

UN DECADE ON ECOSYSTEM RESTORATION

REVIEW ARTICLE

Organizational capacity and ecological restoration

Susan Galatowitsch^{1,2} 

Organizations entrusted with responsibilities and resources to repair ecosystems have for many decades pursued their defining purpose against long odds created by a host of inherent challenges, notably the long time frames required for ecological recovery and landscape-level stressors. Global change compounds these challenges, increasing shocks to the operating environments of these organizations. Interest in assessing organizational capacity to respond to system shocks (i.e. resilience) productively has been strong in many fields, though not in the restoration arena. The objectives of this paper are to build awareness of the importance of organizations for achieving the aims of restoration and to spur organizational research to strengthen the restoration sector. I summarize research on organizations relevant to the restoration sector and with this foundation propose a framework for assessing the capacity of restoration organizations. The proposed framework is an adaptation of models used in other sectors, based on five critical capacities: situation awareness, governance and leadership, internal resources, external relations, and change readiness. We can assess the extent to which an organization possesses each capacity by eliciting feedback about functions linked to each capacity. Devising assessment tools from this framework requires attention to key realities of the restoration sector including prevalence of short-term funding, effect of externalities on restoration outcomes, dependence on partnerships of multiple organizations for complex and large restorations. Exploration into assessment approaches for restoration organizations highlights a major knowledge gap that, if addressed, could enhance the reliability of restoration as a global and local strategy for improving ecosystems services.

Key words: conservation organizations, ecosystem restoration, organizational functions, organizational resilience, strategic planning

Implications for Practice

- The capacity of people (i.e. organization) undertaking a restoration greatly affects what can be accomplished with available resources and support. Yet, there has been little exploration of how to assess organizational deficiencies so these can be addressed, potentially improving outcomes of their restoration.
- Using precedents from other sectors, a framework to assess restoration organizations' capacity is proposed here. Assessments of organizational capacity can be undertaken for an individual organization or as an external assessment of multiple organizations.
- Because many restoration organizations depend on external support to pursue projects, expectations linked to funding decisions can accelerate the adoption of organizational capacity assessments.

Restoring degraded ecosystems, especially those within highly transformed landscapes and those with major abiotic alterations, are often poor candidates for “passive restoration.” Regaining valued ecosystem services requires well-planned and executed interventions (Zahawi et al. 2014; Suding et al. 2015). Primary barriers to achieving ambitious restoration aims are often presumed to be adequate financial resources and societal support (e.g. Menz et al. 2013). Yet, within a locale, what can be accomplished with available resources and support can vary greatly, depending on whether planning of the interventions is strategically sound, efficiently undertaken, and responsive to setbacks. These aspects of restoration depend on the capacity of the group of people undertaking a project (Ntshotsho et al. 2015;

Author contributions: SG is responsible for all aspects of the paper—conceptualization of topic, literature review, formulation of the findings, writing and editing the manuscript.

¹Department of Fisheries, Wildlife and Conservation Biology, University of Minnesota, 2003 Upper Buford Circle, Saint Paul, MN 55108, U.S.A.

²Address correspondence to S. Galatowitsch, email galat001@umn.edu

Introduction

Globally, the highest priorities for ecological restoration are typically places where environmental degradation has been most severe and extensive (IPBES 2018; United Nations 2019).

© 2022 The Author. Restoration Ecology published by Wiley Periodicals LLC on behalf of Society for Ecological Restoration.
This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial License](#), which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
doi: 10.1111/rec.13757

Galatowitsch & Bohnen 2020; Nerfa et al. 2021). In ecological restoration, preventable unfavorable outcomes are, however, seldom distinguished from failures that could not have been averted (e.g. due to extreme weather events, novel stressors).

Individuals working together as a group to achieve a collective purpose, that is, organizations, have been studied for decades in order to understand what makes them more or less effective (Scott 2004). Uncritically attributing poor restoration outcomes to unforeseeable circumstances means that the need to assess and build organizational capacity in the restoration sector has been largely overlooked. Moreover, there has been almost no exploration of how to assess organizational deficiencies so they can be addressed, potentially improving outcomes of their restoration projects and more broadly, the predictability of restoration as a conservation strategy (Catalano et al. 2019; Galatowitsch & Bohnen 2020).

