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Urban environmental stewardship networks: How organizations collaborate, share resources, and exchange knowledge within Baltimore, Maryland

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ABSTRACT

Who are the groups stewarding the environment within local communities, where do they work, and who do they work with? The Stewardship Mapping and Assessment Project (STEW-MAP) survey has cataloged and mapped environmental stewardship groups in dozens of cities within the US and worldwide. The survey collects relational, network ties among respondents and their collaborators. In this study, we focus on the 2019 Baltimore, Maryland survey to better understand the relationships among environmental stewardship organizations across the city. We utilize exponential random graph models (ERGMs) to explore the factors that predict the formation of three distinct types of ties: collaboration, resource sharing, and knowledge sharing. The networks include 1,201 nodes with 2,884 total ties among them. Our results show that the network structure of each tie type is unique, but there is a shared tendency for degree distributions to be positively skewed, indicating the presence of many lower degree nodes. We also find that the main focus of these organizations and the organization type create substantial variation in their behavior; with some groups siloed, and others underutilized, one set of groups has managed to permeate all three networks: stormwater-focused groups. This study is the first to analyze this specific dataset and one of the few to use network models to analyze data collected through the STEW-MAP project. This work helps us understand the social forces shaping Baltimore's stewardship network, while pointing to ways in which practitioners could potentially expand their reach. Overall, this work helps broaden our understanding of local environmental cooperation within a modern urban context.

1. Introduction

Environmental stewardship organizations – defined as groups who conserve, manage, restore, monitor, advocate for, and/or educate about the local environment, can be a catalyst for community or individual transformation and resilience (Svendsen and Campbell, 2008; Campbell et al., 2024). On an individual level, engagement in environmental stewardship can lead to increased civic participation (Fisher et al., 2015), sense of place (Kudryavtsev et al., 2012), and likelihood to visit wild urban nature (Sonti et al., 2020). At the community or regional level, environmental stewardship is increasingly relied upon to accomplish urban sustainability goals (Campbell et al., 2022) while improving social cohesion (McMillen et al., 2016). Stewardship in the age of urbanization connects people to their environment, can reduce degradation, and increase urban ecosystem services (Andersson et al., 2014; Andersson, 2021). Stewardship group "turfs", or their geographic footprints, may vary spatially across urban neighborhoods (Johnson et al., 2019) and can be associated with distribution of urban vegetation (Locke et al., 2014; Romolini et al., 2013). Furthermore, there is a recognition of the importance of networked, collaborative environmental governance to urban environmental sustainability (Connolly et al., 2013), which is multi-scalar and requires coordination across actors with complementary or competing goals (Bodin, 2017). STEW-MAP, or the Stewardship Mapping and Assessment Project, seeks to understand urban environmental governance networks in order to fill critical gaps in our knowledge about community-based natural resource management (Svendsen et al., 2016; Campbell et al., 2024). Social Network Analysis (SNA) provides a unique perspective into stewardship governance by showing how actors connect, and direct the flow of information (Muñoz-Erickson and Cutts, 2016). In particular, there is a need to better understand the types of interactions between organizations that contribute to cooperative environmental governance, and how these networks vary across the urban landscape, by sector, and by organizational focus.

Baltimore, Maryland, USA is one of the largest urban centers in the Chesapeake Bay watershed. The city has a long history of urban

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forestry and urban greening, which includes the establishment of the City's Forestry Division and the development of the Olmsted Plan for the city's parks and green spaces at the turn of the twentieth century (Friends of Maryland's Olmsted Parks, 2004; Buckley, 2011). Since 1950, post-industrial depopulation and economic decline has led to a large number of vacant properties in Baltimore's urban center (Boone et al., 2009; Locke et al., 2023). However, Baltimore's greening efforts have intensified in recent decades with the TreeBaltimore mayoral initiative to increase the city's urban tree canopy cover, and the city's Office of Sustainability, both established in 2007 (Locke et al., 2013). Tree giveaway programs are also used to increase tree canopy on residential properties via public–private partnerships (Nguyen et al., 2017; Locke and Grove, 2016). Located in the middle of the Chesapeake Bay watershed, the city's environmental agencies and organizations also have a strong focus on water quality improvement in order to meet watershed restoration goals outlined in the Chesapeake Bay Watershed Agreement and administered by the Environmental Protection Agency. In addition, Baltimore has several environmental partnership networks driven by federal government and academic institutions, including the Baltimore Ecosystem Study (baltimoreecosystemstudy.org), Urban Waters Federal Partnership (baltimoreurbanwaters.org), Greater Baltimore Wilderness Coalition (baltimorewilderness.org), and the Baltimore Social-Environmental Collaborative (bsec.21cc.jhu.edu). The combination of top-down recognition and embrace of sustainability issues, and the myriad of organizations managing their local environments, makes Baltimore an ideal location for studying environmental stewardship groups, their geographies, and their networks.

2. Background

Despite its name, social network analysis has been used in a variety of fields from the social sciences to computer science, biology, and even chemistry. In this work we have applied it to a social ecological setting. While the focus of this research is broad, in the sense that it is describing the system of Baltimore's environmental stewardship as a whole, it also deepens our knowledge of such networks by analyzing the individual, yet interacting mechanisms that form such a system, something that Romolini et al. (2016) directly call for in their study of urban environmental governance.

2.1. Network structure

In order to distinguish between the types of variables we are interested in, we at times discuss mechanisms that can be measured at the node level, meaning the individual organization in our context, the edge level, meaning the relationship between organizations, and the structural level, meaning the network as a whole; for more information on network terminology, see Wasserman and Faust (1994).

While the overarching structure of a network is not often the focus of on the ground practitioners, it can have consequences for how easy it is for individual organizations to access resources in the network. Networks may vary in how resources are divided across individual organizations and how much resource sharing is reciprocated. Networks that are densely connected allow organizations in them to reach other organizations more readily, but they may also mean that limited resources get divided across more partners. This will of course vary by the type of resource being shared, just as reciprocation of some resources, such as financial assistance, may be less likely than others, such as institutional knowledge. For this reason, this study breaks apart the different types of ties measured within our data.

While this work focuses on Baltimore's most recent STEW-MAP data collection effort (from 2019), there is prior literature that studied the 2011 Baltimore STEW-MAP data. Romolini et al. (2016) conducted a comparative study of Baltimore's 2011 and Seattle's 2012 stewardship networks, and while this work did not formally model the networks, it does provide a starting place for variable selection. At the structural level, Romolini et al. (2016) found that degree centralization varied substantially between the two cities, with Baltimore being over five times as centralized as Seattle; this means that Seattle's organizations are more evenly connected to one another than Baltimore's. This indicates the need to account for degree distribution in our modeling approach, as more recent studies have done.

While most of the early environmental stewardship network papers relied on descriptive statistics and cross-site comparisons, research in the past half-decade has begun to embrace inference from statistical modeling, and has produced analyses that predict the connections between stewardship organizations, helping us to understand these systems as a whole. Ovalle et al. (2024) used exponential random graph models (ERGMs) to analyze the funding network of environmental non-profits across the state of Texas. Their "popularity" term was negative, indicating that many organizations were predicted to have a low number of funding partners. While this work focused on a more narrowly defined tie between organizations as well as a more narrowly defined set of organizations, this term's significance is consistent with research that analyzed a broader set of ties and groups (Jasny et al., 2019).

Jasny et al. (2019) is the clearest analogue to the work presented here. Also using ERGMs, they compared STEW–MAP networks surveyed in Philadelphia and New York City in order to understand similarities and differences among their stewardship systems. One similarity across the two cities was their tendency for a positive degree distribution term, opposite of what Ovalle et al. (2024) found, as this term was significantly negative in their analysis. What this means is that in the Texas' funding network, it is predicted for many organizations have no or few funding connections, while a handful of groups have more. In New York's and Philadelphia's collaboration networks, because this term is positive, it suppresses lower degree nodes, indicating that it is unlikely for organizations to have no or few collaborators. This finding reiterates the importance of this term in predicting stewardship ties, but also points to differences that may be arising due to differences in tie type. Additionally, given that they focused on the collaboration network, as opposed to resource or knowledge flows, they looked at the influence of reciprocity on tie formation, and they found large effects in both cities, with a larger effect for Philadelphia than New York.

2.2. Organizational type

Moving down to the node level, environmental stewardship networks involve coordinated efforts between government groups, private businesses, non-profits and many local community groups. It is important to understand how these various sectors of organizations are interacting with one another as resource control is often unevenly concentrated in each sector – community groups do not have the same financial resources that government and private organizations do, and non-profit organizations often house large amounts of institutional knowledge that some private businesses and community groups lack. Sharing of these resources among the various sectors is necessary for successful environmental stewardship.

Despite this need, it is unlikely for all organizations to be connected to one another at a city scale, which is why brokerage organizations often play a key role in connecting the network. Connolly et al. (2013) combined data from the first STEW–MAP survey, conducted in 2007 in New York City, with semi-structured interviews in order to understand more about brokerage within the city. They found that these organizations often helped to broker partnerships between different sectors, frequently connecting smaller non-profits and community groups with governmental organizations or grant making foundations. From a modeling standpoint, we might find that this leads to heterophilous ties by organizational type — meaning that there is a tendency for different types of organizations to connect to one another as opposed to the same type of group, which can be measured at the edge level.

