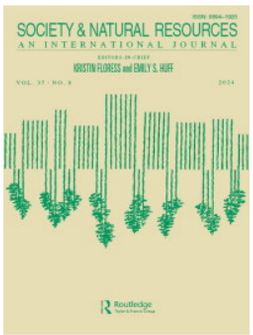

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Effects of Trust, Public Engagement, Conflict, and Social Networks on Satisfaction with Ecological Restoration

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ABSTRACT

River restoration is one of the most common, expensive, and environmentally influential forms of restoration, but has little post-restoration assessment of social success. In this study, we use social network theory and analysis (SNA), an emerging approach for understanding social dynamics in restoration projects, to examine the social connections, perceptions of project success, and attitudes of stakeholders involved in a river restoration project. We find that positive and negative social network ties have asymmetrical effects on stakeholders' attitudes and satisfaction with project outcomes. Trust ties positively influence perceptions of public engagement, while avoidance ties negatively influence satisfaction. Trust in leaders positively influences satisfaction and both public engagement and perceived conflict influence the development of that trust. We contribute to the growing body of research using SNA in natural resource contexts through quantitative tests of social networks' effects on stakeholder satisfaction with project outcomes.

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conflict; ecological restoration; social networks; stakeholder engagement; trust

Introduction

Ecosystem restoration blends science and practice with the goal of transforming degraded areas to improve ecological integrity and benefit human wellbeing. River restoration is one of the most common, expensive, and environmentally influential forms of restoration (Bernhardt et al. 2005), but has little post-restoration assessment of ecological or social success (Wortley, Hero, and Howes 2013). Bernhardt et al. (2005) study of 37,099 river restoration projects found that only 10% included assessment or monitoring; of those that did, project records were often too rudimentary to provide useful information on success of natural, human, or coupled natural-human systems.

Social factors are fundamental to evaluating restoration success (Metcalf et al. 2015) but are not as well understood as ecological factors (Baker, Eckerberg, and Zachrisson

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2014), leading to calls to quantify social metrics of restoration success (Palmer et al. 2007). We assessed the relationships between social dimensions and one well-established social metric of restoration success: the satisfaction of stakeholders with project outcomes (Lauer et al. 2018; Metcalf et al. 2015).

An emerging approach to understand social dynamics of river restoration is social network theory and analysis (SNA), conceptual and analytical tools to examine the influence of social systems on natural resource governance (Bodin et al. 2011). Accordingly, SNA is increasingly used in natural resource governance contexts (Sandström and Rova 2010; Teodoro, Prell, and Sun 2021), although less so in restoration (Fliervoet et al. 2016). We use SNA to study relationships between project stakeholders and their attitudes toward and satisfaction with a river restoration. Because positive and negative network relationships may have divergent effects on stakeholder satisfaction with project outcomes (Peretz et al. 2021), we include both types of relationships within a network of project stakeholders from different organizations, citizen groups, and recreational groups – each of which likely has different goals (Cockburn et al. 2020). We contribute to the growing body of research using SNA in natural resource contexts through quantitative tests of social networks' effects on key relational variables as well as stakeholder satisfaction with project outcomes.

Background

Social Context in Ecosystem Restoration

Social processes in restoration are poorly understood, in part, because of the complexity inherent to large projects with diverse participants and interests. Wortley, Hero, and Howes (2013, p. 542) review of 301 articles found that only 3.5% examined social and economic outcomes in addition to ecological outcomes; they called for more research into social and economic impacts. We address this call, focusing on one important metric for social success in social-ecological systems: satisfaction of project stakeholders with restoration outcomes (Lauer et al. 2018; Metcalf et al. 2015). In related research, Holl and Howarth (2000, p. 261) argued that natural resource projects can "enhance social welfare…" to the extent that it "…promotes the satisfaction of people's preferences." Robertson and Choi (2012, p. 86) suggested that the main goal of decisions in the collaborative contexts is "to increase the average level of satisfaction among the stakeholders."

Several social factors contribute to stakeholder satisfaction through their influence on the quality of stakeholder interactions (Lauer et al. 2018; Metcalf et al. 2015). One critical factor is the *trust* stakeholders have in project leaders, defined as their expectations that project leaders will behave with stakeholders' best interests in mind (Sharp et al. 2013), and the willingness of stakeholders to be vulnerable to project leaders (Lijeblad, Borrie, and Watson 2009). Other crucial social factors include *public engagement* – defined as the extent and effectiveness of project leaders' involvement of and communication with key project stakeholders (Lauer et al. 2018; Yung et al. 2013); and *conflict* – defined as the extent and severity of disagreements between stakeholders surrounding the project (Metcalf et al. 2015).

Extensive research addresses the role of trust in restoration contexts. Trust can facilitate dialog across communities and agencies, increase acceptance of policies and initiatives, and reduce conflict among stakeholders (Sharp et al. 2013). Trust facilitates cooperation (Gray, Shwom, and Jordan 2012), especially during times of conflict (Earle and Siegrist 2008), compliance (Dickson, Gordon, and Huber 2009), coordination (Owen and Videras 2008), collaboration (Lachapelle and McCool 2012), information sharing (Levesque et al. 2017), and ultimately, implementation (Lachapelle and McCool 2012). Trust is tenuous, however. It can be difficult to establish because of competing views on resource management (Lachapelle and McCool 2012), limited stakeholder engagement, poor communication, a perception that the community lacks power or is resentful (Davenport et al. 2007), or distrust in government (Lachapelle, McCool, and Patterson 2003). One way to facilitate trust is by providing stakeholders with opportunities to participate in decision-making (Gray, Shwom, and Jordan 2012; Lauer et al. 2018; Metcalf et al. 2015). A deliberative process that integrates local concerns and knowledge, and that demonstrates cooperation among agencies involved, can bolster perceptions of fairness (Earle and Siegrist 2008), lead to learning and cooperation between parties (Davenport et al. 2007; Sharp et al. 2013) and ultimately facilitate trust.

