Understanding the discourse of forest restoration and biomass utilization: a Q-method case study of the Uncompahgre Plateau in western Colorado, USA

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Abstract

Using Q-method, we characterize the discourse surrounding forest restoration activities on public lands and the potential harvest and use of resulting forest biomass for the production of bioenergy and biofuels. Q-sorts were completed by 41 participants representing 11 different self-identified stakeholder groups in the Uncompahgre Plateau region of Colorado, USA. We identified four distinct themes, all of which appear to support restoration and utilization to some degree. However, among four distinct themes we find evidence that stakeholders have different levels of and reasons for social acceptance of biomass utilization as a component of forest restoration, which may have implications for how restoration projects will be planned and carried out. Our results contrast with many past conflicts over federal land management, especially timber harvesting, where outright polarization among stakeholders has been evident. In this region there has been consistent collaboration around forest restoration since 1996, which may help explain the lack of polarized opposition to restoration and associated utilization of biomass. The different themes that resulted in this Q-study are intended to provide the collaborative group with information to help them identify divergent and convergent perspectives regarding biomass utilization and therefore what collaborative options might be available to them. The results on the one hand provide evidence of the efficacy of using collaborative restoration approaches, and also provide tools with which this collaborative group can unravel the complex subject of biomass utilization.

Key words: biomass utilization, forest restoration, Q-methodology, stakeholder analysis

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Introduction

In the United States (US) and much of Europe, a wide range of public policies promote the use of forest biomass[1] as a renewable energy resource (Aguilar et al. 2011; Stupak et al. 2007). Previous research has identified social acceptance as a major factor influencing forest management in general (Brunson 1993, Clement and Cheng 2011) and the viability of using forest biomass for bioenergy and biofuels in particular (Stidham and Simon Brown 2011). Social acceptance in this context can be defined as willingness to support rather than oppose the use of forest biomass for these purposes, and can be divided into three dimensions: socio-political acceptance (by the public, stakeholder groups, and policy makers), community acceptance (by authorities and local residents, especially for industrial facility siting), and market acceptance (by consumers, investors, and businesses) (Wustenhagen et al. 2007). In practical terms, the perceptions and attitudes of these groups toward forest land management goals and activities shapes social acceptance and can work to either strengthen or undermine efforts to produce woody biomass as a fuel or raw material.

Though the activities of all landowners are subject to some level of public scrutiny, the influence of social acceptance on the use of forest biomass for energy is generally intensified when the source of biomass is public land (Becker et al. 2009; Nielsen-Pincus and Moseley 2009; Pinchot Institute for Conservation and The Heinz Center 2010; Stidham and Simon-Brown 2011; Sundstrom et al. 2012). Federal land management agencies in the US, such as the US Department of Agriculture (USDA) Forest Service (USFS), must comply with myriad laws and regulations, and are also subject to administrative appeals and litigation by stakeholders who believe management activities are violating the law. This is most commonly associated with environmental groups opposed to timber harvesting but can come from other stakeholders as well (Keele et al. 2006).

The emergence and expansion of collaborative approaches to federal forest management since the early-1990s is due in part to a desire by many stakeholders and the USFS to proactively address conflicts and improve social acceptance of forest land management goals and activities (Cheng and Sturtevant 2012). In the Western US, this move toward collaboration has occurred against a backdrop of large and severe wildfires that have burned millions of hectares since 2000. Past logging, grazing, and fire suppression activities have resulted in unnaturally dense forest conditions, especially in frequent-fire dry forest systems. Encouraged by broad agreement on the need to restore natural forest structures and patterns, stakeholders from across the political and values spectrum have been working collaboratively to accelerate

[1] The United States Forest Service defines "woody biomass", in this paper called "forest biomass", as the trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are generated as the by-products of forest management activities.

the pace and scale of strategically-located management activities, specifically by removing small-diameter subdominant trees and understory vegetation (Allen et al. 2003; DellaSala et al. 2003). Twenty of such collaborative forest restoration initiatives have received targeted funds through the Collaborative Forest Landscape Restoration Program (CFLRP) administered by the USFS (Schultz et al. 2012). However, the high cost of harvest and transport and the low or non-existent market value of biomass removed during forest restoration projects has hampered the economic viability of restoration efforts (USDA Forest Service 2005). Unmerchantable woody biomass is often burned in piles for disposal or left on site to either burn or decompose, which can have impacts on regeneration, fuel loading, wildfire behavior, insect outbreaks and visual aesthetics (Griffin et al. 2013; Johnson et al. 2013).

Simultaneously, over the last 15 years, biomass energy has emerged as a public policy priority for the US federal government (e.g., the Biomass Research and Development Act of 2000, Food Conservation and Energy Act of 2008). As a result, forest restoration activities have been widely regarded as an untapped potential source of woody biomass for emerging bioenergy and biofuels applications (Polagye et al. 2007). In turn, wood bioenergy is seen as a way to improve the economics of forest restoration; the harvest and utilization of biomass can offset restoration costs and generate local employment and economic activity (Domac et al. 2005), reduce local air pollution (Loeffler and Anderson 2014), and contribute to societal renewable energy production goals (Carley and Browne 2013). However, in many cases our understanding of the ecological, technical and economic aspects of using biomass for energy have outpaced our knowledge of the perceptions of stakeholders of both forest restoration and biomass utilization, not to mention how these perceptions may impact social acceptance of related activities. One such case is the Uncompahgre Plateau in southwest Colorado.

