A Proposed Multi-Agency Program for Stewardship Science

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Poorly planned development, resource over-exploitation to feed expanding per capita consumption, and climate change interact to diminish native biodiversity, degrade natural resources, and compromise human well-being in urban and urbanizing environments. Because urban dwellers are expected to represent 60 percent of people on Earth by 2030 (UNFP 2007), these impacts are extensive. Innovative approaches to reducing impacts of urban living are being sought across the United States, providing compelling counter-examples of how communities are creatively meeting challenges by enhancing stewardship linkages between people and place. These complex exchanges have important implications for the resilience of coupled natural and human systems, especially regarding response to disturbances and disasters. To date, however, the science available for stewarding coupled urban systems lacks a national framework and coordinated operating environment.

Elected and appointed leadership, urban planners, and sustainability officers all require current and accessible information about the stewardship actions of nonprofits, civic and religious groups, and neighborhood associations. Unfortunately, this information is hard to secure in a timely way and information from other cities is often not available or accessible. Given that stewardship linkages often enhance resilience of coupled systems to global change, disturbances, and disasters, efficient and inclusive institutional structures are needed at multiple scales to support knowledge co-production and exchange across research, practice, and policy in an urban context. Although highly creative and potentially transformative approaches are being taken globally to understand stewardship (Campbell et al. 2016, Fisher et al. 2015, Grove et al. 2015, Kealiikanakaoleohaililani and Giardina 2016, Munoz-Erickson 2014, Svendsen et al. 2016), funding for such efforts is limited, national-scale syntheses are rare, and the means for productive interaction among researchers, resource stewards, and policy entities are lacking (McMillen et al. 2016).

To address these gaps, we propose the establishment of a joint stewardship science program (JSSP), to which USDA Forest Service would be a contributing member. Much as the Joint Fire Science Program is a broad partnership representing agency and organization interests in fire science and management, the JSSP would: 1) serve as a national, multi-agency, and multi-organization entity for advancing the science of urban stewardship; 2) fund the next generation of urban stewardship science; 3) establish the stewardship inventory and analysis (SIA) program to initiate standardized and baseline inventories of stewardship networks (Svendsen et al. 2016); 4) oversee the creation of a regional stewardship knowledge exchange consortia (SKEC) that links practitioners, researchers, and policy leaders; 5) enhance community stewardship capacity that serves a critical technology transfer

function in urban centers of the United States; and 6) create an urban stewardship learning network.

From these activities, a JSSP would stimulate the creation, synthesis, and exchange of stewardship knowledge through unprecedented support for hydrological, climatic, biophysical, social, economic, biocultural, and disaster resilience research and knowledge needs of urban resource stewards while also directly supporting technical assistance needs of communities (Figure 1). Further, we see a great need for the integration of multiple data streams (e.g., numerical biophysical models and collaboratively developed decision support tools) into new ways of thinking about sustainability and resilience planning and policy development as well as the structures that stimulate local to international discussions on collaborative knowledge production, outreach, and management.

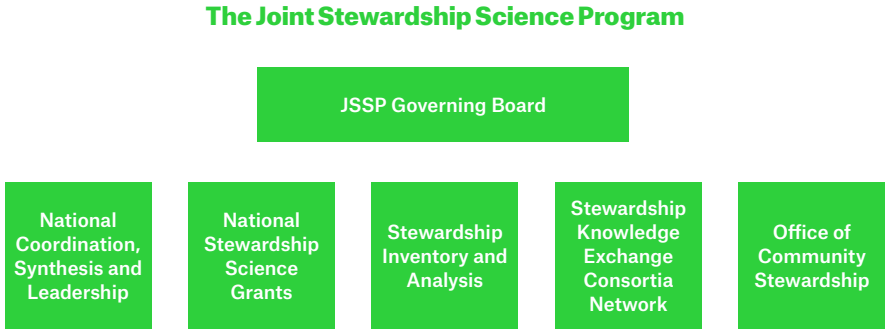

Figure 1: Draft vision for a national Joint Stewardship Science Program.

