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Examining the Social Acceptability of Forest Biomass Harvesting and Utilization from Collaborative Forest Landscape Restoration: A Case Study from Western Colorado, USA

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Collaborative efforts have expanded in recent years to reduce fuel loads and restore the resilience of forest landscapes to future fires. The social acceptability of harvesting and using forest biomass associated with these programs are a hot topic, with questions about the extent to which collaboration can generate unified acceptance. We present results from a Q-Method study of the variation of acceptability judgments of participants engaged in the Uncompahgre Plateau Collaborative Forest Landscape Restoration Project in western Colorado in the United States. Four factors encompassing discourses of acceptability judgments were identified: protecting and conserving ecosystem health and wildlife habitat, supporting local wood products industry, supporting biomass utilization to reduce waste, and protecting and sustaining multiple use. Consensus judgments include perceptions that biomass harvesting can help fund restoration treatments to create a win-win situation and that collaboration is the preferred strategy to arrive at win-win outcomes. Our results indicate that the acceptability of forest biomass harvesting and utilization from the project is conditional on other values, some of which are in tension with one another. Collaboration is a beneficial strategy to elicit varying stakeholder perspectives, but substantive differences in acceptability judgments are likely to persist based on competing values.

Keywords: social acceptance, forest biomass, collaboration, Q methodology

The increasing number of large, severe forest fires since 2000 has spurred the expansion of collaboration among government, tribal, nongovernmental, and community-based organizations to reduce fuel loads and restore the resilience of forest landscapes to future fires through mechanical vegetation removal and prescribed fire. This expansion has been due in part to a succession of national-level policies underscoring the use of collaboration to achieve forest restoration and wildfire risk reduction goals (Cheng and Sturtevant 2012), including the National Fire Plan of 2000 and the corresponding Ten-Year Implementation Strategy (Pinchot Institute for Conservation 2002), the Healthy Forest Restoration Act of 2003 (P.L. 108–148; Jakes et al. 2011), and the Federal Landscape Restoration Act of 2009 (P.L. 111–11, Sec. 4001), which authorized the Collaborative Forest Landscape Restoration Program (Monroe and Butler 2016, Schultz et al. 2012).

Over approximately the same time period, investments by public and private sector entities in policies, programs, and technologies to expand woody biomass utilization, especially as an energy source, have generated optimism that economically viable options exist for using low-value woody biomass produced by management activities, thereby helping offset forest restoration costs (Aguilar and Garrett 2009, Becker et al. 2011, Sundstrom et al. 2012). The convergence of forest restoration and biomass utilization seemingly represents a triple win for the forest-carbon-climate nexus, simultaneously addressing ecological, economic, and social objectives (Malmsheimer et al. 2011, Tidwell 2015).

Despite the widespread occurrence of place-based collaborative initiatives organized around these issues, there is little information about the social acceptability of biomass harvesting and utilization activities held by stakeholders engaged in these processes. In forestry contexts, Brunson (1993) conceptualizes social acceptability as a judg-

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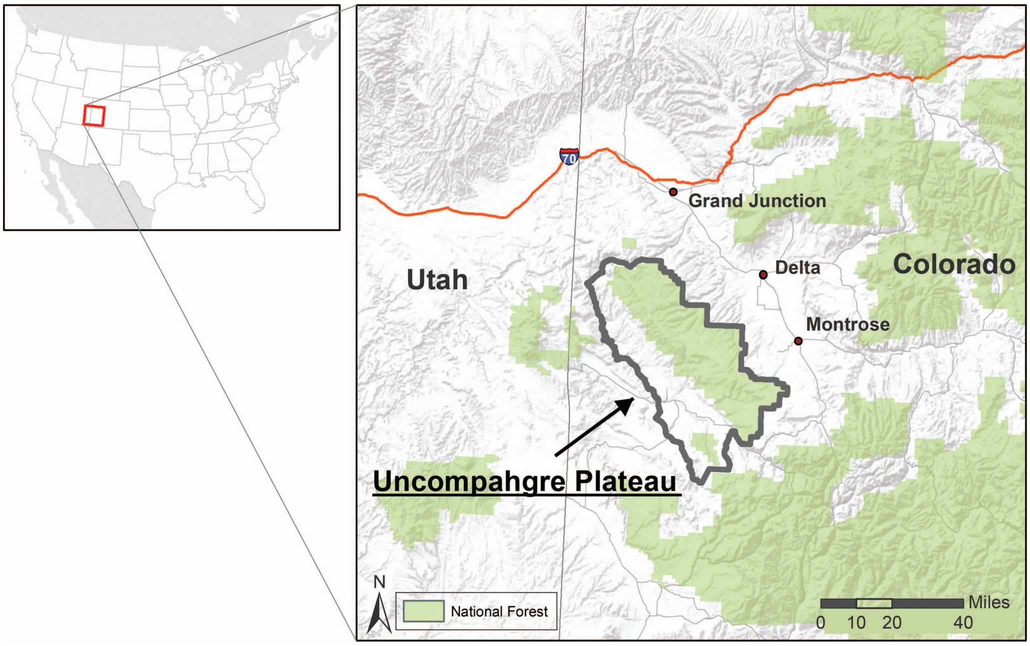

