

Society & Natural Resources

An International Journal

ISSN: 0894-1920 (Print) 1521-0723 (Online) Journal homepage: <https://www.tandfonline.com/loi/usnr20>

Institutional Diversity in the Planning Process Yields Similar Outcomes for Vegetation in Ecological Restoration

Liam Heneghan, Lynne M. Westphal, Kristen A. Ross, Cristy Watkins, Paul H. Gobster, Basil V. Iannone, Madeleine Tudor, Joanne Vining, Alaka Wali, Moira Zellner & David H. Wise

To cite this article: Liam Heneghan, Lynne M. Westphal, Kristen A. Ross, Cristy Watkins, Paul H. Gobster, Basil V. Iannone, Madeleine Tudor, Joanne Vining, Alaka Wali, Moira Zellner & David H. Wise (2020) Institutional Diversity in the Planning Process Yields Similar Outcomes for Vegetation in Ecological Restoration, *Society & Natural Resources*, 33:8, 949-967, DOI: [10.1080/08941920.2019.1703062](https://doi.org/10.1080/08941920.2019.1703062)

To link to this article: <https://doi.org/10.1080/08941920.2019.1703062>



View supplementary material [↗](#)



Published online: 24 Dec 2019.



Submit your article to this journal [↗](#)



Article views: 184



View related articles [↗](#)



View Crossmark data [↗](#)



Institutional Diversity in the Planning Process Yields Similar Outcomes for Vegetation in Ecological Restoration

Liam Heneghan^a, Lynne M. Westphal^b, Kristen A. Ross^{c*}, Cristy Watkins^{d†}, Paul H. Gobster^b, Basil V. Iannone^e, Madeleine Tudor^d, Joanne Vining^f, Alaka Wali^d, Moira Zellner^{g,h}, and David H. Wise^{c,h}

^aDepartment of Environmental Science and Studies, DePaul University, Chicago, IL, USA; ^bNorthern Research Station, USDA Forest Service, Evanston, IL, USA; ^cDepartment of Biological Sciences, University of Illinois at Chicago, Chicago, IL, USA; ^dThe Field Museum, Chicago, IL, USA; ^eSchool of Forest Resources and Conservation, University of Florida, Gainesville, FL, USA; ^fDepartment of Natural Resources and Environmental Sciences, University of Illinois, Urbana-Champaign, IL, USA; ^gDepartment of Urban Planning and Policy, University of Illinois at Chicago, Chicago, IL, USA; ^hInstitute for Environmental Science & Policy, University of Illinois at Chicago, Chicago, IL, USA

ABSTRACT

Conservation organizations undertaking ecological restoration and the lands they manage constitute a social-ecological system (SES). We implemented SES analysis to examine the relationship between diversity in organizational structure and restoration planning processes, and vegetation outcomes on the ground. Understanding the restoration consequences of multiple approaches to planning and implementation is relevant to assessing the resilience of this SES, especially if disagreements about the effectiveness of some approaches lead to conflict in the socio-political arena. We studied 10 conservation organizations in the Chicago Wilderness region that are restoring Midwestern oak woodlands of global conservation concern. Despite the institutional diversity of these organizations, we found little relationship between restoration planning and vegetation outcomes. This result has implications for the resilience of restoration as an SES, since similar outcomes from diverse processes should increase resilience of this SES, especially when controversial restoration practices are employed, and when priorities and funding levels change.

ARTICLE HISTORY

Received 23 August 2018
Accepted 17 November 2019

KEYWORDS

Institutional Analysis and Development; Social ecological system; biodiversity; restoration ecology; social resilience

Introduction

Human decision-making directly or indirectly influences all areas on Earth to some degree; this is one meaning of the term the Anthropocene (Anderies et al. 2013; Ellis 2015). Since social-ecological systems (SES) now collectively encompass the entire globe, environmental questions often need to be answered by recourse to SES analysis

CONTACT Liam Heneghan  lhenegha@depaul.edu  Department of Environmental Science and Studies, DePaul University, Chicago, IL, USA.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/usnr.

*Current Address: Natural Sciences Department, Castleton University, Castleton, Vermont, USA.

†Current Address: University of Michigan, School for Environment and Sustainability, Ann Arbor, MI, USA.

 Supplemental data for this article can be accessed on the at <https://doi.org/10.1080/08941920.2019.1703062>.

(Ban et al. 2013; Schultz et al. 2015). When social and ecological analysis is successfully integrated, SES investigations can help reveal the most successful means by which natural resources can be governed (Bodin and Crona 2009; Carmona-Torres et al. 2011).

A particular challenge for SES research is to detect the sometimes subtle differences in collective decision-making practices, and then relate these differences to those ecological patterns that result from the implementation of management. Are there, for example, best-governance practices for the management of a given natural resource (Baggio et al. 2016; Ostrom 1990)? What is the interplay between social and ecological resilience at various spatio-temporal scales in nested systems (Berkes and Ross 2013; Garmestani and Benson 2013)? Furthermore, in circumstances where the governance of a single resource is shared by multiple institutions (polycentric governance), do redundancies among disparate institutions confer social resilience (Adger 2000; Biggs et al. 2012; McGinnis 1999)? In this paper, we follow Keck and Sakdapolrak (2013) in defining social resilience as the capacity of social entities “to tolerate, absorb, cope with, and adjust to environmental threats of various kinds.” Social resilience may be especially advantageous in circumstances where one source of governance is precarious (Chaffin, Gosnell, and Cosens 2014). Institutional precarity can emerge for political, economic, or other social reasons, leading to institutional attrition or failure (Garicano and Rayo 2016).

Using SES analysis to investigate how variation in social systems influences natural resources creates challenges that are exacerbated as the research teams investigating them become more interdisciplinary (Angelstam et al. 2013). The challenge emerges from a divergence in ontologies and methodologies; for example, the social sciences use both qualitative and quantitative methods whereas the natural sciences are dominated by quantitative approaches. In this study, we confronted these challenges by conducting an SES analysis using the Institutional Analysis and Development (IAD) framework (McGinnis 2011; Ostrom 2005, 2011) to inform the collection of both quantitative and qualitative data with the following question in mind: *Does variation in the organizational structures and decision-making processes that govern the ecological restoration of conservation lands influence outcomes for vegetation structure and diversity?* Throughout this paper, we refer to restoration outcomes for vegetation structure and diversity as “vegetation outcomes.” The IAD framework can be regarded as “a multi-tier conceptual map” (Ostrom 2011, 9) that describes the variety of actors and their interactions with each other and with resources within the SES (Ostrom 2005, 2011; Westphal et al. 2014).

Use of the IAD framework has primarily been applied to situations where resources are extracted; in contrast, here we applied it to the *value-adding* practice of ecological restoration (Clewett, Aronson, and Winterhalder 2004; Watkins and Westphal 2016). Specifically, across the SES we collected data both within and outside the action arena, as depicted in Figure 1; this paper focuses on the action arena and its biophysical changes. We are, therefore, applying the IAD framework to non-extractive use of the commons (publically accessible natural areas).

