Social Networks xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Social Networks

journal homepage: www.elsevier.com/locate/socnet

Role analysis using the ego-ERGM: A look at environmental interest group coalitions

J.M. Box-Steffensmeier[a,*], B.W. Campbell[a], D.P. Christenson[b], Z. Navabi[a]

[a] Department of Political Science, The Ohio State University, 2140 Derby Hall, 154 N. Oval Mall, Columbus, OH 43210, United States
[b] Department of Political Science, Boston University, 232 Bay State Road, Boston, MA 02215, United States

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Network analysis
Role analysis
Lobbying
Environmental politics
Ego-ERGM
Community detection
Interest group coalitions
Amicus curiae briefs

ABSTRACT

Interest groups coordinate to achieve political goals. However, these groups are heterogeneous, and the division of labor within these coalitions varies. We explore the presence of distinct roles in coalitions of environmental interest groups, and analyse which factors predict if an organization takes on a particular role. To model these latent dynamics, we introduce the ego-ERGM. We find that a group's budget, member size, staff size, and degree centrality are influential in distinguishing between three role assignments. These results provide insight into the roles adopted in carrying out coalition tasks. This approach shows promise for understanding a host of networks.

> "Typically there is a group that takes a lead . . . We have a coalition of what we call the Green Groups, which is predominately environmental organizations based in Washington, D.C., which focus on federal and environmental policy. And so, that's what binds us together: we are all environmental groups; we are all based in D.C.; and we all work on federal environmental policy" (Correspondence, 2016).

Interest group coalitions are ubiquitous in American politics, and analyzing the social roles in interest group coalitions sheds light into the fundamental question of politics: who gets what, when, and how? In this paper we argue that interest groups take on varying roles that are critical to the overall structure of the coalition. Our general queries are similar to the ones that intrigued Faust and Skvoretz (2002) and Box-Steffensmeier and Christenson (2014), which are to determine the driving factors of particular network structures and the roles of individual players within them. To tease out different roles, we compare egocentric networks, that is, the immediate network of any specific group, across a wide range of similar interest groups within the environmental politics space. Comparing these ego-networks with respect to their similarities and differences gets us closer to answering whether networks are structured differently within a specific policy domain. More generally, we make advances about why networks may be structured differently, what the structure means for the roles adopted within the coalition, and what the policy and effectiveness implications may be for the coalition.

Given the collective goals of interest groups, we develop a novel theory of interest group roles which posits that actors join coalitions seeking partners that can make up for their weaknesses, while searching for partners whose weaknesses they can make up for. Our analyses utilizes novel network data on all interest groups that coauthored amicus curiae briefs for 2000–2009 Supreme Court cases on natural resources and environmental protection. This novel dataset where interest groups are tied to one another through coauthoring the same brief captures a purposive and coordinated network of interest groups lobbying collectively on environmental policy issues. Once the network is assembled, our first step is to focus on the roles of actors within a network. We do so using a novel methodological innovation that extracts the ego-networks for each group, such as the network for the Sierra Club or National Wildlife Federation, from the larger environmental advocacy coalition. This allows us to characterize the ego-networks and find which are similar. These groups are then sorted by whether they play similar roles within the larger environmental interest group coalition network. We use a novel and flexible methodological framework developed by Salter-Townshend and Murphy (2015) based on a mixture of Exponential-family Random Graph Models to cluster the nodes into

* Corresponding author.
E-mail addresses: steffensmeier.2@osu.edu (J.M. Box-Steffensmeier), campbell.1721@osu.edu (B.W. Campbell), dinopc@bu.edu (D.P. Christenson), navabi.2@osu.edu (Z. Navabi).

http://dx.doi.org/10.1016/j.socnet.2017.08.004
0378-8733/

like roles. This methodological advancement is referred to as the ego-ERGM.[1]

The ego-ERGM allows analysts to examine the structural roles that exist within a given network, and the structural dependencies and covariates that may inform the prevalence of certain social roles. Conventional qualitative approaches do not offer the opportunity to rigorously measure these endogenous and exogenous processes for large groups. Alternatively, conventional network approaches like stochastic block modeling or community detection do not allow for the specification of specific processes that the analyst may think informs role assignment. The ego-ERGM resolves both of these shortcomings by allowing the analyst to highlight similar structural roles within a network conditioned on a specified model.

In the particular case of the environmental interest group coalitions, we specify a generative model for structural roles that includes 6 ERGM terms, including two structural features, Edges, Concurrent Ties, and 4 nodal covariates, Group Budget, Members, Staff, and Degree Centrality. We find that an ego-ERGM specified with these ERGM terms produces three distinct role assignments. We refer to these roles as Teammates, Coordinators, and Peripheral Specialists. Within a coalition of industry interest groups, we find similarity across the network gives rise to one role, Teammates, which reflects a network process of equality and shared obligation for lobbying. Within the coalition of pro-environment lobbying groups, we detect roles associated with a dominant core-periphery structure where core nodes, Coordinators, appear to be coordinating the coalition through its material resources and relative influence. On the periphery of the coalition, we see the emergence of Peripheral Specialists which may offer specialized knowledge and research over particular topics that Coordinators may otherwise be missing.

This method holds great promise beyond this immediate application. There exists a great deal of literature to suggest that roles emerge within a variety of group-based political dynamics, from fundamental theories of International Relations (Wendt, 1999) to Congressional representation (Alpert, 1979), from mid-level theories of foreign policy behavior (Cantir and Kaarbo, 2012; Chafetz et al., 1996; Holsti, 1970) to Supreme Court decision-making (James, 1968). The ego-ERGM brings opportunities to understand the interdependencies that exist between these roles and the larger network consequences that were left previously impossible to consider, and thus, providing the opportunity for a great deal of theoretical innovation and methodological tests to those interested in network dynamics.

In the following section, we present a discussion of how scholars have historically considered, measured, and empirically studied group-based roles. We then move towards our specific application of role analysis through considering the environmental interest groups coalition in Section 2. In particular, we discuss the history of environmental interest groups, the nature of their political objectives, and how these objectives influence the advocacy coalitions they form. In Section 3, we present our theory of environmental interest group role behavior. We argue that given the costs associated with joining a coalition, and the effort needed to extract the gains from collective lobbying, we expect that groups will join coalitions knowing the particular value that they can add, and the role that they would best serve. In Section 4, we present a detailed and approachable introduction of the ego-ERGM, as well as our research design including the data used for our study. This section serves as a primer for those interested in using it for their own research while attempting to balance accessibility with technical detail. Section 5 presents the results of our analysis. We include a discussion of the implications of our findings, and in particular, how applicable the ego-ERGM may be to scholars interested in understanding group-based social phenomena. We offer parting thoughts in Section 6.

1. Role analysis of coalition dynamics

Perhaps one of the best ways to understand environmental advocacy is to understand the particular tasks that actors adopt when undertaking large-scale collective lobbing efforts. Central to this dynamic, is role analysis. Role analysis has been a relatively recent phenomena in network science, but has its roots in a long tradition in the social and behavioral sciences. Role analysis, which initially was used by psychology, found itself permeating into other disciplines such as sociology and political science (Parsons, 2013; Rizzo et al., 1970; Gouldner, 1957).

Only recently with the development of community detection in the study of networks and techniques such as those applied in this paper, has an inferential approach to understanding social roles become possible. An inferential approach is particularly appealing. In this section, we discuss these two literatures, paying mind to how social role has been conceptualized with time and how recent network analytic methods offer an opportunity to revitalize a literature and technique that offers great promise in answering important social and behavioral scientific questions.

1.1. Conceptualizing social roles

Within social groups, actors can be said to adopt certain roles. Generally a role is defined with respect to social position and behavioral expectations associated with that position. Sociological and psychological approaches have employed certain theories to explain the importance of roles for outcomes. While a review of all of these theories is beyond the scope of this project, we briefly discuss two that frame our discussion of roles.[2] First, "Structural Role Theory" considers role as parts played by an actor in scripts that have been written by society. Within structural role theory, society is described as a system of functional substructures where actors learn roles through repeated interactions. Individuals generally interact in groups delineated by people with shared goals and who are therefore willing to cooperate. Despite shared goals, not everyone has the same role within a group. Second, "Organizational Role Theory" is concerned with the role of formal organizations and how individuals interact with these organizations. Roles are associated with social positions and come from normative expectations generated by the organization. The theory allows for consideration of several concepts such as role conflict and role strain.

Our approach to understanding roles is built primarily upon these two theories of social roles. Social role, as a concept, has been discussed over 100 years of literature and in broad ways that vary from discipline to discipline. When discussing social roles, we employ the definition of roles outlined by Gleave et al. (2009) who builds upon Callero (1994). Roles are defined with respect to social and structural positions within a network, emerge from structural features of a community, and reflect commonalities in behavior (2). In particular, social roles are defined as cultural objects that are accepted and understood within a community and are used to accomplish community-based tasks (Gleave et al., 2009, 1).

[1] It is worth noting immediately that the ego-ERGM utilized here is distinct from the `ergm.ego` function used in `statnet`. This model is distinct as it can be seen as a latent-clustering routine performed on a multitude of egocentric networks as opposed to a single ERGM performed on an egocentric network.

