
Reflecting on Local Ecological Stewardship, Care, and Action across Two Decades of Research

In this perspective, we draw from 20 years of implementing the Stewardship Mapping and Assessment Project (STEW-MAP) to show how civic actors provide capacity and local knowledge needed for effective decision-making and implementation in the face of multiple interconnected stressors, including climate change and inequality. Urban areas are striving to achieve sustainability and resilience goals while advancing diversity, equity, inclusion, and justice. There is broad recognition that systematic change cannot be achieved via single sector solutions. Rather, just and equitable sustainability and resilience outcomes will be achieved through multi-sector, trans-disciplinary efforts led by diverse and inclusive partnerships. Processes of collaboration between groups and across sectors can foster trust and social cohesion to build adaptive environmental governance capacity. Hindering these outcomes is a lack of approaches for identifying civic groups and their networks, understanding their roles in the larger governance system, and harnessing their capacities systematically and at landscape scales. STEW-MAP was developed to address this gap in a natural resources management context and has been applied in 20 locations across the Americas. Synthesizing key insights for practitioners and researchers, we identify the critical role of civic organizations in collaborative, networked governance, while highlighting inequities that affect this stewardship work. We reflect on how stewardship mapping has been used as a decision-support, networking, and visualization tool and identify future research and practitioner directions that fully acknowledge the persistent role of civic groups in caring for the environment and enlivening democratic practice.

Keywords

civic engagement, governance, sustainability, environmentalism, partnerships, multiscalar approaches, network analysis

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Authors

Lindsay K. Campbell, Erika S. Svendsen, Michelle L. Johnson, Natalia C. Piland, Dexter H. Locke, Nancy F. Sonti, J. Morgan Grove, Michele Romolini, Heather L. McMillen, Rachel Dacks, Bryce B. DuBois, Jesse S. Sayles, Tisha A. Muñoz-Erickson, Laura Landau, Lorien Jasny, Krista Heinlen, Maria Arroyave, Camille McCarthy, David Bloniarz, Brian A. Goldberg, Gerald P. Bauer, Travis Warziniack, Sophie Plitt, Julio Onofre, Nicole Heise Vigil, Arantxa Zamora-Rendon, Alejandra M. García Castro, Nicole A. Harmelin García, and

Bryan Flores

We, authors of this perspective, are committed to understanding how local, civic stewardship can contribute to collaborative governance in the service of more sustainable, just futures. In 2004, the research subcommittee of the Urban Ecology Collaborative (a partnership of universities, non-profit organizations, and state, local and federal officials working in cities in the Eastern United States, <https://urbanecologycollaborative.com/>) assessed its members to better understand the structure, function, and network of these community-based urban land managers. These findings were published in the first issue of *Cities and the Environment* (Svendsen and Campbell 2008). Twenty years later, this assessment has grown and evolved into the Stewardship Mapping and Assessment Project (STEW-MAP), a replicable methodology that has been applied across cities and communities of different sizes and different cultural, political, and ecological contexts. Here, following a review of key concepts from the literature, we reflect on results from these implementations and synthesize them into key insights that aim to understand and equitably strengthen the system of local ecological stewardship, care, and action.

Civic capacity in general (Sampson 2012; Clifford 2018), and civic environmental stewardship in particular (Rigolon and Gibson 2021), remains poorly studied, and is often ignored by agency-driven resource planning efforts. Approaching collaborative governance from the lens of environmental stewardship provides “a powerful leverage point for catalyzing more effective and equitable nature conservation and other large-scale societal transformations necessary for just sustainability (Heller et al. 2023, p. 731). Stewardship is not the same as ownership: care, knowledge, and agency can be expressed on public, private, and collaboratively managed lands (Enqvist et al. 2018). Therefore, formal and informal civic actors play multiple roles in environmental governance networks, not only as property owners or land managers, but as stewards who engage in acts of caretaking and claims-making across land jurisdictions (Andersson et al. 2014). Civic stewardship ranges widely in form, influence, and effectiveness, occurs at multiple scales, and varies in tactics from collaboration to contestation (Connolly et al. 2013). While civic engagement is influential in social movements and protests, there is a need to understand how civic engagement in ‘everyday’ neighborhood spaces such as parks and community gardens plays a role in strengthening social cohesion and collective efficacy (Sirianni and Friedland 2001). Working across a range of physical sites and contexts, civic engagement in environmental stewardship contributes to both community quality of life and ecosystem health (Svendsen and Campbell 2008). Civic environmental stewardship can then be defined through the actions that stewards take: conservation, management, education, advocacy, monitoring, and transformation (Fisher et al. 2012).

Governance arenas, including in natural resources management, are multi-scalar, polycentric and engage numerous actors collaborating and contesting in networks (Bodin and Prell 2011; Connolly et al. 2013; Bodin 2017). Practitioners engage in collaborative conservation and shared stewardship across jurisdictional and sectoral boundaries, addressing landscape-scale challenges that affect organizational interests beyond the biophysical, such as wildfire risk management through prescribed fire (Huber-Stearns et al. 2021), insect infestation and species management (Steen-Adams et al. 2020), and urban forestry and urban agriculture (Lawrence et al. 2013; Campbell 2017). Governments are thus increasingly developing sustainability and resilience plans geared towards driving societal changes, moving away from single-sector solutions that have rarely reflected the full diversity of potential partners (Portney and Berry 2016). Civic actors—including non-governmental organizations (NGOs), community-based

organizations, faith-based groups, and civic minded individuals—provide capacity, local knowledge, and a voice in decision-making and implementation (Campbell et al. 2021). Processes of collaboration between individuals, between groups, and across sectors can foster trust and social cohesion, which can build more adaptive environmental governance and strengthen democratic processes (Siriani 2009; Connolly et al. 2013). Civic groups and their networks produce bonding and bridging ties, contributing to adaptive capacity when faced with crisis (Tidball et al. 2010; Klinenberg 2018; Campbell et al. 2019; Kyne and Aldrich 2020; Landau et al. 2021).

