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Ego network properties as a way to reveal conflict in collaboration's clothing

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Abstract

A need for successful collaborative strategies is an enduring problem in natural resource management. Several qualities of "successful" partnerships have been identified but few empirical studies have tested these claims against the information sharing structure of "unsuccessful" partnerships. This paper examines the ego networks of members in a partnership that has not successfully reached its goals as an illustration of the ways in which external ties relate to attitudes and relationships within a partnership. By focusing on information sharing frequencies, member ideologies, and power structure among organizations involved in a groundwater controversy, we test the extent to which the process and outcomes of participation align with conditions often used to indicate "success". Results show that individuals who think that science is objective maintain information sharing ego networks that include a larger proportion of ties outside of the partnership than those who consider science to be less certain. Individuals who consider themselves a member of the partnership are more central to the network of organizations invited to join the partnership and maintain a greater proportions of unique ties relative to ties common across multiple actors. This case study challenges widely held assumptions about the properties of successful collaborations and supports claims that scientific discourse can be used to obscure debates over values.

Keywords: social networks; collaboration; conflict; unique ties; water resources

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1 The role of partnerships in natural resource management

Natural components of hydrological systems rarely restrict themselves to governance at a single scale, making their management a complex task. Previous research has shown that knowledge building and decision-making appropriate to the scale of water resources requires information flow across multiple levels interests at multiple scales (Bulkeley 2005, Lebel 2005, Cash et al. 2006, Sneddon et al. 2002). This has, in part, contributed to a proliferation of multi-stakeholder partnerships established with the intention to be inclusive mechanisms for setting management priorities and reducing conflict between resource users. Through partnerships, stakeholders negotiate with each other directly under the assumption that they might be able to reach more widely acceptable resource management decisions than could occur through top-down decision-making (Olsson et al. 2004, Leach and Pelkey 2001).

Research often portrays successful partnerships as able to bridge boundaries between horizontally stratified (e.g. adjacent local governments) or vertically differentiated (e.g. upstream and downstream) interests (Ostrom 1972; Schneider et al. 2003). However, there are many cases in which conflict persists even though geographically and ideologically diverse audiences participate in an open and democratic process (see Singleton 2002 for a review of cases in the western U.S.). Researchers have yet to identify specific ways in which information flow patterns create or perpetuate barriers to consensus, however there is emerging research that suggests external ties may play a critical role (Reagans & McEvily, 2003). In this paper, we review the literature on how information sharing might create opportunities for conflict to exist and persist using the structure of the Verde River Basin Partnership (VRBP). The analysis builds on earlier work (Muñoz-Erickson et al. In Press) by evaluating free-responses to questions about personal information sharing from actors whom had previously provided attitude data and fixed-response questions about sharing information with other VRBP members.

1.1 Background on the Verde River Basin Partnerhsip (VRBP)

The VRBP was created by federal legislation in 2004 to develop and share scientific knowledge and to inform watershed management in the Central Highlands region of central Arizona, USA, a rural region with a handful of growing population centers. At issue is the level of connectivity between the Big Chino aquifer and surface water flow in the Verde River (1). The VRBP is required to submit a final report to the United States Department of Agriculture and Governor of Arizona that includes the results of assessments of connectivity between the Big Chino aquifer and the Verde River surface waters. Specifically, the report must (1) identify areas in the Verde River Basin that have groundwater deficits or other potential water supply problems, (2) provide an outline of long-term water supply management options, and (3) provide additional scientific information necessary to make a decision to enact any one of the proposed groundwater management strategies (Verde River Basin Partnership 2007). Controversy over the legitimacy of extant scientific reports and the democratic structure of the VRBP has lead to substantial conflict among stakeholders (Bolin et al. 2008). Despite high levels of conflict, many of the original members of the VRBP continue to exchange information and chare opinions with each other regularly, forming a social network.

