a tendency to be the perspective most deeply concerned with the development of biofuels. Specifically, their highest-priority areas of concern regard treating forests as fuel (#18) and utilizing more wildland "natural" forests for plantations (#19). These concerns deal more specifically with the theme of using wild forests as resources, a theme that emerged because this research did not limit participants to considering woody-based feedstock sources from national forests or private timber

lands. Given that biomass from whole trees is the one area of clearly defined boundaries presented by most environmental advocacy groups (Schlossberg, 2016), this point warrants thoughtful planning, attention, and communication to pertinent stakeholders.

Stakeholders who loaded onto the *Risk-Averse Environment-Focused Perspective* are also concerned that the required amount of feedstock will be greater than anticipated, and that once the cellulosic biofuels industry gets started, things may get out of hand (#47). Reassurance in this area will be critical for people holding the Risk-Averse Environment-Focused Perspective to support the development of biofuels.

The other area of concern that needs to be addressed specifically for people holding Perspective 2 (*Risk-Averse Environment-Focused Perspective*) is their risk aversion toward the potentially large unknown consequences resulting from technology associated with the development of biofuels (#37, #43). These statements are worded in a way that might resonate with a deeper discourse of risk aversion toward technological/ecological innovations and thus care should be taken in communication around the innovative technological aspects of biofuels development. In the next section, I discuss further recommendations for addressing this discourse of risk aversion.

The last two areas for concern should be addressed specifically for people holding the *Skeptical Pragmatic Perspective*. Stakeholders who load onto the *Skeptical Pragmatic Perspective* express skepticism over government subsidies (#32) and the overall feasibility of wood-based biofuels in general (#21). The *Risk-Averse Environment-Focused Perspective* shares these concerns, but considers them a lesser priority. Policy makers need to address these themes by prioritizing issues strategically to emphasize shared benefits, provide opportunities for co-learning

and initiate communication surrounding these concerns. Additionally, policy makers and natural resource decision makers need to invite relevant stakeholders to engage in a newly reframed policy dialogue centering on shared preferences.

3.6.3 *Importance of Framing and Alignment with Values*

Another relevant tenet of diffusion of innovation is *compatibility*, or the need for the innovation to be aligned with existing values (Rogers, 2010). I will briefly outline important implications for how to factor salient benefits and concerns in order to improve issue prioritization, strategic communication, and development of marketing campaigns for new programs.

Compatibility with existing values is key to the innovation and diffusion of technology (Rogers, 2010). One can anticipate social acceptability by examining the overarching connections between the dominant discourses existing for environmental proposals and the emergent perspectives themselves (Dryzek, 2005; Schindler et al., 2004). Frame alignment is important for resolving environmental conflict and identifying the most constructive direction for all parties. In several cases, the use of Q-methodology in particular has helped manage existing environmental conflict and facilitate the creation of better project outcomes (Asah et al., 2012a; Asah et al., 2012b; Danielson, 2014; Mazur & Asah, 2013; Webler et al. 2009). Applying Q-methodology in advance of such problem development can aid in clarifying and reframing polarized discourse to direct it toward more open dialogue on actual relative concerns and benefits. In the realm of program implementation, strategic communication that resonates with existing discourses and values systems is an effective method for improving program outcomes (McKenzie-Mohr, 2000).

Given all the above, I propose turning to a few notable examples of environmental discourse including Hajer's (1993) discussion of discourse coalitions and Dryzek's (2005) typology of environmental discourses. Additionally, Focht and Lawler's (2000) review of stakeholder viewpoints on the environment can help provide context for existing values and discourses with a capital *D* that might be more relevant for crafting strategic communication and prioritizing policy decisions.

Two main discourses emerged in a study on social perspectives on acid rain in Britain, *Traditional Pragmatism* and *Ecological Modernization* (Hajer, 1993). These bear similarities to discourses that emerged in the three perspectives from this study. For example, the *Ecological Modernization* discourse frames environmental concerns very similarly to the *Risk-Averse Environment-Focused Perspective* in the Pacific Northwest. However, Hajer (1993) presents these as more of a status quo viewpoint versus a departure from the status quo expressed through the *Ecological Modernization* discourse. That said, the three discursive frames that emerged from this study go beyond that polarity because the phenomenon of biofuels is in itself a departure from the status quo.

Dryzek's (2005) typology of prominent environmental discourses provides a helpful framework for understanding discourses that depart from the status quo. This theory proposes four main environmental discourses: *Survivalism, Environmental Problem-Solving, Sustainability*, and *Green Radicalism*. The three perspectives in this study do not map directly on to any one of these discourses, but instead share elements from each of them, indicating an important direction for future study. One of these discourses, the *Promethean* discourse, is quite prevalent among the *Risk-Tolerant Optimistic Perspective*, and understanding how this broader discourse interacts with the

Survival discourse will provide insight into how the *Risk-Tolerant Optimistic Perspective* might conflict with the *Risk-Averse Environment-Focused Perspective*, which takes a more resource limited view. All three perspectives seem to contain salient elements from the *Environmental Problem-Solving* and *Sustainability* discourses. Further exploration of these discourses and their interactions will be helpful for policymakers and communication specialists going forward by providing them with the knowledge they need to create the successful conditions for effective policy dialogue.

A literature review specifically examining environmental technological proposals proposed three main discursive perspectives: the *Technocratic Supporter,* the *Pragmatic Guardian*, and the *Disaffected Opponent* (Focht and Lawler, 2000). This discursive typology seems to align more with the three viewpoints that emerged from this study. The *Risk-Tolerant Optimistic Perspective*) is most like the *Technocratic Supporter,* the *Risk-Averse Environment-Focused Perspective* is most like the *Pragmatic Guardian*, and the *Disaffected Opponent* is most similar to the *Skeptical Pragmatic Perspective*. Although I have only briefly presented the importance of aligning with existing discourses, I hope it is discernable how useful they might be for providing richer analytical context and anticipating how different perspectives might interact.

3.7 CONCLUSION

Despite the broader international debate about our energy future, we can only move forward effectively if all alternatives and options, transitional though they may be, are seriously considered for their economic, ecological, and social impacts. For the good of this planet and all living and non-living life, there is a collective need to get beyond rhetoric, strive to understand one

another, and look for the underlying values and shared common ground in order to cooperate on priorities to move forward together. Characterizing how people collectively "feel" via their social perspectives presents many challenges, especially when researchers are trying to gauge social viewpoints around a new industry that social influencers have no models for. Furthermore, the information about the biofuels industry that citizens base their opinions on may be inaccurate, based on outdated technology, or overly influenced by the national news media's issue-attention agenda-setting cycle (McCombs & Shaw, 1972). This complicates the developing discourse, potentially creating conflict and the inability to engage meaningfully in constructive dialogue.

As stakeholders struggle to create meaning, concepts are often in flux, both intra-personally and interpersonally, increasing the difficulty of gathering useful knowledge for decision-makers to make effective choices on behalf of society and the greater good (Stephenson, 1988/1989). To further complicate things, as issues emerge, concepts begin to take form and discourse starts shaping salient values. In this process, different stakeholder groups are simultaneously vying for space for their definition of the problem/concept space to be heard, thereby influencing the public sphere in a direction aligned with their mission (Hannigan, 2006; Boykoff, 2012). Thus, it is important in the development of new alternative energy industries such as biofuels and bioenergy that in early issue identification we explore the mental models of potential influencers. By examining the social feasibility of biofuels in the Pacific Northwest, this study did just that.

Q-methodology allowed for the identification and characterization of three predominant perspectives about woody-based biofuels for the region. These three perspectives aligned well with existing environmental discourses and policy recommendations can be further clarified by including this context. Findings cut across stakeholder type, and provide early insight into

important nuances for program implementation and communication with stakeholders holding different viewpoints. These elements are essential for developing clear recommendations for government policymakers, managers in industry, research extension agents, and practitioners facilitating future collaboration, co-learning and strategic communication.

Ultimately, Q-methodology is a powerful approach that can be used to generate important fine-scale recommendations about priorities for different perspectives. It does so by providing a structured way for participants to examine their own subjectivities without getting caught up in the rhetoric, or political identity that sometimes primes people's viewpoints obscuring underlying beliefs and values.

4. ISSUE PUBLIC PERSPECTIVES AND MEDIA ANALYSIS OF THE TWITTERSPHERE

4.1 INTRODUCTION

Chapter 4 explores stakeholder perspectives on biofuels in response to the United States' increasing need to mitigate climate change through the adoption of renewable, low-carbon energy sources (IPCC, 2014). This chapter extends existing research by measuring stakeholder and other potential political actors' perspectives directly through accessing the social discourse about biofuels from the Twittersphere.

As previously noted, stakeholders articulate their perspectives through many different communication channels, including social media. This naturally occurring communication provides a rich source of knowledge that can help decision-makers find information about salient themes, engaged publics' sentiment, and key outreach pathways for enhancing social acceptability of forthcoming policies. Furthermore, perspectives which emerge out of social discourse are rooted in actual discussions of the issue and are therefore less subject to researcher bias. Decision-makers may encounter difficulty, however, accessing naturally occurring communication, especially as events unfold in real time (Bengston et al., 2009), because the large volume of communication poses practical barriers to extracting relevant knowledge. Furthermore, keeping track of evolving public values and perceptions of environmental issues through more traditional approaches such as focus group and survey research can be costly and time consuming. Thus, approaches that provide meaningful access to the abundance of social discourse taking place in the public sphere in a cost effective and timely way provide a valuable contribution to the field.

Social media provides researchers unprecedented access to naturally occurring social interactions and discussions. Digital communication platforms such as Twitter, Facebook, and Reddit provide an easily accessible source of active discourse produced by engaged publics who have created accounts and followed issues online. Nearly two-thirds of all adults in the United States use social media, with over 70% active on sites like Facebook, YouTube, or Twitter (Perrin, 2015; Gottfried & Shearer, 2016). Furthermore, social media sites have become a source of micro-political mobilization and community activism (Bekkers et al., 2011; Shirky, 2011). The successful implementation of programs such as hybrid poplar biofuels development depends on anticipating social acceptability and future activism prior to making environmental management decisions. Social media provides a valuable new avenue for gaining access to such insights (Bengston et al., 2009; Ngai & Lee, 2016; Di Minin et al., 2015).

In this study, I explore the issue public's attitudes, values, and beliefs through a grounded interpretive mixed methods analysis of the social discourse about biofuels found in the Twittersphere. I focus on three primary areas for analysis: examining information about the identities of the engaged publics, the content of the communication, and the structures associated with information sharing such as message type and mode of information transmission. More specifically, I seek to address the following research questions: *1) What are the salient themes present in the social discourse? 2) What is the sentiment associated with specific themes? 3) What types of communication are most prevalent? 4) What is the relationship between sentiment, salient themes, and stakeholder groups or account types?* and *5) What is the structure of the tweets?* In the following sections, I present my rationale for using a grounded interpretive mixed methods analysis of the social discourse, discuss existing literature on similar analyses, and present my

rationale for focusing on Twitter as a communication channel. I follow this with my research design, a presentation of results, and a discussion of my key findings. I conclude with a discussion of applications for future work regarding place-based discourse.

4.1.1 *Rationale and Significance*

I conducted a grounded interpretive mixed methods analysis following emerging conventions for working with social media data (Maddock et al., 2015; Palen & Anderson, 2016; Starbird et al., 2015). A mixed methods approach, incorporating interpretative, exploratory, and quantitative elements, is appropriate for the study of emerging environmental issues in the Twittersphere. This is especially true when the findings are applicable to a local or regional context, because results will likely only be useful for managing the developing perspectives at a regional level if they are context-specific and thus meaningful to the target demographic (Shindler et al., 2004).

While "Big Data" approaches consider the macro-level analysis of thousands or millions of cases, "Thick Data," a term borrowed from the ethnographer Clifford Geertz (1973), focuses on fewer cases and micro-level analysis. Interpretive approaches for analyzing fewer samples of "Thick Data" more intensively, such as grounded theory or ethnographic content analysis are ideally suited for such context-specific studies (Altheide & Schneider, 2013; Charmaz, 2006). These reflexive approaches are appropriate for working with Twitter data because they allow the researcher to revise the coding protocol as findings emerge throughout the coding cycle and offer important insight that might be lost via a macro-level analysis (Altheide & Schneider, 2013; Alles & Vasarhelyi, 2014; Curran, 2013). This is achieved through a process of constant comparison and

close examination of texts (Charmaz, 2006). Furthermore, these approaches are in alignment with reflexive policy and planning (Healey, 2006) and includes the more specific lens of psychological thematic analysis that has made other environmental planning studies successful at providing detailed, context specific-knowledge to decision-makers (Reddy et al., 2016).

Social Media platforms such as Twitter are unique because they enable the researcher multiple viewpoints with which to explore social perspectives. While smaller sample sizes of "Thick Data" provide important nuanced views of social discourse and issue public perspectives, "Big Data" analytic approaches provide a more extensive view, offering unique insights that maybe invisible in smaller datasets (Ngai & Lee, 2016; Di Minin et al., 2015). Because Twitter is a "Big Data" platform generating millions of unique sources, "Big Data" analytic practices such as quantitative data analysis, network analysis, and visual analysis (Starbird et al., 2015) are helpful for sampling and structuring the data (Maddock et al., 2015). More specifically, this entails analyzing tweet frequencies, keyword co-occurrences, and hashtag use to explore issue salience; in addition, it involves examining top user accounts and networks, as well as the use of replies and mentions, to distinguish patterns of influence and behavior in the Twittersphere. This study expands and develops these methods by exploring how the issue public frames the biofuels social discourse as it occurs in the Twittersphere.

4.1.2 *Opinion Mining in the Twittersphere*

Twitter is a rich source for opinion mining and sentiment analysis (Russell, 2013) because its diverse users employ it directly for expressing opinions about a broad range of subjects, thereby generating large quantities of primary text data (Pak & Paroubek, 2010; Russell, 2013). Moreover,

interactions taking place on Twitter create a record of co-constructing ideas, thereby capturing emergent and interactive frames. Twitter is also one of the best social media sources for political or issue-specific discussion (Pak & Paroubek, 2010; Mitchell et al., 2013a) because it allows for access to recent and real-time data for how stakeholders are discussing specific issues. This is especially important in natural resource management, where resource managers have specific timelines for policy implementation and the generation of program alternatives.

Additionally, the issue public for biofuels may be more readily accessed on Twitter than on other social media-based news sharing sites because it is representative of a range of diverse demographic types as compared with other social media such as Reddit or Instagram for the topic of biofuels (Mitchell et al., 2013b). It is also useful for accessing communication produced by businesses and organizations because utilizing social media is an increasingly common practice for these types of users in order to share information with their consumer base (Dhar & Jha, 2014). In short, Twitter may be more representative of diverse views than other social media platforms such as Reddit or Instagram for the topic of biofuels specifically. Furthermore, users on Twitter tend to be more interested in new technology topics than the general public, making Twitter an ideal digital source for examining the issue public's perceptions of biofuels technology development (Matsa and Mitchell, 2014).

4.1.3 *Existing Studies of the Biofuels Social Discourse*

Several content analyses have been conducted on biofuels social discourse in the United States and Internationally. They have tended to focus on news media framing of biofuels, particularly through national news coverage (Delshad & Raymond, 2013; Kim et al., 2014;

Sovacool, 2014; Wright & Reid, 2011). Prominent frames or discourses relating to biofuels include environmental impacts, national security, and economic development (Delshad & Raymond, 2013; Wright & Reid, 2011). Like opinion surveys, these studies show decidedly mixed sentiment about biofuels depending on the biofuel type the study focuses on or makes salient for the participant (Cacciatore et al., 2012; Delshad & Raymond, 2013).

Analysis of broad public sentiment or national-level news journals is often limited in applicability toward the evaluation and management of locally influential stakeholder perspectives because it is not specific enough to be useful. For example, content analyses that draw from news sources circulated throughout the United States shed little light on the lived realities of people in specific regions. Moreover, while media substantially shapes political attitudes and social communication, studying it is nonetheless indirect and may miss critical context-dependent issues (Cappella & Jamieson, 1996; Hertog, & Fan, 1995). This study addresses this gap in knowledge about region-specific stakeholder perspectives. Few, if any existing studies have examined local natural resource management issues through an analysis of the Twittersphere.

4.2 METHODS

The analysis took place in several phases, beginning with an exploratory analysis of the larger "Big Data" sample of tweets, mentions and retweets. I then conducted a more in-depth examination of a smaller "Thick Data" sample of tweets where I classified users, tweet text, and analyzed URL links. I continued to analyze the larger "Big Data" sample of tweets concurrently. This study uses three main units of analysis: the tweet, the user account, and the websites associated with linked URLs. I collected each tweet in its entirety for context and further data

analysis including the following information about each tweet: date, time, text, location, number of retweets, mentions, friends, and followers. Additionally, I gathered user profile descriptions for the 704 twitter accounts associated with my "Thick Data" random samples (Table 10).

Table 10. Description of Tweet Keyword Collection and Samples

	"Big Data" Purposive Samples			**"Thick Data" Random Samples**		
Sample Name	Twitter Keyword Collection	User-Specified Location Sample	Geographic Keyword Sample	Twitter Keyword Collection Random Sample	User-Specified Location Random Sample	Geographic Keyword Random Sample
Total # of Relevant Tweets	426,229	14,864	3,183	255	253	285
Total # of Users	144,910	4,412	1,716	269	204	223
Mean Tweets per User	3	3	2	-	-	-
Description	All English Tweets including the keywords: Biofuel(s) Bioenergy Biochar Biomass Biodiesel Ethanol	Only tweets sourced from the Pacific Northwest including: Oregon Idaho Montana California Washington	Only tweets about the Pacific Northwest including: Oregon Idaho Montana California Washington	Random Sample of Twitter Keyword Collection	Random Sample of User-Specified Location Sample	Random Sample of Geographic Keyword Sample

4.2.1 *Sampling and Data Collection*

For this analysis, I used a tweet-based sampling approach rather than a user-based approach, although I still collected user account information for each tweet. I located and collected

the population of texts from the Twitter Streaming API using a sampling frame that included all tweets about biofuels created between September 2014 and February 2015. I searched the Twitter streaming API for a set of keywords including: biofuel(s), biomass, ethanol, bioenergy, biochar, biodiesel, and biomaterials. This relevance sampling approach captured tweets specifically relating to the broader concept of biofuels (Krippendorff, 2012).

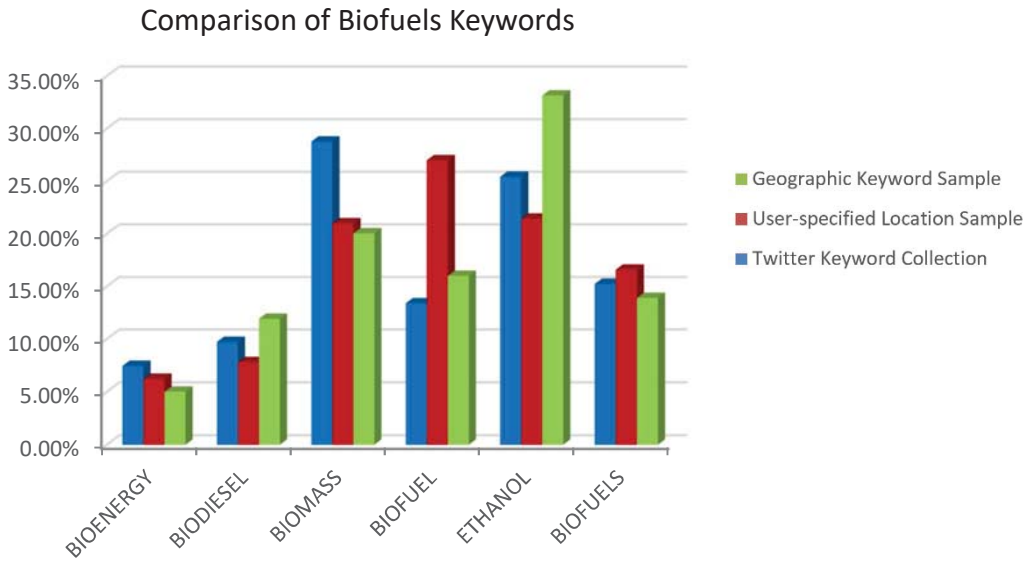

Figure 5. Comparison of relative percentage of keywords.

