Network Power in the Ecology of Games: The Effect of Cohesion across Collaborative Institutions

Jack Mewhirter
Department of Political Science
Florida State University

Abstract

How institutions and actors combine to influence policy outcomes and cooperation is a central question in political science, one that is particularly important in decentralized, collaborative management systems. While a multitude of empirical research analyzes how actors shape policy outcomes in the individual institutions that compose such systems, rarely do they directly model underlying social-political networks that are developed across the system level. This paper does so by analyzing how individual actors harness social capital across the large scale network and utilize it to influence policy decisions within individual institutions. A comparative analysis of the water management networks of Parana River Delta in Argentina, the Tampa Bay Estuary in Florida, and the Sacramento-San Joaquin Delta in California finds that actors that represent organizations with cohesive connections to other organizations across the larger network evaluate the institutions in which they participate more positively, suggesting that these cohesive connections can be utilized to reap positive gains within individual institutions. Moreover, once accounting for cohesion, representing an organization with more connections offers minimal benefits.

Word count: 8,518

How actors interact within institutions to influence policy outcomes in decentralized-collaborative management systems has been at the heart of recent debates in political science and public policy (Koontz et al. 2004; Heikkila and Gerlak 2005; Sabatier et al. 2005; Ansell and Gash 2008). While frameworks and theories often speculate about how institutional design affects which actors participate, how they behave in specific scenarios, and how such factors affect policy outcomes, the role of institutional complexity has often been overlooked (Lubell 2013). Work in the Ecology of Games (EoG) framework addresses such complexity, positing that policy institutions (hereafter referred to as forums) are rarely independent, and are better conceptualized as single components within the larger management system. These systems are comprised of an interdependent set of forums whose geographic coverage and issue-area often overlap; the actors involved in this system have interests in multiple forums and interact repeatedly and often contentiously across them (Long 1958; Berardo and Scholz 2010; Lubell 2013).

Whereas scholars of the EoG framework often focus on demonstrating large scale system dynamics (Cornwell, Curry and Schwirian 2003; Berardo and Scholz 2010; Lubell, Robins and Wang 2011), traditional institutional research places greater emphasis on micro-level, in-forum actor behavior and how such behavior is shaped by institutional constraints (Ostrom 1990, 2005; Prell 2009; Reed et al. 2009). This paper attempts to bridge the gap between these two traditions by demonstrating how an actor's evaluations of individual forums is shaped by the social-political networks that they develop across the larger policy system. This effort is crucial to gaining a better understanding of decentralized, collaborative policy systems as it directly stipulates that the relationships and interaction between participants of a given forum are, to a great extent, determined outside of the forum itself. Such a claim is problematic for research that seeks to link actor interaction to institutional

outcomes but fails to model system-level effects as the relationships between actors that drive such interactions are likely misspecified at the forum-level.

In this paper, I analyze actor evaluations of forums as a function of the degree to which they are connected with other actors within the larger network, as well as of the level of interconnectivity (or cohesiveness) of those connections. I posit that high levels of uncertainty and risk within collaborative systems shape which type of network structures grants an actor more leverage within individual forums, leading to better evaluations of those forums. Specifically, I claim that while maintaining a large degree of connections to other actors should never be a disadvantage, the marginal benefit of additional connections is minimal after controlling for their cohesiveness: an actor's satisfaction with an individual forum is not dictated by the number of actors with whom they have the opportunity to communicate, but by their ability to reach and communicate with a subset of trustworthy, cohesive partners, with whom bargaining and defection costs are low.

I use a survey-based study to test how an organization's number of connections and the cohesiveness of their connections within the larger management system affect their representative's satisfaction with the process as well as the output of a forum within collaborative systems. Criteria for process includes perceived efficacy in shaping forum activities and perceived fairness. Criteria for output includes a rating of how forum decisions impact the interests of their organization as well as their perceptions towards how output contributes to the overall water management goals of the larger community. The survey is administered to participants in three collaborative, water management settings: the greater Tampa Bay watershed (Florida, US), the Parana River Delta (Entre Rios, ARG), and the Sacramento-San Joaquin Delta (California, US). While all sites can be considered to be complex social-ecological systems (Ostrom 2005), there is strong variation in both the institutional structure of the management system as well as the level of institutional

development. Overall, I find significant support for my arguments within the US watersheds but less support in the Argentinean case. I posit that this is largely due to the lack of overlap among forums: when forums generate fewer externalities, actors deal with a smaller set of known actors with whom uncertainty and bargaining costs are low. When reduced, the effect of cohesion is low.

The Institutional Ecology of Fragmented Systems

Collaborative governance structures are becoming an increasingly popular alternative to centralized management schemes, especially with regard to the management of resources shared between communities or for resources shared between stakeholders with competing interests (Ostrom 2005; Lubell 2013). In this section, I provide a functional definition for collaborative systems, describe the emergence of network structures among participants, and elucidate why analyzing the dynamics of actors in individual forums requires the understanding of their position in the larger network structure.

The Ecology of Interdependence

Collaborative management schemes are those that encourage the involvement a diverse group of public and private stakeholders that, together, attempt to mitigate collective action issues within a particular issue space and geographical area (Karkkainen 2002; Koontz et al., 2004; Lubell 2004; Wondolleck & Yaffee, 2000). Collaborative institutions largely diverge from traditional, top-down governance structures in that they delegate strong influence over policy making to those that are personally invested in the issue area (Heikkila and Gerlak 2005). By doing so, a dialogue opens up between those with overlapping interests who interact to form collective decisions (Connick & Innes 2003). Those who are better able to bargain among participants in any forum will be more apt at shaping policy outcomes. Recent research demonstrates that the heterogeneity of interests among actors,

combined with their relative unfamiliarity creates a difficult and often contentious arena for negotiation and bargaining among actors (Lubell, Robins and Wang 2011).

Traditional analyses of collaborative institutions generally conceive of forum output as a function of the interests and incentives of the actors that participate and how such factors interact with institutional constraints (Woondolleck and Yaffee 2000; Imperial 2004; Karkkainen 2002; Kauneckis and Imperial 2007).[1] The EoG framework challenges this approach by positing that forums rarely exist autonomously, but rather are single entities that interact within the institutional system (Long 1958; Dutton 1995; Schrapf 1997). Management of a water resource in a geographic area, for example, is rarely conducted within a single, independent forum, but through numerous forums that are delineated specified goals or regions (Berardo and Scholz 2010). The intrinsic relatedness between the issues addressed in each forum, as well as the externalities generated between them leads to 'institutional- overlap'. Policies in one forum are often affected by the policy environment and policy output of a related forum (Bodin and Crona 2009). If, for example, a water-management forum enacts a policy that allows industry to pollute a river, then the goals and strategies of actors within a forum that manages a connected bay will change. Similarly, the policy space that the different forums cover often overlaps: various forums exist that are designed to solve specific issues but differ in the geographic range managed.

The overlap of issues and jurisdiction in a policy system leads actors to select into multiple, inter-related forums in which they have vested interest (since those who have a stake in one forum are likely have a stake in other forums across the policy system). Given that single actors can only accumulate limited knowledge and exert limited energy, actors form connections with others across the policy system in an attempt to join forces and overcome these barriers: who actors tend to trust, and how they form these networks work are

[1] Even when aggregate trends across a given policy system is analyzed, authors generally conceive of the institutions within said system as independent entities both in theoretical development and empirical assessment.

largely defined by the political environment across the system (Berardo and Scholz 2010; Lubell, Robins and Wang 2011).