Figure 1. Location of the UP.

ment people make about whether an action, attribute, or condition is rated as superior or relatively neutral when compared with potential alternatives (Brunson and Shindler 2004). As such, social acceptability is critical for any forestry activity to succeed. Most relevant to place-based collaborative forest restoration initiatives, social acceptability judgments are context dependent, wherein generically acceptable practices identified through public surveys may be unacceptable when proposed for specific places (Brunson 1993).

This last point is important because, although survey research suggests broad acceptance of forest management activities such as tree harvesting and prescribed fire to lower forest fire risks (Loomis et al. 2001, Manfredo et al. 1990, McCaffrey et al. 2008, Toman et al. 2011, Weible et al. 2005), such judgments may vary from place to place (Brunson and Shindler 2004, Winter et al. 2002) and have been shown to be multifaceted, with a concern about the process by which decisions are made, not just forest management actions themselves (Burns and Cheng 2007, Ostergren et al. 2006). Social acceptability judgments of biomass harvesting and utilization for bioenergy are similarly tied to geographic and socioeconomic contexts (Aguilar and Garrett 2009), with support for biomass harvesting and utilization often being contingent on the broader ecological rationale for forest management (Hjerpe et al. 2009) and dependent on the collaborative nature of the process through which decisions are made (Stidham and Simon-Brown 2011). Such geographic and social context-based variation in social acceptability judgments concerning biomass harvesting and utilization necessitates place-based, context-specific research to complement regional and national social assessments.

In this vein, this case study presents research on the range and depth of social acceptability judgments concerning woody biomass harvesting and utilization made by participants engaged in the Uncompahgre Plateau (UP) Collaborative Forest Landscape Restoration Project (CFLRP) in western Colorado in the United States. By focusing on acceptability judgments of place-based collaboration participants, our intent is to contribute empirically based information about the interaction between local geographic and social contexts and the social acceptability of biomass harvesting and utilization. We applied a social science research approach called the Q-Method to generate four variations of acceptability judgments concerning woody biomass harvesting and utilization. After describing the UP Project context and process, we present the rationale and procedure for the Q-Method and present results. The article concludes with a discussion about the research implications on the broader understanding of social acceptability for forest restoration and biomass utilization as a function of place-based collaboration.

UP CFLRP

The UP (Figure 1) is a 1,030,429-acre fault-block uplift in western Colorado in the United States. Ranging in elevation from 4,921 to 10,348 ft, vegetation communities include sagebrush (*Artemesia tridentata* var. *tridentata*) rangeland and pinion-juniper

Management and Policy Implications

Collaborative efforts have expanded in recent years to reduce fuel loads and restore the resilience of forest landscapes to future fires. The social acceptability of harvesting and using forest biomass associated with these programs is a hot topic, with questions about the extent to which collaboration can generate unified acceptance. Our research demonstrates that, although biomass harvesting and utilization may be generically acceptable to achieve forest fuel reduction and restoration goals, acceptability judgments are multidimensional, context specific, and conditional on other values. Managers can use collaboration to surface these values and conditions to generate a more comprehensive understanding about where opportunities and barriers exist to developing or expanding biomass harvesting and utilization. Managers should also be attuned to the possibility that collaboration does not always generate complete consensus acceptance because there are almost always substantive differences in forest management stakeholders' acceptability judgments.

woodland (*Pinus edulis*, *Juniperus* spp.) at the lowest elevations; warm-dry forest types (e.g., Ponderosa pine (*Pinus ponderosae* var. *scopulorum*); Douglas fir (*Pseudotsuga menziesii* var. *glauca*) at the middle elevations; and cool-moist mixed conifer (e.g., Engelmann spruce (*Picea engelmannii* subsp. *engelmannii*) and subalpine fir (*Abies lasiocarpa* var. *lasiocarpa*) at the higher elevations. Quaking aspen (*Populus tremuloides*) and Gambel oak (*Quercus gambelii*) are also widespread throughout. Approximately 56% of the UP is under the administration of the Grand Mesa, Uncompahgre, and Gunnison National Forest and managed for multiple uses by the US Department of Agriculture Forest Service (USFS).