A Case Study on the Uncompahgre Plateau

The Uncompahgre Plateau (UP, Figure 1) is a 417,000 ha tilted fault-block plateau in western Colorado, USA. Ranging in elevation from 1,500 to 3,154 m, several vegetation communities exist on the UP, including sage brush rangeland and pinion-juniper woodland at the lowest elevations, warm-dry forest types (e.g., Ponderosa pine, Douglas-fir) at the middle elevations, and cool-moist mixed conifer (e.g., Engelmann spruce, subalpine-fir) at the higher elevations. Aspen and Gambel Oak are also widespread throughout. Approximately 56% of the UP is designated as the Uncompahgre National Forest and managed for multiple uses by the USFS.

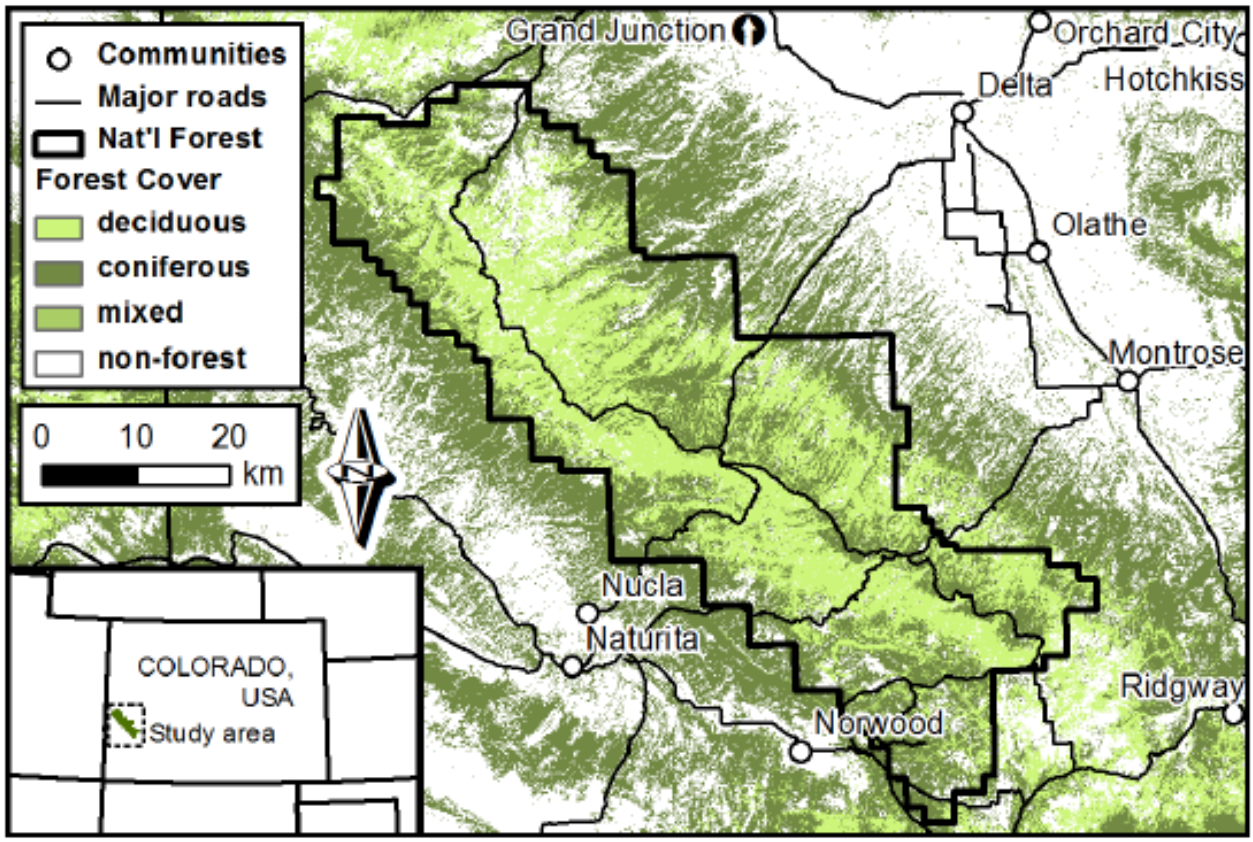

Figure 1. Location of the Uncompahgre Plateau, Colorado

Collaborative efforts to develop and implement forest restoration projects on the UP began in the late-1990's and have expanded in scope and geographic scale (Cheng 2006; Cheng and Sturtevant 2012). In 2010, the UP was selected as a CFLRP project, with nearly 63,000 ha in completed and planned projects. While the solid wood products industry has been able to use merchantable timber from UP restoration projects and some biomass has been removed from treated sites, there is a growing problem associated with very large volumes of non-merchantable woody biomass being piled and burned. With its selection as a CFLRP project, stakeholders associated with the UP began to explore the possibility of promoting non-merchantable woody biomass as a fuel source for co-firing at the existing coal-fired power plant (Loeffler and Anderson 2014) or as fuel for new, local small-scale (e.g., 1 to 5 MW) biomass electricity power stations.