Natural resource management often involves diverse actors with competing interests and goals (Bodin and Prell 2011; Sandström 2011), which can generate conflict and disagreements (Carlsson and Berkes 2005); such conflict can erode trust among participants (Hahn et al. 2006). Indeed, distrust is often the *de facto* attitude of stakeholders toward project leadership (Lachapelle, McCool, and Patterson 2003). Additionally, perceived inter-agency conflict can erode trust in project leadership (Metcalf et al. 2015).

Social Networks and Ecosystem Restoration

For two decades, researchers in natural resource governance have used social capital theory to understand social phenomena. *Social capital* exists when people collectively generate social resources - such as support for one's suggestions or initiatives - that in turn enable more inclusive, collaborative, and adaptive forms of governance (Harrison, Montgomery, and Bliss 2016; Rydin and Holman 2004). Social capital accrues from *social networks*, the interlocking relationships between individuals. Networks create an informal structure that provides opportunities and imposes constraints on the individuals within them (Borgatti et al. 2009). Network ties can be *positive*, such as feeling trust in others' good intentions or competence *negative*, such as preferring to avoid interaction with certain people, or *neutral*, such as communication or knowledge-sharing ties. Studies in natural resources have tended to focus primarily on positive or neutral network ties, and rarely have considered both positive and negative ties simultaneously.

The nature of the tie has a profound impact on social capital (Labianca and Brass 2006). An individual's or group's social capital derives from the resources and opportunities embedded within the structure of their social networks (Nahapiet and Ghoshal 1997). Social capital in turn influences individual and group attitudes, behaviors, and outcomes (Borgatti et al. 2009). Thus, the social network approach addresses how the relational context influences individual attitudes, behavior, and outcomes (Borgatti et al. 2009).

The restoration context, like many cooperative governance contexts, is characterized by a complex constellation of conflict and cooperation (Carlsson and Berkes 2005; Sanginga, Kamugisha, and Martin 2010). SNA provides a unique opportunity to examine conflict and cooperation concurrently in relationships and test their differential effects on outcomes (Beilin et al. 2013; Bodin, García, and Robins 2020; Smith et al. 2014). Two recent studies have capitalized on this opportunity. Robins, Bates, and Pattison (2011) examined the network of positive and negative ties between organizations involved in a river restoration project; the authors defined positive and negative ties based on two different dimensions. Positive ties reflected the importance of the dealings between the organizations (e.g., an instrumental evaluation, rather than relational). Negative ties were based on the respondents' rating of the ease or difficulty the organizations had in working together, with "difficult" and "extremely difficult" ratings indicating negative ties. Although they found that both positive and negative ties existed within many relationships simultaneously (e.g., *multiplex ties*), the network failed to exhibit relational and structural embeddedness, indicating that organizations likely were pursuing different goals for the project. Villegas et al. (2021) content analysis of networks based on the valence and strength of conflict and cooperation events in small-scale fishery systems in Puerto Rico revealed a gap in cooperation between environmental managers and fishers.

We build upon these recent developments by (1) simultaneously examining positive and negative ties between individuals, rather than organizational actors, (2) directly surveying stakeholders regarding their affective relations with others, and (3) quantitatively examining the relationships between the social network ties and stakeholder attitudes to better understand their impact on restoration outcomes in a large-scale river restoration project. In particular, we explore the effects of positive and negative network ties on stakeholders' attitudes (public engagement, perceived conflict, and trust in project leadership, e.g., social factors) and on satisfaction with restoration outcomes.

Conceptual Model

We examine three research questions: (1) what social factors directly and indirectly affect stakeholder satisfaction with project outcomes? (2) What are the relationships between the social factors? (3) How do stakeholders' positive and negative networks affect social factors? Our conceptual model, Figure 1, posits that stakeholders' satisfaction with restoration project outcomes is influenced by their trust in project leaders, which in turn is influenced by perceptions of public engagement of stakeholders, conflict between project stakeholders, and the size of stakeholders' positive and negative networks. We conceptualize positive network ties as instances when a person trusts another, and negative network ties as instances when a person prefers not to interact with another. Thus, our network ties are defined by the affective social relations between the stakeholders (see Borgatti et al. 2009).

Trust relationships can be defined by an evaluation of the other person's good intentions (affect-based trust) or competence (cognition-based trust) (Chua, Ingram, and Morris 2008; McAllister 1995). We include both types of trust in our study. Trust

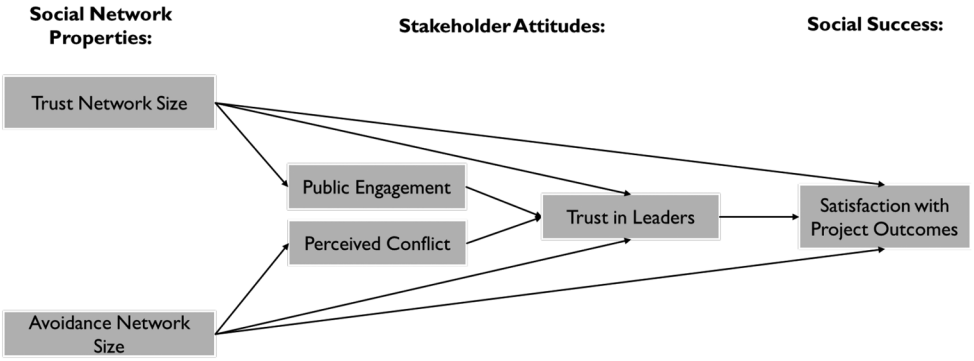

Figure 1. Conceptual model. Relationships between social network properties, stakeholder attitudes and success.

networks are generally considered to be positive. In contrast, *avoidance networks* capture negative relationships, or instances when one individual tries to avoid working with another. Asking about preferring to avoid certain people is a common method used to measure negative ties, because respondents tend not to describe negative feelings toward others in more explicit terms (Labianca, Brass, and Gray 1998). Importantly, we test how the size of an individual's trust (positive) and avoidance (negative) networks differentially affect attitudes and satisfaction with restoration project outcomes.