The Chicago Wilderness alliance—an internationally recognized conservation coalition that provides the settings for our research—emerged in the 1990s to preserve, protect, and enhance native biodiversity. Counterintuitively, considerable biodiversity

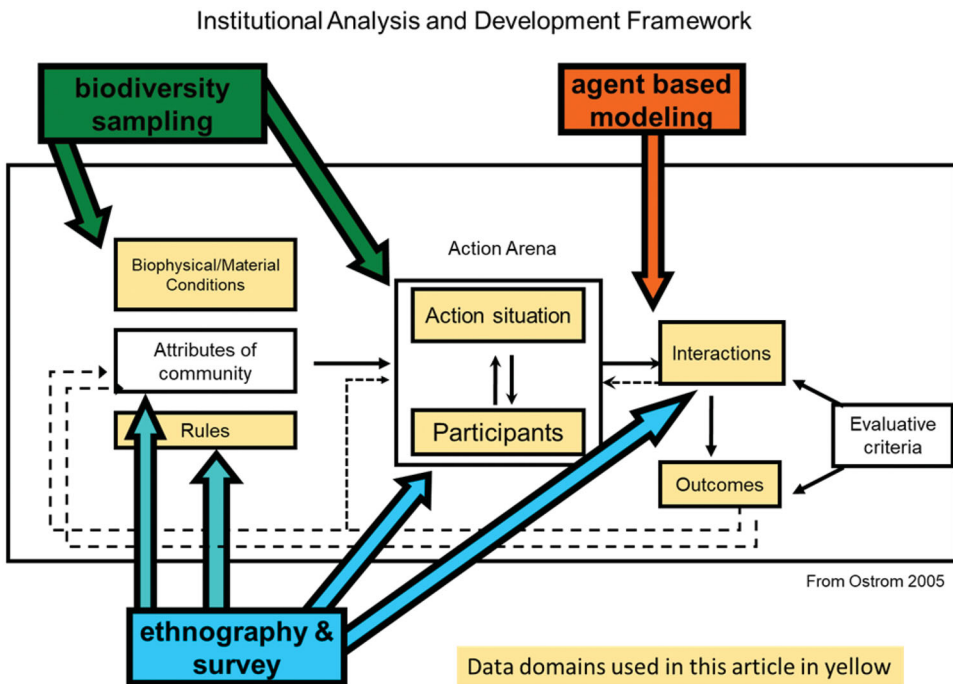


Figure 1. The Institutional Analysis and Development Framework diagram connects the action arena (center box; in our case, oak-ecosystem restoration efforts of Chicago Wilderness organizations) with the larger-system variables (left-hand side, including attributes of the wider community, such as nearby residents, economic structure of the region, etc.; and right-hand side, including interactions, outcomes, and evaluative criteria used to determine success). Our fuller project collected data across nearly all these domains; this paper reports on the “biodiversity sampling” and “ethnography and survey” applied to the action arena of oak ecosystem restoration.

survived in the greater Chicago metropolitan region while much was lost to the plow in rural parts of Illinois and adjacent states. The name “Chicago Wilderness” crystallizes the incongruity of having globally important habitats embedded in a major urban area. Chicago Wilderness now comprises over 200 organizations that include public land-management agencies, conservation organizations, and scientific and cultural institutions across parts of four U.S. states (Heneghan et al. 2012, Figure 2). This organizational diversity reflects the multi-sectoral form of polycentric governance, where “public, private, voluntary, community-based, and hybrid kinds of organizations” work together within the constraints and possibilities presented by their overlapping jurisdictions and multiple centers of authority (McGinnis 2011, 6). As members of the Chicago Wilderness alliance, all organizations are committed to shared goals for restoration outcomes—broadly, the elimination of non-native shrubs and herbaceous species, and the reestablishment of native vegetation (Chicago Region Biodiversity Council 1999). In addition to “Chicago Wilderness” being the name for the coalition of organizations with biodiversity conservation as part of its mission, the term also describes over 220,000 hectares that have been set aside as protected open land across the greater Chicago region, including habitat of biodiversity conservation interest such as tallgrass prairie, woodland, and oak savanna (Heneghan et al. 2012, Figure 2). Numerous stressors like

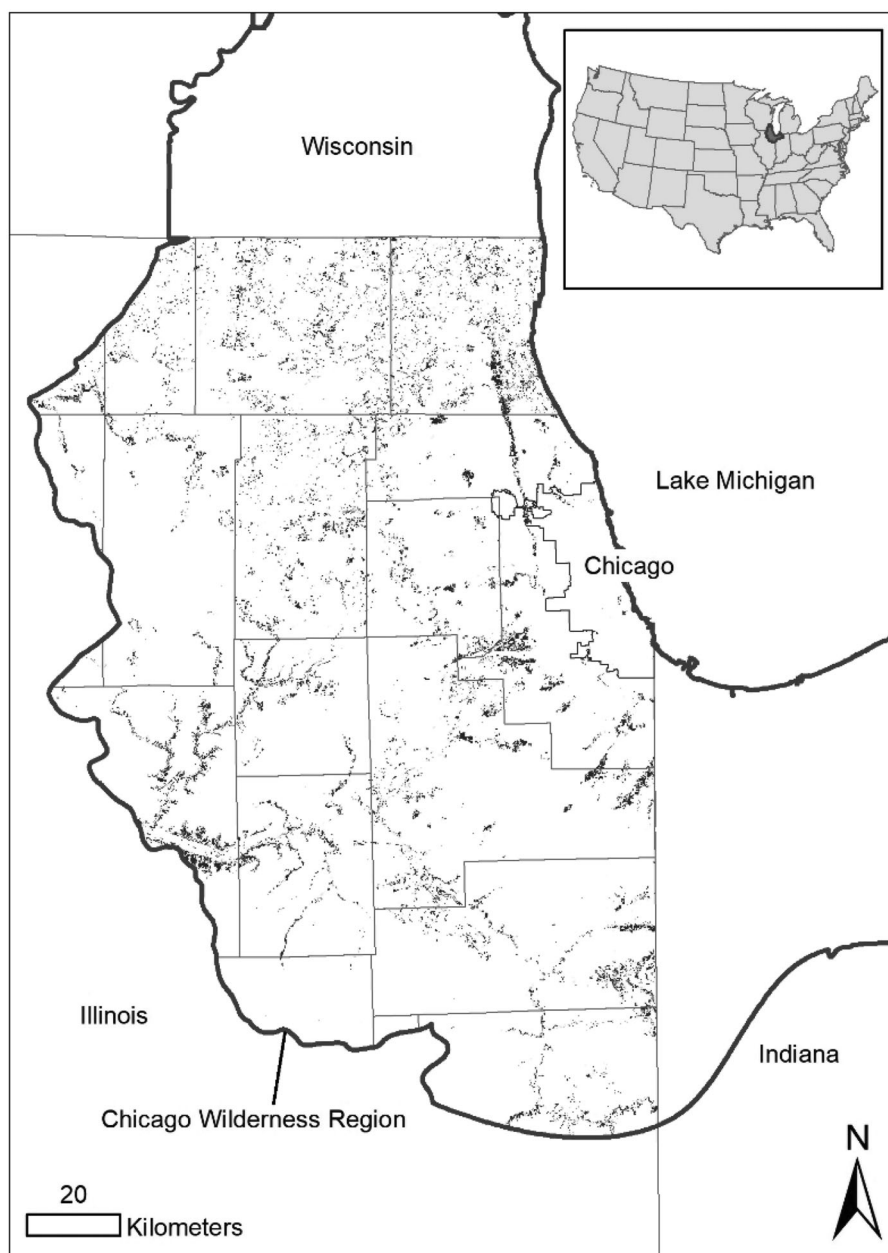


Figure 2. The Chicago Wilderness region fans out from the city of Chicago, Illinois (USA) to include parts of four states: northeast Illinois, northwest Indiana, southeast Wisconsin, and a portion of southwest Michigan. Only 17% of oak woodlands remain from the presettlement era, shown in Illinois. Our study sampled from these oak woodlands. (Credit: Lindsay Darling, The Morton Arboretum).

hydrological changes, habitat fragmentation, altered fire regimes, invasive species, loss of structural diversity, and ecosystem nutrient loading, have resulted in generally poor ecological quality of these lands. Consequently, ecological restoration is a core conservation strategy across the Chicago Wilderness region (Chicago Region Biodiversity Council 1999; Heneghan et al. 2012).