Collaborative efforts to develop and implement forest restoration projects on the UP began in the late 1990s and have expanded in scope and geographic scale (Cheng 2006, Cheng and Sturtevant 2012). Individuals from public land and resource agencies, environmental groups, commodity and noncommodity public land-user groups, and local governments have engaged in various social learning initiatives over this time frame to collaboratively develop shared knowledge, information resources, and value orientations concerning the purpose and need for restoration. The collaborative learning process has been convened and coordinated by a nonprofit organization, the Uncompahgre Partnership; resources concerning the history, participants, and products of the collaborative learning can be found on its website (http://upartnership.org).

In 2010, the Uncompahgre Partnership was selected to receive funding under the CFLRP, a national competitive funding program administered by the USFS to support the implementation of collaboratively developed forest landscape restoration strategies (Schultz et al. 2012). As of this writing, the UP Project has nearly 155,676 acres in completed and planned projects. Management actions include variable-density mechanical and hand-thinning and prescribed fire. Although the solidwood products industry has been able to use merchantable timber from the UP Project and some biomass has been removed from treated sites (Lund Snee et al. 2014), there is a growing problem associated with very large volumes of nonmerchantable woody biomass being piled and burned.

With its selection as a CFLRP project, stakeholders associated with the UP Project have been exploring the possibility of promoting nonmerchantable woody biomass as a fuel source for cofiring at the existing coal-fired power plant in Nucla, Colorado (Loeffler and Anderson 2014) or as fuel for new, small-scale (e.g., 1- to 5-MW) biomass electricity power stations managed by the local utility provider. In addition to questions concerning the technical and operational feasibility associated with harvesting, processing, and delivering biomass to such facilities, UP Project participants have been deliberating potential benefits and costs arising from increased demand for forest biomass, including possible negative effects on ecological, recreational, and economic values.

As part of a woody biomass assessment for the UP Project conducted by the USFS Rocky Mountain Research Station, a social analysis was commissioned to the Colorado Forest Restoration Institute at Colorado State University (Agreement No. 10-DG-11031600-049 Modification 1, Project 3b; Colorado State University Institutional Review Board Protocol No. 079-12H). The goal of the analysis was to identify and examine the range and dimensions of acceptability judgments of biomass harvesting and utilization as a component of the UP Project. The main objectives of the study were to understand and describe the variation in acceptability judgments held by stakeholder interests concerning biomass harvesting and utilization, the degree of differences between these sets of interests, and the extent to which there existed common themes across acceptability judgments.

Method

Following Brunson (1993), we conceptualized UP Project participants' acceptability of woody biomass harvesting and utilization as being composed of multiple dimensions organized as a coherent judgment. These dimensions include ecological, economic, and social factors. A common method to assess the social acceptability of forest management is using surveys, in which randomly sampled individuals assign ordinal preference values, typically using Likert-type scales, to statements defined by the survey researcher through a mail or online survey or a telephone questionnaire (Brunson and Shindler 2004, Loomis et al. 2001, Weible et al. 2005). Factor analysis is applied to aggregate respondents around specific statements to identify patterns of ratings. A benefit of this method is that it identifies respondent groupings—individuals with common responses. This helps decision-makers understand the types of potential stakeholder groups holding similar acceptability judgments and the strength of those judgments.

We elected to use the Q-Method because we were less interested in grouping randomly sampled respondents with common acceptability judgments and were more interested in the range and depth of the acceptability judgments across UP Project participants. In contrast to itemized surveys, in which the researcher crafts the statements for respondents to rate, the Q-Method uses statements that come from participants themselves via prior interviews, media sources, information campaign materials from government and nongovernment organizations, and public input to USFS planning documents. As such, Q-Method statements originate from existing judgments expressed by various individuals and organizations concerning a specific context. These are termed *discourses*, defined as "a pattern of subjective views held by a certain group of people," or they can be defined as "a way of seeing and talking about something" (Addams and Proops 2000, p. 3). These subjective views capture the central ideas, meanings, attributes, and trade-offs associated with a topic (Brown 1996, McKeown and Thomas 1988), corresponding to the multidimensional aspects of acceptability judgments (Brunson 1993).