Background and Rationale

Global change is having unprecedented impacts on coupled human and natural systems and challenging the capacity of human dominated landscapes to provide resources and services to humanity. Efforts to understand why people steward a place, how people benefit from these stewardship interactions, and in turn how people shape the green and blue spaces in natural, residential, industrial, commercial, and agricultural land use types are emerging globally, but are constrained by: 1) access to relevant information on the independent and interactive effects of global change on coupled and natural human systems; 2) lack of a comprehensive science for managing the composition, structure, function, and dynamics of coupled natural human systems, especially in urban centers; 3) weak coordination of resource data exchange among research, management, and policy infrastructure; 4) lack of integrated information on how social, hydrological, and ecological variables support the resilience of communities; 5) lack of collaboratively developed,

model based decision support tools; and 6) limited capacity to forecast global change impacts on stewardship capacity and associated linkages. These capacity gaps are made larger by the rapid pace of global change, and the lack of infrastructure to develop, organize, and share this knowledge.

Of course, distributing scientific information about the dynamics and benefits of built environment stewardship may not influence policy or practice if the information is not used or if it has unanticipated or even negative impacts. Scientific understanding can clash with the way that communities understand, experience, and live in the environment (Jasanoff 2010). Knowledge production is an inherently social process (Mitchell et al. 2004), and the credibility of scientific knowledge is not the only or even the most important reason that information is taken up by potential users. The utility of scientific information often has more to do with the way it is salient and legitimate within a specific social context (Cash et al. 2003), and for many communities it is stewardship groups, not scientists, who have the greatest ability to combine science with local understanding of place, and put this understanding into practice. Accordingly, if we want to create usable science, we need to find ways to engage stewardship groups in research design, development, analysis, and dissemination of findings, as well as promote collaborative learning among stewardship groups. Participation in assessments allows stewardship groups to engage each other in the crafting of meaningful and motivating stories about their communities (Shaffer 2014). This requires developing partnerships with stewardship groups because these groups are best situated to work with communities to develop and share stewardship knowledge.

We suggest that holistic community and built environment-focused approaches are needed to develop and implement effective resource management and resilience strategies—approaches that integrate social, hydrological, ecological, and cultural knowledge on resource use (who needs it) and sustainability (how to manage change) in order to inform management and policy with the most current and relevant information. While several networks for policymakers and planners have emerged in urban resilience and sustainability planning and implementation (e.g., Urban Sustainability Directors' Network, Rockefeller Foundation's 100 Resilient Cities), there is no complementary network that connects the science of built-environment stewardship with community practitioners, which may include building bridges and networks between urban and rural areas. A JSSP could meet this need locally to nationally, with anticipated opportunities to encompass international initiatives. Developing this holistic approach to guide management, policy, and approaches to community sustainability and resilience in the face of global change and natural disasters will be made more achievable through the

creation of a national program and network of regional consortia and practitioners to help guide the next generation of urban stewardship research and practice. In addition to strengthening community-based efforts, a JSSP would support development of cutting edge anticipatory management actions and inform policy.

The Approach

It is critical that a JSSP be grounded in a thoughtful planning process and a concrete framework for knowledge co-production and exchange among researchers, practitioners, decisionmakers, community leaders, stakeholders, and benefactors. We propose that the program rely on six principles for executing its vision: 1) improve access to information sources, 2) provide better and more comprehensive information, 3) enhance stewardship inventory and analysis capacity, 4) improve and diversify technical assistance, 5) create a more collaborative information exchange environment, and 6) create a stewardship learning network. The strategies for achieving the principles are described below in detail.

1. Easier Access to Information Sources. Stewardship science has no centralized information source or repository, with rural to urban-relevant information often identified as being needed to assist resource planning and decision making, but it is currently difficult to access by researchers and practitioners. For example, managers of landscapes are left to use Internet search engines to locate information of sometimes uncertain reliability. Some peer-reviewed sources, such as journal articles, are often accessible only through academic institutions or for purchase, and so are not readily available to managers. Even when broadly relevant publications are accessible, applicability to specific management situations or built environments is often hindered by differences in geography or practices, writing styles that are difficult to interpret by managers, and lack of content describing management implications. As a result, managers most often learn through on-the-job training and trial-and-error experiences. Upper-level resource managers, agency leaders, and policymakers also require clear yet comprehensive data and information that would be easy to access through a data management structure that can promote effective knowledge and technology transfer. There is a need for information and products that are "manager-ready" and "policy-maker-ready." Centralized, Web-based, and region-focused clearinghouses for readily accessible, relevant, and understandable summaries addressing specific management needs will provide an important vehicle for meeting the knowledge needs of stewards.