[2] For those interested in a broader reading, we suggest the following: Stryker (2001), Turner (2001), Collins (1994), Heiss (1990), Biddle (1986), Thomas and Biddle (1966) and Sarbin and Allen (1954).

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1.2. Previous applications of role theory

Role analysis has been incorporated, with success, in many disciplines. While it emerged from sociology, where it remains an essential tool in understanding social behavior (Morris, 1971), it has been adopted in the study of religion (Van Der Lans, 1987; Källstad, 1987; Parsons, 1986; Flint, 1968), education (Kremer, 1983), management (McKee, 1970), organizational commitment (Hrebiniak and Alutto, 1972), and gender studies (Komarovsky, 1992). Compared to other disciplines, role analysis has rarely been used in Political Science, and thus there are numerous fundamental questions it could assist in answering.

With that being said, role analysis has been used in examining a few forms of political behavior. Alpert (1979) examines principal-agent models of political representation and finds that the "agent" may not be acting according to their role as a representative of the "principal", but rational self-interest that leads them to representative behavior. James (1968) examined how Supreme Court Justices develop a conception of their role based upon previous experience, opinions and expectations associated with the Office. Models of state-based decision making have provided the insight that expectations of social role can be used to understand foreign policy behavior (Cantir and Kaarbo, 2012; Chafetz et al., 1996; Holsti, 1970).

There is a strong tradition of role analysis in many disciplines, however, there has been little done recently to examine the importance of social roles that has utilized modern statistical developments. Recent innovations within the field of network science provide promise for a modern revival of role analysis. With the development of modern statistical techniques and the tools of network science, the move towards quantitative approaches to role analysis has become possible (Gleave et al., 2009), with applications to online social networks (Gleave et al., 2009; Welser et al., 2007; Fisher et al., 2006), energy conservation (Peterman et al., 2014, 2015), Wikipedia-editing networks (Welser et al., 2011), advice-seeking (Salter-Townshend and Murphy, 2015), and microfinance lender-borrower networks (Salter-Townshend and Murphy, 2015). We believe that analyzing social roles can shed light into the fundamental question of politics: Who gets what, when, and how? By understanding the division of labor within a collective lobbying effort, one can uncover a unique set of theoretical dynamics about how the organization of a group may influence its success. One can imagine the insight such techniques could provide in a variety of large questions that remain in political science. We examine one such question in the next section: the behavior of environmental interest group coalitions.

2. Environmental interest groups and coalition dynamics

Environmental interest groups and their coalitions have a rich history in the United States; this movement, which emerged in the 1960s, has become central to policy issues in the United States. We discuss the history of environmental interest group behavior in the United States in an effort to understand the context of their current lobbying behavior. We then move towards a discussion of modern environmental interest group coalitions and the function they serve in American politics. We pay close attention to the literature on coalitions writ large, and use it to assist in the development of a functional theory of roles. We argue that in coalitions, interest groups may adopt certain roles that are integral to the overall functioning of coalitions and their importance in achieving their politically-oriented goals.

2.1. Environmental interest group behavior networked over time

Environmental interest groups advocate a broad platform of modern environmentalism, an ideology promoting good stewardship of the Earth, respect for the integrity of its elements that sustain life, and the defense of endangered natural places and species. The environmental movement has its origins in the 1960s and initially succeeded with the passage of substantial environmental legislation. As the movement grew in influence and size, environmental interest groups continually reinvented their strategies and behavior to maintain their influence. By adapting strategies and diversifying their focus, environmental interest groups have sustained the movement's perceived importance and become a formidable force in American politics.

A dramatic increase in the number of environmental interest groups occurred in the 1960s and was accompanied by early success. In particular, Howard Zahniser of The Wilderness Society worked aggressively and directly to establish environmental protection. The Wilderness Act, which the national government passed into law in 1964, protected around five percent of land in the United States from any development. Despite only seeking to accomplish modest goals and avoiding systematic challenges to the nation's economy or industries, the environmental movement continued to gain momentum, accomplishing impressive legislative victories through the 1970s (Turner, 2012). The federal government implemented laws such as the National Wild and Scenic Rivers Act of 1968, which established a system to protect designated rivers from development, and the Endangered Species Act of 1973, which expanded federal protection to all endangered species. Throughout the 1970s, interest groups were heavily involved in writing or rewriting legislative statutes (Young, 2010). These impactful legislative victories highlighted faith in the government to protect public interest, initially a central claim of environmental reform (Turner, 2012).

Unlike the preceding decades, environmental interest groups shifted to broader agendas with more ambitious public lands reform goals in the 1980s and 1990s (Turner, 2012). Congressional gridlock challenged environmental interest groups, whose behavior is derived from the political climate (Dusso, 2008). To bypass the gridlock, interest groups adopted a diverse set of strategies that were multi-level and multi-arena. Pralle (2010) refers to this as the venue choice of local, state, national and even international levels as well as the legislative, judicial or agency arenas. Diverse strategies, coupled with growing scientific concerns, new economic analyses, and evolving environmental and political values allowed for environmental interest groups to maintain leverage over policy decisions, e.g., Turner (2012) and Gray and Lowery (2000).

With the growth of the environmental movement, environmental interest groups needed to adjust their behaviors to stay relevant. The number of environmental groups almost tripled between 1960 and 1990 (Nownes, 2013) and, according to the Washington Representatives directory, doubled from 1981 to 2006 (Grossmann, 2013). Group proliferation has slowed, which Meyer and Imig (1993) attributes to saturation. In 2012, 87 environmental groups with around 10 million members collectively competed for the large market shares needed to maintain themselves (Grossmann, 2013). Consequently, individual groups have successfully specialized to distinguish themselves not only from other groups, but from the movement as a whole.

This proliferation of individual interest groups has created a strong need for the aggregation of interests and political power into advocacy coalitions and networks. One such influential network, the Group of Ten, was organized in 1981 in response to the Reagan Administration's environmental policy: Anne Gorsuch and James Watt were nominated to management of the U.S. Environmental Protection Agency and Department of the Interior, respectively

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(Whitford, 2003). The Group of Ten was comprised of a wide variety of both old and new, resource poor and resource rich, and small and large based interest groups. The formation of the group was a rational move for interest groups, as coalitions are generally considered a low-cost method to assemble minority interest into powerful blocs and serve to share information, reduce uncertainty, and broaden the member groups' leverage (Whitford, 2003). Coalitions also allow for one basis of judicial participation among interest groups. Together, they gained distinct advantages in the environmental arena; the coalition regularly used litigation strategies to respond to government decisions or to the actions of other groups as direct litigants or amicus partners (Whitford, 2003). The U.S. Supreme Court acted as the primary battleground where environmental interest groups were able to push their agenda against the Reagan Administration.

In 1991, the Group of Ten, plagued with growing problems and providing less utility, disbanded. Anne Gorsuch and James Watt, commonly considered enemies to environmentalism, eventually stepped down and the subsequent heads of the Environmental Protection Agency and the Department of the Interior were considered less hostile to the interests of the coalition. Former president of the World Wide Fund of Nature, William K. Reilly, became the administrator of the Environmental Protection Agency in 1989 and was an instrumental figure in shaping environmental legislation, such as the Clean Air Act Amendments of 1990. Informal coalitions comprised of 15–20 major interest groups involved in environmental and population issues at local, national, and international levels united to fill the void left from the Group of Ten (Whitford, 2003).

Lobbying for environmental interests is still a major force in U.S. politics and millions of dollars are spent to advance their agendas. Global climate change has become an increasingly significant issue in Washington throughout the years. Virtually every segment of the economy has a stake in environmental policy regarding climate change and has great reason to push policies in their favor. The numerous groups lobbying on climate policy present a challenge to environmental interest groups. Environmental and alternative energy lobbyists are typically outnumbered by lobbyists on the other side of the issue (Mulkern, 2010; Delmas et al., 2016). This challenge has created incentives to aggregate interests into strong environmental advocacy coalitions.

Between 2006 and 2009 alone, firms in the manufacturing, natural resources, and utilities sectors spent over a billion dollars on lobbying for and against climate issues at the federal level (Delmas et al., 2016). While the exact amounts spent per side of the issue are unknown, there appears to be a u-shaped relationship between greenhouse gas (GHG) emissions and lobbying expenditures. In this case, green firms which do not emit many GHGs are just as likely to lobby as brown firms which emit many GHGs. During the same period, environmental interest groups spent only a fraction of this amount, approximately 71 million dollars on lobbying to protect the environment (CRP, 2016). Among the top spenders during this period include the Environmental Defense Fund, Sierra Club, and the National Resources Defense Council. To get a sense of the incentive for interest groups to form coalitions, during 2006 to 2009, ExxonMobil alone spent 70.95 million dollars on lobbying, almost as much as *all* environmental interest groups during the same period. Additionally, in the last year of this period, 2009, oil and gas companies alone spent twice as much as environmental interest groups did from 2006 to 2009, 154 million dollars (Mulkern, 2010). While millions are certainly spent on both sides, the relative disparity in lobbying expenditures between industry-firms and environmental interest groups highlights the need for environmental interest groups to behave strategically and align to increase their political power.