To help decision-makers effectively navigate and operate in this complexity, data that show how networks are structured, which actors are influential as brokers, and how information and resources are flowing across partners can enable strategic decision-making. Despite the widespread *scientific* knowledge and framing of social-ecological systems, there remains a need to operationalize this integrated understanding in natural resources management *practice* (Muñoz-Erickson et al. 2016; May 2022; Gomez-Jaramillo et al. 2024). In the context of natural resources management in the United States, social information about groups and networks is rarely collected systematically, nor is it coordinated with the collection of ecological data (i.e., data on biophysical resources like trees, forest, or parks) (Robinson et al. 2019). Consequently, decision-makers rely on aggregate information from the U.S. Census or similar population-level demographic surveys of households and individuals. These data broadly characterize socioeconomics, but cannot identify the civic groups and networks that are brokers of trust and expertise, and create capacity for transformative action. On the other hand, case study research on the nature and outcomes of different partnerships in collaborative planning and land management are abundant (e.g., Kamelamela et al. 2022). There are numerous guides on how to cultivate partnerships and manage collaborative decision-making processes (e.g., U.S. Environmental Protection Agency 2008). But there is a dearth of scientific approaches to this work that are replicable, scalable, and allow for comparison of civic capacity and governance networks across space and time. Given varied governance structures and community contexts, there is a need for replicable methodologies, like STEW-MAP, that can be applied across cities and communities of different sizes and cultures.

THE STEWARDSHIP AND MAPPING ASSESSMENT PROJECT

STEW-MAP is an interdisciplinary research methodology, community organizing approach, and partnership mapping tool that answers the fundamental question: Who takes care of the local environment? It generates otherwise-unavailable robust information about civic groups for use by social and biophysical scientists, land managers, and decision-makers working in fields of sustainability and natural resources management through surveys and interviews. Surveys of stewardship groups provide insights into organizational characteristics (e.g., year founded, number of employees, mission), geographic areas stewarded, and organizational social networks (Svendsen et al. 2016). Qualitative, semi-structured interviews with a subset of groups help us understand organizational histories and impacts. Once data are collected, they are organized into a public database shared via online maps, articles, websites, and meetings (U.S. Forest Service 2024). STEW-MAP has been applied in both urban and rural settings in both North and South America and adapted to fit various governance structures and ecological and cultural contexts (See Appendix, Table 1 for information on 20 locations).

Results from STEW-MAP generate insights into stewardship practice. They can be used to describe stewardship capacity, inventory stewardship goals, and map spatial characteristics of the places where stewardship occurs. STEW-MAP asks groups to provide information on their most important partners, which is used to visualize and understand the structure of collaborative networks and the flow of resources and information. Decision-makers can then use these results to understand, support, and enhance the governance system (Wagner et al. 2022). As a cross-sectional survey, results have been correlational, but repeated surveys in the same location (e.g., in Baltimore, New York, and Los Angeles (See Appendix, Table 1)) have the potential to yield causal understanding of stewardship's role in social-ecological systems.

The STEW-MAP process is as critical as the results: the adjustment of the survey can contribute to systems-level change by creating conversation spaces that connect disparate groups. The first step of STEW-MAP involves scientists, practitioners, and decision-makers collaboratively building the sampling frame for the survey, and is an opportunity for community organizing and partnership development. For example, in New York City (NYC) and Baltimore, there are tightly connected networks of community gardens and of watershed/waterfront groups, but these entities do not necessarily work with each other—all are included and engaged in STEW-MAP. As the survey is implemented, conversations around what data to collect can lead to a more representative survey. The Hawai'i STEW-MAP engaged land management agencies, Indigenous leaders, and hula schools to adjust the survey tool to their local context. They tailored stewardship types, sites, and activities in the survey to reflect Hawai'i-based practices and Hawaiian language (e.g., *mālama* as an option to care for; *loko i'a* as stewardship site; *āina*-based learning as a service provided).

Understanding stewardship as a system can shift organizations' perspectives from one of competition to one of collaboration. For example, the first STEW-MAP step has been necessary in all locations where we have worked, because no comprehensive, place-based directory of stewardship groups existed in any of those locations. When lists of partners do exist, they are often held by particular individuals in an organization, which can lead to a loss of information during staff turnover, or not shared because of a sense of competition between groups with overlapping missions. Public sector agencies and large NGOs that partner with local groups each understand their constituencies or members, but none of these organizations has a comprehensive understanding at the system level. STEW-MAP helps shift this sense of scarcity by highlighting opportunities for groups to collaborate and share information and resources. STEW-MAP includes all types of groups to understand the entire, connected system across green, gray, and blue spaces (Landau et al. 2019; Sonti et al. 2023). By combining previously disparate organizational databases and publicly available registries, STEW-MAP allows groups from adjacent fields (e.g. housing, social services, youth development) to self-identify as stewards, developing a more complete, and long-lasting, picture of the civic stewardship landscape than before.

While rendering civic stewardship groups more visible is an important outcome of this methodology, not all groups seek that visibility. Smaller grassroots groups often do not have paid staff, websites, or offices. For diverse reasons, including insecure land tenure or contentious politics, some groups do not want to have their work publicly mapped. Committing one's area to a public GIS, and documenting collaborators in a network map is a powerful act that can be seen

as threatening or empowering depending on context. As such, it is critical to follow not only best practices in protecting confidentiality, but also take extra care in allowing groups to “opt in” to any public database. Groups can also contribute their data for systems-level analysis that maintains organizational-level anonymity. For example, in La Paz, Mexico, participating groups requested a formal confidentiality agreement. Those who decided to make their information public had the option of not sharing sensitive data, such as their location and budget. Additionally, stewardship science research building on the initial survey has been developed to create safe and brave spaces for groups that may not want the public attention (such as stewardship salons, McMillen et al. 2020; Campbell et al., *in review*).