In addition to questions concerning the technical and operational feasibility associated with harvesting, processing and delivering biomass to such facilities, stakeholders identified key potential benefits and costs arising from increased demand for forest biomass, including possible negative effects on ecological, recreational and economic values. The opportunity to explore these trade-offs through a Q-study was approved and funded in part by the UP CFLRP group.

Study Objectives

The goal of this study was to understand the range and depth of different stakeholder perspectives on the acceptability of biomass harvesting and utilization as a component of forest restoration activities on the Uncompahgre Plateau. A deeper understanding of the acceptability of biomass harvesting may assist the US Forest Service and its collaboration participants to find solutions that meet as many interests as possible regarding biomass utilization based on the trade-offs articulated in the results of this study. This study therefore sought to understand: 1) What the dominant themes are in relation to stakeholders interests in biomass utilization in the context of forest restoration, 2) the characteristics of these interests and 3) whether there were any interests that are held in common among the dominant themes. Our approach is similar to Brunson's (1993) characterization of social acceptability as a function of nuanced, context-specific values and norms and uses Q-method to identify distinct themes that characterize the discourse on this issue. Q-method facilitates examination of the nuances of those themes, the quantitative characterization of thematic patterns of perspectives, and identification of areas where themes diverge and overlap (Shinebourne 2009). We also developed insights into how the identified themes and patterns may affect the collaborative process moving forward, especially with regards to the utilization of biomass from forest restoration treatments.

Methods

Q-method

Q-method is a social science research approach to explore how people subjectively engage in a contested topic by examining the words and phrases that constitute their frames of reference regarding that topic. These words and phrases are known as 'discourses' and capture the central ideas, meanings, attributes, and trade-offs associated with a topic (Brown 1996; McKeown and Thomas 1988). Q-method is an approach that elucidates the nuances of *why* people find a policy or management proposal acceptable or unacceptable. Traditional social science survey research analyzes the range of responses to a set of survey questions (crafted by the researcher) of a large random sample from a general population; descriptive and correlative statistics and associated hypothesis tests are used to assess relationships between respondents' traits and their survey responses. Q-method analyzes the prevalence and nuances of discourses (generated by the subjects themselves) of a relatively small selectively-sampled group of people; factor analysis is used to organize individual discourses into distinct thematic groupings (Shinebourne 2009).

Q-method has been employed successfully across several environmental and natural resource contexts in the western US and around the world (Addams and Proops 2000), such as the meaning of ecological restoration (Woolley and McGinnis 2000), rationales for non-participation in collaborative resource management (Cheng and Mattor 2006), and understanding public perspectives on forest management (Burns and Cheng 2007; Steelman and McGuire 1999). Other recent examples of the Q-method applied to natural resources

include studies focused on wildfire, water management, and wind energy (Vugteveen et al. 2010; Brannstrom et al. 2011; Ray 2011).

The general sequence of conducting a Q-method study, or Q-study, is to generate a Q-sample, conduct interviews to collect Q-sorts from participants that represent the full range of attitudes among stakeholders, code the Q-sorts, and then analyze the Q-sorts using multivariate factor analysis. The Q-study described here began in early 2010 and was generally completed by the end of 2012, and includes 11 stakeholder groups (Table 1).

Table 1. Number of participants in the Q-study partitioned according to self-identified stakeholder groups.

Stakeholder Group	Participants
Recreation (motorized and non-motorized groups)	5
Representatives of other collaborative groups	4
Grazing permittees	1
Conservation groups	7
Federal agency	5
State agency	3
Local government	5
Energy utility industry	3
Forest products industry	4
Biomass utilization interests	2
Landowners	3
Total	42

Q-Sample Development

Following Addams and Proops (2000) sequential process, we first compiled a set of statements reflecting people's sentiments toward forest restoration, biomass harvesting and utilization from statements made in semi-structured interviews with active members of the UP CFLRP group (Knapp 2010), from published and publicly-accessible notes from field trips and regularly-scheduled meetings, and from printed and electronic media from various regional sources. This extensive "concourse" of statements was collected to represent the full range of ways people talk about the prospect of biomass harvesting and utilization on the UP, especially as it relates to forest restoration. From the concourse, we strategically selected a subset of 36 statements by arraying the concourse statements according to six categories of values: Aesthetic/Recreation Values; Ecological Values; Cultural/Historic Values; Social/Decision Process Values; Economic/Market Values; and Woody Biomass Energy Values. These values categories have been widely applied as a valid approach to assessing social acceptability of environmental and natural resource management (Brown and Reed 2002; Clement and Cheng

2011; Rolston 1994). The resulting Q-sample reflects a broad range of sentiments in an appropriately sized subset (see Table 2 for the specific statements used).

Q-Sort

The participants of a Q-study are selected specifically to represent key stakeholders in the discourse, with an effort to represent all stakeholder groups, regardless of their proportional representation in the general population. Q-method participants were selected from the collaborative stakeholder processes concerning forest restoration on the UP, some of whom have been involved since 1998. A list was drawn up of all known past and current stakeholders, and partitioned by self-identification into the general stakeholder groups shown in Table 1.

The stakeholders who had been most involved in collaborative meetings in the most recent two years, and were therefore more intensively involved in the more recent biomass utilization component of the restoration discourse, were targeted for Q-study participation. First, an invitation letter was sent to potential participants, then a phone-call was made to determine availability and arrange a meeting. Forty-one individuals agreed to participate in the study.