I used the Tweepy Module in Python to collect the sample of tweets that used the key search terms. This process gathered roughly 166 tweets per hour for a total sample of roughly 550,000 tweets over the six-month period. After filtering out non-English tweets, the total collection was 426,229 tweets produced by 144,910 users (Table 10). The mean tweet rate was 3 tweets per Twitter user. The distribution, however, was characteristic of the heavy-tailed

distribution commonly found on Twitter. For this analysis, I refer to the collection of 426,229 tweets as the Twitter Keyword Collection (Table 10).

4.2.1.1 "Big Data" Purposive Samples

I created the Twitter Keyword Collection by filtering out all non-English Tweets from the original collection of tweets that mentioned the keyword search terms. This resulted in 426,229 tweets. Because I conducted sampling through keywords using the streaming API and the frequency of tweets per hour is well below the threshold for rate-limiting, the Twitter Keyword Collection should include the majority of publicly available tweets for the keywords used in the search (The Streaming APIs: Overview, 2014).

This research specifically explores how a place-based phenomenon is constructed across the placeless digital Twittersphere, as well as how relevant place-focus tweets are for understanding local controversies. Within the broader Twitter Keyword Collection, I am interested in users who are from or focus their conversation specifically on the Pacific Northwest. Therefore, I created two additional samples to differentiate location-focused tweets (Table 10).

First, I located tweets from the Pacific Northwest. I drew the first sub-sample from the Twitter Keyword Collection from users who specified their locations as Oregon, Idaho, Washington, Montana, or California in their user accounts. This User-Specified Location Sample contained a total of 14,864 tweets from 4,412 users (Table 10).

The second sub-sample, the Geographic Keyword Sample, consists of users who referenced locations within the Pacific Northwest. I included tweets from the Geographic Keyword Sample in this analysis because users in other parts of the country may influence the views of key actors in the Pacific Northwest. Users in Geographic Keyword Sample either did not indicate a

location in their profiles or indicated a location that was outside the targeted five states. I identified location references within the tweet text by searching for state names and major cities. Preliminary results suggested county references and minor city references contributed a negligible number of additional tweets to the set. The Geographic Keyword Sample contained 3,183 tweets from 1,716 users (Table 10).

Because I utilized a keyword search to collect data on the biofuels discourse, the search results collected some non-relevant tweets and potentially excluded relevant ones, which is a common problem in keyword search-produced samples (Stryker et al., 2006). In order to reduce this possibility, I diligently selected my search terms and initially sampled several combinations to reveal the best set of terms (Stryker et al., 2006). After examining a subset of the tweets more closely via the initial grounded interpretive analysis, I removed tweets containing biomaterials because it created excess noise. The remaining sample contained low noise with a precision estimate of 95% based on the frequency of non-relevant tweets found in the "Thick Data" random samples described in the next section.

4.2.1.2 "Thick Data" Random Samples

To prepare the smaller random samples, I used a random number generator to select tweets from the full Tweet Keyword Collection and other two "Big Data" purposive samples (Table 10). This resulted in a random sample for the Twitter Keyword Collection consisting of 300 tweets, a sample for the User-Specified Location Sample of 300 tweets, and a random sample from the Geographic Keyword Sample of 324 tweets. I sifted through the full corpus of sampled tweets and removed non-relevant tweets resulting in the final sample totals of 255, 253 and 285 for each

collection respectively (Table 10). Of the 793 relevant tweets collected they are associated with 696 unique twitter accounts (Table 10).

4.2.2 *Exploratory Analysis*

I initially approached the biofuels tweet collection quantitatively, calculating the larger features of the dataset including frequency counts for top tweeters, and users with high numbers of mentions, and retweets associated with their accounts. I also explored potential location-based differences using network graphs of retweets and mentions using Gephi version 0.8.2 Beta. This provided context for the larger set and enabled insight into the information flow within Twitter. I also looked at the percent of geo-coded tweets to determine if that was a viable option for determining location (Table 11). These initial findings informed the sampling strategy.

4.2.3 *Interpretive Analysis*

For the interpretive analysis, I primarily followed a Grounded Theory approach (Charmaz, 2006) using a combination of inductive and deductive iterative open and axial coding which I describe further in my description of the codebook development (Saldana, 2012). I coded across three different dimensions: user account, tweet text, and URL links. Thus, the recording unit for this study is composed of a subset of information collected from the tweet itself, including within-tweet elements such as hashtags, retweets, mentions, place references, and URL links. I also collected account descriptions for each of the 704 unique users in the "Thick Data" random samples.

4.2.3.1 User Analysis

In order to better understand the types of individuals making up the issue public for this topic, I coded all 704 unique Twitter accounts for account type and stakeholder classification (Appendix B). Account types classifications primarily make the distinction between individuals and groups. Account types included: *Individual, Entity, Business, Other*, or *Account Closed.* I limited account classification to one classification per tweet.

I also coded for stakeholder type. Stakeholder type was based on the classification scheme developed in chapters 2 and 3 of this dissertation, but was modified to include additional categories relevant for Twitter. I classified stakeholders as *Industry, News, Advocacy, Research, Government, Citizen,* or *Other*. Stakeholder classifications included sub-categories for the *Industry* and *Advocacy* groups (Appendix B). I assigned stakeholders to one classification per account.

I also gathered user information for the profiles of users with the most frequent tweets. In order to aid in the quantitative analysis of user profiles, I sampled the broader Twittersphere for 100 users with the highest number of tweets, friends, and followers. This provided insight into not only stakeholder and account types, but also which users might be influential in the biofuels discourse.

4.2.3.2 Tweet Text Analysis

I analyzed two different aspects of tweet text: sentiment and salient theme. These themes may be an indicator of issue salience. The relative frequency of their occurrence reveals specific priority areas policymakers should focus on for issue prioritization, problem identification, and examining specific policy preferences around. The average number of tweets per user within

Twitter Collection, User-Specified Location and Geographic Keyword Random Samples is 1.3 tweets, indicating that no one user is likely to skew the frequency tweets in the random samples. Tweets were coded at the tweet level for sentiment, where each tweet could contain either a positive, negative, neutral, or unclear sentiment (Appendix B). In the very rare case that sentiment was both positive and negative within the tweet, the tweet was coded as neutral.

I coded tweets at the expression level for salient themes, thus allowing for tweets to contain more than one theme. I only counted same-theme expressions within tweets once. I coded for 13 broad themes, including: *International Efforts, Energy Independence, Security or Energy Needs, Capacity-building and Education, Feasibility, Compatibility, Economic Impacts, Environmental Impacts, Research and Technology, Military, Policies and Politics, Social and Human Impacts, Operations and Logistics,* and *Feedstock Uses and Types* (Appendix B).

4.2.3.3 Structural Level Analysis

In the structural analysis of tweet text, I noted message type, URL and link information, (Appendix B). I classified tweet messages as *Advertisements, Calls to Action and Campaign Ads, Expert Appeals, Straight Information Sharing, Opinions, Questions,* and *Not Relevant* (Appendix B). Multiple classifications were allowed for Expert Appeals and Calls to Action that contained an opinion or question. Otherwise, accounts had singular classifications.

In order to explore how users were sharing information sources, I collected URL link information. I also coded tweets to determine the feasibility of interpreting the tweet independently from the URL link—a necessity in this research, since upwards of 80% of the tweets in the sample contain a link. In 93.4% of cases, it was possible to code the tweet-text without opening the URL. Although many URL links were inactive at the time of this analysis, I was still able to access over

84.4% of the links embedded in this dataset's tweets that were still present in 2017. I used a 9-point classification scheme to categorize successfully accessed URLs as *Websites, News Sites, Social Media, Technology News, YouTube Videos, Perceived Neutral Sources, Blogs,* or *Other* (Appendix B).

4.2.4 *Quantitative Analysis*

The recording unit for the quantitative analysis was composed of within-tweet elements such as hashtags, retweets, mentions, place references, and URL links. Additionally, I collected information associated with each tweet's user account profile, including User-Specified location, account ID, user name, geolocation, time zone, number of friends, number of followers, and time of tweet. Beyond the initial exploratory analysis of retweets, mentions, URL links, and location, I also used Wordstat and QDA Miner to conduct a hashtag and keyword frequency comparison examining the broad context for keyword use across the dataset. To discover related concepts for each of the keywords, I analyzed keyword co-occurrence. I also explored differences between the Twitter Keyword Collection and two sub-samples.

4.2.5 *Software*

I used QDA Miner version 6 and its embedded module, Wordstat, to conduct analysis for the quantitative dataset, and I used NVivo version 10 to code the "Thick Data" random samples. QDA Miner is unique in its ability to handle over 2000 cases at a time, and is an excellent choice for algorithmic and quantitative queries of larger datasets. NVivo is more appropriate for grounded

interpretive coding analysis of smaller sampling sets. I used Gephi version 0.8.2 Beta for exploring the network of retweets and mentions. Gephi is an open source platform developed for visualizing networks and complex systems. I also used Tableau version 8.2 to further explore retweets and mentions and calculate basic descriptive statistics for users and the overall dataset.

4.2.6 *Codebook Development and Reliability Assessment*

I developed my initial coding frame for tweet text level coding from the online biofuels news sources I used to inform Chapters 2 and 3. Thus, the original coding frame was stable but not Twitter-specific. I used a grounded theory constant comparative approach to develop the new coding frame for tweet texts (Charmaz, 2006) via a combination of inductive and deductive iterative open and axial coding (Saldana, 2012). I worked with a pilot dataset of 150 tweets in iterations of 50 tweets at a time until the coding frame seemed stable for use with Twitter.

Though I had created and tested an initial coding protocol, my methodological choice of ethnographic content analysis provided flexibility for revising the coding scheme in response to emergent patterns in the data (Altheide & Schneider, 2013). I began the main coding with a trained second coder, with whom I divided the three samples. We coded independently and continued to expand the coding frame with axial coding as we worked, reconciling our revised categories after each iteration of 50 tweets and reclassifying prior coding decisions as necessary. We discovered several unanticipated themes in this process.

I followed similar procedures for developing the user level and the structural level coding schemes. I checked external validity for all three coding dimensions by triangulating the broadest concepts with existing literature and the two Q-studies in this dissertation (Cooney, 2011;

Krippendorff, 2012). Although this coding approach resulted in a robust coding scheme, the iterative nature of code development and interactions between coders did not create independent enough samples to compare for use with an inter-coder reliability measure. This is a limitation of this coding approach. I provide a detailed description of the key concepts, final code definitions, and examples of coded text in Appendix B.

4.2.7 *Data Limitations*

There are several limitations to using Twitter data in the study of the social discourse surrounding biofuels. Although Twitter is one of the best sites for issue-specific discussion, its user demographic tends to be slightly biased compared with the general population (Matsa and Mitchell, 2014; Mitchell and Page, 2013). This may lead to the exclusion of potentially influential viewpoints; for example, individuals from rural communities may be less comfortable using this online channel of communication.

It is also difficult to ascertain the quality of data collected from Twitter and how representative it is of all tweets in the collection. Twitter users may hold multiple accounts, and some accounts are used exclusively by bots and spammers. Twitter occasionally bans users, blocks accounts, removes tweets that violate their user agreement, and loses tweets in database closures (Boyd and Crawford, 2012).

Furthermore, the notion of discourse itself is limited by the selection of keywords used in the tweet collection. In all likelihood, there is much more discourse related to the topic of biofuels. However, I am confident I collected a meaningful subset through my purposive sampling approach.

4.3 RESULTS

4.3.1 *Exploratory Findings*

Initial exploration of retweets, mentions, and location data helped inform my sampling procedure and provided insight into biofuels' issue salience and virality. Retweets for the quantitative dataset are slightly above the 2014 Twitter average of 25% (Liu et al., 2014) (Table 11). Although this is an indication of user engagement with the biofuels discourse and other users, it is nowhere near the level of activity one sees during a natural or environmental disaster. For example, average retweets neared 50% for the 2010 Deep Water Horizon Oil Spill (Starbird et al., 2015). This does not necessarily suggest biofuels is *not* an important issue for the region, but rather may indicate that the biofuels discourse is a different type of discourse limited to a smaller information-gathering group of the issue public. Visual inspection of retweet and mention networks indicated that retweet activity occurs mostly outside of the User-Specified Location Sample. This finding provided the rationale to develop the Geographic Keyword Sample in order to explore how a place-based environmental issue like biofuels might be constructed by people residing outside the local area.

The rate of geocoded tweets found in the Twitter Keyword Collection and two sub-samples neared the Twitter average of 1% (Liu et al., 2014). Because the dataset is relatively small, this represents a comparatively small subset of the data. Therefore, I did not include geocoding as the basis for location sampling in this study.

Table 11. Unique user, retweet, mention, URL and geocoded tweets percentages over full data collection for 6-month period.

Sample	% Users with less than 3 Tweets	% Users with Unique* Tweets	% Total Retweets	% Total Mentions	% Total # with URL Links	% Total # Geocoded
Twitter Keyword Collection	90%	66%	36%	27%	79%	0.5%
User-Specified Location Sample	88%	85%	25%	32%	87%	1%
Geographic Keyword Sample	93%	80%	30%	15%	94%	0.6%

**Unique tweets are tweets with original tweet text content*

4.3.2 *User Analysis*

4.3.2.1 Top Users and Unique Contributions

Analysis of the top ten Twitter users across the Twitter Keyword Collection and two sub-samples is evidence of prominent users' disproportionate influence on the discourse as a whole. In the Twitter Keyword Collection, the top users generally consist of citizens and possible bots; industry stakeholders, particularly industry news entities such as @Green Globe, LLC, which publishes Ethanol Producer Magazine; a business that supports the biomass industry (@BiomassUpdate); and a technology commentator (@Greattweets2go) (Table 12). The User-Specified Location Sample and the Geographic Keyword Sample have a similar breakdown of potentially influential users. There is also some overlap between the Twitter Keyword Collection accounts and the Geographic Keyword Collection because some of the most prolific tweeters, @maskunta and @MyGreenGlobeTM, tweet about new biofuel developments in the Pacific

Northwest. The top ten list found in the User-Specified Location Sample contains economy-focused stakeholders such @environmentguru, a green jobs website, and @Anonymous4, an individual user who works in marketing. The top ten lists for the Twitter Keyword Collection and two sub-samples include individual, business, and entity account types (Table 12).

To characterize and gauge the influence of the top users in Twitter Keyword Collection and two sub-samples, I considered the number of unique contributions measured by counting the number of original tweets made by users. Despite only a handful of top users tweeting high volumes of tweets characteristic of many tweet samples, individual users made a substantial number of unique contributions. In the Twitter Keyword Collection, 90% of users contributed at least 3 tweets (Table 11), and 66% of users overall made original contributions. The User-Specified Location Sample evinced similar engagement rates, with 88% of users contributing at least 3 tweets and 85 % of users making original contributions (Table 11). This example provides further support for the proposal that users are engaged with the biofuels discourse on Twitter, despite the relatively low retweeting activity. It is challenging to interpret these findings beyond the initial conjecture provided here because there are no comparable studies examining environmental discourse in the Twittersphere. Future work should focus on exploring measures for user engagement because it is important for natural resource managers and decision-makers to have a means of evaluating social acceptability for specific issues over time.

Table 12. Top users. Stakeholder classification and description for top tweeters in Twitter Keyword Collection, User-Specified Location Sample and Geographic Keyword Sample.

User	Count	Stakeholder Type	Description
Twitter Keyword Collection			
maskunta	18,578	Industry: Association	Alternative Energy Advocate
Anonymous1*	8,454	Citizen	Individual / Bot?
Anonymous2*	3,606	Citizen	Individual / Bot?
BiomassUpdate	1,861	Industry: Related Business	The Center for Site Location Assistance
MyGreenGlobeTM	1,489	Industry: News	Green Globe, LLC
Greattweets2go	1,440	News / Science	Technology Commentator
SugarcaneBlog	1,248	Industry: News	Next Generation Ethanol Blog
Greenbiofuels	1,232	Industry: Producer	Green Biofuels, LLC
JohnNMarketing	1,179	Industry: News	Publisher of Ethanol Producer Magazine
Anonymous3*	1,173	Citizen	Mother from North Carolina
User-Specified Location Sample			
MyGreenGlobeTM	1,489	Industry: News	Green Globe, LLC
workisbeautiful	500	Industry: Producer	Co-Founder of Vitruvian Energy, SPC
fuelfreedomnow	464	Industry: Association	Fuel Freedom Foundation
TeruTalk	214	Industry: News	Waste Conversion Blogger
EnergyTech_News	210	Industry: News	Energy News International
Quippper	186	Industry: Transportation	Urban Planning Enthusiast
Anonymous4*	165	Industry: Economic Development	Marketer and Database Administrator
vitruvianenergy	105	Industry: Producer	Vitruvian Energy, SPC
environmentguru	93	Environmental / Labor	Search Platform for Green Jobs
Geographic Keyword Sample			
maskunta	160	Industry: Association	Alternative Energy Advocate
bdigest	79	Industry: News	Biofuels Digest
JohnNMarketing	51	Industry: News	Publisher of Ethanol Producer Magazine
Anonymous3*	50	Citizen	Mother from North Carolina
MatthewSpoor	49	Industry: Producer	Vice President at BBI International
Anonymous5*	38	Citizen	Businessman
BiomassUpdate	38	Industry: Related Business	The Center for Site Location Assistance
BiomassMagazine	32	Industry: News	Biomass Magazine
Greattweets2go	29	News / Science	Technology Commentator
SugarcaneBlog	26	Industry: News	Next Generation Ethanol Blog

*Individual account names who were also classified as Citizens were anonymized to protect user privacy

4.3.2.2 Account Types

Of the 696 relevant user accounts in the "Thick Data" random samples, the majority are classified as individuals and entities such as organizations or associations (Figure). Businesses make up the next most common category. Individual accounts consist of users who present themselves as individual people. In reality, however, celebrity accounts, government official accounts, and others are frequently manned by a team of tweeters working under the public figure's name. 1.13% of individual accounts are individuals tweeting on behalf of an organization or business. They make up a very small percentage of tweets, but this behavior stands out because of the blurring of lines between individual and organizational actions. Since the period of data collection, 11.34% of accounts in the smaller "Thick Data" random sample have been closed.

Examples of business accounts with the highest number of tweets include @NewburgEquip, an equipment supplier; @greenbiofuels, @GreenCircleNC, and @GSBiodiesel, which are all bioenergy companies; and @firepitsstore, which sells a specific product. All of these businesses, which participate in discourse about biofuels on Twitter, are physically located outside of the Pacific Northwest.