The history of environmental politics in the U.S. poses several interesting questions about the Group of Ten and environmental coalitions broadly. Are coalitions typically comprised of interest groups with varying sizes and resources? Do interest groups adopt roles that reflect these dynamics? Given that interest group coalitions may pursue varying strategies for changing public policy, would we expect there to be topological differences in the ego-networks of different groups? If interest groups form their coalitions to increase information and resource dissemination, do roles form to assist in these coalition-based dynamics? In the following sections we shed light on both these questions from a theoretical and empirical perspective.

2.2. Modern advocacy coalitions and network behavior

The modern study of environmental advocacy coalitions includes two competing approaches to understanding the motivation of groups to ally. The first approach argues that groups align themselves based upon common viewpoints. Coalitions are said to organize themselves around "ecophilosophy", or a set of values, attitudes, and beliefs about the environment, which impact the strategies groups adopt (Comi et al., 2015). This particular approach seems to dominant early-based environmental activism, as evidenced by the preceding discussion. The early history of the environmental advocacy movement, the 1960s and 1970s, focused heavily upon policy related issues, but groups tended to align based upon shared ecophilosophies. In particular, groups were divided and aligned based upon their views towards economic growth, development, and sustainability (Turner, 2012).

An alternative approach finds that environmental organizations align based upon shared political objectives in an attempt to share the burden for costly endeavors such as lobbying and litigation (Dreiling et al., 2008; Yanacopulos, 2005). This interest group alignment approach is consistent with many theories of broader interest group behavior; while environmental interest groups are better staffed and more likely to be involved in courts than traditional interest groups (Grossmann, 2006), there are many reasons to believe that the literature on broader interest group behavior is still relevant (Dreiling et al., 2008; Yanacopulos, 2005). Coalitions signal a desire of interest groups to aggregate their power in an efficient and economical way than the alternative of individual lobbying alone (Berry, 1977; Schlozman and Tierney, 1986; Hula, 1995; Hojnacki, 1998). Providing the initial studies of collective lobbying, Berry (1977) and Schlozman and Tierney (1986) study the decision-making of large interest groups acting as principled-agents and how, with limited resources, they coordinate with others to accomplish their organizational goals. Hula (1995) attempts to crack into the black box of interest group coalitions by demonstrating that coordination and clearly defined roles can undermine the incentives to free-ride. In an effort to further this study of interest group dynamics, Hojnacki (1998) notes that interest groups may seek to capitalize on their strengths, or focus on tasks that their coalition partners may not be able to.

The strategic functions of interest group coalitions raise interesting questions about the exact processes whereby coalitions become efficient in organizing lobbying behavior. As a result, network based approaches to understanding coalition behavior can be extremely effective (Berry, 1993). Treating coalitions as networks allows for us to understand network based dynamics that can impact a coalition's effectiveness. Clearly networks can be mechanisms for the diffusion of resources and information (Gilsing et al., 2008), both of which can be exceptionally important to lobbying behaviors. Beyond the diffusion of information and resources, networks can improve performance for the collective or individuals through growth (Powell et al., 1996), innovation (Hagedoorn, 1993), learning (Hamel, 1991), and reputation (Stuart, 1998).

While many have hypothesized and found empirical support for these mechanisms, few have hypothesized about the factors

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that lead certain actors to adopt roles that may be associated with network dynamics. Our piece aims to fill this gap while offering substantively interesting insights about the roles that actors adopt in environmental interest group coalitions. Likewise, such insights also apply to the study of interest groups broadly. While research on coalitions and lobbying has yielded many findings on the formation of coalitions (Holyoke, 2009; Hula, 1999), and the factors that influence their lobbying efforts (Box-Steffensmeier et al., 2013; Wright, 1990), such research has rarely focused on the dynamics within those coalitions. Central to the debate of coalition dynamics, however, are the social roles that are adopted in a coalition. These roles may shed additional light on the mechanisms whereby resources or information in a coalition network are diffused and consumed. Bringing the study of roles back into coalition analysis achieves two ends. First, understanding roles and their structural location can assist in understanding how resources become diffused throughout the coalition. This allows scholars to examine the presence of structural conditions that inform the efficiency with which resources and information are diffused. Second, examining the roles that are present within a coalition may shed light on previously unconsidered dynamics within a network and allow for the theorizing of coalition dynamics that make those roles important.

3. Towards a theory of environmental interest group role behavior

While there is a strong history of role analysis, there has been relatively little theorizing about the roles that actors adopt in environmental networks beyond Peterman et al. (2014, 2015), and to our knowledge, no theorizing about roles that interest groups may adopt in lobbying coalitions. In our theorizing, we build upon the group dynamics and collective action literatures, e.g., Olson (1965), Salisbury (1969), Walker (1983), Baumgartner and Leech (1998) and Prakash and Gugerty (2010). Our focus on how groups organize and strategize draws our attention to the broader context of the network any particular group is situated in. This affects the demand for and the supply of advocacy and pushes interest groups to adopt different roles within the broader context of the policy network. The cooperation and competition within the network helps define the roles as well since groups need to simultaneously be concerned about their own survival.

We also bring in network-based dynamics, such as those previously discussed (Gilsing et al., 2008; Stuart, 1998; Powell et al., 1996; Hagedoorn, 1993; Hamel, 1991). For example, if one function of a network is the dissemination of information or resources, certain actors may adopt roles that are central to such dynamics. While we outline propositions that are used to examine theories, it is worth noting that the model used in this paper, the Ego-ERGM, is without the measures of uncertainty typically used for hypothesis testing (Salter-Townshend and Murphy, 2015; Krivitsky et al., 2011). As a result, we examine whether the effects revealed by the Ego-ERGM are consistent with those we theorized.

Joining a coalition is not a costless action. A rational interest group faces a decision about the strategic incentives and costs associated with joining a large group (e.g., Hula, 1999; Olson, 1965). Hojnacki (1998) highlights three factors associated with the decision of groups to form or join coalitions: perceived strength of the opposition, previous interactions between groups in a coalition and their shared history, and lastly the importance of a group to the overall success of a coalition. In presenting our theory, the first and third components are particularly important: the perceived strength of the opposition and marginal gain of a group joining the coalition on its probability of success. Both of these require an understanding of interest-group roles and labor specialization to understand the broader coalition dynamic. When joining a coalition, social pressure creates incentives for groups to adopt costly behavior and activities that are essential to the overall functioning of the group. These behaviors and activities constitute the social roles that interest groups are expected to adopt when joining a coalition. The alternative, which is to free-ride and allow others to bear that burden on behalf of those with similar interests is what constitutes the collective action problem. With that being said, when each group feels that they can benefit the goals of the group, and the aggregation of resources and expertise is in their best interest, then they make the decision to join the coalition (Hula, 1999; Olson, 1965). Because of that, we may expect groups to join a coalition knowing the unique contributions they can adopt for the benefit of the group. In other words, groups may be cognizant of the specialized labor they can provide to a coalition. This motivates us to consider two things. First, we should consider the particular roles that may emerge within a coalition of interest groups. Second, we should consider the attributes of groups that lead them to adopt those specialized roles.

We propose five dynamics that may inform both the emergence of roles within a group and the covariates that determine groups adopting those roles: Group Budget, Group Members, Group Staffing, Degree Centrality, and Concurrent Ties. We choose these covariates from discussions in the interest group and network dynamics literature, which we discuss when presenting each covariate and its potential importance for role emergence.

First, there may be differences based on the budget or resources of the group (e.g., Peterman et al., 2014, 2015; Hula, 1999). That is, the adoption of a particular role within an interest group coalition may depend on the resources that the group possesses. Many of the goals coalitions pursue are resource-costly pursuits, whether in time or money: litigation, the drafting of legislation, lobbying, and research all require capital and staff-hours (Hula, 1999; Gerber, 1999; Nownes and Freeman, 1998). We test for whether there exists different roles within coalitions associated with high and low budgets.[3] Similarly, we test whether a model specified without the group budget variable has a significant change in the role assignment relative to a model with this variable, which is the accepted approach for interpreting this unique ego-ERGM.

Second, some of the tasks performed by an interest group coalition may require large amounts of members to lobby their congresspersons, volunteer, and use the cache of a grassroots movement to pursue their interests (Hula, 1999; Gerber, 1999; Nownes and Freeman, 1998). In other words, a large membership base can be a source of power and influence (Gerber, 1999, 59). We test for whether there exists different roles within coalitions associated with large or small memberships. Similarly, we test whether a model specified without the membership variable has a significant change in the role assignment relative to a model with this variable.

Third, some tasks may require interest groups to team up with other interest groups that have more staff dedicated to litigation or lobbying efforts (Peterman et al., 2014, 2015; Hula, 1999). In these cases, interest groups may not have the human resources necessary to lobby or litigate, and seek out coalition partners who may make up for what they lack in terms of staff members. We test for whether there exist different roles within the coalition associated with large or small numbers of staff. We test the sensitivity of the model to the inclusion of this covariate to assess the relative influence of this covariate to role assignment.

[3] While there are many measures we could include to capture how resource-rich an interest group is, such as the size of its legal department or annual expenditures, we opt to examine budget for two reasons. First, such data is more publicly accessible than many alternatives. Second, while budget may be a blunt measure, it is a proxy that captures many different dimensions of capital-intensive activities.