Understanding why some organizations are more likely to accomplish their purpose than others has been a research focus in other sectors, notably business, public health, and natural disaster response (e.g. citations in Galatowitsch 2012). Knowledge development has often been spurred by a desire to diagnose the capacity or reliability of organizations that operate in complex environments where failures have high-stakes consequences (Linnenluecke et al. 2012). Often framed as organizational resilience, key aspects of this capacity relate to identifying, understanding, evaluating, monitoring, and revising unexpected situations and for intervening before negative effects escalate. Developing a predictive understanding of restoration organization function is likely to be at least as complex as for other sectors because of the diversity of types of organizations that pursue restoration, which includes professional contractors, non-profit organizations, government land management agencies, scientific research entities, among others. As importantly, some restoration projects (i.e. the purpose) are undertaken by individuals from a single organization while others by groups formed from multiple organizations.

Ideally, those undertaking a restoration project should sustain their involvement until the restored ecosystem has attained functions for self-regeneration (Reid et al. 2017; Nerfa et al. 2021). During this period, an organization is likely to face numerous challenges that can threaten the restoration's outcome or longevity, including unstable funding, leadership change, new or unmitigated stresses to the ecosystem, unanticipated responses to restoration actions, gaps in knowledge and expertise, and variable levels of commitment of participants (Reid et al. 2017; Galatowitsch & Bohnen 2020). Moreover, many organizations that do restoration work regularly take on new projects and must be able to identify and react to challenges across a portfolio of projects.

Many ecological restorations, especially of highly degraded ecosystems, are labor- and skill intensive, requiring significant financial resources entrusted to organizations that accept responsibility for achieving the proposed aims of the projects, including management of human resources, contractors, and partnerships (BenDor et al. 2015). Although some organizations informally may earn a reputation for the quality of their work, sound approaches for assessing their capacity to take on the responsibility of proposed work are needed. A common practice for ascertaining organizational capacity focuses on the expertise

or credentials of individuals (e.g. Society of Ecological Restoration's Certified Ecological Restoration Practitioners). However, the influence of specific individuals on organizational function and decision-making, regardless of their experience and skill, varies greatly, and so an unreliable sole indicator of restoration capacity. Because restoration organizations are team based, how members function together can have a strong impact on the contributions of individual members.

Within the past 20 years, organizational research has shifted to be almost completely within the domains of applied fields, where interest in developing predictive frameworks of organizational capacity and resilience is strong (Sutcliffe & Vogus 2003). Approaches for building and assessing organizational capacity and resilience are also a critical need for ecological restoration and conservation more generally (Catalano et al. 2019). In this paper, I will: summarize organizational research relevant to the restoration sector, propose a framework for assessing the capacity of restoration organizations, and identify the likely challenges for building the capacity of restoration organizations. The intent of this paper is to build awareness of the importance of organizations for achieving the aims of restoration and to encourage organizational research to strengthen the restoration sector.

Understanding Organizations and Their Capacity

Essential Functions of Organizations

Early organizational research was entity-based, that is, closed social systems regulated by a chief or director (Scott 2004). The research paradigm shifted to organizations as inherently open systems, reliant on both internal "core" functions and externalized functions. This shift (from the 1970s onward) mirrored a real-world trend toward open-system organizations. The "open-system" paradigm is relevant to the restoration sector since most of its organizations are highly externalized, often reliant on others to provide goods and services. This body of organizational research suggests that capacity depends on the extent to which: (1) there are ways to achieve a shared purpose collectively; (2) self-organization and bottom-up decision-making can be fostered; (3) group leadership remains effective over time; (4) individuals can acquire new collective knowledge; and (5) the organization be managed competently (Black et al. 2011; Fabricius & Cundill 2014; Haveman & Wetts 2019). How organizations attend to these functions is situation-dependent, notably reflecting their complexity, purpose, and size.