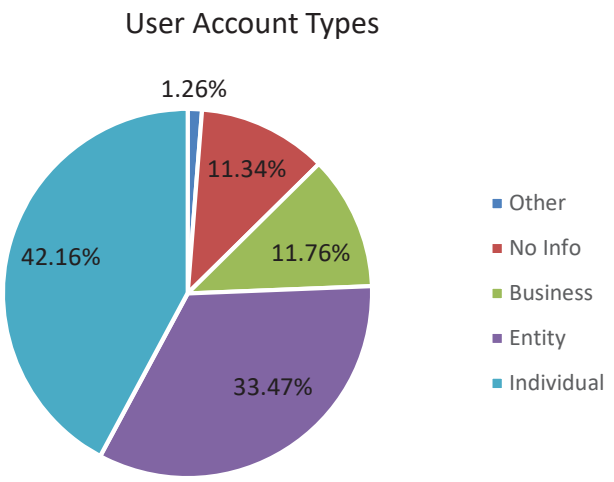

Figure 6. User account type. Percentages associated with all three "Thick Data" random samples of the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Sample.

Prolific entity accounts include @BiomassUpdate, @MyGreenGlobeTM, @AmericanDRecord, @SugarcaneBlog and @BioenergyIntl (Table 12). These accounts all appear as part of the top tweeting accounts in the "Big Data" samples. @AmericanDRecord, @SugarcaneBlog are both types of *News* entities focusing on the United States, whereas, @BioenergyIntl is an internationally-focused industry news entity. @BiomassUpdate is an industry-related business entity which provides support services for new or expanding biomass companies. @MyGreenGlobeTM is a bioenergy-focused investment resource based out of California.

Most frequently tweeting individual users from the "Big Data" samples include industry professionals, a mom, and unaffiliated advocacy or citizen stakeholders (Table 12). About 70% of the biofuels discourse in the Twittersphere comes from three accounts: @maskunta, @Anonymous1, and @Anonymous2 (Table 12). I classified @maskunta as an advocacy

stakeholder based on the user's account description, but I determined that @Anonymous1 and @Anonymous2 are citizen stakeholders.

@JohnNMarketing, @Anonymous3, and @MatthewSpoor are also among the most frequently tweeting industry stakeholders in the "Big Data" samples (Table 12). @MatthewSpoor is the Vice President of Operations for BBI International, and one of the publishers of @EthanolMagazine, @TheBakkenMag, @BiomassMagazine and @BiodieselMag, all of which are distributed nationwide. @JohnNMarketing is the Sales and Marketing Director for BBI International. @Anonymous3, although classified as an industry account is a citizen stakeholder classification and mother and wife who professes to be "living the life" in North Dakota while tweeting about the renewable fuels industry.

4.3.2.3 Stakeholders

The coding of the 696 relevant user accounts in the Twitter Keyword Collection, User-Specified Location and Geographic Keyword random samples revealed six main stakeholder groups associated with Twitter's biofuels discourse. There did not appear to be notable differences between the Twitter Keyword Collection and the two "Big Data" Purposive Samples. Overall, a majority of users belong to either the industry (33.10%) or citizen (24.23%) stakeholder groups (Figure 7). General news and technology stakeholders are the next most common, followed by advocacy stakeholders. Fewer stakeholders are affiliated with research institutions, and government stakeholders were rare in this sample.

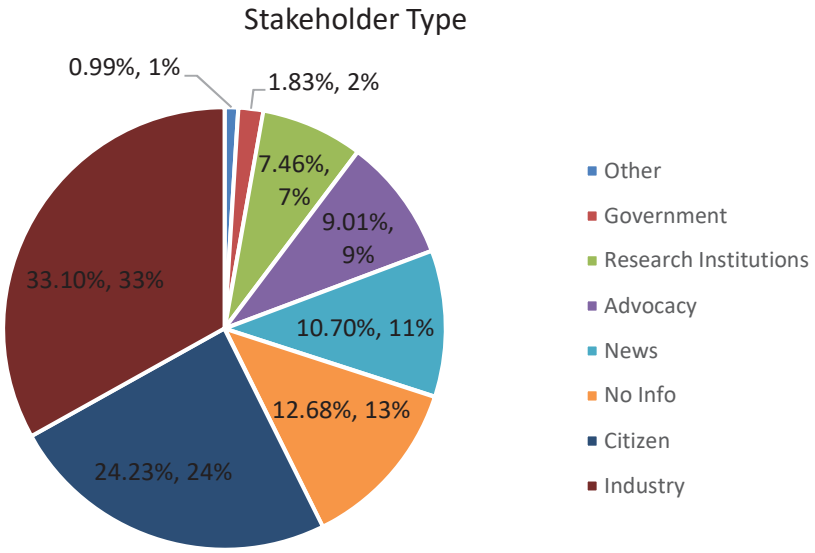

Figure 7. Stakeholder type. Percentages associated with the Twitter Keyword Collection, User-Specified Location and Geographic Keyword "Thick Data" Random Samples.

Because the industry stakeholder group is such a broad classification category, research into intra-group demographics may also be valuable to policymakers. The industry stakeholder group contained eight main subgroups which, examined in greater detail, provide important insight into issue-framing for particular audience segments and potential political actors (Figure 8). 26.81% of tweets came from industry news stakeholders. Biofuels-related businesses and bioenergy companies were the next most prominent stakeholder groups, producing 23.82% and 18.30% of tweets respectively. Farmers, growers, and foresters belonged to the smallest sub-group comprising just 2.98% of industry stakeholders.

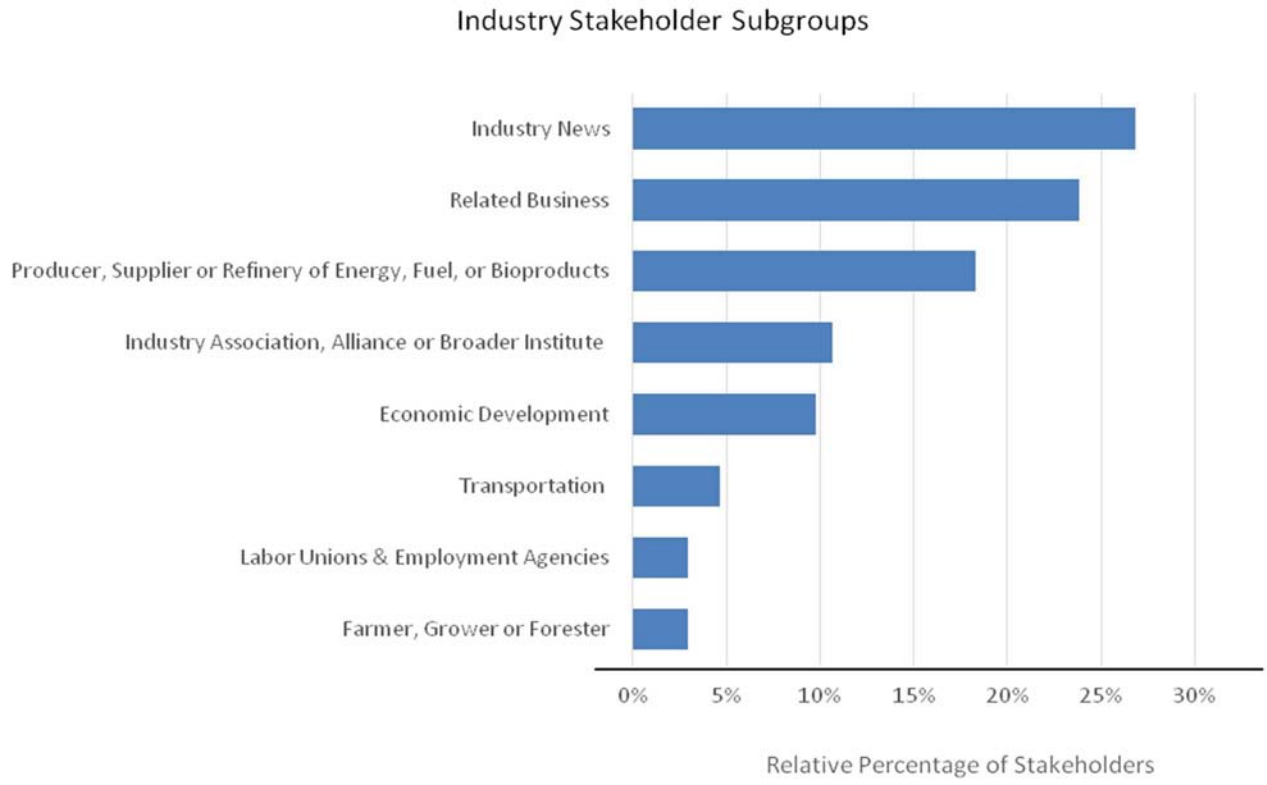

Figure 8. Industry stakeholder subgroups. Percentages associated with the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Random Samples.

Accounts with the highest number of tweets from within the industry subgroup include industry news such as @Bdigest and @EINEthanolNews, producers such as @GSBiodiesel and @workisbeautiful, related business accounts such as @Abengoa and @freebirdbfcj, and economic development accounts like @Petrol_Price and @SolarLeadDirect. Other examples include the industry association accounts such as @fuelfreedomnow, @iowafuel, @PANGEA_LINK, and @EthanolRFA. Some of these associations are either based in the Pacific Northwest, and others work more centrally out of D.C. Most, however, appear to have a broader geographic focus for their organizational missions (region, country or world). For example, @fuelfreedomnow is an industry association which advocates for increasing market competition for fuel. It is based out of

California but works globally. @PANGEA_LINK is an international network focused on sustainable bioenergy production, investment, and policymaking in Africa. Another example is @EthanolRFA, which works primarily out of D.C. and advocates for renewable ethanol development and production.

Examples of related business accounts include renewable energy companies such as @Amyrus and @Abengoa, as well as lesser-known companies such as @FiftyPlusOne, @MethesEnergies, and @OregonRecyclers. Although Amyrus and Abengoa are fairly large and easily researched companies, other biofuels-related businesses may be harder to find via online searching, obscuring their stake in biofuels development. As such, Twitter holds a great deal of promise for revealing unanticipated stakeholders who might have varying levels of support, interest, and perceptions of biofuels.

Twitter is also helpful for gaining insight into the broader citizen stakeholder group, whose information and engagement may be less predictable, and whose motives are harder to access because they are not posted publicly. Top citizen stakeholder accounts include @Anonymous1, @Anonymous2, and @Anonymous3 (Table 12). Citizen stakeholder accounts are individual accounts whose user has not provided any identifying information that denotes another stakeholder group. For example, one can be an individual industry stakeholder like and @Anonymous3, but she would still be classified as an industry stakeholder because she describes herself as following renewable fuels. A citizen classification, on the other hand, is used for individuals with no account description or who, like @Anonymous4, write something such as 'Database Administrator… with a [scary affinity] for cats and technology.'

@Anonymous1 and @Anonymous2 make up 78% of the tweets produced by citizen stakeholder accounts, though many of their tweets are nonsensical. These accounts are most likely bot accounts. I discuss further implications for these accounts and suggestions for managing them in the discussion.

Other citizen accounts who do not include descriptive information in their account profile produce the remaining 22% of tweets in this sample. Tweets from accounts such as @Anonymous4 express viewpoints about biofuels that might be missed otherwise. Even so, individual stakeholders who present at least some identifying information tend to be associated with more relevant opinions for this dataset. The more "generic" Citizen stakeholder accounts may not be as informative as originally thought for providing detailed knowledge about the preferences of the issue public in the Twittersphere. Following accounts such as @Anonymous3 should be a higher priority for tracking sentiment, specific themes, and preferences for bioenergy in the Twittersphere.

Twitter provides access to discourse generated by advocacy stakeholders, who are non-industry stakeholders who make stronger position statements. This study discovered two main groups of advocacy stakeholders, environmentalists and social justice/community activists. Environmental stakeholders made up 70.31% of the advocacy stakeholders in the "Thick Data" Random Sample, while human-focused stakeholders comprised just 29.69%.

Examples of prominent environmental accounts include @Anonymous6, @biofuelwatch, and @Anonymous7. @Anonymous6 is a journalist account and @Anonmous7 is an individual account. These accounts discuss positives and negatives of biofuels, particularly biomass**.** These users frequently frame biofuels, and especially biomass as having negative impacts for the

environment, focusing on themes such as air quality, climate change mitigation and destroying or "exploiting" forests as in the examples below shown in Figure 9 and Figure 10.

Figure 9. Example of tweet containing negative sentiment retweeted by @Anonymous6

Figure 10. Example of tweet containing negative sentiment posted by @biofuelwatch

Many of the negative biomass sentiment expressions have their origins from these accounts, demonstrating that these users are especially important stakeholders to invite into policy dialogue. @omkunta, @ActionAidUSA, and @Anonmous7 represent human-focused stakeholders with the highest number of tweets after @maskunta. The human-focused stakeholders concentrate on issues such as freedom of speech and providing aid to other countries and thus may

not be as relevant for considering social discourse around potential concerns with biofuels in the Pacific Northwest.

However, website and account descriptions reveal that the most prominent environmental accounts also have a social justice component within their mission statements. @Energy_Justice, for example, is one of the most active environmental advocates among the "Thick Data" random samples, achieving the highest number of tweets and mentions and of the second-highest number of retweets among environmental advocacy accounts. However, @Energy_Justice messages cannot be classified easily using only the environmental code. For example, their website states the following:

> *"Energy Justice is the grassroots energy agenda, supporting communities threatened by polluting energy and waste technologies. Taking direction from our grassroots base and the Principles of Environmental Justice, we advocate a clean energy, zero-emission, zero-waste future for all."*

The pattern that emerges among these types of accounts is that of a discourse group forming clear position statements around the issue of energy justice. It's possible that a third classification for energy justice stakeholders may be appropriate in the future.

4.3.3 *Tweet Text Findings*

4.3.3.1 Sentiment

International public sentiment on biofuels is mixed (Halder et al., 2015); however, the overall trend appears more positive among the issue public on Twitter (Figure 1). Over 60% of the

tweets expressed positive sentiment toward biofuels, whereas only about 16% expressed negative sentiment and over 20% expressed neutral sentiment. There do not appear to be strong differences between the three "Thick Data" random samples. The relatively high proportion of positive sentiment-based discourse is surprising given the highly controversial biofuels debate abroad, though it may be partially explained by demographic differences between the issue public on the Twittersphere and the general public. It is also likely due in part to the high percentage of industry stakeholders active in the discourse (Figure 7). Sentiment at this broad level may obscure more discourse-specific differences such as specific preferences for biofuels type. Further, examining strongly-expressed opinions might provide insight into context-specific views of biofuels as beneficial or harmful for the region overall. Below, I explore this issue further in my discussion of micro-discourses.

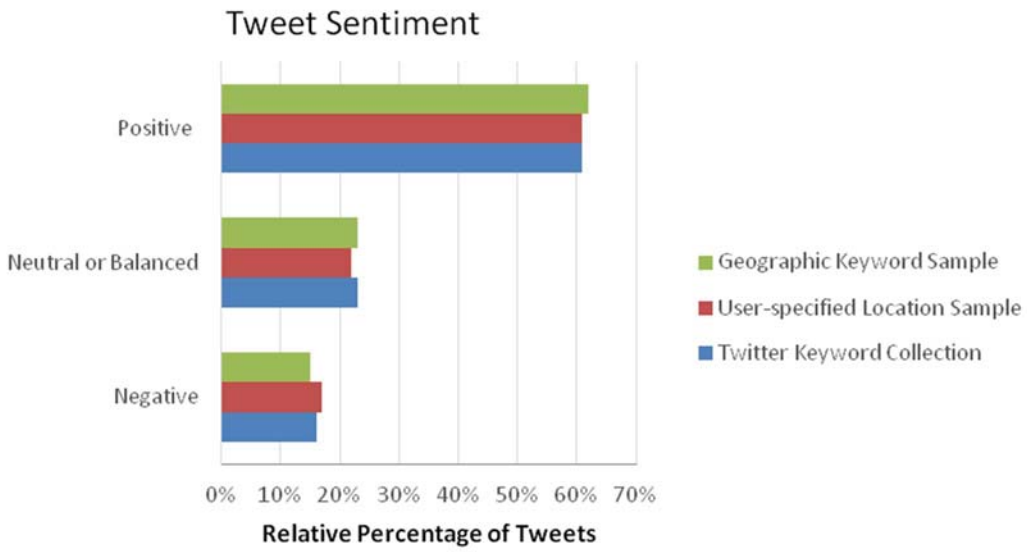

Figure 11. Overall tweet sentiment. Percentages associated with all three "Thick Data" random samples of the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples.

4.3.3.2 Issue Salience and Dominant Themes

A number of prominent themes emerged from analyzing tweets at the expression level. By far, the most common theme in the dataset was information about what specific type of biofuels are used for specific purposes. These tweets comprised 34% of the total expressions counted in combined dataset of all three samples (Figure 12). This is expected, as biofuels are the focus of this discourse. Although information about biofuels type doesn't necessarily indicate policy preference based on the frequency of expression alone, it proves illuminating when combined with sentiment and opinion data. I analyze these implications in greater detail in my discussion of micro-discourses associated with bioenergy type.

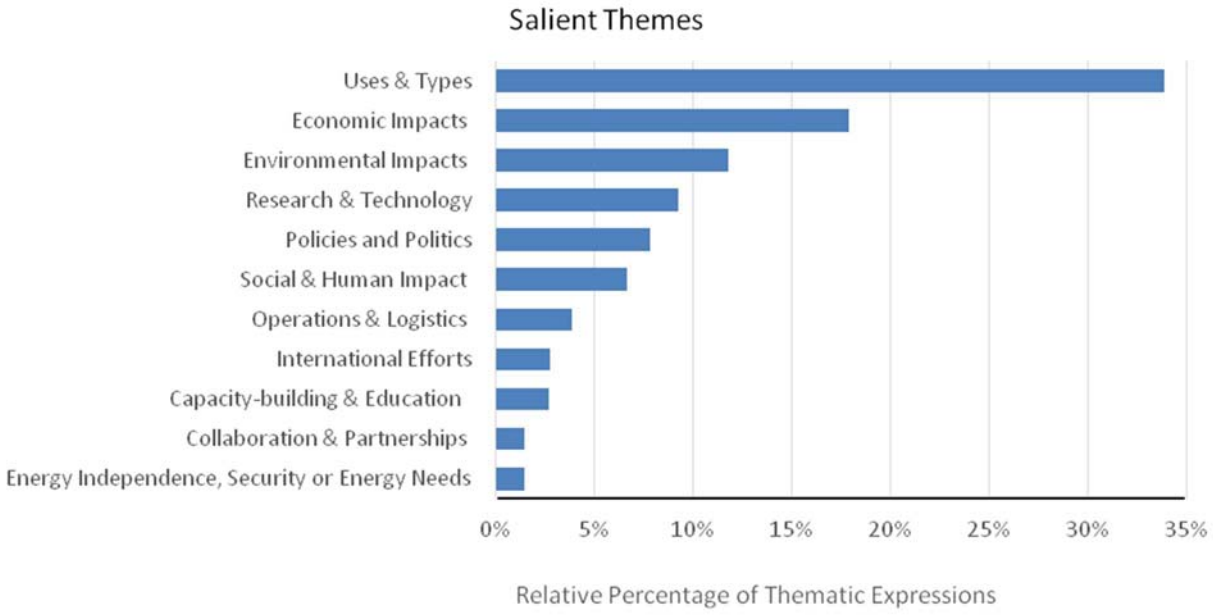

Figure 12. Salient themes in the biofuels discourse. Percentages associated with all three "Thick Data" random samples of the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples.