Our experiences and research with STEW-MAP have contributed five key insights, which we describe below:

Key Insight #1: Stewardship Groups Come in All Shapes and Sizes

More is understood about NGOs than about informal, community-based groups (Toepler 2003), despite their important contribution to stewardship goals (Sirianni and Friedland 2001). STEW-MAP helps fill these gaps by collecting data about community-based stewardship (civic groups without formal nonprofit 501(c)3 status and without paid staff) (Muñoz-Erickson et al. 2019) and groups with numerous paid staff and budgets of over \$1 million (Landau et al. 2019). Many groups grow and formalize, while others remain all volunteer-run or with part-time staff. Whether due to philosophy—of focusing on mutual aid or community engagement—or out of necessity due to resource constraints, volunteer-run groups are less embedded in what some critics call the “nonprofit industrial complex”—or the web of non-profit, government, and business relationships (Rodriguez 2007).

The presence and diversity of groups is also linked to their origins. Environmental civic engagement can be ephemeral or episodic—with social movements mobilizing around particular disturbances or crises (Tarrow 1993; Fisher 2019). Yet, many civic stewardship groups persist over time through everyday acts of care. Through STEW-MAP, we have identified stewardship groups with origins as early as the 18th century. We found that the number of groups generally increases from the 1970s onward (e.g., Figure 1), a time frame associated with the growth of the modern, American environmental movement—as well as the Hawaiian cultural renaissance (Connolly et al. 2014; Grandinetti 2021). We found similar patterns in our Colombia, Peru, Mexico and Dominican Republic datasets, aligning with earlier work showing that neighborhood associations formed to improve quality of life in Latin American cities in the 1980s (García 1992). We note that these patterns are associations without demonstrated causality, and that a present-day snapshot does not account for groups that were founded, operated for a period of time, and folded (e.g., Twombly 2003). Other methods, such as interviews and/or archival research, may be better suited for documenting groups that no longer exist and learning why their stewardship ended. As STEW-MAP becomes a long-term, temporal dataset, e.g. 2007 and 2017 data collections in NYC, 2011 and 2019 in Baltimore, MD, and 2014 and 2019 in Los Angeles, CA, plus replications planned elsewhere, our knowledge will increase. These historical views may give further insight to how social-ecological organizing relates to other political movements with material consequences.

Given this diversity of stewardship groups, we need many means to showcase the capacity and leadership that local groups bring to neighborhood decision-making and action, particularly in under-resourced and historically marginalized communities. To describe the diversity in types of groups, we developed a “professionalization index” categorizing groups by number of staff and size of budget, finding differences in level of professionalization among groups working on different sites across urban ecosystems (Fisher et al. 2012). We recently extended this work to develop a spatialized “capacity index,” characterizing groups’ ability to address collective issues in a particular place by leveraging information on human and social capital (Johnson et al., *in review*). Finally, semi-structured interviews revealed that groups with smaller geographies and fewer network ties still play a role in fostering collaborations and resolving conflicts (Campbell et al. 2021).