Moreover, a single actor is limited in the amount of political influence that they, alone, can yield when attempting to impact negotiations within an individual forum. As with physical and cognitive limitations, actors attempt to overcome these barriers through the formation of social-political networks. Actors that are 'well connected' can utilize the resources and information given to them by the partners to gain better bargaining position within a forum. More importantly, actors can form united fronts with their partners within forums or potentially use their partner's connections in order to increase bargaining strength (Sabatier 1988).

Political Networks & Institutional Power

The ability to connect and access others in a meaningful fashion is not ubiquitous across individuals but is largely a function of their position within the forum and across the aggregate policy network. If an actor can utilize contacts to more meaningfully communicate with essential actors better than others in a given forum, then they should be better able to influence any decisions or outcomes that occur within that forum. The advantages granted to actors due to their network positions are known as their *social capital* (Bordieu and Wacquant 1992).

Two types of network-generated social capital have generally been evaluated in this literature: degree centrality and network closure. Degree centrality simply refers to the notion that an individual that is connected to more actors within a network should outperform those with fewer connections (Cook and Emerson 1978; Wasserman and Faust 1994). As related to the outcome of a given institution within the context of a larger management ecology, proponents of degree centrality would suggest that an actor tied to more people in a given network will be privy to more information, and will have the opportunity to collaborate with

more actors at any given moment. As such, those with more connections (or higher degree) should be better able to manipulate the policy game that occurs within a single institution when compared to those with fewer connections.

Network closure, on the other hand, refers to how an actor's connections are connected: if all of one's partners are also connected to each other, the actors network can be considered closed, or *cohesive*; if none of the actor's connections are connected to each other then the actor's network is open, on *non-cohesive*. Different arguments have been made for whether cohesive or non-cohesive networks should be more advantageous. Coleman (1988, 1990) claims that cohesive networks, or those that have attained *network closure*, create trust between partners which promote the attainment of social capital. In a closed network with continued interaction, each member of the cluster has an incentive to cooperate once any agreement is made between members, as defection would likely result in sanctions by the community. Furthermore, efficient bargaining and communication tend to develop as the interactions between participants are observed among the cohesive group, allowing for bargaining preferences among members to be more readily discovered. Burt (1992, 2001, 2002) posits that cohesive networks are unlikely to produce social capital as the information received in a dense cluster of actors is often redundant and does not allow the actor to easily access the rest of the network. In order to efficiently access and spread information (and influence), one should communicate with other actors that grant access to unique groupings of other actors. By selectively accessing actors that have non-redundant contacts (with other actors with whom one is connected), and spreading or receiving information through them an actor can more efficiently access a greater amount of actors through ones direct connections.

Risk, Uncertainty & Social Capital in Collaborative Management Systems

The ability of network structures (in this case, degree centrality and closure) to generate social capital is not unconditional, but is contingent on the goal of actors as well as

the conditions that limit their ability to ascertain that goal (Berardo and Scholz 2010). With regard to collaborative management systems, the most useful type of social capital will be a function of the underlying political environment of the system itself.

As previously stated, collaborative resource management systems are defined as an amalgam of interrelated forums where stakeholders interact to resolve collective action problems. Resource management systems, for example, involve numerous types of organizations including local, state and federal government, tourist boards, business, education, conservation, homeowners associations, as well as various others. While all actors seek to connect and collaborate with actors across the network to increase their bargaining strength within forums, they are hindered by bargaining constraints. Foremost, heterogeneity among the diverse interests of stakeholders makes collaboration between two partners problematic as they have a difficult time negotiating a shared bargaining position. This issue is complicated by the lack of familiarity among many stakeholders: while many groups or organizations may have had contact at some point, the stakeholders often lack familiarity as interaction between their organizations is due solely to their shared interests in water management, which is outside of the organization's day to day operations. Together, these factors complicate the bargaining process by creating barriers to interaction among participants: how can two actors form a unified front if there is a strong uncertainty about their true bargaining position; how can one be sure that the other will not defect on any arrangement?

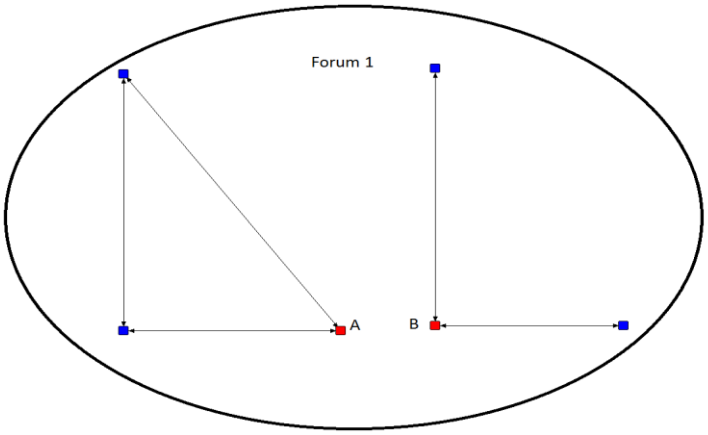
Forming cohesive bonds may greatly reduce these burdens, allowing for stronger collaboration between members that share cohesive bonds and increasing their collective bargaining power. First, information about the actors' past performance and negotiations are more readily available to members in a cohesive-cluster, allowing all members to have some knowledge about the interests, bargaining tactics, and credibility of their fellow actors. While

there still may be disagreement between different actors within the cluster, bargaining should be relatively efficient as members have a reasonable degree of insight into the 'win set' of the other groups, reducing the options that the group must consider (Miller 1992; Putnam 1995). Second, cohesive subunits inflict higher defection costs for members, reducing the perceived commitment risks. Since all actors can actively communicate, this makes defection quite costly: if two actors within a larger sub-group make a contract and one of those actors fails to comply, that actor jeopardizes her future ability to utilize contacts with all others in the sub-unit. This punishment mechanism allows for the members within the group to more easily commit them, when they would normally be more apprehensive.

Cohesion within Forums

These qualities grant actors with cohesive connections leverage over specific forums when members of the subgroup select into the same forum, as compared to those with non-cohesive networks. When in the same forum, cohesive actors can more effectively negotiate and form alliances, granting them more leverage within the forum; actors who are not part of a cohesive subgroup but participate in the same forum should face higher negotiation and defection costs, decreasing both the probability that true collaboration happens and resulting in less valuable collaboration even when it does. Consider a situation in which all participants of a forum only participate in that particular forum, as illustrated in Figure 1. In this example, the red nodes A and B represent the actors of interest and blue nodes indicate which actors they have ties with. In this forum, actors A and B each have to two different partners that are participating in the forum. According to the theory developed thus far, actor A, who has a cohesive network, has a higher probability of meaningfully negotiating and collaborating with connections than Actor B, who has a non-cohesive network. As such, Actor A should be better able to shape the processes that occur within the forum, and should be more satisfied with forum policies.

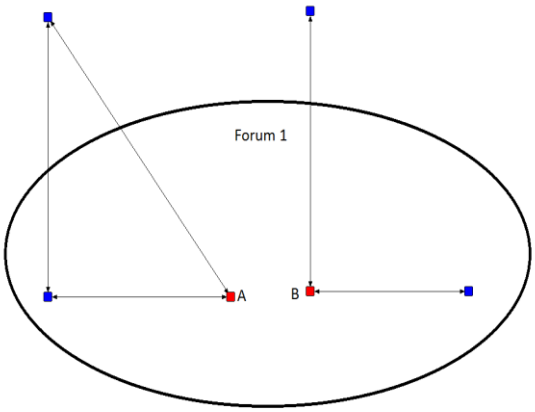
Figure 1: Direct connections when actors participate in a single forum



That said, actors generally participate in multiple forums across a given network, connecting with a diverse array of actors who simultaneously select into multiple forums. If network structure is defined by the unobserved relationships that exist outside of that forum, and if network structure affects how actors within a forum interact, then solely modelling forum-dynamics will lead to inaccurate results. Such an assertion challenges traditional institutional analysis and builds on the EoG framework by positing that the complex interdependencies that exist among institutions and the actors that participate across them simultaneously affect the individual policy games, themselves.