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Fourth, in our promise to test roles associated with network dynamics, we examine the impact of degree centrality in determining the roles that an interest groups may adopt. Many argue that for coalitions to work, there must be some centralized structure with leaders at the center (Sueur et al., 2012). These highly centralized leaders are typically considered to be important brokers for the coalition, serving in important formal or informal positions (Hula, 1999, 42). We examine this dynamic by including a variable for degree centrality, which is a measure of the influence of a node with respect to the total count of ties it has.[4] We test for whether degree centrality predicts a small amount of highly influential roles. The interest groups that adopt these influential roles may be in charge of organizing the coalition, for example. In particular, we believe degree centrality to be more important for coordination than eigenvector or betweenness centrality as the ability of one group to coordinate others, or to introduce one group to another, is more of a first-order process than second, or third-order process. Thus, we test for whether there exists different roles within coalitions associated with degree centrality. Similarly, we test whether a model specified without the degree centrality variable has a significant change in the role assignment relative to a model with this variable.

Fifth, within a coalition, we may expect certain interest groups to take the role of diffusing resources and information throughout the network (Gilsing et al., 2008). These groups may be considered information brokers, and capable of disseminating resources or information through the network (Hula, 1999, 51). To capture this dynamic, we specify the count of concurrent ties that an actor may have as essential to its capacity to disseminate information and resources to other groups. Concurrent ties are defined as the count of ties incident on each actor beyond the first. For example, if the ego, group i is connected to group j, which is connected to group k which is connected to group l such that $i \rightarrow j \rightarrow k \rightarrow l$, then a statistic of two is added to the network. Groups with higher counts of concurrent ties may be said to have more paths through which information and resources and be disseminated. We test for whether there exists different roles within coalitions associated with the count of concurrent ties. Similarly, we test whether a model specified without the concurrent ties variable has a significant change in the role assignment relative to a model with this variable.

4. Method and data

In this section we describe a novel model that is fit on novel data to gain novel insights. Using data on environmental interest group coalitions generated through amicus curiae brief coauthorship networks, we attempt to derive a set of meaningful roles using the ego-ERGM developed by Salter-Townshend and Murphy (2015). This model allows for the extraction of latent roles within a network that may be conditioned on a variety of pre-specified parameters, returning probabilities that any given node be assigned to these roles, and the coefficients associated with a particular node adopting a role. The general problem is similar to the one that intrigued Faust and Skvoretz (2002) and Box-Steffensmeier and Christenson (2014), which is comparing and contrasting network structures to gain insight into power and influence of groups. In this paper we want to determine whether ego-centered networks are similarly structured for all groups in spite of surface differences. We want to go further and ask if not, why not.

We approach the problem by ascertaining the roles of actors within a network.[5] We do so using a novel methodological approach that extracts the ego-networks for each group, for example the network for the Sierra Club or National Wildlife Federation, from the larger environmental coalition. This allows us to characterize the ego-networks and find which are similar. The groups can then be sorted by whether they play similar roles or not within the larger environmental interest group network. The Salter-Townshend and Murphy (2015) methodological framework is based on a mixture of Exponential-family Random Graph Models (ERGM) to initially cluster nodes into like roles based upon ERGM maximum pseudolikelihood (MPLE) parameter estimates. Once initialized, group parameters and assignments are estimated according to an expectation-maximization (EM) algorithm. Importantly, structural features and exogenous covariates are used in the ego-ERGM to highlight similar or different roles for specific interest groups. We begin with an introduction of the ego-ERGM, and then move on to a short review of the data conventionally used in the study of environmental lobbying, and the data we use.

4.1. Network approach to role analysis: the novel and flexible ego-ERGM

Role analysis offers an opportunity to shed light on many questions about the formation and function of environmental coalitions while incorporating the powerful tools of network analysis. Examining roles through the a networks-based lens can explain why actors select into a network, how certain organizations benefit the larger collective, and the dynamics that influence successful lobbying. Gleave et al. (2009, 2) argue that roles emerge from structural features of a community and reflect commonalities in behavior. As a result, detecting the structural position of nodes within a network, as Salter-Townshend and Murphy's (2015) ego-ERGM does, allows for statements about the roles that actors adopt.[6] Combining these concepts of social role with the technique for role detection in ego-centric networks developed by Harrigan et al. (2012), the Ego-ERGM is capable of assigning roles to a given node in the network.

The literature's primary approaches to clustering nodes in a network, such as latent space models or stochastic blocks models, focus on community detection, that is, finding nodes highly connected to each other (Salter-Townshend and Murphy, 2015). We want to do something different; we want to be able to talk about the network of particular nodes and whether they are similar in network structure and exogenous covariate values to each other. If they are, then they play a similar role in the network. Salter-Townshend and Murphy's (2015) work allows us to do just this as they develop a statistical model of clustering based on the role of the node in the network.

Within network analysis, most examinations of structural positions have focused upon the density of ties within certain clusters, e.g., Handcock et al. (2007) and Snijders and Nowicki (1997). We find this dissatisfying for our questions. In contrast, Salter-Townshend and Murphy (2015) point out that the clustering of nodes by similarity of role, or position within each distinct cluster has received very little attention, and develop the ego-ERGM to fill such deficiencies. Their approach is much more complex because both structural and explanatory parameters are used versus approaches that are based only on degree, centrality, or other

[4] For a strong discussion on centrality, see Borgatti and Everett (2006).

[5] While one can imagine that roles emerge over time, and that some actors may adopt a role in one time period and a different role in the next, such questions are beyond the scope of this study. Additionally, a temporally-informed version of the ego-ERGM remains for future research.

[6] Welser et al. (2011) have applied these conceptions of social role to studying such online communities as Wikipedia.

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basic and one-dimensional measures of the network.[7] While role assignment and analysis in Network Science has received some attention, the literature focuses overwhelmingly on visualization based methods of discerning roles, or methods strictly based upon in-degree and out-degree (Salter-Townshend and Murphy, 2015; Fisher et al., 2006; Lerner, 2005; Fisher, 2005; Everett and Borgatti, 1994). We prefer the inferential and statistical approach gained by the ego-ERGM.

Importantly, the ego-ERGM allows researchers to examine roles within a network of interest, and the dependencies and covariates that make roles more or less likely to appear. Equally insightful is the fact that the model differentiates among different patterns of connectivity. The ego-ERGM offers a tremendous opportunity to understand roles within a network.[8]

Applications for the ego-ERGM abound. As previously discussed, it could be used to study the roles that organize international politics (Wendt, 1999), foreign policy behavior (Cantir and Kaarbo, 2012; Chafetz et al., 1996; Holsti, 1970), and Supreme Court decision-making (James, 1968). In general, however, one can now empirically examine any social system where actors occupy unique structural positions or carry out particular tasks. Take for example, the roles that states may adopt in international politics. Many theories of international politics are intrinsically about the roles that states may adopt when interacting with one another. Consider balance of power theory, a hallmark of international relations describing how states attempt to preserve their security by balancing stronger states. This theory is intrinsically about the roles that states may adopt as aggressors, defenders, or balancers (Holsti, 1970). More recently, Wendt (1999) indicates that states may adopt certain identities and roles ascribed to and by them within the community of nation-states. In turn, these roles greatly influence their behavior and broader system-level dynamics, making them more prone to war or peace, or more influential in the development of international norms. These roles, however, have not been considered in a systematic and inferential way, and as such, there is a significant theory-empirical gap. Through utilizing the ego-ERGM to include the configuration of the international alliance network (or another inter-state network) and exogenous covariates including military capacity, economic productivity, state ideology, etc., analysts can gain insights on one of the more interesting and empirically unexamined concepts of a discipline. Additionally, the ego-ERGM can shed light into the particular roles that may exist in congressional networks, including collaboration networks (Fowler, 2006) and committee membership networks (Porter et al., 2005). These networks, while extensively studied, are rarely considered in terms of the particular roles congresspersons may adopt and the subsequent influence of those roles on political phenomena. Examining the roles that exist within these networks can shed light into not only how congress is organized, but how organization informs outcomes of interest such as voting behavior or polarization. These are just two questions of many that are now answerable as a result of the ego-ERGM.

Ego-networks offer an opportunity to understand the local structure of a network around each node, as a result, offering the best opportunity to understand roles. The Salter-Townshend and Murphy (2015) implementation of the ego-ERGM looks at one alter removed from the ego, and the connection between those alters, noting that it is possible to move out to a larger order of alters, as we do in this research (523). The ego-ERGM is a finite cluster model performed through fitting maximum pseudo-likelihood (MPLE) estimated ERGMs on extracted ego-networks, from these, clusters that contain similar parameters are detected. These ERGM estimates are compared using the Krivitsky et al. (2011) offset term to adjust for network size.