A shared purpose depends on "collective sense-making": that is, individuals in a group use their expertise and perceptions to develop a common understanding of situations (Virji et al. 2012; Takeda et al. 2017; Haveman & Wetts 2019). Opportunities to develop a shared sense of purpose are critical for sustaining engagement, committing to excellence, and minimizing operational conflicts. Collective sense-making for restoration organizations might include addressing challenges such as guidance offered to clients related to invasive species methods, how to respond to a structural problem in restoration (e.g. stream channel reconfigurations), or establishing appropriate goals for a high risk project. Reaching a common understanding in

restoration organizations is influenced by the different disciplines of professionals within the group as well as norms and culture of broader society (Clement et al. 2016). Achieving a shared purpose is often more complicated if the group is composed of participants from multiple organizations, each with their own culture and priorities. As the scale and scope of restoration projects has increased, so has the prevalence of multi-organizational groups. In multiple organization situations, intentional efforts toward collective sense-making may be needed to reduce the risks of dysfunctional decision-making, communication snafus, and systematic failure (Takeda et al. 2017).

Organizational decision-making processes range from being primarily reliant on one to several leaders (i.e. “top-down”) to being mostly a function of self-organization (Virji et al. 2012). While “top down” decision-making may be required in many organizations for some decisions (e.g. major financial decisions, human resources, responding to governing boards or other authorities), organizations vary considerably in their level of delegated authority for ongoing or local decision-making. The extent to which a shared purpose exists often translates to a capacity for a group to self-organize rather than be reliant on a few decision-makers (Virji et al. 2012). Restoration projects are a product of myriad decisions, notably responses to on-site situations that differ from assumptions made during planning, such as how to react to the arrival of an invasive species, hazards that emerge during a prescribed burn or regrading, or prioritizing work when staff capacity is limited. Self-organizing, the capacity for individuals to share knowledge and experience and make decisions together informally, offers greater flexibility in responding to fast-changing situations and filling gaps in formal responsibilities. Restoration effectiveness often benefits from rapid response based on site observations. However, without a solid sense of shared purpose and accountability, self-organization can lead to inconsistency in following agreed upon project priorities.

Even if self-organization and devolved decision-making are well-established and effective, leaders are needed to orchestrate the group’s operations. Ideally, leaders offer strategic direction (“the big picture”), while also tending to administrative functions (Black et al. 2011). For leaders of restoration organizations, setting strategic direction is often connected to seeking opportunities (i.e. partnerships, funding) for new projects. Effective leaders also foster learning, support collective sense-making, and steward the group’s long-term vision. Administrative functions of organizations are pragmatic concerns like managing resources, operational efficiency, and productivity (Haveman & Wetts 2019). A key organizational function is to have competent administrative capacity to manage, adapt, and secure human and financial resources proportional to the scale of the problem (Virji et al. 2012; Clement et al. 2016). For restoration organizations heavily reliant on short-term grant funding, administrative functions are often exacting for their leaders.

Acquiring knowledge and promoting learning is essential to an organization’s capacity to solve problems, innovate, and be aware of emerging trends (Fabricius & Cundill 2014; Catalano et al. 2019). Restoration organizations often seek to build teams of individuals with diverse expertise and backgrounds to have

the capacity for sound and innovative problem-solving. However, navigating knowledge sharing within a diverse group often requires pro-active attention to practical challenges such as addressing individuals’ cognitive biases, cultivating psychological safety within teams, and fostering team learning behaviors (Catalano et al. 2019). Organizations also need to create ways to learn from direct experiences, including using a project’s failures as a source of knowledge and learning. For each project completed, knowing what worked, what did not work, and why is crucial when designing and implementing future restoration projects. However, this type of analysis has been largely underutilized in conservation (Catalano et al. 2019). Knowledge gained in the context of planning and implementation (i.e. tacit knowledge) is as vitally important to the field of restoration as is research-based knowledge (i.e. explicit knowledge). Sharing tacit knowledge broadly has been especially challenging (Hulme 2014), though restoration organizations also face barriers to the acquisition of explicit restoration knowledge, that is, accessibility of academic journals.

Studies of community-based restoration organizations indicate that their capacity to adapt and respond to changing circumstances links to their ability to access resources, especially consistent funding and recruitment of volunteers with needed expertise (Gooch & Warburton 2009; Peters et al. 2015). Overall, these studies highlight the importance of several organizational functions—knowledge acquisition, administrative competence, and leadership. Unfortunately, organizational capacity of professional groups has not received research attention. Professional groups are likely to function in ways that pose different challenges and opportunities than community-based groups and also are more likely to undertake complex projects. Consequently, we have an incomplete understanding of the linkage between essential organizational functions and capacity for the restoration sector.

