Do Networks Solve Collective Action Problems? Credibility, Search, and Collaboration

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Abstract

Two competing theories suggest different ways in which networks resolve collective action problems: small, dense networks enhance credible commitments *supportive of cooperative solutions, while large boundary-spanning networks enhance* search and information exchange *supportive of coordinated solutions. Our empirical study develops and tests the competing credibility and search hypotheses in 22 estuary policy arenas, where fragmentation of authority creates collective problems and opportunities for joint gains through collaboration. The results indicate that search rather than credibility appears to pose the greater obstacle to collaboration; well-connected centrally-located organizations engage in more collaborative activities than those embedded in small, dense networks.*

When political actors face a common collective action problem, informal relationships provide one potential resource for mitigating the problem. Two competing theories suggest very different ways in which these informal relationships can enhance the likelihood of collaborate to achieve joint benefits. The well-known social capital perspective suggests that collaboration is more likely for actors embedded in dense, overlapping relationships with like-minded others (Coleman 1988, Putnam 2000, Burt 2000). On the other hand, network analyses suggest that collaboration is more likely for well-connected, centrally-positioned actors with extensive "weak tie" relationships (Granovetter 1973) that span the structural holes between groups that otherwise do not communicate (Burt 1992, 2004). If networks do indeed help resolve institutional collective action problems, which theory is most relevant for explaining observed patterns of collaboration?

This problem lies at the intersection of two rapidly growing fields of inquiry in political science. The collective action perspective focuses on situations in which individual incentives lead to collectively undesirable outcomes, and analyzes the impact of alternative institutional rules on the social efficiency of expected outcomes (Ostrom 1990). Network analysis focuses on relationships between individuals, and analyzes both how these relationships are structured and how alternative structures influence individual behavior (Wasserman and Faust 1994, Scott 1991). We investigate the possibility that policy networks provide self-organizing solutions to collective action problems imposed by fragmented formal authority.

From this perspective, a political actor will seek densely-clustered relationships when *credibility of commitment* imposes the greatest constraint to gaining the rewards of collaboration, and densely-clustered relationships will enable the involved actor to collaborate at higher levels. Conversely, an actor will seek more extensive, centrally-located relationships when *search* for collaboration opportunities imposes the greatest constraint, and higher levels of collaboration will be associated with actors in central locations in the policy arena. We elaborate and empirically test these credibility and search hypotheses in terms of three relevant network characteristics (Scott 1991)—degree, density, and centrality.

The credibility and search hypotheses are applicable to the study of relationships and collaboration among legislators (Fowler 2006), lobbyists (Carpenter et al. 2003, 2004), and actors in regional policy arenas (Bardach 1998, O'Toole 1997, Leach et al. 2002), and social movements (McAdam and Snow 1997), and could potentially explain the interdependencies that reduce the likelihood of war among nations (Ward et al. 2007). Our empirical study focuses specifically on collaboration in interdependent, fragmented policy arenas in which the decisions by one authority impose costly externalities on other authorities and their constituencies, thereby creating an institutional collective action problem (Feiock 2005). Estuary watersheds (the geographical areas where rivers meet oceans) provide a critical research site for studying dynamic policy arenas because increasing interdependence among authorities within these local policy arenas creates many new challenges and opportunities for mutual gains through collaboration (Scholz and Stiftel 2005). Our analyses are based on 508 respondents surveyed in 22 major estuaries in the United States about collaboration, policy concerns, and the organizations they contact for policy discussions.

The competing theoretical perspectives take on practical significance in this context because of their divergent policy implications for resolving institutional collective action problems. The policy community perspective (reviewed in Dowding 1995, Marsh and Rhodes 1992) emphasizes the role of densely-connected, consensual policy communities that encourage cooperation, a position reflected in the popular ecosystem planning policies like the EPA's

National Estuary Program (Schneider et al. 2003). On the other hand, the issue network perspective recognizes the difficulties of forming such communities and highlights instead the role played by entrepreneurs creating central positions in more heterogeneous issue networks in developing coordinated project plans (Heclo 1978, Bardach 1998). We consider these issues in the conclusion, but first we clarify the problem of collaboration in the context of the estuary policy arenas, introduce the network concepts of degree, density and centrality, elaborate the credibility and search hypotheses, and present the research design and results.

Collaboration in Estuaries

Our empirical study focuses on environmental policies in estuaries, where the increasing costs imposed by collective action problems force actors to seek new relationships with a broader set of actors. Historically, many specialized federal, state and local agencies were created within politically-determined subregions in the estuaries to develop efficient rules and infrastructure for the exploitation of land, water, and other natural resources. American federalism has always imposed some interdependencies among different levels of government and specialized agencies, but ironically it is the success of these authorities that has dramatically increased the scope of the collective action problem. A new second generation of “wicked” conflicts has arisen as resource users push natural systems beyond their capacities, revealing in the process interdependencies across previously independent policy domains (Scholz and Stiftel 2005). Decisions in one specialized arena increasingly affect other agencies and their constituents throughout the estuary, and these conflicts can no longer be settled within the stable policy arenas that developed around each authority. The resultant fragmentation and dissatisfaction with the status quo creates a dynamic policy arena (Baumgartner and Jones 1993) in which actors seek new policies and new relationships capable of mitigating the externalities arising from the interdependent formal authority structure.

As in other interdependent policy arenas (Agranoff and McGuire 1998, Bardach 1998, O'Toole 1997), an estuary's actors can improve their individual policy outcomes by collaborating on policies and projects that can mitigate negative externalities as well as capture greater advantage from positive externalities. For instance, by coordinating one town's wastewater facility planning with another agency's recreational and habitat restoration projects in the same estuary, the concerned stakeholders and related agencies might both avoid pollution problems near recreational facilities and take advantage of wetland processing for more efficient wastewater treatment.

Widespread efforts to increase collaboration throughout estuaries and other watersheds involve government agencies as well as their constituencies. In watershed planning efforts, for example, government agencies generally provide the majority of participants, with slightly more local or regional agencies and slightly fewer federal agencies compared with state agencies; but agencies only slightly outnumber organized resource users and environmental interests plus scientists and engineers who are also active participants (Leach et al. 2002, Schneider et al. 2003). Agencies tend to avoid collaboration (Thomas 2003), however, because joint efforts can impose high transaction costs. As in all potential contractual situations, collaboration imposes information costs required to develop a mutually advantageous agreement, negotiation costs for dividing the cooperative gains, and enforcement costs to minimize the risk that partners will shirk and not fulfill their commitments. Network relationships affect collaboration by reducing these transaction costs, as elaborated by Jones et al. (1997) for industrial networks and by Hindmoor (1998) for policy networks. Our inquiry divides these costs into two primary constraints to collaboration—search and credibility— that are closely related to the two competing theories linking networks and collaboration.