In Figure 2, actors A and B each have two connections: one connection in the forum, and one connection in another forum in which they participate. Actor A's connection within the forum is also tied to their connection outside of that forum, leading to a cohesive network structure. Actor B's connections are not tied across the broader network, and as such, are non-cohesive. In this situation actor A should outperform actor B. If system level networks were ignored, actor A's network would be considered non-cohesive.

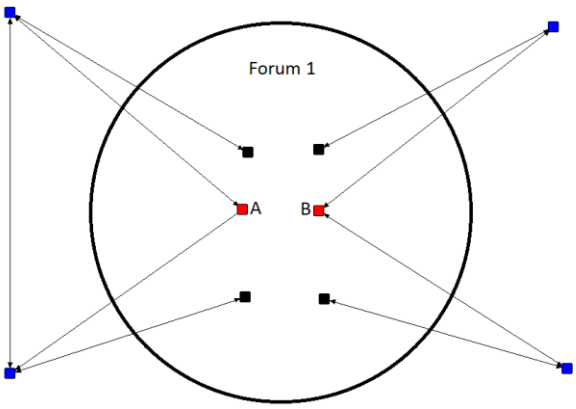
Figure 2: Direct connections when actors participate in a multiple forums



Cohesion outside Forums

While directly accessing and collaborating with one's partners in a forum is expected to yield a stronger bargaining position that allows them to better shape forum output, it is possible that utilizing 'indirect connections' may prove equally important (Granovetter 1973, 1983): here, utilizing indirect connections refers to an actor's capacity to access and collaborate with the 'partners of one's partners' either by passing information or spreading influence through a mutual connection. In Figure 3 actors A and B have two indirect connections in the forum which they may attempt to access.

Figure 3: Indirect Connections



As with direct connections, the ability to meaningfully access indirect connections should be greater for those that have cohesive networks. This effect is attributable to two factors: an increased willingness of the outside connection to link the cohesive member to the desired indirect connection; an increased probability that the indirect connection accepts and trusts the information spread from the cohesive partner.

First, connecting an actor to a 'sought after' indirect connection is inherently risky for the outside actor. If a connecting partner links the two on a partner's request, and the intentions of the 'seeking' actor are predatory or dishonest, the connecting party risks their connection with the actor which they are helping access. Cohesion helps alleviate this problem as the cohesive group may punish such behavior, making devious action a more costly strategy. When the actor seeking a connection is not part of a cohesive group, the actor is more likely to attempt predatory action as the only potential costs is the potential loss of the tie to the outside actor. Knowing this, connecting actors will be less likely to link an actor not part of shared cohesive group.

Second, the information spread from a cohesive actor is more likely to be trusted by the indirect connection as the outside actor can validate that any information spread is consistent with information spread amongst the cohesive group, or is reflective of the true interests of that party. As such, the connecting party can help foster the spread of credibility from such an actor. Information on the true interests or bargaining position of a non-cohesive actor are less likely to be believed or trusted by the indirect connection as all behavior can only be validated through the previous interactions with that particular actor who has, in the aggregate, comparatively scarce information.

In Figure 3, actor A (cohesive group) should have a marked bargaining advantage over actor B (non-cohesive group), leading to an increased satisfaction with the forum process as well as the outcomes of the forum.

Hypothesis 1: An increase in cohesion should lead to an increase in an actor's satisfaction with an individual forum.

Degree Centrality

Maintaining a higher degree centrality should not be a strong strategy when compared to network cohesion. Holding cohesion constant, the maintenance of large degree of ties should prove cumbersome given the inherent risk and bargaining costs between actors in this system. Since actors have limited time and energy they can dedicate to bargaining and given that risk and uncertainty increase the effort required to foster collaborative efforts, those with a large number of connections have a comparatively less effort that they can dedicate to each connection that they maintain, as compared to actors without as many connections. When deciding whether to attempt to access more connections, one must ascertain whether the benefit of the additional tie is worth the reduced effort that they can exert on utilizing the ties they currently maintain. Given this logic, one would expect that while ascertaining more ties should never be a disadvantage, it is a relatively inefficient strategy.

Hypothesis 2: An increase in degree centrality should be a positive, but weak predictor of an actor's satisfaction with an individual forum.

Research Design

I test these hypotheses with data collected in the Tampa Bay Watershed (FL, US), the Sacramento-San Joaquin Delta (CA, US) and the Parana River Delta (Entre Rios, ARG)[2]. In all cases, the individual institutions that make up the network are collaborative forums, comprised of a multitude of stakeholders with diverse interests. All three estuaries manage complex ecosystems but differ in complexity and level of institutionalization.

[2]Data funded by NSF grant SES-0921154. I would like to express my gratitude to John Scholz, Mark Lubell and Ramiro Beraro for collecting this data and granting me access to it.

Demographics and Institutional Variation among Sites

The first research site is the Sacramento-San Joaquin Delta (hereafter, CA Delta). With a multitude of different distinct water districts, the CA Delta is a highly decentralized system. In the site, the waters for northern and southern California flow through the delta, ensuring a complex mix of interests and conflicting views over the best management of water resources. This system has developed over many decades, resulting in considerable institutional development over a long period. The diverse set of stakeholders (both economic and geographic) involved in the management initiatives have caused bargaining in the system to be quite tumultuous.

The second study includes the water resources restricted by the geographic boundaries of the Southwest Florida Water Management District (SWFWMD), a regional agency established by Florida in 1961. The mission of SWFWMD, originally a flood control agency, has rapidly expanded its mission, and is currently charged with the oversight of all major water related issues such as flood protection, water use, well construction and environmental resource permitting, water conservation, education, land acquisition, water resource and supply development, and supportive data collection and analysis efforts. The District is responsible for the management of all relevant water sources in 16, diverse counties and serves a population of more than 5 million people, the majority of whom live in the Tampa Bay watershed. For simplification I refer to the study area as Tampa Bay, although it includes a several water sources outside of those boundaries. The increase in the geography and mission of the management system, in conjunction with economic expansion in the area (leading to heightened demand) has drawn a great number of diverse organizations to the collaborative forums, as the decisions made in the management regime become pertinent for their self-interest.

The final site is the Parana River delta (hereafter, Parana). The management area consists of approximately 5,200 square miles and extends from northwest to southeast in the eastern portion of Argentina for a length of almost 200 miles. This area extends through three provinces (Santa Fe, Entre Rios, and Buenos Aires) and is one of the most bio-diverse regions in the world. Both the upper and lower sections of the delta have been subject to considerable environmental stress in the last decades due to the growing expansion of different economic activities that have an impact on the ecological balance of the region (related mostly to the use of agricultural practices).

While all three cases are considered collaborative water management systems, the US cases should be considered more complex than the Argentinean case. The management system in Parana tends to selectively set up smaller, more ephemeral forums that deal with relatively isolated issues. Such issues tend to be highly localized to a small, identified set of stakeholders. As such, the Parana case has little institutional-overlap, which discourages stakeholders to be active across the broad policy system). The US cases involve forums that deal with more complex and contentious issues. The forums are both larger in number and denser with regard to both geographic space and issue overlap. As such, there is a greater degree of interdependency between individual forums which encourages actors to be to be more active across the system (Berardo and Scholz 2010; McAllister, McCrea and Lubell 2013).