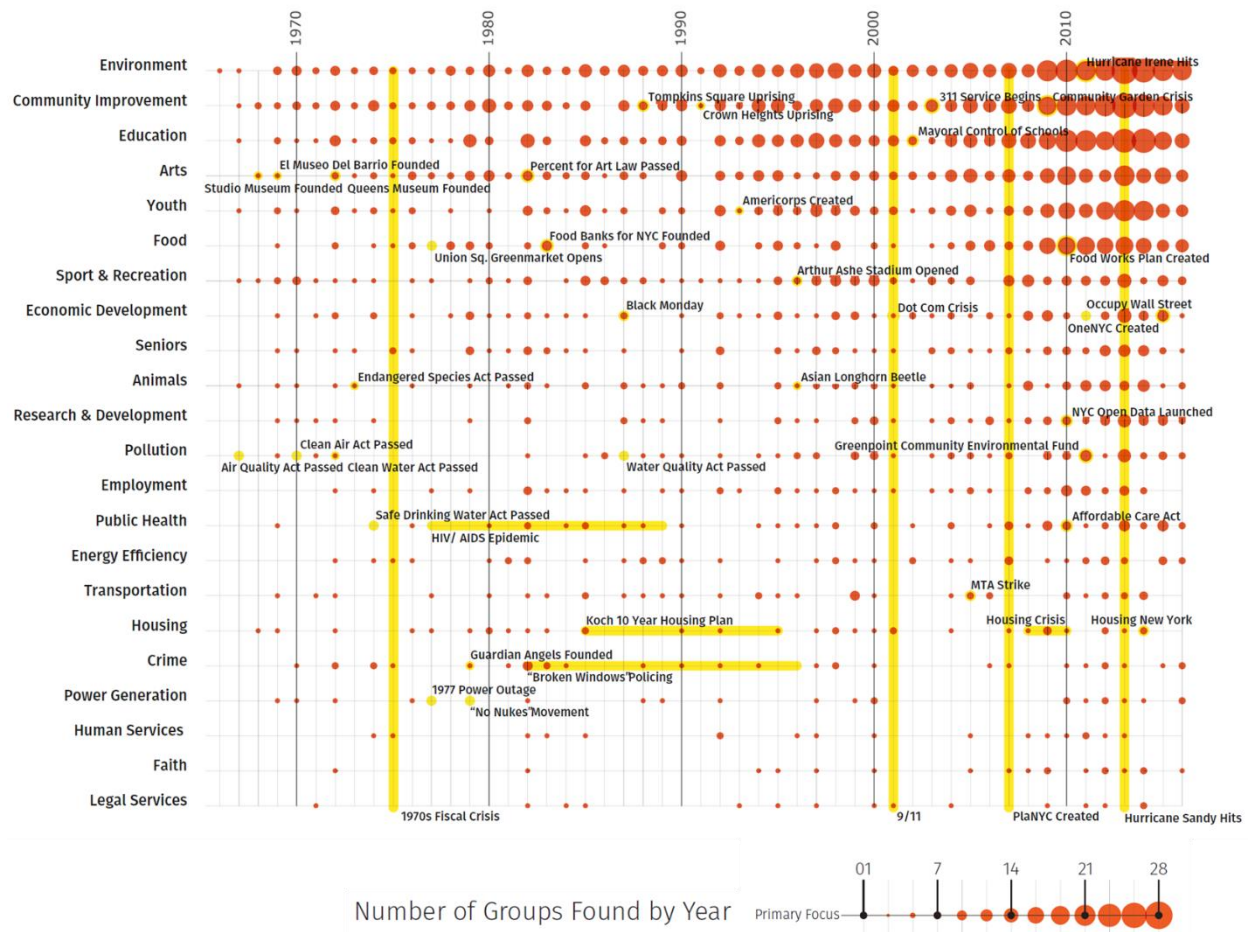


Figure 1. Stewardship groups come in all shapes and sizes, reacting to and shaping the landscape around them. This timeline shows when NYC stewardship groups were formed by their organizational focus. Important local social-ecological events alongside each of these foci are highlighted. Figure adapted from the “Who Takes Care of New York?” exhibit at the Queens Museum held in September 2019 and organized by the USDA Forest Service’s New York City Urban Field Station (NYC UFS) and Pratt Institute’s Spatial Analysis and Visualization Initiative (SAVI), along with Independent Curator, Christina Freeman. An online version of this exhibit can be found at The Nature of Cities, <https://www.thenatureofcities.com/frie/wtcony-2020/>.

Key Insight #2: Stewardship Groups are Agents of Social-Ecological Change

Stewardship groups manage and transform environments and communities through care, direct action, hands-on work, education, and advocacy (Svendsen and Campbell 2008; Bennett et al. 2018). These groups are not only environmentally focused; they focus on youth, seniors, social services, arts, and more (Figure 1). Groups engage in stewardship as a means to advance community quality of life. For example, in NYC, groups' mission statements were framed as addressing an integrated social-ecological system, and coding could not disentangle a "social component" from an "environmental component" (Landau et al. 2019). Similarly, in Hawai'i, education and cultural perpetuation emerged as highly salient themes, alongside conservation in coded mission statements (Grandinetti et al. 2021). In the Los Angeles River Watershed, STEW-MAP captured groups often overlooked in established concepts of environmental stewardship, such as universities and research institutions (Thomas and Romolini 2023). For natural resources management agencies, partnering with diverse civic groups extends their reach and relevance to strengthen diversity, equity, inclusion, and justice (DEIJ) through partnerships (Campbell et al. 2022).

Decision-makers often seek metrics by which to track the actions and impacts of organizations. Across locations, STEW-MAP data have been used to discern not only the number of groups working in a region, but also the number of staff and volunteers leveraged, the acreage of land and waters that are cared for, the metrics groups themselves track for this work, and groups' perceived ecological and social impacts. Ecologically, stewardship supports the health and function of various green and blue spaces—such as street trees, parks, and estuaries—so that they can provide ecosystem services like clean air and water. Socially, groups can foster community cohesion and social trust (Landau et al. 2019). For example, in the Lima STEW-MAP (EcoRed in Spanish), many groups are neighborhood associations that have joined forces to defend their parks, green areas, or unique ecosystems in their neighborhoods. This includes organizations of "lomeros" who are concerned with the care of the lomas ecosystem, an ecosystem endemic to the Peruvian and Chilean coastlines that provides climate regulation, water cycle regulation, air quality improvement, recreation, and identity creation. Thus, civic stewardship groups activate green space to function as social infrastructure. Stewards create gathering spaces, enliven them with culturally relevant programming, and engage in community organizing and planning (Campbell et al. 2021).

Although more work is needed to causally link the presence and effort of organizations with changes in social and ecological conditions, strong associational patterns do exist between stewardship groups and ecosystem quality. Neighborhoods in Baltimore, MD with more tree canopy tend to have more environmental stewardship groups, when controlling for known confounders, such as the number of ties and density in each neighborhoods' network, population density, race (% White), owner-occupied housing, education and income (Romolini et al. 2013). In addition, the presence of volunteer-initiated stormwater green infrastructure was positively associated with the number of stormwater management stewardship groups (Ponte 2023). In NYC, most neighborhoods lost vegetation cover from 2000 to 2010, but those gaining vegetation had significantly more stewardship organizations (Locke et al. 2014). In Medellín, an i-Tree and STEW-MAP integrated project implemented in the Comuna 10 district indicated a positive association between the ecosystem benefits provided by urban trees and the number of civic

groups, activities, and links among them (Arroyave et al. 2020). In La Paz, STEW-MAP results were combined with i-Tree and the Watershed and Aquifer Management Action Plan. By integration of different data and strategies, these cross-sector partnerships are contributing to the long-term sustainability and resilience of the city.

Key Insight #3: Stewardship Groups Respond to Disturbance and Foster Resilience

Working in a context of multiple, overlapping disturbances and stressors, stewards foster social and ecological resilience. Whether the disturbance is acute or chronic, stewards engage in all stages of the recovery cycle, from short-term responses to long-term recovery to adaptation through acts of environmental care and community organizing that promote place attachment, social cohesion, social networks and knowledge exchange and diversification (Figure 2; McMillen et al. 2016; Campbell et al. 2019). STEW-MAP data demonstrate that stewards have played transboundary governance roles in the urban climate adaptation planning arena (Caggiano et al. 2022), and have identified climate change as a key motivating driver, even if their efforts are not focused directly on climate adaptation and mitigation (Landau et al. 2019). In responding to this challenge, stewards engage a range of tactics and practices, including shaping physical spaces, brokering partnerships, disrupting the status quo, building civic capacity, and envisioning new futures (Fisher 2021; Caggiano et al. 2022).



Figure 2. Stewardship groups respond to disturbance and foster resilience through acts of environmental care and community organizing, as can be seen from this picture of stewards planting 'ōhi'a trees in response to Rapid 'Ōhi'a Death. Photo courtesy of the Division of Forestry and Wildlife, State of Hawai'i.