1.2 Social Networks

Social networks are representations of the pattern and content of interactions within and between social units. Social network analysis defines networks as sets of linkages between several actors. The purpose of the linkages, or ties, represents an exchange or relationship that takes place. Most research takes either a whole network or ego network approach to understanding how relationships affect outcomes. Under the whole network approach, researchers aim to understand how power sharing and information flow occurs in a defined group. Asking network members about who they share information with and how frequently offers insight into the structure information sharing. Ties can be combined with information about the attitudes, perceptions, and perspectives of network members to provide insight into how different dimensions of conflict align serve to unite or undo cooperation within the partnership. In an ego network approach, individual actors, or egos, and their information sources are important. Individuals completing ego network surveys are not bounded by a predefined sampling scheme as they respond. It is possible to understand how distinct one actor's ties are from those of others. In natural resource policy, studies have typically used whole network methodologies (Bodin et al. 2006).

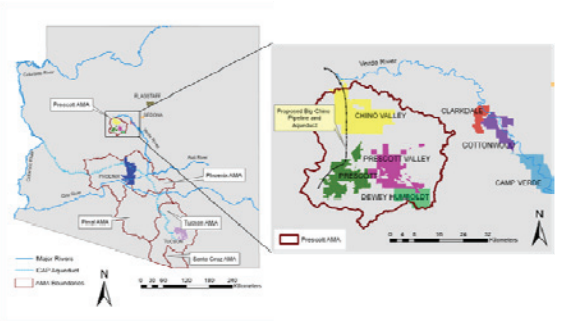

Figure. 1: The study area as it is situated in Arizona, USA. Inset is the geographical extent of interest to the Verde River Basin Partnership.

This study builds on an emerging literature that examines the effects of relationships outside of the network with those within it. The way in which external ties perpetuate or negate conflict within a group depends on the degree to which internal and external information management strategies are complementary (Shah et al. 2006). For example, external relationships provide technical knowledge about performance or serve as a source of new ideas (Adler & Kwon, 2002; Farris,1969). In contrast, intragroup relationships facilitate the ability of group members to share ideas, information, and knowledge cooperatively and to integrate them together to arrive at an optimal solution. In networks, the ratio of external to internal ties if often used to analyze subgroups within a network. Here, we use it to analyze the structure of ties to other VRBP participants and outside sources of information. Additionally, we evaluate the extent to which actors identify unique contacts in their ego networks, that is contacts that no other respondent identified as a source of information sharing and exchange. Particularly if an ideological position is identifies itself as disenfranchised by the dynamics of the VRBP, it may seek to amass either a larger assortment of informational ties or rely on a more unique set of information sources.

We use whole network and ego network methods together to examine barriers to, and opportunities for, collaborative decision making in the VRBP. The degree to which ego network ties are external to the VRBP and unique to individuals provides additional information about the qualities of the participants that may allow them to garner power and the influence of connections to actors outside of the whole network on power distribution and conflict in the network. We aim to understand how whole network and ego network information relate to (a) *power differences* that might provide a source of conflict and the role that patterns in ego-network size and composition may play in perpetuating conflict and whether or not (b) *ideologies* about the role of science or (b) recognizing a continuing *affiliation* with the VRBP relates to an individual's role in information exchange.

Power asymmetries can promote conflict (Brass et al. 2004, Ostrom 1990). Recently whole network studies have been used to evaluate power distribution and cooperation in regional and water-related partnerships across multiple policy levels (Henry 2007, Berardo and Scholz 2007). We focus on in-degree centrality, measured by connections from others to a node as an indicaor of prestige (Knoke and Burt 1983, Brass and Burkhardt 1993), though power can be derived from network position a variety of ways (see Brass and Burkhardt 1993, Brass et al. 2004, Ibarra 1993). Actors may derive power from surveying the diversity knowledge and opinions that exist in the network and use their "gate-keeping" abilities to limit the diffusion of some perspectives more than others.

The results of previous research concerning the power structure of the VRBP indicate that, among VRBP members, indegree centrality is significantly higher for those who think scientists should play a role in policy decision making (Munoz-Erickson et al. In Press). By examining the ego networks of VRBP members, we seek to understand whether or not the number (as a proxy for investment in VRBP issues) and composition (as a proxy for their uniqueness in the network) play a role in why these actors occupy positions of power.

Developing a collective identity requires members to maintain and draw from individual ties but also transcend them to act collectively (Astley 1984; Lawrence et al. 2002). The VRBP is among a class of collaborative groups that adopt a mediation approach, focused on resolving a particular issue (Conley and Moote 2003). In the case of

the VRBP, group membership and the group's mission were established through external forces. This calls in to question the legitimacy of the group structure and the appropriateness of its stated objectives. We use affiliation information to understand if information sharing is related to sustained involvement in the VRBP as indicated through voluntarily acknowledging an affiliation with the organization.