Organizational Capacity and Resilience

To achieve envisioned project outcomes, a restoration organization must respond to challenges they plan for as well as to unforeseen setbacks and even to fundamental changes in their operational environment. Potential setbacks in restoration projects are myriad, such as loss of an experienced practitioner or key leader, funding gaps, and delays in required permits or shipments of necessary supplies. Changes that restoration organizations may face are also highly disruptive, novel or not reasonably predictable at the onset of a project (*sensu* Linnenluecke et al. 2012). These major disruptions or system shocks can be environmental and social, that is, natural disasters, extreme weather caused by climate change, catastrophic release of toxins, increased social conflict. Some organizations respond to change more effectively than others, presumably because they have the necessary capacity to reconfigure themselves or develop new ways to carry out their work when confronted with unpredictable, disruptive circumstances (Linnenluecke et al. 2012). Because preparing contingencies for every challenging event that could arise is not feasible, researchers have tried to understand how organizations can predict the extent to

which the way they function could limit their capacity to change (McManus et al. 2008; Linnenluecke et al. 2012; Ruiz-Martin et al. 2018).

The capacity to respond to system shocks has been defined as resilience (e.g. Olsson et al. 2015). In an organizational sense, resilience refers to the inherent or latent characteristics of organizations that can be activated or adjusted as different adverse conditions arise (Linnenluecke 2017). Organizational sociologists adapted the concept of resilience advanced by ecologists to explain the variable ability of ecosystems to withstand stresses and shocks and persist (Holling 1973). In both realms, resilience is the system behavior in response to an event of an unusual nature (i.e. disturbance), and the extent to which the system will return to a pre-disturbance state or be fundamentally altered. As applied to organizations, the concept of resilience has been criticized for being normative because it has sometimes been interpreted to indicate that resisting change or rapidly recovering to a previous state is “good” (Olsson et al. 2015). However, as applied to real-world challenges, researchers have interpreted resilience as a capacity for an organization to continue to pursue its purpose, potentially in fundamentally different ways (McDaniels et al. 2008; Linnenluecke & Griffiths 2010). This interpretation still views resilience as a desirable property because an organization that has thrived through change may respond to future shocks well.

For the concept of organizational resilience to have practical value, it needs to be translated into a predictive framework with measurable and interpretable components (McManus et al. 2008). Building a resilience framework often begins with a prototype model that groups specific organizational traits and functions likely to co-act during a disturbance response. Disturbance responses in a restoration organization might be triggered by events such as major loss of funding, departure of critical leaders or experts, supply-chain issues for essential goods (i.e. plant materials, “back-lash” to project activities). The model structure may be based on a new conceptualization, one developed from a post-hoc analysis of organizational responses to disturbances (McManus et al. 2008; Tengblad & Oudhuis 2017), or one previously forwarded by theoretical or applied research (Clement et al. 2016). The set of traits and functions most likely to determine an organization’s capacity for change is determined from surveys of organizational leaders and group members. Surveys can also be used to elucidate underlying reasons that some traits are more important than others or some functional approaches more adaptable to change (Seville 2009; Stephenson et al. 2010). These deeper-level understandings offer an opportunity to validate the model structure.

Assessing Organizational Capacity and Resilience

Resilience frameworks are typically built for specific types of organizations (Linnenluecke 2017). The extent to which approaches developed for one sector are adaptable to others has received limited research attention although organizations that vary tremendously in purpose and complexity share essential functions. These functions are central to responding to

uncertainty, so adapting at least the higher level components of diagnostic frameworks to new applications should be possible.

Several frameworks exist that are potentially adaptable for the restoration sector. McManus et al. (2008) developed a resilience framework based on case studies of 10 organizations selected to represent a wide range of sectors and sizes in New Zealand, including, for example, a local government organization, a private manufacturer, a public infrastructure provider, and a wholesale distributor. In the early 1990s, research on the resilience of New Zealand organizations flourished due to government policies aimed at improving the effectiveness of organizations providing front-line response during and after crises, especially natural disasters. The New Zealand model has three main components: situation awareness, management of keystone vulnerabilities, and adaptive capacity. They identified key indicators for each component, addressing both functions internal (“core”) and external to the organization, and based on this, developed a diagnostic assessment intended to build awareness of resilience vulnerabilities within the organization and provide tangible direction for improvement (see Stephenson 2008). Through further application and validation (Seville 2009; Stephenson et al. 2010; Brown et al. 2017), the model structure has evolved to retain many of the indicators (i.e. traits and functions), grouped within three components: change readiness, leadership and culture, and network and relationships (Brown et al. 2017).