Despite its widespread adoption, ecological restoration can be controversial because of conflicting views about restoration goals and the means to achieve them (Gobster and Hull 2000; Hobbs 2007). For example, in the 1990s, there was a challenge to ecological restoration practices on some public lands in the Chicago Wilderness region, resulting in a moratorium on restoration practices (Gobster and Hull 2000; Woodworth 2013). This stoppage was brief in some places, did not apply to others at all, but lasted for 10 years in one Illinois county. While work ceased in some cases, region-wide ecological restoration efforts continued. In other instances, methods used by volunteers were disparaged as “gardening,” or the restoration equivalent of a hobby farm (Jordan and Lubick 2011). Even when practices are widely accepted, organizational priorities and budgets can change rapidly, impacting long-term restoration efforts. Additionally, organizations with distinct governance structures may prioritize restoration goals differently (Clewett and Aronson 2013). For example, decisions concerning restoration on public lands may emphasize access to nature for diverse human populations, whereas land trusts may prioritize the rehabilitation of habitat of exceptional conservation interest. Additionally, methods and approaches to restoration may differ in parallel with differences in organizational structure. Volunteer restorationists, for instance, typically work with hand tools on small sites and have time for tasks like hand-pollinating rare plants; in contrast, professional land managers work at a larger scale, often with mechanical equipment that allows clearing many hectares of invasive species in a single season. Therefore, even within one region, different decision-making pathways may lead to a variety of restoration approaches, which may manifest different ecological outcomes.

We hypothesized that different restoration planning and implementation styles will lead to differences in vegetation outcomes (Figure 3(A,B)). Alternatively, vegetation outcomes may not reflect differences in the planning and implementation process (Figure 3(C)). Understanding the nature of this relationship is important, because if divergent outcomes emerge, some organizations may have to reevaluate how they make restoration decisions if they are falling short of attaining their goals. On the other hand, if there is little difference in restoration results associated with distinct styles of restoration-planning (thus implying institutional redundancy), then a plurality of restoration approaches may strengthen resilience of the SES. Absence of a connection between diversity in the planning process and vegetation outcomes becomes especially critical in cases where some approaches to planning and practice are controversial (Gobster and Hull 2000; Woodworth 2013).

Methods

Study Design

To test our hypothesis that different planning and implementation styles lead to different vegetation outcomes, we needed to study a broad spectrum of organizations that had been managing the same type of plant community. We selected 14 oak-ecosystem restoration sites managed by 10 Chicago Wilderness land-management organizations; therefore, oak ecosystem recovery was our action arena (Figure 1). Some sites were owned by the same organization, but the decision-making process for the sites differed in meaningful ways, such as different volunteer groups being in the lead.

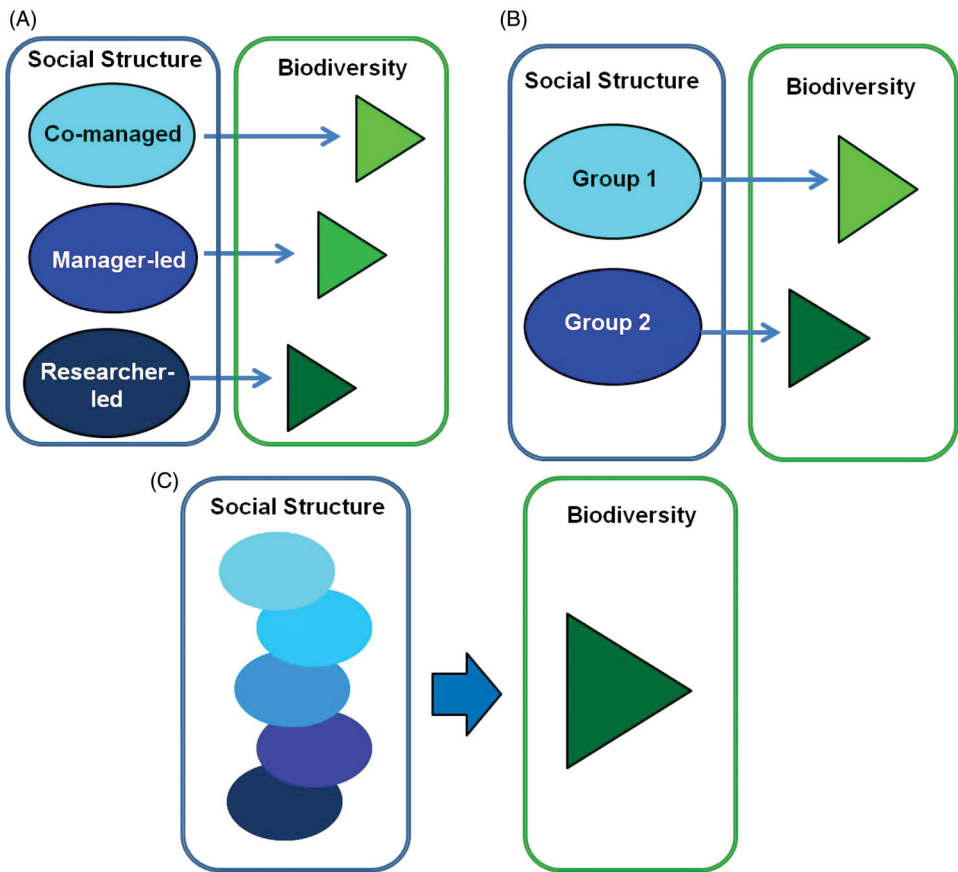


Figure 3. Three alternative hypotheses explaining the relationship between social structure (organizational structure and decision-making processes) and differences in vegetation community structure ("Biodiversity") on managed lands. Blue ovals represent different social structures of conservation organizations; green triangles represent plant communities that differ in relative representation of species. (A) Our original hypothesis that three distinct categories of social organization in Chicago Wilderness organizations would lead to three distinct biodiversity outcomes. (B) Alternatively, a different categorization of social structure explains substantial amounts of biodiversity variation. (C) The third hypothesis, that variation in social structure does not result in meaningful differences in plant community structure.

The organizational structure and planning processes associated with these 14 sites, which reflected the range and variety of restoration decision-making processes in the greater Chicago metropolitan region, were placed into one of three categories based upon the investigators' many years of interacting with managers in the Chicago Wilderness region. These *a priori* categorizations were validated after considerable discussion with land managers. Sites were designated as "manager-led", "co-managed", or "researcher-led". "Manager-led" was the most prevalent restoration planning style. At these sites, professional (paid) managers dominated decision-making. On "Co-managed" sites volunteers worked with professional managers but had a high degree of autonomy in restoration decision-making and management, often leading the decision-making. On "Researcher-led" sites scientific exploration was central to restoration activities.

We selected the 14 study sites according to several criteria:

- Be under restoration management for 5 or more years,
- Be accessible to the public by trail or other access,
- Have nearby residential neighborhoods,
- Be large enough to ensure sufficient sub-sampling of the vegetation.

Some criteria were required to enable the full SES analysis, such as a survey of site users and nearby residents, i.e. impacts of the action arena on broader components of the SES (results published elsewhere, Westphal et al. 2014).

Pre-restoration site conditions were generally poor. While remnant populations of native plants gave reason to consider a site for restoration, there have been few areas throughout Chicago Wilderness where significant effort was not required in restoration. That is, none of the organizations had an “easy” site to start with:

In a review for the Biodiversity Recovery Plan, the Chicago Wilderness Science and Land Management Teams found that more than half of the major community types of the region were at the highest level of conservation concern due either to the small amount remaining or to the poor ecological health of the remaining examples (Chicago Region Biodiversity Council 1999, 5).

Further, a 2006 Chicago Wilderness Alliance-wide assessment of ecosystem health noted the positive impact of active management, while also saying this of area oak woodlands:

Taking into account floristic quality, canopy trees and four measures of invasive species, the audit rates 42 percent of the region’s oak woods as poor, 38 percent as fair, 17 percent as good and only four percent as excellent. Of high concern is the degenerating shrub layer in mesic upland forests, and the fact that oak woods are being replaced by maple stands (The Chicago Wilderness consortium 2006, 21).