Q-Method studies have been applied to numerous subjects worldwide, and the method has also been used in relation to environmental and natural resource contexts in the western United States and around the world. Recent examples of the Q-Method applied to natural resources include studies focused on wildfire, gray wolves, ATV use, water management, and wind energy (Asah et al. 2012, Brannstrom et al. 2011, Mazur and Asah 2013, Vugteveen et al. 2010). Following Addams and Proops' (2000) sequential process, we first compiled statements reflecting the sentiments toward forest restoration, biomass harvesting, and utilization in statements made by UP Project participants in semistructured interviews from a prior study (Knapp 2010). Statements were also included from published and publicly accessible notes from field trips and regularly scheduled meetings and from printed and electronic media from various regional sources. A list of 70 statements, called a *concourse*, 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. A final set of 36 statements was selected by assigning the concourse into a classification matrix according to an environmental values typology used to assess the social acceptability of environmental and natural resource management (Brown and Reed 2002, Clement and Cheng 2011, Rolston 1994). The matrix included five value types: aesthetic, recreation, ecological, cultural/historic, and economic. A sixth value was assigned to the sampling frame pertaining to decision process. As a research team, we iteratively eliminated redundant or ambiguous statements within each sampling frame to arrive at a balanced set of six statements per frame for a total of 36 statements (Table 1).

Study participants were strategically selected from the UP Project collaborative group list to represent key stakeholders, with an effort to represent all stakeholder groups, regardless of their proportional representation in the general population. We further targeted participants who had been most involved in UP Project meetings in the most recent 2 years; therefore, we were more intensively involved in the more recent biomass utilization component of the restoration discourse. Forty-two individuals agreed to participate in the study, with one person declining (Table 2). During an individual, in-person session, the participant was asked by the researcher to place cards, each containing a discourse statement, into a spatial arrangement called a “Q-sort” (Figure 2). Cards were arranged by participants into a quasi-normal distribution on a Likert-type scale from *strongly agree* (+5) to *strongly disagree* (–5). This card-sorting process results in an arrangement of statements that reflects a participant’s internally coherent discourse about a forest biomass harvesting and utilization topic. The Q-sort exercise was followed by a semistructured 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. To ensure that no bias was perceived by the diverse participants, they were explicitly asked whether their particular perspective was represented in the Q-sort statements and whether anything was missing.

Each participant’s Q-sort was entered into PQMethod software (Schmolck 2015). PQMethod software generates factor scores and factor loadings for each participant’s Q-sort, allowing clusters of Q-sorts to be assigned to each factor (Table 3). Each factor is associated with Q-sorts that loaded together; thus, they reflect individuals that share a subjective perspective on biomass harvesting and utilization in the context of the UP Project. PQMethod also provides the average ranking of statements in each factor from 5 to –5 (Table 1). An unrotated principal components analysis was initially performed, resulting in eight factors that had eigenvalues greater than 1, in which the eigenvalue measures the amount of variance explained by each factor. Four of the eight factors with eigenvalues greater than 1 were disregarded because they had fewer than two Q-sorts loading significantly on them, composite reliability coefficients of 0.88 or lower, standard errors of 0.33 or higher, and unclear interpretations (Brown 1996). Next, a Varimax rotation was applied to unrotated factors to generate four factors (Table 1) explaining 63% of variation across the Q-sorts, with a composite reliability coefficient of 0.92 and the highest level of simplicity and clarity of interpretation (McKeown and Thomas 1988, p. 53). 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 $SE = 1/$[GRAPHIC], where $N =$ 36 statements in this Q-study. The interviews with participants provided more detail and understanding regarding the nature and extent of social acceptability represented in each factor. In the results below, we have used participants’ language to clarify each factor.

Results

Results include four factors that together comprise the discourse of acceptability judgments of biomass harvesting and utilization in the context of forest restoration for this study.