For the Q-sort, participants arranged cards, each containing a Q-sample statement (Table 2). These cards were arranged by participants on a flat surface into a quasi-normal distribution on a Likert-type scale from "strongly agree" (+5) to "strongly disagree" (-5) (Figure 2). This card-sorting process results in an arrangement of statements that reflect the participant's subjective frame of reference on the forest biomass utilization topic. Rather than assigning a Likert-type ranking to an individual statement or question as in a survey, the subject deliberates and arranges all 36 statements relative to one another. The Q-sort exercise was followed by a semi-structured interview that offered participants the opportunity to describe reasons for why they sorted statements in the manner they did and to articulate their views regarding biomass utilization in their own words.

Analysis

Each participant's Q-sort was entered into PQMethod software (Schmolck 2013; McKeown and Thomas 1988, Brown 2000, Vugteveen 2012). Following McKeown and Thomas's (1988) analytical protocol, a correlation table was derived from the sorts, arraying all 41 Q-sorts against each other. To extract factors, an unrotated principal components analysis was initially performed to reveal eight factors that had eigenvalues greater than 1. Four of the eight factors had only one or two sorts loading significantly on them, composite reliability coefficients of 0.88 or lower, standard errors 0.33 or higher and provided little clarity in interpretation (Brown 2000). A Varimax rotation restricted to four factors provided the greatest "vantage point", allowing almost all sorts to load significantly one of the four factors, composite reliability coefficients of 0.92 and higher and provided simplicity and clarity of interpretation (McKeown and Thomas, 1988, p. 53).

Table 2. Factor Q-sort values for each statement.

		Factor Arrays			
No.	Statement	1	2	3	4
1	Forest treatments should minimize visual disturbances whenever possible.	0	-2	0	-1
2	Large slash piles created during fuels treatments are ugly and should be removed.	-1	-3	2	0
3	There are many people who recreate on the Plateau. Their use should be considered a high priority.	-1	-2	1	5
4	I don't think forest treatments have negative impacts on recreationists.	-2	-1	0	-3
5	I love to explore the large network of Off Highway Vehicle roads and trails that the Uncompahgre Plateau offers.	-3	-1	-1	3
6	I would accept additional truck traffic on forest roads and increased in-woods mechanized harvesting activities on a greater number of acres than what is currently being accomplished on the Plateau if it increases renewable energy production.	-2	0	2	0
7	I am not in favor of slash burning that negatively impacts air quality.	-1	-2	2	1
8	Roads break up habitat and bring in traffic. The bigger the roads are, the worse they are.	2	-3	-3	-1
9	Burning trees for energy is unsustainable.	-3	-4	-5	-2
10	Subjecting forests to the risk of environmental damage from treatments without substantial social and/or economic benefits is unacceptable.	0	-3	-1	-2
11	Forest treatments should be designed to increase habitat diversity and complexity.	4	1	-2	0
12	Treatment emphasis should be on improving and maintaining ecosystem health.	5	1	1	3
13	Removal of woody biomass will have negative impact on the soil if an appropriate amount of material is not left in the forest.	2	-1	-2	-2
14	Risk of uncharacteristically large stand-replacing fires is a problem that should be addressed with forest treatments.	3	2	3	0
15	I am concerned that treatment activities within spruce/fir and mixed conifer forests will degrade lynx habitat.	1	-4	-4	-4
-4	The Plateau contains important habitat for various species of wildlife. Treatment activities should not degrade habitat.	4	-1	-2	-1
17	Forest treatments can restore forest conditions and benefit wildlife populations.	3	2	0	3
18	I am concerned that biomass harvest will lead to overharvesting and threaten forests.	-1	-5	-4	-5
19	The cultural significance of the Plateau to the Ute Indians should be a high priority when considering treatments.	1	-1	-1	-1
20	Treatments should protect historical structures and landforms such as ranger stations and ranch sites.	1	0	0	4
21	The forest products industry cannot afford to wait two years for the forest Service and a collaborative group to determine what is socially and environmentally viable.	-4	0	-1	-3
22	Inclusion of and collaboration with as many partners as possible is a win-win strategy for industry, the forest and environmentalists.	2	1	3	2
23	If we are going to emit carbon let's do it using local renewable forest biomass rather than fossil fuels.	0	0	1	-3
24	To make biomass economically feasible current roads weight limits should be increased, allowing companies to use larger trucks with heavier loads.	-4	0	1	1
25	Harvesting biomass can help fund necessary forest treatments, creating a win-win situation.	2	2	2	2
26	Using woody biomass instead of wasting it by burning or scattering on the ground has numerous social, economic and environmental benefits.	1	3	5	-1
27	I support forest treatments that create a long-term supply of wood to generate heat and electricity.	0	3	3	0
28	It is important to me that forest treatments are economically viable. Costs should be	-2	3	0	2

	offset with forest products like logs and biomass.				
29	The most important treatments are those that reduce fire risk to infrastructure like power lines and private property.	-1	2	0	1
30	Treatment emphasis should be on providing commercial forest products to support our existing timber industry and develop new industry.	-3	4	-2	2
31	It is critically important to industry to have a sustainable, predictable supply of material.	1	5	1	1
32	I support forest treatments that increase landscape diversity even if there is no commercial gain.	3	0	-1	0
33	Our wood products industry is an important component of our local economy.	0	4	4	4
34	The needs of existing and longstanding companies should be considered before developing new biomass industry.	-2	1	-3	1
35	Local biomass utilization for energy is important so we're not held hostage by the fossil fuel industry.	0	1	4	-4
36	We should not use biomass for energy if it is more expensive than using coal for energy.	-5	-2	-3	-1