Based on the review above, this study tests the following hypotheses related to power and affiliation:

H1. The size and composition an actor's ego network and will vary with power (network position).

H2. Those who acknowledge their affiliation with the VRBP will differ in their whole power (network position) from those who do not acknowledge this affiliation.

H3. Those who acknowledge their affiliation with the VRBP will differ from those who do not in the uniqueness of their ego networks.

H4. The size and composition an actor's ego network will vary with ideologies.

2 Methods

We set our whole-network sampling frame as the published list of attendees from the first VRBP meeting, inviting all 42 members from the list to participate in our study. Following Dillman's Tailored Design Method (2000), we implemented a multi-modal survey design. We sent each sampled individual a letter introducing the survey. The letter contained a link to the internet version of the survey as well as a postcard that could be returned for those who preferred to fill out the survey on paper. Letters that were returned were sent to updated addresses. Approximately three times over six weeks, we provided email and/or telephone reminders to non-respondents. After six weeks, we sent a hard copy of the survey to remaining non-respondents.

Table 1

Matrix of hypotheses tested in this paper and Muñoz-Erickson (In Press). Our work builds on Muñoz-Erickson by considering that ego networks properties may play a significant role in explaining conflict in a partnership that meets nearly all of the criteria for successful collaboration internally. H1-H4 indicates the four hypotheses tested in this paper.

	Whole Network	**Ego network**		
	Indegree Centrality (power)	Number of contacts	External:Internal contact ratio	Unique:Shared contact ratio
Whole network power	Muñoz-Erickson (In Press)	H1	H1	H1
Affiliation	H2	H3	H3	H3
Ideologu about objectiv ity in science	Muñoz-Erickson (In Press)	H4	H4	H4

Our survey instrument includes a social network component, and a world view component (See Muñoz-Erickson et al. In Review for a full description; survey available online at http://www.public.asu.edu/~bcutts). The social network component of the survey consists of affiliation and ego network free-list items and a whole network recall item. In the affiliation free-list, respondents list all organizations they represent in discussions related to the Big Chino Project. This allows us to identify respondents who consider themselves VRBP members. Respondents provide ego network information through lists of up to 15 people and/or organizations with whom they share information. Later in the survey, we ask respondents to identify those in our sampling frame with whom they share information "at least once per week". The world view component draws from a diverse arrangement of previously

validated survey questions that use "strongly agree" to "strongly disagree" scales to represent complicated underlying constructs. A summative scale assesses views on the role of scientists in natural resource policy formation (Steel et al. 2004).

Thirty four of 42 (80.9%) of potential survey respondents completed the Big Chino Project Survey between November 2007 and January 2008. They had been involved with issues pertinent to the proposed Big Chino Water Ranch for between 2 and 28 yrs with an average of 7.8 (sd 5.5). Metrics for the whole network information diagram indicates a density of 0.056 and in-degree network centralization of 0.19. Of those responding, actors reported belonging to an average of 2 (sd 1.53) organizations interested in the Big Chino Project controversy and an average of 5.45 (sd 4.73) alters in their ego network.

3 Analysis

We used SPSS v.10.0 (1999) to calculate descriptive statistics using survey responses and to test the validity of item scales using principle components analysis. Since our sample size is small, the summative scales used to measure respondent ideologies about the role of scientists in policy decisions formed a single factor. As an alternative to the scale, we assigned respondents to binary categories based on their summed score across all items, dividing the group based on the mean score.

We used UCINET (Borgatti et al. 2002) social network analysis software to develop descriptive characteristics of the network, to conduct statistical analyses, and to test hypotheses concerning relationships within versus between groups for each hypothesis. First, we used survey information to construct graphs for the network of actors identified in our sampling frame. For this paper, we constructed the graph using the most frequent level of information sharing (at least once a week). We calculated the centralization and tie density of the graph and in-degree centrality for each actor. We used this metric as measure of power (Brass and Burkhardt 1993).