2. Better and More Comprehensive Information. The types of information that are most often used in making management decisions, and the types of new information most useful in stewarding natural resources are limited and what exists is scattered across sources (libraries; individual researchers; university, federal, and state data-bases). Unmet information needs, especially with regard to scientific research and real-time data, include high resolution forecasts of urban resource information, for example hydrological modeling capacity, because this information is inadequate or lacking across most if not all urbanized areas of the United States. Other needs include greater capacity for real-time data collection and trend analysis—including weather, impacts of climate, site-specific and species-specific model outputs, and for certain areas, drought maps/warnings. Further, a JSSP could: promote creation of stewardship-focused knowledge exchange (SKEC), which would serve as regional knowledge clearinghouses for stewardship information; expand collaboration on research proposals with explicit input from regional managers on the design of requests for proposals; and finally provide a central Website connecting users to data, maps and trend analyses. Through improved communications and reciprocal, double-loop and triple-loop learning (Peschi 2007), consortia will improve the reach and appropriateness of information.

3. Enhanced National Stewardship Inventory and Analysis Capacity. A critical new investment area for a JSSP would be the creation of a stewardship inventory and analysis (SIA) program, which will be designed to provide a national approach to and funding for understanding the composition, structure, function, and dynamics of stewardship groups and networks. As part of the envisioned planning process, the program would elaborate: desired outcomes, required approaches and methods, potential pilot sites and demonstrations for stewardship inventory, and required technical capacity for running such a program including the conveying of information to user groups and decisionmakers. Through baseline inventories and periodic re-surveys of stewardship nodes and resulting networks, a JSSP seeks to provide a national-scale understanding of how stewardship is meeting the needs of people, shaping the rural to urban environments, responding to disasters and change, and over time, shifting and adapting to new conditions. Additionally, a national urban tree canopy program (high-resolution land cover data and tools) would be a fundamental component of our efforts to be used in concert with stewardship inventory data.

4. Improved Technical Assistance. Information and technology exchange are important challenges for a JSSP because in the past century, threats to community-relevant resources (e.g., invasive species, climate change, fire, sea level rise) have expanded dramatically across local, county, and state geographies, but capacity to deal with these threats has not kept pace. Managers repeatedly identify capacity to address topics such as watershed planning, disaster recovery, climate mitigation, and invasive species control as being constrained by inadequate funds or limited knowledge exchange. In turn, knowledge exchange is constrained by limited access to "translated" science summaries and dialogue, technical assistance lacks centralized planning and adequate resources, and training opportunities are inadequately supported. Other suggestions include: a database of community, built environment, urban specific or otherwise relevant technical research; coordinated sharing and access to cameras, weather stations, and equipment; expanded training opportunities such as webinars and workshops; Web-based "ask an expert" service; and built-environment focused best management practices. Through multi-directional exchange, a JSSP will help to improve the quality of technical assistance by creating opportunities for technical experts to received feedback from stewards.

5. More Collaborative Information Exchange Environment. Currently, a lack of structured sharing mechanisms among stewards, partners, resource managers, and policymakers may be the biggest hindrance to effective information sharing. Improved communication mechanisms and a feedback process between scientists, managers, stewards and policymakers would help scientists conduct research that better addresses user needs. Potential mechanisms for information and knowledge exchange via the SKEC network could include: 1) Web-based tools and regular meetings, symposia and workshop; 2) facilitated transfer of science and information that directly addresses management and policy needs, particularly building upon the place-based science hubs of the USDA Forest Service's network of urban field stations (e.g., www.nrs.fs.fed.us/ufs/ and www.laurbanresearchcenter.org/); 3) organize information by responsibility area (e.g, land management, policy, climate science); and 4) create opportunities for one-on-one practitioner-researcher exchanges to better address issue/site specific needs. Other opportunities include: targeted list-serves; Web-based and facilitated discussion boards; local, regional, and national symposia at workshops and conferences; list of partners, areas of expertise, and resources; and interactive maps showing study sites, key research findings, available extension and outreach products, and points of contact.

6. Opportunities for Practitioners and Scientists to Engage in Collaborative Framing of Science and Collaborative Knowledge Production. A JSSP could encourage interaction between scientists and the public in ways that both influence the conduct of science and shape how stakeholders understand the application and practical value of the knowledge about urban stewardship (Lemos and Morehouse 2005). Collaborative framing (coframing) of science needs and collaboratively produced (coproduced) knowledge is more likely to be attuned to social, political, and cultural context in ways that make it practically relevant, usable, credible, legitimate, and actionable (Edelenbos 2011, Akpo et al. 2014). Coframing and coproduction require relationship building, clarity about terms and assumptions, and authentic dialogue about the choices and assumptions that go into scientific assessment (MacLean and Cullen 2009). Many of the collaborative design guidelines that have been developed to support co-production require long-term partnerships, since there is often social distance or even a legacy of distrust to overcome between communities and scientists as well as the agencies who sponsor scientific work (Mitchell et al. 2004). Ultimately, learning networks will enhance capacity and accelerate learning across networks.