Each individual ego-network is drawn and analyzed according to a set of user-defined parameters. First, the user defines the number of alters out to include in a given ego-network. For our analysis, we find that three is optimal for model fit and that assignments do not change dramatically if this is increased or decreased. However, one must ultimately consider this as a substantive question as well. We believe that by increasing the number of alters out to include to 3, we may best capture the actors that individual groups may encounter on a regular basis. Second, the user defines the minimum size that an ego-network must achieve to be analyzed. This parameter specification is highly related to the first and may influence the reliability of individual ego-network estimates. While smaller sizes for this parameter may lead to more interesting roles being isolated, it may lead to estimation problems. For our analysis, we choose a minimum network size of 30. Third, the user specifies a vector of network covariates to estimate on each ego-network. Once ego-networks are drawn according to these parameters, a finite mixture model with a user-defined number of groups G is then fit on the extracted ego-networks utilizing an ERGM estimated through MPLE, with the previously specified network covariates and the Krivitsky et al. (2011) offset term to allow for comparability. Once all ERGMs are fit and groups are assigned, an expectation-maximization (EM) algorithm is used to estimate group parameters and final assignments. It is worth noting that the specification of G is not as problematic as it seems – should a large value of G be specified but a value of 3 is optimal, then the model will account for this by assigning very low (to zero) probabilities to observing those additional groups. Additionally, model BIC may be used to choose G. For the model presented here, we find that 3 produces the best fit. From this, the probability of a given ego-network Y is given by the following mixture model with G number of clusters:

$$Pr(Y_i \mid \underline{\tau_g}, \theta) = \sum_{g=1}^{G} \tau_g \exp\left[\underline{\theta_g}^T S(Y_i) - \delta(\underline{\theta_g})\right] \quad (1)$$

For this particular joint probability, the $\underline{\tau_g}$ and $\underline{\theta_g}$ are group specific model parameters. $\delta(\underline{\theta_g})$ reflects the normalizing constant conventionally used in ERGMs. The component distribution within each cluster of that model is an ERGM with cluster specific parameters. An expectation-maximization (EM) algorithm is used to find maximum likelihood estimates for those cluster parameters and group assignments and is estimated through the following log-likelihood:

$$\log[Pr(Y, Z \mid \underline{\tau}, \theta)] = \sum_{i=1}^{N}\sum_{g=1}^{G} Z_{ig}[\log \tau_g + \underline{\theta}^T S(Y_i) - \delta(\underline{\theta_g})] \quad (2)$$

For this log-likelihood, we are interested in extracting maximum likelihood estimates for group-based parameter estimates $\underline{\theta_g}$ while ensuring the role assignments for an individual i to group g, Z_{ig}, most likely to produce this network.

The model allows for tests of role assignment and overall model performance. One drawback that remains with this model is in its inability to make statements about the uncertainty of parameter estimates or true effect sizes. This is largely the result of utilizing expectation-maximization for parameter estimation on non-independent ego-networks. As Salter-Townshend and Murphy (2015) note, the prior equation is not a precise likelihood as ego-networks overlap and are, in fact, not independent (525). The result of this is that the model will cluster nodes that are close within the network to a greater extent (Brandes and Lerner, 2007; Salter-

[7] Faust and Skvoretz (2002) and Box-Steffensmeier and Christenson (2014) use dimensional approaches to compare networks, but not ego-networks within a network.

[8] The commands to execute the model in R are publicly available: http://www.tandfonline.com/doi/suppl/10.1080/10618600.2014.923777.

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Townshend and Murphy, 2015). This, however, makes great sense as structurally similar nodes may be expected to perform the same role. Nevertheless, the inability to substantively interpret effect sizes is an inconvenience. However, tests of role assignment and overall model performance allows modelers to analyze theoretical statements about the factors impacting role assignment. In addition, without knowing the roles ahead of time and assessing model fit based upon prediction, one may best consider model fit with the ego-ERGM as a function of the sensitivity of role assignments and effect sizes to the inclusion of covariates. If removing a covariate leads to dramatic changes in assignments or effect sizes, then that particular covariate may be said to be doing the "heavy-lifting" of the model.

As previously mentioned, given that the ego-ERGM iteratively fits ERGMs on the egocentric network for each node, one argument that must be specified is how many orders to include, or how many nodes out from the ego to include in a network. For the environmental policy coalition, we set this argument equal to three for three reasons. First, this seems to be the norm for egocentric sampling (Salter-Townshend and Murphy, 2015). Second, to ensure interesting inferences and sufficient data for each ERGM to fit, we determine that looking three nodes out should provide sufficient network size for each network. This is also our defense for choosing a minimum network size of 30. Third, given that the concurrent ties covariate is contingent upon higher-order effects, it would make little sense to restrict this sampling parameter further. For the sake of model parsimony, we restricted the number of roles that may emerge to three. It is worth noting that even when specifying higher numbers of roles, usually no more than three roles are ever selected according to model BIC. The only remaining aspect to specify are our covariates, which we have previously discussed.

4.2. Data on environmental interest group coalitions

A variety of data have been used to examine environmental coalitions and their lobbying behavior. Fredriksson et al. (2007), for example, have measured environmental lobbying through the count of World Conservation Union affiliated non-governmental organizations in a country. The large *N* approach here is an invaluable contribution, but one which poses a problem for some of the questions in our study. Our network analysis requires that interest groups are involved in both purposive and coordinated behavior, something that many would say are fundamentally necessary to define interest group networks at large (Box-Steffensmeier and Christenson, 2014). That is, creating networks of interest groups depends on ties that take into account not mere affiliation, but mutual and directed political action.

Others adopt an interview or case studies approach to examining the success of lobbying, e.g., Mahoney (2007), Smith (2000) and Jenkins-Smith and Sabatier (1994).[9] While these studies have also added greatly to our understanding of coalitions, both the case study and interview approaches to inference are practically limited (by time and money) in terms of the scope of interests under study. Rich descriptions and detailed case studies provide leverage in understanding particular events and coalitions at times, but are unlikely to be representative beyond them. Indeed, our study of environmental coalitions included interview data as well. However, to make more generalizable statements about interest group coalitions, we require data that is purposive and coordinated, but also extends beyond any one case, time, or policy dimension.

To this end, we use patterns of cosigning behavior collected from amicus curiae briefs to the Supreme Court to create a network of interest groups (Box-Steffensmeier and Christenson, 2014; Box-Steffensmeier et al., 2015, 2013). Amicus curiae briefs, or "friend of the court" briefs, reflect the public position of a particular entity not involved in a court case with respect to the issues being heard. Their purpose is to provide evidence, opinion, and testimony that the parties directly involved in the case may not provide. Amicus curiae participation requires a statement on the position of a group, and cosigning the same brief indicates coordinated efforts with a shared purpose (Box-Steffensmeier and Christenson, 2014, 84). Given the relative importance of the courts to environmental interest group lobbying behavior, Carney (2006) and Grossmann (2006) argue that amicus curiae briefs may be increasingly important in capturing the underlying environmental interest group coalition.

There are at least four reasons to believe that amicus curiae briefs and their coauthorship networks reveal dynamics of interest group coalitions. First, these briefs may be mechanisms that allow for the consolidation and maintenance of relationships between groups, e.g., Collins (2004) and Wasby (1995). Second, interviews with interest group leaders reveal that there has been a large amount of negotiation and coordination when coauthoring a brief (personal communication, November 2010). Third, participation in the amicus curiae process can be costly (Caldeira and Wright, 1988), particularly in environmental litigation (Carney, 2006). Fourth, regardless of cost, it is a public signal of a group's position and whom it chooses to align itself with, which is itself a costly activity given the proliferation of interest groups in the last 40 years.

We assemble the network of all 275 interest groups that signed amicus briefs between 2000 and 2009 where the cases were concerned with issues of natural resources and environmental protection for our study here.[10] Ties are determined by whether two groups have cosigned a brief on the same case at least once. Within our network of interest, we find 2185 ties and 27 groups that never coauthored a brief.[11] In sum, we arrive at a purposive and coordinated network of interest group lobbying across a number of environmental policy issue dimensions in the first decade of the millennium. This network has a density of 0.06, where each node has 31.78 ties on average. Fig. 1 provides the distribution of degree counts for each node and the geodesic distances between any two nodes. This network is presented in Fig. 2, where darker nodes have

[9] It is worth noting that while these authors use case studies or interviews as an approach to inference, others use interviews or case studies as methods of data collection, e.g., Heaney and Lorenz (2013), Heaney (2004a,b, 2006).

[10] We used the Supreme Court Database's case issue categorization value 80,130, which refers to "natural resources – environmental protection (cf. national supremacy: natural resources, national supremacy: pollution)" (Spaeth et al., 2014). Simply put, the issue variable identifies the issue for each decision. In the words of the database authors: "Although criteria for the identification of issues are hard to articulate, the focus here is on the subject matter of the controversy (e.g., sex discrimination, state tax, affirmative action) rather than its legal basis (e.g., the equal protection clause) (see the variable lawType)." Thus interest groups that signed on environmental cases before the Court are included in our data.

[11] A reviewer noted that this is naturally a value-edged network as groups can coauthor on multiple briefs during the 2000–2009 period. We make the decision to binarize this network for four reasons. First, currently the ego-ERGM for weighted networks does not exist. While the development of the Generalized Exponential Random Graph Model (GERGM) has made the ego-ERGM for value edged networks possible (Desmarais and Cranmer, 2012; Wilson et al., 2017), we leave for future research the development of the ego-ERGM for valued ties. Second, given that most networks are binary, we find it pedagogically useful to present the ego-ERGM applied to a binarized version of the amicus network. The hope is that this may allow readers to have a clearer understanding of the types of roles they may consider for their own networks. Third, the distribution of tie weights is unimodal and does not lead us to believe that much interesting variation exists across coauthorship relationships. The median weight for a tie is 1 and the mean value is 1.113. Fourth, while there may be reason to think the relationship between groups that coauthor frequently may differ from those which coauthor only once, we do not expect role assignment to change upon accounting for weighted ties. This is due to the relative stability of the network's topological structure prior to and after the network is binarized.