After coding free-responses to ego network questions by organization, we developed three measures of ego network characters, the first calculated the ratio of ties to organizations external to the VRBP to those invited to join the VRBP (internal ties) using the E-I measure developed by Krackhardt and Stern (1988).
This is calculated as:

$$(X-Y)/\Sigma(X+Y)$$

where X represents external ties and Y represents internal ties. Values range from -1 to 1. To measure ego network uniqueness we devised a similar calculation for uniqueness in which we calculate the ratio of unshared ego network (X in this calculation) contacts as it relates to shared contacts (Y). Lastly, we calculated the total number of alters identified by each respondent.

To test whether or not power relates to properties of an actor's ego network, we use the UCINET regression test for nodes. We use the program's t-test for non-independent samples to determine whether or not particular network positions affiliated with power were more likely to be filled by actors with particular ideologies (about the role of scientists in decision making) and affiliations (with the VRBP). UCINET's hypothesis testing algorithms include bootstrap routines to overcome the problem of sample non-independence (Hanneman and Riddle 2005).

4 Results & Discussion

Our research highlights the crucial role that perspectives toward science and expertise can have in the way that information flows through the VRBP and potential for ego network and whole network data to present very different perspectives on network dynamics than either perspective taken in isolation. Muñoz-Erickson et al. (In Press) conclude that, though conflict persists in the VRBP, the network relationships meet many of the criteria for successful partnership building discussed in the literature. Here, we look more closely at the results from ego networks analyses and find that, when asked to free list contacts, information sharing contacts from the same respondents reveals ways in which gate-keeping and reliance on heterogenous information sources could belie the inability of the group to make a consensus decision. We find that:

H1. The size and composition an actor's ego network and will vary with power (network position). There is no relationship between the proportion of external ties, uniqueness of ties, or size of ego network and power as measure through either indegree or betweenness centrality (Standardized beta for Intercept: 0, E-I: 0.028, Uniqueness: -0.142, and Egosize -0.167. Model R-square: 0.052, F value: 0.551, P: 0.668)

H2. Those who acknowledge their affiliation with the VRBP will differ in their whole power (network position) from those who do not acknowledge this affiliation. This hypothesis is supported. Indegree centrality differs between those who identify themselves as VRBP members and those who do not. Members of the VRBP tended to have higher mean indegree rankings than those who did not acknowledge membership (20.50 ± 6.40 versus 13.65 ±8.82; p 0.02)

H3. Those who acknowledge their affiliation with the VRBP will differ from those who do not in the uniqueness of their ego networks. This hypothesis is supported. Uniqueness differs between those who identify themselves as VRBP members and those who do not (Table 2).

H4. The size and composition an actor's ego network will vary with ideologies. This hypothesis is supported. E:I ratio differs between those who have a positivist view of science and those who do not (Table 2). Those with a positivist view of science have positive scores.

Table 2

Differences in whole network position and ego network characteristics of organizations by (a) affiliation and (b) ideology concerning the certainty of science.

	Whole network	**Ego network**		
	Indegree centrality	Number of contacts	External:Internal contact ratio	Unique:Shared contact ratio
Affiliation[a]				
include partnership[b]	3.71(2.12)	5.14(4.32)	0.09(0.68)	0.23(0.59)
does not include partnership[b]	1.50(1.68)	5.81(4.99)	0.41(0.33)	-0.51(0.72)
p value	0.003	0.69	0.15	0.03
Ideology concerning objectivity in science[a]				
Science is objective[b]	2.52(2.25)	5.21(4.5)	0.44(0.41)	-0.31(0.72)
Science is not objective[b]	2.11(1.79)	6.44(5.1)	-0.05(0.57)	0.15(0.82)
p value	0.66	0.52	0.02	0.63

Notes: [a] bootstrapped t-test [b] mean (standard deviation)