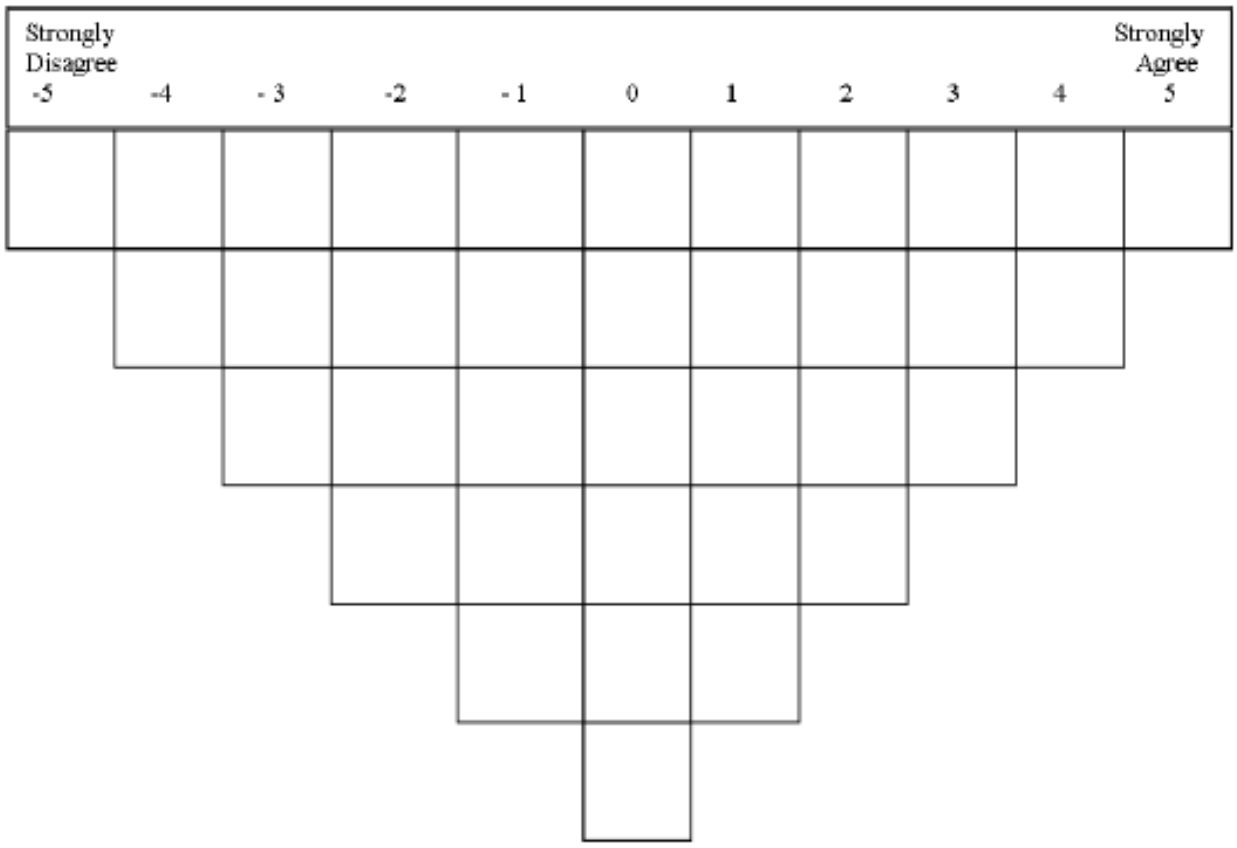

Figure 2. Q-sort template.

Q-sorts that had loadings of +/- 0.43 were significant at the p=0.01 level based on the standard error for a zero-order factor loading given by the expression SE = $1/\sqrt{N}$, where N=36 statements in this Q-study. The only sort that did not load significantly on any factor was #2, a member of a conservation group. PQMethod software generates factor scores and factor loadings for each participant's Q-sort (Table 3), allowing clusters of Q-sorts to be assigned to

each factor. Hence, each factor contains Q-sorts that loaded together and, thus, reflect individuals that share a subjective perspective on biomass utilization.

Table 3: Factor loadings for the five resulting factors (themes). Q-sorts are loaded on each factor at p < 0.01.