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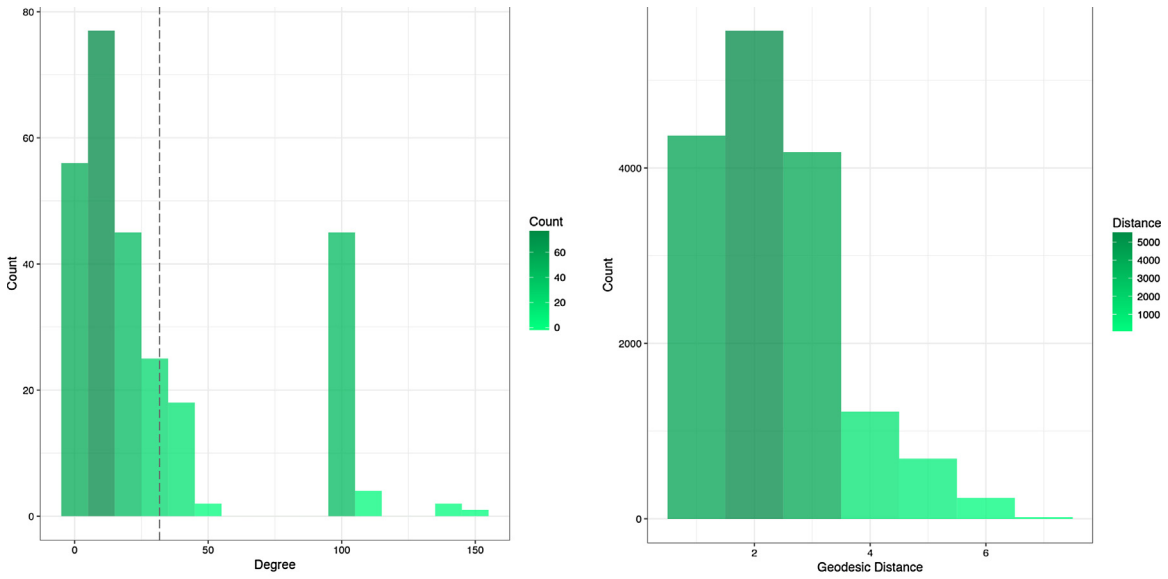

(a) Degree Distribution (b) Geodesic Distances Distribution

Fig. 1. Descriptive network measures.

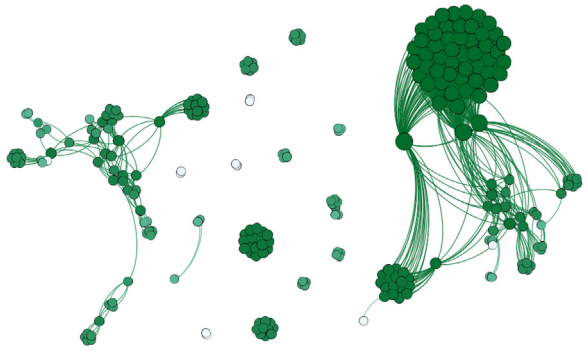

Fig. 2. Full network of environmental amicus brief coauthorships.

large degree counts relative to lighter nodes.[12] In addition, we collect data on attributes for each of these groups which then goes on to be utilized in this model.[13]

5. Results

Table 1 presents the results from our Model. We begin by interpreting the constant term, which may make more sense with respect to the network presented in Fig. 4. After estimating the model according to our previously described parameters, we are left with 157 ego-networks that are compared.[14] Our discussion of roles is largely informed by Anklam (2011) who describes role typologies according to topological positions. Given the topographic nature of the plot, we label the roles as follows. "Teammates" (the grey circles) are largely constituted by Industry-based interest groups. Given that these groups appear to have uniform roles throughout their coalition and are typically defending the economy through equal and uniform lobbying efforts, we refer to these nodes as "Teammates" (Box-Steffensmeier and Christenson, 2014; Box-Steffensmeier et al., 2015). Teammates constitute 33.1% of the roles in this network and are interesting in that the role is constituted entirely by nodes in a separate coalition.[15] While the other coalition is constituted by environmental advocacy groups like the World Wildlife Fund, Greenpeace, and the Natural Resources Defense Council, the coalition constituted by Teammates largely includes groups like the Cato Institute and varying state mining and coal associations. The individual egocentric network for a Teammate, the Pacific Legal Foundation, is presented in Fig. 3(a).

The blue circles in Fig. 4 are the second role, which we refer to as Coordinators.[16] Coordinators constitute only 8.3% of the roles in this network and generally appear to be highly centralized in their coalition, hence their name. Coordinators are generally larger pro-environment interest groups, like the National Resources Defense

[12] This network could easily be built as a bipartite network observed longitudinally. However, we choose to examine the one mode projection of the network within a single time-slice for three reasons. First, we are interested in the direct coordination that occurs between groups on political issues broadly, and not on particular court cases. We believe that this is a fair categorization of the process of brief coauthorship, which reflects, at a minimum, regular contact (Carpenter et al., 1998; Box-Steffensmeier and Christenson, 2014). Second, while interesting questions can be asked about the roles that exist within the group-brief bipartite network, from a theoretical perspective we are more interested in the roles that may exist within the network of groups. Third, we believe there are pedagogical benefits to analyzing the one-mode network as it provides a more parsimonious understanding of the roles that may become defined within a larger social group.

[13] To assist in estimation, these data were recoded into discrete categories based upon their distance from the mean value. For missing values zero-imputation was used given that in cases where data was often unavailable, groups were small enough not to report such figures.

[14] This number is reached by subsetting the total 275 ego-networks only to those with a minimum network of 30. This parameter value is chosen for two reasons. First, given the time-period we are pooling over and the degree distribution presented in Fig. 1(a), we determine that requiring a minimum network size of 30 truly captures the groups that are the most active within the coalition, as opposed to coauthoring with only one or two other groups once or twice. These smaller, more isolated groups might not be expected to adopt roles as they may not truly be a part of the coalition. Second, attempting to estimate an ERGM on small networks can create degeneracy problems, especially when using a model specification designed for much larger networks. To get a sense of the ego-networks dropped through this procedure, one must only compare the networks presented in Fig. 2 to those in Fig. 4.

[15] This closely resembles the expectations of Berry (1993), who argues that there may clearly defined and partitioned interest group coalitions based upon ideology and policy-based objectives.

[16] For those familiar with Peterman et al. (2014, 2015), these are similar to "Commissioners."

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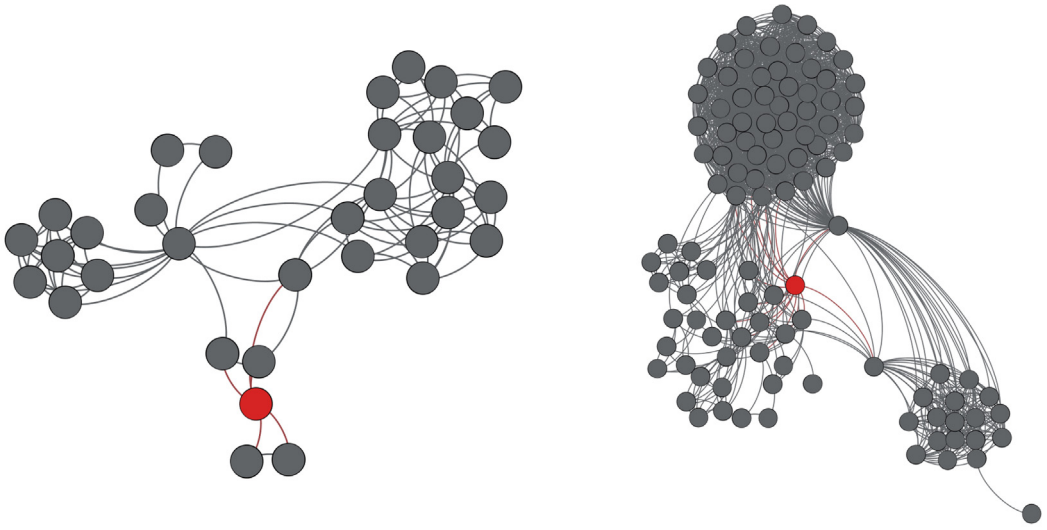
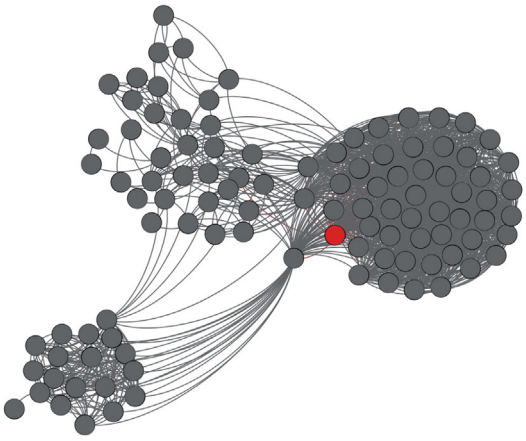
Table 1
Ego-ERGM model results. Model specification reflects that previously discussed and only includes the terms listed. Other parameters include a minimum egocentric network size of 30, a group parameter of 3, and an alter sampling parameter of 3.