Power within the VRBP is not associated the number of external or unique ties held by an actor. Therefore power appears to be generated from processes within the network. This is further supported by the finding that actors who acknowledge an affiliation with the VRBP in the survey occupy positions of power more frequently. The finding that actors acknowledging a connection to the VRBP have more unique networks seems to indicate some effort to draw information in from a large arrangement of sources. This extent to which new information flows through the network, may however still be limited by the more central position of positivists (noted in Muñoz-Erickson et al, In press) and their tendency to have more external ties than people with the view that science is subjective. The extent to which external ties might influence dynamics, the focus of this paper, has been largely missing from studies of collaborative partnerships. However, it is useful in tandem with the emerging literature that uses whole networks (e.g.Schneider et al 2003, Bulkeley 2005, Lebel 2005, Cash et al. 2006). It is of particular value to cases involving natural resource management in which relevant expertise types might exists in bodies concerned with parallel but not necessarily overlapping issues. While the analyses used in this study are unlikely to provide prescriptive parameters for future watershed partnerships, using this method widely might provide insight into general characteristics that describe partnerships which are able to meet their stated objectives and those who

are not. Understanding the structural relationships of partnerships can also help determine how groups can build adaptive capacity and resilience as a result of collaboration (Janssen et al. 2006, Bodin et al. 2006).

Work by Hardy et al. (2005) discusses the evolution of an intergroup identity through which members contribute expertise from their primary affiliation to the mission of the larger group. They find that, when a group identity emerges, conversations allow participants in the collaboration to develop consistent discourses when in and outside of intergroup conversations. The formation of an intergroup identity relies on members placing a high degree of importance on the issues being addressed, consistency of group discursive practices with their individual values and beliefs, and their ability to move from general to particular shared identities (Hardy et al. 2005). We found that those who identify an affiliation with the VRBP are those who have most likely maintained an active interest in and optimistic opinion of the capabilities of the group to reach its stated goals. They were most likely to know about what is going on in the network and were most likely to be efficient information gatherers and dispersers.

It is plausible that the mismatch between a mandate to solve the Big Chino controversy through science and the belief of partnership members that conflict persists because of values plays a large role in halting cooperation. The network's structure appears to be to maintain a system that looks to science for a definitive resolution. Central actors play a key role in fostering leadership, developing a shared knowledge and motivating creativity in natural resource management (Bodin et al. 2006). They have access to and can synthesize across a large knowledge pool. This is demonstrated by the higher uniqueness and centrality scores of those acknowledging a connection to the VRBP. However, the structure of the network also indicates that the interactions is constrained by the inequitable distribution of power across views about the role of scientists in policy (those believing scientists should make policy decisions have higher indegree centrality). If central members choose to exploit asymmetries in the network to advance their personal views, this can affect the group's ability to find common ground and define problems (Choo Wei 2002, Manring 2007). While the central actors' belief that scientists should serve as advocates in the policy process is consistent with the mission of the VRBP, it does not appear to be a view widely shared with the rest of the group.

Understanding the structural relationships of partnerships through social network analysis can help determine the role that information exchange networks may play in promoting and/or inhibiting collaboration (Hardy et al. 2003). Network connections can allow access to diverse and dispersed knowledge (Hollingshead 1998, Moreland et al 1996, Wegner 1987) and decrease levels of internal conflict. When these homogenous beliefs foster polarized "us vs. them" mentalities between groups of actors within a partnership, conflict can become deeply entrenched (Krackhardt and Stern 1988, Shutters and Cutts 2008). In many qualitative policy and organizational studies, collaboration is limited by deeply entrenched political differences, low trust, few alternative management options, and restrictive external institutions (Leach and Pielke 2001, Manring 2007). When there is evidence that a particular perspective or characteristic of the respondents corresponds with tie frequency, then we might surmise that it plays a prominent role in conflict (e.g. Shutters and Cutts 2008).

We acknowledge that the ultimate success of a watershed partnership, or any form of collaborative management, needs to be evaluated through long-term analysis of both its process and socio-ecological outcomes (Muñoz-Erickson et al. 2007, Conley and Moote 2003), as well as meeting stated policy goals. Therefore, the results presented in this study should not be interpreted as an evaluation of the success or failure of the VRBP writ large, but rather as an assessment of conditions that may promote or inhibit collaboration and their goals of science-based management. Given the short time span of the VRBP, we have observed that the partnership's information network and its ability to span multiple boundaries is conducive to collaboration, but that differences in structural positions between science 'experts' and other members, as well as between central actors and the rest of the network, could inhibit collaboration and the success of the VRBP in the future. These barriers to more successful collaboration would not have come to light through any assessment of collaboration focused solely on ideologies, whole networks, or ego networks.

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