Beyond references to specific uses and types of biofuels, *economic impacts* were the most frequently referenced theme, making up 18% of expressions. Only 12% of tweets referenced *environmental impacts*. Other prominent themes included *research and technological advancement*, *policies and politics, and social impacts*, each contributing approximately 8% of the discourse. Less frequent themes included *operations and logistics*, references to *international efforts, capacity-building and training, collaboration,* and *energy independence.* Although each of these themes make up less than 5% of the dataset, they do represent areas of potential importance to stakeholders.

Taken together, these themes offer a broad overview of potential policy preferences and priority areas to consider in planning; however, they are aggregated at a broad scale for users across the Twittersphere. Place-based discourse may be more relevant for policymakers and resource managers focused on developments in the Pacific Northwest because it provides a region-specific context.

4.3.4 *Structural Analysis Findings*

4.3.4.1 Message Type

The Twittersphere's biofuels discourse displayed five distinct communication types. *Straight News and Announcements* comprised over half of the posting content (Figure 3). *Opinions* made up the next most frequent communication type, totaling about 20% of expressions. *Advertisements* and *Calls to Action* each contributed about 6% of the discourse, and *Questions* were the most infrequent type, comprising less than 3% of posting content.

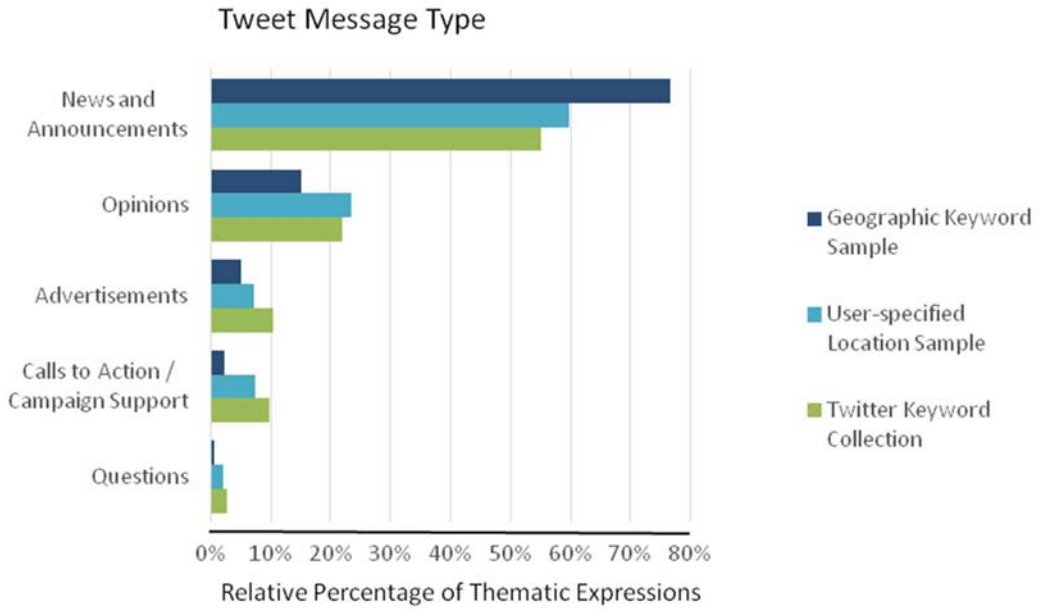

Figure 13. Tweet Message Type. Percentages associated with all three "Thick Data" random samples of the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples.

The Twitter Keyword Collection and two sub-samples exhibit notable differences from one another. The proportion of *News and Announcements* is greatest for the Geographic Keyword Random Sample (77%), smaller for the User-Specified Location Random Sample (60%), and smallest for Twitter Keyword Collection Random Sample (55%). We see the inverse of this trend with *Opinion* statements, which are more frequent in the User-Specified Location Random Sample than in the Twitter Keyword Collection Random Sample (Figure 13), where subjective opinions are more likely to appear in the form of *Advertisements* and *Calls to Action*. One might expect the opposite trend, given the more established debate framing for biofuels in the international Twittersphere. That said, perhaps it makes sense that the Twitter Keyword Collection Random Sample would contain more *Advertisements* and *Calls to Action* because biofuels industries are

better established nationally and internationally, whereas in the Pacific Northwest they are still in a pilot phase.

The Geographic Keyword Location Random Sample appears somewhat anomalous in its distribution of tweet message types. Upon closer inspection, it becomes clear that tweets sampled using location keywords are fundamentally different types of tweets which cover different types of content. Tweets sampled in this way appear to focus more on straight news reporting. Location keyword sampling thus creates additional considerations for comparison and use in informing environmental issue preferences for policy analysis.

4.3.4.2 Information Sharing (URL Links)

A regional industry report found that for a cross-section of Twitter data from the West Coast U.S., tweets with URL links comprised 30% of the sample (Smith, 2017). Another study conducted by Liu et al., (2014) considering tweet behavior in 2014 suggests that across the broader Twittersphere, about 12% of tweets contain URL links. In contrast, this dataset found that on average across the smaller "Thick Data" random samples of the Twitter Keyword Collection and two main samples, approximately 87% of the messages included URL links (Table 11). The higher frequency of URL links in this issue-specific discourse may indicate that users engaged in conversations about biofuels on Twitter rely on the site more for information sharing rather than as a social media source. This finding contribute to the theory suggested by Kwak et al. (2010) about Twitter's role as a direct news and information conduit rather than a platform for social media use. That being said, Twitter has recently developed features which make it easier for users to share retweets and comment on them (Shu, 2015). This may change the nature of how Twitter is used in the future independent of the topic of discussion.

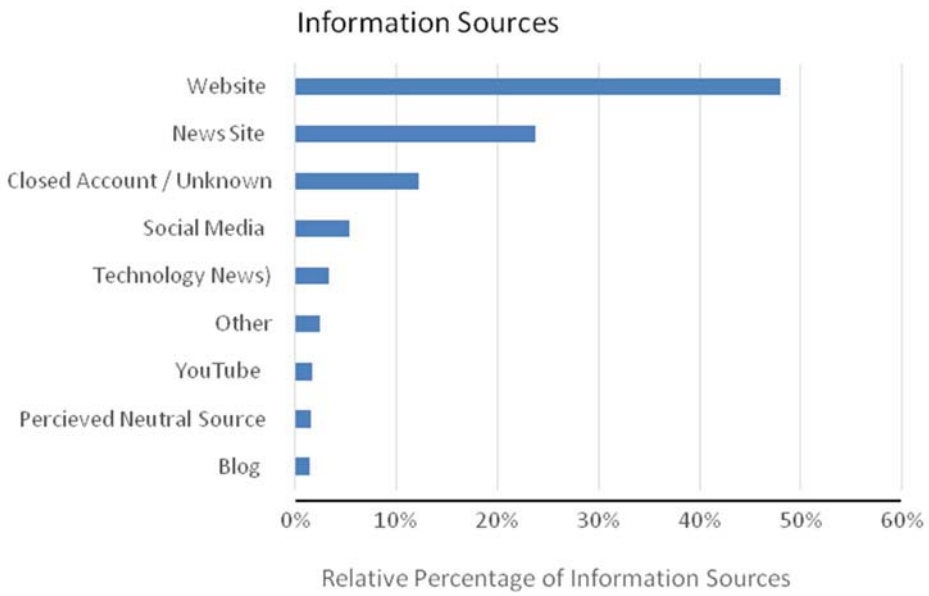

Figure 14. URL links to specific type of information sources. Percentages associated with all three "Thick Data" random samples of the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples.

Results from the URL coding of the Twitter Keyword Collection, User-Specified Location Sample and Geographic Keyword Random Samples showed that the majority of URL-linked sources were issue-specific websites (Figure 14). These results are evidence that Twitter users focused on the biofuels social discourse share URL links to support very specific topics. Moreover, approximately 43% of users who include a URL link in their tweet have at least one link directly to an advocacy site or website presenting a particular frame rather than a more "balanced" news reporting frame (Boykoff & Boykoff, 2004). This may be explained by the Pacific Northwest region's growing research advances in biofuels. For example, through the development of the Northwest Advanced Renewable Alliance, the Advanced Hardwood Biofuels research consortium and the advent of five new demonstration sites for growing wood-based cellulosic feedstock (Advanced Hardwoods Northwest; Northwest Advanced Renewables Alliance).

4.4 Discussion

Though Twitter has its limitations, it is a useful medium for helping policymakers and natural resource managers to identify relevant discourse and determine issue priorities. In policy dialogue and environmental planning, discerning preferences is a necessary foundation for developing more socially acceptable outcomes. Twitter supports this through providing access to salient themes and associated opinions and sentiment. *Opinions* were present in 20% of the tweets collected from the "Thick Data" random samples. Additionally, *Calls to Action* provide further access to policy actors who may be influential in the development of biofuels in the region.

Salience for each expressed theme can be measured based on tweet frequency per user, number of mentions, and retweets. In addition, researchers must compare not only the relative frequency of tweets across samples, but also the number of unique contributions made by users. Across the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples, 90% of users contributed at least three tweets and 77% contributed unique tweets, demonstrating that some members of the issue public are actively engaging with the biofuels discourse. The lower virality in this sample may be a sign that biofuels discourse has not yet spread to the broader public and is limited to a small group of more knowledgeable users, though further study is need to validate this.

In the following discussion, I present four key findings that may prove beneficial for policy analysts in prioritizing issues, as well as natural resource managers seeking to implement policies, programs, and projects. These include a discussion of micro-discourses; the presentation of an emerging position discourse; a characterization of key stakeholders, institutions, discourse

coalitions, and vocal minorities; and a discussion of these stakeholders' influence in the Twittersphere. I end with a discussion of the importance of place-specific context considerations.

4.4.1 *Biofuels Micro-, Meso-, and Macro-discourses*

Micro-discourses are context-specific, sometimes localized subsets of broader discourse (Alvesson & Karreman, 2000). A key finding from this study is that micro-discourses exist for biofuels and that these discourses are accompanied by their own set of salient themes and preferences. Several micro-discourses are associated with specific types of biofuels and bioenergy. The most frequently referenced bioenergy types across the Twitter Keyword Collection, User-Specified Location and Geographic Keyword Samples were advanced cellulosic biofuels, biomass, and ethanol. By examining frequency of expression, I discovered differences in sentiment across these three bioenergy types (Figure 15), as well as differences in theme salience (Figure 16).

In the micro-discourses around these bioenergy types, 75% of tweets express positive sentiment toward advanced cellulosic biofuels energy sources, 72% express positive sentiment toward biomass, and 50% express positive sentiment toward ethanol. Only 4% of tweets associate advanced cellulosic biofuels with negative sentiment (Figure 17). Only 9% of tweets about biomass express negative sentiment, compared to 20% of tweets about ethanol (Figure 18).

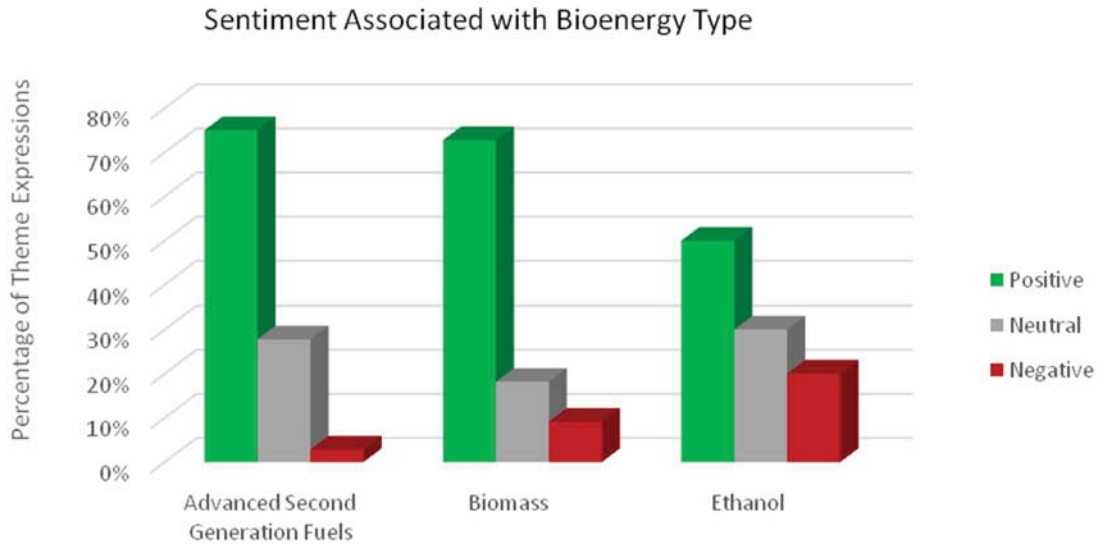

Figure 15. Sentiment associated with bioenergy type. Percentage of tweets classified by sentiment associated with the three primary bioenergy types for the Twitter Keyword Collection Random Sample.

Negative sentiment for biomass is lower than I expected given the national and regional protest movements against this type of biofuel (Tomei & Helliwell, 2016). Perhaps this is because mentions of biomass often reference feedstock more generically, rather than specifically discussing combustion-based power generation. Such distinctions were difficult to determine based on tweet text alone, so both reference types were grouped into the same category. This is one of the limitations of working solely with the tweet text. Future analysis might consider using the URL links to provide additional context to help distinguish between these categories. It is likely the positive sentiment would be lower and negative sentiment would be higher for biomass-based power.

Upon closer examination of the themes associated with these bioenergy categories clear differences also exist and may provide more insight into corresponding sentiment. For example,

relative to other biofuels types, ethanol is more strongly associated with themes regarding *politics and policies, social and human impacts,* and *economic impacts* (Figure 16).

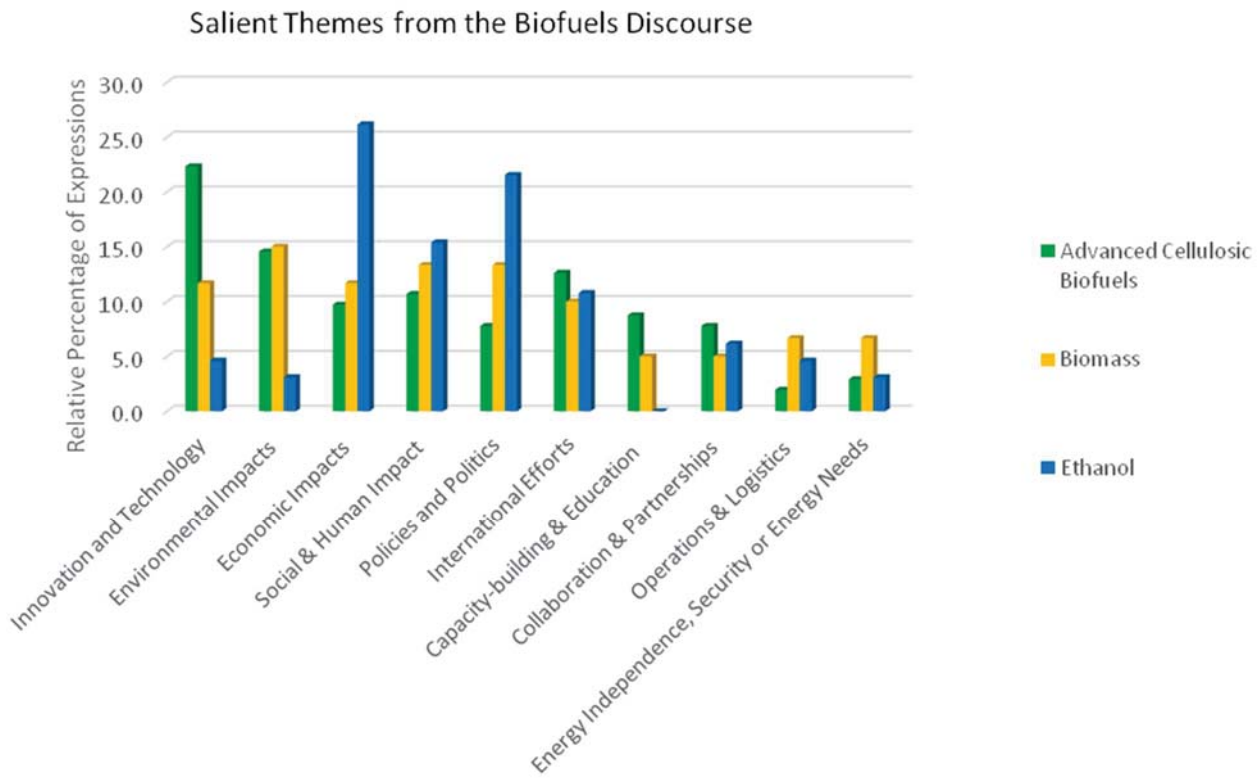

Figure 16. Comparison of salient themes in the biofuels discourse based on bioenergy type for the Twitter Keyword Collection Random Sample.

References to politics and policies regarding ethanol focus on the renewable fuels standard, regulations associated with different ethanol types (E15, E85 etc.), and discussions of government subsidies. Additionally, safety concerns regarding railway transport of ethanol may partly explain the higher frequency of expressions about *social and human impacts*.

Another notable thematic difference is that *innovation and technology* is far more prominent in the advanced cellulosic biofuels micro-discourse than it is in the micro-discourses

associated with biomass and ethanol. Given the recent outpouring of support for developments in biofuels, it makes sense that the discourse would be dedicated so strongly to this theme. This also accounts for the relatively higher frequency of *capacity-building and education* themes in tweets about advanced cellulosic biofuels.

Frequency of expressions for *operations and logistics* is notably higher for ethanol and biomass than it is for advanced cellulosic biofuels. Many logistics discussions focus on the challenge of supply and feedstock access to support demand for energy production. This may be in part because ethanol and biomass are more generic terms however.

It is important to remember that the frequency of expression of themes contains positive, negative, and neutral sentiment, and that these themes are broader indicators of issue salience, rather than delineating areas of contention. For instance, the *environmental impacts* theme is associated with positive sentiment in the advanced cellulosic biofuels micro-discourse, primarily due to stakeholders' hopes about this feedstock's potential to mitigate climate change and its ability to serve as a green alternative fuel source (Figure 17).

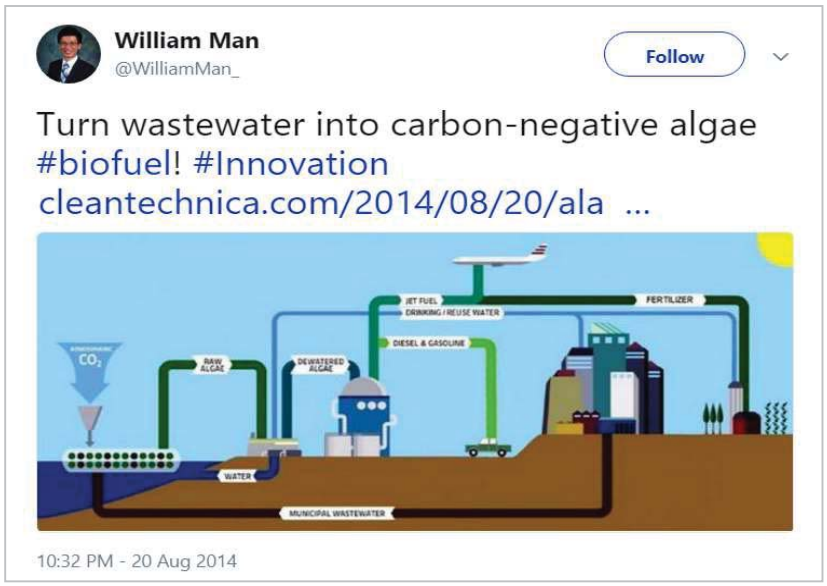

Figure 17. Example tweet about advanced cellulosic biofuels expressing positive sentiment toward biofuel potential to mitigate climate change.