Factor 1: Forest Ecosystem Health and Habitat Conservation

Twenty-four of the 41 participants loaded on the first factor, in which biomass harvesting and utilization is contingent on the larger goal of improving forest ecosystem health and wildlife habitat. The statements that ranked highest in the first factor were Statement 12, “Treatment emphasis should be on improving and maintaining ecosystem health”; Statement 16, “The Plateau contains important habitat for various species of wildlife. Treatment activities should not degrade habitat”; and Statement 11, “Forest treatments should be designed to increase habitat diversity.” In the interviews these participants placed importance on forest health, wildlife habitat, and minimizing fire risk, which was borne out of a larger concern for landscape, forest, wildlife, and habitat. Acceptance of biomass harvesting and utilization was moderately strong but subsidiary to ecological considerations.

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 Statement 36, “We should not use biomass for energy if it is more expensive than using coal for energy”; Statement 24, “To make biomass economically feasible current road weight limits should be increased, allowing companies to use larger trucks with heavier loads”; and Statement 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.” Hence, although biomass utilization is viewed as a viable means to achieving ecological goals, participants loading on this factor see no urgency or need for special accommodation to accelerate mechanical treatments either for solidwood products or bioenergy.

Factor 2: Local Wood Products Industry

Eleven participants loaded on this factor, in which forest restoration and biomass utilization are connected to the importance of and opportunities for economic benefit related to timber harvesting for solidwood products. The statements that received the most agreement in this theme were Statement 31, “It is critically important to industry to have a sustainable, predictable supply of material”; Statement 33, “Our wood products industry is an important component of our local economy”; and Statement 30, “Treatment emphasis should be on providing commercial forest products to support our existing timber industry and develop new industry.” Participants in this factor felt that environmental, cultural, aesthetic, and recreational objectives were a lower priority, 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 and to restore the forest in an economically efficient manner. There is

Table 1. Q-sort statements, primary factors resulting from principal components analysis and Varimax rotation, and average scores for each statement by factor.

No.	Statement	Factors			
		1: Ecosystem Restoration and Habitat Health	2: Wood Products Industry	3: Biomass Utilization	4: Multiple Use
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
16	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 offset with forest products like logs and biomass.	−2	3	0	2
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
	Eigenvalues	13.79	7.66	2.41	2.10
	Explained Variance	34	19	6	5

Table 2. Number of participants in the q-study partitioned according to self-identified stakeholder groups.

Stakeholder group	Participants
Recreation (motorized and nonmotorized 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

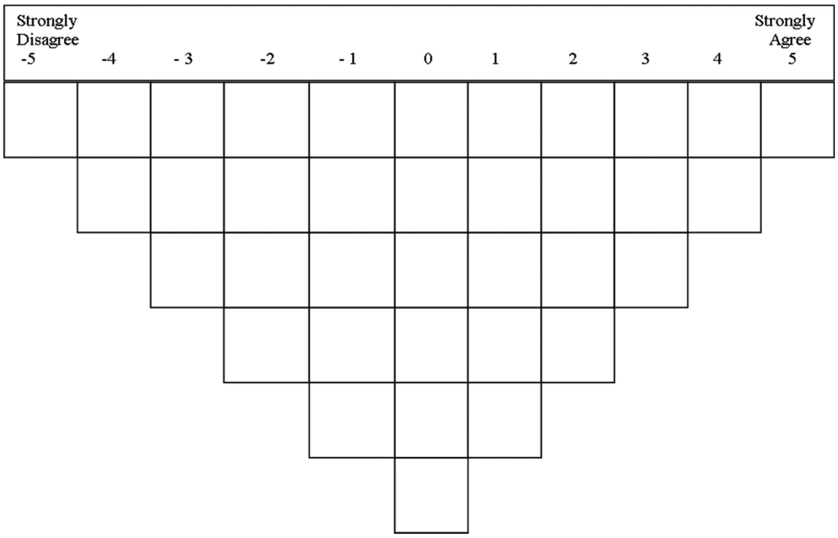

Figure 2. Placement of statements and corresponding values in a Q-sort.

weak agreement among participants associated with this factor 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 in this second factor were Statement 18, "I am concerned that biomass harvest will lead to overharvesting and threaten forests"; Statement 15, "I am concerned that treatment activities within spruce/fir and mixed conifer forests will degrade lynx habitat"; and Statement 9, "Burning trees for energy is unsustainable." Statements regarding the importance of forest restoration for ecological reasons, such as forest health and wildlife habitat, are generally ranked in the middle of these Q-sorts with weak agreement. The participants who loaded on this factor felt that forest restoration should happen only if it is economically profitable and supports the wood products industry in the local towns of Montrose and Delta on the basis of the belief that without an industry to perform the work, forest restoration and fuel reduction is not possible.