These six principles and associated strategies would serve as a preliminary foundation for a JSSP, which will rely on collaborative evaluation, iterative exchange, and adaptive methodologies to enhance success in these six principle arenas.

Outcomes of a Joint Stewardship Science Program

While centers of stewardship activity support a number of permanent research and technology transfer positions focused on stewardship issues, including via the USDA Forest Service network of urban field stations, a national level coordinating, synthesis, promotion, and leadership entity whose primary focus is place-based stewardship science, management, and policy does not exist. Given adequate, but even minimal stewardship-focused resources, a JSSP may be uniquely capable of filling coordination, synthesis, communication, delivery, promotion, and leadership functions while supporting the activities of existing and especially urban-dedicated positions and organizations. The structure and approach of the JSSP would parallel that of the highly successful Joint Fire Science Program (Figure 1). In similar fashion, a JSSP would need multi-agency support and stakeholder trust (locally, regionally, and nationally) to be successful. Here we articulate specific functions that such a program could serve the urban stewardship community.

National Coordination, Synthesis, and Leadership.

A JSSP could provide a national operating platform and structured organizational venue for promoting stewardship science. Such a body will enhance efforts, from local to regional to national and even international levels, to coordinate local to regional research and knowledge exchange activities, synthesize this rapidly growing field of study, promote needed integration across disciplines, and enhance leadership capacity in and advocacy for stewardship science.

National Stewardship Science Grants. Currently urban stewardship has no centralized structure supporting a state-of-the-science grants program. We envision a JSSP as managing a national stewardship science grants program, which could provide a national home to stewardship science, much the way the Joint Fire Science Program serves as a multi-dimensional, national coordinating body for stakeholder driven fire science in the United States. National stewardship science grants would provide rigorously administered, peer-reviewed funding for stakeholder identified priority urban stewardship research, resulting from annual integrated evaluation and assessment of program successes and future needs. Again, modeled after the Joint Fire Science Program, JSSP grants would provide multi-year grants of sufficient size to address applied research needs of significant scope. Identifying priorities and coordinating research would result from a national dialogue among JSSP board members, practitioners and stewardship leaders, SKEC coordinators, managers, policy and agency leadership.

Stewardship Inventory and Analysis. Relying on the Stewardship Mapping and Assessment Project (STEW-MAP; www.nrs.fs.fed.us/urban/monitoring/stew-map/), a USDA Forest Service developed methodology that combines social science surveys, geospatial techniques, and social network analyses to map stewardship connections in domestic and international urban centers, stewardship inventory analysis (SIA) would provide a nationally coordinated approach to elaborating urban stewardship networks including establishing baseline inventories, conducting periodic resurveys, devising national monitoring and synthesis standards, and implementing revisions to existing or new methodologies.

The resulting and unprecedented understanding of stewardship networks will provide planners, disaster relief and recovery agencies, and stewards themselves with critical insights required for resilience planning and preparation. An SIA program would be in a position to rely on decades

of experience provided by the USDA Forest Service's Forest Inventory and Analysis Program and by expanding applications of STEW-MAP, already in a dozen U.S. cities, as well as in Paris, France; Santo Domingo, Dominican Republic; and Valledupar, Columbia. Ultimately, an SIA would help to lead comprehensive and standardized approaches to mapping and understanding stewardship networks; with repeat inventories, the dynamics of stewardship networks over time could be elaborated. This last feature is especially valuable in the context of understanding responses to change and disasters.

The Regional Stewardship Knowledge Exchange Consortia Network. Again, modeled after the regional consortia of the Joint Fire Science Program, a JSSP would support a network of regional consortia. These consortia would be staffed with coordinators who would coordinate the program's work within a region, and serve as a regional urban stewardship hub, while overseeing/coordinating the production of outputs and solutions resulting from consortium activities. Coordinators would facilitate communication and coordination among consortium staff, partners, and end-users, and assist with developing and filling research, extension and outreach positions associated with other entities, with the goal of enhancing capacity to achieve the JSSP's objectives.