Network Solutions to Credibility and Search Constraints

We view policy networks as dynamic structures that evolve from the sequence of strategic decisions made by independent policy actors to improve their individual payoffs in the collective dilemma (Snijders 2001). Actors cultivate new relationships and drop old ones in order to increase the likelihood of favorable outcomes and expand the possibilities for potential joint efforts. However, these network decisions are constrained by the formal authority structure and by existing relationships as well as by the costs and uncertainties of seeking and maintaining relationships. Thus networks are perceived as instruments that expand the strategy space of a boundedly-rational policy actor, with limitations imposed by relational capacities that mirror the limitations imposed by cognitive capacities.

From this perspective, the key differences in the two competing theories can be illustrated by the simplified scenarios in Figure 1 that focus on two actors, A and B, who are embedded in two independent but equivalent policy arenas. Each arena has six other actors controlling resources potentially important to our focal actors and six network relationships indicated by the lines connecting actors who know and communicate regularly with each other. The only difference between the two arenas is that A's contacts all know each other in the high-density scenario, but none of them know the other isolated actors. On the other hand, B's contacts as a group know all other actors in the high centrality scenario, but do not know each other.

[Figure 1 here]

The difference in personal or "ego" networks for A and B can be summarized in terms of three standard measures from network analysis (Wasserman and Faust 1994). *Degree* simply measures the number of contacts, and the two scenarios are designed to illustrate the case in which A and B both have the same degree of three. *Ego density* calculates the proportion of ego's direct contacts that have links with each other. Since all of A's contacts know each other but none of B's contacts do, the density score for A is one and for B is zero. *Betweenness Centrality* (Freeman 1977) measures the proportion of shortest information paths (or geodesics) between any two stakeholders in the policy arena that include ego. For example, all communications between actors 2 or 5 must pass through B, and so on for 1and 4 as well as 3 and 6. On the other hand, there are no actors in the high density scenario who depend on A to communicate with any other actors, since all connected actors have direct communication links that would be shorter than sending a message through A. Thus A's betweenness centrality is zero. By adding up all possible shortest paths that include B, we see that B is involved with 80% of all shortest paths in the connected policy arena, so B's betweenness centrality is 0.8. The central question for our empirical study is whether A or B is most likely to collaborate with other actors.

Credibility, Density, and Collaboration

The high density scenario in Figure 1 represents the common perception that dense, overlapping networks of reciprocity provide credibility and social capital that are critical to the resolution of collective action problems (Coleman 1988, Granovetter 1985, Putnam 2000). Consider, for example, the advantage of A over B in resolving credibility problems associated with a collaborative project with actor 1 in their respective arenas. Collaborative projects provide the temptation to shirk as represented in the prisoners dilemma game (e.g., Miller 1992)—both partners gain if both cooperate, but once one partner has committed investments in the project, the other partner faces the temptation to minimize its own investment and gain the shirker's advantage. The risk of a partner's shirking makes joint projects unattractive unless credible commitments can be made by both sides.

In the high-density scenario, actors 2 and 3 know both 1 and A, and can initially provide information about the credibility of the other's contractual promises. In addition, if 1 and A sign a contract, 2 and 3 can readily monitor and report potential shirking by either one to the other. Furthermore, shirking by either 1 or A can adversely affect the shirker's relationships with 2 and 3, possibly involving joint punishment strategies with 2 and 3 that could minimize shirking even in larger joint projects (Ostrom 1990). Over time, densely-clustered networks can foster shared interests, norms, and beliefs capable of supporting a broader array of cooperative activity not only between 1 and A, but also among the other densely-connected actors (Coleman 1988, Putnam 2000, Sabatier and Jenkins-Smith 1993).

In sum, dense relationships reduce enforcement costs and associated credibility problems, so actors with greater density of relationships are more likely to be involved in collaboration. They also reduce information and bargaining costs, but only among actors within the dense cluster. The credibility hypothesis predicts that, all other things being equal, the higher density score for A will result in a higher level of collaboration in comparison with B. To the extent that dense relationships have existed long enough, one corollary would also suggest that A will perceive greater agreement on the policy problems and goals in her policy arena than will B, since A's judgment depends primarily on her direct associates whose beliefs and attitudes are expected to converge over time because of the density of relationships.

Search, Centrality and Collaboration

Density of relationships may not provide as great an advantage when credibility is not the primary concern in collective action situations. Granovetter (1973) found, for example, that more extensive "weak tie" networks perform better than smaller, denser "strong-tie" networks in the coordination game of matching job seekers with companies seeking workers. The redundancy of contacts in Figure 1's high-density scenario for actor A enhances credibility, but at a cost of reducing the amount of novel information available to A. Actor B's contacts do not know each other, but instead know other actors with potentially valuable information. If both A and B are searching for jobs, if everyone has the same probability of knowing about available jobs, and if this knowledge is accurately transmitted through any links in a network, then B's contacts provide a greater probability than A's of finding the available job. B can gather information from twice the number of actors as A can. By choosing partners who do not know each other, B develops a greater capability to search the policy arena for information—his three partners are in contact with all actors in the arena, while A's partners contact only each other. If collaboration is limited primarily because the opportunities for mutual gain are not well-known, then the greater search capability of B should provide a comparative advantage over A in discovering the most advantageous type of collaborative activities as well as the best collaborative partners.

Although every connected actor in the high centrality scenario shares the informational advantage with B in pure coordination games, B has a greater advantage in asymmetric coordination games (battle of the sexes) in which all actors are better off agreeing on a single choice, but each actor would prefer a different outcome. Consider, for example, the increasingly common situation in which authorities are independently developing standards and policies to deal with a new generation of water-related problems (Scholz and Stiftel 2005). Authorities could gain considerable advantage by adopting compatible standards that would allow them to share resources and participate in joint projects in the future. B's central position allows B to control the flow of information and negotiations among all actors in a manner that would favor standards and policies most preferred by B.

The centrality of B's position in the policy arena provides a structural position commonly associated with policy entrepreneurs whose success depends on their ability to resolve collective action problems (Frohlich et al. 1971, Mintrom and Vergari 1998). Burt (1992, 2004) demonstrates that entrepreneurs in private organizations who provide links across "structural holes" between unconnected organizational divisions are most successful in developing new projects and in gaining the salary and career advantages accompanying this success. The search hypothesis contends that actors with greater centrality will have higher levels of collaboration whenever search is the primary constraint to collaboration.

Degree and Collaboration

Figure 1 is intended to clarify the difference between density and centrality while holding degree or the number of contacts constant. However, particularly in larger policy arenas, increasing the number of direct contacts provides an additional method of increasing search capacity. Each additional contact provides not only additional information but also further contacts with other actors. We therefore include in our analysis the number of contacts for each actor, called "degree" in network analysis. The higher an actor's degree, the greater the search potential and hence the higher the expected level of collaboration whenever search is a limiting factor for collaboration.