This effect might also be more prominent for resources like funding and knowledge than for collaborative partnerships and it may differ by the specific organizational sector. To this point several other studies have analyzed networks of environmental stewardship, collected outside of the STEW–MAP survey. Svendsen and Campbell (2008) used data from various cities across the Northeastern U.S. and found a difference in the private sector with few edges between private businesses and other types of groups. Additionally, Belaire et al. (2011) conducted a network analysis of environmental stewardship groups, who attended a summit on the Calumet region, an area in northeastern Illinois and northwestern Indiana in the United States, known for its biodiverse wetlands. They looked at various measures of density by organizational type and used contingency table analysis (Pearson, 1904) to determine whether these organizations were significantly organized by this feature. They found significantly strong connectedness for federal groups and primary school groups, meaning these groups were more connected to the network, but significantly weak connectedness for advocacy groups and commercial businesses. These findings suggest the potential of homophily and heterophily by organizational type, meaning the increased (homophily) or decreased (heterophily) likelihood of organizations within the same organizational type to tie together. This emphasizes the need for future analyses to distinguish organizations by their respective occupational sector, both at the individual organization level and at the edge level.

2.3. Organizational focus

Along with organizations varying by occupational sector, they are also further divided by their organizational focus. Environmental stewardship encompasses many different causes, from pollution and stormwater management to education and community improvement, and this may factor into which partnerships are realized and which are not. Connolly et al. (2014) expands upon prior research, moving to understand the system of stewardship within New York City as a whole. While this work relies on a descriptive analysis, they find that the network appears to be organized around ecological function, including clusters of "land" and "water" focused groups, legal advocacy groups, and neighborhood focused groups. When comparing stewardship in New York City and Philadelphia, Jasny et al. (2019) found that one effect for organizational focus (which ranged from general environmentally focused groups to those focused on education, community improvement, religion, etc.) that was shared by both cities was the decreased likelihood for general environmentally-focused groups to receive ties. This may indicate a tendency to diversify partner organizations by specialization, which could arise as a heterophily effect for organizational focus.

Comparing two different cities, Romolini et al. (2016) found that Baltimore had a larger presence of non-profits, when compared to Seattle, and that the focus of these organizations was more heavily centered around community and other social causes, whereas Seattle's organizations more often focused on general environmentalism and science-based work. This may mean that organizations could vary on their connectedness to the network based on their node level environmental focus, which is likely a city specific phenomenon. While we are not comparing multiple cities, we might suspect these same factors to vary by the type of network tie being studied.

2.4. Additional variables

While organization type and focus likely have a large impact on which organizations tie to each other, there are several other variables of interest that prior literature suggests help to shape local stewardship networks. More specifically, age, distance, and location based factors could impact which organizations choose to work together. While some studies have not found support for the influence of geography or age of an organization (Ovalle et al., 2024), it is reasonable to suspect that partnerships might be localized and become more likely with proximity, while older organizations may be more embedded due to their longer histories within their communities. Belaire et al. (2011) also checked for significant correlation between geographic distance and network connectedness and they found evidence to suggest that geographic distance may decrease the likelihood of having a network connection. Jasny et al. (2019) also found significant associations of characteristics investigated in the prior literature. They found that the likelihood of collaboration is inversely related to geographic distance in both cities. They also found differing effects for location-based measures, such as population density and median income. These variables are important to include in this analysis as their effects may be more prominent for certain types of resource exchange.

This work adds to prior findings and expands upon them, by being the first to statistically model the STEW–MAP network in Baltimore, MD, USA. We incorporate previously tested measures into our analysis, while including both sending effects and governmental organizations, which were not tested in Jasny et al. (2019). Finally, we are also the first to analyze all three types of ties collected through a STEW–MAP survey, collaboration, knowledge sharing, and resource sharing. This work broadens our understanding of environmental stewardship, while providing specific insights into the case of Baltimore's stewardship system.

3. Data and methods

The data for used in this analysis was initially collected as a part of the USDA Forest Service's STEW–MAP project, or Stewardship Mapping and Assessment Project (https://www.fs.usda.gov/research/projects/stew-map). This survey has been conducted in over a dozen cities across the world since it initially launched in 2007.

For this study we utilized the 2019 Baltimore STEW–MAP survey data (Sonti et al., 2023). In order to reach as many of Baltimore's environmental stewardship organizations as possible, an initial list of organizations was gathered, which were then sent the first round of the survey. The network responses were then used to survey the next round of organizations, those that were newly named as alters. In total, three rounds of surveys were conducted with up to three to five attempts at contacting each organization. The STEW–MAP survey collects three main categories of data: geographic location, organizational characteristics, and network ties.[1] We analyzed the network ties, while using the organizational characteristics as variables for our analyses. The full network is shown in Fig. 1, with the nodes scaled by each organization's in-degree (the number of ties they received) and colored by the organization sector (public, private, non-profit, and other[2]).

As shown in Table 1, the networks are noticeably sparse (with an overall density of 0.19% with all ties combined). While this is common for large real-world social networks which is highlighted by that fact that our isolates come from organizations not naming any partners, while completing the survey, this is in part due to our sampling scheme. Many of our groups were named in the network, but gave no survey response (1037 organizations or 86.3% of all nodes). The vast majority of these nodes received the survey but chose not to respond.

[1] The specific survey questions that were used to collect collaboration, knowledge, and resource ties respectively were, "Please list groups with which you regularly collaborate on environmental projects or programs", "Please list groups that you go to for knowledge, data or expertise related to environmental issues", and "Please list groups/organizations/agencies from which you have received resources – funding or materials—in the last two years".

[2] Some of the more highly connected groups in the "other" category were organizations that represented partnerships between universities, governments, non-profits, and or private organizations that could fit into more than one of the categories, such as the Baltimore Ecosystem Study and the Powdermill Avian Research Center.

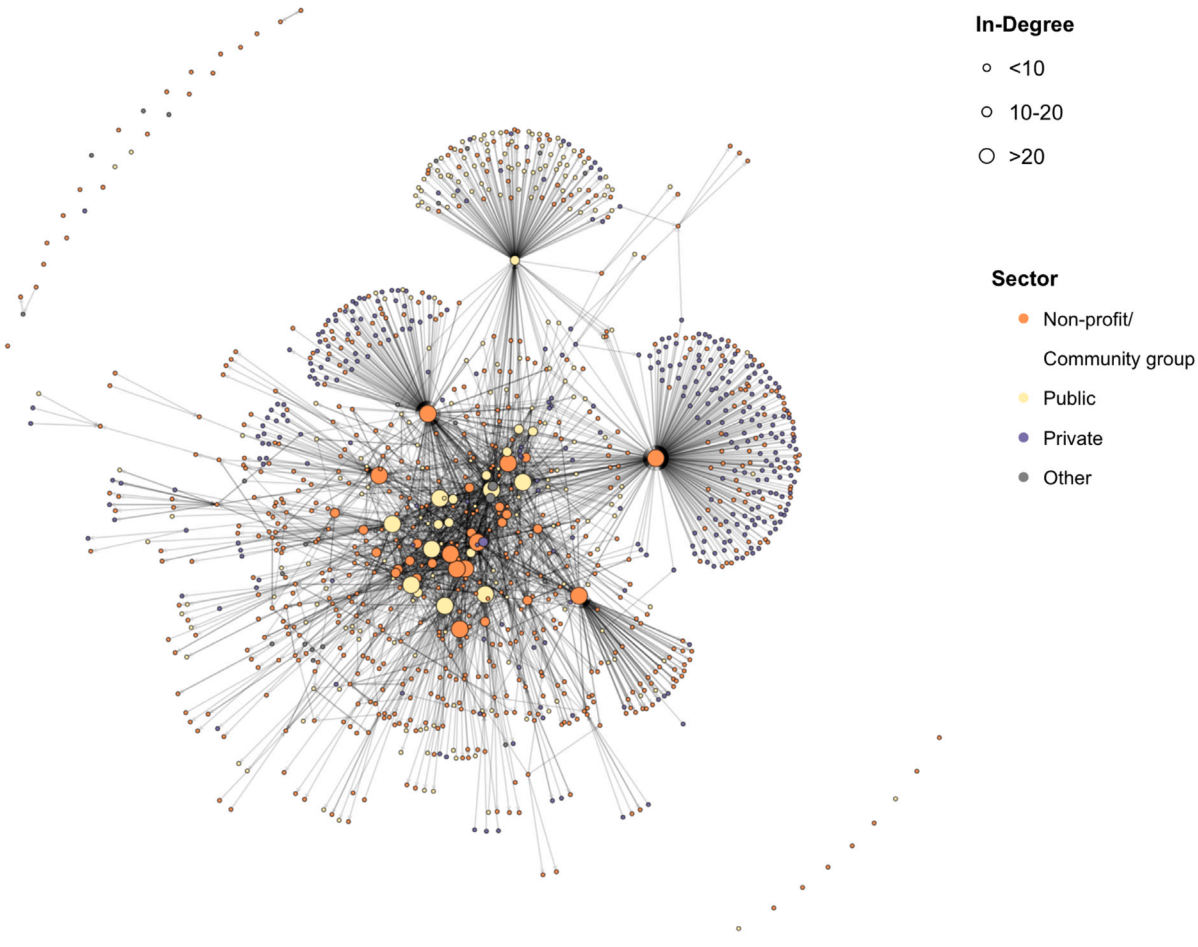

Fig. 1. Network graph of all nodes and edges of all types with node size indicating in-degree and color indicating organizational sector. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 1
Summary statistics for three exchange networks.

	Collaboration	Resources	Knowledge
Edges	1275	899	710
Density	8.85e−04	6.24e−04	4.93e−04
Mean in-degree	1.06	0.75	0.59
Mean out-degree	1.06	0.75	0.59
Edgewise reciprocity	0.07	0.01	0.04
Degree centralization	0.07	0.11	0.03
Transitivity	0.14	0.03	0.12

For these organizations, we only had their tie information based on other respondents, and we conducted an internet search to fill in our other variables of interest. This process resulted in a network of 1201 nodes with 2884 total ties between them. The network data collected through the STEW–MAP survey includes information on tie type as well, asking organizations to not only name alters, but to name alters with which they collaborate, share resources, and exchange knowledge. By separating out our ties by the specific type, we ended up with 3 networks, collaboration, resource sharing, and knowledge sharing, which are comprised of the same 1201 nodes and 1275, 899, and 710 edges, respectively (Table 1).