Data

The Indiana Center for Survey Research (CSR) conducted the web-based Tampa Bay survey from November 2010 to February 2011. The sample was developed through web and media-based search for all major water forums, with participant names gathered from eligible web sites as well as directly from the forums. In order to reach as many participants as possible, all names were included even from land use forums that only occasionally

considered water issues, resulting in a considerable number of ineligibles in the list. The original list of 966 names with available email addresses was extended by a snowball question in the survey that yielded an additional 71 names for a total of 1037 possible respondents. After multiple reminders, 259 respondents completed at least part of the survey and 31 refused for a 90% ratio of cooperation per respondent. Using the 97 respondents who reported ineligibility in the screening questions to estimate the number of eligible names among the 504 who did not respond at all to the email, the AAPOR estimated response rates vary from 32% to 37% depending on the estimation method

For the CA Delta surveys, the CSR was again contracted and ran the exact protocol that was conducted in Tampa Bay. In the end of the procedure, 1494 respondents were identified as possible participants. From the 1300 possible respondents found eligible, 319 completed at least part of the survey and 42 refused, for a cooperation rate of 88%. Considering the 194 respondents that were deemed ineligible and the 806 that did not respond at all, the AAPOR estimates a response rate between 25 and 37%, depending on the method used.

As in Florida and California, the sample of participants in Parana was developed through web and media-based search of forums where water-related issues may be discussed, which were then used to identify participant names (this was complemented with searches in relevant web sites). A total of 261 individuals were identified and contacted over the phone to answer the survey. Of the 261 identified individuals, 177 responded to the survey (at least in part), giving a response rate of roughly 68%. An Argentine survey company, Gestion Consultora, was contracted to conduct this segment of the survey.[3]

In the end, three separate datasets were created, one for each site. In all datasets, *there are multiple observations for some actors*, as each participant was asked questions

[3] The survey in Argentina was administered over the phone as a much lower percentage of individuals have ready access to the internet.

about *each* forum that they participate in. Whether a measure is unique to the forum observation or specific to the actor across multiple observations is noted in the all variable descriptions. Finally, it should be noted that while some actor's in our networks represent their own personal interests, the majority of actor's are organizational representatives that are sent to participate on behalf of organizational interests.

Dependent Variables

To fully explore whether an actor's degree centrality and level of cohesion actually give that actor leverage within an individual forum, I utilize four dependent variables, two of which are designed to ascertain an actor's perception of the forum process (one's personal efficacy in shaping forum output, the perceived fairness of procedures) and two designed to understand their perception of the forum's output (how it impacted them personally, how it contributed to overall water management). By utilizing each variable instead of an "aggregate effectiveness measure" I am able to test each dimension's independent response to the network variables. All four dependent variables are measured on a 0-10 scale where low values represent low or negative evaluations. Since all dependent variables are in reference to an individual forum, all are unique to the observation and vary across multiple responses for the same actor.

The process variable, *efficacy,* captures the individual's ability to shape policy outcome in a meaningful way. To attain this measure, respondents were asked: "How effective has [your | your primary organization's] participation been in shaping policy outcomes important to your organization?" The other process variable, *fairness,* captures the perception about the fairness of the process of reaching decisions in venues as measured with the following question: "How fair would you say that the process of reaching decisions in the forum is for all stakeholders?"

The outcome variable, *impact*, captures the forum's direct impact on the interests of the respondent, or the organization represented by the respondent. Respondents were asked: "Overall, have the activities that took place in the forum during the past year had a major negative impact, no net impact, or a major positive impact on [your | your organization's] interests?" The outcome variable *contribution* captures how well the individual forum succeeded or failed with regard to improving the overall water management system, and asks the following of respondents: "Please rate each forum in terms of whether the activities that took place in the forum during the past year contributed significantly or not to improving water management in the Tampa bay region in the past year.

Table 1: Mean and Standard Deviation of Dependent Variables for Each Site

Site	*Efficacy*	*Fairness*	*Impact*	*Contribution*
Tampa Bay	6.81 (2.45)	7.36 (2.47)	6.81 (2.33)	6.65 (2.65)
CA Delta	5.73 (2.38)	6.35 (2.96)	5.70 (2.34)	4.66 (2.75)
Parana	5.31 (2.18)	7.50 (2.06)	6.81 (2.33)	6.22 (2.34)

Network Variables

To test the hypotheses it is necessary to enumerate both the number of connections one's organization actually has as well as well as how well the mentioned organizations are connected. These are measures of connections across the management network as illustrated in Figure 2, not just connections within a given forum, so the responses are *not* unique for multiple observations from the same respondent.

In order to access the number of connections that an actor has, the variable *Organizational Degree* was created. The survey asked "How many organizations do you have contact with: 1=None; 2= 1; 3= 2-4; 4=5-10; 6=11-25; 7= >25." The other variable, *Organizational Cohesion*, attempts to measure the cohesiveness of those connections that one

has contact with. Respondents were asked: "Roughly describe the proportion of the organizations with which you contact interact with one another: 1-10 Scale: 1=None interact; 5=Some interact; 10=They all interact." The mean result in Tampa was 7.31 in Tampa Bay (standard deviation of 2.31), 6.56 in CA Delta (2.31 standard deviation) and 6.61 in Parana (1.83 standard deviation). Note that this measure is designed to capture the same relationship as "egonet density", which is calculated as the proportion of alters that are directly connected to each other. [4] Higher proportions should correspond to stronger cohesion effects as discussed above. While there may be some error in responses, such error is not expected to be correlated to any dependent variables, making it a viable measure. Cohesion should be perceived as a relatively neutral term, and as such, actors that perform better should not be more likely to perceive cohesion above their actual level at a higher rate than those that performed poorly.

Control Variables

To test the hypotheses about network relationships, we include several control variables to reduce the possibility of spurious relationship and underspecified models.

Scientific Uncertainty refers to one's ability to understand how forum decisions actually affect the environment which they are trying to modify. Individuals that are better able to distinguish how policy alternatives will affect their own interests should more apt at supporting the policies that will generate the most utility, making their performance more effective. Such actors may be perceived as sophisticates in the forum, making their opinion carry more leverage, giving them greater bargaining leverage negotiation power and perceived the process and outcomes as more favorable (Ostrom 2005; Ahn, Huckfeldt and Ryan 2010). Furthermore, a representative's personal knowledge of current scientific

[4] Of course, this perceived measure of cohesiveness may not be an exact match for egonet density measured from an observed network. It is not clear which measure would be most accurate for this study if the network measure were available, since the network measure is highly sensitive to missing data that is inevitable in self-reported networks with response rates varying from 32-68% across sites that produces both missing nodes and links.

practices is likely a function of how well they can readily access and share information in a given network. To control for such effects, participants are asked the following: "In your opinion, how adequate is the currently available scientific knowledge to understand the future impacts of water policies?"

Behavioral Uncertainty refers to a lack of information about the preferences and strategies of other actors in the forum. When interacting and negotiating with others in a forum, those with more information may have a strategic advantage, as they are more aware of other's bargaining spaces than their peers. As such, actors with greater levels of information may be better able to manipulate others and therefore be more satisfied with the forum (Miller 1992). *Behavioral uncertainty* may simultaneously correlate with the network variables as well as actors with less certainty may attempt to ascertain more by connecting to more partners, or conversely, because those with better connections have higher certainty. *Behavioral uncertainty* is measured in the following manner: "For water issues most important to [you | the organization you represent], would you say that [you know | your organization] know/s the policy interests of the most active water management stakeholders in the region?" Possible responses ranged from 0 (do not know their interests) to 10 (definitely know their interests).