Factor 3: Biomass Utilization Emphasis

Participants loading on Factor 3 perceive biomass utilization as the most important method to improve the economic efficiency of forest restoration and reduce waste. This factor is moderately concerned with forest restoration itself, with a strong primary concern for reducing fire danger by converting nonmerchantable woody biomass to energy. This concern was shared between the one industry-affiliated participant on this factor and the two who were not, indicating a concern that is shared by multiple interests. The statements that received the most agreement in this factor were Statement 26, "Using woody biomass instead of wasting it by burning or scattering on the ground has numerous social, economic and environmental benefits"; Statement 35, "Local biomass utilization for energy is important so we're not held hostage by the fossil fuel industry"; and Statement 33, "Our wood products industry is an important component of our local economy."

Social acceptance in this factor is not only contingent on achieving these goals, but participants loading on this factor also see biomass utilization as an objective in itself; forest restoration as a means of biomass production, rather than viewing biomass as a byproduct of restoration, as in Factor 1. Statements regarding the need for roads and a steady supply of biomass received strong agreement whereas statements regarding historical and cultural values were placed in the middle section. Positive statements regarding forest ecosystem health and wildlife habitat were placed on the disagreement end of the spectrum. Furthermore, there is considerable overlap between Factors 2 and 3, but with clear differences. Both themes are oriented toward improving economic efficiency and generating local economic benefits, and they are generally supportive of biomass utilization. However, the distinguishing statement in Factor 3 is Statement 34, "The needs of existing and long-standing companies should be considered before developing new biomass industry." This statement is disagreed with (–3) in Factor 3, but agreed with (+1) in Factor 2 (Table 2). Biomass utilization in Factor 3 is seen as its own economic activity that should not be directly dependent on existing solidwood product businesses.

Factor 4: Protecting and Sustaining Multiple Uses

Acceptance of biomass harvesting and utilization in this fourth factor is tied to the desire to see multiple-use objectives realized on the UP. The top positively ranked statements were Statement 3, "There are many people who recreate on the Plateau. Their use should be considered a high priority"; Statement 33, "The needs of existing and longstanding companies should be considered before developing new biomass industry"; and Statement 20, "Treatments should protect historical structures and landforms such as ranger stations and ranch sites." As with other themes, participants loading on Factor 4 supported biomass utilization, particularly because of their desire to reduce waste, but only if it supports other forest uses. For example, this factor was concerned about landscape diversity, not harming the forest, and favoring biomass utilization if it is economically viable and sustainable.

Table 3. Factor loadings for the four resulting factors. 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
% Explained Variance	30	19	8	6
Eigenvalues	13.79	7.66	2.41	2.10

In this factor, there is a considerable amount of trust in the USFS and the US Department of Interior—Bureau of Land Management 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 is perceived as worth the costs and risks, but on the condition that it is done in a manner that optimizes economic efficiencies.

Convergence and Divergence Across the Factors

The variance in Q-sort values across all factors indicates the level of agreement (low variation) or disagreement (high variation) for specific statements. There were two statements considered consensus statements across all four factors (i.e., statements that do not distinguish between any pair of factors and do not load on any factor at the $P =$ 0.01 or 0.05 level): Statement 25, "Harvesting biomass can help fund necessary forest treatments, creating a win-win situation" and Statement 22, "Inclusion of, and collaboration with, as many partners as possible is a win-win strategy for industry, the forest and environmentalists." This indicates that across all factors, biomass harvesting and utilization hinges on their agreement that harvesting biomass can facilitate the implementation of treatments that are considered to be necessary and that collaboration is an effective strategy to achieve this outcome.

Areas of disagreement also stand out. For example, Statement 35, "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 Statement 30, "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, there is also a general acceptance of biomass harvesting and utilization as a potentially important component of forest restoration and agreement that sticking points can be resolved through collaborative processes.

Discussion

Our research demonstrates that complex and sometimes contentious subjects such as harvesting and using forest biomass can benefit from collaborative approaches to allow context-specific acceptability to emerge, as well as any differences among stakeholders. Initially, at a general level, different stakeholders may embrace biomass utilization, but when a deeper dive is made into methods and purposes, it can become clear that there are fundamental differences in the interests that stakeholders wish to meet. These differences have implications for harvesting and implementation methods. Our research shows that collaboration can allow these differences to emerge, be used to increase consensus, and provide greater understanding for these differences for managers.