The size of an individual's network is defined as the number of direct relationships the individual has with other people in the network (Borgatti et al. 2009). Because a larger positive network provides an individual with greater access to flows of information, resources, or support (Borgatti and Halgin 2011), stakeholders with larger (vs. smaller) trust networks should be better informed regarding project goals and progress toward those goals. Hence, stakeholders with larger positive networks may be: (1) more trusting of project leaders and (2) have more positive perceptions of their engagement with the project. In turn, trust of project leaders and engagement can generate higher satisfaction with project outcomes. In addition, through increased access to information, resources and social support, a larger trust network may positively influence stakeholders' satisfaction directly (e.g., Abrams et al. 2003; Coleman 1988; Helliwell 2006).

In contrast, a larger negative network might expose individuals to negative behaviors and impediments to knowledge-sharing (Labianca and Brass 2006), leading to conflict, withdrawal, and lack of engagement in the project, potentially lowering satisfaction with project outcomes.

Methods

Study Site and Sample

In 1983, the Clark Fork River was designated as a Superfund site (under the Comprehensive Environmental Response, Compensation, and Liability Act), extending over 120 miles from Butte, Montana to Missoula, Montana. The complex is made up

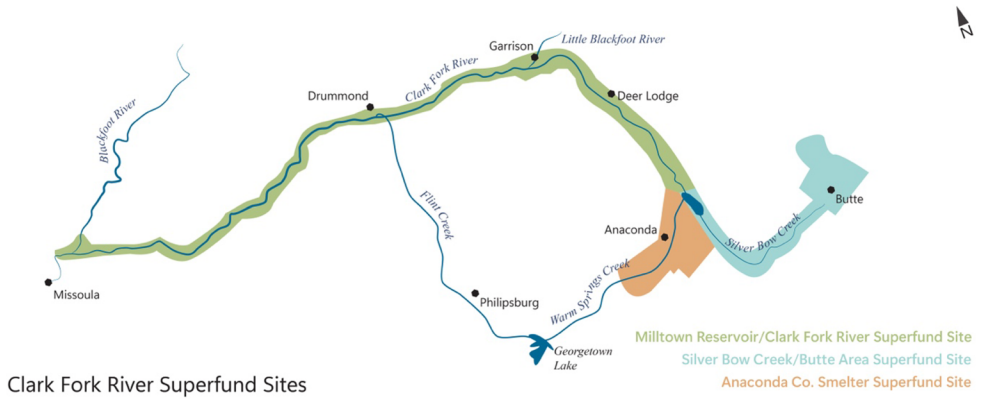

Figure 2. Map of clark fork river superfund site from EPA 5-year review.

of four operable units (see Figure 2). The legacy of contamination began over 100 years ago, resulting from copper mining in Butte, often referred to "the richest hill" for becoming one of the world's largest sources of copper. In 1983, arsenic was found in the groundwater near Missoula in the Milltown area, originating from a 1908 flood which deposited millions of tons of mine waste behind the Milltown Dam. As a result, it was one of the first locations to receive remediation. In December 2004, the remediation plan called for the removal of the dam and of more than two million cubic yards of contaminated sediment. Restoration began in 2007 and included restoration of the river channel, floodplain function, fish populations, and riparian vegetation (see Metcalf et al. 2015 for complete history of the Milltown Dam).

In addition to physical changes to the site, the project exhibits frequently shifting social dynamics due to the varied roles of those involved and their strongly-held views about who would benefit from the project, how the project would be implemented, and how the potential impacts of the project would be managed. The project involved multiple restoration businesses (Mohr and Metcalf 2018), state agencies (e.g. Montana Fish, Wildlife, and Parks, Montana Department of Environmental Quality), federal agencies (e.g. US Fish and Wildlife Service, US Environmental Protection Agency), NGOs (e.g. Trout Unlimited, The Nature Conservancy), academics (e.g. the University of Montana), community and working groups (e.g. Clark Fork Technical Advisory Committee), and other businesses (e.g. outfitters and guides, Northwestern Energy). Our goal was to understand how the interactions between the various project participants affected a key indicator of social success, stakeholder satisfaction. We received approval for the project from our university's human subjects review (#159-17).

Based on our engagement in previous research at the site, we developed an initial roster of individuals who had significant involvement in the project, or direct or indirect influence over its outcomes. We identified additional network members through key informants, news articles, academic sources, and government records. Local private citizens were included only if they were actively involved in the project. All those in the sample self-identified their role on the project as citizen advisor, ecological advisor, human health advisor, press, project leader, recreation advisor, research advisor, or technical advisor (see Figure 3).