Galatowitsch and Bohnen (2020) adapted the New Zealand framework to assess the importance of organizational capacity on restoration outcomes in the Midwestern US (Minnesota). They identified nine potential indicators of situation awareness and 19 of keystone vulnerabilities based on McManus et al. (2008) and related work (Stephenson 2008; Stephenson et al. 2010), modified to be relevant to restoration organization capacity, as proposed in Galatowitsch (2012). They evaluated the importance of these indicators with data gathered from in-depth interviews with managers. Although developing an assessment approach for restoration organizations was not within the scope of this study, the results showed potential for the New Zealand framework to serve as a model structure for this sector.

Responding to the increasing reliance on community-based volunteer groups for environmental stewardship in Australia (i.e. “Friends Groups”), Dhakal (2011) adapted the “Five Capitals Framework” to assess the capacity of friends groups to carry out their responsibilities, such as invasive species removal, erosion control, and bush revegetation. Previously the Five Capitals Framework, based on five main forms of capital (i.e. financial, human, natural, physical, and social), had been used to ascertain community capabilities to address local and global environmental challenges (e.g. Nelson et al. 2007). Dhakal (2011) linked friends group functions to each of the five forms of capital and based on this structure devised a survey used to understand overall strengths and weaknesses of the approximately 400 Friends Groups in the vicinity of Perth, Australia (Table 1). From this survey, he identified that functions related to Human Capital were a particularly serious and widespread limitation for organizational capacity. Similar to the study by Galatowitsch and

Table 1. Functions of volunteer restoration organizations categorized by five forms of capital, characterized for Friends Groups in Western Australia (Dhakal 2011).

Capitals	Functions
Natural	Accomplish restoration and ecological management objectives
Physical	Adopt and utilize information and communication technologies
Human	Attract and retain volunteers
Social	Maintain relationships with relevant stakeholders
Financial	Raise adequate funds to support activities

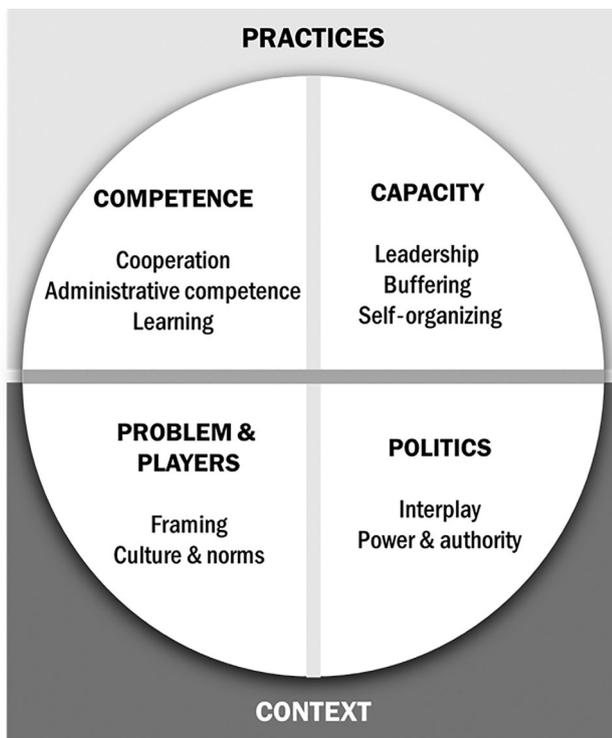


Figure 1. A framework proposed by Clement et al. (2016) designed to assess the capacity of conservation organizations to identify and solve problems, deploy knowledge and skills, and respond to change. The framework has four components: Two that are primarily external (i.e. context) and two that are internal (i.e. practices).

Bohnen (2020), Dhakal (2011) did not develop this framework to use as a diagnostic tool for individual organizations but to elucidate common challenges that could be addressed by coordinating agencies.