The variables we chose to include in our analysis were those that we had a high response rate for, were easily searchable for our alters, and were likely to influence one or all of our three types of ties. The first of these was organization type, displayed in Fig. 2. While the majority of our organizations are non-profits or community groups, almost a third are private businesses and another fifth are some form of public organization. These sectors are further divided into 10 categories (shown on the y-axis) that were used in our network models. The inclusion of governmental organizations is a novel contribution of this paper as well, as previous network models of STEW–MAP data have not analyzed these types of organizations (Jasny et al., 2019). The next variable of interest, shown in Fig. 3 was the "main focus" of the organization's work. There were a total of 32 categories to chose from for this variable, with the two most popular topics being "community improvement" and a general "environmental" focus. All 32 categories were tested within the our analyses. For the categorical variables of "type" and "organizational focus", a reference category is necessary, we chose to make these 501(c) / non-profits for the organization type, and "community improvement and capacity building" for focus. We chose these because they were the largest category for each respective variable. Next, we included the age of an organization by subtracting their founding year (shown in Fig. 4) from 2022 (the newest founding year of a group reported).[3] Many of the organizations were founded before the year 1900, so these are shown cumulatively in Fig. 4 in order to make the image more legible. Older organizations tended to be government agencies, universities, and churches — institutions with long histories. However, when looking at founding years over time,

[3] While the survey data was collected in 2019, some alter data was collected in 2023 resulting in a handful of official founding years being later than unofficial forming of groups. For example, a group may have been listed as an alter in 2019, gained 501(c)(3) status in 2022, and then this information was used to fill in its missing data.

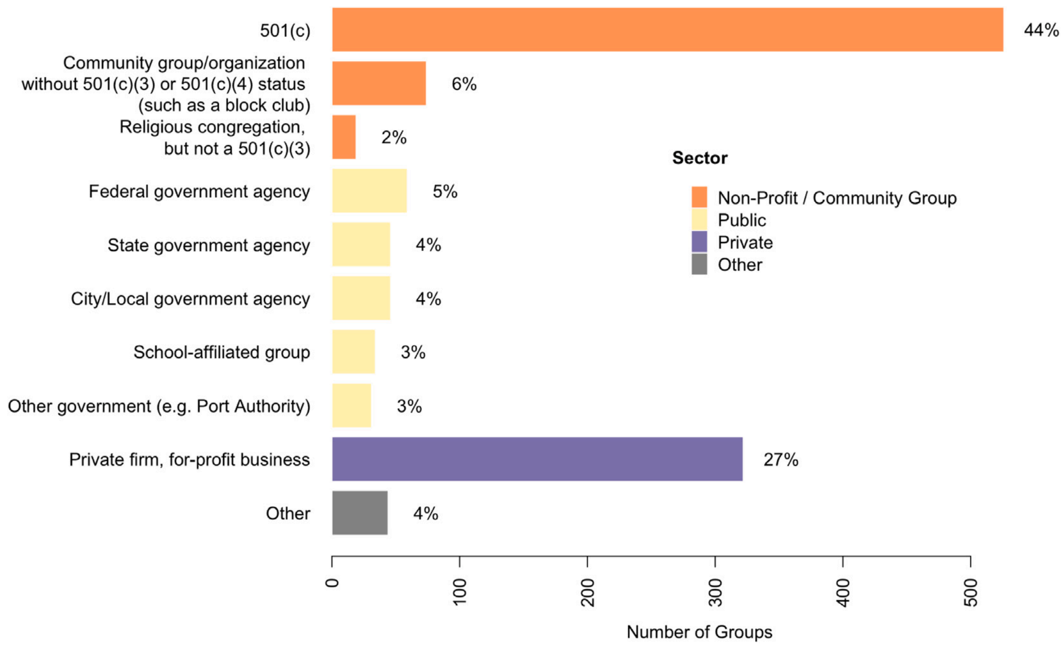

Fig. 2. Percentage of the network within each organizational type category, colored by sector type. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

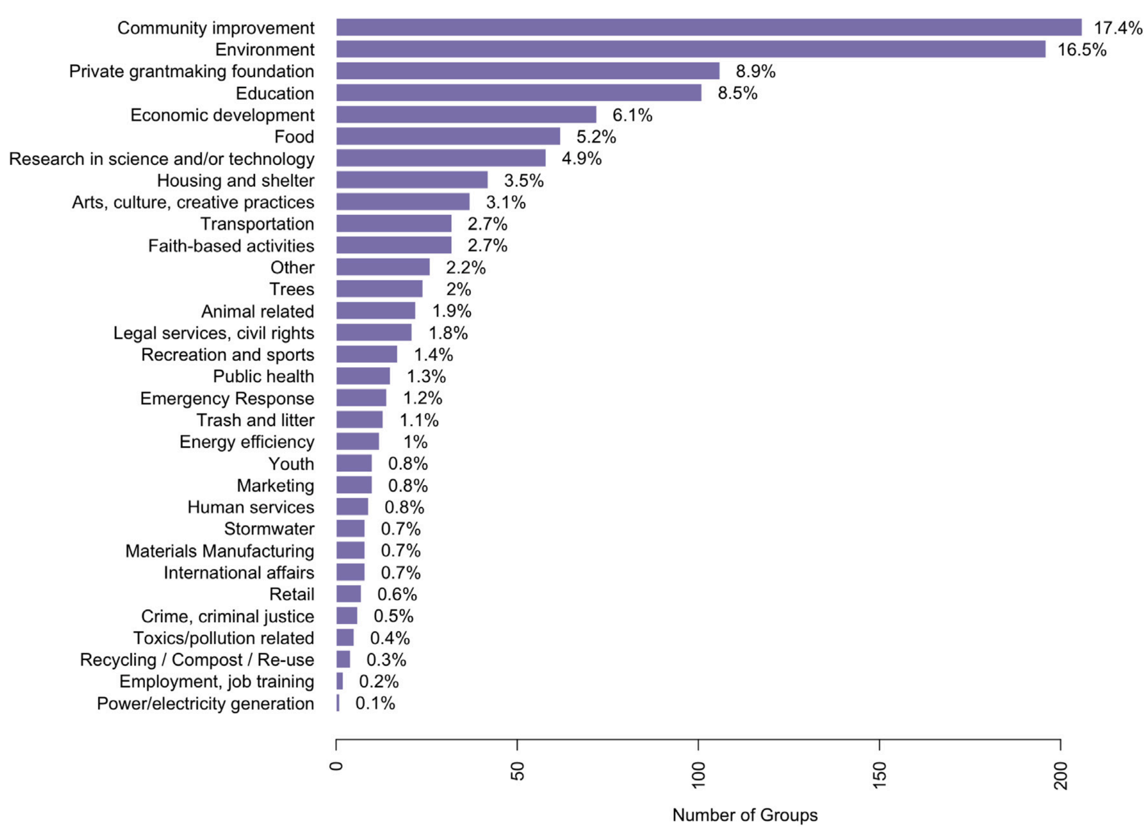

Fig. 3. Percentage of the network within each main focus category.

there is a general tendency for newer organizations to be represented at higher rates in the data. Lastly, we proxied the geographic location of each group by using the zip code of each organizations' main office or mailing address. From the zip code, we were also able to include the corresponding median household income and the population density associated with each office location. Along with these organization level characteristics, we also added measures of proximity, evaluated at the level of the dyad (or each pairing of organizations), which included distance (in miles) and contiguity, which was coded as 1 if two organizations shared a zipcode or were in bordering zipcodes and 0 otherwise. We utilized the `sf`, `tidycensus`, and `zipcodeR` packages for our location based variable construction (Walker and Herman, 2024; Pebesma, 2018; Pebesma and Bivand, 2023; Rozzi, 2021).

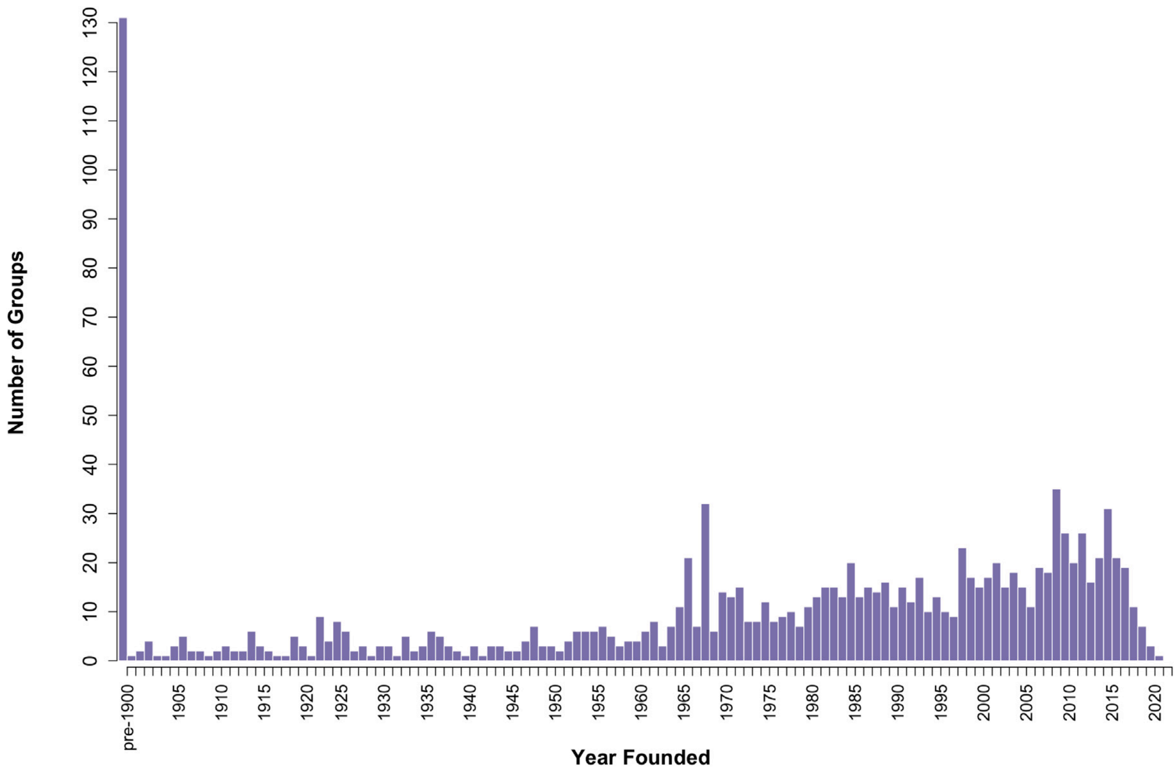

Fig. 4. Total number of organizations founded within each year across all founding dates.