While degree appears complementary to centrality's search capability, its impact on density's credibility assurances is less clear. On the one hand, a larger number of contacts mathematically increase the likelihood that the group will include more partners suitable for joint action, suggesting a complementary relationship. On the other hand, a larger number of partners exponentially increases the total number of links those partners must have to maintain the same density of relationships—if A adds just one additional contact in Figure 1, four additional links would be needed between the new contact and the four other members of the group to maintain the same density for A. As group size expands, either maintenance costs increase because more links are required to maintain the same density or the effectiveness of collective monitoring and punishing strategies decrease because of the decrease in density. In either case credibility become more questionable (Olson 1965), leading to diminishing returns at best (Hicklin et al. 2007) and possibly even negative returns for increases in degree. Thus the net effect of degree on A's level of collaboration is not clear when credibility is the limiting factor for collaboration.

Does Collaboration Pose Search or Credibility Problems in Estuaries?

We have argued that the relative advantage of density or centrality depends on the primary obstacle to collaboration. Of course, the obstacle is not always readily apparent, as illustrated by the observed importance of density (called transitivity in their study) to Washington lobbyists (Carpenter et al. 2004). Since information plays a critical role in lobbying, centrality would arguably provide the greatest advantage in ensuring that a lobbyist would have access to important information from a wide variety of actors. Dense relationships are actually wasteful since they gain only redundant information. However, Carpenter et al. (2003, 2004) explain that the observed preference for dense relationships is apparently due to the critical need for *timely* information rather than for extensive information. The redundancy of dense relationships ensures the timely delivery of information.

What is the nature of the collaboration problem in estuaries? On the one hand, the recent upsurge of externality problems suggests that information about opportunities for collaborative gains may be the greatest constraint to collaboration. Existing networks have developed primarily within the relatively independent spheres of authority of each specialized agency, providing considerable opportunity for brokers or entrepreneurs who can discover mutual advantages for collaboration across the traditional boundaries separating the independent spheres of influence. To the extent that the search for mutually advantageous collaboration provides the greatest rewards, actors with greater centrality are in the best position to both discover opportunities for themselves and to shape the nature of the agreement to their advantage.

On the other hand, if collaborative opportunities are reasonably evident to relevant actors, then credibility problems may impose a more critical constraint to collaboration. The efforts required to reach agreement on a collaborative project, the risks of shirking by collaborating partners, and the uncertainty about resolving unforeseen problems frequently discourage agencies from collaborating unless forced by legislation to do so (Thomas 2003). Dense relationships that provide mutually-enforcing linkages between both collaborating parties can enhance the likelihood of collaboration by reducing transaction costs: dense relationships provide multiple channels for sharing information required in planning the project, for negotiating mutually satisfactory terms for the project, and for monitoring and enforcing terms of the agreement.

The primary aim of our empirical study is to determine the relative impacts of centrality, density, and degree on levels of collaboration. The significance of impacts will test the relevance of either theory, while the magnitude of impact will indicate the relative importance of search and credibility in constraining collaboration. Testing the impact of other factors on each actor's centrality, density, and degree will provide further evidence about actor's motivation for improving their capacity for search and credibility.

Research Design

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Our empirical study provides two features that are relatively novel for network analysis—observations in multiple independent arenas taken at two time periods. Elite interviews and available lists of participants in government agency identified active participants in water policy deliberations in 22 estuaries. A randomly-sampled panel within each estuary produced 508 respondents representing 401 organizations who completed surveys in 1999 and 2001.[1] Since the importance of networks was recognized only after the first survey, only the second survey contains the detailed measures of network positions and levels of agreement and collaboration that are most important for our study. This design provides first wave attitudes, conditions, organizational type, and a rudimentary network measure as controls for the relationship between network positions and collaboration in the second wave. The same measures provide the independent variables for predicting second wave network positions. Summary statistics and question wording for all measures are included in the separate Appendix.

Measuring Network Positions of Organizations

Translating the complexity of relationships involved in policy collaboration (Bardach 1998) into simple measures required for network analysis remains one of the most critical challenges to the analysis of policy networks. Agranoff and McGuire (1998) distinguish planning and policy, resource exchange, and project networks dealing with economic development in cities; Imperial (1999) separates operational, policymaking, and institutional levels of networks in watersheds; and Weible and Sabatier (2005) discuss information, resource exchange, ally, resource control, and coordination networks. Since there is no emerging agreement on the appropriate dimensions of relationships to measure, particularly for the newly-emergent arenas and dynamic relationships we study, we focus on general relationships rather than seeking to distinguish specialized relationships that might be more appropriate for studying stable policy arenas.

To identify these general relationships, we utilized the common approach of asking respondents who they contact regularly for issues relating to estuary policies, a method whose limitations are reasonably well-known (Marsden 1990). The first survey asked each respondent for the name and organizational affiliation of the respondent's three most important contacts relating to estuary policies. The second survey aggregated these responses into a list of the active agencies and organizations in the respondent's estuary, which ranged between 25 and 137 for the 22 estuaries that were surveyed. A mail component of the second survey asked each respondent to check names of all organizations on the list (for the relevant estuary) with which the respondent had direct contacts about estuary policy issues on at least a quarterly basis—write-ins were encouraged for organizations not identified by our initial survey.

The *Degree* measure is the sum of organizations whose names were checked by the respondent, which varied in our data from 1 to 55. We use the natural log of this count not only to limit the impact of the few outlier observations with large values, but also to reflect the assumption of diminishing returns for additional network contacts on collaboration (Hicklin et al. 2007).[2]

Density and *Betweenness Centrality* both require information about contacts of the organization's contacts, which requires two choices to create the full matrix of contacts necessary to calculate these items. First, we define a **network link** between organization A and organization B as a report by any respondent in A or B of contact with the other organization.[3]. Second, we limit the network matrix for each estuary to include only organizations that were surveyed, since links are not observed for organizations not represented in the survey.[4] We used

UCINET (Borgatti et al. 2002) to calculate the betweenness centrality and density for each organization in the resultant 22 undirected matrices. The resultant values for the 401 organizations were then assigned to the 508 respondents, with respondents from the same organization receiving the same values.

Missing data problems are more complicated for network measures than for survey measures of individual characteristics (e.g., Burt 1987). Our decision to exclude organizations that were not surveyed in calculating network measures could produce what has been called a boundary problem if substantial percentages of actors in a policy arena are excluded. For example, Costenbader and Valente's (2003) Monte Carlo experiments found a correlation of only .4 between the "true" measure of betweenness centrality for selected full populations and measures taken from random samples excluding 50% of the actors. Fortunately, the snowball method of identifying respondents minimizes this problem to the extent that identified contacts are exhaustively surveyed (Scott 1991). This method was used in 10 of the 22 estuaries.