Clement et al. (2016) proposed a framework to assess the capacity of conservation organizations based on their potential to identify and solve problems, deploy knowledge and skills, and respond to change. This framework uses adaptive governance, institutional theory, and public administration as the foundation for its model structure. The model includes four components, two that are primarily external (i.e. context) and two that are internal (i.e. practices) (Fig. 1). The resulting

Clement et al.'s model is similar to the most recent New Zealand model (Brown et al. 2017), especially regarding indicators and groupings related to "Practice." The Clement's model was used to diagnose the capacity of local organizations to achieve biodiversity conservation aims of landscape-scale programs in an agricultural region of Tasmania, Australia (Clement et al. 2017). Applying the model allowed researchers to identify a suite of constraints caused by the central structure of the program, including a narrow framing of the program objectives and a lack of devolved decision-making.

Tuda and Machumu (2019) also focused on attributes of adaptive governance to assess the capacity of organizations managing marine protected areas in East Africa. They aimed to assess the extent to which social factors affect an organization's capacity to adapt to climate change and effectively pursue marine conservation. Their empirical study compared two models of Marine Protected Area governance, centralized and collaborative (co-management), and found that the well-developed networks typical of collaborative governance served as a source of novel and diverse information and beneficial redundancy that may not be readily available to a focal organization. Other studies have also explored how specific aspects of organizational functions affect the capacity to pursue conservation work, including leadership behaviors and approaches (e.g. Black et al. 2011).

Assessing Organizational Capacity in the Restoration Sector

Overview of a Framework to Assess Restoration Organizations (FARO)

For assessment frameworks to be worthwhile for restoration organizations, they should include: (1) sound assumptions about organizational functions; (2) diagnostic criteria (indicators) relevant to the organizations assessed; and (3) interpretation with respect to improving capacity to respond to future changes (resilience). Adapting an existing framework and assessment process with these features, even if validated in other sectors, reduces some of the uncertainties associated with designing a diagnostic tool. For this reason, the framework I propose for restoration organizations is an adaptation of the New Zealand model, used and refined since 2008 (e.g. Brown et al. 2017). The Framework for the Assessment of Restoration Organizations is based on five critical capacities: Situation Awareness, Governance and Leadership, Internal Resources, External Relations, and Change Readiness (Fig. 2). The extent to which an organization possesses each capacity is assessed by eliciting feedback about a set of associated functions (3–4 per capacity). FARO delineated the scope of organizational functions essential to each capacity based on conservation organizations and governance research, notably Clement et al. (2016), Virji et al. (2012), Dhakal (2011), Brown et al. (2017), Catalano et al. (2019), as well as from the New Zealand model.

An operational level understanding an organization's functional strengths and weaknesses can be probed using diagnostic criteria (Tables 2–6). Questions developed for criteria are used



Figure 2. The Framework for the Assessment of Restoration Organizations (FARO) is based on five critical capacities. The extent to which an organization possesses each capacity is assessed by eliciting feedback about functions associated with each capacity.

to elicit insights into key strengths and weaknesses about the associated functions. For each function in FARO, 2–6 diagnostic criteria are provided, some important to multiple functions and capacities.

Assessment Scope of Critical Capacities and Associated Functions

Situation Awareness. An organization with sufficient situation awareness understands what is happening around it, monitors its own functions, and uses that information to make informed decisions (Endsley 1995). To assess its situation awareness, a restoration organization needs to examine whether its group members are adequately engaged in the organization’s mission, whether there is a robust culture of collective sense-making, learning and knowledge sharing, including adaptive decision-making (Table 2). Situation awareness is a fundamental aspect of resilience because it allows an organization to minimize surprises and be well-positioned to find solutions to emerging challenges (McManus et al. 2008).

Leadership and Governance. For an organization to most effectively pursue its purpose, especially in times of crisis or

Table 2. Assessment criteria for functions associated with an organization’s situation awareness (SA). Criteria also linked to other functions are noted in parentheses: CR, change readiness; ER, external relations; IR, internal resources; LG, leadership and governance.