4. Statistical analyses

Our data were analyzed using best-fitting Exponential Random Graph Models (ERGMs). We chose ERGMs as they are naturally suited to the network data we have and STEW–MAP data from other US cities has been analyzed using the same methods (Jasny et al., 2019). ERGMs model the likelihood of a tie as the dependent variable like a logistic regression. However, the use of ERGMs is for data in which one assumes that the likelihood of a tie existing is dependent on the presence or absence of other ties in the network. ERGMs use Markov chain Monte Carlo simulations to generate the statistics used for hypothesis testing, which regular logistic regressions cannot reliably do in the presence of such network dependence. Moreover, EGRMs can simultaneously model terms at various levels of the network, from the individual node to the network itself, while reliably providing significance testing on dependent network data. We used the `ergm` command in the `ergm` package (Hunter et al., 2008; Handcock et al., 2023; Krivitsky et al., 2023), which is part of the `statnet` (Krivitsky et al., 2003/2024) suite of packages for R (R Core Team, 2021).

Our independent variables can be categorized into three broad groups: node, edge, and structural terms. Node terms measure the association of organizational characteristics and tie formation, edge terms measure the association of dyadic characteristics, or something measurable between two organizations (such as geographic distance), on tie formation, and finally, structural terms measure the net tendency in the network for certain configurations of ties to emerge. The node terms are described above along with two edge variables, contiguity and geographic distance. In addition to these, we included edge variables for homophily on both organization type and main focus. Homophily is the tendency for entities that share a characteristic, to be more likely to tie to each other, compared to those that differ on that characteristic (McPherson et al., 2001). In this case, for each subcategory of the two variables, we test whether organizations that share the same type or focus have a higher likelihood of tying. Lastly, we include four structural terms. The first controls for the overall density of the network, net of our other variables, and is standard for all analyses of this type (Lusher et al., 2013). The second measures the effect of reciprocity, or how more or less likely a mutual tie is compared to an asymmetric tie, which is also standard for analyses of directed networks, such as ours. Our last two terms are geometrically weighted in and out degree terms. If these terms are positive, they indicate that more ties to or from a node increases the likelihood of that node tying within the network. If they are negative, they indicate more ties to or from a node decreases the likelihood of tying more. These effects occur at a decreasing rate, however, so that the added effect for each additional tie is less than the previous one.

As stated above, a subset of the organizations in the network gave no survey response. This was either from not receiving the survey or in almost all cases, from choosing not to respond; they are in the network because they were named as an alter by another organization. Due to the phrasing of the questionnaire, for our resource and knowledge networks, these organizations cannot receive ties, and in the collaboration network, they cannot send ties. We were able to constrain the models to account for this missingness and our ERGM results reflect this constraint. More specifically, the results are conditioned on the absence of these ties, so our results are reflective of the network as reported by our respondents and should be interpreted as such. We discuss the limitations of this approach in the discussion section.

All three networks, collaboration, resource sharing, and knowledge sharing, were modeled separately using the same process to choose the best fitting model based on the Akaike Information Criterion (AIC) (Akaike, 1973). Best fitting models were chosen based on a backwards selection process. For each network, we started with the same full model of 15 terms (multiple of which contained various categories), then we removed each term, one at a time, kept it removed if it improved model fit, and put it back in if it did not. Within this process, backwards selection was also used to choose each level of our categorical node and edge variables. More specifically, we started with each level (e.g. 501(c), federal government, state government, etc.) in the model and removed one level at a time, testing for model fit at each removal. This whole process resulted in a different chosen best fitting model for each of our three networks. This process was conducted without the inclusion of our structural terms in order to save time and reduce the risk of our process failing part way through, due to poor model fit. Instead, we added these terms in one at a time to the models chosen in our backwards selection function, and kept them in if they improved the fit of our models. We chose to add these terms in separately at the end because the computational burden of keeping them in for the full backwards selection process was too great. The results of this process are discussed below for each of the three networks.

5. Results

5.1. Network structural terms

For ease of interpretation, we discuss our results in terms of odds ratios, or the exponentiated value of the coefficient. For negative coefficients, the odds ratio lies between 0 and 1 and for positive coefficients, it lies between 1 and positive infinity. This allows us to talk about how much more or less likely a tie is, given the variables in question. All final models included an edge and mutual term to control for density and reciprocity, respectively. The "edge" term in our network models can be thought of as an intercept term, indicating how likely a tie is, net of all other effects in the model. For all of our models, this term is quite low (below 1%), indicating that our network is sparse, which is also reflected in our density measures, shown in Table 1. The edge term is highest in our collaboration network, followed by resource sharing and then knowledge sharing. The "mutual" term in our models measures the effect of reciprocity within these networks; in the collaboration network, a mutual tie is over 16 times more likely than an asymmetrical tie and it is over 9 times as likely for our knowledge sharing network. Resource sharing does not follow this pattern, though, and has no significant effect for mutuality, indicating that reciprocating resource sharing is no more or less likely than not reciprocating. The relative levels of reciprocity are also mirrored in the networks' edgewise reciprocity displayed in Table 1.

We added two other network terms to our models: geometrically weighted in-degree and out-degree terms. These terms are included to capture the in and out degree distributions of each network. Both terms improved model fit for the collaboration and resource networks, but only the in-degree term improved model fit for the knowledge network. While present in the resource network, the out-degree term is only significant in the collaboration network. Substantively, the significant and negative values for the in-degree term in all three models indicates that all networks have a tendency towards lower in-degree nodes, meaning that the distribution of tie receiving is more skewed towards the lower end of the distribution, which would result in more isolates and pendants than would be expected in a random graph. The significantly negative term for out-degree in the collaboration network similarly indicates that the distribution of tie sending is skewed towards lower degrees. No such effect exists for the resource and knowledge networks, indicating no strong tendency towards or away from an even sending distribution (see Fig. 5).

Overall, all three networks are quite sparse based on their edge terms, while only collaboration and knowledge sharing show strong mutuality, unlike the resource network. Finally, all three networks have skewed distribution of tie receiving towards low degrees, but only the collaboration network has a similarly skewed distribution of tie sending as well.

5.2. Organization characteristics

The organizational characteristics we tested included the age of the organization, the organizational type with a reference category of "501(c) / non-profits", and the main focus of the organization with a reference category of "community improvement and capacity building". We found that older organizations are less likely to send collaboration ties, but more likely to send both resource and knowledge ties, while having no significant association with receiving any tie type.

Looking at the influence of organizational type and focus for each tie type, starting with resource exchange, 501(c)'s are the most likely organization type to receive resources, while state and city government are the most likely type to send resources. Stewardship organizations with a main focus of environment are almost three and a half times as likely to receive resources, compared to community-focused groups, while retail- and pollution-focused groups are 4.1 and 3.5 times as likely as community-focused groups to send resources, respectively. The largest effect related to organizational focus in both sending and receiving resources is among stormwater-focused groups, who are 9.7 and 13.8 times as likely to send and receive resources, respectively.

When it comes to the knowledge exchange network, aside from city government, the various organization types are not statistically different in their receiving patterns. However, city government organizations are the most likely to both receive and send knowledge. Private firms and religious congregations are the least likely to send knowledge, followed by community groups. As for the organizational focus variable, recycling and re-use-focused groups are by far the least likely to receive knowledge, with an odds ratio of 0.12 while being among the most likely to send knowledge to other organizations, with an odds ratio of 4.58. Once again, the largest effect for focus comes from stormwater focused groups who are 14.7 and 3.7 times as likely to send and receive knowledge ties, respectively.

Lastly, for the collaboration network, city government is the most likely group type to receive ties and the second most likely to send ties along with federal government organizations who are nearly 5 times more likely to send collaboration ties than non-profits. Private firms are the least likely to receive collaboration ties, followed by community groups, being 0.27 and 0.62 times as likely as non-profits to receive ties. The least likely organization type to send collaboration ties are school-affiliated groups. As for the influence of organizational focus, private grant-making foundations are by far the least likely to receive ties, with only 0.14 times the odds of community-focused groups and the most likely to send ties, with 4.6 times the odds of community focused groups. Stormwater-focused groups are once again among the most likely to send and receive ties, being 4 times as likely to receive and 2.5 times as likely to send collaboration ties, compared to our community-focused groups.

5.3. Edge characteristics

The edge terms we tested in each model included matching terms for organizational type and focus, as well as two dyadic terms for distance and zip code area overlap. The included matching terms measure the extent to which organizations of the same type or with the same organizational focus work with each other more or less than with those of a different type or different focus. The reference category for these terms is the general heterophilous tie, meaning any tie between two organizations of differing categories.