Perceived conflict is controlled for because one's perception of bargaining within the forum will likely contribute to the overall evaluation of the forum and because conflict is likely correlated with level of cohesion. This effect could manifest in one of two ways: organizations that perceive more conflict flock to more cohesive networks where risk is less likely; organizations that are in cohesive groups perceive less conflict. Perceived *conflict* is measured by asking the following question about each of the forums in which the respondent said she (or her organization) had participated: "Which of the following statements best characterize the typical decision processes about water-related issues in each forum in the

past year?: 1) For most decisions in this venue, most groups can gain as long as they can develop a common policy, 2) Although most groups can gain from most decisions, there is conflict over who will gain the most, and 3) For most decisions, one group's gain involves another group's loss.

Three demographic control variables are also included: *number of forums*; *frequency of participation*; *government dummy*. In these variables, *government dummy* as well as the *number of forums* variables are not dependent on the given forum and therefore do not vary across multiple observations for the same actor. One's *frequency of participation* is unique to the forum and will vary for multiple responses from the same actor.

Those that participate in more forums may be more productive within a forum due to their increased experience in dealing with forum matters; such actors may also, over time, learn which type of connections are more useful, and select into those structural types with greater frequency. By failing to address this, the estimated effects of *organizational. degree* would not simply be indicative of the effects of social capital. *Frequency of participation* is added as actors who are more active in a forum may be more effective within the forum (affecting the dependent variables). *Frequency of participation* should be associated with the degree of organizational connections as well: if one attempts to work with more organizations in a forum (those with more connections should, on average, have more) they would have to dedicate more time attempting to access those connections. Finally, actors who are government employees may be more efficacious in forums as their organization may play a role in the crafting of the forums. Such forums, in some cases, may have special rules and considerations for such representatives that allow them more authority. Furthermore, government organizations are likely more bonded with other, government organizations (as seen in the data).

The number *of forums* variable is simply a count of the forums one participates in. To calculate *frequency of participation* the participants were asked the following question: "For each forum listed below, how frequently on average [have you| your organization] participated in forum activities in the past year?" Possible responses ranged from 1-5 where: 1=Daily; 2=Weekly; 3=Monthly; 4=Quarterly; 5= Annually. Finally *government dummy* is a binary variable that takes the score of 1 when the participant works for a government agency and 0 when she does not.

Table 2: Mean and Standard Deviation of Independent Variables for Each Site

	Org. Degree	*Org. Cohesion*	*Scientific Uncertainty*	*Behavioral Uncertainty*	*Perceived Conflict*	*Num. of Forums*	*Frequency*	*Gov. Dummy*
Tampa	3.55 (1.26)	7.31 (2.31)	6.29 (2.25)	7.75 (2.17)	1.47 (.70)	3.21 (1.83)	2.34 (.92)	.69 (.46)
CA Delta	3.89 (1.42)	6.66 (2.44)	4.56 (2.68)	7.93 (2.35)	1.86 (.82)	3.77 (2.35)	2.87 (1.06)	.72 (.45)
Parana	4.10 (1.27)	6.62 (1.83)	6.35 (2.11)	6.75 (1.82)	1.44 (.63)	1.56 (1.59)	2.04 (.83)	.42 (.49)

Analysis & Results

This dataset should not be analyzed with regression methods that assume independence of observations. First, the dataset includes multiple observations for a single actor evaluating multiple forums. Second, responses from actors who are in the same organization should be largely interdependent. Third, the theory specifies that connections likely exist within an individual forum as well as within the larger management network and as such, assumes a non-random and unseen dependence among observations.

The inherent dependencies in the data prevent the use traditional OLS regression techniques as such dependencies would lead to potentially inefficient results (Freeman 2006). To correct for this, I utilize multiple regression with a random permutation test. This technique is utilized for this study as it makes no assumption of observation dependence,

and as such allows for unbiased standard errors (Borgatti & Cross 2003; Hanneman and Riddle 2005). The procedure is described below.

Procedure

After the data collection stage, the datasets were pooled, and multiple imputation techniques were utilized to correct for missing data believed to be 'non-ignorable' (Sherman 2000; King, Honaker, Joseph & Sheve 2001) creating 20 newly imputed datasets. After this stage, the data were separated by site for each management network.[5] The extent of missing data corrected for via imputation is reported for each variable in Table 1 in the Appendix.

For each dataset, the 2-stage permuted regression procedure was run in the UCINET VI program (Borgatti, Everett & Freedman 2002). In the first stage of the procedure, a standard OLS multiple-regression is run, and parameter estimates are stored. In the second stage, the dependent variables are randomly permuted, parameter estimates are taken again, and stored. This procedure is repeated 1000 times for each dataset. Once completed, the program calculates the proportion of estimated coefficients that were generated in the randomized, second stage that yielded coefficients larger than the absolute value of the coefficient estimated in the first stage. Using the absolute value as the standard provides a test comparable to the standard two-tailed test, since coefficients larger than the absolute value fall in the two tails of the standard distribution that are farther from zero than the observed value. Lower proportions of random-values that exceed the estimate in stage one demonstrate lower likelihoods that the estimated in the first stage occurred by chance (Labianca et al. 1998; Dekker, Krackhardt and Snijders 2003). As with traditional 2-tailed

[5] I utilized a pooled dataset with site predictors included in the imputation steps. I did so as the method would impute missing data more towards the 'general trends' found in the aggregate data, while still allowing for a large degree of predictions being fostered by site specific attributes. The rationale for this is that this is the most conservative approach as it should push my results away from finding discernible differences between the data sets. In particular, this was to hedge against Parana's results from being too heavily influenced by the limited predictor variables in the data set and limited observations.

significance tests in OLS, estimates under .10 (two-tailed) or .05 (one-tailed for directional hypotheses) are considered 'significant' (Bowler & Brass 2006).

After this procedure was completed for all 20 datasets for each site, the mean of the parameter estimate and the mean of the 'proportion-as-extreme' estimates were taken. The point parameter estimate simply pools the estimate over all 20 imputed samples prior to permutation. The average of the proportion as extremes is an approximation of the proportion with absolute values above this point estimate, since the proportions are actually measured from the point estimation for each independent imputed data set. These results for our variables of interest, the *network variables,* are presented in Table 4. In the table, the top number in each cell is the mean coefficient that occurred across the 20 imputed sets for each site; the lower number is the average proportion-as-extreme value. The coefficients for all variables for each site can be found in Tables 1a-1c in the Appendix. To test for model dependency and assure those unfamiliar with permutation tests, regressions are simultaneously run with the imputed data using standard errors clustered by individual respondents. As seen in Tables 2a-2c in the Appendix, the impact for variables of interest is robust across the different estimation models.