Participant # and Stakeholder Type	Factor 1	Factor 2	Factor 3	Factor 4
4 Conservation group	0.8694			
24 Non- Motorized Recreation	0.8422			
8 Conservation group	0.8143			
34 Landowner	0.7997			
18 Local Government	0.7828			
21 Local Government	0.7749			
7 Conservation group	0.7499			
27 State Agency	0.7261			
41 Representative other collaborative	0.6984			
14 Federal agency	0.6869			
40 Federal agency	0.6795			
17 Representative other collaborative	0.6781			
33 Landowner	0.6775			
13 Federal agency	0.6741			
32 Non-motorized recreation	0.6648			
5 Conservation group	0.6496			
16 Landowner	0.6392			
22 Local Government	0.6283			
39 Conservation group	0.5947			
15 Federal agency	0.5852			
3 Conservation group	0.5428			
12 Federal agency	0.5218			
20 Local Government	0.4746			
6 Conservation group	0.4200			
37 Forest products industry		0.8299		
10 Energy Utility Industry		0.7763		
29 Forest products Industry		0.7644		
31 State Agency		0.7282		
30 Forest products industry		0.7193		
38 Federal land management agency		0.7189		
28 State agency		0.7125		
2 Biomass Utilization Interest		0.7086		
11 Energy Utility Industry		0.6201		
19 Local Government		0.5999		
35 Timber Industry		0.5906		
23 Local Government			0.7678	
1 Biomass Utilization Interest			0.7280	
25 Recreation Motorized			0.6786	
36 Grazing Permittee				0.6489
26 Recreation Motorized				0.6453
9 Energy Utility Industry				0.4976

Results

Four Primary Themes in the Discourse Regarding Biomass Harvesting and Utilization on the Uncompahgre Plateau

"Theme" and "factor" in this article denote the same construct resulting from factor analysis. The four themes, or factors, together comprise the entire discourse that was studied regarding biomass utilization in the context of forest restoration. Each factor represents a particular viewpoint or theme within the discourse concerning biomass utilization on the UP and is discussed in detail below; however, several broad observations are worth noting here

Generally, the Q-sorts and follow-up interviews indicated some level of support in all four themes – or at least no evidence of strong oppostion – for forest restoration and the use of biomass and associated opportunities to achieve restoration goals. However the frames of reference associated with individuals who load onto each factor accept biomass utilization differ greatly across the factors. The first theme reflects the desire to manage the forests for ecological reasons, especially forest health and wildlife habitat; biomass utilization is considered a by-product and side-benefit of achieving a larger ecological goal. The second theme sees commercial timber production as a more important means of forest restoration than biomass utilization, as well as an important goal in and of itself. The third theme sees biomass utilization as the preferred means of forest restoration, as well as an end in itself that serves to reduce 'waste' left in the forest, but independent of solid wood product industry needs. The last theme views forest management treatments in the context of multiple uses of the UP, from recreation and wood products, to historical sites and maintaining ecosystem health. Biomass utilization is seen as a residual benefit of maintaining multiple uses. Biomass utilization was neither a primary viewpoint nor an antithetical viewpoint.

Factor 1: Forest Ecosystem Health and Habitat Conservation

Twenty-four of the 41 participants loaded on this theme, which focused on biomass utilization as a means toward the larger goal of improving forest ecosystem health and wildlife habitat. The statements that ranked highest in the first factor were: "Treatment emphasis should be on improving and maintaining ecosystem health"; "The Plateau contains important habitat for various species of wildlife. Treatment activities should not degrade habitat"; and "Forest treatments should be designed to increase habitat diversity". The importance of forest health, wildlife habitat and minimizing fire risk is borne out of a larger concern for landscape, forest, wildlife and habitat and may reflect the concern for declining mule deer populations, which was a catalyst for early collaboration. As one participant expressed: " 'Treatment emphasis should be on improving and maintaining ecosystem health'. I put that statement in the 'most strongly agree' section because with our projects that's the starting point. It's all about improving forest health and the trees that come off and the woody biomass are just byproducts in my mind. There's my anchor point." This theme's conditional support for biomass utilization is

well-summarized by another participants' comment: "If it helps to do actual forest restoration and we don't see it as an end in itself. It has to be the tool we use to get to the better environmental conditions and does not become an end to itself to where we're taking more than we should and not leaving enough for ecological processes".

This larger concern outweighs arguments regarding the need for additional road capacity to accommodate logging equipment, usually because the participants feel there is an adequate existing road infrastructure in place. Statements that received the most disagreement in this theme were: "We should not use biomass for energy if it is more expensive than using coal for energy", "To make biomass economically feasible current road weight limits should be increased, allowing companies to use larger trucks with heavier loads" and "The forest products industry cannot afford to wait two years for the Forest Service and a collaborative group to determine what is socially and environmentally viable". Hence, while biomass utilization is viewed as a viable means to achieving ecological goals, this factor encompasses the notion that there is no urgency or need for special accommodation to accelerate silvicultural treatment, either for solid wood products or bioenergy.

Factor 2: Solid Wood Products Industry Objective

Eleven participants loaded on this factor, a viewpoint that reflects an emphasis on the importance of and opportunities for economic benefit related to timber harvesting. The statements that received the most agreement in this theme were: "It is critically important to industry to have a sustainable, predictable supply of material", "Our wood products industry is an important component of our local economy" and "Treatment emphasis should be on providing commercial forest products to support our existing timber industry and develop new industry". Participants in this theme felt that it is appropriate to put environmental, cultural, aesthetic, recreational priorities at a lower level, at least in the near term. Also in the near term, participants felt that roads need to be temporarily opened and improved to allow contractors to remove biomass and timber in order to restore the forest in an economically efficient manner. There is a mild agreement in this theme that the forest needs to be restored, but the primary objective is the continuation of a forest products industry in the local area.