First, looking at resource exchange by organizational type, we see that federal governmental groups have the highest level of homophily. Federal governmental organizations are over 11 times as likely to exchange resources among themselves as opposed to with other types of groups, which includes other types of government (state, and local). While only significant at the 0.1 level, state governmental organizations are also over 4 times as likely to exchange resources with other state governmental groups than with other types of organizations. As for

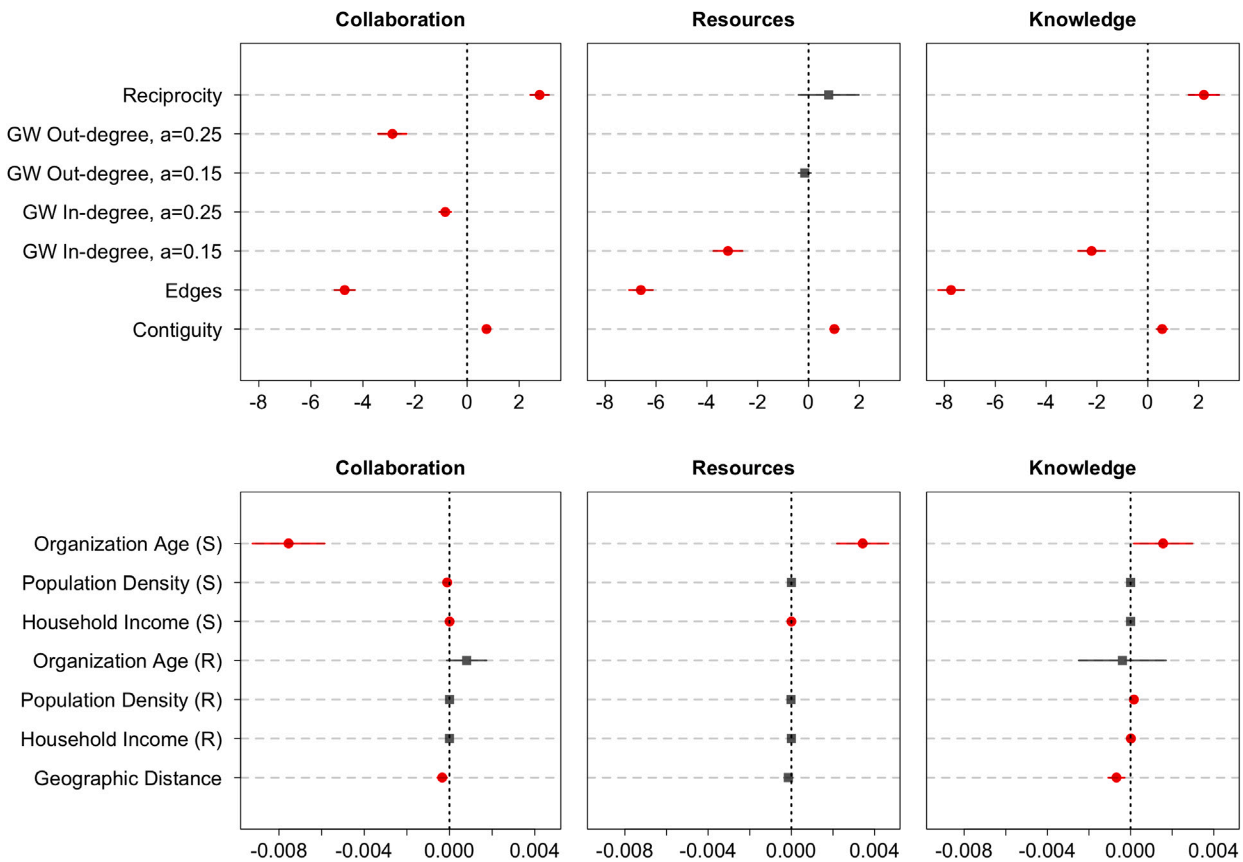

Fig. 5. Coefficient values for structural terms and location-based terms from final ERG Models. Red circles indicate coefficients that are significant at the 0.05 level or less, while gray squares indicate terms that are outside of this significance cutoff. (S) indicates sending effects, while (R) indicates receiving effects. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

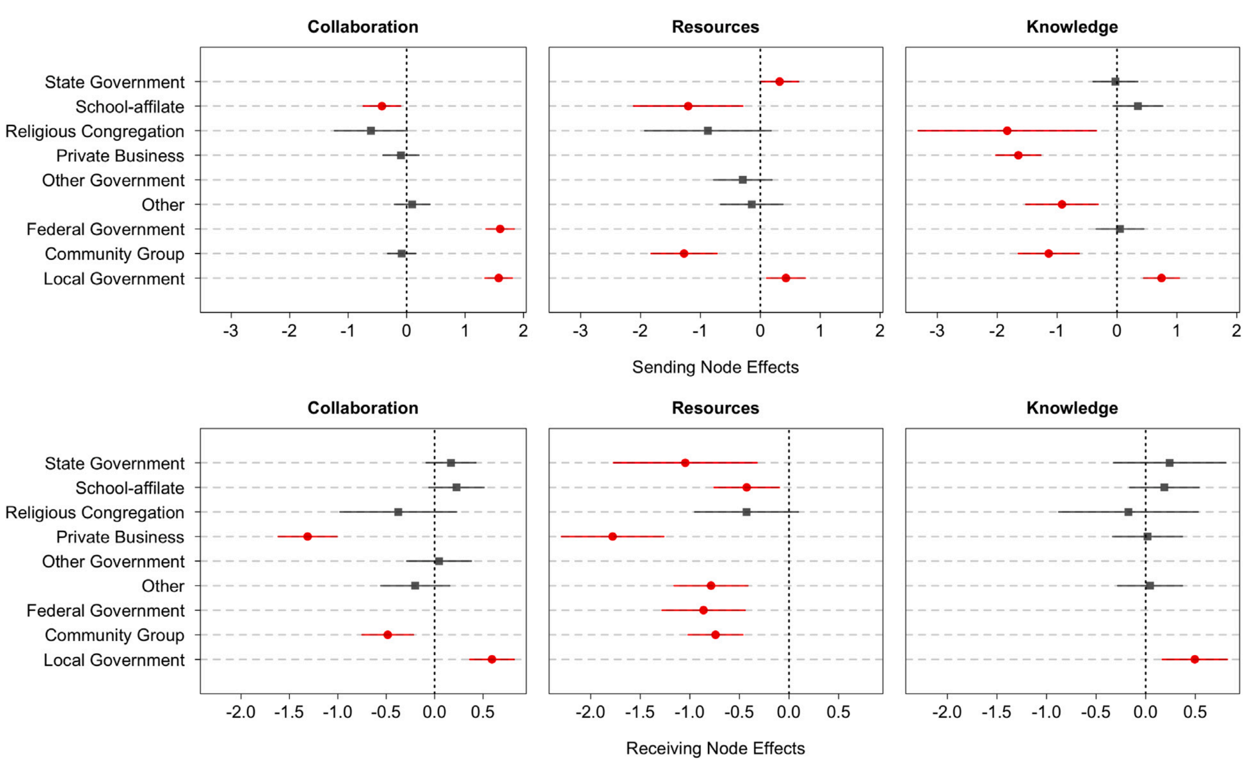

Fig. 6. Coefficient values for organization type, both sending and receiving nodal terms from final ERG Models. Red circles indicate coefficients that are significant at the 0.05 level or less, while gray squares indicate terms that are outside of this significance cutoff. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

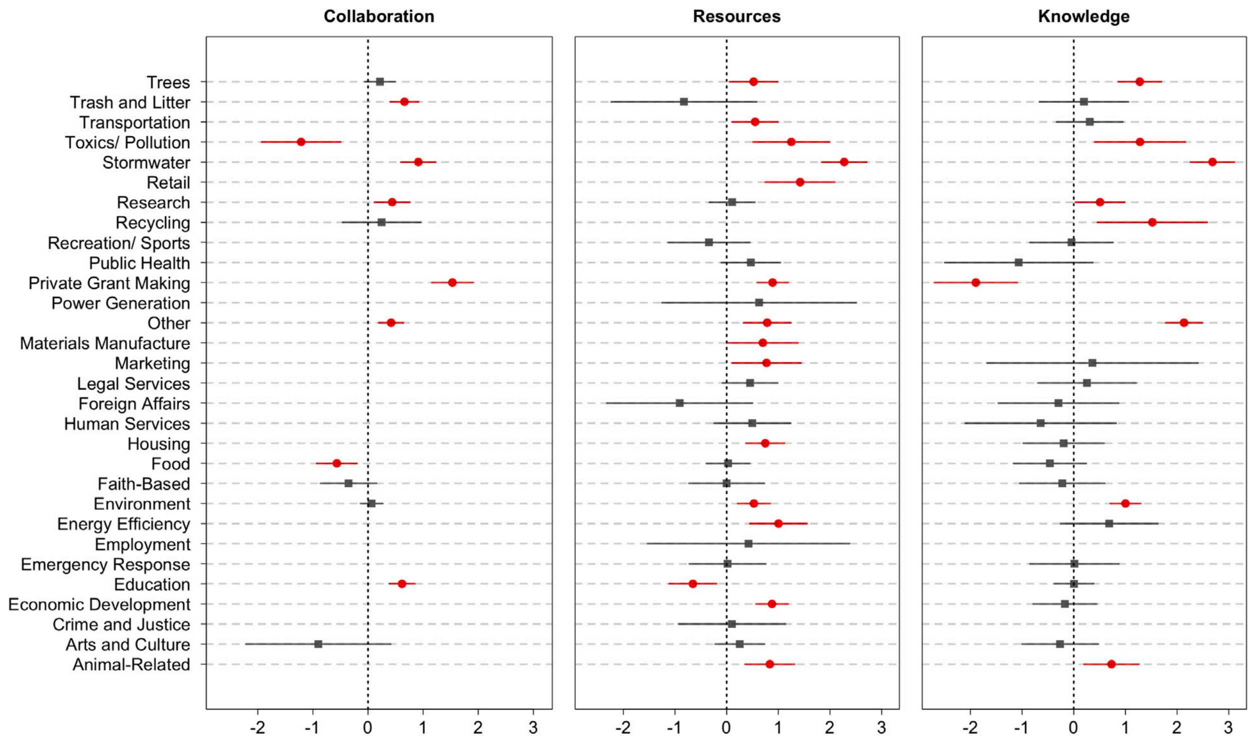

Fig. 7. Coefficient values for main focus, *sending* nodal terms from final ERG Models. Red circles indicate coefficients that are significant at the 0.05 level or less, while gray squares indicate terms that are outside of this significance cutoff. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