Decision-makers increasingly call for a greater collaboration with civic groups in the coordination of disaster planning and recovery (e.g., Resilient Nation Partnership Network in U.S. Department of Homeland Security 2024); STEW-MAP data offer opportunities for such engagement. Guidance such as the National Disaster Recovery Framework directs coordinated federal response and enables federal funds to flow to local civic groups who have community trust and buy-in (Halfon and McLachlan 2019). Identifying and tracking potential civic partners is needed; it is important to collect data in advance for use after a disaster. For decision-makers, STEW-MAP databases have served as a roster of civic groups, which are repositories of civic capacity, holders of local ecological knowledge, and potential partners in both disaster recovery and long-term climate adaptation planning (e.g., NYC Mayor's Office of Resiliency and Recovery in Wagner et al. 2022). To address urban forest resilience, STEW-MAP data have also been incorporated into urban forest management plans, like in Valledupar, Colombia (Alcaldía de Valledupar 2017). Interview and survey work in NYC, Hawai'i, and Southeastern New England during the early months of the COVID-19 pandemic reveal that stewardship groups are both impacted by and able to flexibly adapt to the pandemic, supporting community well-being in novel ways (Landau et al. 2021; Dacks et al. 2021; Merkle et al. 2022). The STEW-MAP survey collects actionable data for decision-makers on the organizational networks involved in disturbances of most concern to a particular location (e.g., hurricanes, Rapid Ōhi'a Death in Hawai'i; wildland fire in Bridger-Teton National Forest; Water crisis in La Paz, Mexico), such as identifying key brokers ready to disseminate information and foster collaborations.

Key Insight #4: Stewardship Groups Operate Through Polycentric Collaborative Networks

Stewardship network data from STEW-MAP shows how groups work in complex networks with key brokers who disseminate resources and information to more peripheral actors (Connolly et al. 2013; Berardo and Lubell 2016). More advanced social network analysis (SNA) methods, such as Exponential Random Graph Models (ERGM), can also be used to understand the relationships and actor attributes relating to specific network patterns (Lusher et al. 2013) and handle missing data when predicting whether one particular group collaborates with another. For example, ERGM analysis found that focal issue area (e.g., youth, environment, community development) was associated with collaborative ties in the Philadelphia STEW-MAP but not in the NYC STEW-MAP, while geographic proximity was associated with collaborative ties in NYC but not Philadelphia (Jasny et al. 2019). These results show the heterogeneity determining stewardship networks (Jasny et al. 2019). Qualitative data drawn from interviews complement these quantitative modeling approaches, providing more contextual detail about how and why collaborations form and are sustained (Campbell et al. 2022).

Network diagrams effectively communicate complexity to a range of users, stakeholders, and decision-makers visually. In STEW-MAP workshops in Los Angeles, stewardship organizations found utility in the data and visuals in reflecting on their own work (Maharramli and Romolini 2023). For example, participants in these workshops reflected that these data add texture to the stewardship narratives that they found in a place (Maharramli and Romolini 2023). Web tools display STEW-MAP network data in a customizable and filterable way by topic area of interest, allowing the user to see the network of stewards engaged in recreation, watershed restoration, or youth engagement, for example (Figure 3 and Table 1). Network visuals also demonstrate which groups a particular entity may not already be working with, allowing them to

think strategically and inclusively about growing new partnerships. These visuals also help funders and government entities understand which parts of the networks need more support. Indeed, the STEW-MAP project in Southeast New England not only asked groups who they collaborate or share knowledge with, but also what other groups they would like to build relationships with and why. As an example, the results (which were only reported in aggregate for confidentiality reasons) outlined several opportunities to support groups working on environmental justice and equity issues (DuBois et al. 2023).