Table 4: Average Permuted Regression Results for the Network Variables

	Process Variables		***Outcome Variables***	
	Personal Efficacy	***Fairness of Forum***	***Personal Impact***	***Contribution to Management***
CA-Delta				
Org. Cohesiveness	.10* .05	.15*** .00	.09* .05	.14*** .00
Org. Degree	.26 ** .03	-.05 .62	.05 .25	-.01 .73
R^2	.17	.21	.17	.10
Observations	894	894	894	894
Tampa Bay				
Org. Cohesiveness	.25 *** .00	.21*** .00	.22*** .00	.17*** .00
Org. Degree	.30** .02	.03 .66	.11 .33	.15 .25

R^2	.33	.29	.23	.22
Observations	772	772	772	772
Parana				
Org. Cohesiveness	.13 .11	.15*** .04	.06 .37	.12 .18
Org. Degree	.22 .18	.08 .59	.06 .67	-.14 .36
R^2	.20	.20	.11	.12
Observations	335	335	335	335

*NOTE: ***= significant at the .01 confidence interval; **= significant at the .05 confidence interval; *= significant at the .1 confidence interval.*
NOTE 2: Coefficients for unreported variables noted in text are listed in appendix tables.

Analysis: Cohesion

The parameter estimates and proportion-as-extreme scores presented in Table 4 provide robust support for Hypothesis 1. As expected, the coefficients for *cohesion* are positive across all regressions for all sites, demonstrating that more cohesive network connections should never be a disadvantage. The significance of the effect of network cohesion is more pronounced in the Tampa Bay and CA Delta management systems.

In the CA Delta, the effect of network cohesion is positive and significant across all four process and outcome dependent variables, demonstrating that those with more cohesive connections should be more satisfied with how the forum works as well as with the outcomes generated by the forum itself. The effect of *organizational cohesion* is strongest in the *fairness of forum* and *contribution to management* regressions: holding all variables at their means, an increase from 'no-cohesion' to 'total cohesion' should increase a representative's rating of *fairness forum* from 5.44 to 6.82, (25.36% increase) and *contribution to management* from 3.87 to 5.11 (32.04% increase).[6] The effects of cohesion on *personal efficacy* and *personal impact*, while smaller, still demonstrate significant effects: holding all variables at their means, an increase from no-cohesion to full-cohesion increases an actor's

[6] Fixed effects, in this section, are calculated using the regression coefficients from the permuted regression estimates in UCINET, and calculated with the imputed datasets in STATA 12. This was necessary as UCINET does not have an option to calculate fixed effects.

personal efficacy from 4.52 to 5.42, and an increase *personal impact* from 5.05 to 5.84: such increases reflect a 19.91% and 15.87% increase, respectively.

The effects are equally significant and of somewhat greater magnitude for the Tampa Bay region, with the same increase from no-cohesion to full-cohesion increasing *personal efficacy* by 53.47% *fairness of forum* by 30.78%, *personal impact* by 34.26%, and *contribution to management* scores by 39.32%.

The effect of *organizational cohesion* is less consistent in the Parana regressions, especially with regard to the outcome-based dependent variables. The effect of cohesion is a strong predictor in the *fairness of forums* regression: holding all variables at their means, increasing *org cohesion* from no-cohesion to full-cohesion leads to an increase in rating from 4.66 to 6.00, or 34.53%-- a greater increase than in the other two estuaries. The same increase in the *personal efficacy* regressions, leads to, on average, a change from 6.01 to 7.22, demonstrating a 28.45% increase. That said, nearly 11% of simulated regressions generated coefficients larger than the absolute value of the coefficient in the first stage MR for the *efficacy* regression, which makes drawing conclusions about this effect less reliable. Although the effects of cohesion in the procedural regressions are somewhat comparable to the effects found within the more institutionalized settings, the failure to even approach significance in the outcome regressions demonstrate that the effects of cohesion are less evident.

The difference in effect between the US sites and Parana may be attributable to the difference in institutional complexity between the US and Argentinian sites. Forums that comprise the Parana system are generally ephemeral and regulate single issues that are salient for a specific group of actors. Since the problem is highly localized, there is little potential for institutional overlap: this lack of overlap encourages participation from local actors who are likely familiar with one another, and discourages the participation from actors that are not

from within the closed community. Uncertainty among actors is reduced as stakeholders are likely aware of the other stakeholders' preferred strategies, making cohesion a less valuable option. When institutional overlap is low, actors have less incentive to form highly complex networks across the ecology. When this occurs, modelling system level effects may be less important as the power dynamics and interrelationships between actors reflect dynamics established within the forum, and, when the problem is highly localized, prior to the forum.

Analysis: Degree

As predicted, the effect of degree, while generally positive, is only a significant predictor of *personal efficacy*, and only in strongly institutionalized management networks. Such a finding, when compared to the ubiquitous role of *organizational cohesion*, demonstrates a weaker aggregate effect for degree centrality. Furthermore, it provides some evidence that the effect of degree centrality may only be a factor in more institutionally developed management systems.

In both strong institutional systems, the effect of an added organizational connection is positive and significant predictor of *personal efficacy*, and fails to attain significance in any other dependent variables. In the CA Delta, holding all other variables at their means, moving from representing an agency with no organizational connections to one with over 25 (the lowest value to the highest) organizational connections should increase one' *personal efficacy* rating from 4.33 to 5.86, an increase of 35.45%. In Tampa Bay, holding all variables at their means, moving from representing an agency with no connections, to an organization with more than 25 organizational connections should increase one's *personal efficacy* rating from 5.42 to 6.93, an increase of 35.37%. Such a finding demonstrates that added organizational connections may improve one's ability to influence forum procedures, but it does not improve one's personal outcomes, their perceptions of procedural fairness or their satisfaction with how forum output affected the general management of the resource at hand. This may be

largely attributable to the notion that those with more organizational connections often attempt to work with a greater number of actors leading them to think they are doing more than other representatives in the forum, leading to the false attribution of power.

In Parana, there is no significant effect for *organizational degree.* This finding suggests that while extra connection may affect negotiating power in institutionalized settings, this effect may be largely muted in less institutionalized systems.

Discussion and Conclusion

The results of this analysis suggest that understanding micro-level behavior of individual actors in single policy-games is largely contingent on understanding the broader ecological system, and how the actors of a given institution interact across it. Specifically this paper finds that cohesive networks in the full ecology of games better allow actors to mitigate the inherent bargaining and defection risks that are rampant in collaborative systems. The effect of cohesion can manifest in one of two ways. First, cohesive partners should be able to better organize when they participate in a forum together, allowing them to better shape forum output. Second, cohesive partners may be better able to utilize the 'connections' of their cohesive partners, even when their cohesive partners are not in a given forum.[7] In both scenarios, understanding how actor's relationships within a forum are defined are contingent on being able to directly model their structural relationship with other actors with whom they are connected across the ecology of policy games. Such a finding is important for the study of intuitions as it provides further support for the EoG framework, demonstrating that not only do complex interdependencies between institutions and actors exist across a broader ecology, but that the shaping of such interdependencies simultaneously alter the individual policy games as well as the incentives of actors who play them across this ecology.

[7] Currently the data does not allow us to explore the difference in effectiveness of accessing direct, as opposed to indirect connections. Ascertaining this difference will be the aim of future works.

Furthermore, this paper provides a word of caution to researchers of social capital by demonstrating that social capital is largely contingent on the environment and constraints present in a given network: here, social capital is not simply a function of forming a network structure, but of forming a network structure with structural characteristics that allows one to better exploit the conditions in which one operates. While cohesion allows for actors to better promote their interests in the collaborative systems studied here (particularly in more complex systems), such an effect is driven by the inherent bargaining and defection costs involved in collaborative governance: if bargaining and defection costs were lower, however, cohesive bonds may be less valuable, and may even cause one to face a bargaining disadvantage.