Acceptability judgments of forest management activities are multidimensional and stem from geographic and social contexts (Brunson 1993). Despite the prevalence of forest biomass harvesting and utilization associated with forest fuel reduction and restoration on national forestlands in the United States, relatively few studies examine the social acceptability of these activities (Hjerpe et al. 2009, Nielsen-Pincus and Moseley 2009, Stidham and Simon-Brown 2011). In this article, we present findings from a Q-Method examination of the variation in acceptability judgments for forest biomass harvesting and utilization by participants engaged in the UP CFLRP. As a caveat, this single case study of the UP Project does not permit drawing inferences to social acceptability judgments of biomass harvesting and utilization across collaborative forest fuel reduction and restoration projects. The Q-Method approach uses discourse statements expressed by individuals and organizations associated with the UP Project. Although these statements may bear similarity to those in other contexts, the results are idiosyncratic to the UP Project. Despite this limitation, our study contributes empirical findings to the evolving body of research on social acceptability judgments concerning biomass harvesting and utilization associated with forest fuel and restoration specifically and forest management in general. Our study also assesses the extent to which collaboration plays a role in shaping acceptability judgments among participants.

We identified four factors accounting for 63% of this variation. Overall, biomass harvesting and utilization were acceptable across the factors. However, each factor contained conditions on this acceptance, corresponding to the multidimensional nature of social acceptability noted by Brunson (1993). Our study lends empirical support to Becker et al.'s (2011) assertion that a suite of social factors affects the prospects of any biomass utilization enterprise and the ability to accomplish ecological and economic objectives in a given context. Under Factor 1, acceptance was conditioned by the primary goal of protecting and improving ecological and habitat conditions on the UP. Participants loading on this factor regard biomass harvesting and utilization as a means to achieve broader ecological ends, with biomass utilization providing necessary cost offset to treatments and a beneficial byproduct. This is consistent with assessments in other regions of the western United States (Evans and Finkral 2009, Hjerpe et al. 2009, Stidham and Simon-Brown 2011). These results also speak to broader concerns about not placing biomass harvesting and utilization as a forest management goal ahead of ecological goals, such as biodiversity (Hesselink 2010, Root and Betts 2016).

Acceptability judgments embodied by Factor 1 stand in contrast to those in Factors 2 and 3, in which acceptability is contingent on supporting the existing wood products industry and emerging biomass energy development as an economic driver of forest landscape restoration. This is consistent with national and regional studies that indicate that biomass harvesting and utilization to support forest industry capacity is an end in itself (Aguilar and Garrett 2009) and is linked to observations that, without harvesting and utilization, forest restoration and wildfire mitigation treatments would not be accomplished (Evans and Finkral 2009). However, this sentiment creates a tension with the acceptability judgments in Factor 1 and those from other studies that demonstrate the primacy of ecological goals, but in which sustaining local forest industry capacity is moderately to weakly supported. With the small number of forest products firms in the UP Project area, sustaining this capacity is a concern.

If increasing the pace and scale of forest restoration and wildfire mitigation treatments is to occur as a broadly accepted national policy goal (US Department of Agriculture, Forest Service 2012), then the high costs of treatment coupled with the low economic value of biomass can be addressed in part by the existing forest products industry capacity and operations (Evans and Finkral 2009). Although there is a consensus across study participants that biomass utilization can help offset project costs, recent biomass utilization assessments cite the problem of lacking markets and appropriately scaled industry (Becker et al. 2011, Hjerpe et al. 2009), with the magnitude of the problems being highly variable from region to region, and within a region, depending on transportation distance, the existing wood products industry, and bioenergy alternatives (Aguilar and Garrett 2009, Dwivedi and Alavalapati 2009, LeVan-Green and Livingston 2001, Sample et al. 2010, Sundstrom et al. 2012). One direction of future research would be to determine the interaction between the number and density of wood products firms, public value orientations and acceptability concerning the role of industry as an economic development option, and acceptability of bioenergy as a biomass utilization alternative.

Factors 2 and 3 contain additional acceptability judgment dimensions worth noting. The first is tension between supporting the existing solidwood products industry in the local area versus emerging woody biomass businesses. Our study does not suggest a zero-sum problem, in which woody biomass utilization by emerging businesses results in a corresponding decline in wood supply to existing industries, because of the small number of both solidwood products and woody biomass firms in the UP Project area. However, this potential trade-off is a concern identified in other biomass assessments (Dwivedi and Alavalapati 2009) and a subject of needed research. Factor 3 identifies biomass utilization as a solution to waste left by restoration treatments, reflecting a traditional utilitarian viewpoint. This judgment contrasts with values expressed by ecosystem scientists who caution against large-scale removal of woody biomass over concerns over soil productivity, hydrologic quality, and biodiversity (Janowiak and Webster 2010). That USFS managers must account for the environmental impacts on these ecosystem values raises a challenge to this acceptability judgment.