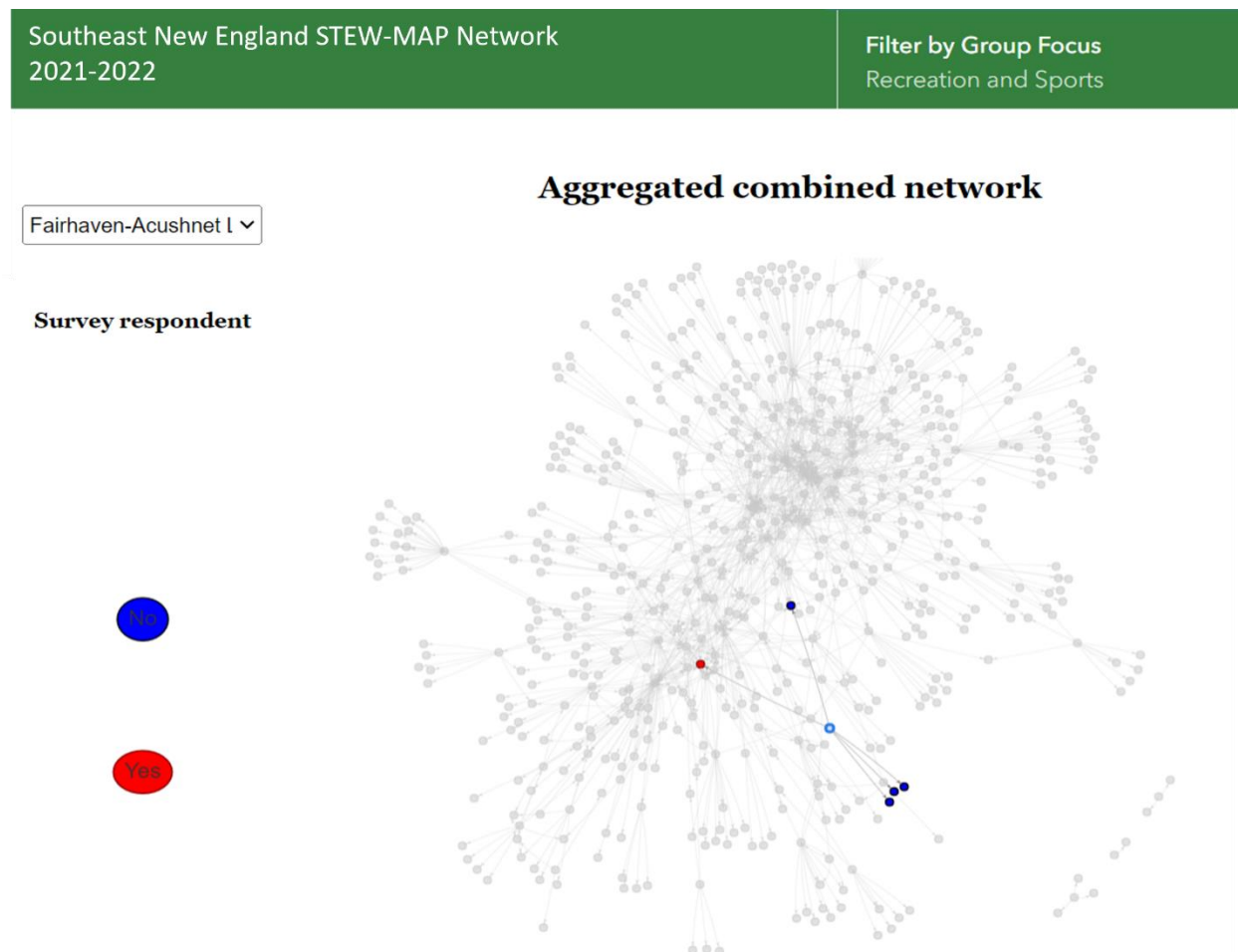


Figure 3. Stewardship groups operate through collaborative social networks, highlighted in this screenshot from the Southern New England STEW-MAP dashboard, <https://www.arcgis.com/apps/dashboards/2fe9393c3fe343ab80cdcaf6c1a2cb33>. This dashboard allows us to see the different stewardship groups in the area and their networks (here, we see Fairhaven-Acushnet Land Preservation Trust’s network, one of three groups in the database that focus on recreation).

Key Insight #5: Stewardship Groups are Distributed Unevenly Across the Landscape

Civic groups offer capacities to land management, disaster response, and collaborative governance, yet they are unevenly distributed across the landscape (Figure 3). STEW-MAP

identifies the spatial boundaries and geographies where stewardship groups have their most direct physical sphere of influence, local capacity, and power. Scholarship from nonprofit studies, park management, and stewardship science has identified the challenge of uneven patterns of civic engagement (Sayles 2018; Rigolon and Gibson 2021). Because civic stewardship activities are heterogeneous, the relationship to other demographic, open space, or built environment factors is similarly complex. Across STEW-MAP locations, Johnson et al. (2019) found that specifics of the organizational landscape (e.g., average professionalization and diversity of group focus) had the strongest relationship with the density of stewardship groups, rather than community demographics or amount of greenspace. This finding suggests that who else is working in the same space can have a strong effect on how many groups work there. This dynamic needs to be better understood to assess whether this is due to inclusionary or exclusionary practices in those locations.

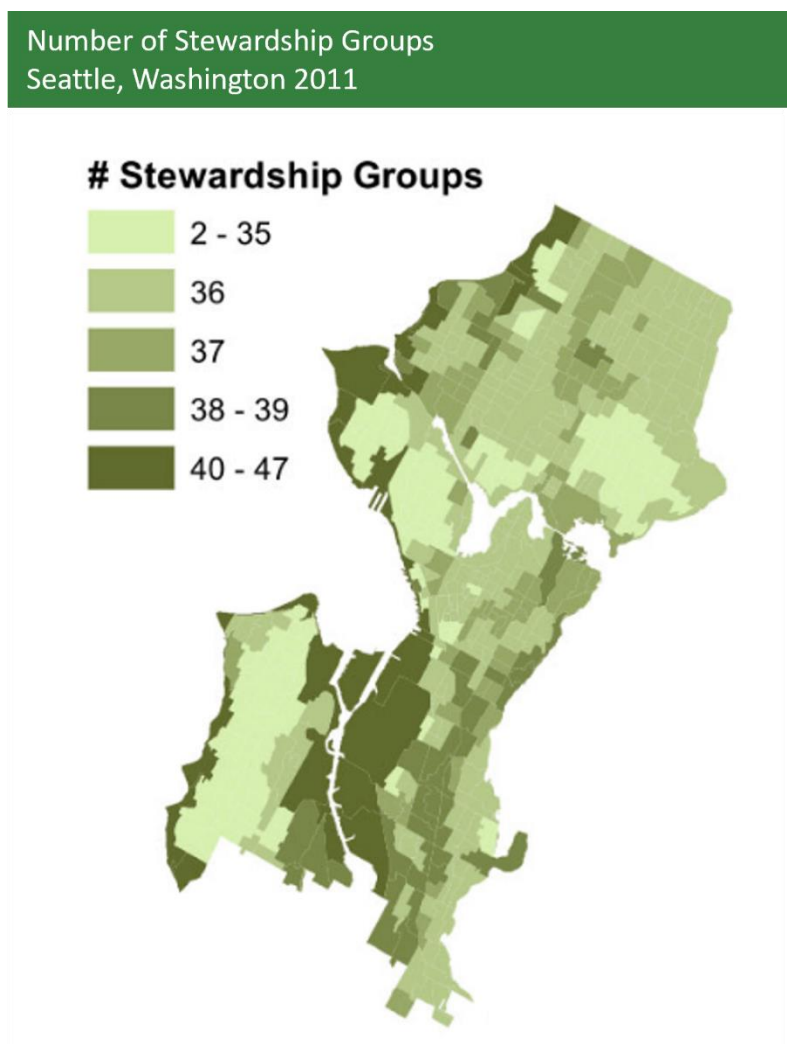


Figure 4. The distribution of stewardship groups is uneven across Seattle, Washington. We see similar unevenness across STEW-MAP locations, including Baltimore, Chicago, and New York (Johnson et al. 2019).

The spatial unevenness of group distribution is directly relevant to the planning processes in both agencies and NGOs that embrace equity in urban greening as a goal, as they often center distributional equity. However, our qualitative work suggests a need to similarly center procedural or recognitional equity (fair processes of decision-making that recognize all members of the public, their concerns, and forms of speech) (Nesbitt et al. 2019; Campbell et al. 2022). These plans call on the need to engage historically marginalized or underserved communities, and access to data about civic groups' capacities, geographies, and networks can support equitable engagement strategies and partnerships that uplift the stewardship already being carried out and address systemic barriers to these communities' stewardship goals. The Southeast New England STEW-MAP project was carried out as part of a larger inter-agency program to enhance capacity building for environmental restoration, stormwater management, and climate resilience (Merkle et al. 2022). This program is interested in exploring how to use survey results to inform planning and outreach for helping to address environmental justice (DuBois et al. 2023). Such equity focused work in general leads to answering questions such as: Are decision-makers continuing to privilege certain voices and groups over others? Who are the key partners connected to decision-making processes in a particular place? If building more equity into the stewardship system is a goal, then we need to understand the enabling conditions that allow these groups to emerge and sustain. The collection of geographically specific social network data can provide key insights when replicated among communities of different sizes and contexts and measured longitudinally over time – approaches which the STEW-MAP methodology enables.