The remaining 12 estuaries were selected because they were sites for the National Estuary Program (NEP), an Environmental Protection Agency program created by the US Congress in 1987 that subsidizes comprehensive planning efforts in selected estuaries to mitigate environmental problems. The survey was originally designed to evaluate the impact of the program (Schneider et. al. 2003), and the samples in these estuaries were drawn from the extensive but generally over-inclusive lists of active policy actors identified by the estuary's NEP.[5] To control for potential difference in NEP estuaries, all regressions reported later include a dummy variable equal to one for NEP estuaries. To test whether the sampling method and smaller proportion of potential actors interviewed in these estuaries created missing data or other biases, we included interaction terms (NEP dummy variable with the network variables) in the cooperation and agreement regressions to test for differences in coefficients between NEP and non-NEP estuaries. Since the results showed no significant differences in coefficients between the two types of estuaries, we conclude that the measurement errors from sampling in NEP estuaries at least did not significantly affect the observed relationships we are testing.[6]

Dependent Variables: Collaboration and Perceived Agreement

Our measure of collaboration identifies an organization's level of activity in joint projects. Preliminary studies identified seven categories of collaborative activities (Bardach 1998) that range from easy and commonplace to difficult and rare: provision of information to another organization; sharing of personnel; collaboration on joint research projects with other stakeholders; collaboration on joint grant/funding proposals; creation of an interagency taskforce; signing a memorandum of understanding; and sharing permitting or regulatory activities. Respondents were asked which of these collaborative activities their organization had undertaken in the past year, so the count of activities provides a scale that differentiated relatively inactive from the main collaborative organizations in the estuary.[7] The collaboration index [0,1] measures the proportion of potential collaborative activities undertaken by the organization. Collaboration has a mean of .68 and a standard deviation of .24.

Our measure of agreement reflects the respondent's perception of the level of agreement among all stakeholders in the estuary. Respondents were asked to characterize on a ten-point scale the level of agreement reached among estuary stakeholders on the following six items: causes of estuary problems, severity of estuary problems, the amount and type of research needed, the best policy tools to address problems, the economic consequences of estuary policies, and the environmental consequences of estuary policies. As with our measure of collaboration, our agreement index ranges from 0 to 1 and captures the proportion of affirmative responses to the six items that signal agreement (alpha= .87). Agreement has a mean value of .58 and standard deviation of .16.

Independent Variables

The two-wave design provides first wave measures of attitudes and conditions expected to shape both the structure of networks and resultant levels of agreement and collaboration in the second wave (e.g., Leach et al. 2002, Lubell et al. 2002). Since they are of interest primarily as controls against potentially spurious relationships between network characteristics and collaboration, we introduce them briefly here, discuss significant variables in the results section, and provide details in the internet appendix for this article at the Journal of Politics.

Prior Attitudes are measured on a ten-point scale and rescaled to a 0-1 interval with higher scores assumed to predict higher levels of collaboration and agreement. *Problem Severity* reflects the respondent's judgment about the severity of environmental problems facing the estuary, with greater perceived severity suggesting greater motivation to resolve the problems. *Trust* that other policy participants will fulfill their obligations in the estuary is expected to increase perceived agreement and collaboration, since trust reduces problems of credible commitment (Ostrom 1990). *Teamwork*, as measured by agreement with the statement that stakeholders work together well in the estuary, serves as a rough proxy measure for previous levels of collaborative activities. *Fairness* of the existing policy process in the estuary for the interests of the respondent suggests satisfaction with the existing process and possibly a willingness to participate more broadly in estuary affairs (Schneider et al. 2003). Conversely, *Domination by Experts* reflects a more negative judgment about the policy process that would reduce willingness to participate. Finally, *Environmental Concern* averages responses to three items about the importance of property rights, the intrusiveness of government regulation, and the relative importance of environmental protection and economic development, all recoded such that higher variables indicate greater concern and hence greater motivation to seek the benefits possible from joint projects.

We include the *Response Time*—the length of the telephone survey in seconds—as a control for response bias in predicting network positions. If respondents providing short surveys also reported fewer contacts, the fewer contacts might represent a response bias from respondents unwilling to take more time to identify contacts.

Organizational Context dummy variables identify the major types of organizations identified in estuary policy (Schneider et al. 2003), including government, research, environmental, resource users, and a miscellaneous category of other organizations. Government agencies have the authority, resources, and responsibility to complete joint projects, and are therefore likely to have greater levels of network and collaborative activities. Since scientific questions are central to many issues and joint undertakings in estuaries, research organizations are expected to be involved to a greater extent than other organizations of comparable size.

Based on our case studies, environmentalists and resource users play very different roles; environmental groups are most concerned with enhancing the effectiveness of policies protecting the estuary, while resource users are more concerned with streamlining existing regulations and minimizing the costs imposed by environmental policies. Environmental groups perceive greater gains from the coordination of estuary policies and resource users perceive greater threats, which would suggest that resource users will tend to discourage collaboration and avoid broader contacts in favor of small, dense clusters of like-minded contacts more concerned with economic growth than with environmental problems. The analyses use resource users as the excluded category to test these differences.

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Estuary Conditions are represented by measures with the same value for all respondents in a given estuary. The *National Estuary Program* dummy variable discussed earlier controls for incentives in the 12 NEP estuaries that may stimulate network developments, agreement, and collaboration. The *Estuary Change* scale from the second survey averages responses to evaluations about favorable changes during the two years since the previous survey in expenditures, stakeholder participation, effectiveness of existing programs, and support for estuary policies; positive changes may increase willingness to invest in networks and joint programs. We include general measures of the estuary *Area* in square kilometers, the total *Population* (logged), and *Poverty*, the percentage of the population below poverty level. Larger areas impose greater travel time and hence greater costs of providing networks; larger populations and urbanization may increase the probability of finding worthwhile contacts, but reduce density and the resultant homogeneity of relationships; and poverty may reduce the resources or social capital available and hence decrease the ability to build networks. Since differences in the number of stakeholders and the nature of the policy problem across estuaries may influence network positions, we also include *stakeholders in estuary* that counts the total number of organizations identified by the survey and *water quality problems*, an objective measure of water quality problems in the estuary developed as part of NOAA's Coastal Assessment Framework.

Prior Conditions include several variables for use only in equations predicting network positions, since they are expected to affect network structure but not agreement and collaboration. *Number of contacts* counts the number of close allies (up to three) identified in the first survey, providing a censored measure of degree for the first wave. *Years in job* counts the number of years the respondent held his current position, and *Years in residence* count the number of years the respondent had lived in the estuary, both recorded in the second survey.

Estimation Procedure

Table 1 provides regression estimates of the impact of network positions on collaboration and perceived agreement, controlling for prior attitudes and conditions, organizational context, and estuary conditions. Since observations are not fully independent within each of the 22 estuaries, we use Huber –White clustered robust standard errors for significance tests of the coefficients. Although our models are designed to test the two hypotheses rather than to fully explain the dependent variables, they do explain 21 percent of the variance in collaboration and 27 percent in agreement. Note that all variables are transformed to a zero-one scale to facilitate comparisons, so all coefficients report the proportion of change in the dependent variable associated with a full-range change from zero to one in the independent variable. Since degree has no natural maximum, we used the maximum observed value to convert this and the other two network measures to the zero-one scale. The reported results use values estimated by the Stata imputation procedure for missing data, although imputation does not affect any results discussed below.