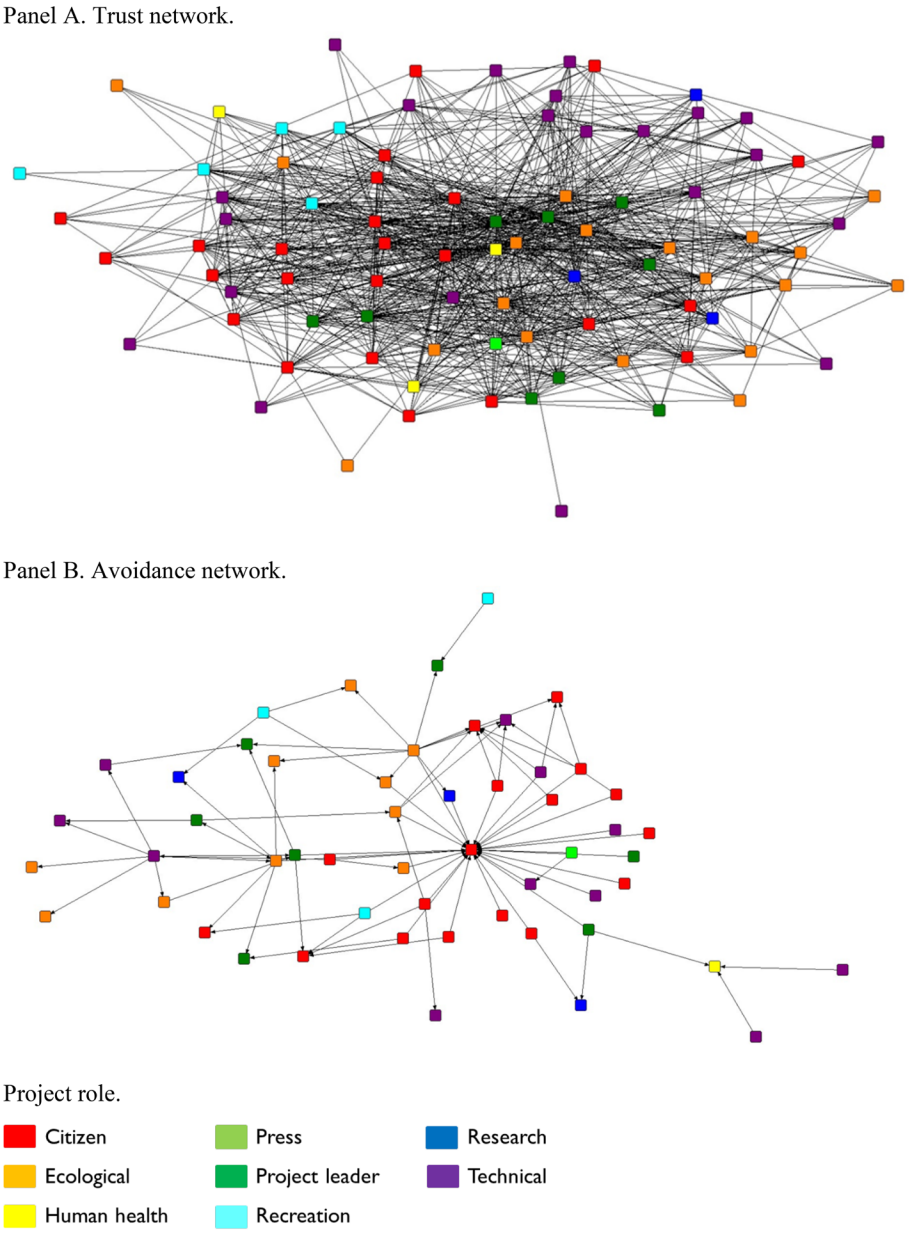

Figure 3. Social network maps. Node color indicates project role.

All network members were contacted via email and/or phone to explain the purpose of the project and to request participation. The final network population was 86. Of these, four individuals were unable to participate, but allowed us to list their names on the survey roster. We administered the survey to the remaining 82 members. Of the 86 in the population, 68 completed the survey, for a response rate of 79%. Given the size of the stakeholder group surrounding the project, and the ambitious goal of identifying the network *a priori*, this is a robust data set. Independent samples t-tests confirmed no significant differences between respondents and non-respondents on role or gender.

Procedures

Respondents clicked a link provided in an emailed invitation to complete a confidential online survey generated by SurveyGizmo (Vanek and McDaniel 2006). We administered the survey over the course of seven weeks in the fall of 2017. The survey used 7-point Likert-type scales (1 = strongly disagree to 7 = strongly agree), unless otherwise noted. All scale items are shown in Table S1. The survey randomized question order to alleviate bias (Dillman 2011, p. 93).

Given the difficulty of collecting data on negative relationships (Bodin, García, and Robins 2020; Labianca and Brass 2006), we took particular care to facilitate the data collection. First, we established trust between the research team and the respondents through extensive collaboration on a previous research project. If the opportunity for this proactive trust-building is lacking, future researchers can, at minimum, interact with each potential respondent, preferably in person, to explain the purpose and goals of the study to secure their participation. Second, we explained in detail in the informed consent portion of the survey how we would protect respondents' confidentiality and encouraged anyone with concerns to contact the lead investigator directly. No respondents availed themselves of this opportunity. Third, since respondents are often reluctant to divulge negative relationships (Labianca and Brass 2006; Robins, Bates, and Pattison 2011), we carefully crafted the question we used to elicit negative ties (see social network measures below). Finally, just before the social network section of the survey, we reminded respondents that their responses were completely confidential.

Dependent Variable

Given our study's diverse stakeholders, and the likelihood of differing goals for the project, our outcome variable gave participants the opportunity to evaluate overall satisfaction with restoration outcomes relative to their individual perspectives (e.g., Åberg and Tapsell 2013; Lah, Park, and Cho 2015). Stakeholder satisfaction effectively answers Wortley, Hero, and Howes (2013) call for more research into social impacts, since it is often considered to be a key factor in social success (Holl and Howarth 2000; Robertson and Choi 2012). Although many restoration studies use one-item measures, we desired a multi-item scale to ensure validity and reliability. We adapted Cammann et al.'s (1983) widely used and validated scale. Our four-item scale (sample item: "Overall, I am satisfied with the outcome we achieved here in the Milltown project" (Lauer et al. 2018, p. 8)) exhibited acceptable reliability (α = .90; see Table S1 for all items). The four items loaded on one factor; loadings ranged from .81-.94 and explained 82.10% of the variance, exceeding the average of 56.60% in a meta-analysis of factor analyses in behavioral sciences studies (Peterson 2000).