The relatively poor conditions overall informed our requirement that a site be under restoration management for at least 5 years, to allow time for management effects to show on the land. Recent regional vegetation and soil surveys confirm that a minimum of 5 years is sufficient to see some positive effects of restoration efforts (Umek 2018). In addition, the Umek (2018) data confirms the overall similarity of oak woodland vegetation in the region prior to management. We selected only oak woodlands in order to limit variability in habitat type. Comparing prairie to wetland to oak woodland would have substantially weakened the statistical power of the study design. Furthermore, sites were selected to minimize variation in characteristics not related directly to restoration activities (slope of the terrain, percent canopy cover, etc.), so that variation in understory vegetation among sites undergoing restoration could be attributed to variation in the variables selected to reflect differences in organizational structure and the decision-making process.

Social Data

To understand the organizational composition and the decision-making processes of the 10 study organizations, we conducted 80 in-depth interviews with restoration decision

makers across all the groups (interviews typically lasted 60–90 min, were recorded and transcribed for subsequent analysis). We interviewed across the range of decision-making input, from those central to the process to those more peripheral. We also observed meetings and restoration workdays for each organization (field notes were taken during the events and finalized within 24 h; see [Supplemental Table 1](#) for details on data collection).

Interview data were analyzed by the social science team comprised of scientists with wide-ranging disciplinary expertise, including anthropology, environmental psychology, and landscape architecture. To outline the coding frame, a subset of interviews was read by the entire team, with each member identifying important themes and issues. These were then discussed by the group to ensure consistency and reliability and to develop a coding structure. A subset of the team then coded the interviews using NVIVO (QSR International Pty Ltd., Version 9, 2012; see [Supplemental Table 2](#) for the final code tree, and Westphal et al. 2014 for further coding details). Four broad themes were of central importance: decision-making information, management action, perceptions of landscape, and emotion (Westphal et al. 2014). “Decision-making information” included topics such as communication strategies, group processes, and decision criteria. “Management actions” coded the specific restoration techniques such as fire and seeding, as well as strategies like creating a management plan. “Perceptions of landscape” captured individual’s comments about topics such as a sense of ownership of the site, participation, sustainability, and motivations; this category had the largest number of subthemes ([Supplemental Table 2](#)). Emotion was coded to “positive” (e.g., pride, amazed/awe, happy), “negative” (e.g., conflict, disgust, frustrated), and “other” (e.g., surprise, concern/care). The team’s environmental psychologist led the emotion coding.

We also extracted Institutional Statements, or “the shared linguistic constraint or opportunity that prescribes, permits, or advises actions or outcomes” (Ostrom 2009). That is, we extracted the rules, strategies, and norms regarding ecological restoration from each interview (see [Supplemental Tables 3](#) and [4](#); Ostrom 2005; Westphal et al. 2014). Working with a subset of the interviews, two authors extracted the Institutional Statements and established strong inter-rater reliability (kappa score over .80; details in Watkins and Westphal (2016)) and then extracted Institutional Statements from the remaining interviews ([Supplemental Table 5](#)). They then brought the results to the full social science team for review. The process is detailed in Westphal et al. (2014) and Watkins and Westphal (2016). Because we used the *number* of Institutional Statements in our quantitative analysis with the vegetation data (see below), we had to ensure that the totals were not a consequence of some sites having more data – more or longer interviews – than others. There was no bias, as we did not find that sites with more rules, norms, and strategies were also those for which we had more data.

The data management described so far was instrumental in analyzing the social data on its own. But to analyze it with the ecological data, we had to transform the text-based interview data into numerical data for use in these analyses (see below). Two members of the social science team developed the variables, and presented them to the full research team for discussion and consensus. Most are ranked ordinal variables, though some are continuous, dichotomous, or categorical (see [Supplementary Information](#) “Social Science Variables” for details). The number of Institutional

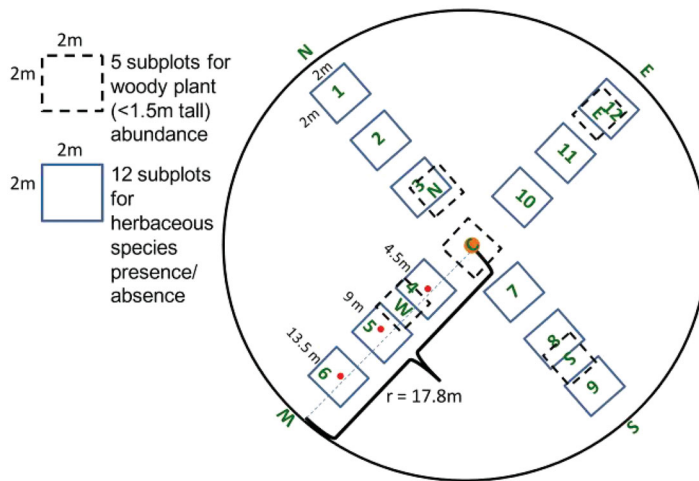


Figure 4. Design for sampling the vegetation. A single 0.1-ha circular sampling plot is depicted; 74 of these plots were distributed across the 14 study sites. Because sites ranged from 0.7 to 59 ha, we divided each site into 1–5 blocks with 2–5 plots per block, resulting in 2–14 circular 0.1-ha sampling plots per site. In each 0.1-ha sampling plot, herbaceous species presence/absence was determined in 12 subplots distributed among two transects, and the number of stems of woody plant species (shrubs and tree seedlings/saplings <1.5 m) was counted in five different randomly placed subplots. Densities of woody vines, a few individuals of which can cover large areas, were expressed using a modified Braun-Blanquet cover-abundance scale (Braun-Blanquet 1965).

Statements has rarely, if ever, been used as a variable in its own right, but we see it as an indicator of organizational complexity. For example, an organization with significantly more aggregation statements and a high level of emotion indicates a potentially volatile organization. Or, an organization with primarily norm-based statements rather than rule-based statements indicates meaningfully different decision-making and management styles.

Vegetation Data

Because regional restoration protocols focus on restoring native flora (e.g. Packard and Mutel 1997), we intensively sampled the understory vegetation. We analyzed differences between sites in three plant communities: all herbaceous species, all woody-plant species, and invasive species considered separately (herbaceous and woody species combined). We modified vegetation sampling designs from Stohlgren, Falkner, and Schell (1995) (see details in McCary et al. 2015) to capture the level of detail needed to assess understory community composition, but also to allow reasonably rapid sampling of 74 large plots across 14 sites (Figure 4).

Biological communities often are compared by relying on measures of species diversity defined as a single statistic or index, such as total number of species (S), or the distribution of relative species abundances in the community (e.g. H) (Legendre and Legendre 2012). Comparing communities by relying on such indices ignores critical information, because two or more sites could have identical indices but differ markedly in community composition (e.g. relative abundances of particular species of native and

invasive plants). We therefore compared the similarity of plant communities across sites using measures of community similarity that take into account the identity of each species (Legendre and Legendre 2012).

Measures of species diversity and community similarity are sensitive to sampling effort (Legendre and Legendre 2012). Thus, we had to adjust the species abundance data, as sampling effort varied across the 14 sites because sites differed in area (Figure 4). The rarefaction technique we used to make this adjustment is detailed in the [Supplemental Information](#) (Vegetation Data: Correcting for Sampling Effort). Correcting for sampling effort resulted in statistical analyses of plant communities based upon 198 herbaceous species, 38 species of woody plants, and 17 invasive species,

Statistical Analyses of Social and Vegetation Data Sets

Most analyses involved multivariate statistics, i.e. the response variable was not a single variable, but a multivariate data set represented by a $14 \times n$ similarity matrix, in which each of the 14 rows contained values of the n response variables for that particular site. The nature of the n response variables depended upon the data set (social data or vegetation data). For all analyses the similarity matrices were first converted into corresponding distance matrices using a distance that depended upon the type of data (refer to [Supplemental Information](#), Distance Measures Used in the Multivariate Analyses).

We first tested our hypothesis that the three *a priori*-designated categories of restoration planning yielded differences in the restored vegetation communities. We plotted the first two axes of a principal coordinates ordination (PCo) of each vegetation distance matrix with the 14 sites identified by membership in one of the three categories (manager-led, co-managed, or researcher-led), followed by permutational multivariate analysis of variance (PerMANOVA; 10,000 permutations) to evaluate the evidence for separation of restored sites according to our hypothesized *a priori* categories.