IMPLICATIONS FOR STEWARDSHIP RESEARCH AND PRACTICE

We argue that a systematic understanding of civic groups' capacities, geographies, and networks is critical to support more effective and inclusive governance arrangements that address current sustainability and inequity crises. We use the key insights from the last twenty years of research to identify future directions of inquiry and enhance STEW-MAP as a decision-support tool. STEW-MAP provides a way to quantify the presence, extent, connections, and actions of civic environmental groups. Interviews and case studies document factors influencing groups, and the individual and collective impacts of civic environmental groups (Campbell et al. 2022; Landau et al. 2021). More work remains to quantify these relationships at a network or system level and to more fully examine the myriad effects of stewardship across a landscape (Heller et al. 2023). Additionally, more work is needed to understand stewardship group membership as it relates to the broader public, particularly from an equity lens. Numerous research questions remain in terms of networks, power and influence, and the universality or place-based nature of stewardship. First, how do governance networks evolve over time? While the impact of disturbance events has been demonstrated for individual stewards and group levels, how might the structure of networks reorganize in response to stresses and shocks? Second, how does power operate in various stewardship arenas? Which groups have the most influence over resource allocation, decision-making, and management of places; and what are the outcomes? How do different arrangements between the public, civic stewards, government, philanthropies, and the private sector lead to different outcomes for sustainability, resilience, and democratic practice? These questions provide ample opportunity to continue to develop stewardship science. Understanding more about the ways to manage and harness stewardship as a social-ecological system is critical for effective and sustained collaboration.

STEW-MAP is already designed to comprehensively capture data about groups, geographies, and networks at the landscape scale – and can be repeatedly measured over time (e.g., New York City STEW-MAP has been collected in 2007, 2017, and is planned for 2027). Additional planned improvements to STEW-MAP as a decision-support tool include increasing the frequency of data collection and making databases more quickly updateable – an approach is in development for the entire United States. We are experimenting with a range of approaches beyond our current decadal survey, integrating web scraping tools (e.g., Sayles et al. 2022) and artificial intelligence as alternatives to collect stewardship network data, currently being deployed in STEW-MAP implementations across a rural-to-urban gradient in Missouri and in wildfire vulnerable regions of Colorado and Idaho. Further, we seek to identify and reach all stewardship groups. This requires new data sources (e.g., lists of Homeowners Associations, Community Land Trusts, faith-based groups) and methods, and is a clear opportunity for partnership with these entities in co-developing the research. Since each STEW-MAP implementation is not a “replicate,” but rather is an adaptation to local context and needs – each time the method is deployed there are learnings and refinements exchanged among the community of practice.

Centering equity in our stewardship science approach offers opportunities for methodological innovation and co-production. STEW-MAP already identifies key civic brokers who disseminate knowledge and resources, which present opportunities for partnership and mutual learning with government actors. Findings from STEW-MAP in Baltimore and New York City have demonstrated that disparate networks that require coordination are an opportunity for investment in coalitions and shared funding (e.g., Chesapeake Bay Funders Network n.d., and City Parks Foundation 2023). Going beyond STEW-MAP’s original focus on group capacity, networks, and territories -- information about organizations’ leadership, staff, or member demographics has been noted as a gap in the knowledge base among nonprofit, Diversity, Equity, Inclusion, and Justice (DEIJ) scholars. Indeed, some have called for IRS 990s to collect demographic data on nonprofits (Adediran 2022). As such, the STEW-MAP survey in Missouri has been adapted to gather data on group leadership demographics and organization investments in DEIJ planning processes.

Stewardship science is being enriched through engaging with different cultural contexts. We are building intentional relationships with those that center racial and environmental justice in their aims and approach and those working in both rural and urban contexts. By co-producing knowledge we can tailor methods to address environmental justice concerns, but also identify alternative methodologies (e.g., interviews, workshops, ethnography, participatory approaches) and ways of knowing (e.g., Indigenous epistemologies, artistic approaches) that contribute to our understanding of stewardship. We can do this work through both research and our programs (McMillen et al. 2020; Campbell et al. 2024a, 2024b), which in turn feed back into our conceptualization of stewardship. Strengthening knowledge exchange among a diverse community of stewards and land managers is another crucial step. We are doing this work via organizing place-based fora, where culture, stories, and Local Ecological Knowledge are mutually shared in a respectful setting (see, e.g., Stewardship Salons, McMillen et al. 2020). We have developed an informal stewardship community of practice among researchers and practitioners interested in this topic across the United States and internationally. These fora provide opportunities to engage multiple actors and worldviews in their own time and on their

own terms, outside the context of a grant deadline or capital project. By strengthening relationships over time, actors in a network will be better poised to take on novel and complex challenges that will inevitably arise. With each application of the research, we learn more about how stewardship networks operate in entirely different governance regimes and cultural contexts. We continue to grow these knowledge exchanges throughout the world as the persistent, responsive, and networked nature of everyday care is critical in addressing the complex social and ecological issues of our time.

CONCLUSION

Reflecting on these insights and looking forward, we affirm that the same level of precision and care that is focused on biophysical systems must be put on social systems. The focus of natural resource management is often aimed toward physical places, while social systems, organizations, and human institutions profoundly influence the structure and function of ecosystems. As social-ecological dynamics are increasingly recognized as complex, so too must our knowledge systems and knowledge infrastructure evolve. There is a need to expand stewardship science that is embedded in local context, culture, and ecological knowledge, responsive to disturbance, and enabled to track change in real time. Better understanding of those systems requires a geospatial, networked, and temporal approach that can detect capacities and gaps, relationships, and change over time. Recognizing these stewardship groups as critical broadens the constituency of those working towards a better future, builds local capacity, embeds best practices in the local context, and, importantly, fosters innovation and trust. Capturing the networked and multi-scalar nature of our complex governance system reveals the actions and resulting effects of the collective, and how it might produce more sustainable, equitable, and inclusive solutions.