However, *environmental impacts* is associated with more negative sentiment in the ethanol micro-discourse due in part from concerns over climate change mitigation potential, the ability for ethanol to function as a green fuel alternative and land use change (Figure 18).

Figure 18. Example tweet about ethanol expressing negative sentiment toward biofuels' potential to mitigate climate change.

Without the consideration of these micro-discourses, important preferences may be missed. For example, the higher-level sentiment analysis of the biofuels macro-discourse suggests the issue public holds a more positive sentiment toward biofuels in the United States. However, because bioenergy type-specific differences exist at the theme level, the macro-level results seem to obscure fine-level details about issue public sentiment. Thus, the findings that preferences are linked to specific bioenergy type are evidence that these details matter in examining the biofuels discourse.

4.4.2 *Emerging Position Discourse*

Analysis of biofuels at the micro-discourse level provides evidence for the existence of related *meso-* and *macro-discourses* associated with it. For example, at the macro-level, biofuels may relate to the Grand Discourse-level discussion of climate change. The Grand Discourse-level includes an integrated collection of discourses within it presented as a holistic frame (Alvesson & Karreman, 2000). In the biofuels discourse, this is demonstrated most prominently by themes relating to carbon reduction and climate change mitigation. The issue publics' position statements about biofuels may stem from previously formed positions about climate change. Thus, understanding biofuels through the lens of the Grand Discourse on climate change may provide additional insight into the issue public's underlying problem definitions and conceptualization of the issue.

The meso-discourse level is characterized by seeking patterns within the broader discourse, though sometimes still in a localized context (Alvesson & Karreman, 2000). In this case, a prominent pattern that seems to be occurring is the coupling of social justice and environmental

frames when advocacy groups describe energy policy issues. This meso-level discourse might be thought of as an *energy justice discourse* or a *clean energy discourse.* A mature policy discourse, one in which a problem frame exists for both proponents and opponents, is often measured on the bases of publicly articulated position statements and the development of institutions or organizations supporting that position (Hajer, 1993). This appears to be the case with the *clean energy meso-discourse*, with organizations developing around several prominent discourse coalitions. Discourse coalitions are entities that form and act in connection with a particular discourse (Hajer, 1995).

Examples of primary entities associated with the *energy justice discourse* include Biofuel Watch, which operates internationally but has a local campaign; the Energy Justice Network, which is primarily focused on the United States; and No Biomass Burn, which operated in Oregon and Washington at the time of this study. This discourse appears to be in opposition to the development of biofuels at first glance (Figure 19).

Figure 19. Example tweet from possible *Energy Justice Discourse*

However, deeper examination of micro-discourses around bioenergy type suggest that although there is negative association with biofuels as evidenced by tweets and text available on

websites, this appears to be most strongly focused on opposition to biomass-to-energy plants, first-generation ethanol production and feedstock extraction that takes place in previously forested land. Biofuelwatch for example, has very little mention of biofuels in their mission statement on their website (Biofuelwatch, 2017). Furthermore, the vast majority of the 360 tweets produced by Biofuelwatch included in the Twitter Keyword Collection focus on #biomass as demonstrated by a simple keyword search among tweets (Figure 20).

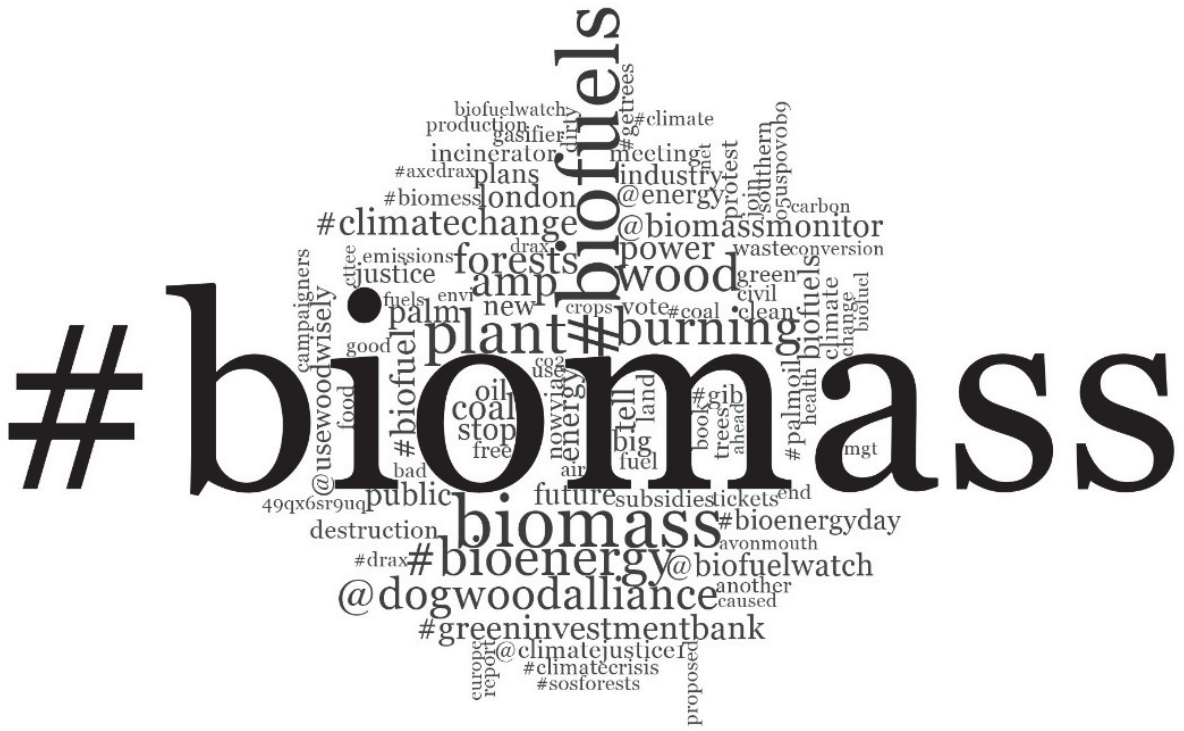

Figure 20. Word cloud demonstrating prevalence of tweets focused on #biomass produced by @biofuelwatch in the Twitter Keyword Collection.

The biomass-to-power component in advanced cellulosic biofuels generation may be responsible for drawing the ire of this discourse coalition. Of note, No Biomass Burn appears to

be reducing its activity. Originally responsible for organizing protest campaigns, this group became less active after several losses in 2011 and 2012; it is unclear how active this group is now (Bach 2012; King 2011). According to the Way Back Machine, the nobiomassburn.org website went up for sale in 2015. Moreover, the organization stopped tweeting in 2012. Despite the possible dismantling of this group, approaching biofuels through the lens of this meso-discourse of *energy justice* and *clean energy* may help identify key political actors, particularly those taking oppositional position statements. It also improves access to texts regarding this discourse coalition's underlying preferences, which may inform more acceptable policy outcomes.

4.4.3 *Key Biofuels Issue Publics & Influence*

In addition to understanding the *what* of positions and preferences via biofuels discourses, Twitter can help identify the *who*. Moreover, through an examination of relative retweets, tweet frequency, and mentions, it is possible to determine the level of influence political actors may have in the Twittersphere. Analysis of tweet texts and user accounts makes it possible to identify which individuals and groups are expressing preferences around biofuels, even if they have not yet formally presented these attitudes. This provides clues to future position statements that existing organizations may have, and points to the existence of pre-organizations which may eventually form a discourse coalition and are therefore important to monitor for future activity. In the following sub-sections, I discuss the relevance of using Twitter to examine established organizations, vocal minorities, and pre-organizations. I also discuss the influence of bots on the biofuels discourse and implications for policy analysis and environmental planning.

4.4.3.1 Established Organizations and Discourse Coalitions

Established organizations with position statements are the most accessible political actors for policy analysis. They usually have a web presence, are mentioned in the news, and may have public relations or communications specialists actively working to make their organizations more well-known. Twitter appears to be an excellent medium for gaining access to organizations affiliated with industry, research institutions, and advocacy organizations (Table 12.) This leaves out government stakeholder groups who don't use Twitter, which does pose some real limitations. That said, Twitter can be used to help identity or confirm potentially influential stakeholders who should be invited to participate in policy dialogue, and to prioritize which positions and underlying preferences to consider in crafting new programs. These entities are important because they represent discourse coalitions which act together to influence discourse and policy development within their sphere of interest.

Twitter is also valuable for helping identify and characterize preferences for established organizations which do not express position statements publicly. These organizations are often either peripherally related to the biofuels discourse or are still deciding how to proceed with their positions on the issue. Industry groups and research organizations have a clear motivation for participating in the biofuels discourse, while the majority of environmental advocacy groups, with the exception of the Natural Resources Defense Council (NRDC, 2015; Schlossberg, 2016), have not taken strong positions beyond the opposition to burning whole trees for biomass. It is possible to extract environmental advocacy stakeholders' preferences by examining their tweets, which may in fact serve as a proxy for future positions. Within the three "Thick Data" random samples, I identified 25 environmental advocacy entities, which contributed 1,629 tweets to the broader

discourse on biofuels. These findings reaffirmed the presence of the *clean energy meso-discourse* and revealed organizations and individuals who might have otherwise been missed via traditional snowball sampling techniques.

User-based sampling is an excellent option for examining organizations and potential discourse coalitions in situations where political actors and more established organizations can be anticipated. The Rainforest Action Network (RAN), a prominent national environmental advocacy organization is one such example. A simple search of RAN in the Twitter Keyword Collection revealed 34 tweets in the dataset. All of these tweets were part of @TransportEnvironment's a letter-writing campaign to support biofuels reform. @TransportEnvironment contributes 202 tweets to the dataset. By following a link-trace snowball approach of references within the tweet text combined with automated network analyses of retweets and mentions, Twitter quickly becomes an asset for identifying established organizations and gaining access to their stated and sometimes unstated positions. This example is particularly useful for understanding RAN's preferences, because although they do not provide a very clear stance of their position online, there are hints of the organization's strong opposition to biofuels development in forum comments and unofficial pages (Rainforest Action Network, 2017). However, their shared campaign with Transport&Environment makes it clear that they are opposed to first-generation biofuels in particular. This provides additional insight into RAN's possible flexibility in preferences toward hybrid poplar biofuels grown on non-forested farm land.

4.4.3.2 Vocal Minority, Pre-organizations, and Influence

Twitter users can exert a disproportionate amount of influence over the discourse by flooding the Twittersphere with tweets. This creates an opportunity to identify these vocal minority

voices and assess their influence. Vocal minority users include both individual and entity accounts. Accounts such as @MME_Seattle and the @TheClimateCult actively express opinion statements in the Twittersphere, but do not have much presence outside of it. Their activity may indicate a pre-organizational stage where positions exist, but no official institutional arrangement has formed to support the development of a discourse coalition. Twitter allows for access to accounts such as these and provides opportunity to consider stakeholders who may have been missed through more traditional sampling techniques such as snowball sampling or literature reviews.

Keyword co-occurrences in the Twitter Keyword Collection and two sub-samples can provide additional insight into vocal minority accounts. I present a comparison of keyword co-occurrence results from #*Biofuel, Biofuel, Biofuels* and #*Biofuels* in Table 13 found in the User-Specified Location Sample. At first glance, each keyword appears to be associated with relatively different keywords. #*Biofuel* messages focus on hemp and the medical marijuana industry, whereas *Biofuel* is more closely linked with waste energy and energy production in general. #*Biofuels* appears related to climate activism, while *Biofuels* is associated with fracking, energy, and advanced bioenergy (Table 13).

Table 14. Comparison of Top Keyword Co-occurrences
Top 7 most frequently occurring words associated with #Biofuel, Biofuel, #Biofuels and Biofuels in the User-Specified Location Sample.

#Biofuel	Biofuel
#HEMP	ENERGY
INTERESTED	PRODUCTION
#FOOD	POOP
#CBD	#CROWDFUNDING
#MEDICAL	RENEWABLES
#CANNABIS	ALGAE
ENERGY	GREEN
#Biofuels	Biofuels
CLIMATE	INDUSTRY
CHANGE	FRACKING
STOP	ENERGY
FOREST	AUTO
DESTRUCTION	ADVANCED
VOTE	RESEARCH
#WASTE CONVERSION	PLANT

After further investigation, I removed retweets and mentions from the set, suspecting their inclusion might unduly influence keyword co-occurrence. This shifted the keywords associated with *#Biofuels* to align more closely with keywords associated with *Biofuels*. It turns out the *#Biofuels* mentions were associated with an environmentalist letter-writing campaign which flooded the Twitter discourse (Figure 21). The author of the campaign is an individual user from California called @wildincrisis. Her tweets alone were enough to influence the keywords in the set toward more environmental themes (Table 13).

Figure 21. Example Tweet from @wildincrisis

Another example I discovered through the keyword co-occurrence was, @MME_Seattle. @MME_Seattle is part of a larger Twitter network of medical marijuana growers who support using hemp as a feedstock for biofuels. The discovery of @MME_Seattle ultimately unearthed four other MME accounts spanning different cities. MME accounts do not express position statements publicly, which obscures their potential to influence biofuels development. Through the purposeful or accidental coupling of keywords such as #hemp, MME accounts were able to flood #biofuels related discourse (Table 13). Despite only making up 2% of industry association discourse, they have linked #Biofuels with their position statement supporting hemp rather than trees for feedstock in favor of trees.

Vocal minority accounts can also be located through an examination of the top tweeting user accounts. @TheClimateCult is example of a vocal minority entity account that lacks a public presence such as a website or other indicators of a more established organization. @TheClimateCult presents climate-skeptical views and opposes bioenergy development. @TheClimateCult accounts for 1031 tweets and about 0.2% of the total tweets in the Twitter Keyword Collection.

Example Tweet from @TheClimateCult:
[#BioFuels If At First You're Not Believed, Lie, Lie Again http://t.co/OPwKhjK4Tq]

Tweets from @TheClimateCult make up the largest proportion of advocacy tweets after @maskunta in the "Thick Data" random samples. @TheClimateCult represents a second pathway to influencing the biofuel discourse by engaging in frequent direct tweets, in contrast to strategic coupling with a hashtag.

@Anonymous6 is an example of a prominent individual account that provides tweets with a position statement toward biofuels. @Anonymous6's tweets are negatively associated with bioenergy in general and biomass in particular. @Anonymous6 also appears to be affiliated with @Energy_Justice and @BiomassMonitor, two established advocacy entities.

Example Tweet from @Anonymous6:
[#Biofuel Hell http://t.co/WIKV8jacAI #bioenergy #biofuels #biofuel #biomass #biomess #dirtyenergy #airpollution #asthma #pollution @350]

Individual accounts such as @wildincrisis and @Anonymous6, and entity accounts such as @TheClimateCult and @MME_Seattle provide evidence for the influence of the vocal minority in the Twittersphere. These accounts should be simultaneously monitored for their expression of preferences on biofuels as well as invited to participate in future policy dialogues on the development of biofuels in the Pacific Northwest.

4.4.3.3 Bots and Implications for Sentiment Analysis

An important finding from this research is that bots may influence the dataset; it is therefore essential to identify them so researchers can anticipate their influence on interpretations of the discourse. Bots and spammers are either fully automated or semi-automated computer programs

that are able to post to social media platforms with little to no human oversight once the program is initiated (Howard & Kollanyi, 2016). Political bots, now commonly found in social media, are more specialized and were first recognized in 2010 (Wooley, 2016). They are designed with the specific purpose of spreading political propaganda, flooding newsfeeds and making it difficult for users to determine facts clearly (Wooley, 2016). It is currently unclear how much influence these political bots may have in the online discourse in the Twittersphere, however, recent literature suggests there may be an influence on hashtag associations (Howard & Kollanyi, 2016).

Two possible bot accounts in this dataset are @Anonymous1 and @Anonymous2. It is difficult to tell if these are people or bots definitively; however, the tweets only make marginal sense, have similar sentence structure, and have cryptic profile photos and descriptions which are all common features of bot profile accounts (Howard and Kollanyi, 2016). Combined, tweets from these two accounts comprised almost 4% of the total discourse over the 6-month period. Because their tweets are frequently nonsensical or neutrally worded, @Anonymous1 and @Anonymous2 exert an unclear influence over the discourse about biofuels.

However, due to the positive word associations, they might influence unconscious psychological associations over time. For example, @Anonymous2 frequently uses the word "biomass" in association with positive words such as "renewable" and "cornucopia" (Figure 22).

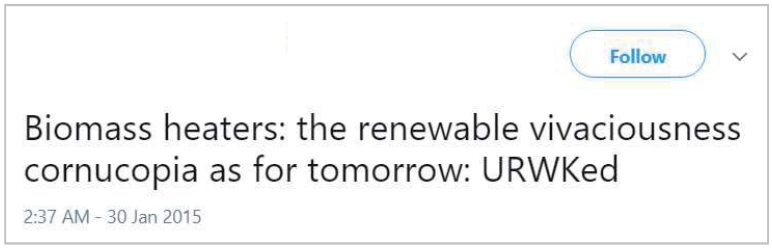

Figure 22. Example tweet from @Anonymous2

Eventually, this might influence the discourse itself if it shapes the unconscious associations of other users (Bazerman, M. H., & Moore, 2008). Further research is needed in this area to explore alternative methods for validating this influence.

Ultimately, any large-scale application of a sentiment dictionary for analysis will most likely skew the results if word associations produced by bots are included in the dataset. "Big Data" researchers should take precautions to filter for bots as much as possible seeking out common features of bots such as frequency and timing of tweets and account profile information (Howard & Kollanyi, 2016). The fact that there are bots present in this dataset is interesting unto itself because most of the research that has been conducted on bots has focused on polarized issues or political elections, where political actors are seeking to manipulate public opinion (Wooley, 2016). The existence of bots is an indicator that someone is seeking to manipulate the discourse. Understanding more about who these sources are and what topics they are seeking to influence may provide keys for future development of the biofuels discourse in the United States.

4.4.4 *Place Matters*

In natural resource management, place matters. Regional environmental policies, local and state environmental planning efforts, and boots on the ground in the farm next door all have specific place-based influences that need to be considered for piloting socially acceptable policies, programs, and projects for biofuels development (Shindler et al., 2004). Place-based discourse, or at least place-focused discourse, is a meaningful part of environmental planning and natural resource collaboration (Burdge, 2004; Healey, 2006; Wondolleck & Yaffee, 2000). That said, how important is place-based discourse for environmental issue conceptualization in the Twittersphere?

Results from this study are evidence that place matters in the Twittersphere as well for the overarching biofuels discourse. This is most clearly seen through a comparison of the frequency of thematic expressions between the Twitter Keyword Collection (Figure 16) and the User-Specified Location Sample which focuses on themes from the Pacific Northwest (Figure 23). Despite clear differences in theme frequency related to bioenergy type within each collection of tweets, there are prominent differences between the two samples most likely due to differences in local context, preferences and understanding of biofuels. Differences are most noticeable among *economic impacts, social and human impacts*, *policies and politics*, and *international efforts*.