Finally, while this paper provides strong support for the EoG framework, and demonstrates that cohesive bonds developed across the ecology shape the interaction of actors at the forum level, this study is not able to discern the differences in effect of direct and indirect connections. In order for this to be ascertained, future works would need to conduct network analytic research utilizing sociometric data across a set of interrelated forums. Moreover, while this paper posits that cohesion is becomes important as it allows actors to overcome risk and uncertainty across collaborative networks in the aggregate, future works should recognize variability in the level of uncertainty and risk as within the ecology. Here, researchers should be careful to discern which types of rules mitigate or exacerbate such conditions.

Citations

Ahn, T. K., Robert Huckfeldt, and John Barry Ryan. 2010. "Communication, Influence, and Informational Asymmetries among Voters." *Political Psychology* 31 (5): 763-87.

Ansell, C., and A. Gash. 2008. "Collaborative governance in theory and practice." *Journal of Public Administration Research and Theory* 18 (4): 543-71

Berardo, Ramiro, and John T. Scholz. 2010. "Self-Organizing Policy Networks: Risk, Partner Selection, and Cooperation in Estuaries." *American Journal of Political Science* 54 (3):632-49.

Bodin, Orjan and Beatrice I. Crona. 2009. "The Role of Social Networks in Natural Resource Governance: What Relational Patterns Make a Difference?" *Global Environmental Change* 19: 366–374.

Borgatti, Stephen P., and Rob Cross. 2003. "A Relational View of Information Seeking and Learning in Social Networks." *Management Science* 49 (4):432-45.

Borgatti, S.P., M.G. Everett, and L.C. Freeman, L.C. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Bourdieu, Pierre, and Loïc Wacquant. 1992. *An Invitation to Reflexive Sociology*. Chicago, IL: University of Chicago Press.

Bowler Matthew, and Daniel J. Brass. 2006. "Relational Correlates of Interpersonal Citizenship Behavior: A Social Network Perspective." *Journal of Applied Psychology* 91 (1):70-82

Burt, Ronald S. 1992. "The Social Structure of Competition." *Networks and Organizations: Structure, Form, and Action*: 57-91.

———. 2001. "Structural Holes Versus Network Closure as Social Capital." *Social Capital: Theory and Research*: 31-56.

———. 2002. "The Social Capital of Structural Holes." *The New Economic Sociology: Developments in an Emerging Field*: 148-90.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *American Journal of Sociology* 94:S95-S120.

———. 1990. "Foundations of Social Theory." Cambridge, MA: Belknap.

Connick, Sarah, and Judith E. Innes. 2003. "Outcomes of Collaborative Water Policy Making: Applying Complexity Thinking to Evaluation." *Journal of Environmental Planning and Management* 46 (2):177-97.

Cornwell, Benjamin, Timothy J. Curry, and Kent Schwirian.2003. "Revisiting Norton Long's Ecology of Games: A Network Approach." *City & Community* 2(2): 121-142.

Cook, Karen S., and Richard M. Emerson. 1978. "Power, Equity and Commitment in Exchange Networks." *American Sociological Review* 44 (5):721-39.

Dekker, David, David Krackhardt and Tom Snijders. 2003. "Multicollinearity robust QAP for multiple regression." 1st Annual Conference of the North American Association for Computational Social and Organizational Science.

Diduck ,Alan, and John Sinclair. 2002. "Public Involvement in Environmental Assessment: The Case of the Nonparticipant." *Environmental Management* 29 (4):578-88.

Dutton, William H. 1995. "The Ecology of Games." *Communication Theory* 5 (4):379-92.

Freedman, David A. 2006. "Statistical Models for Causation what Inferential Leverage do they Provide?" *Evaluation Review* 30 (6):691-713.

Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78 (6):1360-80.

———. 1983. "The Strength of Weak Ties: A Network Theory Revisited." *Sociological Theory* 1 (1):201-33.

Hanneman, Robert A. and Mark Riddle. 2005. *Introduction to social network methods.* Riverside, CA: University of California, Riverside.

Heikkila, Tanya, and Andrea K. Gerlak. 2005. "The Formation of Large-scale Collaborative Resource Management Institutions: Clarifying the Roles of Stakeholders, Science, and Institutions." *Policy Studies Journal* 33 (4):583-612.

Kauneckis, Derek, and Mark T. Imperial. 2007. "Collaborative Watershed Governance in Lake Tahoe: An Institutional Analysis" *International Journal of Organization Theory & Behavior*. 10 (4): 503-46

Karkkainen, Bradley C. 2002. "Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism." *Virginia Environmental .Law Journal.* 21 :189-243.

King, Gary, James Honaker, Anne Joseph, and Kenneth Scheve. 2001. "Analyzing Incomplete Political Science Data: An Alternative Algorithm for Multiple Imputation." *American Political Science Review* 95 (1):49-70.

Koehler, Brandi, and Tomas M. Koontz. 2008. "Citizen Participation in Collaborative Watershed Partnerships." *Environmental Management* 41 (2):143-54.

Koontz, Tomas M., Toddi A. Steelman, JoAnn Carmin, Katrina Smith Korfmacher, Cassandra Moseley, and Craig W. Thomas. 2004. *Collaborative Environmental Management: What Roles for Government?* Washington, DC: Resources for the Future Press.

Labianca, Giuseppe, Daniel J. Brass, and Barbara Gray. 1998. "Social Networks and Perceptions of Intergroup Conflict: The Role of Negative Relationships and Third Parties." *Academy of Management Journal* 41 (1):55-67.

Lubell, Mark. 2004. "Collaborative Watershed Management: A View from the Grassroots." *Policy Studies Journal* 32 (3):341-61.

———.. 2013. "Governing Institutional Complexity: The Ecology of Games Framework." Policy Studies Journal 41 (3): 537-59

Lubell, Mark N., Garry Robins, and Peng Wang. 2011. "Policy Coordination in an Ecology of Water Management Games."

Lubell, Mark, Adam Douglas Henry, and Mike McCoy. 2010. "Collaborative Institutions in an Ecology of Games." *American Journal of Political Science* 54 (2):287-300.

McAllister, Ryan R. J., Rod McCrea and Mark N. Lubell. 2013. Policy networks, stakeholder interactions and climate adaptation in the region of South East Queensland, Australia. *Regional Environmental Change* DOI 10.1007/s10113-013-0489-4.

Miller, Gary J. 1993. *Managerial Dilemmas: The Political Economy of Hierarchy*. Cambridge, UK: Cambridge University Press.

———.1990. *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press.

Ostrom, Elinor. 2005. *Understanding Institutional Diversity*. Princeton, NJ: Princeton University Press.

Prell, Christina, Klaus Hubacek, and Mark Reed. 2009. "Stakeholder Analysis and Social Network Analysis in Natural Resource Management." *Society and Natural Resources* 22 (6):501-18.

Putnam, Robert D. 1995. "Bowling Alone: America's Declining Social Capital." *Journal of Democracy* 6 (1):65-78.

Reed, Mark S., Anil Graves, Norman Dandy, Helena Posthumus, Klaus Hubacek, Joe Morris, Christina Prell, Claire H. Quinn, and Lindsay C. Stringer. 2009. "Who's in and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management." *Journal of Environmental Management* 90 (5):1933-49.

Sabatier, Paul A. 1988. "An advocacy coalition framework of policy change and the role of policy-oriented learning therein." *Policy Sciences* 21 (2): 129-168.

Sabatier, Paul A, Will Focht, Mark Lubell, Zev Trachtenburg, Arnold Vedlitz, and Marty Matlock, eds. 2005. *Swimming Upstream: Collaborative Approaches to Watershed Management*. Cambridge, MA: MIT Press

Sherman, Robert P. 2000. "Tests of Certain Types of Ignorable Nonresponse in Surveys Subject to Item Nonresponse or Attrition." *American Journal of Political Science* 44 (2): 362-74.