	Teammates (Black)	Coordinators (Blue)	Peripheral Specialists (Green)
Constant	0.331	0.083	0.587
Edges	29.047	26.196	27.855
Concurrent ties	−13.868	−13.538	−13.465
Members	0.072	−0.048	0.022
Budget	−0.084	0.173	0.138
Staff	0.054	−0.123	−0.062
Degree centrality	0.023	0.033	0.019
Model BIC: −745752.5			



(a) Egocentric Network for the Pacific Legal Foundation (Teammates)

(b) Egocentric Network for the Sierra Club (Coordinator)



(c) Egocentric Network for the Waterkeeper Alliance (Peripheral Specialist)

Fig. 3. Prominent egocentric networks according to role assignment.

Council, Sierra Club, and the National Wildlife Federation. The egocentric network for the Sierra Club is presented in Fig. 3(b).

The third role, as represented by the green circles in Fig. 4, we refer to as Peripheral Specialists. These roles appear to be more in the periphery of the network and include groups like the Southern Environmental Law Center, the Center for Biological Diversity, and the Catskill Mountains Chapter of Trout Unlimited which are highly technical and specialized to particular environ-

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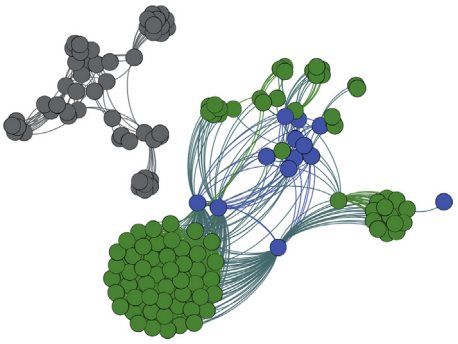

Fig. 4. Role assignment in interest group coalitions. (For interpretation of the references to color in the text citation of this figure, the reader is referred to the web version of this article.)

Table 2
Variable means per role.

	Budget	Staff	Members	Degree centrality
Teammates	1.63	1.44	1.87	8.5
Coordinators	2.62	2.08	2.85	26.08
Peripheral Specialists	0.30	0.33	0.60	32.62

mental issues.[17] These groups are what we may consider small, specialized, and niche groups, such as the Waterkeeper Alliance presented in Fig. 3(c). To examine the particular role-assignments for interest groups, see Tables 4–6 in Appendix A.

It is worth noting that the model as specified (and specified in alternative ways) does not pick up distinct roles in the coalition-bloc constituted by Teammates. We believe that there are two possible explanations for this. The first is that the included covariates may be responsible as there are some differences in the mean value of the covariates per role. As a result, Teammates are simply substantively different on the observed covariates included in the model, as presented in Table 2. However, whenever we iteratively remove covariates later in this section, there is little to no change in which groups are assigned to the Teammates role. An alternative explanation is that given the two blocks that exist, the Model may be selecting one bloc as completely distinct and homogenous. To test this, we increased the number of roles the model is allowed to fit, and there was no change. This demonstrates that the bloc constituted by Teammates is fairly homogenous across covariates and topology. This makes sense given what we know about environmental interest group networks, in which two lobbying-based blocs may emerge, with reflecting business interests and the other reflecting pro-environmental views and "citizen groups" (Berry, 1993, 35–36).

We begin by discussing the Concurrent Ties term, which does not seem to create any clear distinction between role assignment. The number of Concurrent Ties appears to be inversely associated with the adoption of any role, however, there is little difference substantively in the value of concurrent ties for an ego-network for any of the estimated roles. This is demonstrated in Table 1. However, it is worth noting that these coefficients cannot be interpreted precisely as they are not true likelihood estimates. As such, we typically encourage comparing them in a naive sense and by looking at the sensitivity of the model to the inclusion of covariates. Removing the Concurrent Ties term does very little in changing role assignment, which suggests that this term does not explain a great deal of the behavior of roles within environmental interest group coalitions. Table 3 shows that the baseline probability of any given node falling into one of our three roles does not change by removing the concurrent ties term.

Table 3
Change in baseline probability of role assignment (constant) by variable exclusion.

	Teammates	Coordinators	Peripheral Specialists
Baseline	0.33	0.08	0.59
No concurrent ties	0.33	0.08	0.59
No members	0.33	0.00	0.67
No budget	0.32	0.05	0.63
No staff	0.33	0.00	0.67
No degree	0.33	0.32	0.34

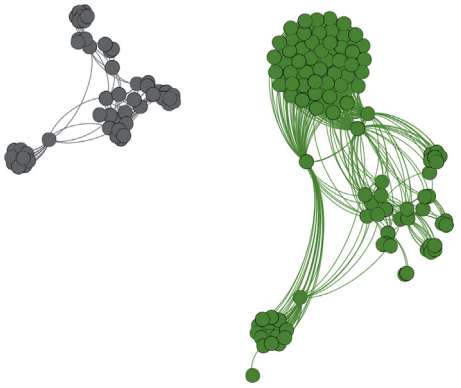

Fig. 5. Role assignment sensitivity to member covariate inclusion.

The members term, however, appears to be very informative. The distinction between Coordinators and Peripheral Specialists on this covariate is sizable, as presented in Table 1. The ego-network for coordinators typically includes nodes with lower members, which would demonstrate that "coordinators" with large member counts may be able to make up for those in their network with lower member counts. This story is confirmed by Table 2 which shows the relative difference in the mean of the members covariate for Coordinators versus Peripheral Specialists. In addition, the exclusion of this term leads the model to no longer detect Coordinators altogether. This presents strong evidence that groups like the Sierra Club or Greenpeace, which have large member counts, may be able to mobilize their members on behalf of smaller, focused, or regional interest groups when certain environmental issues are at stake. This is demonstrated by Fig. 5 where role assignment changes and the clear core-periphery structure becomes less prominent.

The budget covariate does not seem to make a difference in distinguishing between Coordinators and Peripheral Specialists, but may make a difference in distinguishing these groups from Teammates. In Table 1, both Coordinators and Peripheral Specialists appear to have positive group centroids while counter intuitively, Teammates have a negative coefficient. However, when examining the change in role assignment for a model excluding this term, the assignment difference becomes clearer. Fig. 6 and Table 3 demonstrate that Coordinators all but disappear when excluding the budget term, which demonstrates that there may be some sorting that happens according to this covariate. When looking at the mean value of this variable for each role, as is done in Table 2, one can see the average budget for Coordinators is almost 8 times larger than that for Peripheral Specialists. As to be expected, Teammates also have larger budgets than Peripheral Specialists, which makes sense given their affiliation with business interests.

The staff covariate also appears to matter a great deal when comparing Teammates with Coordinators and Peripheral Specialists, as revealed in Table 1. Interestingly, however, when examining the role assignments for a model excluding the staff covariate, the Coor-

[17] These most closely resemble what Peterman et al. (2014, 2015) refer to as "Interpreters."

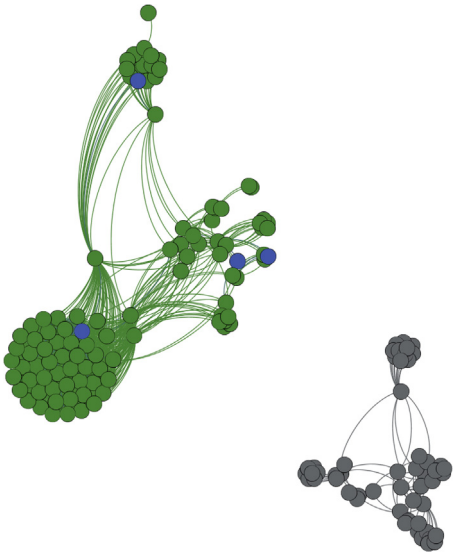

Fig. 6. Role assignment sensitivity to budget covariate inclusion.

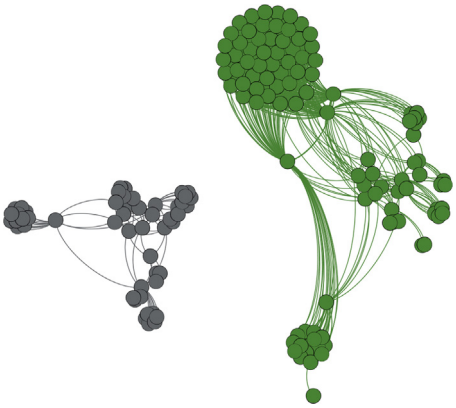

Fig. 7. Role assignment sensitivity to staff covariate inclusion.

dinators term disappears. This is shown in Fig. 7. This demonstrates that the staff term may matter in ways that group centroids cannot detect. Whenever comparing the mean value of each variable, however, Coordinators appear to have 1.4 times the staff of Peripheral Specialists on average. This makes sense given our theoretical expectations.