Stakeholder Attitudes

Trust in Leaders. Trust in the agencies involved in conservation efforts has been operationalized in past research as trust in moral competency and shared values (Smith

et al. 2013), trust in ability, benevolence, and integrity (Sharp et al. 2013), and trust in shared norms and values and perceived efficacy (Lijeblad, Borrie, and Watson 2009). Accordingly, we developed a five-item scale that incorporated many of these concepts, while also including items designed to assess collaboration and transparency. Our scale focused on stakeholders' trust in leaders of the project. One item read: "Project leaders working on Milltown were transparent with communication to the public" (see Table S1) (α = .84). All items loaded on one factor, with loadings ranging from .54-.89, which explained 64.15% of the variance.

Public Engagement. We adapted a six-item scale from previous research that captures stakeholder perceptions of the way that project leaders interacted with them about the project (Germain, Floyd, and Stehman 2001; Niehoff and Moorman 1993; Smith and McDonough 2001). One item read: "Stakeholders were able to have sustained influenced over the decisions made about the Milltown project" (α = .91). All items loaded on one factor, with loadings ranging from .72-.89, which explained 68.98% of the variance.

Perceived Conflict. We used items from previous research to assess stakeholders' general perceptions of three facets of conflict: goals, process, and relationship conflict (Jehn et al. 2008). One item read: "There was disagreement about the best process to achieve the Milltown project restoration goals." Although all items loaded on one factor (with loadings ranging from .60-.84, explaining 58.50% of the variance), the reliability coefficient (α = .61) is low.[1] This low reliability is a limitation, and our results must be interpreted in light of this.

Social Network Properties

The survey presented respondents with a roster of the names and organizational affiliations of the 86 Milltown participants and asked them to check the boxes next to the names of people they interacted with and then to evaluate those names based on the following statements.

For the trust network, respondents were asked about *cognition-based* trust (perceptions of the other party's competence at work-related tasks); the measure read "I could rely on this person to complete tasks they agreed to do for me" (Chua, Ingram, and Morris 2008; McAllister 1995) and the respondent scored each person they interacted with on the seven-point strongly disagree to strongly agree scale. They were then asked about *affect-based trust* (the degree to which a person trusts another to act in a good-faith fashion); the measure read: "I felt comfortable going to this person to share my problems and difficulties related to the Milltown project" (Chua, Ingram, and Morris 2008; McAllister 1995), and the respondent scored each person they interacted with on the same seven-point scale. Consistent with accepted SNA methods, we dichotomized the resulting data using the following rule: scores greater than or equal to 5 (5 = slightly agree; 6 = agree; 7 = strongly agree) were replaced with a 1; scores less than or equal to 4 (4 = neutral; 3 = slightly disagree; 2 = disagree; 1 = strongly disagree) were replaced with a 0. Next, we arranged the data into two adjacency matrices in which a 1 in cell x_{ij} indicates that *i* has rated *j* favorably on trust. The two dichotomized matrices were then combined into one by summing them, which is commonly done for multiplex ties (Schnegg 2018); a 1 in cell x_{ij} in the newly summed matrix indicates that *i* views

j with either cognition-based or affect-based trust, a 2 indicates that *i* views *j* with both forms of trust, and a 0 indicates that *i* views *j* with neither form of trust.[2]

For the avoidance network, the measure asked, "Which (if any) people did you prefer to avoid during the Milltown project?" (Labianca, Brass, and Gray 1998). Respondents checked the names of people they preferred to avoid. The resulting binary data were arranged into an adjacency matrix in which a 1 in cell x_{ij} indicated that respondent *i* nominated person *j* as someone they preferred to avoid, and a 0 indicated that *i* did not nominate *j*.

Trust and Avoidance Network Size. We used UCINET VI (Borgatti, Everett, and Freeman 2002) to calculate *network size* for each stakeholder's trust and avoidance networks using a simple count of their outgoing ties within each network (Borgatti et al. 2024). Trust network ties that were weighted as "2" (because they contained both cognition-based and affect-based trust) were counted as two in the calculation of network size.[3]

Control Variables

We tested the effect of potential control variables including gender, organizational affiliation, project role (Section 5.1 and Figure 3, presented subsequently, provide the various project roles), and whether the individual was a project leader or not. None of these variables were significantly related to the outcome (satisfaction), and none had any impact on the direction or significance of our results. Thus, for parsimony, we dropped them from our models.

Model Analysis and Testing

Recall that Figure 1 specified our conceptual model, outlining the hypothesized relationships between social network properties, stakeholder attitudes, and satisfaction with project outcomes. Because our sample size was insufficient for structural equation modeling (Wolf et al. 2013), we conducted path analysis of the two sequential mediation models using the SPSS (IBM Corporation 2016) PROCESS macro (Hayes 2012, 2015). See Figure 4, Panels A and B. We tested indirect effects using 5,000 bias-corrected bootstrapped samples (Preacher and Hayes 2008). We standardized all variables prior to analysis to account for differences in scale between our variables and make interpreting model coefficients easier (Schielzeth 2010).

Results

Network Maps

Figure 3 presents the social network maps. Nodes are colored according to the project role of each person. Lines between the nodes indicate relationships. Project stakeholders' roles included: citizen advisor (24), ecological advisor (19), human health advisor (3), press (1), project leader (9), recreation advisor (5), research advisor (3), and technical advisor (22). Fifty-six participants were men and 30 were women.