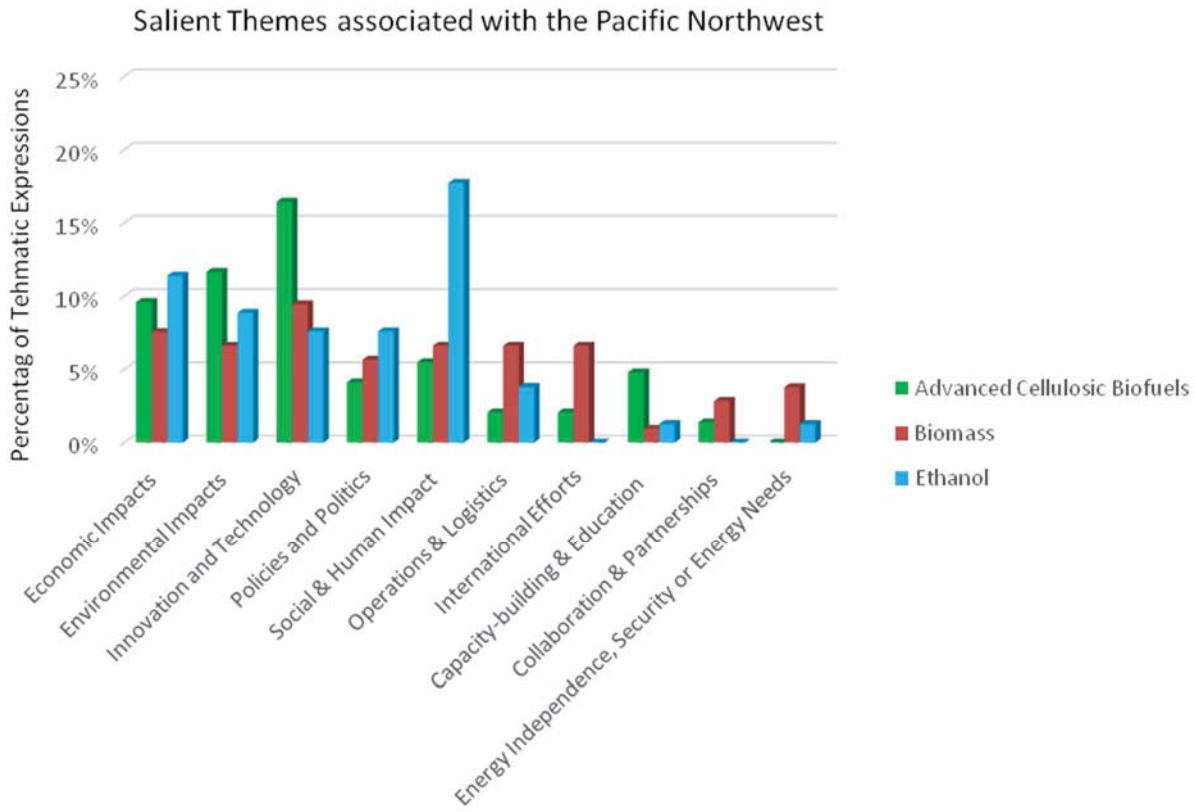

Figure 23. Comparison of salient themes in the biofuels discourse for the User-Specified Location Random Sample

Social and human impacts themes follow what one might expect for this trend upon first inspection. Human rights discussions and the *food versus fuel* debate are strongly present in the international discourse. This appears to be reflected in the Twitter Keyword Collection Random Sample, which holds the most frequent number of expressions on this theme (Figure 16). NIMBY concerns and protests are specific place-based behaviors, and thus more likely from stakeholders actually living in or identified with a particular region. Thus, one might expect the User-Specified Location Random Sample to exhibit the highest relative frequency of *social and human impact concerns*. However, the Twitter Keyword Collection Random Sample has an overall higher frequency surrounding this theme due to social justice and human rights concerns throughout the international biofuels discourse. Although the overall median trend is higher, with 16% of the Twittersphere's thematic expressions focused on social and human impacts, it appears that ethanol specifically is associated with 18% of social impacts-related discourse in the Pacific Northwest. Upon closer examination of the tweets connected to ethanol in the Pacific Northwest, it appears many of these tweets are related to concerns over *food versus fuel*. Although these findings warrant further examination, it seems that in the Pacific Northwest, many negative perceptions of the social impacts of biofuels are associated with ethanol, and are specifically tied to the *food versus fuel* debate. This finding points to an important priority area for collaboration and exploration with stakeholders in the formation of constructive management alternatives for biofuels development in the Pacific Northwest.

4.5 CONCLUSION

This study of the Twittersphere contributes to the emerging body of literature that explores the potential of social media analysis for policy guidance and rapid issue tracking (Bengston et al., 2009). Accessing such a high volume of naturally occurring communication continues to pose a challenge, especially as events unfold in real time (Bengston et al., 2009). That said, advances in technology and in researcher understanding create better guidance for application in environmental policy and planning (Jang & Hart, 2015).

This work offers a novel examination of what kinds of knowledge can be meaningfully gathered from Twitter data, since environmental discourses differ depending on place-based phenomena. Further, this study contributes to the literature by demonstrating that Twitter is a viable source for not only theme-specific sentiment, but also opinion data, both of which can be utilized to explore social perspectives of the issue public.

Several key findings from this study will prove helpful for policy analysts in prioritizing issues and making decisions, as well as program managers seeking to implement policies and programs on the ground. First, by examining user behaviors such as infrequent retweeting, this study discovered that the biofuels policy discourse appears to be limited to more knowledgeable users more interested in accessing Twitter as a news source. Furthermore, though not a contentious issue as a whole in the United States, biofuels does have an engaged issue public. Second, both interpretive analysis of themes and quantitative keyword co-occurrence suggest distinct micro-discourses surrounding specific feedstock types and uses. Decision-makers, program managers, and communication specialists must bear in mind the specific bioenergy type in order to successfully communicate and prioritize issues. Lastly, results from the interpretive analysis

indicate location-based differences in theme salience for biofuels issues. This reaffirms the importance of context-specific knowledge for natural resource managers and environmental planners.

In addition to providing information about what is being said, an examination of Twitter discourse can also identify who is saying it. This Twitter analysis brought to light several related industries that were not captured through literature reviews and exploratory conversation with stakeholders. Thus, Twitter data may help policymakers identify and include unanticipated political actors and characterize their level of influence in the Twittersphere.

Given that this research suggests the importance of place for the construction of social discourses around environmental issues, future studies might explore the link between place-focused tweeters and place-based environmental phenomena. For example, researchers could identify place-based discourses by comparing tweet source locations with proposed and existing bioenergy plant sites. This would provide policymakers with a readily available source of key stakeholder policy preferences, position statements, and perhaps even discourse coalitions. It may even indicate a list of existing and future policy actors who should be brought into planning and decision-making discussions. Ultimately, Twitter's direct real-time access to relevant discourse and key policy actors can provide critical knowledge for arriving at constructive natural resource management decision-making and policy outcomes.

5. CONCLUSIONS

In this dissertation, I introduce three complementary yet distinct research studies in order to explore the ways that shared meaning supports constructive policy dialogue. I used Q-methodology and a grounded interpretive mixed methods approach to conduct a systematic analysis of the structure of stakeholder and issue public social discourse surrounding biofuels development. Taken together, these three studies generate knowledge that will help policymakers gauge the social acceptability of hybrid poplar-based biofuels in the Pacific Northwest. These studies provide detailed information about the social perspectives of stakeholders and the issue public engaged in shaping the development of this new industry.

This research contributes to the literature advocating for a more constitutive role for discourse in policy analysis and a more reflective approach to policy analysis itself. Moreover, this investigation contributes methodologically to the field of environmental policy analysis and planning by providing a model for structured analysis of social perspectives, detailed knowledge of which aids decision-makers in successfully negotiating potentially polarizing policy proposals such as those for sustainable energy.

This research also extends the potential for rapid issue tracking (Bengston et al., 2009) to the realm of social media. Mixed methods interpretive approaches for "Big Data" studies are comparatively rare and as such, developing effective methods for handling these type of data are critical to advancing the field. This work also offers a novel examination of what kinds of knowledge can be meaningfully gathered from Twitter data, while further exploring how users in the Twittersphere engage with a place-based phenomenon.

In the final chapter of this dissertation, I present a brief comparison of the key insights generated from each study, summarize the major policy recommendations resulting from those insights, offer an overview of core methodological learnings, and provide suggestions for future research.

5.1 Comparison and Synthesis of Findings

Each of the three studies in this dissertation contributes distinct yet complementary insights to the overall understanding of the biofuels social discourse in the Pacific Northwest. In Chapter 2, I focused on exploring stakeholder perspectives of biofuels as a perceived potential problem in this region. This study revealed three distinct perspectives that were deeply interrelated in some ways, yet quite opposing in others. The *Political Social Will Perspective* defined biofuels as a problem in terms of logistic, political, and public perception challenges; the *Compatibility and Capacity Perspective* focused on issues of regulation, transportation, and compatibility; and the *Supply and Communication Perspective* was concerned about challenges with supply, information, and compatibility. None of these perspectives were negatively correlated with one another, indicating that the different problem conceptualizations are not incompatible, and in fact overlap in certain key areas. Needless to say, this was a good sign for future policy dialogue. Chapter 2 contributed the important insight that the international food versus fuel debate is less relevant for stakeholders in the U.S at this time. All three perspectives agreed unanimously that fuel versus fuel is *not* a problem.

In Chapter 3, my research moved beyond problem definition, delving into specific concerns stakeholders may have about biofuels, as well as how they conceptualize biofuels' benefits. The

discourse around wood-based biofuels is so nascent in the Pacific Northwest that concerns might be easier to capture than specific problem definitions, particularly among stakeholders who are relatively new to the emerging policy dialogue. In other words, stakeholders' concerns may offer early insight into problem definition before those definitions are even formed.

Three perspectives emerged from this Q-study: the *Risk-Tolerant Optimistic Perspective*, in which stakeholders favored technology and expressed more comfort with biofuels' perceived risks; stakeholders who loaded onto the *Risk-Averse Environment-Focused Perspective*, who advocated for environmental concerns; and stakeholders who loaded onto the *Skeptical Pragmatic Perspective*, who expressed a strong hesitancy to leave the status quo. Stakeholders associated with the *Risk-Tolerant Optimistic Perspective* and *Risk-Averse Environment-Focused Perspective* held conflicting frames around of biofuels' risks and benefits; their perspectives were negatively correlated with each other.

That said, this study clearly delineated which benefits to highlight for each of the three groups, which issues to downplay to avoid alienating other perspectives. and which specific concerns were priority areas to address before they evolve into perceived problems. Chapter 3 also linked pre-existing environmental discourse with the emergent perspectives surrounding biofuels' perceived risks and benefits. In particular, this study's findings overlapped strongly with the stakeholder typology developed by Focht and Lawler (2000). By drawing from existing discourses, policy analysts may be able to anticipate how stakeholders will respond to future discourse interactions.

Chapter 4 provided broader context to the biofuels discourse through a quantitative analysis of the Twittersphere biofuels discourse. It also used a grounded interpretive coding protocol to

examine location-specific tweet samples in order to discern areas of discourse that the Q-studies overlooked. Analysis of the Twittersphere provided information about the users' behavior in the Twittersphere, the user accounts themselves, tweets, and the structure of tweets and messages. Based on user behaviors such as infrequent retweeting, this study concluded that the biofuels policy discourse was still emerging on the Twittersphere, a finding that corroborates Chapter 3's analysis.

The Twitter analysis confirmed the stakeholder categories used for the Q-studies, and also added several stakeholder groups such as Citizens, Transportation, and Related Businesses. I targeted Related Businesses as a stakeholder group for the Q-study, but it was difficult to anticipate which businesses might be related to biofuels development without first conducting the Twitter analysis. The Twitter analysis brought to light several related industries that were not captured through literature reviews and exploratory conversation with stakeholders. Future studies would do well to conduct the Twitter analysis in advance of the Q-study, enabling researchers to decide which stakeholder groups to include on the basis of empirical observation rather than theoretical conjecture.

Analysis of tweet-based discourse also provided valuable information about the geolocation of the issue public discourse in relation to the place-based proposals for biofuels development. Place matters in this discourse. Results from the grounded interpretive analysis of the Twitter Keyword Collection and two sub-samples suggest location-based differences exist in theme salience for biofuels issues.

Furthermore, this research indicates that the biofuels type matters to the issue public. The grounded interpretive analysis points to the importance of the biofuels type in determining the

associated sentiment and themes. For example, while sentiment for the overall biofuels discourse is largely positive, the biomass and especially the broader ethanol discourse provokes much more mixed sentiment. Additionally, different stakeholders are also associated more strongly with distinct biofuel technology types. Stakeholder comments collected from the problems Q-sort and concerns and benefits Q-sorts confirm these findings. Finally, analyzing the structure of the tweet provided information about the types of messages shared in the discourse and how users shared information.

The two Q-studies and the grounded interpretive analysis of the Twittersphere are complementary though not necessarily substitutable because of the different types of knowledge they generate. Nevertheless, a comparison between the two study types provides a useful synthesis of important themes and supports triangulation of the research findings. In Table 14 I present a shortlist of the priority problems, concerns, negative opinion themes and examples synthesized across all three studies. The salience of each theme presented for the Q-studies was determined by selecting problems or concerns where stakeholders ranked them with a Z-score of 1 or higher. The Twitter theme salience was determined by selecting from among the top five most frequently tweeted-about themes in the regional-focused twitter discourse (User-Specified Random Sample and Geographic Keyword Random Sample). Each theme within the Twitter top five listed includes several original tweets per theme produced by unique users unless otherwise noted. The top five themes that emerged from examining negative opinion about biofuels in the regionally-focused Twittersphere include *Environmental Impacts*, *Social and Human Impacts, Economic Impacts, Policies and Politics* and *Operations and Logistics.* I reclassified each example from across the three studies within a new composite list of themes generated from the Twitter top five list just

described and the coding classification scheme used in the Q-study design structure listed in Appendices A-3 and A-4.

Table 14. Synthesis of priority problems, concerns or negative opinion themes from Q-study 1, Q-study 2 and regional analysis of the Twittersphere

Priority problems, concerns or negative opinion themes	Q study 1: Regional stakeholder perspectives about problem definition	Q study 2: Regional stakeholder perspectives about specific concerns	Regional-focused issue public twitter discourse
Economic Impacts	Cost of transportation of feedstock	"Biofuels needs to make money"	"Can hardly make a buck"
	Level of government subsidies	Not in favor of subsidies	May "waste billions in public money"
Environmental Impacts	Sustainably meeting demand	Exploiting forests for fuel	Drives deforestation (especially abroad) and generally unsustainable
		Drought may be a concern	Causes droughts
		Conversion of wildlands and habitat reduction	Cause of species extinction*
			Biomass harmful to air quality
			Does not help with climate change mitigation
			GMO benefits associated with biofuels are misleading
			Concerns over raising cost and reduced yields of competing grain-based foods
Social Psychological		Risk aversion toward new technology	
		Desire for trust and communication with developers	
		Lack of faith in industry	

Logistics and Supply	Logistics is a challenge rather than having enough land base	Challenge of compatibility with existing infrastructure	
Logistics and Supply	Lack capacity to produce enough fuel to meet demand	Not sure if they are feasible	Not renewable, need of systemic change to make them feasible, "unrealistic"
	Access to "readily available feedstock"		
			Transporting biofuels via train a concern
Politics and Policy	Political will and lack of government support for biofuels		
Regulation	EPA is against everything and "analysis paralysis"		Biofuels mandates are more harmful then helpful
	Lack of access to water rights		
Social/ Human Impacts	Marginalized communities are impacted by pollution from industry	Importance of siting location to minimize smell and visual impacts	Marginalized communities in industrial areas**
Departure from the Status Quo	Competition with Natural Gas		
Communication and Public Perception	Need for demonstration site		
	Reliability of information rather than slogans and propaganda"		Information claims are misleading, studies promoting biofuels are "flawed"
	Biggest problem is public perception		
Performance and Safety	Biofuels harm machinery and vehicle engines	Disagreement that wood-based biofuels are safe for use with vehicles	Ethanol is harmful for cars

**Only 1 original source replication (though multiple retweets within random sample)*

***Although the tweet content focuses on pollution, the broader campaign shared through the website links embedded within the tweets are part of Clean Energy Meso-discourse focusing on marginalized communities*

There appears to be considerable cross referencing for most of the main themes among the three different studies with concerns regarding economic, social and environmental impacts, performance and safety, and logistics and supply remaining consistent (Table 14). In fact, all

themes from this composite list were found to exist across the three studies however there are differences in which themes were discussed or ranked as a high priority. For example, social psychological themes surrounding trust and sense of risk were ranked as high priorities only in Q-study 2 which focused more on the future development of biofuels. Climate change mitigation is an example of a subgroup within the *Environmental* theme where differences arose between the Q-study priorities and the Twittersphere concerns. Although Q-study participants across all perspectives considered this theme, they did not rank it as a priority concern, whereas it repeatedly surfaced as a concern in the Twittersphere. This may be due to the disproportionate influence of specific vocal minority users I discussed in Chapter 4. The difference in priorities might signal a strongly held minority viewpoint that may need to be addressed in order to develop constructive alternatives that are socially acceptable or at least tolerable to engaged stakeholders and the issue public.

"Food versus fuel" is another difference in priorities emerging out of the Q-study and the Twitter analysis. "Food versus fuel" was a prominent aspect of the *Social Impacts* theme among the regional Twittersphere discourse even though among the targeted stakeholder groups across all three perspectives in Q-study 1 they did not find it to be problematic. Again, this may relate to differences in bioenergy type because there were no mentions of advanced cellulosic biofuels associated with the "Food versus fuel" concern in the regional tweet sample. These concerns were expressed in association with ethanol or biofuels more generally.

Taken as a whole, the three studies indicate both a certain frame flexibility across stakeholders and a lack of clarity around biofuels as a concept. Both Q-studies suggest that individual stakeholders hold multiple perspectives, and in the benefits and concerns Q-study

stakeholders even hold conflicting ones (approximately 30%). This is echoed in the grounded interpretive analysis of the tweet-based discourse of biofuels, with 60% of stakeholders viewing biofuels more positively, and 16% viewing them more negatively. Although overall sentiment was more positive in the Twittersphere, it was still quite mixed for four of the six stakeholder groups. This may be partially explained by the finding that there are distinct discourses relating to bioenergy type existing within the broader biofuels discourse, and that the biofuels discourse itself is connected to an even broader and more mature discourse of sustainable energy, which is in turn complicated by its association with the highly politicized climate change debate. Priming any particular aspect of this discourse influences how stakeholders conceptualize biofuels development issues.

That said, even though I primed stakeholders in both Q-sorts to consider wood-based biofuels specifically, stakeholders who completed the sort repeatedly referenced other types of bioenergy in their explanations for their choices. Additionally, in my initial thematic analysis of online sources about biofuels, I observed the issue public indiscriminately using different terms such as biomass and biofuels to presumably mean the same thing within a single forum or online conversation. This was further echoed by specific instances of advocacy organizations who posted mission statements about biofuels in general online, while they actually expressed specific preferences for bioenergy type without clarifying distinctions in their tweets. Thus, although the synthesis of themes presented in Table 14 combines observations of the discourse from very specifically selected stakeholders with the issue public who make reference to biofuels more generally the cross validation of themes may still be helpful for anticipating the emerging preferences around hybrid poplar biofuels more specifically.