The statements that were most disagreed with were: "I am concerned that biomass harvest will lead to overharvesting and threaten forests", "I am concerned that treatment activities within spruce/fir and mixed conifer forests will degrade lynx habitat", "Burning trees for energy is unsustainable", closely followed by "Subjecting forests to the risk of environmental damage from treatments without social and/or economic benefits is unacceptable". Statements regarding the importance of forest restoration for ecological reasons, such as forest health and wildlife habitat, are generally ranked in the middle with mild agreement.

The participants who loaded on this theme were deeply concerned that forest restoration happen on the condition that it was economically profitable in order to maintain the wood

products industry in Montrose and Delta; they maintain a strong belief that forest restoration and fuel reduction is not possible without an industry to carry out the work. Hence, maintaining and/or creating that industry becomes of first concern, while still being mindful of the state of forests on the Uncompahgre Plateau. As one participant articulated:

> "The issue of biomass utilization is just extremely important to me because we care about the Plateau. We love the Plateau…That's what's important to me. And I think to so many others. The little stuff that hang us up along the way is like dealing with log trucks or dealing with too many roads or whatnot. You know we've got to get beyond that if we're ever going to accomplish what our ultimate goal is."

Factor 3: Biomass Industry Objective

Three participants loaded significantly on Factor 3. In this theme biomass utilization is seen as the most important method to improve the economic efficiency of forest restoration and reduce waste. This theme is moderately concerned with forest restoration itself, with a strong primary concern for reducing fire danger by converting non-merchantable woody biomass to energy. Biomass utilization is not only seen as a means toward achieving these goals, but also as an objective in itself. In this theme, participants view forest restoration as a means of biomass production, rather than viewing biomass as a byproduct of restoration, as is common in Factor 1. Statements regarding the need for roads and a steady supply of biomass received agreement, while statements regarding historical and cultural values were placed in areas of mild agreement. Statements affirmative toward forest ecosystem health and wildlife habitat were placed on the disagreement end of the spectrum.

There is considerable overlap between Factors 2 and 3, but some clear differences distinguish them. Both themes are oriented toward generating economic efficiency and local economic benefits, and are generally supportive of biomass utilization. Both factors are concerned with the need for roads, a stable resource supply and the "well-being" of the forest. However, a distinguishing statement in Factor 3 is that statement #34, "The needs of existing and long-standing companies should be considered before developing new biomass industry" is disagreed with (-3). Biomass utilization is seen as its own economic activity that should not be directly tied to existing solid wood product businesses.

Additionally, the wood products theme contains higher agreement levels for statements regarding habitat and the need for forest restoration, while the biomass utilization theme is more sympathetic to recreational considerations. Although the biomass utilization theme is more sympathetic towards recreation, both Factors 2 and 3 are willing to trade recreational opportunities, at least temporarily, to enhance forest restoration using wood products and biomass industries as tools. For example, statement #5, which articulates the enjoyment of exploring the forest using motorized recreational vehicles, is disagreed with by both themes. Factor 2 would also have greater acceptance of biomass burning than the Biomass Industry theme.

Factor 4: Multiple Use Objective

The three participants who loaded on Factor 4 emphasized the importance of multiple use management on the UP. The top positively-ranked statements concern the importance of recreation on the UP, the value of the wood products industry, and the view that forest treatments should protect historic structures and sites, as well as ecosystem health. As with other themes, participants loading on Factor 4 supported biomass utilization, particularly due to their desire to see as little waste as possible, but supported other opportunities as well. In this context, forest treatments and biomass utilization can improve the economic efficiency of sustaining multiple uses. For example, this theme was concerned about landscape diversity, not harming the forest and favoring biomass utilization if, as one participant put it: "it's economically viable and sustainable". The theme does not support biomass utilization if: "we are going to degrade the forest." The same participant added: "But I don't see that happening. I think we should be using as much of that material as we possibly can. I think it's wrong to be creating huge slash piles and just burning them. It should be used".

In this theme the relative role of fossil fuels was deliberated more than in other factors, because two of the participants had economic ties related to fossil fuel. Statement #35, "Local biomass utilization for energy is important so we are not held hostage by the fossil fuel industry" was mildly disagreed with because of the fossil fuel argument, not because participants were against biomass utilization. Another participant placed a statement focused on carbon emissions (#23), in his most strongly disagree placement because "I just don't feel that that was important because of the fact that most of the carbons emitted into the atmosphere comes from volcanoes. Compared to that, it's a drop in the bucket."

In this theme, there is a considerable amount in trust in the USFS and the BLM to conduct treatments in such a way that the environment is not harmed, that temporary roads will be closed eventually, that biomass harvesting will not lead to overharvesting, and that forests will regenerate successfully after treatment. Here too, biomass harvesting for restoration of the forest are worth the costs and risks because "I love the forest. It needs to be cleaned up so it can be there for my kids and other kids", but on the condition that it is done in a manner that optimizes economic efficiencies and hopefully creates a profit.

This theme illustrates the importance of conducting interviews after Q-sorts are completed because the three participants represent wide-ranging perspectives: a power company representative, an OHV equipment business owner, and a grazing permittee. The power company representative was deeply concerned about forest restoration and wildlife habitat, felt that the biomass resulting from fuel reduction treatments should not be wasted but converted to energy and disagreed with arguments for using biomass to offset fossil fuel use because his company provides fossil fuel energy. The OHV person cared about habitat, forest health and "cleaning up" the forest to enhance motorized recreational opportunities. The grazing permittee was generally most concerned that as little was wasted as possible.