The trust network (Figure 3, Panel A) is characterized by a highly connected central group and peripheral members who are connected into the core. This type of core-periphery

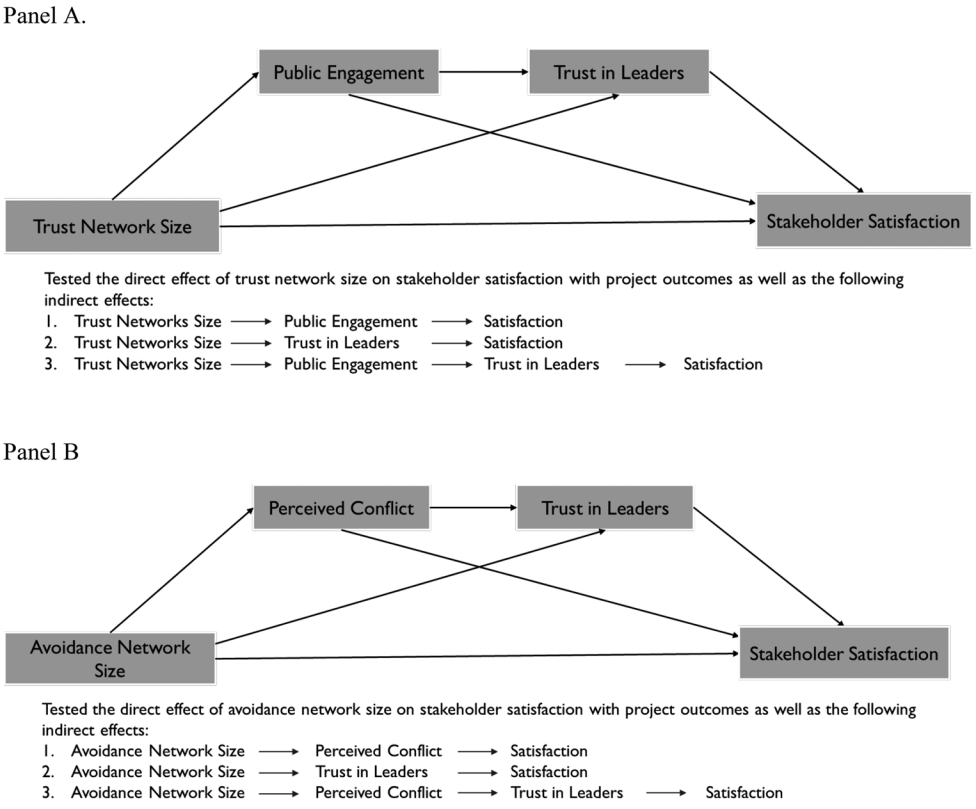

Figure 4. Sequential mediation models. Trust network and avoidance network.

structure (e.g., Borgatti and Everett 2000) is associated with good morale and consensus (Johnson, Boster, and Palinkas 2003). The structure may have contributed to the relatively high project satisfaction among stakeholders ($\overline{x}$ = 6.32/7.0; std. dev. = 0.94).

In the avoidance network (Figure 3, Panel B), lines between the nodes indicate that one party prefers to avoid working with the other. The arrow points to the party who is being avoided. The avoidance network is much sparser than the trust network, which is common for negative ties (Labianca and Brass 2006).

We examined the possibility of multiplex ties (ties that contain both positive and negative relations) between the stakeholders in our study using a QAP (Quadratic Assignment Procedure) correlation of the two network matrices (Krackhardt 1988). As a non-parametric test used for matrix-based variables, QAP allowed us to test for overlap between the trust and avoidance matrices; in other words, were there pairs of stakeholders that exhibit both types of relations? We found no significant correlation between the two matrices (-.015, p =.204), indicating that they did not overlap. We explore the implications of this in the discussion section.

Means, Standard Deviations and Zero-Order Correlations

Table 1 presents descriptive statistics and zero-order correlations. The mean size of an individual's trust network in our study was comprised of 34.8 people (std. dev. =

Table 1. Means, medians, standard deviations, and zero-order correlations.

Variable		*Mean*	*Median*	*SD*	*Min*	*Max*	1	2	3	4	5
1	Satisfaction	6.32	6.75	0.94	2.50	7.00					
2	Trust in Leaders	5.40	5.80	1.13	1.80	7.00	0.65**				
3	Public Engagement	5.53	5.67	1.11	2.33	7.00	0.64**	0.89**			
4	Perceived Conflict	4.61	4.67	1.25	2.00	7.00	−0.30*	−0.45**	−0.38**		
5	Trust Network Size	34.76	33.00	25.03	0.00	128.00	0.19	0.31*	0.34**	0.02	
6	Avoidance Network Size	1.20	0.50	1.82	0.00	10.00	−0.16	0.11	0.08	0.00	0.11

Note. Table presents bivariate correlations. $N = 68$.
*$p < .05$. **$p < .01$.

Table 2. Sequential mediation process models examining effect of trust network size on satisfaction with project outcomes through public engagement and trust in leaders.

	Model 1	Model 2	Model 3
	Mediating variable	Mediating variable	Dependent variable
	Public engagement	Trust in leaders	Satisfaction
	β *(SE)*	β *(SE)*	β *(SE)*
Independent variable			
Trust network size	.34 (.12)**	.01 (.05)	−.01 (.10)
Mediator variables			
Public engagement		.82 (.05)***	.27 (.21)
Trust in leaders			.45 (.22)*
Mediation (indirect effests)			Effect [95% CI]
Trust network size -> Public engagement -> Satisfaction			.09 (.07) [−.02, .29]
Trust network size -> Trust in leaders -> Satisfaction			.00 (.02) [−.05, .06]
Trust network size -> Public engagement -> Trust in leaders -> Satisfaction			.13 (.09) [−.04, .32]
Constant	−.01(.12)	−.01 (.05)	−.01 (.09)
F-statistic	8.66**	130.15***	17.22***
R^2	0.11	0.80	0.44

Note. $N = 68$. All mediation tests were done using 5,000 bootstrap samples.
*$p < .05$ **$p < .01$ ***$p < .001$.

25.0) while the mean size of an individual's avoidance network was comprised of only 1.2 people (std. dev. = 1.8).