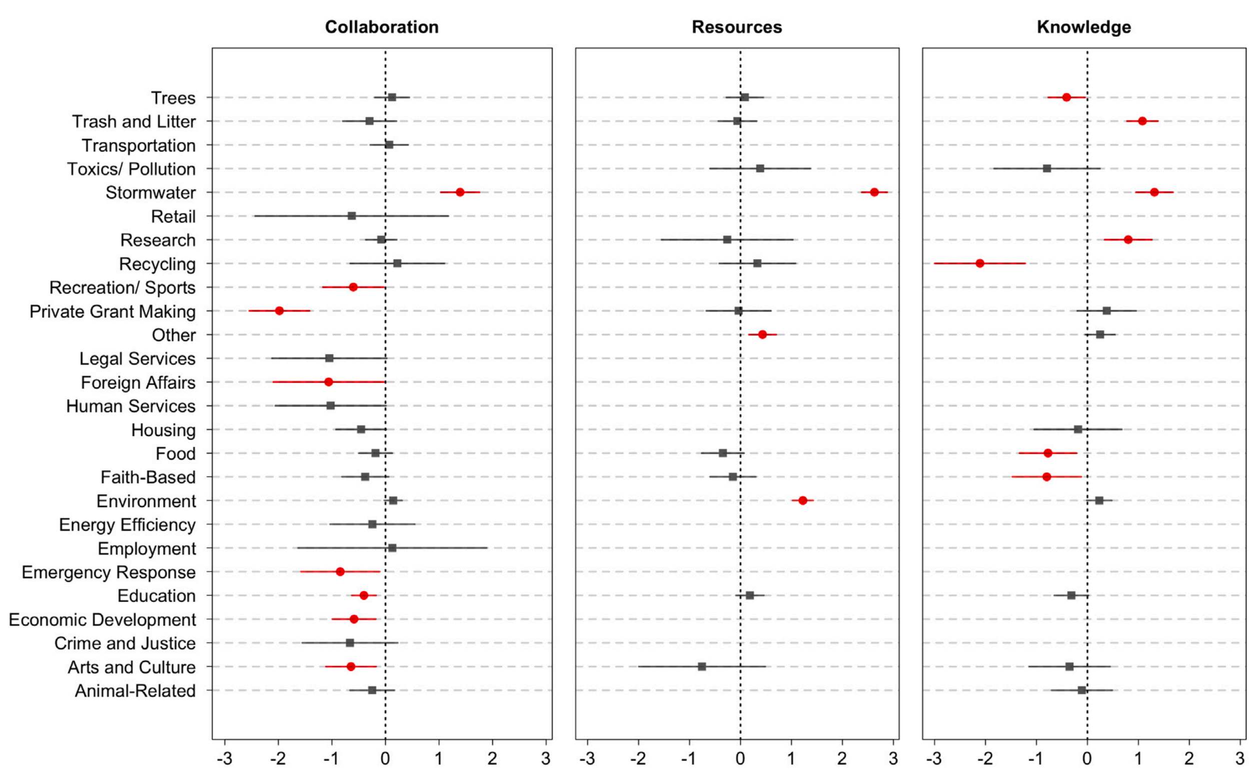

Fig. 8. Coefficient values for main focus, *receiving* nodal terms from final ERG Models. Red circles indicate coefficients that are significant at the 0.05 level or less, while gray squares indicate terms that are outside of this significance cutoff. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

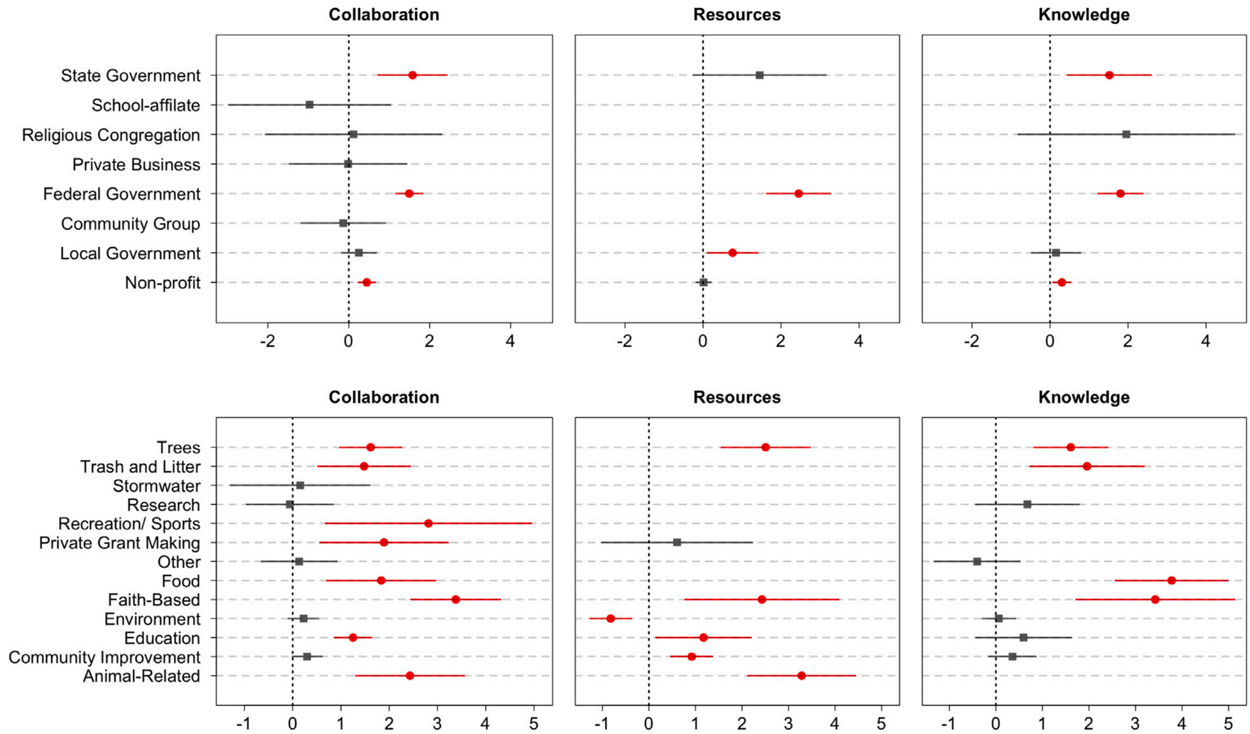

Fig. 9. Coefficient values for homophily terms from final ERG Models, with the top three panels showing organization type homophily and the bottom three panels showing main focus homophily. Red circles indicate coefficients that are significant at the 0.05 level or less, while gray squares indicate terms that are outside of this significance cutoff. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

focus, three main groups stand out; faith-based groups and tree-focused groups are over 11 and 12 times, respectively, as likely to exchange resources with each other than with other groups. The largest homophily effect by far, though, is for animal-focused groups, which are 26.6 times as likely to exchange resources with other animal-focused groups than with others. It is also worth noting that the environmentally-focused groups are the only ones more likely to exchange resources with groups having a different organizational focus than they are with each other; this is the only significant tendency towards heterophilous ties that we see among any of the networks for both organizational type and focus.

Moving on to our knowledge exchange network, among our various organizational types, state and federal government groups once again have the highest levels of homophily, with state groups being over 4.5 times as likely to exchange knowledge with each other than with other types of organizations and federal groups being over 6 times as likely to do so. As for organizational focus, tree and trash focused groups have high homophily with 5 and 7 times greater odds of exchanging knowledge with similarly-focused groups than with others, while faith and food focused groups are extremely homophilous, being 30.7 and 43.7 times as likely to exchange knowledge with each other than with other focused groups, respectively.

Finally, looking at the collaboration network, we once again find our highest levels of homophily among both our state and federal governmental groups with 4.8 and 4.4 times the odds of collaborating with groups of the same governmental type than with other group types, respectively. There are various homophily effects for organizational focus (displayed in the top three panels of Fig. 9), including education, food, trash, and trees with odds ratios ranging between 3.5 and 6.3. We see a large coefficient value for sports and recreation with an odds ratio of 16.7 and as before we see high homophily among faith-based groups and animal focused groups with odds ratios of 29.3 and 11.4, respectively. One last effect to note is the high level of homophily among private grant-making foundations, being 6.6 times as likely to collaborate with each other than with other groups.

Finally, our location based variables have highly consistent effects across all networks, with zip code overlap or adjacency increasing the likelihood of a tie, doubling it in the case of collaboration and knowledge sharing and almost tripling it for resource sharing. Distance decreases the likelihood of collaboration and knowledge ties and has no added effect for resources.