After this initial analysis based upon our *a priori* categorization of the social structure associated with each of the 14 sites, we used hierarchical cluster analyses (Legendre and Legendre 2012) to uncover alternative groupings of the social variables. We plotted the first two axes of each vegetation PCo ordination with sites identified by the new group membership created from the cluster analysis, and then tested for separation of sites with PerMANOVA.

Finally, we used partial distance-based redundancy analysis (partial db-RDA; Legendre and Legendre 2012) to investigate whether relationships exist between differences in vegetation structure between the sites and variation within subsets of the social variables, without employing groupings based either upon our *a priori* categorization of organizations or the results of the social-variables cluster analysis. We employed partial db-RDA because it can be used to explain variation in a distance matrix if the explanatory variables are continuous, ordinal, or categorical, and also because we wanted to remove any variation that might be explained by the three site-description variables – hectares owned, site size, and time under restoration. The latter two variables were included as covariates because an initial db-RDA using just these variables resulted in a model that explained $>10\%$ of the variation in the structure of the herbaceous community distance matrix ($\text{Adj } R^2 = 0.13$, $p = 0.02$). We subdivided the full social data set

into six thematic subsets that were small enough to meet the assumptions of statistical analysis for partial db-RDA (i.e. fewer explanatory variables than sites), and that also reflected similarities in organizational structure and decision-making. The subsets were organizational complexity, restoration attitudes, conflict, seeding philosophy, mission, and the “IAD” set – numbers of Institutional Statements, Aggregation Statements, and Collective-Choice and Operational Statements (see “matrix analysis” and [Supplemental Table 6 in Supplemental materials](#); Westphal et al. 2014). Some variables were included in more than one subset as they described more than one aspect of organizational structure or decision making. In each subset, we eliminated redundant explanatory variables that were highly correlated with other explanatory variables (correlation metric > 0.90 based upon the Goodman-Kruskal gamma statistic or Spearman’s rho). For each subset of the social variables, we then used partial db-RDA to test for explanatory relationships with each of the three vegetation distance matrices, controlling for site variables not related to the social variables. We employed a step-wise procedure that added and removed each variable in both directions one at a time.

We also used multiple linear regression to analyze effects of the social data on two indices of floristic quality (FQI and AFQI) directly related to the restoration goals of land managers. These indices, which are univariate measures, are based on the coefficient of conservatism for each plant species. FQI includes only native species and AFQI includes all species regardless of origin (Swink and Wilhelm 1994, 1979; Allain et al. 2004). These were our only non-multivariate analyses.

Statistical analyses were done using the *R* computing language, version 3.0.2 (R Core Team 2013).

Results

No Relationship Between *a Priori* Planning Categories and Vegetation Outcomes

Our hypothesis that the three *a priori*-designated categories of restoration planning would yield different vegetation outcomes ([Figure 3\(A\)](#)) was not supported. Contrary to our expectations, PCo plots ([Figure 5\(A\)](#)) and PerMANOVA (pseudo- $F_{2,11} = 0.97$, $p = 0.49$) revealed that differences between sites in herbaceous plant community structure were not related to the three hypothesized restoration-planning categories. There also was no relationship with the community structure of the woody vegetation or invasive species (PerMANOVA pseudo- $F_{2,11} = 1.02$ and 0.78 , $p = 0.43$ and 0.61 , respectively).

There Are Two, Not Three, Planning Categories

Hierarchical cluster analysis of the 22 social variables did not support our initial categorization, into three distinct groups, of the 14 different organizational structures associated with the 14 sites. Cluster analysis revealed two, not three, groupings of the social variables ([Figure 5\(B\)](#)). Membership of the smaller group (Group 1) was associated with three of the four sites defined *a priori* as co-managed, which could be interpreted as a partial confirmation of our *a priori* categorization of organizational structure. However,

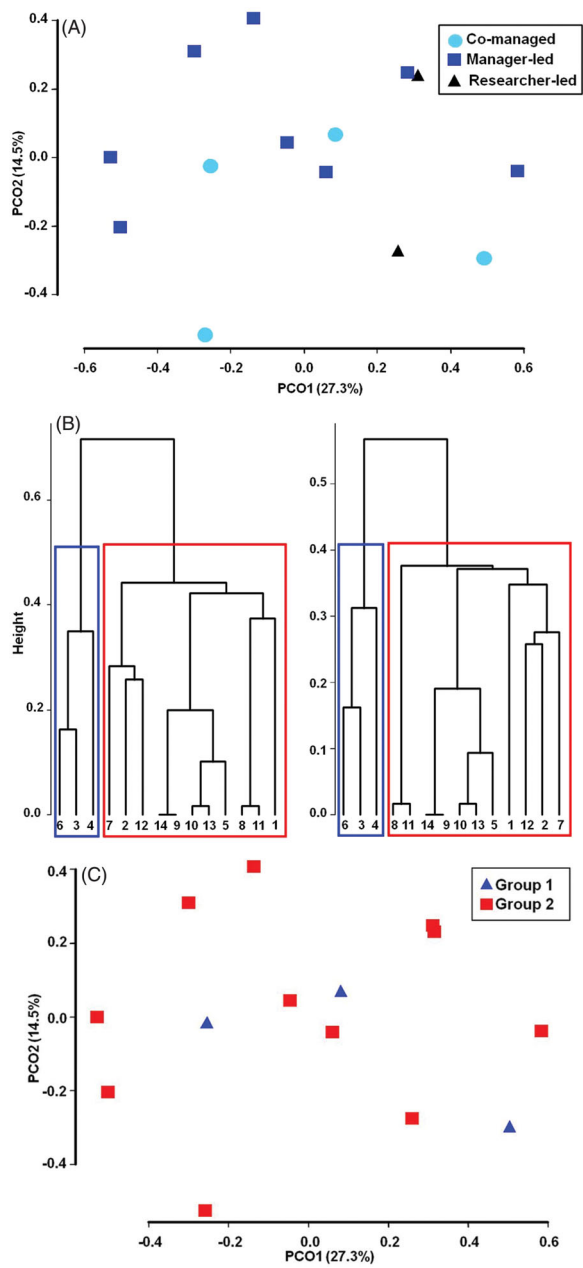


Figure 5. (A) The first two axes of a principal coordinates analysis (PCo) explained 42% of the variation in herbaceous species composition, but PerMANOVA revealed that separation of sites based upon vegetation differences was not related to the three *a priori* restoration-planning categories. (B) Hierarchical cluster analysis based on a Gower's distance metric of the social structure data revealed two distinct groupings using both complete linkage (at left) and UPGMA (at right) clustering methods. The cophenetic correlation coefficients for the two methods are high and similar (0.93 and 0.94, respectively), indicating that both methods yield a clustering pattern strongly correlated with the original distance matrix (C). The same PCo of the vegetation distance matrix as in (A) with sites coded according to results of our analysis of social structure data illustrated in (B). Again, perMANOVA (refer to text) revealed no effect of social structure on the plant community.

Table 1. Results of the stepwise partial distance-based redundancy analyses (partial db-RDA) of each subset of social explanatory variables with distance matrices for each subset of vegetation data.