Our model assumes that networks develop before voluntary collaboration. The exchanges involved in developing and maintaining reciprocal network relationships are themselves an initial form of cooperation that can lead to collaboration on the kind of riskier joint projects measured by our dependent variable and the agreement values assumed to support involvement in these projects. However, collaboration and agreement could also affect network position, which suggests the possibility of simultaneity bias that is always present when measures are from the same time period. For our estimations, the Hausman specification error test rejects the hypothesis of simultaneity (p>.05) for each network measure individually and for all network measures as a whole.[8] As an added precaution against endogeneity bias, we have included in Table 1 the first period variables assumed to affect both networks and collaboration, which control for potentially spurious correlation of networks and collaboration related to these variables.

Table 2 provides OLS estimates of the impact of the independent variables on degree, and tobit estimates for density and centrality-- both of these measures present censored data containing many zero values (29% for density and 32% for centrality).[9]

Network Impacts: Centrality Increases Collaboration, while Density Increases Agreement

The estimates for the collaboration equation reported in Table 1 are consistent with the search hypothesis and counter to the credibility hypothesis: the coefficients for degree and centrality are large in magnitude, positive, and significant, while the coefficient for density is actually negative.

[Table 1 here]

From our theoretical perspective, this suggests that the ability to obtain and control information from a large and varied network may play a more critical role than the ability to make credible commitments in fostering collaborative activities. Given the recent upsurge in externalities in the relatively disorganized and immature estuary policy arenas, the greatest challenge facing policy actors appears to be one of finding suitable partners and coordinating activities in ways not previously considered by either partner. As is implicit in the issue-network perspective, well-connected central actors can glean and control information and therefore gain greater opportunities and advantages from collaboration.

On the other hand, the results for perceived agreement support the credibility hypothesis. The significant negative coefficient for degree and positive coefficient for density indicate that perceived agreement is greater in organizations with fewer contacts that tend to know each other, as expected in the policy community perspective. Small dense networks can provide the basis for trust, for greater redundancy of information, and hence for greater agreement among network participants, which apparently is extrapolated to perceived agreement among all stakeholders in the estuary.

Note, however, that agreement is not significantly related to collaboration in the first equation, which explains why the impact of degree and density on agreement do not carry over to collaboration. These results suggest that collaboration in estuaries is more consistent with the issue network image of mutually advantageous exchange among heterogeneous partners seeking different interests, and less consistent with the policy community image of exchange among homogeneous, trusting partners seeking common goals and governed by shared norms. Of course, agreement between the smaller set of collaborators in a joint project may still be important—we have no measure to test this proposition—but widespread agreement throughout the estuary does not appear to be important to the most active collaborators.[10]

Another interesting disjuncture between collaboration and agreement in our analysis is reflected in the remaining explanatory variables: network positions have a greater influence on collaboration, while individual and estuary positions have a greater influence on perceived agreement. Both degree and centrality coefficients predicting collaboration are considerably larger than those of other significant variables. Of the other significant variables, first-period teamwork acts in part as a proxy for previous levels of collaboration, while government and research reflect and control for the expected collaborative advantages of these organizations discussed earlier.

Agreement, on the other hand, is affected by other variables with equal and larger coefficients than those of the network variables. The impact of first-period trust and fairness on second-period agreement reflect the expected connection and continuity among related concepts. The large coefficient for estuary changes indicates that self-reported perceptions of improvements or declines in estuary conditions are very centrally connected to perceived agreement (reported at the same time period). The insignificant impact of these changes on collaboration is puzzling, although it may reflect the more rapid adjustment and greater volatility of perceptions compared with collaborative practices.

Finally, all organizations have significantly higher perceptions of agreement than the omitted category of resource users, although the magnitudes of coefficients are somewhat less than those of the network variables in this case. The results are consistent with the previously-discussed perspective that resource users tend to be more marginally involved in broader efforts to coordinate estuary policies and generally perceive themselves to be in disagreement with existing and proposed remedial policies for estuary problems. The positive impact of the NEP on attitudes but not on collaboration is consistent with Lubell's (2004) analysis.

Network Motivations: Activists Seek More Contacts

Overall, the pattern of influences on network positions reported in Table 2 is not very revealing, although there is some support for a simple picture consistent with our interpretations of Table 1: policy activists with greater resources and motivation to undertake joint policy projects in the estuary seek central positions and more connections, while resource users and others with less enthusiasm for estuary-wide environmental policies embed themselves in smaller, denser networks.

[Table 2 here]

The positive coefficient for degree and centrality and negative coefficient for density support this picture, although only degree has a significant coefficient. Those expressing most concern about the environment in the first survey develop more contacts and tend to seek central positions associated with more collaboration, while those with the least concern seek smaller, dense relationships associated with perceived agreement. The organizational coefficients in the degree equation extend this picture, with all organizations seeking more contacts than the omitted category of resource users who are least concerned about environmental matters.

The remaining significant findings add details that provide only mixed support for the simplified picture. For example, only government organizations achieve significantly higher levels of centrality compared with resource users, most likely reflecting their greater financial resources and authority. And no organizations are significantly less likely than resource users to be embedded in dense networks.

The years in residence (but not years in job) for the organization's typical respondent is positively related to both degree and density, apparently reflecting a tendency over time to build on contacts who know each other. Furthermore, water quality problems marginally increase centrality, as expected in the simplified picture, but also increase density and do not increase degree, contrary to the picture; perhaps tightly linked clusters emerge in response to threatening problems, providing opportunities for entrepreneurs to establish links across these clusters. The NEP program enhances boundary spanning networks (Schneider et al 2003), a homogenizing influence that here leads to lower density and centrality but not degree. Fairness appears to motivate a search for centrality, but not for degree or for avoiding density. Larger estuary area significantly decreases density and centrality, while larger population decreases only density. Finally, the number of reported contacts (up to 3) in the first period marginally increases degree in the second period, as expected, but this earlier proclivity to form relationships surprisingly has no impact on density or centrality—most likely reflecting the limitations of this censored measure.

Conclusion

In sum, the preponderance of evidence in Table 1 and some evidence in Table 2 supports the search hypothesis rather than the more widely-known credibility hypothesis; well-connected policy actors playing central roles in policy networks collaborate at higher levels, and the most motivated stakeholders seek more contacts and centralized positions. Actors embedded in small, dense networks perceive higher levels of agreement among estuary stakeholders, as predicted by the credibility hypothesis, but this perception is not related to collaboration. Indeed, such positions appear to be sought primarily by actors less motivated to resolve policy problems at the estuary level.

These findings are consistent with the view that collaborative solutions to fragmentation problems in estuaries require enhanced search capacities more than enhanced credibility. Information about potential partners appears to pose the greatest constraint to the expansion of joint programs, at least at this stage in the development of the estuary policy arena. The formidable task of creating a dense, fully integrated “policy community” that spans the estuary might ultimately produce the broader collaboration and greater mutual gains suggested by the policy community perspective. However, in the emergent, unorganized estuary policy arenas we study, the entrepreneurial activities of well-connected, centrally located actors appear most effective in enhancing collaboration in the short run. In such settings, the redundancy of contacts required for dense networks diverts resources that appear to be better used in creating the larger, less redundant "issue networks" associated with higher levels of collaboration.