Overall, we find many similarities among our three tie types with regards to homophily effects, geographic proximity, in-degree distribution, and the effect for stormwater focused groups, but they differ greatly on many of our other nodal effects for type and focus, age, and mutuality.

6. Discussion

In this work, we analyzed three types of networks among local environmental stewardship organizations based in Baltimore, MD, USA: collaboration, knowledge exchange, and resource exchange. This work builds on previous studies across the US, using an ongoing data collection program, known as STEW–MAP. This is the first statistical network modeling of Baltimore's data as well as the first to analyze the separate types of ties collected in the survey. Our findings suggest differences by both organization type and focus, with strong homophily effects for both as well as a difference by age and geography. Some of these findings are consistent across tie type, while others vary.

Considering that these networks can be mapped to geographic space, prior work along with ours has tested the impact of geographic proximity on tie formation. As was found in Belaire et al. (2011) and Jasny et al. (2019), geographic distance was inversely related to the likelihood of tie formation for both collaboration and knowledge exchange, while being in the same or neighboring zip codes was positively associated with the likelihood of tying in all three networks. This indicates that organizations that are more geographically proximate to others are also more likely to be socially embedded in the network, regardless of what is being exchanged.

Another shared tendency among our three networks was skewed in-degree distributions. We found that in-degree distributions tended to be skewed towards the low end for all types of ties, which indicates that net of our other effects, most nodes are predicted to receive a relatively low number of incoming ties, with a handful of organizations receiving more. This suggests that many groups are receiving low amounts of collaboration, knowledge, and resources, despite this behavior only being mimicked for the sending of collaboration ties. This could indicate that few organizations have resources to give, distributing them among many smaller partners, or that there are more potential partnerships that could be realized if specific connections were made. A potential point of future research could be to investigate those organizations that do receive resources from many different groups and understand their strategies and outcomes in doing so. This finding could also indicate a difficulty in entering Baltimore's environmental stewardship network as a new organization since most groups are predicted to be receiving few resources; if this is the case, given the strong mutuality effect, the best way to gain knowledge and collaborative partnerships may be to offer them. However, this would need to be tested further using time series data. Additionally, this finding echoes that of Ovalle et al. (2024) in that they also found a negative coefficient for their degree distribution effect, but is contrary to Jasny et al. (2019) who found positive coefficients for degree distribution in New York City and Philadelphia. This means that this effect has been documented across four different cities' stewardship networks, but how it operates is context dependent. This pattern could be further investigated with more geographic locations in order to understand how it typically operates under various conditions.

While geography and skewed degree distribution cut across all networks, age and reciprocity highlight the differences in our exchange networks. Organization age is one of a few variables with a different direction depending on the network type; while organization age is positively associated with sending out resources and knowledge, it is negatively associated with the likelihood of sending out collaboration ties. This may indicate that older organizations are better resourced overall, but they are more rigid or narrow in who they choose to work with, perhaps because they have refined their partnerships over time. It is also worth noting that organization age is not related to receiving ties, which indicates an even distribution of incoming ties across the network, with regards to age. This also implies that newer organizations may have an easier time integrating themselves into the existing system. As for reciprocity, we found different levels of reciprocity for each network, with the collaboration and knowledge networks having positive reciprocity and with no effect for our resource network. Additionally, the effect for reciprocating collaboration is almost double the effect size of reciprocating knowledge exchange. This indicates that knowledge flows are not one-sided, but they are not quite as reciprocal as collaboration (a type of relationship that is more inherently reciprocal). The extremely high reciprocity term in the collaboration network also displays consensus among organizations, as to who is working with whom. Considering that collaboration can be thought of as undirected (though our methods are better suited to preserving direction here), high mutuality indicates that the organizations surveyed are to a large extent in agreement about which collaborative relationships exist in the network and our survey results are picking this up. There is no reciprocity among resource exchange, which indicates that those receiving resources are not more or less likely to send them in return. While collaboration and knowledge are easy to both give and take, considering that all organizations have some capacity for both, resources can only be sent by those that possess them.

Differences by network type are also apparent among our various effects for organization type and focus. Looking at Fig. 6, we can see that knowledge *sending* patterns differ more by organization type than the collaboration and resource networks, meaning there are more significant differences by organization type for the knowledge network, compared to the other two tie types. On the other hand, resource *receiving* patterns differ more by organization type than the other two tie types. Other differences can be observed for our organizational focus sending and receiving effects (shown in Figs. 7 and 8) and homophily effects (shown in Fig. 9). These differences underscore the importance of modeling these types of exchanges separately. However, combining the three analyses also allows us to understand general trends among stewardship groups. Groups that mainly focused on food, animals, or faith appear to be relatively siloed from the rest of the network. The evidence for this is in the extremely high levels of homophily within these groups, coupled with moderate sending and receiving rates. This means that these groups in particular have a lot of room to expand their connections into the broader network. This is contrasted by the results for groups focused on stormwater management; while they have among the highest receiving and sending effects of any category for all networks, they display no homophily. This means that stormwater groups are highly embedded in the stewardship networks and are managing to tap into a wide variety of resources. It is worth noting that stormwater management in Baltimore is more formally regulated than other natural resources, such as tree canopy or urban agriculture. Established under the Clean Water Act in 1972 and administered by the US Environmental Protection Agency (EPA), Maryland's municipal separate storm sewer system (MS4) permits require local jurisdictions, including Baltimore, to implement stormwater best management practices and programs to reduce pollution discharges and to protect water quality (State of Maryland, 2024). This program formalizes and requires Baltimore City environmental stewardship to demonstrate commitment to stormwater management and improving local water quality in the Chesapeake Bay. Because of the MS4 permit program, other types of environmental organizations often tie their work to water quality improvement, which may contribute to the behavior of stormwater-focused groups in our networks. Future research on stormwater-focused groups may provide a better understanding of how they have managed to position themselves in such a strategic way and whether or not this can serve as a model for network integration.

While not siloed from the rest of the network, our findings do suggest that both private grant-making groups and private businesses are potentially underutilized by other organizations. While these groups are among the least likely to send knowledge ties, grant-making groups are more likely than many to send resource ties and they are the most likely to send collaboration ties, while private businesses are as or more likely than most other group types to send collaboration ties. Despite this, they are both the least likely categories of groups to receive collaboration ties. This could be explained by the way private grant-making foundations and some private businesses are viewed – perhaps they are seen only as funding sources rather than collaborators and therefore were not listed by organizations. However, this still does not reflect how these groups see themselves; the high likelihood of these groups sending collaboration ties would suggest that they consider themselves equal partners in the network. This may leave room for strengthening those relationships at the very least. The lower likelihood of receiving collaboration ties could also be coming from a lack of exposure; if organizations are not listing these groups because they are unaware of them, then this could represent an underutilized resource for the network.

Lastly, one of the most striking findings was the presence of homophily for governmental groups; in every network we modeled, federal, state, or local government organizations had the highest levels of homophily. When coupled with the effects for sending, as federal, state, or local government groups are the most likely to send ties in all three networks, our findings suggest that much like the animal and faith focused groups, governmental groups in these networks are potentially siloed. Net of other effects, this indicates that a large share of resources (all ties included) are likely to be funneled from government groups back into other government groups of the same jurisdiction. This may be the result of Baltimore's federally mandated partnerships. Several major networks in the Baltimore region are led by federal government

Table 2
Full resource ERGM results.

	Coefficient	St. Error	
Edges	0.001	0.239	***
Mutual	2.207	0.604	
In-degree	0.042	0.292	***
Out-degree	0.86	0.123	
Age (Send)	1.003	0.001	***
Organization type receiving			
Community group	0.477	0.141	***
Federal Govt	0.422	0.213	***
Other	0.455	0.189	***
Private	0.169	0.263	***
Religious	0.651	0.266	
School affiliate	0.652	0.168	*
State Govt	0.351	0.37	**
Organization type sending			
Local Govt	1.533	0.165	**
Community group	0.28	0.28	***
Other	0.867	0.265	
Other Govt	0.746	0.248	
Religious	0.416	0.538	
School Affiliate.1	0.3	0.465	**
State Govt	1.379	0.162	*
Focus receiving			
Arts & Culture	0.47	0.633	
Education	1.202	0.14	
Environment	3.402	0.104	***
Faith	0.862	0.229	
Food	0.707	0.212	
Other	1.542	0.137	**
Grants	0.963	0.323	
Re-Use	1.392	0.382	
Research	0.771	0.657	
Stormwater	13.848	0.128	***
Toxics	1.47	0.503	
Trash	0.94	0.192	
Trees	1.089	0.185	
Focus sending			
Animal	2.304	0.245	***
Arts & Culture	1.288	0.243	
Crime	1.107	0.527	
Economic	2.403	0.158	***
Education	0.52	0.235	**
Emergency	1.018	0.378	
Employment	1.526	0.997	
Energy	2.725	0.282	***
Environment	1.693	0.161	**
Faith	1	0.373	
Food	1.028	0.214	
Housing	2.111	0.189	***
Human services	1.64	0.378	
Foreign affairs	0.403	0.72	
Legal	1.573	0.274	
Marketing	2.161	0.342	*
Materials	2.013	0.346	*
Other	2.19	0.234	***
Power	1.873	0.959	
Grants	2.432	0.154	***
Public health	1.597	0.291	
Recreation	0.71	0.402	
Research	1.112	0.225	
Retail	4.143	0.344	***
Stormwater	9.721	0.223	***
Toxics	3.493	0.378	***
Transport	1.735	0.227	*
Trash	0.438	0.719	
Trees	1.684	0.24	*

(*continued on next page*)

Table 2 (*continued*).