Finally, we examine the degree centrality covariate, which is extremely influential in explaining role assignment in the case of Coordinators and Peripheral Specialists. While degree centrality does not appear to distinguish groups according to centroids, the removal of the term significantly changes the overall composition of the network, as revealed in Fig. 8. In particular, the removal of the degree centrality term leads to a proliferation of Coordinators to such a degree that the title itself becomes watered down. In fact, after removing this network effect, the likelihood of being assigned to the Coordinators role increases from 0.08 to 0.32. This is strong and supportive evidence for the expected effects of our theory.

6. Conclusion

Analyzing the diverse roles of interest groups in networks can shed light on the fundamental question of politics: who gets what, when, and how? Our examination of how environmental interest groups organize their networks and what roles particular groups play in the context of the larger coalition provides a new first step in analyzing coalitional behavior and suggests a number of

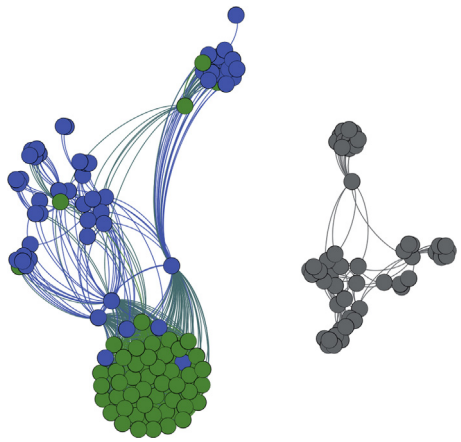

Fig. 8. Role assignment sensitivity to degree centrality covariate inclusion.

novel insights. Foremost, we have found that different interest group characteristics leads to different roles in the network. One can imagine the insight such techniques could provide in a variety of organizational questions that remain in the social sciences. The methodological advances provided by the ego-centric network approach put a number of classic questions into reach, including the aforementioned examples: the roles structuring international politics (Holsti, 1970; Wendt, 1999), foreign policy behavior (Chafetz et al., 1996; Cantir and Kaarbo, 2012), Supreme Court decision-making (James, 1968), and Congress (Porter et al., 2005; Fowler, 2006).

The preceding results demonstrate the ego-ERGM's promise in evaluating the network structure of environmental advocacy coalitions, and in particular, extracting meaningful information about the structural and social roles that interest groups adopt in collective lobbying efforts. In particular, it appears that the budget of a group, its staff, member count, and its degree centrality are all essential features of an actor in determining the role it serves within the coalition. This is consistent with the observable implications of our theory, and as such, we conclude that interest groups join these coalitions with particular roles in mind, and that these roles are essential to the coalition's success. One interesting question that these results cannot answer is whether the presence of these clearly defined roles ensures success in collective lobbying efforts. In other words, is a coalition with the structure presented here more successful than one with a more diffuse, less clearly defined structure?

An important caveat to the implications of this paper has to do with its generalizability. We have focused on the environmental policy area, which while a substantively important domain, may or may not share role structure with other domains, including health care or education. Indeed, one might expect the coordinator-specialist and opposition structures to travel from the environmental domain to the education or health care domains, however, there may be important but subtle nuances in the particular dynamics that could be uncovered. From these particular domains, one might also drive into particular subsets. For example, from this broad study of the coalition of environmental advocacy, future research may dig into particular issues, including water quality management or pollution regulations. *A priori* we expect the structure within these distinct advocacy networks to mirror that previously uncovered, but this is largely an empirical question that we leave for further study.

The study of roles within group-based dynamics has faced inferential obstacles for decades. Many of these have stemmed from data availability issues, as roles are often qualitative attributes of states that are fairly difficult to observe. The ego-ERGM allows scholars

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interested in these questions an inferential tool that allows for the extraction of meaningful, if unobserved, roles when a broader network structure and nodal attributes are known. Our hope is that by introducing this method, scholars may be more likely to ask and answer questions regarding the roles that emerge in group-based dynamics. In particular, this method shows great promise for the study of any social group-based phenomena where we would expect heterogeneity in the particular ways that actors experience the network, its structure, and its implications.

Future research interested in the strategy and advocacy of interest groups as it furthers specific policy goals should similarly be interested in this work. As Prakash and Gugerty (2010) point out, "advocacy is integral to politics." It is part of American democracy, and the structure of interest groups' networks and the particular roles of groups may provide insights into why coalitions win and lose. Comparing ego-networks for similarities and differences moves us closer to answering the question about why networks may be structured differently, what the structure means for the roles adopted within the coalition, and, ultimately, what the policy implications are for the coalition.

Appendix A. Role assignments

Tables 4–6

Table 4
List of Teammates.

Interest groups ($n = 52$)
Alabama Coal Association
American Chemistry Council
American Farm Bureau Federation
American Forest and Paper Association
American Gas Association
American Petroleum Institute
American Public Power Association
American Resort Development Association
American Seed Trade Association
American Soybean Association
Arizona Mining Association
Associated General Contractors of America Inc
Biotechnology Industry Organization
California Cattlemens Association
California Farm Bureau Federation
California Forestry Association
Cato Institute
Coal Operators and Associates
Colorado Mining Association
Corporate Environmental Enforcement Council
CropLife America
Edison Electric Institute
Environmental Technology Council
Florida Farm Bureau Federation
Florida Fruit and Vegetable Association
Foundation for Environmental and Economic Progress
Illinois Coal Association
Indiana Coal Council
International Council of Shopping Centers
Kentucky Coal Association
NAIOP - Commercial Real Estate Developers Association
National Alfalfa and Forage Alliance
National Association of Home Builders
National Association of Real Estate Investment Trusts
National Association of Realtors
National Association of Wheat Growers
National Cotton Council
National Environmental Development Association
National Hydropower Association
National Mining Association
National Multi Housing Council
National Potato Council
New Mexico Mining Association
Pacific Legal Foundation
Pennsylvania Coal Alliance
Real Estate Roundtable
Superfund Settlements Project
Utah Mining Association
Utility Solid Waste Activities Group
Utility Water Act Group
West Virginia Coal Association
Western Coalition of Arid States

Table 5
List of Coordinators.

Interest groups ($n = 13$)
American Rivers
Defenders of Wildlife
Environmental Defense
Federation of Fly Fishers
Florida Wildlife Federation
National Audubon Society
National Parks Conservation Association
National Wildlife Federation
Natural Resources Defense Council
Oregon Wild
Sierra Club
Tongue River Water Users Association
Trout Unlimited Inc

Table 6
List of Peripheral Specialists.

Interest groups ($n = 92$)
Alabama Rivers Alliance
Alaska Community Action on Toxics
American Sportfishing Association
American Whitewater
Amigos Bravos
Anglers of the Au Sable
Appalachian Mountain Club
Arizona Wildlife Federation
Atlantic Salmon Federation
Audubon Society of the Everglades
California River Watch
California Sportfishing Protection Alliance
California Trout
California Wilderness Coalition
Carolina Canoe Club
Catawba Riverkeeper Foundation
Catskill Mountains Chapter of Trout Unlimited Inc
Catskill-Delaware Natural Water Alliance Inc
Center for Biological Diversity
Center for Environmental Law and Policy
Community Association for Restoration of the Environment
Concerned Citizens for Clean Water
Connecticut River Watershed Council Inc
Conservation Law Foundation
Dakota Resource Council
Deerfield River Watershed Association
Environment Maine
Environmental Confederation of Southwest Florida
Federated Sportsmens Clubs of Ulster County Inc
Foothill Conservancy
Friends of Butte Creek
Friends of Eel River
Friends of Hurricane Creek
Friends of Merrymeeting Bay
Friends of the Columbia Gorge
Friends of the Crooked River

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Table 6 (*Continued*)

Interest groups ($n = 92$)
Friends of the River
Georgia Canoeing Association
Headwaters Inc
Humane society of the United States
Idaho Conservation League
Idaho Rivers United
Idaho Rural Council
Iowa Farmers Union
Izaak Walton League
Lake Wateree Home Owners Association
Maine Rivers
Minnesota Center for Environmental Advocacy
Montana River Action
Mountain Meadows Conservancy
Natural Resources Council of Maine
New Hampshire Rivers Council
New Mexico Acequia Association
New York Rivers United
Northern Alaska Environmental Center
Northern Plains Resource Council Inc
Northwest Environmental Defense Center
Northwest Resource Information Center Inc
Ohio Greenways
Oregon Natural Desert Association
Oregon Rural Action
Oregon Trout
Pamlico Tar Riverkeeper
Patapsco Riverkeeper
Powder River Basin Resource Council
Public Citizen Foundation
River Alliance
Riverkeeper
Rivers Alliance of Connecticut
Rivers Unlimited
Saluda Reedy Watershed Consortium
Satilla Riverkeeper Inc
Snake Valley Citizens Alliance
South Carolina Progressive Network
South Yuba River Citizens League
Southern Environmental Law Center
Tennessee Clean Water Network
Theodore Gordon Flyfishers
Upper Chattahoochee Riverkeeper
Upstate Forever
Walker Lake Working Group
Washington Kayak Club
Water Stewards Network
Waterkeeper Alliance
West Rhode Riverkeeper
West Virginia Rivers Coalition
Western Colorado Congress
Western Lands Project
Western Organization of Resource Councils
Wild Fish Conservancy
World Wide Fund for Nature
Wyoming Outdoor Council

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