Wasserman, Stanley. Katherine Faust. 1994." *Social Network Analysis: Methods and Applications*. Cambridge, UK: Cambridge University Press.

Wondolleck, Julia M., and Steven Lewis Yaffee. 2000. *Making Collaboration Work: Lessons from Innovation in Natural Resource Management*. Island Press.

Appendix

Table 1: Extent to Which Variables are Imputed

	Answered	***Incomplete***	***Imputed***	***Total***
Personal Efficacy	*1341*	*660*	*660*	*2001*
Fairness of Forum'	*1350*	*651*	*651*	*2001*
Personal Impact	*1357*	*644*	*644*	*2001*
Con. To Management	*1367*	*634*	*634*	*2001*
Org. Cohesion	*1505*	*496*	*496*	*2001*
Org. Degree	*1692*	*309*	*309*	*2001*
Behav. Uncertainty	*1949*	*52*	*52*	*2001*
Science Uncertainty	*1901*	*100*	*100*	*2001*
Perceived Conflict	*1513*	*488*	*488*	*2001*
Freq. or Participants	*1398*	*603*	*603*	*2001*
Number of Forums	*2001*	*0*	*0*	*2001*
Gov. Employee	*2001*	*0*	*0*	*2001*

Table 2A: Regression Results for CA Delta with Permutation Test[8]

	Process Variables		***Outcome Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.26 ** .03	-.05 .63	.05 .25	-.01 .73
Org. Cohesiveness	.10* .05	.15*** .00	.09* .05	.14*** .01
Control Variables				
Behavioral Uncertainty	.12* .08	.06 .40	-.11* .08	-.07 .29
Scientific Uncertainty	.03 .53	.12*** .00	.07* .05	.08 * .06
Perceived Conflict	-.88*** .00	-1.38*** .000	-1.06*** .00	-.76*** .00
Frequency of Participation	.22* .08	-.10 .44	.02 .74	.03 .70
Number of Forums	.06 .34	.09 .19	.05 .35	.13* .07
Government Employee	.04 .69	.08 .67	.11 .54	.48 ** . 05
Other				
R^2	.17	.21	.17	.10
Intercept	3.13	6.93	6.90	4.50
Observations	894	894	894	894

[8] Numbers include regression coefficient s and proportion-as-extreme values. ***= proportion-as-extreme < .01; **= proportion-as-extreme <.05; *= proportion-as-extreme <.1

Table 2B: Regression Results for Tampa Bay with Permutation Test

	Process Variables		***Outcomes Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.30** .02	.03 .65	.11 .32	.15 .25
Org. Cohesiveness	.25 *** .00	.21*** .00	.22*** .00	.17 *** .00
Control Variables				
Behavioral Uncertainty	-.01 .66	.02 .63	-.13** .02	-.17*** .00
Scientific Uncertainty	.22*** .00	.15*** .00	.21*** .00	.20** .00
Perceived Conflict	-.90*** .00	-1.41*** .00	-.98*** .00	-.95 *** .00
Frequency of Participation	.52*** .00	.20* .11	.27** .0	.33** .01
Number of Forums	.13* .08	.01 .71	.03 .66	.20*** .01
Government Employee	.84*** .00	.18 .44	.29** .16	.50*** .04
Other				
R^2	.34	.29	.23	.22
Intercept	1.16	6.09	5.43	4.63
Observations	772	772	772	772

Table 2C: Regression Results for Parana with Permutation Test

	Process Variables		***Outcome Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.21 .18	.08 .59	.06 .67	-.14 .36
Org. Cohesiveness	.13 .11	.15*** .04	.06 .36	.12 .18
Control Variables				
Behavioral Uncertainty	.10 .21	.12 .14	.04 .57	-.03 .67
Scientific Uncertainty	.10 .14	.07 .27	-.00 .68	.05 .46
Perceived Conflict	-1.01*** .00	-1.15*** .00	-.69*** .00	-.78*** .00
Frequency of Participation	.38*** .02	.24 .10	.32*** .04	.13 .42
Number of Forums	.10 .21	-.02 .67	.01 .79	.25 ** .013
Government Employee	.05 .72	.14 .57	-.02 .69	.19 .54
Other				
R^2	.20	.20	.11	.12
Intercept	4.30	6.21	6.71	6.13
Observations	335	335	335	335

Table 3A: Regression Results for CA Delta (clustered SE on each unique respondent)[9]

	Process Variables		***Outcome Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.24** .12	-.04 .69	.07 .10	.01 .13
Org. Cohesiveness	.11** .05	.17*** .05	.09* .05	.14** .06
Control Variables				
Behavioral Uncertainty	.11*** .06	.06 .05	-.10** .05	-.08 .07
Scientific Uncertainty	.03 .05	.12*** .04	.07* .04	.08 .05
Perceived Conflict	-1.03*** .14	-1.56*** .14	-1.20*** .12	-.90*** .14
Frequency of Participation	.34*** .11	-.05 .11	.07 .09	.08 .12
Number of Forums	.04 .06	.07 .05	.05 .06	.12* .07
Government Employee	-.00 .25	-.02 .24	.09 .21	.42 .28
Other				
Ave.RVI	.38	.31	.37	.39
Intercept	3.17	7.19	7.03	4.69
Observations	894	894	894	894

[9] NOTE: All OLS regressions include coefficient estimates, and standard errors. ***= significant at the .01 confidence level;**=significant at the .05 confidence level; *=significant at the .1 confidence level.

Table 3B: Regression Results for Tampa Bay (clustered SE on each unique respondent)

	Process Variables		***Outcome Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.30** .12	.03 .11	.09 .11	.15 .14
Org. Cohesiveness	.25*** .05	.21*** .05	.18*** .05	.17*** .05
Control Variables				
Behavioral Uncertainty	-.01 .07	.02 .72	-.13 .06	-.17*** .06
Scientific Uncertainty	.22*** .06	.15*** .05	.21*** .05	.20*** .06
Perceived Conflict	-.90*** .16	-1.41*** .16	-.98*** .15	-.95*** .16
Frequency of Participation	.52*** .12	.20* .11	.27** .10	.33*** .12
Number of Forums	.13* .07	.01 .07	.02 .07	.19*** .07
Government Employee	.86*** .26	.18 .29	.30 .23	.50* .26
Other				
Ave. RVI	0.33	0.35	.32	.36
Intercept	1.16	6.08	5.43	4.63
Observations	772	772	772	772

Table 3C: Regression Results for Parana (clustered SE on each unique respondent)

	Process Variables		***Outcome Variables***	
	Personal Efficacy	*Fairness of Forum*	*Personal Impact*	*Contribution to Management*
Network Variables				
Org. Degree	.22 .15	.08 .14	.06 .14	-.15 .22
Org. Cohesiveness	.13* .08	.15** .07	.06 .07	.12 .09
Control Variables				
Behavioral Uncertainty	.10 .09	.17* .08	.04 .07	-.03 .11
Scientific Uncertainty	.10 .07	.07 .07	-.00 .06	.05 .09
Perceived Conflict	-1.00*** .23	-1.15*** .22	-.69*** .21	-.783*** .24
Frequency of Participation	.38** .15	.24* .13	.34** .15	.13 .16
Number of Forums	.11 .07	-.02 .08	.01 .07	.25** .09
Government Employee	.05 .30	.14 .28	-.03 .30	.19 .37
Other				
Ave RVI	.28	.32	.29	0.35
Intercept	4.29	6.21	6.70	6.13
Observations	335	335	335	335