The issue public and stakeholders' lack of consistency in referencing biofuels demonstrates the complexity of defining biofuels as a natural resource management issue. The way stakeholders and the issue public express their associated preferences suggests that they lock on to one particular discourse—for instance, biodiesel or corn-based ethanol—and develop beliefs around it that are difficult to speak to unless one knows which core discourse they are referencing. Ultimately, this kind of precision in communication is vital for facilitating a constructive policy dialogue, rather than one in which people unknowingly speak past each other.

5.2 SUMMARY AND RECOMMENDATIONS

Wood-based biofuels in the Pacific Northwest are just becoming part of the policy dialogue for biofuels. This issue is still in the early phases of formation. The discourse includes five main types of policy actors, only some of whom have taken active positions on the issue of biofuels. In the following summary; I describe the emerging biofuels dialogue; characterize policy actors; and discuss recommendations for policymaking, collaboration and co-learning, and strategic communication.

5.2.1 *Emerging Biofuels Policy Dialogue*

- The biofuels policy dialogue in the United States, though ongoing for some time now, is still very fluid. Clear issue crystallization does not appear to exist across the country, let alone the Pacific Northwest.

- The Biofuels Discourse is strongly tied to, and in some cases may be considered a subset of, the broader discourse of Sustainable Energy or Clean Energy. Because the Sustainable Energy Discourse is related to the Climate Change Debate, there is potential for more politicized frames to emerge.
- Ethanol has become a highly politicized discourse, but first-generation alternatives have largely been dropped from the discussion on meeting sustainable energy development goals.
- Stakeholders may confuse the biofuels discourse with any number of distinct sub-discourses associated with specific feedstock types and uses. Biomass, which is associated with the biofuels discourse, is viewed negatively by several strong interest groups.
- The conversation has moved toward second-generation advanced biofuels and overall sentiment tends to be more favorable toward these fuels.

5.2.2 *Policy Actors*

- The biofuels discourse is characterized by six main policy actor groups: news media, government, research and education, industry, advocates, and engaged citizens.
- Of these six stakeholder groups, only some of them are engaged in formal position discourse, and of these only some have developed organizations and institutions to support their positions.

- Industry stakeholders who have taken favorable positions toward biofuels include growers, related businesses, the transportation sector, and energy producers. Government stakeholders have taken a position formally supporting biofuels, as indicated by the Clean Energy 2007 Bill and recent USDA NIFA grants support biofuels development in the region. Researchers have also taken a favorable position toward biofuels.
- Both environmental and community advocacy stakeholders are generally mixed in their support of biofuels, and have not taken clear positions. There are three notable exceptions: rural community advocates, climate skeptics, and clean energy activists.
- Rural communities, especially eco-villages, are in various stages of organizing to support bioenergy development. They are especially focused on sourcing their own local energy supply. A notable development is the biomass2methanol group in the Windward Community located in Klickitat, WA.
- Climate skeptics make up a small but active subset of advocacy stakeholders who take a position against the development of biofuels.
- Clean energy activists comprise another subset of the advocacy stakeholders. These activists have taken a strongly negative stance toward biomass incineration in particular, and by association tend to take a negative position toward biofuels as well. These stakeholders are most strongly affiliated with the No Biomass Burn group, the Energy Justice Network, and the international organization Biofuels Watch, which also heads up local campaigns. Clean energy activist stakeholders focus both on social justice and environmental issues. They are actively engaged in protests across the country.

- The main active campaign in the Pacific Northwest was run by the No Biomass Burn group in association with the Energy Justice Network. They protested development of the Seneca Co-generation Facility in Eugene, Oregon due to air quality concerns for local marginalized communities.

5.2.3 *Recommendations for Policymaking*

- Stakeholder perspectives on biofuels are complex: design policies to address emergent perspectives rather than appeal to specific stakeholder group interests. This holds true for stakeholders who have taken positions, and also for those who have not.
- Most stakeholders are flexible in the frames they hold toward biofuels, and may be open to reframing exercises.
- Use caution in highlighting benefits, as some benefits alienate different segments of the population.
- Problem definitions and specific concerns for biofuels tend to be associated with distinct biofuel feedstock types and energy use. Create very specific recommendations for each feedstock type and use where possible.
- Political party affiliation may be a dividing feature among stakeholders because the biofuels discourse is associated with pre-existing debates. A deeper investigation into intrapersonal perspectives and frame flexibility may improve the success of future dialogue.

- State location may be a dividing feature among stakeholders due to differences in cultural and/or state-wide regulations. A deeper investigation into intrapersonal perspectives and frame flexibility here may improve the success of future dialogue.
- An urban-rural divide appears to exist among advocacy stakeholders. This is associated with NIMBY campaigns and localized health concerns. A deeper investigation into intrapersonal perspectives and frame flexibility here may improve the success of future dialogue.

5.2.4 *Recommendations for Collaboration and Co-learning*

- The seven areas of contentious disagreement from Q-sort 1 related to problem definition are the main priorities for collaboration and co-learning. Areas were stakeholders held differing levels of belief regarding the main challenge of biofuels include: supply, compatibility, water, politics, regulation, social justice, and public perception.
- The five areas of contentious disagreement from Q-sort 2 regarding benefits and concerns are additional areas for collaboration and exploration with stakeholders. These include: the perception of national security as a benefit, the viability of biofuels as an alternative to fossil fuels, the long-term sustainability of biofuels, environmental impacts, human impacts and the level of governmental support of biofuels development.
- Clarifying issues surrounding the compatibility and safety of biofuels with existing vehicles and machinery, food versus fuel, genetic modification and the possible

conversion of "wild" forested lands to feedstock grow sites are priority areas raised by vocal minority in the Twittersphere discourse.

- Areas where stakeholders feel neutral sometimes represent areas where they lack knowledge. The points of neutrality highlighted in the two Q-studies are important places to prioritize for co-learning and outreach.

5.2.5 *Recommendations for Strategic Communication*

- Problem definitions and specific concerns for biofuels tend to be associated with distinct biofuels feedstock types and energy use. Distinguish which biofuels type and use stakeholders are referring to prior to communicating associated benefits, risks, or concerns.

- All three perspectives strongly agreed on the importance of trust and good communication with biofuels developers. Strategic communications specialists should ensure this need is met by striving for inclusion and highlighting process components to biofuels development.

5.3 COMBINED INSIGHTS FROM TWITTER ANALYSIS AND Q-METHODOLOGY

There are several advantages to using Twittersphere analysis and Q-methodology as complementary sources for social perspectives. Both Q-methodology and Twittersphere analysis offer insight into the conscious and unconscious preferences of stakeholders and the issue public, but they do so in different ways. Q-methodology is superior to other methods in its ability to reveal

latent values and beliefs embedded in subjects' preferences; however, it is also possible to identify these attitudes by analyzing Twitter data.

Twitter represents a platform for free communication exchange, which creates an environment where language is occurring naturally. Thus, topics gleaned from this dataset can reveal its users' conscious and sometimes unconscious—conceptual frames. As in Q-methodology, these themes emerge directly from the data and represent a less biased sampling of issues. Furthermore, although Twitter is influenced by the news media's issue-attention cycle, this effect can be partially buffered by collecting themes over time—an advantage it holds over single point in time methods such as Q-methodology, surveys, and interview research. Generally speaking, analyzing discourse in the Twittersphere is a better approach than using Q-methodology to extract conscious preferences and intentionally expressed agendas.

Twitter data also hold distinct advantages over datasets collected from other digital media platforms. Because interactions in the Twittersphere are more anonymous, discourse on Twitter is subject to less bias than one observes in the direct user-to-user discussions in online forums and news media websites. Thus, preferences expressed over Twitter may be closer to those that would be expressed in person, while still being produced freely and interpersonally rather than elicited through a survey.

Twitter has the advantage of helping capture potentially unforeseen stakeholder groups and identify new citizen policy actors. This dissertation discovered that the transportation sector, clean energy activists, and related businesses were key stakeholders in the biofuels discourse. For all the care taken to explore as many relevant dimensions as seemed warranted, the Q-method studies overlooked these actors entirely. Furthermore, Twittersphere data include important information

about behavioral trends such as mentions and retweets, which can be used to track the influence of these new policy actors.

Finally, one of the great strengths of using Twitter as a data source for social perspectives is the option to collect location data from users at such a large scale. Linking the discourse to location is very important for researchers interested in place-based phenomena such as biofuel development in the Pacific Northwest.

5.4 Suggestions for Future Research

I suggest four avenues of inquiry for future research: examining dimensions of influence between perspectives more deeply; conducting geospatial analysis of tweets in association with physical energy production plant locations; automating sentiment and thematic analysis of "Big Data;" and exploring the connection between news media framing, public opinion, and stakeholder specific discourse.

5.4.1 *Dimensions of Influence*

One of the findings from this study regards the different dimensions which may cause differences in social perspectives. Though these are difficult to determine in advance, both Q-methodology studies discovered distinct potential differences within the Pacific Northwest. It falls to policymakers to consider each state's differing preferences for sustainable energy development due to variations in cultural context, state regulations, and ecological characteristics. At a local level, investigating the urban-rural divide may provide deeper insight into stakeholder preferences. In addition, while researchers frequently explore political affiliation, examining within-group

differences may prove invaluable for navigating identity-based tensions as they map to politicized discourses such as corn ethanol and the broader climate change debate.

5.4.2 *Geospatial analysis of Tweets Based on Bioenergy Type*

The differences between location-based tweets provide evidence that exploring both place-based phenomena and users' spatial relationship to discourse can provide the hyper-local context knowledge that policy analysts need to facilitate more constructive policy dialogues. Furthermore, since different bioenergy types such as biodiesel, biofuel, and biomass appear to have distinct discourses, researchers can focus their explorations of these discourses by homing in on the geographical regions where these bioenergy types are most prevalent. Parsing tweets by keyword could determine whether tweets associated specifically with ethanol, biomass, or biodiesel occur with more frequency in locations that support plants producing that specific type of biofuel. This simultaneous identification of location-specific micro-discourses and broad-scale analysis of online discourse could have tremendous implications for environmental policy and praxis.

5.4.3 *Automated Sentiment and Thematic Analysis*

Advances in software for automated text analysis have made it possible to conduct high level sentiment analysis on large datasets (Liu, 2012; Young and Soroka, 2012). Thematic analysis will soon be possible, though the technology is still being developed and tested (Jang & Hart, 2015). Part of the task of developing automated analysis is training the program with human-coded data. This dissertation lays the foundation for this training dataset and can be used to apply it toward thematic analysis of large corpuses of data. Automated theme and sentiment coding would be especially valuable for gaining quick insight into stakeholder preferences surrounding the

different feedstock types and energy uses, which appear to cue distinctly different discourses, values, and belief systems. This particular topic could be auto-coded more readily than others due to the simplicity of the keywords associated with each feedstock type.

5.4.4 *Connection between news media, public opinion, and stakeholder discourse*

Both Q-studies suggest that news framing of the biofuels discourse focuses more on energy independence and food versus fuel debates than actual stakeholders discussing biofuels in the Pacific Northwest. The results indicate that stakeholders are most concerned with other issues, though this is not mirrored in the news media coverage. This discovery is slightly incongruent with prior research findings indicating that public opinion mirrors the news media's issue-attention cycle (Fan, 1995).

There are several potential explanations for this phenomenon, all of which bear further study. One possibility is that energy independence and food versus fuel issues are more readily accessible points of debate for the general public. Results from the Twitter analysis considering the issue public perspective supports this by demonstrating differences for sentiment that vary by stakeholder type, geographic location and bioenergy type. Future work could explore this further through in-depth interviews with stakeholders or other more "Thick Data" interpretive means.

5.5 Concluding Remarks

How do we as a society have a dialogue with ourselves? When different words can mean the same thing, and the same words can mean different things, how can we reach shared meaning with one another? For that matter, how do we arrive at shared meaning within ourselves, integrating competing narratives and value systems?

This research can help stakeholders reach clarity around their dueling monologues to arrive at a shared dialogue about sustainable energy alternatives. Much of this work involves engaging the unconscious level of social perspectives (Stephenson, 1988). Sometimes, this means redefining concepts to show the range of different meanings present in a discourse. Other times, it means helping people understand the disparate meanings they hold for terms like "biofuels" and "sustainable energy," which seem to cue unique and distinct discourses. When our preferences become known to us, and we share meaning, we can begin to enter into collaborative dialogue and develop constructive alternatives together.

The conscious levels of social perspectives frequently involve knowingly-held identities and agendas, which are often more salient around adversarial policy dialogues (Rydin, 2003). In this case, a skilled facilitator equipped with the knowledge produced in this work can aid in the construction of shared meaning and help move us more toward collaborative dialogue (Healey, 2006). Gaining clarity around conscious and unconscious priorities fosters the development of more constructive resource management options.

This kind of non-zero-sum collaboration brings engaged stakeholders closest to Bohm's (1996) original view of dialogue, which seeks to preserve the humanizing relationship between parties. The philosopher Martin Buber (1970) refers to this conscious effort at humanization as the I-You relationship. In an ideal world, policy dialogue takes place in conditions close to Bohm's Dialogue and preserves the I-You relationship (Buber, 1970) between all parties. As many scholars have noted, processes that foster trust and goodwill are critical to successful collaboration (Wondolleck & Yaffee, 2000). Therefore, beyond constructive directions for the policy problem at hand, decision-makers should also strive for human outcomes that inspire,

replenish, and nourish participants in the planning and implementation process. This orientation in praxis has the potential to produce outcomes that honor the earth's planetary boundaries, foster collaboration and democratic engagement, and respect the living and non-living beings involved.

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APPENDIX A-1: Q-STUDY DESIGN P-SET STRUCTURE (Q-SORTS 1 & 2)

Main Effects	Level I	Level II	N
A. Stakeholder Group	(a) Industry	1) Trade Association Representatives 2) Biofuel Company Executives (refineries, blenders and chemical companies) 3) Representatives of Biofuel Consulting Firms 4) Labor Representative Executives 5) Small Scale Landowner Associations 6) Industrial Landowner Executives 7) Producer Association Executives 8) Grower Association Executives 9) Energy and Fuel Association Executives 10) Machinery Business Association Executives 11) Transportation Business Association Executives 12) Representatives of Energy Investment Firms	19
	(b) Government	13) State Representatives 14) Local Government Leadership 15) Native American Tribes	
	(c) Research	16) Academic Institutions 17) Private Research Institutions	
	(d) Advocacy	18) Environmental Organizations 19) Community Advocacy Groups	
B. Region	Pacific Northwest	(f) Washington (g) Oregon (h) Idaho (i) California (j) Montana	5

APPENDIX A-2: Q-STUDY DESIGN SUMMARY

Q-sample	Types of Statements	Rational	Significance
Problem Framing (Q-sample 1)	Statements framed specifically as a problem or cost	Statements framed specifically as problems or costs were prominent in the concourse.	Understanding the diagnostic framing of biofuel is critical for understanding how stakeholders are defining the problem, and as such how socially acceptable biofuel may be in the future.
General Perceptions (Q-sample 2)	Statements framed as specific benefits or concerns	These more broadly framed statements are distinct from prognostic or diagnostic statements and made up the largest percentage of the concourse.	Broad attitudinal framing is important because it captures nuanced details about how people feel prior to problem identification as well as providing a rich understanding for underlying attitudes, beliefs and values. This helps to more fully characterize the broader picture of sentiment toward biofuel.

APPENDIX A-3: Q-SORT 1 STUDY DESIGN STRUCTURE

Statement Category	Statement Subgroup
A. Economic	Supply; Not Feasible; Subsidies; Conversion Costs; Start Up Costs; Indirect Impacts; Price
B. Environment	Water; Air; Destroy Ecosystem; Beneficial Microbes; Biodiversity; Sustainability; Carbon
C. Social Psychological	a) Negative perception b) Uncertainty c) Risk
D. Logistics	a) Scale b) Logistics c) Infrastructure
E. Politics and Policy	a) Policy bridge b) Politics controlled by industry c) Politics controlled by vote
F. Regulation	a) Enforcement b) Paralysis by Analysis
G. Social Justice	a) Human rights abuses b) Social equity
H. Technology	a) Battery technology b) Outdated technology
I. Energy Efficiency	a) Energy efficiency
J. Status Quo	a) Still gasoline
K. Mechanical Problems	a) Mechanical problems
L. Communication	a) Lack of information
M. Military	a) Cannot have a green military
N. Phosphorous	a) Peak Phosphorous
Total Number of Statements = 43	

APPENDIX A-4: Q-SORT 2 STUDY DESIGN STRUCTURE

Statement Category	Statement Subgroup
1. Environment	Sustainability; Fertilizer; Renewable; Soil; GM; Contamination; Monocultures; Biodiversity; Trees or Forests; Chemicals; Keep Forest Lands; Water; Carbon
2. Social Psychological	Uncertainty; Emotional; Social Identity; History; Trust; Communication; Need for Belonging
3. Economic	Rural Economy; Local Benefits; Diversity; Jobs Future Generations; Made in America; Small Forest Landowner; Competition; Government Subsidies
4. Social Justice	NIMBY; Voice; Exploitation
5. Senses	Smell; Aesthetics; Noise
6. Human Health	Allergies; Air Pollution
7. Status Quo	Maintain Current Lands; Better than Fossil Fuels
8. Food VS Fuel	Inappropriate use of land; Biofuel = Burning Food.
9. Education	Benefits community colleges
10. Feasibility	Feasibility
11. Infrastructure	Works with existing infrastructure
12. Safety	Safe to use
13. Labor	Labor Intensive
14. Energy Efficiency	More energy in than out
Total Number of Statements = 49	

APPENDIX A-5: Q-STUDY DESIGN: POST-SORT QUESTIONNAIRE

Stakeholder Affiliation*
Please select the top stakeholder group you identify with:
○ Farmer / Grower
○ Land Owner
○ Refinery / Producer
○ Labor Union or Labor Representative
○ Investment Company
○ Industry Association
○ Other Industry
○ Academic Institution
○ Private Research Organization
○ Government
○ Native American Tribe

Work Location*
Please select the location where you primarily work:
○ Washington (State)
○ Oregon
○ Idaho
○ Montana
○ California
○ Pacific Northwest
○ Nationally
○ Other

General Comments and Feedback

APPENDIX B: TWITTER CODING PROTOCOL

Example Main Themes	**/ Example Sub-Themes & Definitions**	
Level I: Tweet Textual Content*	**I did not code for emoticons or pictures*	
Sentiment*	*Definition*	*Examples*
Positive	Statements are classified as positive if the topic they are referring to is somehow beneficial, or seen as a positive to some end. AND if it is a positive statement somehow associated with biofuels. Any statements referring to the industry expanding are coded as positive. (Job announcements, new hires, plant expansions, grants are all coded positively.)	- Project LIBERTY Biorefinery Starts Cellulosic Ethanol Production - Torrefied pellets would make your Neos Pellet Cooker even more efficient - California Energy Commission awards $5.1M to 3 alt-fuels projects; - Fantastic end at the Nordic Biogas Conference in Iceland, visiting the
Neutral	Information is presented in more of a journalistic or objective tone. Either balanced presentation of content OR it is hard to tell if supportive or not given the lack of information. (Note: If message is about advancement or development of biofuels industry even if worded neutrally that is positive.)	- Director of @NEChamber member @reheatRT joins board of national trade org. @NECCLesd #northumberland - does BAE stand for boost and ethanol? - Biofuels Program - School of Trades, Technology, Sustainability and Professional - #IPB Public Lecture of Microalgae and Biofuel Expert of IPB with Murdoch University in FPIK IPB

Negative	Not supportive of biofuels or bioenergy; or is negative and somehow associated with biofuels or bioenergy. Statements that are related to the industry contracting or failing are coded as negative.	- EPA GHG regs put biomass plant at risk - World does not have room to produce 20% of human energy needs from bioenergy by 2050 - Public Opposition Spurs County to Delay - Dear @spietikainen please vote to stop #biofuels increasing hunger, forest destruction and climate change
Unclear	Sentiment is expressed but unclear whether in support or not of biofuels (For example, mergers and acquisitions are sometimes unclear if biofuels project is expanding or closing down) And price announcements, when we do not know if they are meant to be received as high or low	- Ethanol acquisition is largest Sacramento takeover in years - Sacramento Bee - $PEIX DTN - Friday 02/27/15 | Northern - California ethanol 8-cents per gallon gain. - Energy Production | EPA delays decision on biofuel blending mandate - Minneapolis Star - Comment period on Oregon Clean Fuels Program closes Nov. 7, hearing scheduled for Nov. 6. #ethanol
Salient Themes	Definitions	*Examples*
Advocacy	Author tries to persuade reader or tweet recipient to take specific action. News about other people trying to persuade leaders and citizens to take specific action. Public comments solicited for government policies or policy reports.	- Dear @spietikainen please vote to stop #biofuels increasing hunger, forest destruction and climate change - I voted @CountableUS on "Less Corn in Your Gas Tank: Eliminating an Annual Ethanol Incr..."