Convergence and Divergence Across the Four Factors

The variance across all factors' Q-sort values indicates the statements with which there is agreement and disagreement across all factors (Table 2). There were two consensus statements across all four factors: #25 "Harvesting biomass can help fund necessary forest treatments, creating a win-win situation" and #22 "Inclusion of, and collaboration with, as many partners as possible is a win-win strategy for industry, the forest and environmentalists". These two statements show that across all factors, participants agree that harvesting biomass can facilitate the implementation of treatments that are considered to be necessary, and that collaboration is the strategy by which participants would like to achieve this. There also remain divergent viewpoints that are important to acknowledge, even if they do impede collaborative progress towards forest restoration goals on the UP. For example, the statement "Local biomass utilization for energy is important so we're not held hostage by the fossil fuel industry" was rated "agree" in Factor 3 but rated "disagree" in Factor 4. Perhaps more critically, values for the statement "Treatment emphasis should be on providing commercial forest products to support our existing timber industry and develop new industry" varied across the factors, with negative sort values in factors 1 and 3 and positive sort scores in factors 2 and 4. Together these results indicate that although there are still potential sticking points in collaborative discussions, such as the perspective that the solid wood products industry is key to the facilitation of forest treatment restoration projects, there is also: a) a high social acceptance of biomass harvesting as an important forest management outcome and b) high agreement that sticking points can be resolved through collaborative processes.

Discussion

These results uncover a basic level of acceptability for biomass harvest and utilization among UP stakeholders, but also highlight that stakeholders understand and rationalize their acceptance through their subjective frames of reference, with different objectives in mind. Whether restoration is implemented to achieve solely ecological objectives or solely economic objectives will make a difference to forest managers in their planning, and to stakeholder interests in their collaborative efforts. It is important to note that Q-method is not intended to extrapolate findings to the general population of the geographic vicinity as would a well designed opinion survey, because it does not employ a random sample design. In other words, the fact that about half of the participants loaded to the first factor does not necessarily mean that half the population of the region would be similarly classified. The Q-method is, however, a useful tool in discovering and examining the themes most likely relevant to active stakeholders.

In this case, if the use of biomass for energy moves forward in the region, understanding these themes may help local forest managers, policy makers and businesses deliberate how to design restoration projects that utilize biomass and achieve as many of the objectives as possible, rather than responding after the fact to formal objections, administrative appeals, or litigation. This particular group has already become familiar with the scale, location and type

of restoration treatments that are appropriate for this area through collaborative learning and interaction, which may be one reason why basic agreement exists regarding forest restoration (Binkley et al. 2008). This study and its results may also act as information to help this group find options regarding biomass utilization for the future.

Generally, the study indicates that biomass harvesting and utilization on the UP is in principle supported with little staunch opposition among all the stakeholder groups. Does this mean that all stakeholders would support widespread, large-scale clearcutting paired with whole tree harvesting for energy chips because they are unconditionally "pro biomass"? We think not. For example, the local and national conservation groups involved work together to provide input. Although they are in agreement regarding the need, scope and scale of restoration on the Uncompahgre Plateau thanks to the joint efforts previously mentioned, their primary concern is ecological, not economic interests in the long term (See Factor 1 above). Although in concept there is broad support for biomass utilization, each theme does reflect a different set of conditions and objectives under which different stakeholder groups can be expected to support biomass utilization, and conversely, the conditions that might result in opposition. These differences have consequences for planning and will need to be deliberated between the stakeholders in their ongoing collaborative efforts. These results make the differences explicit and provide the group with a place from where to tackle negotiations.

Stakeholders may hold ecological values higher than economic values, or vice versa, but we did not find any evidence of extreme polarization among stakeholders with regards to forest restoration and biomass utilization. Unlike other regions of the western US with large extents of federal forests that have experienced strong opposition to commercial timber harvesting and have stakeholder groups taking a severely antagonistic view of forest industry, our study participants perceive that developing and sustaining a forest industry, potentially including the production of renewable energy from biomass, is a valuable outcome, and one that may additionally contribute to both local economic development and the ability of managers to implement ecologically-oriented treatments. We believe this is a testament to the long-standing collaborative learning that has taken place on the UP in particular and western Colorado in general for nearly two decades (Cheng 2006). For example, the statement "I am concerned that biomass harvest will lead to overharvesting" received only a moderate level of agreement (Q-sort value = 1. See Table 2 for Q-sort values). If participants loading on this theme do not feel a high level of agreement with this statement, this indicates a decrease in distrust from a few years ago (Binkley et al. 2008, Knapp 2010). The reason for this trust appears partially rooted in studies that have taken place regarding historical forest conditions on the UP, which have been incorporated into current management approaches by the USFS (Binkley et al. 2008).

As with previous studies, this work shows that Q-method can be an efficient social science research approach and contribute useful information to guide land managers, facilitators of collaborative processes, as well as inform policy-makers who are interested in getting a broad perspective of where different stakeholders in a community stand on potentially contentious

issues. Our results offer additional support that forest restoration, especially in frequent-fire dry forest types in the western US, enjoys broad public support and is seen as an important tool for forest managers who are charged with protecting and enhancing a broad range of market and non-market resources that highly valued by diverse stakeholders.

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