Consortium coordinators could serve any of the following specific roles:

- Link program activities to upper level management and decision-makers via regular attendance at meetings and workshops.
- Represent the regional consortium at national meetings, as well as other national urban-focused meetings.
- Identify opportunities and secure support from regional to national funding sources for JSSP enhancement or development.
- Develop, maintain, and expand consortia and JSSP websites.
- Coordinate stewardship staff to ensure information is shared and addresses practitioner needs.
- Periodically assess program effectiveness in meeting the needs of end-users, while identifying new needs.
- Organize symposia at city, state, or national levels on topics of interest.

- Support recipients of national program grants to regions including managing budgets, staff schedules, agendas, and grant reporting.

- Collect existing and new research ideas according to practitioner needs, and develop and disseminate research-based extension information and products for practitioner use.

- Help researchers understand management information needs and develop long-term research agendas.

- Help create summary research products and communicate these with networks.

- Lead or assist development of multi-media communication strategies.

- Lead or assist development of management-driven research projects.

- Help collaborative development of decision support and other tools for urban stewardship applications.

As with the Joint Fire Science Program's consortia, the JSSP would implement strong and regular evaluation protocols, with goals of seeking actionable feedback from on-the-ground stewards and stewardship groups.

A Stewardship of Place Learning Network. A JSSP would design a practitioner-centered learning network, coordinated closely with or even by the above SKEC, to collaboratively produce actionable knowledge about urban stewardship. This learning network would be staffed with network facilitators who would recruit participants, support communication and logistics, and facilitate interaction. Learning networks are interorganizational, voluntary, collaborative organizations that focus on nurturing expertise in applied fields such as environmental management, public health, and education (Dolle et al. 2013). Each participating site in a learning network defines problems in its own way, accommodating local context and contingencies to generate distinct strategies and solutions. This autonomy is balanced with a network-wide coherence that advances collective action to address the systemic issues that require integrative planning and policymaking. Learning networks can foster an open culture of inquiry and trust, increase willingness to take risks in order to extend learning opportunities, promote the transparency required

to challenge embedded values, and enable development of shared meaning and understanding through dialogue (Goldstein and Butler 2010). Learning networks not only can nurture an evidence-base for urban stewardship that communities are more likely to understand and use, they provide researchers the opportunity to explore how they can be effective partners in knowledge co-production. These capacities can promote shared identity and a sense of ownership among all participants, increasing their commitment over time and expanding network capacity and impact (Goldstein and Butler 2009).

Building Community Stewardship Capacity. An important function of the JSSP could be to enhance stewardship capacity to meet the enormous needs of urban centers across the United States with regard to rapid access to technical expertise in understanding and assessing urban stewardship needs, support of planning and policy processes required to address needs, and building a national resource base for stewardship and resilience actions at the local, regional, and national level. This function of the JSSP could rely on the large and sophisticated network of USDA Forest Service experts as well as university and private sector partners to support short-term but also longer-term assignments designed to directly meet the needs of urban stewards. A particularly important role for JSSP could be to: manage conflicts or unintended outcomes for greening efforts in urban environments, for example green gentrification; work within broad collaborative partnerships to reduce or eliminate barriers to stewardship; or address why private sector stewardship may not be effective. It would be advantageous for this aspect of the JSSP to be closely linked to the USDA Forest Service's Regional State and Private Forestry Urban and Community Forestry programs. Given the research and knowledge exchange functions of the JSSP and its various component programs, but the highly applied nature of this work, planning would necessarily engage multiple branches of the USDA Forest Service.

Conclusion

To date, urban-focused stewardship science has made enormous progress in understanding the patterns and processes of complex coupled human and natural systems—progress that has been led by passionate individuals operating in a mostly unstructured field. But important questions regarding global change and more pedestrian questions about coordination and long-term support are pushing the limits of the current case-study approach that has typified this field. Much the way the USDA Forest Service's Forest Inventory and Analysis Program brought standardization to the inventory of forest composition, structure, function, and dynamics, and much the way the Joint Fire

Science Program brought coordination, collaboration, synthesis, and higher levels of support to fire science and extension in the United States, we envision the JSSP greatly enhancing capacity for engaging partners, knowledge creation, and coordinated and collaborative synthesis to the stewardship science community. As with any ambitious initiative, careful planning will be required to learn from and improve upon previous learning network based initiatives.

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