		- Comments due Dec. 8 on California Energy Commission's Draft 2014 Integrated Energy Policy Report Update. #biomass - RT @DomesticFuel: Preaching Conservation with Biodiesel and Ice Cream: Three recent college grads have been spending their summe...
International Efforts	Tweets about international trade, partnership, and collaboration; includes tweets about business/industry, treaties and policies, research, conferences, NGO work, and other cooperative efforts.	- PDF: Global #Bioenergy Supply and Demand Projections for the Year 2030 - Fantastic end at the Nordic Biogas Conference in Iceland, visiting the Sorpa landfill biomethane plant - Time to move forward on EU biofuel policy
Energy Independence, Security, or Energy Needs	Tweets about sourcing energy needs from within the nation, state, or community. Emphasis on energy security and freedom from fossil fuels.	- RT @RepScottPeters: California leading the way in advanced #biofuels innovation that will help our military's energy security. - RT @ENERGY: We're investing home-grown biofuels to increase our energy security, create jobs & #ActOnClimate - Largest City In Vermont Now Gets All Its Power From Wind, #Water And Biomass
Capacity Building and Education	Announcements for conferences, public lectures, training opportunities, internships/fellowships, and online education materials.	- Oregon Ethanol Producers to Get Safety Seminars: Ethanol producers in Oregon will be getting some safety help.... - Policy Fellowships Available for Clean Energy Non-Profits-Autumn 2014-Washington, DC-Biomass Thermal Energy Council
Feasibility	Tweets about how workable and possible the transition to biofuels, renewable energy, and	- World does not have room to produce 20% of human energy needs from bioenergy by 2050

	carbon-neutral/carbon-negative infrastructure may be. Includes studies on technological compatibility, biofuels' economic viability, and the carrying capacity of the earth. Includes speculation on "potential" or "viability."	- EU biofuel production could rise without adding to deforestation, study says - New Report Urges Western Governments to Reconsider Reliance on Biofuels
Compatibility With Existing Technology	Tweets about how compatible biofuels are with current technology. (For example: Will ethanol ruin the engine in my car?)	- 92% of all new sold cars in Brazil use ethanol as fuel - New GMO Corn #Ethanol Will Ruin Your #Car and Void Your #Warranty http://t.co/85kfuxwRFO via @naturalsociety#RadiantHealth
Economic Impacts	Messages about regional economic benefits, industry news, new plants and projects, job opportunities, tourism, grants and other funding opportunities, finance, markets and investing, mergers and acquisitions, etc.	- Ethanol Joins U.S. Fuels Dominating Global ExportÂ Market - @Pacific_Ag is seeking growers in Kansas for residue management pilot program. #biomass #wasteconversion - #Energy #Job in #Geneva, Geneva: EXPERIENCED ETHANOL OPERATOR - PC003914 at Ampersand World http://t.co/KksV3KFIWy #Jobs
Environmental Impacts	Messages and opinions about the effect of biofuels on the environment. Includes rhetoric around "sustainable," "alternative," "green," and/or "clean" energy, business, etc.	- Fact check: Ethanol mandates are doing more harm to the environment than good - US, California double down on climate change, energy security via new initiatives: - Study shows biochar alters water flow to improve sand and clay - Badgers set to live alongside biomass plant!
Innovation, R&D, Technological Advancement	News about research (especially from universities), technological advancement (including biotech), and pilot programs to test new technology or business models.	- Merrick designs, commissions hydrothermal processing pilot system for algae. #biomass - Evaluation of the efficiency of

		biogas treatment for the removal of siloxanes: Raich, Jordi, author - @PelletFuel Calorgen Biomass Ltd have developed a 100% green binder that has lowered energy consumption in making wood pellets & briquettes.
Military	For use by the military.	- US Navy Eyes Biofuels to Fuel Fleet of the Future #biofuels innovation that will help our military's energy security.
Policies and Politics	Legal disputes, policies, regulations, law makers, government actions.	- More Regulatory Stability and Incentives for Biogas and Biomass Projects - E.P.A. Postpones Setting Standards for Biofuel Blends
Social & Human Impact	<u>Impacts related to the following:</u> Accidents & Safety DIY Energy Projects Food vs Fuel Human Health -- Air Pollution Local Impacts Protests & Opposition Substance Use Trust & Information Claims <u>Local Impacts:</u> where local city name, town or reference is made. Reference to local area is made.	<u>Example of Local Impact:</u> - This Sunday at @kansasspeedway 700 #ethanol advocates will cheer on @anonymous - Growing bio-fuels deprives locals of their natural foodstuffs.
Operations & Logistics	Tweets about transporting fuels and feedstock, current supply, equipment and machinery used as well as other logistics of production and distribution of biofuels	- #Backpacking Biomass Stove that fits your Pocket - the fuel at this station is non ethanol which is often better
Feedstock Uses & Types		

	Relating to different feedstock types and alternative energy sources including the following: Advanced /Second-generation Biodiesel Biomass to Electricity Ethanol Natural Gas Other Part of Commercial Product Renewable Energy Transportation [cars and flights] Waste to Fuel Wind Solar Geothermal Wave	- Project LIBERTY Biorefinery Starts Cellulosic Ethanol Production - 2% of all new sold cars in Brazil use ethanol as fuel - Tiny algae are making big plays: cleaning up water, then making biofuels - #ethanol has reduced gas prices by more than $1/gal. - Using sewage sludge to obtain bioenergy

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Level II: **User Information**		-
Account Type	*Definition*	*Examples*
Private /Individual	Users are classified as Private/Individual if their name or Handle (or both) reflect an individual and their photo is of an individual.	- Full Name = Matthew Spoor, Handle = @MatthewSpoor, Twitter Picture = Individual - Full Name = Anonymous, Handle = @Anonymous, Twitter Picture = Logo,
Organization	Users are classified as an Organization if their name or Twitter Handle reflects an entity perceived as larger than an individual, their photo is a logo, and they are a news source, news aggregator, or advocacy group not selling a product.	- Full Name = FreshPatents, Handle = @FreshPatents, Twitter Picture = Logo, Description = NEW Patents, Technology, Gadgets & Science for inventors, entrepreneurs, scientists, IT pros. FREE patent PDFs by Google, Apple, Facebook, social media & more - Full Name = CSLA Biomass, Handle = @BiomassUpdate, Twitter Picture = Logo, Description = Biomass energy information captured from the world in real time. Brought to you by The Center for Site Location Assistance - Full Name = VegasLifeToday, Handle = @vegaslifetoday, Twitter Picture = Logo,

		Description = Keeping our friends informed about everything that's happening in Las Vegas
Business	Users are classified as a Commercial Business if their name or Twitter Handle reflects an entity perceived as larger than an individual, their photo is a logo, and their entity represents a product or service for purchase.	- Full Name = Fluke Corporation, Handle = @FlukeCorp, Twitter Picture = Logo, Description = OFFICIAL FLUKE TWITTER ACCOUNT - A manufacturer and seller of world-class test and measurement equipment for over 60 years! - Full Name = Solar Analytics, Handle = @PVwizard, Twitter Picture = Logo, Description = PVwizard's monitoring solutions are designed to detect and diagnose solar under performance for revenue critical PV sites. - Full Name = Anonymous, Handle = @Anonymous, Twitter Picture = Logo, Description = innovative packaging solutions with a focus on sustainability ~ consumer | retail | industrial #innovative #sustainable #packaging
Other	Users are classified as Other if they do not fit into the pre-existing categories of Private/Individual, Commercial Business, or Organization. One such example is bots.	- @xxaanet with the following info in their account description: "http://xxaa.net - fill your data - xxaa.net"
No Info	Users are classified as No Info if their account has been closed.	- @ theDailyGlobals - @AgCenterSUBI - @Techscram - @vravibabu97
Stakeholder Group	*Definition*	*Examples*
Industry	The stakeholder is classified as Industry if it is representing a distinct group of productive or profit-making enterprises, including: trade association representatives, biofuel company executives, representatives of biofuel consulting firms, labor representative executives, small scale landowner associations, industrial landowner executives, producer association executives, grower association executives, energy and fuel	- @WA_Waste with the following info in their account description: "Waste resource management - waste treatment and energy recovery facilities – from MRF and anaerobic digestion to MBT and advanced thermal treatment plants." - @NEWBioProject with the following info in their account description: "Northeast Woody/Warm-season Biomass Consortium is building robust, scalable, sustainable value chains for biomass energy. ○ Pennsylvania State University

	association executives, machinery business association executives, transportation business association executives and representatives of energy investment firms.	○ newbio.psu.edu”
Government / Political	The stakeholder is classified as Government / Political if it is of, relating to, involving, or involved in politics or concerned with the administration of governmental policy, including state representatives, local government leadership, Native American tribes and political pundits.	- @FOrnbrant with the following info in the account description: “Consul General for Sweden in Mumbai. Tweets about events, happenings and news in Sweden and India. Particular focus on trade, investments, innovations and food!” - @NECCTom with the following info in the account description: “NECC Relationship Manager for Tees Valley - Championing local businesses.”
Research Institutions	The stakeholder is classified as a Research Institution if it functions for either private or public research, or research within academic institutions.	- @LANL_Tech with the following info in the account description: “The union of technology, innovation and business from Los Alamos National Laboratory. (RTs and MTs do not imply endorsements.)” - @P2P_NiBB with the following info in the account description: “Network of Integrated Technologies: from Plants to Products.”
Advocacy Organizations	The stakeholder is classified as an Advocacy Organization if it is supporting a cause or proposal and the main functions is not to sell a product on the marketplace, including environmental organizations and community advocacy groups.	- @Anonymous with the following info in the account description: “Our Lady of Perpetual … rants about food security, climate, and … politics’ - @UseWoodWisely with the following info in the account description: “Help us stop Britain’s wood harvest being burnt. You can also find us on Facebook “
News Agency / Reporter	The stakeholder is classified as News Agency / Reporter if the primary function is to provide news, including community / social advocacy news, environmental news, industry news, and medical news.	- @vegaslifetoday with the following info in the account description: “Keeping our friends informed about everything that's happening in Las Vegas” - @iEPAclimate with the following info in the account description: “News, analysis and perspective on EPA regulations and the climate change policy debate.”

General Issue Public Citizen (Individual)	The stakeholder is classified as General Issue Public Citizen (Individual) if they are representing themselves, determined whereby their name or Handle (or both) reflect an individual and their photo is of an individual, as opposed to presenting as an organization or business.	- @Anonymous with the following info in the account description: '_____ professional…, genomics _____employee. http://yuz.li/8j http://yuz.li/8n Opinions are my own.'
Related Business	The stakeholder is classified as Related Business if it is functioning within the sphere of sustainability and they and they represent a product or service for purchase.	- @forexgood with the following info in the account description: #binary #forex #money Watch Over The Shoulder Of Professional Traders! , follow our Guarantee system" - @cascadiapkg with the following info in the account description: "innovative packaging solutions with a focus on sustainability ~ consumer | retail | industrial #innovative #sustainable #packaging" - @ignivacommodity with the following info in the account description: "Igniva is an International Trading Company, principally engaged in merchandising agricultural Commodities"
Level III: Tweet Structure		
Message Type	*Definition*	*Examples*
Advertisements - Products - Services - New Hire Recruitment - Conferences, Workshops or Training Program	Announcement offering a good product or service for sale. Announcement of job opportunity. Advertisement for conference, workshop or program training. - Excludes biofuel plant/refinery or new grow operation announcements - Excludes references to business names (because majority of tweets includes this or an @ reference)	- Pellets for a Neos Pellet Cooker - What cooking device is in your …bag? - Seeking Experienced Ethanol Operator - Prairie Stop has E85@ $1.59/gal! Not THIS: - Back from filming with a great crew - Visit us at @Kansas Speedway 700

Call to Action & Campaign Ads	Message calling for an action. Action may be letter writing, funding a campaign, or calling for people to change their opinion or behavior.	- Please vote to stop #biofuels increasing hunger. - We stand with the @Dogwood Alliance … stop destroying forests for #biofuels Not THIS: - Stay tuned... We're going to live tweet the grand opening of #cellulosic #ethanol plant
Expert Appeals	Message includes scientific name of species, technical jargon or refers to a study, scientific body, or research group (body of people viewed as credible)	- European study shows biofuel production can increase with low impacts - Promising results from Mercedes-Benz fleet test of Clariant high-octane cellulosic E20 - #USDA #Biomass program promotes forest health and fuels
Straight Info Sharing OR Announcement	Straight News or Announcement often secondary sources but not necessarily. Uses neutral language and tone (though sentiment may be positive).	- Report on ILUC - U.S. funding projects meant to make biofuels competitive - This Sunday at @kansasspeedway 700 #ethanol advocates - Stay tuned... We're going to live tweet the grand opening of #cellulosic #ethanol plant
Opinion	Statement made in users own words most often from primary source. Usually includes a positive or negative sentiment. Op Ed, and editorials titles are coded as opinions. Includes emotionally charged, or non-neutral language (frequently through adjective use). Additional use of adjectives to promote intensity is also coded as opinion. Hashtags may also be used to signify support (sometimes).	- Ethanol pays more than food. That's your future in a nutshell - [We should] encourage clean wood heat/energy, we have inexhaustible supply - Indonesia to squander fuel savings on biofuel subsidies that may drive deforestation

		- City of Gresham Wastewater Treatment Plant. #Biogas #NoIncineration
Question	Message seeking information or an answer - Excludes questions which are news titles - - Excludes questions that are answered within tweet	- Is there a soy shortage in California? - What is biochar and how can it help reduce my carbon footprint? - @SiouxlandNews - Bruce, do you agree with Tom Steyer and Al Gore's position on corn-based ethanol?
Not – relevant	Tweets that share one of the key search terms but are not relevant (Note – includes 1 tweet with no content except a link and *mention*)	- Please read about the #biomaterials used in … #Essure. We need your voice! - …Which means overall fish biomass probably went up. - Ethanol is a poison to the brain. As opposed to cannabis
URL?	*Options*	*Examples*
Presence	Yes/No	This was determined by whether or not a URL was present in the tweet. Examples include: - In Southern Oregon, a $200M project to turn forestry waste into jet fuel http://t.co/1QNd6k7bq6 via @SustainableBzOR #biofuel #aviation - California reclamation authority marks start-up of biogas production - Renewable Energy Focus http://t.co/i1uMPLjriw - Biofuels Policy Analyst: Washington DC - and national biofuel demand on food insecurity... http://t.co/eCTCfTtzC9 #biofuel #foodsecurity

Able to interpret w/out clicking?	Yes/No	This was determined by whether you could identify the Website type from the tweet, without needing to click on the link. Examples include: - Senate candidates stress support for ethanol - Washington Times http://t.co/yR6oCxbvuo - #ProcessNews Bioenergy: California landfill taps methane for power: The $60 million plant is expec... http://t.co/GXIc47P11d @PennEnergy - News: Pacific Northwest National Laboratory Acquires Freeslate Systems to Support Biomass and Renewables Research http://t.co/RolTOSnM4H
URL Links Analysis:	*Definition*	*Examples*
News Article	This type was chosen for news articles coming from online news source publications such as New York Times/Straight News Article or news aggregator sites.	- #BioFuel China ExIm may back Mississippi biofuel plant - Bellingham Herald http://t.co/8b39R8KFJm - Energy Production | Biomass causes problematic emissions too - Washington Post http://t.co/nSUGO49010
Website	This type was chosen for links leading to a website or advocacy news site such as Environment Today Website.	- RT @BiomassMagazine: California offers $11 million in grant funding for dairy digester development program. #biogas http://t.co/Ur34812rzA - Lawrence Berkeley National Laboratory startup Afingen uses precision method to enhance plants. #biomass http://t.co/S5cwdGFEEt
Blog	This type was chosen for links leading to a blog website such as	- Oregon may get rid of ethanol in gasoline: Filed under:

	AutoBlog or Green Environment Blogs.	Government/Legal, Green, Ethanol, Un... http://t.co/zdgaal2O92 via AutoblogGreen - Ethiopia plans to revive biodiesel production: Ethiopia is an unlikely setting for a revived â€œfood ... http://t.co/tbOneIGPEz #biodiesel (http://blogs.ft.com).
YouTube	This type was chosen for links leading to a YouTube video, such as the AHB Biofuels Demonstration Video.	- Check out new @PANGEA_LINK video looking at environmental sustainability of African bioenergy! http://t.co/sqogRQ3AWB @ePURE_ethanol - Ck out this video from @AHB_NW "Building a Bioenergy Workforce in the Pacific Northwest: http://t.co/d7eQiWnxJZ #bioenergyday - I added a video to a @YouTube playlist http://t.co/8J2qoqDVm3 Biochar - agrichar - Terra Preta
Other	This category was used for situations where there were multiple URLs included of disparate types or where the word BioMass was unrelated to sustainability, such as the Xbox 360 Video Game “BioMass” .	- Xbox 360 fsd http://t.co/ltCdxlMxbI - We Share Environment: Renewable energy policies drive production of Southern wood pellets f... http://t.co/lFUgH2AJ2P http://t.co/Rkn2IRjqyV

VITA

Miku graduated from Western Washington University at Huxley College of Environment with her Bachelor of Science in terrestrial ecology in 2006. After working as a field assistant for the Fish and Wildlife Service tracking Mountain Goats in the Cascade Mountains Miku moved to Canada to attend Simon Fraser University and graduated with a Masters in Resource Management in 2010. For her master's thesis, Miku researched community-based collaboration in the Gifford Pinchot National Forest and lived in the town of Packwood for 6 months working with the local community conducting participatory action research. Following graduation, Miku worked for Grassroots Campaigns as a canvassing director in Seattle until she entered the doctoral program at the University of Washington in 2011.