Social model	Vegetation community	No. of explanatory variables	Partial adj R^2	p
Organizational complexity (7)	Herbaceous community	5	0.17	0.03
	Woody plants <1.5 m	No multivariate model	–	–
	Invasive species	No multivariate model	–	–
Restoration attitudes (6)	Herbaceous community	2	0.10	0.02
	Woody plants <1.5 m	No multivariate model	–	–
	Invasive species	No multivariate model	–	–
Mission (5)	Herbaceous community	2	0.01	0.34
	Woody plants <1.5 m	No multivariate model	–	–
	Invasive species	No multivariate model	–	–
Conflict (4), Seeds (5), IAD (6)	Herbaceous community	No multivariate model	–	–
	Woody plants <1.5 m	No multivariate model	–	–
	Invasive species	No multivariate model	–	–

The partial db-RDA controlled for time under restoration and site size. Eighteen (6×3) models were tested (the last row summarizes nine of these separate analyses). Numbers in () next to each social model in the first column indicate the original number of variables included in each model before variables were removed through the stepwise modeling procedure. “No. of explanatory variables” is the final number of variables after the stepwise partial db-RDA. “No multivariate model” indicates that the partial db-RDA did not produce a multivariate model to explain any of the variation in the corresponding subset of the vegetation community.

although the three sites had been co-managed by different teams of volunteers, the sites in this smaller group are owned by the same organization. Thus, a significant number of social variables were identical across these three co-managed sites, which may have swamped subtler differences among them. The remaining sites clustered to form Group 2. This distinct clustering of the social variables also was not related to differences in herbaceous plant community structure (Figure 5(C); PerMANOVA pseudo- $F_{1,12} = 0.81$, $p = 0.68$), nor was this new grouping related to differences in the community structure of woody vegetation or invasive species (PerMANOVA pseudo- $F_{1,12} = 0.66$ and 0.32 , $p = 0.77$ and 0.88 , respectively). Thus, these different analyses failed to provide support for the first two alternative hypotheses (Figure 3(A,B)).

Limited Relationships Between Social Variables and Vegetation Outcomes

Vegetation outcomes may nonetheless relate to differences in the social data among sites even if attempts to categorize groups reveal them to have blurry boundaries. Therefore, we used partial db-RDA to model the linear relationship between subsets of social explanatory variables and vegetation distance matrices (which reflect variation between sites in plant community structure), controlling for site-description variables. Variables in only two subsets explained any variation in the vegetation data; furthermore, these relationships were weak and limited to the herbaceous plant community (Table 1). Five of the seven “organizational complexity” variables together explained 17% ($p = 0.03$) of the herbaceous distance matrix, and two of the seven “restoration attitudes” variables accounted for 10% of the variation ($p = 0.02$). The partial db-RDA on subsets of the vegetation data specifically related to management goals, i.e. invasive species, revealed no impact of the planning process (Table 1). Furthermore, the multiple regression analyses of two floral quality indices employed by managers as measures of restoration success also found no relationships with any of the social variables (Table 2).

Table 2. Results for the multiple linear regressions using variables from the Organizational Complexity and Restoration Attitudes subsets of social explanatory variables (Table 1 – those subsets with some evidence for a relationship between two or more explanatory variables and the herbaceous vegetation distance matrix).

Social model	Vegetation community	Adj R^2	p
Organizational complexity	FQI (all)	0.12	0.40
	FQI (herbs only)	0.03	0.48
	AFQI (all)	0.20	0.32
	AFQI (herbs only)	0.49	0.16
Restoration attitudes	FQI (all)	0.38	0.19
	FQI (herbs only)	0.25	0.28
	AFQI (all)	0.49	0.12
	AFQI (herbs only)	0.37	0.20

The covariates used in partial db-RDAs were also included in the model. After highly correlated variables were removed, each model contained seven explanatory variables.

No Evidence of a Relationship Between Vegetation Outcomes Related to Management Goals and Differences in Organizational Structure and the Planning Process

The two small adjusted R^2 values with relatively weak strength of evidence resulted from 18 partial db-RDA analyses (Table 1). Adding the eight statistical tests in Table 2 and the six per MANOVA analyses of the three types of vegetation community yields a total of 32 statistical tests, of which only two yielded p values indicating any evidence for the observed relationship. We did not formally correct for multiple comparisons because we analyzed different aspects of the overall data sets using different statistical models, but out of 32 tests one would expect to observe, by chance alone, one or two p values marginally less than the conventional level of $p = 0.05$. Thus, although our analyses detected two relationships between some social variables and vegetation patterns, these relationships could likely be due to the vagaries of sampling. Furthermore, the tests more explicitly related to restoration goals yielded p values that provided no evidence of a relationship. Thus, our statistical analyses, which examined the relationships between two complex biological and social diversity data sets from different angles, found no evidence of a connection between vegetation outcomes on the ground that were related to management goals, and differences between organizations in their structure and the processes they employed to plan and implement restoration of the vegetation.

Discussion and Conclusions

Organizations throughout the Chicago Wilderness region have largely assented to a shared vision for restoration outcomes (Chicago Region Biodiversity Council 1999). The commonality of a broad vision among such a diversity of organizations managing extensive areas of habitat presented a rare opportunity to investigate how variation in organizational structure and the decision-making processes might affect outcomes in a single complex region. If the basic, overall restoration goal were not the same among organizations, we could not have tested our central hypothesis. Characterizing how decision-making processes are governed in volunteer, manager-led, and research-oriented organizations was one of the broader aims of our research program and has been

reported in detail elsewhere (Watkins et al. 2015; Watkins and Westphal 2016). In this paper, we asked whether ecological restoration undertaken by organizations sharing the same broad restoration vision, but varying in some aspects of the decision-making processes regarding management, produce distinguishable restoration outcomes for the understory vegetation in upland oak woodlands.

Despite the shared vision among organizations, the 14 different combinations of diverse organizational structures and planning processes that we *a priori* assigned to one of three groups might reasonably be expected to diverge in some aspects of their goals for vegetation outcomes (as discussed in the Introduction; see Woodworth 2013). Our initial hypothesis (Figure 3(A)), therefore, was that vegetation outcomes for woodland sites that had been managed for 5 or more years would be detectable. Contrary to our expectations, we found no relationship between our *a priori* grouping and restoration outcomes. Furthermore, our *a priori* designation of organizations and planning processes into three types was not confirmed by an analysis of the governance data. There were, in fact, two distinct clusters of the social data, which also showed no relationship with restoration outcomes. Additional statistical modeling revealed two weak relationships not obviously related to management goals, and which lacked supporting evidence when *p* values are corrected for multiple testing. Therefore, we found no compelling evidence that differences between organizations in planning and implementation led to differences in plant communities on the restored sites – a confirmation of the third alternative hypothesis (Figure 3(C)).

Therefore, diverse planning processes did *not* manifest distinctly different ecological results. Such buffering between planning processes and ecological outcomes has potentially important implications for the social resilience of restoration planning. It suggests that whether decisions regarding restoration are made primarily by a professional land manager or in conjunction with volunteers, in a land trust or with a research focus, by hand or with power equipment, the vegetation outcomes may prove much the same.

We used the IAD to frame the study, and gathered data in most domains of the IAD as a part of our broader study (Figure 1). An early focus of the IAD was analyses of common pool resources, or extractive use of natural resources (Ostrom 2005). In contrast, we applied the IAD to a largely public goods situation. We found the IAD framework could be used to parse the different components of the overall SES, and the analysis of institutional statements (rules, norms, strategies) helpful in distinguishing differences among organizations. However, the IAD framework did not provide meaningful insight beyond structuring the SES and its interplay between the action arena and beyond it.

As we were planning and conducting our study, others in the Ostrom universe were developing and adapting the SES model, itself an adaptation of the IAD, to better account for ecological processes (Ostrom 2009; Epstein et al. 2013). Vogt et al. (2015) applied this SES model to a community-managed forest in Indiana. Given a lack of fit, they proposed adding a set of variables to the SES system to bring a more detailed account of the ecosystem into the SES model. The variables they proposed adding included system size, productivity of the system (dynamics and species composition), and ecosystem history. However, the original set of variables and those suggested by Vogt et al., include only two human actions on the land: harvesting, and built structures

that affect ecological processes (e.g., dams). Even in a common pool resource, there are more activities than these—planting, applying fertilizer or herbicide, weeding to name just a few. When looking at a public goods situation like ours, there are yet more: prescribed burns, hand pollination, and other restoration techniques. Therefore, our study provides support for a further broadening of the Ostrom SES model to include additional intentional acts by people on the land. These would fit in the “Activities and Processes” section of the original model (Epstein et al. 2013; Vogt et al. 2015).