We speculate that the importance of degree and centrality is most likely in dynamic, relatively unstructured policymaking arenas, and become increasingly less applicable in arenas with more stable interorganizational relationships, particularly those dealing primarily with policy implementation. Given these results, we further speculate that encouraging entrepreneurial activities may be more effective than comprehensive planning activities in increasing collaboration in dynamic policy arenas.

For network analysis to contribute significantly to understanding the fundamental collective action problems that define the central issues of governance, such speculations require further theoretical elaboration and testing of the link between specific network characteristics and specific collective action problems. In particular, new studies are needed to analyze the structural characteristics sought for network contacts and the impact of network structures on collaborative behavior for different types of collective action problems.

Recent advances in network analysis provide very promising concepts and analytic methods to address these broader issues. For example, Watts (1999) "small world networks" provides a formal description of one form of social capital; small world networks shorten the number of steps linking actors while maintaining strong clustering, potentially enhancing both search and credibility capabilities of the network. Agent-based simulation studies (Cohen et al. 2001, Scholz and Wang 2004) and experiments (Ule 2006, Ahn et al. 2007) are building a stronger foundation for understanding the relationship between network structures and cooperation. For appropriately-designed field studies, exponential random graph theory and

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Markov Chain Monte Carlo estimation techniques (Carrington et al. 2005) provide rigorous methods specifically designed to estimate the impact of network structures on collaboration or other behaviors. The greater analytic power of models such as Snijder's actor-oriented longitudinal model of network dynamics (2001, 2007) may potentially overcome the limitations of standard regression techniques for explaining network dynamics (Snijders et al., Berardo and Scholz 2007).

The currently dominant paradigms in political science focus primarily on characteristics of individuals or formal institutions that contribute to the solution of collective action problems. Network approaches take us another step toward a comprehensive understanding of these dilemmas, providing precise tools for analyzing the role of informal relationships and self-organizing networks in mediating between individuals and institutions.

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Endnotes

[1] See Schneider et al (2003) for more information about the surveys and sampling framework. The 508 respondents represent 58.8 percent of the 864 surveys completed in the first wave, and the response rate in the first wave was well over 70%. The primary losses in the panel represent changes in the respondent's job that resulted in exit from the estuary policy arena or in an inability to contact the individual, with very few refusals. There were no statistically significant differences between those remaining in and dropped from the panel relating to the variables in the analyses reported here. This loss is not unusual in panel data, but undoubtedly focuses our analysis on the more stable and prominent network participants over time.

[2] An alternative measure would sum over all reports for the organization to provide an organizational total. We choose to use the respondent's report since respondents provide our analytic unit for all non-network independent variables.

[3] Measuring networks for large organizations remains challenging because individuals in one subunit may know only the set of partners dealing with the subunit, and one subunit may not even interact much with other subunits in the same organization. We use undirected measures without verification from the named organization because the limited ability to sample multiple respondents in every organization already tends to undercount connections, and verification requirement would exacerbate this problem. We divide agencies with multiple field offices in the estuary into separate entities to ensure that each respondent is more likely to be familiar with the full range of the entity's contacts.

[4] We do not use the alternative "reconstruction" approach that assumes reciprocity of links because the assumed symmetry is not apparent in the observed matrix of respondents.

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[5] We have no clear estimate of the proportion of the population actually sampled because the lists were padded on the side of including many non-participants, which were screened out with initial survey questions.

[6] We omit these interaction terms in reported results to simplify the presentation. In the cooperation equation, the t test for the interaction terms were 0.13 for centrality, -0.44 for degree, and -0.44 for density. In the agreement equation, the t test for interaction terms were 0.15 for centrality, 1.17 for degree, and 0.03 for density. We omit these interaction terms in reported results to simplify the presentation.

[7] An alternative measure would count the number of organizations that were partners in joint projects. Preliminary interviews found that providing an accurate count by identifying all partners was more difficult than identifying types of activities. Furthermore, counts of "partners" inflate collaboration measures for organizations with token involvement (minor funding, specialized expertise) in many projects in the estuary, which get a low score in our measure.

[8] The Hausman test is based on OLS estimation of the three network measures using all exogenous variables in Tables 1 and 2, with residuals from these estimations added to the Table 1 regression. The F tests rejected the hypothesis that coefficients for the residuals for all three network variables were greater than zero in the cooperation equation at $p=.17$, and that the individual coefficients were greater than zero at $p=.30$ for degree, $p=.07$ for centrality, and $p=.45$ for density. For the agreement equation the values were $p=.29$ jointly and $p=.92$ for degree, $p=.07$ for centrality, and $p=.33$ for density. The possibility of simultaneous effects is close to significance for centrality, the key variable for the search hypothesis. However, collaboration would most likely enhance density and reduce centrality to the extent that partners work with the

same outside consultants or agencies. This expected negative simultaneity bias would *underestimate* the impact of centrality in Table 1, and therefore not threaten the evidence discussed later that supports the search hypothesis.

[9] An organization with large, well-developed networks could theoretically measure zero on clustering (contacts have no mutual contacts) or on centrality (the organization is not in the shortest path between any other two nodes in the network), but the majority of zero values occur for stakeholders with small, unconnected, underdeveloped networks. We interpret the observed zero in these cases to represent a lower threshold below which the desired measurement is not observable, so tobit provides an appropriate estimator for the censored data.

[10] Surprisingly, centrality is also positively related to agreement, suggesting perhaps that the control and manipulation of information by entrepreneurs also increases their perception of agreement. Note, however, that the negative impact of degree offsets the positive impact of centrality, so collaborators with high degree and centrality may have no greater sense of agreement than others. Small dense networks may induce greater policy agreements, but well-connected central locations do not necessarily induce less perceived agreement.

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References

Agranoff, Robert and Michael McGuire. 1998. "Multi-Network Management: Collaboration and the Hollow State in Local Economic Policy." *Journal of Public Administration Research and Theory* 8(1): 67-91.

Ahn, T.K., Justin Esarey, and John T. Scholz. 2007. "Reputation and Cooperation in Voluntary Exchanges: Comparing Local and Central Institutions". Presented at the Annual Meeting of the American Political Science Association.

Bardach, Eugene. 1998. *Getting Agencies to Work Together: The Practice and Theory of Managerial Craftmanship.* Washington, D.C.: Brooking Institution Press.

Baumgartner, Frank R., and Bryan D. Jones. 1993. *Agendas and Instability in American Politics.* Chicago, IL: University of Chicago Press.

Berardo, Ramiro, and John T. Scholz. 2007. "Self-Organizing Policy Networks: Risk, Partner Selection and Cooperation in Estuaries." Presented at the Conference on Advanced Political Network Modelling, Mannheim, Germany.

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

Burt, Robert S. 2004. "Structural Holes and Good Ideas." *American Journal of Sociology* 110(2): 349-399.