Organization type homophily			
Non-profit	1.014	0.095	
Local Govt	2.131	0.329	*
Federal Govt	11.599	0.417	***
State Govt	4.264	0.868	
Focus homophily			
Animal	26.623	0.591	***
Community	2.509	0.229	***
Education	3.233	0.52	*
Environment	0.44	0.226	***
Faith	11.347	0.842	**
Grants	1.832	0.826	
Trees	12.273	0.486	***
Location based-terms			
Density (Receive)	1	0	
Density (Send)	1	0	
Income (Receive)	1	0	
Income (Send)	1	0	***
Distance	1	0	
Contiguity	2.758	0.087	***

agencies, with strong participation from state and/or local government agencies. For example, the Baltimore Urban Waters Federal Partnership (BUWFP) has the express purpose of bringing federal agencies together in partnership and collaboration to share resources with local public and community organizations. While government collaboration and resource exchange through BUWFP may result in local environmental action, the mechanism may be through resource and knowledge exchange between governmental organizations. The Chesapeake Bay Program (CBP) is another major example of federally mandated collaboration between government agencies in the Baltimore region. The many workgroups of the CBP coordinate efforts to help Maryland and other states reach their Chesapeake Bay total maximum daily load (TMDL) pollution reduction requirements (Chesapeake Bay Program, 2024). These types of required collaboration between governmental organizations may be different than voluntary grassroots collaboration. Notably, both BUWFP and CBP are motivated by concerns about water quality, which may also help explain the centralized position held by stormwater management groups in our stewardship networks.

It is important to note the limitations of this study and how they impact the interpretation of our results. First, this study uses data that is cross-sectional. While there is value in cross-sectional analysis, it is also important to understand that the forces shaping these networks might vary with time, and we cannot capture that within our analyses. Along with the temporal bounds of our data, we have bounded it geographically as well. Only organizations that were within Baltimore's geographic scope were surveyed. While this means that there are unobserved partnerships outside of this geography, it also allows us to focus the scope of the study to one city. Considering that local stewardship groups are likely connected to a global network of stewardship organizations, geographic bounds are also necessary from a data collection standpoint. Survey data collection, while an essential tool for social science, almost always brings with it issues of missing data. As mentioned, these data contain many alters that chose not to respond and thus produced missingness within the network. While we have adjusted the modeling approach in order to handle this missing data, it does impact the results; all model results are predictive of the observed network, which is to say they are predictive of the network elicited from the respondents. While the edges term is likely lower due to this missingness, there is still high mutuality predicted in the networks where it might be expected (collaboration and knowledge sharing) and the respondents in our network represent all organizational types as well as the vast majority of organizational focuses, including those that produced the more notable results (such as stormwater and animal focused groups). The network data used in this analysis represent an ongoing data collection effort and we hope these results can inform future environmental stewardship research within Baltimore and other cities alike.

Table 3
Full knowledge ERGM results.

	Coefficient	St. Error	
Edges	4.36e−04	0.258	***
Mutual	9.08	0.307	***
In-degree	0.11	0.271	***
Age (Receive)	1	0.001	
Age (Send)	1.002	0.001	*
Organization type receiving			
Local Govt	1.641	0.167	**
Other	1.044	0.166	
Private	1.018	0.179	
Religious	0.84	0.358	
School affiliate	1.207	0.178	
State Govt	1.273	0.289	
Organization type sending			
Local Govt	2.102	0.152	***
Community group	0.32	0.258	***
Federal Govt	1.051	0.202	
Other	0.399	0.308	**
Private	0.192	0.191	***
Religious	0.16	0.759	*
School affiliate	1.417	0.211	
State Govt	0.974	0.189	
Focus receiving			
Animal	0.896	0.304	
Arts & Culture	0.704	0.406	
Education	0.73	0.172	
Environment	1.262	0.125	
Faith	0.45	0.346	*
Food	0.461	0.286	**
Housing	0.832	0.438	
Other	1.282	0.149	
Grants	1.46	0.295	
Re-Use	0.121	0.454	***
Research	2.227	0.237	***
Stormwater	3.724	0.186	***
Toxics	0.452	0.53	
Trash	2.943	0.155	***
Trees	0.665	0.185	*
Focus sending			
Animal	2.077	0.271	**
Arts & Culture.1	0.767	0.376	
Economic	0.842	0.314	
Education	1.005	0.194	
Emergency	1.012	0.44	
Energy	1.985	0.48	
Environment	2.72	0.151	***
Faith	0.8	0.42	
Food	0.63	0.361	
Housing	0.823	0.4	
Human services	0.527	0.745	
Foreign affairs	0.744	0.594	
Legal	1.292	0.486	
Marketing	1.435	1.042	
Other	8.443	0.182	***
Grants	0.15	0.411	***
Public health	0.344	0.731	
Recreation	0.959	0.411	
Re-Use	4.576	0.542	**
Research	1.662	0.244	*
Stormwater	14.658	0.217	***
Toxics	3.603	0.448	**
Transport	1.363	0.328	
Trash	1.218	0.44	
Trees	3.584	0.215	***
Organization type homophily			
Non-profit	1.356	0.114	**
Local Govt	1.168	0.318	
Federal Govt	6.086	0.291	***
Religious	7.075	1.415	
State Govt	4.585	0.55	**
Focus homophily			
Community	1.428	0.259	
Education	1.813	0.521	
Environment	1.066	0.181	
Faith	30.697	0.869	***
Food	43.653	0.618	***
Other	0.669	0.47	
Research	1.968	0.565	
Trash	7.083	0.623	**
Trees	4.999	0.403	***
Location-based terms			
Density (Receive)	1	0	***
Density (Send)	1	0	
Income (Receive)	1	0	***
Income (Send)	1	0	
Distance	0.999	0	***
Contiguity	1.76	0.105	***

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Table 3 (continued).

Our results have shown the need to understand various forms of organizational interaction separately, while pointing to some patterns that could be general characteristics of environmental stewardship systems. For Baltimore specifically, we have identified subsets of groups that could be further integrated into the network, either by choosing to work with other types of environmental groups outside of their own focus, or by reaching out to private businesses and foundations. We have also shown that governmental groups may want to consider how much they are working with other governmental groups versus non-governmental groups as they may be in a role to create increased network connectedness and resource distribution. Finally, we demonstrated that Baltimore's stormwater-focused groups not only exchange all forms of resources more actively than other organizations, but also effectively engage with diverse segments of the network.

CRediT authorship contribution statement

Selena M. Livas: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Dexter H. Locke:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Data curation, Conceptualization. **Nancy F. Sonti:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Data curation, Conceptualization.

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The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy.

Appendix

A.1. Tables

See Tables 2–4.

Table 4
Full collaboration ERGM results.

	Coefficient	St. Error	
Edges	0.009	0.2	***
Mutual	16.162	0.184	***
In-degree	0.432	0.115	***
Out-degree	0.057	0.277	***
Age (Receive)	1.001	4.72e−04	
Age (Send)	0.992	0.001	***
Organization type receiving			
Local Govt	1.808	0.117	***
Community group	0.616	0.135	***
Other	0.818	0.181	
Other Govt	1.047	0.169	
Private	0.269	0.155	***
Religious	0.687	0.307	
School affiliate	1.254	0.145	
State Govt	1.185	0.131	
Organization type sending			
Local Govt	4.832	0.12	***
Community group	0.919	0.121	
Federal Govt	4.951	0.123	***
Other	1.1	0.155	
Private	0.908	0.156	
Religious	0.543	0.318	
School affiliate	0.655	0.163	**
Focus receiving			
Animal	0.781	0.212	
Arts & Culture	0.525	0.239	**
Crime	0.515	0.455	
Economic	0.556	0.208	**
Education	0.668	0.116	***
Emergency	0.43	0.374	*
Employment	1.137	0.899	
Energy	0.783	0.404	
Environment	1.154	0.085	
Faith	0.685	0.223	
Food	0.829	0.159	
Housing	0.634	0.239	
Human services	0.359	0.527	
Foreign affairs	0.346	0.527	*
Legal	0.35	0.547	
Grants	0.138	0.287	***
Recreation	0.548	0.291	*
Re-Use	1.248	0.449	
Research	0.924	0.147	
Retail	0.533	0.92	
Stormwater	4.03	0.186	***
Transport	1.072	0.181	
Trash	0.743	0.256	
Trees	1.131	0.165	
Focus sending			
Arts & Culture.1	0.406	0.671	
Education	1.853	0.119	***
Environment	1.067	0.104	
Faith	0.702	0.26	
Food	0.568	0.187	**
Other	1.52	0.114	***
Grants	4.623	0.191	***
Re-Use	1.28	0.362	
Research	1.549	0.165	**
Stormwater	2.489	0.162	***
Toxics	0.297	0.365	***
Trash	1.937	0.131	***
Trees	1.242	0.14	
Organization type homophily			
Non-profit	1.559	0.106	***
Local Govt	1.283	0.218	
Community group	0.872	0.531	
Federal Govt	4.449	0.171	***
Private	0.983	0.739	
Religious	1.123	1.11	
School affiliate	0.379	1.019	
State Govt	4.844	0.435	***
Focus homophily			
Animal	11.37	0.574	***
Community	1.349	0.155	
Education	3.494	0.194	***
Environment	1.255	0.161	
Faith	29.34	0.474	***
Food	6.265	0.576	**
Other	1.144	0.396	
Grants	6.627	0.678	**
Recreation	16.681	1.087	**
Research	0.943	0.457	
Stormwater	1.169	0.738	
Trash	4.395	0.488	**
Trees	5.035	0.326	***
Location-based terms			
Density (Receive)	1	0	
Density (Send)	1	0	***
Income (Receive)	1	0	
Income (Send)	1	0	*
Distance	1	0	**
Contiguity	2.103	0.071	***

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Table 4 (continued).

References

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