Our findings are relevant to creating public policy for conservation and restoration management. Though not directly evaluated here, we believe that redundancy, organizational heterogeneity, and diversity of knowledge systems are key to building social resilience, as outlined by Keck and Sakdapolrak (2013). The multiple approaches to planning and implementing restoration activities in the SES of the Chicago Wilderness region increase the likelihood that restoration will continue in the region, even as inevitable obstacles arise and wane for different groups over time. At any time, one or more organizational approaches to restoration will likely be thriving. In fact, we saw this in action during the restoration moratorium (Gobster and Hull 2000; Woodworth 2013). In the face of limits on one approach to ecological restoration on a subset of regional restoration sites, others continued. While there was great distress for those impacted by the moratorium, in fact the system proved itself resilient to this perturbation (Adger 2000).

This outcome can be regarded as good news for the ongoing success of restoration not only in Chicago Wilderness, but we expect more broadly. Fostering diverse approaches to conduct restoration, including from professionals and from engaged volunteers, may prove invaluable for successful long-term stewardship of these restored habitats. If vegetation outcomes are essentially equal for strategies that engage local volunteers versus those that rely on a cadre of ecological professionals, in some situations land managers can build effective long-term support for restoration by recruiting, and sustaining, local involvement.

Like any study, ours has limitations. First, the goals of biodiversity conservation extend to a wide range of organismal groups, a diversity of spatial scales, and to a hierarchy of processes—ecological and evolutionary—that maintain the diversity of life on earth. However, we limited our ecological to analyses of vegetation outcomes. We did this because restoration of upland forests tends to focus on the structure and diversity of the plant community (Ehrenfeld 2000; Suding, Gross, and Houseman 2004). That being said, we acknowledge that it would be useful to design studies to examine how governance also affects other components of the biota. Biodiversity inventories are expensive to conduct and it will likely remain the case that researchers must chose a limited range in any one study.

Secondly, studies such as ours, in which interdisciplinary teams intensively investigate social and ecological processes simultaneously, are expensive to conduct, taxing in terms of resources, and are necessarily limited in scope. These are challenges SES studies share with classical ecosystem studies (e.g. Carpenter 1989; Schindler 1998). By locating 14 sites managed by 10 organizations over a large metropolitan region, we attempted to achieve sufficient replication while allowing in-depth analyses of social and ecological data.

Our results suggest that even when land-management organizations follow diverse planning and decision-making pathways, all lead to broadly similar ecological outcomes for those areas of land upon which restoration is implemented. Encouraging diversity in the elaboration of plans for ecological restoration, while continuing ecological research on how best to achieve specific restoration and conservation goals, is a likely road to long-term restoration success. In fact, resonant with the broader literature, we suggest that a diversity of planning models may be a requirement for ecological resilience in coupled socio-ecological systems.

Acknowledgements

We gratefully acknowledge the dedication of Chicago Wilderness ecological restoration practitioners, and thank those that participated in this study. Chris Mulvaney, formerly of Chicago Wilderness, was helpful in multiple aspects of the research. Thanks also to numerous students of the Heneghan and Wise labs at DePaul and University of Illinois at Chicago, respectively. And last but by no means least, sincere thanks to the reviewers who provided valuable insights that helped improve this paper.

Funding

This research was supported in part by NSF grant numbers DEB-BE-0909043, 0909451, 0909293 and 0909424: Collaborative Research: Coupled Natural Human Systems in the Chicago Wilderness: Evaluating the Biodiversity and Social Outcomes of Different Models of Restoration Planning.

References

- Adger, N. W. 2000. Social and ecological resilience: Are they related? *Progress in Human Geography* 24 (3):347–64. doi: [10.1191/030913200701540465](https://doi.org/10.1191/030913200701540465).
- Allain, L., L. Smith, C. Allen, M. F. Vidrine, and J. B. Grace. 2004. A floristic quality assessment system for the coastal prairie of Louisiana. Proceedings of the 19th North American Prairie Conference. Paper 62, Madison, WI, USA, August 2004.
- Anderies, J. M., C. Folke, B. Walker, and E. Ostrom. 2013. Aligning key concepts for global change policy: Robustness, resilience, and sustainability. *Ecology and Society* 18 (2):16. doi: [10.5751/ES-05178-180208](https://doi.org/10.5751/ES-05178-180208).
- Angelstam, P., K. Andersson, M. Annerstedt, R. Axelsson, M. Elbakidze, P. Garrido, P. Grahm, K. I. Jönsson, S. Pedersen, P. Schlyter, et al. 2013. Solving problems in social-ecological systems: Definition, practice and barriers of transdisciplinary research. *Ambio* 42 (2):254–65. doi: [10.1007/s13280-012-0372-4](https://doi.org/10.1007/s13280-012-0372-4).
- Baggio, J. A., A. J. Barnett, I. Perez-Ibarra, U. Brady, E. Ratajczyk, N. Rollins, C. Rubiños, H. C. Shin, D. J. Yu, R. Aggarwal, et al. 2016. Explaining success and failure in the commons: The configural nature of Ostrom's institutional design principles. *International Journal of the Commons* 10 (2):417–39. doi: [10.18352/ijc.634](https://doi.org/10.18352/ijc.634).
- Ban, N. C., M. Mills, J. Tam, C. C. Hicks, S. Klain, N. Stoeckl, M. C. Bottrill, J. Levine, R. L. Pressey, T. Satterfield, et al. 2013. A social-ecological approach to conservation planning: Embedding social considerations. *Frontiers in Ecology and the Environment* 11 (4):194–202. doi: [10.1890/110205](https://doi.org/10.1890/110205).
- Berkes, F., and H. Ross. 2013. Community resilience: Toward an integrated approach. *Society & Natural Resources* 26 (1):5–20. doi: [10.1080/08941920.2012.736605](https://doi.org/10.1080/08941920.2012.736605).