Burt, Robert S. 2000. "The Network Structure of Social Capital." *Research in Organizational Behavior* 22: 345-423.

Burt, Robert S. 1992. *Structural Holes: The Social Structure of Competition.* Cambridge, MA: Harvard University Press.

Scholz, Berardo, and Kile.

Burt, R. S. 1987. “A Note on Missing Network Data In the General Social Survey.” *Social Networks* 9(1): 63-73.

Carpenter, Daniel P., Kevin M. Esterling, and David M. J. Lazer. 2004. “Friends, Brokers, and Transitivity: Who Informs Whom in Washington Politics?” *The Journal of Politics* 66(1): 224-246.

Carpenter, Daniel, Kevin Esterling, and David Lazer. 2003. “The Strength of Strong Ties: A Model of Contact-Making in Policy Networks with Evidence from U.S. Health Politics.” *Rationality and Society* 15(4): 411–440.

Carrington, Peter J., John Scott and Stanley Wasserman (eds.). 2005. *Models and Methods in Social Network Analysis*. Cambridge: Cambridge University Press.

Cohen, Michael D., Rick. L. Riolo and Robert Axelrod. 2001. “The Role of Social Structure in the Maintenance of Cooperative Regimes.” *Rationality and Society* 13(1): 5–32.

Coleman, James S. 1988. “Social capital in the creation of human capital.” *The American Journal of Sociology* 94: S95-S120.

Costenbader, E., and T. W. Valente. 2003. “The Stability of Centrality Measures when Networks are Sampled.” *Social Networks* 25: 283-307.

Dowding, Keith. 1995. "Model or Metaphor? A Critical Review of the Policy Network Approach." *Political Studies* 43: 136-158.

Freeman, Linton. 1977. “A Set of Measures of Centrality Based on Betweenness.” *Sociometry* 40(1): 35-41.

Feiock, Richard 2005. “Institutional Collective Action and Local Governance.” Presented at the symposium *Creating Collaborating Communities: Management, Networks, Service Cooperation, and Metropolitan Governance*. Wayne State University.

Fowler James H. 2006. “Connecting the Congress: A Study of Cosponsorship Networks.” *Political Analysis* 14(4):456-487.

Frohlich, Norman, Joe A. Oppenheimer, and Oran R. Young. 1971. *Political Leadership and Collective Goods*. Princeton, NJ: Princeton University Press.

Granovetter, Mark 1973. "The Strength of Weak Ties." *American Journal of Sociology*, 78: 1360-1380.

Granovetter, Mark. 1985. “Economic Action and Social Structure: The Problem of Embeddedness.” *American Journal of Sociology*, 91(3): 481-510.

Heclo, Hugh. 1978. “Issue Networks and the Executive Establishment.” In *The New American Political System*, ed. Anthony King. Washington, D.C.: American Enterprise Institute. 87-124.

Hindmoor, A. 1998. “The Importance of Being Trusted: Transaction Costs and Policy Network Theory.” *Public Administration* 76 (Spring): 25–43.

Hicklin, Alisa, Laurence J. O'Toole, Jr., and Kenneth J. Meier. 2007. “Serpents in the Sand: Managerial Networking and Nonlinear Influences on Organizational Performance.” *Journal of Public Administration Research and Theory*. (Advance Access published on June 29, 2007; doi: doi:10.1093/jopart/mum009)

Imperial, Mark T. 1999**. “**Institutional Analysis and Ecosystem-Based Management: The Institutional Analysis and Development Framework.” *Environmental Management* 24(4): 449–465.

Jones, Candace, William S. Hesterly and Stephen P. Borgatti. 1997. “A General Theory of Network Governance: Exchange Conditions and Social Exchange.” *Academy of Management Review* 22(4): 911-945.

Leach William D., Neil W. Pelkey, and Paul A. Sabatier. 2002. “Stakeholder Partnerships as Collaborative Policymaking: Evaluation Criteria Applied to Watershed Management in California and Washington.” *Journal of Policy Analysis and Management* 21(4): 645–670.

Lubell, Mark. 2004. “Collaborative Environmental Institutions: All Talk and No Action?” *Journal of Policy Analysis and Management*. 23(3): 549–573

Lubell, Mark, Mark Schneider, John Scholz, and Mihriye Mete. 2002. “Watershed Partnerships and the Emergence of Collective Action Institutions.” *American Journal of Political Science* 46(1): 148-63.

Marsden, Peter. 1990. “Network Data and Measurement.” *Annual Review of Sociology* 16: 435-463.

Marsh, David and R.A.W. Rhodes. 1992. "Policy Communities and Issue Networks: Beyond Typology." In *Policy Networks in British Government*, eds. David Marsh, and R.A.W. Rhodes. Oxford: Oxford University Press, 249-268

McAdam, Doug and David A. Snow (eds.) 1997. *Social Movements: Readings on Their Emergence, Mobilization and Dynamics.* Los Angeles, CA: Roxbury Publishing

Miller, Gary. 1992. *Managerial Dilemmas: The Political Economy of Hierarchy*. New York, NY: Cambridge University Press.

Mintrom, Michael, and Sandra Vergari. 1998. “Policy Networks and Innovation Diffusion: The Cased of State Education Reforms.” *Journal of Politics* 60(1): 126-148.

Olson, Mancur. 1965 *The Logic of Collective Action.* Cambridge, MA: Harvard University Press.

Ostrom, Elinor. 1990. *Governing the Commons. The Evolution of Institutions for Collective Action.* New York, NY: Cambridge University Press.

Scholz, Berardo, and Kile.

O'Toole, Laurence J., Jr. 1997. "Treating Networks Seriously: Practical and Research-based Agendas in Public Administration." *Public Administration Review* 57(1): 45-52.

Putnam, Robert. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York, NY: Simon & Schuster.

Sabatier, Paul, and Hank Jenkins-Smith (eds.). 1993. *Policy Change and Learning: An Advocacy Coalition Approach*. Boulder, CO: Westview Press.

Schneider, Mark, John Scholz, Mark Lubell, Denisa Mindruta, Matthew Edwardsen. 2003. "Building Consensual Institutions: Networks and the National Estuary Program." *American Journal of Political Science* 47(1):143-158.

Scholz, John T. and Bruce Stiftel (eds). 2005. *Adaptive Governance of Water Conflict*. Washington D.C.: Resources for the Future Press.

Scholz, John T., and Cheng-Lung Wang. 2004. "Learning Networks and the Coevolution of Cooperation between Authorities and Subjects." Presented at the Annual Meeting of the American Political Science Association.

Scott, John. 1991. *Social Network Analysis.* Thousand Oaks: Sage Publications.

Snijders, Tom A.B. 2001. "The Statistical Evaluation of Social Network Dynamics." *Sociological Methodology* 31: 361-395.

Snijders, Tom A.B., Steglich, Christian E.G., and Schweinberger, Michael. 2007. "Modeling the Co-Evolution of Networks and Behavior." In *Longitudinal Models in the Behavioral and Related Sciences*, eds. Kees van Montfort, Han Oud, and Albert Satorra. Mahwah, N.J.: Lawrence Erlbaum, 41-71.