Whatever the desired ecological outcome – better forest health, heat mitigation, improved water quality – these ends require human capacity and care. This includes both investments in paid workforce and better recognition of volunteers. Partnerships and funding opportunities need to be tailored to the capabilities and interests of particular groups – from micro-grants to foster grassroots innovation and amplify neighborhood leadership, to sustaining funding that can support core operations of organizations, to investment in “network weavers” that connect the system. Strengthening the capacity of groups and networks will support a more nimble and responsive system that can respond in real time and persist over time. This deeper understanding of the relationships between individuals and local groups, and the role of resource support, would allow decision-makers to better understand who is and *is not* engaging in stewardship – and would enable strategic partnership development to advance aims of sustainability and justice.

APPENDIX

Table 1. List of publicly available STEW-MAP datasets and maps. Additional locations have used STEW-MAP methodologies but do not have publicly available datasets or maps and are therefore not listed here.

Location	Survey Year	Websites	Geographic Map Links	Social Network Links
Baltimore, MD	2019	https://research.fs.usda.gov/projects/stewmapbaltimore	https://doi.org/10.6073/pasta/ed8e2529ed68f9c697385d1bcf6eaf44	https://kumu.kumu.io/stewardship-networks-in-baltimore
Baltimore, MD	2011	https://research.fs.usda.gov/projects/stewmapbaltimore	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2011-baltimore-map	
Bridger-Teton National Forest	2020	https://research.fs.usda.gov/projects/stewmapbridgerteton	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2021-bridger-teton-map https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2021-bridger-teton-dashboard	https://embed.kumu.io/017695c92f0acc35b1a75378b423d276 https://embed.kumu.io/1a83b01684f1744d6d7bd9e15dda22bd https://embed.kumu.io/bccf8bef0a95a070e0b030787146b8ec
Chicago, IL	2011	https://research.fs.usda.gov/projects/stewmapchicago	http://stewmap.cnt.org/	http://stewmap.cnt.org/stewardship-networks.php
Denver, CO	2020	https://research.fs.usda.gov/projects/stewmapdenver		
Hawai'i (North Kona and South Kohala)	2017	https://research.fs.usda.gov/projects/stewmaphawaii	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-hawaii-phase-i-north-kona-and https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-phase-i-hawaii-dashboard	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-stew-map-hawaii-social-networks
La Paz, MEXICO	2024	https://research.fs.usda.gov/projects/stewmaplapaz#overview	https://usfs.hub.arcgis.com/maps/5acff1cd8c3b4311b220843fe8f7cfa4/about	https://www.fs.usda.gov/nrs/STEW-MAP/LaPaz/red_16.html
Los Angeles, CA	2019	https://research.fs.usda.gov/projects/stewmapla	https://academics.lmu.edu/courses/research/societytheenvironment/stewmap/lariverstew-map/	https://kumu.io/lmucures/la-river-stew-map

Lima, PERU	2022	https://research.fs.usda.gov/projects/stewmaplima	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2022-lima-peru-map	https://kumu.io/ecoredLima/ecored-lima#ecored-lima
Medellin, COLOMBIA	2019	https://research.fs.usda.gov/projects/stewmapmedellin	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2019-medellin-map En español: https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2019-medellin-colombia-map-en	https://embed.kumu.io/ca0d015acb641e7258cc14a6f49990a8
Missouri	2024	https://www.fs.usda.gov/detail/mtnf/workingtogether/partnerships/?cid=fseprd1088705 https://research.fs.usda.gov/projects/stewmapmissouri		
New York, NY	2017	https://research.fs.usda.gov/projects/stewmapnyc	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2017-new-york-city-story-map	https://embed.kumu.io/d94df0d22a6ccb7644843d0007ddf2ee
New York, NY	2007	https://research.fs.usda.gov/projects/stewmapnyc#projects	https://research.fs.usda.gov/products/dataandtools/datasets/stewardship-mapping-project-new-york-city-data-downloads	
NY-NJ Estuary	2015	https://research.fs.usda.gov/projects/stewmapnyc#projects	https://research.fs.usda.gov/treeearch/50713	
O'ahu, HI	2019	https://research.fs.usda.gov/projects/stewmapoahu	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-oahu-dashboard	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-oahu-social-networks
Philadelphia, PA	2014	https://research.fs.usda.gov/projects/stewmapphiladelphia		
San Juan, PR	2015	https://research.fs.usda.gov/projects/stewmapsanjuan		https://kumu.io/tmunozerickson/stew-map-san-juan-2015#stew-map-san-juan-v1
Santo Domingo, DOMINICAN REPUBLIC	2017	https://research.fs.usda.gov/projects/stewmapsantodomingo		https://kumu.io/tmunozerickson/santo-domingo-stew-map-2017#santo-domingo-stew-map-2017-v8-sin-solid-front

Seattle, WA	2011	https://research.fs.usda.gov/projects/stewmapseattle	https://depts.washington.edu/stewmap/	
Southeast New England	2020-2021	https://research.fs.usda.gov/projects/stewmapnewengland http://snepnetwork.org/stewardship-mapping/	https://www.arcgis.com/apps/dashboards/2fe9393c3fe343ab80cdcaf6c1a2cb33	https://www.arcgis.com/apps/dashboards/2fe9393c3fe343ab80cdcaf6c1a2cb33 https://snepnetwork.org/stewardship-mapping-results-products-data/
Springfield, MA	2020	https://research.fs.usda.gov/projects/stewmapspringfield	https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2020-springfield-ma-map https://research.fs.usda.gov/products/dataandtools/interactivemaps/stewardship-mapping-project-2020-springfield-ma-dashboard	https://embed.kumu.io/9f50b76adf40d70981d0368469581f04 https://embed.kumu.io/6d6a777f49135130621b7c92f131a24 https://embed.kumu.io/f3a4a5e249c2f8ac042120bc3189c039
Valledupar, COLOMBIA	2018	https://research.fs.usda.gov/projects/stewmapvalledupar#overview		

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