- Biggs, R., M. Schluter, D. Biggs, E. L. Bohensky, S. BurnSilver, G. Cundill, V. Dakos, T. M. Daw, L. S. Evans, K. Kotschy, et al. 2012. Toward principles for enhancing the resilience of ecosystem services. In *Annual review of environment and resources*, ed. A. Gadgil and D. M. Liverman, Vol. 37, 421. Palo Alto, CA: Annual Reviews. doi: [10.1146/annurev-environ-051211-123836](https://doi.org/10.1146/annurev-environ-051211-123836).
- Bodin, O., and B. I. Crona. 2009. The role of social networks in natural resource governance: What relational patterns make a difference? *Global Environmental Change* 19 (3):366–74. doi: [10.1016/j.gloenvcha.2009.05.002](https://doi.org/10.1016/j.gloenvcha.2009.05.002).
- Braun-Blanquet, J. 1965. *Plant sociology: The study of plant communities*. London, UK: Hafner.
- Carmona-Torres, C., C. Parra-López, J. C. J. Groot, and W. A. Rossing. 2011. Collective action for multi-scale environmental management: Achieving landscape policy objectives through cooperation of local resource managers. *Landscape and Urban Planning* 103 (1):24–33. doi: [10.1016/j.landurbplan.2011.05.009](https://doi.org/10.1016/j.landurbplan.2011.05.009).
- Carpenter, S. R. 1989. Replication and treatment strength in whole-lake experiments. *Ecology* 70 (2):453–63. doi: [10.2307/1937550](https://doi.org/10.2307/1937550).
- Chaffin, B., H. Gosnell, and B. Cosens. 2014. A decade of adaptive governance scholarship: Synthesis and future directions. *Ecology and Society* 19 (3):56. doi: [10.5751/ES-06824-190356](https://doi.org/10.5751/ES-06824-190356).
- Chicago Region Biodiversity Council. 1999. *Biodiversity recovery plan*. Chicago, IL: Chicago Region Biodiversity Council.
- Clewell, A., J. Aronson, and K. Winterhalder. 2004. *The SER international primer on ecological restoration*. https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser_primer.pdf
- Clewell, A. F., and J. Aronson. 2013. *Ecological restoration: Principles, values, and structure of an emerging profession*. Washington, DC: Island Press.
- Ellis, E. C. 2015. Ecology in an anthropogenic biosphere. *Ecological Monographs* 85 (3):287–331. doi: [10.1890/14-2274.1](https://doi.org/10.1890/14-2274.1).
- Ehrenfeld, J. G. 2000. Defining the limits of restoration: The need for realistic goals. *Restoration Ecology* 8 (1):2–9. doi: [10.1046/j.1526-100x.2000.80002.x](https://doi.org/10.1046/j.1526-100x.2000.80002.x).
- Epstein, G., J. M. Vogt, S. K. Mincey, M. Cox, and B. Fischer. 2013. Missing ecology: Integrating ecological perspectives with the social-ecological system framework. *International Journal of the Commons* 7 (2):432–53. doi: [10.18352/bmgn-lchr.371](https://doi.org/10.18352/bmgn-lchr.371).
- Garicano, L., and L. Rayo. 2016. Why organizations fail: Models and cases. *Journal of Economic Literature* 54 (1):137–92. doi: [10.1257/jel.54.1.137](https://doi.org/10.1257/jel.54.1.137).
- Garmestani, A. S., and M. H. Benson. 2013. A framework for resilience-based governance of social-ecological systems. *Ecology and Society* 18 (1):11. doi: [10.5751/ES-05180-180109](https://doi.org/10.5751/ES-05180-180109).
- Gobster, P. H., and R. B. Hull. 2000. *Restoring nature: Perspectives from the social sciences and humanities*. Washington, DC: Island Press.
- Heneghan, L., C. Mulvaney, K. Ross, L. Umek, C. Watkins, L. M. Westphal, and D. H. Wise. 2012. Lessons learned from Chicago wilderness—implementing and sustaining conservation management in an urban setting. *Diversity* 4 (1):74–93. doi: [10.3390/d4010074](https://doi.org/10.3390/d4010074).
- Hobbs, R. J. 2007. Setting effective and realistic restoration goals: Key directions for research. *Restoration Ecology* 15 (2):354–7. doi: [10.1111/j.1526-100X.2007.00225.x](https://doi.org/10.1111/j.1526-100X.2007.00225.x).
- Jordan, W. R., and G. M. Lubick. 2011. *Making nature whole: A history of ecological restoration*. Washington, DC: Island Press.
- Keck, M., and P. Sakdapolrak. 2013. What is social resilience? Lessons learned and ways forward. *Erdkunde* 67 (1):5–19. doi: [10.3112/erdkunde.2013.01.02](https://doi.org/10.3112/erdkunde.2013.01.02).
- Legendre, P., and L. Legendre. 2012. *Numerical ecology*. Amsterdam: Elsevier.
- McCary, M. A., J. -C. Martinez, L. Umek, L. Heneghan, and D. H. Wise. 2015. Effects of woodland restoration and management on the community of surface-active arthropods in the metropolitan Chicago region. *Biological Conservation* 190:154–66. doi: [10.1016/j.biocon.2015.06.005](https://doi.org/10.1016/j.biocon.2015.06.005).
- McGinnis, M. D. 1999. *Polycentric governance and development: Readings from the workshop in political theory and policy analysis*. Ann Arbor, MI: University of Michigan Press.

- McGinnis, M. D. 2011. An Introduction to IAD and the Language of the Ostrom Workshop: A simple guide to a complex framework. *Policy Studies Journal* 39 (1):169–83. doi: [10.1111/j.1541-0072.2010.00401.x](https://doi.org/10.1111/j.1541-0072.2010.00401.x).
- Ostrom, E. 1990. *Governing the commons: the evolution of institutions for collective action*. Cambridge, MA: Cambridge University Press.
- Ostrom, E. 2005. *Understanding institutional diversity*. Princeton, NJ: Princeton University Press.
- Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939):419–22. doi:[10.1126/science.1172133](https://doi.org/10.1126/science.1172133).
- Ostrom, E. 2011. Background on the institutional analysis and development framework. *Policy Studies Journal* 39 (1):7–27. doi: [10.1111/j.1541-0072.2010.00394.x](https://doi.org/10.1111/j.1541-0072.2010.00394.x).
- Packard, S., and C. F. Mutel. 1997. *The tallgrass restoration handbook: For prairies, savannas, and woodlands*. Washington, DC: Island Press.
- R Core Team. 2013. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. URL <http://www.R-project.org/>.
- Schultz, L., C. Folke, H. Osterblom, and P. Olsson. 2015. Adaptive governance, ecosystem management, and natural capital. *Proceedings of the National Academy of Sciences* 112 (24): 7369–74. doi: [10.1073/pnas.1406493112](https://doi.org/10.1073/pnas.1406493112).
- Schindler, D. W. 1998. Whole-ecosystem experiments: Replication versus realism: The need for ecosystem-scale experiments. *Ecosystems* 1 (4):323–34. doi: [10.1007/s100219900026](https://doi.org/10.1007/s100219900026).
- Stohlgren, T. J., M. B. Falkner, and L. D. Schell. 1995. A Modified-Whittaker vegetation sampling method. *Vegetatio* 117:113–21. doi: [10.1007/BF00045503](https://doi.org/10.1007/BF00045503).
- Suding, K. N., K. L. Gross, and G. R. Houseman. 2004. Alternative states and positive feedbacks in restoration ecology. *Trends in Ecology & Evolution* 19 (1):46–53. doi: [10.1016/j.tree.2003.10.005](https://doi.org/10.1016/j.tree.2003.10.005).
- Swink, F.; G. Wilhelm. 1979. *Plants of the Chicago Region*. 3rd ed. Lisle, IL: The Morton Arboretum.
- Swink, F., and G. Wilhelm. 1994. *Plants of the Chicago region*. 4th ed. Indianapolis, IN: Indiana Academy of Science.
- The Chicago Wilderness consortium. 2006. *The state of our Chicago wilderness: A report card on the ecological health of the region*. Chicago, IL: The Chicago Wilderness consortium. <https://www.csu.edu/cerc/documents/StateOfOurChicagoWilderness.pdf>
- Umek, L. 2018. Impacts of restoration and management on plant communities and belowground processes in the Chicago Region. Diss., Northwestern University.
- Vogt, J., G. Epstein, S. Mincey, B. Fischer, and P. McCord. 2015. Putting the “E” in SES: Unpacking the ecology in the Ostrom social-ecological system framework. *Ecology and Society* 20 (1):55. doi: [10.5751/ES-07239-200155](https://doi.org/10.5751/ES-07239-200155).
- Watkins, C., and L. M. Westphal. 2016. People don’t talk in institutional statements: A methodological case study of the institutional analysis and development framework. *Policy Studies Journal* 44 (S1):S98–S122. doi: [10.1111/psj.12139](https://doi.org/10.1111/psj.12139).
- Watkins, C., L. M. Westphal, P. H. Gobster, J. Vining, A. Wali, and M. Tudor. 2015. Shared principles of restoration practice in the Chicago Wilderness region. *Human Ecology Review* 21 (1):155–77. <https://www.jstor.org/stable/24875124>. doi: [10.22459/HER.21.01.2015.07](https://doi.org/10.22459/HER.21.01.2015.07).
- Westphal, L. M., C. Watkins, P. H. Gobster, L. Heneghan, K. Ross, L. Ross, M. Tudor, A. Wali, D. H. Wise, J. Vining, et al. 2014. *Social science methods used in the RESTORE Project*. Gen. Tech. Rep. NRS-138, 116 p. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. doi: [10.2737/NRS-GTR-138](https://doi.org/10.2737/NRS-GTR-138).
- Woodworth, P. 2013. *Our once and future planet: Restoring the world in the climate change century*. Chicago, IL: University of Chicago Press.