Model Testing

Table 2 presents the results of the first PROCESS model testing the direct effect of trust network size on stakeholder satisfaction and indirect effects through the mediators (public engagement and trust in project leaders). We found no direct effects of trust network size on satisfaction, of trust network size on trust in leaders, nor of public engagement on satisfaction. We found a significant direct effect of trust network size on public engagement (β = .34, $p < .01$), of public engagement on trust in leaders (β = .82, $p < .001$), and of trust in leaders on stakeholder satisfaction (β = .45, $p < .05$).

The model explained 44% of the variance in stakeholder satisfaction (F (3.0, 65.0) =17.22, p <.001). There were no significant indirect effects of trust network size on stakeholder satisfaction through any combination of mediators. Follow-up analysis confirmed no significant indirect effect of public engagement on stakeholder satisfaction through trust in leaders (see Table 2).

Table 3 presents the results of the second PROCESS model testing the direct effect of avoidance network size on stakeholder satisfaction and indirect effects through the mediators (perceived conflict and trust in project leaders). We found a significant direct effect of avoidance network size on satisfaction (β = −.23, p < .05), of trust in leaders on satisfaction (β = .74, p < .001), and of perceived conflict on trust in leaders (β = −.41, p < .001).[4] We found no direct effects of avoidance network size on perceived conflict, trust in leaders, nor of perceived conflict on satisfaction. The model explained 48% of the variance in stakeholder satisfaction (F (3.0, 65.0) =20.04, p <.001). There were no significant indirect effects of avoidance network size on stakeholder satisfaction through any combination of mediators. Follow-up analysis confirmed a significant indirect effect of perceived conflict on stakeholder satisfaction through trust in leaders (β = −.29).

Because the sequential mediation PROCESS models did not allow examination of trust and avoidance ties in the same model, we ran post-hoc OLS regression analyses using the measures of network size to test their combined effects on each of the mediating variables and the outcome. Results matched what we found in the sequential mediation analysis–namely, that trust ties predict perceptions of public engagement and trust in project leaders, and that avoidance ties, but not trust ties, predict stakeholder satisfaction when trust in leaders is included in the model. Detailed results available from first author upon request.

Table 3. Sequential mediation process models examining effect of avoidance network size on satisfaction with project outcomes through perceived conflict and trust in leaders.

	Model 1	Model 2	Model 3
	Mediating variable	Mediating variable	Dependent variable
	Perceived conflict	Trust in leaders	Satisfaction
	β *(SE)*	β *(SE)*	β *(SE)*
Independent variable			
Avoidance network size	.00 (.12)	.10 (.10)	−.23 (.09)*
Mediator variables			
Perceived conflict		−.41 (.10)***	.01 (.10)
Trust in leaders			.74 (.11)***
Mediation (indirect effests)			Effect [95% CI]
Avoidance network size -> Perceived conflict -> Satisfaction			.00 (.01) [-.02, .02]
Avoidance network size -> Trust in leaders -> Satisfaction			.08 (.08) [-.12, .21]
Avoidance network sizee -> Perceived conflict -> Trust in leaders -> Satisfaction			−.00 (.03) [-.06, .06]
Constant	.00 (.12)	−.00 (.10)	−.00 (.09)
F-statistic	0.00	8.96***	20.04***
R^2	0.00	0.21	0.48

Note. N = 68. All mediation tests were done using 5,000 bootstrap samples.
*p < .05 **p < .01 ***p < .001.

Discussion

Our study adds to the nascent research on the social dimensions of ecological restoration. Few studies in natural resource contexts have leveraged the use of SNA in concert with attitudinal measures to understand social-ecological system dynamics. Past research has primarily used SNA as a descriptive tool to explain the nature of social ties across people, communities, and contexts. In contrast, by combining both SNA and attitudinal measures, this study provides a more comprehensive examination of social dynamics. To our knowledge, ours is the first to combine network analysis with attitudinal measures to understand their direct and indirect impacts on satisfaction with restoration outcomes.

Our findings deepen the understanding of how social networks and three important attitudinal variables–trust in project leaders, public engagement, and perceived conflict–individually and in concert affect stakeholder satisfaction, a measure of social success. In our first model, the size of the trust network positively affects public engagement. In addition, consistent with prior research (Lachapelle and McCool 2012; Lauer et al. 2018; Metcalf et al. 2015), perceptions of public engagement contribute to trust in leaders. However, neither the trust network nor public engagement has direct effects on satisfaction. Moreover, neither has indirect effects on satisfaction through their impact on trust in leaders. Our second model shows that the size of the avoidance network has a direct negative effect on stakeholder satisfaction. Although perceived conflict has no direct effect on satisfaction, it does exhibit a significant indirect effect on stakeholder satisfaction through its negative impact on trust in leaders.

In contrast to Robins, Bates, and Pattison (2011), our research focused on individual network ties; positive ties were based on trust and negative ties were defined as "individuals preferred to avoid." Recall that Robins, Bates, and Pattison (2011) studied organizational network ties, where positive ties were based on the instrumental necessity of the interactions and negative ties were based on how difficult the interactions were. Hence, it makes sense that their networks exhibited multiplex ties, given that important organizational relationships can concurrently be difficult. In contrast, our QAP analysis showed no overlap in our individual-level trust and avoidance networks. Indeed, it's hard to imagine that individuals prefer to avoid contact with people that they trust to act with goodwill.

Theoretical Implications

Our study offers three primary theoretical contributions. First, it points to the highly salient role of trust in leaders, a critical construct that warrants additional theorizing. In both the trust and avoidance network models, trust in leaders is the only variable that affects the outcome of satisfaction directly. Trust is a complicated construct and can include competence as well as affective components such as benevolence and integrity (Lijeblad, Borrie, and Watson 2009, Sharp et al. 2013). Competence itself may include multiple dimensions, such as technical, social, and even political competence (Lijeblad, Borrie, and Watson 2009). Unpacking this construct by teasing out different dimensions of trust in leaders will add important nuance—perhaps offering insights into why neither the trust network nor the avoidance network exhibited a significant relationship to trust in leaders.