Thomas, Craig W. 2003. *Bureaucratic Landscapes: Interagency Cooperation and the Preservation of Biodiversity*. Cambridge, MA: MIT Press.

Scholz, Berardo, and Kile.

Ward, Michael D., Randolph M. Siverson, and Xun Cao. 2007. “Disputes Democracies, and Dependencies: A Reexamination of the Kantian Peace.” *American Journal of Political Science* 51(3): 583-601.

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

Watts, Duncan J. 1999. “Networks, Dynamics, and the Small-world Phenomenon.” American Journal of Sociology 105(2): 493-527.

Weible, Chris. M. and Paul A. Sabatier, 2005. “Comparing policy networks: Marine protected areas in California.” *Policy Studies Journal* 33(2): 181-201.

Ule, Aljiz. 2006. “Exclusion and Cooperation in Networks.” Tinbergen Institute of Research. Amsterdam: Netherlands.

Table 1

Network Effects on Collaboration and Agreement
(standard errors in parentheses)

Independent Variables	Collaboration	Agreement
Agreement	.044	--
	(.066)	
Network Positions		
Degree (log)	.366	-.092
	(.056)	(.028)
Centrality	.218	.072
	(.036)	(.036)
Density	-.058	.080
	(.030)	(.030)
Prior Attitudes		
Problem Severity	-.029	-.009
	(.047)	(.031)
Trust	.031	.102
	(.060)	(.035)
Teamwork	.151	.073
	(.051)	(.037)
Fairness	-.067	.136
	(.055)	(.041)
Domination by Experts	-.034	.055
	(.066)	(.047)
Environmental Concerns	-.006	.100
	(.060)	(.066)
Organization		
Government	.150	.043
	(.048)	(.019)
Research	.185	.079
	(.050)	(.033)
Environment	.083	.057
	(.050)	(.027)
Other	.070	.063
	(.039)	(.023)
Estuary Conditions		
National Estuary Program	-.024	.050
	(.015)	(.013)
Estuary Changes	.101	.239
	(.080)	(.070)
Area	-.002	-.000
	(.001)	(.000)

Population (log)	.013	.008
	(.004)	(.006)
Poverty	.264	.042
	(.137)	(.101)
Constant	.001	-.034
	(.107)	(.122)
Cases	508	508
R^2	.21	.27

Note: OLS coefficients are reported in columns, with Huber/White robust standard errors in parentheses, based on 22 estuary clusters.

Table 2
Factors Affecting Individual Network Positions
(standard errors in parentheses)

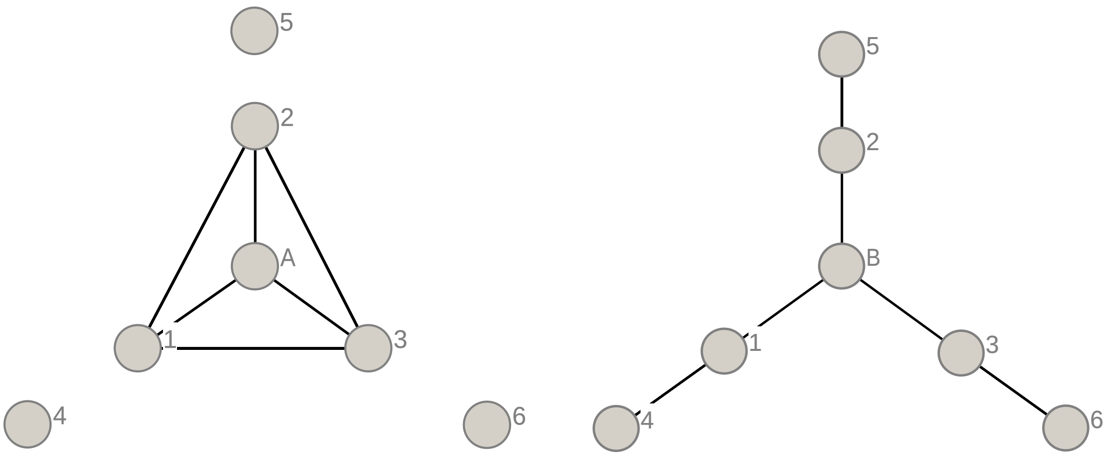
	OLS	TOBIT	
	Degree (log)	**Density**	**Centrality**
Prior Attitudes			
Problem Severity	-0.190	-2.211	0.432
	(0.216)	(6.387)	(2.090)
Trust	-0.370	-2.000	-3.069
	(0.219)	(7.381)	(2.421)
Teamwork	-0.031	-6.493	-0.534
	(0.093)	(6.808)	(2.270)
Fairness	0.130	0.098	8.405
	(0.153)	(8.115)	(2.703)
Domination by Experts	-0.071	-4.758	0.879
	(0.191)	(7.209)	(2.357)
Environmental Concerns	0.513	-3.449	4.296
	(0.145)	(7.715)	(2.524)
(Response time)	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Prior Conditions			
Contacts	0.066	0.422	0.213
	(0.027)	(1.110)	(0.358)
Years in job	0.001	0.104	0.102
	(0.003)	(0.177)	(0.057)
Years in residence	0.009	0.238	-0.061
	(0.003)	(0.096)	(0.032)
Organization			
Government	0.293	0.874	4.544
	(0.125)	(5.287)	(1.802)
Research	0.336	-5.121	3.804
	(0.111)	(6.758)	(2.226)
Environment	0.332	-1.395	3.013
	(0.155)	(6.196)	(2.103)
Other	0.251	5.154	1.472
	(0.110)	(5.947)	(2.018)
Estuary Conditions			
National Estuary Program	-0.109	-15.497	-5.159
	(0.180)	(5.415)	(1.758)
Estuary Changes	0.261	-3.360	-2.192
	(0.285)	(10.171)	(3.353)
Area	-0.005	-3.105	-0.125
	(0.005)	(0.268)	(0.060)
Population (log)	0.018	-3.776	-0.585

	(0.027)	(1.079)	(0.348)
Poverty	-1.116	171.728	10.985
	(1.212)	(29.235)	(9.397)
Stakeholders in Estuary	0.002	0.032	0.013
	(0.001)	(0.031)	(0.010)
Water Quality Problems	0.114	48.848	5.631
	(0.177)	(7.180)	(2.328)
Constant	1.751	57.952	0.797
	(0.573)	(20.247)	(6.443)
Cases	508	508 (365 uncensored)	508 (344 uncensored)
R2/pseudo R2	0.13	0.09	0.03

Note: Each column reports regression coefficients for the dependent variable at the top of the column. Significance is determined using robust standard errors (Huber/ White) based on 22 estuary clusters.

Figure 1

High Density Scenario | High Centrality Scenario



A's Network Position Measures

Degree	3
Density	1
Centrality	0

B's Network Position Measures

Degree	3
Density	0
Centrality	0.8