On the matter of the acceptability of using UP Project woody biomass specifically for energy, our study yielded negative rankings across all factors for only one statement, Statement 9, "Burning trees for energy is unsustainable." It is difficult to draw any conclusions from this single statement. Rankings for other statements relating specifically to bioenergy (Statements 23, 27, 35, and 36) vary across factors, with rankings within each factor being generally internally consistent as a coherent discourse. More utilitarian discourses, such as Factors 2 and 3, tend to have consistently favorable judgments toward forest bioenergy. It is interesting that rankings for bioenergy statements under Factor 1, the more ecologically oriented discourse, tend to be weakly negative, indicating that participants loading on this factor may be unconvinced about the benefits relative to issues such as carbon emissions and cost offsets to UP Project activities. Although these discourses generally correspond to stakeholder assessments of forest bioenergy elsewhere (Aguilar and Garrett 2009, Dwivedi and Alavalapati 2009, Hjerp et al. 2009, Nielsen-Pincus and Moseley 2009, Stidham and Simon-Brown 2011), acceptability judgments concerning wood bioenergy from forest fuel reduction and restoration projects are intermixed with other issues, including those related to fuel reduction, wildfires, carbon sequestration-emissions dynamics, and climate change (Campbell et al. 2011, Malmsheimer et al. 2011). As biophysical science research on these topics continues to evolve, it is important that social science research on value orientations, perceptions, and acceptability judgments concerning forest biomass harvesting and utilization keep pace.

Our study also demonstrates that social acceptability of biomass harvesting and utilization from the UP Project is conditioned by multiple uses on the UP, especially dispersed motorized and nonmotorized recreation, and historic structures and land uses important to area residents as expressed in Factor 4. This acceptability dimension is not unique to the UP Project or the broader population of forest fuel reduction and restoration programs, but it underscores the challenge of federal public land management in general. In addition to ecological values expressed in Factor 1, the recreation, aesthetic, and historical/cultural values of the UP identified in Factor 4 are consistently highly ranked across social research on public forestlands (Clement and Cheng 2011, Manning et al. 1999, Wyatt et al. 2011).

One of the consensus statements across the factors refers to the importance of collaboration as a means to arrive at mutually acceptable management actions to account for these multiple uses, corresponding to Brunson's (1993) proposition that social acceptability judgments are embedded within social contexts and linking to a broad recognition about the utility of collaboration (Brick et al. 2001, Cheng and Fiero 2005; Daniels and Walker 2001, Sturtevant and Jakes 2008, Wondolleck and Yaffee 2000). However, it is important to note that there is wide variation in collaborative processes (Cheng and Sturtevant 2012, Crawford and Wilson 2005), contributing to differences in how collaboration participants and observers judge the acceptability of collaboration outcomes as evidenced by recent critiques of collaboration (Albrecht et al. 2015, Blue Mountains Biodiversity Project 2015, Nie and Metcalf 2015, Petersen 2016). Surprisingly, little research linking collaborative structures, processes, and acceptability judgments exists; the question of whether there are collaborative structures and processes that are more likely than others to result in the convergence of collaboration participants' acceptability around forest management actions would mark an advance in knowledge.

On this last point, the extent to which collaboration plays a role in shaping the social acceptability of forest biomass harvesting and utilization is a matter of serious consideration. In the context of forest fuel reduction and restoration, there are high expectations placed on the role and potential impact of collaboration in national-level policies and by participants in local place-based initiatives. Although reaching consensus is an ideal desired outcome, it does not preclude substantive differences in acceptability judgments. As our study suggests, acceptability judgments of biomass harvesting and utilization are composed of interconnected issues and are likely constructed by a combination of accumulated knowledge, experience, and evolution of value orientations. If this is the case, it may be an unrealistic expectation that collaboration can resolve fundamental differences in acceptability judgments. However, a benefit of collaboration is that it provides the opportunity for forest management stakeholders to thoughtfully present their own judgments, listen to the judgments of others, and jointly deliberate a range of potential alternatives and evidence against these judgments.

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