Second, in contrast to the trust network, avoidance network size exhibits a direct negative effect on stakeholder satisfaction; it shows a disproportionate impact on project outcomes—particularly considering its smaller size compared to the trust network. Numerous social network studies have revealed the impact of negative network ties on social consequences, including reduced trust (Chua, Ingram, and Morris 2008), reduced satisfaction (Baldwin, Bedell, and Johnson 1997), and reduced organizational attachment (Venkataramani, Labianca, and Grosser 2013). For a review, see Labianca (2014). These social consequences appear to be particularly salient in the restoration context, perhaps because project stakeholders often come from numerous organizations and groups and may have little experience working together. Future research could fruitfully examine questions such as: What other structures might these avoidance networks take? Is it possible that avoidance networks offer important relational tensions that reveal potential insight for the projects?

Third, the negative and positive pathways in our model exhibit differential effects on satisfaction. When the direct effect of the avoidance network is combined with the indirect effect of perceived conflict on satisfaction with outcomes, these potentially problematic aspects of interpersonal dynamics have more influence on stakeholder satisfaction than the trust network or public engagement. This asymmetric pattern of findings is consistent with research in social psychology and organizational research: negative relationships often have greater impacts on social outcomes than positive ones (e.g., Labianca and Brass 2006). Although negative interactions and relationships are relatively rare (negative relationships typically make up only 1 - 8% of total relationships), these negative interactions represent a significant discrepancy from the generally positive interactions most people expect (Labianca and Brass 2006). Hence, they weigh more heavily on one's formation of impressions, and therefore have greater consequences than positive interactions. Given this asymmetry, it is critical that theoretical models of social dynamics in ecological restoration include direct *and* indirect effects of social network variables, as well as attitudinal variables. In addition, theoretical models should endeavor to capture both "positive" (e.g., engagement) as well as "messier" variables (e.g., conflict) to assess the differential dynamics.

Practical Implications

Our results offer important practical implications for restoration leaders. First, they reinforce the importance of fostering positive relationships by providing opportunities for stakeholders to interact, formally and informally, across existing stakeholder groups. These efforts can also facilitate engagement, which is a key driver of trust in project leaders.

Second, since trust in leaders is influenced by perceptions of conflict, it may be helpful for project leaders to participate in conflict management training on a regular basis. Relatedly, those leaders should work to signal competence, reliability, and transparency, given the importance of their own actions and behaviors in creating trust in leaders.

Third, our research reveals a vital implication regarding the tenor of interactions among stakeholders. Negative interactions and perceived conflict exhibit more pathways

to impact outcomes compared to positive interactions and perceptions; thus, leaders should be aware of the tenor of interactions among stakeholders in order to immediately address potential conflicts and ensure they are managed effectively. Project leaders should establish clear ground rules and accepted norms for respectful interactions. In addition, leaders might identify individuals whom multiple stakeholders prefer not to interact with and work with those individuals to reduce their negative impacts–perhaps offering communication training and conflict management resources or providing direct constructive feedback to help them improve their relationships. In short, project leaders must ensure that any problematic behavior is addressed before it creates problems in the network (Sutton 2010).

Limitations and Future Research

Our findings are limited by the cross-sectional nature of our data; we encourage additional longitudinal research that can assess causal relationships among variables in our model. For instance, it is possible that trust in project leaders might also drive stakeholder engagement in a reciprocal fashion.

Also, our model included private landowners only if they were actively involved with the project; thus, the goals and concerns of landowners who were not involved actively with the project–a potentially important stakeholder group–may not have been fully represented. Given our focus on assessing network dynamics, excluding this group who did not interact with the project was a logical methodological choice. However, since landowners are key to large-scale restoration efforts, future research could include landowners even if they are not actively involved in project efforts.

Additionally, findings from our single site may not be generalizable to other sites. Conducting studies across different river restoration projects and in different contexts opens the possibility of comparing social processes in different socio-ecological contexts.

In addition, researchers should continue to study both positive and negative networks simultaneously, teasing out both the way positive and negative ties are operationalized, whether the networks are at the organizational or individual level, and possible interactive effects between positive and negative networks. For example, are there circumstances where the positive impacts of trust networks might mitigate the negative impacts of avoidance networks?

Finally, our findings suggest that future research on factors that are related to negative relationships could prove useful.

Conclusion

In our study of stakeholders involved in a river restoration project, positive and negative social network ties between stakeholders exhibited asymmetrical effects on stakeholders' attitudes and satisfaction with project outcomes. Trust ties influenced only perceptions of public engagement, while avoidance ties influenced stakeholder satisfaction directly. Trust in leaders was a key factor influencing satisfaction and both public engagement and perceived conflict influenced the development of that trust.

We hope our study inspires further research that examines positive and negative social networks simultaneously, as well as how social networks and stakeholder attitudes, in concert, affect restoration outcomes.

Notes

1. We also ran our analyses with each conflict item separately (see Table S2). The direction and significance of results were virtually identical to the results with the combined scale.
2. Another accepted method to combine matrices is elementwise multiplication (Hanneman and Riddle 2005; Zagenczyk et al. 2015). As a robustness check, we reran all analyses using this method. The direction and significance of the results were virtually identical. Refer to Table S3 for results.
3. In addition, we ran all analyses using separate variables for cognition-based trust network size and affect-based trust network size. The direction and significance of results were virtually identical. Refer to Table S3 for results.
4. As shown in the map of the avoidance network (Figure 3), one individual received a disproportionally greater amount of the negative relationship nominations. To examine whether this one individual was the sole cause contributing to our finding, as a robustness check, we re-tested the model with that person removed from the network. The direction and significance of the results were unchanged. Refer to Table S4 for results.

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