Function	Characteristics of a Resilient Organization	Criteria	Sources
Staff engagement	Group members are encouraged to be vigilant about the organization, its performance and potential problems. They are rewarded for sharing good and bad news about the organization including early warning signals and these are quickly reported to organizational leaders. They are empowered and use their skills to solve problems.	<ul style="list-style-type: none"> Internal communications (LG) Devolved decision-making (LG) Early warning signal reporting 	McManus et al. (2008), Weick and Sutcliffe (2001)
Learning and knowledge	Group members are encouraged to seek new knowledge and insights, both from external sources and from their own experiences, and share this information with others in the organization. The organization maintains project records and other kinds of essential information and ensures that it is available for analysis.	<ul style="list-style-type: none"> Knowledge acquisition (ER) Knowledge sharing (IR) Knowledge leveraging Detection of trends and emerging challenges (LG, CR) Project record-keeping 	Catalano et al. (2019), Fabricius and Cundill (2014), Hulme (2014), McManus et al. (2008), Virji et al. (2012)
Adaptive decision-making	The organization continually assesses whether reality meets the expectations established by its vision and mission and if not, why not. Tracks progress of projects and adjusts, as needed, based on evidence.	<ul style="list-style-type: none"> Informed decision-making (LG) Project goal-setting and monitoring Project contingency planning 	Galatowitsch and Bohnen (2020), Reid et al. (2017)
Collective sense-making	Group members have regular, ongoing opportunities to build a shared understanding of situations critical to the organization’s purpose, especially those that are complex. In times of rapid change or crisis, leaders facilitate sense-making.	<ul style="list-style-type: none"> Portfolio-scale goal-setting Development of best practices (IR) Knowledge sharing (IR) 	Clement et al. (2016), Haveman and Wetts (2019), Takeda et al. (2017), Virji et al. (2012), Walpole et al. (2020)

rapid change, it needs group processes designed to ensure accountability, transparency, responsiveness, empowerment, inclusiveness, and broad-based engagement (Table 3). These group processes are collectively considered to be organizational governance (UNESCO 2022). Governance depends on capable leadership to serve as a catalyst and provide support and stability for the group. Leaders need to foster collaboration both inside their organization and with other organizations. To do this, they need to bring people together, build trust, broker deals, and manage conflicts (Folke et al. 2005).

Internal Resources. An organization needs sufficient core capacity to foresee potential problems, as well as to effectively respond to unpredictable changes and mitigate likely risks. In the restoration sector, this includes four aspects of internal resources that should be examined during an assessment: (1) technical capability and capacity; (2) prevention of silos; (3) innovation and creativity; and (4) administrative competence (Table 4). An organization lacking people with specific skills, sufficient or available equipment, or adequate scientific or technical knowledge is vulnerable to restoration failure (Gooch & Warburton 2009; Galatowitsch & Bohnen 2020). To maximize the benefits of the expertise within an organization, all group members need well-defined roles and responsibilities under both normal and unexpected circumstances. Restoration organizations with multiple teams (e.g. based on discipline or geography) need to ensure that they do not become isolated from one

another, which can hinder awareness of related skills, knowledge, and activities in other “silos.” A silo mentality reinforces cultural differences and stereotypes, can be challenging to overcome, and limits an organization’s capacity for problem-solving.

External Relations. Restoration organizations often cannot rely solely on their capacity to complete projects and need working relationships with other organizations that provide supplies, services, or local knowledge that complement their capacity. Being able to rely on external networks can be particularly important for minimizing risk associated with peak demands in personnel time and aspects of projects requiring specialized expertise (Table 5). How effectively an organization accesses external resources to fill gaps in internal capacity and knowledge is a key component of assessing the external relations function of an organization. Two other components include the organization’s approaches to partnerships and collaboration, and its ability to influence circumstances politically (Clement et al. 2016). For disruptions affecting large geographic areas, like those associated with climate change, new invasive species, or natural disasters, the best possible solutions may be those formulated collaboratively with other organizations (e.g. Graham et al. 2019). An organization’s capacity to form productive partnerships and long-term collaborations may also allow it to pursue ambitious restorations that are beyond the internal resources of any single organization.

Table 3. Assessment criteria for functions associated with an organization’s leadership and governance (LG). Criteria also linked to other functions are noted in parentheses: CR, change readiness; ER, external relations; IR, internal resources; SA, situation awareness.

Function	Characteristics of a Resilient Organization	Criteria	Sources
Leadership	The organization has leaders who are capable of bringing people together, building trust, mobilizing action toward a collective vision, and devising ways to overcome barriers.	<ul style="list-style-type: none"> Strategic vision and outcome expectancy Leadership for learning, collective sense-making, conflict management Catalyst for network formation and collaboration Administrative direction Leadership succession planning (CR) 	Black et al. (2011), Folke et al. (2005), Nerfa et al. (2021), McManus et al. (2008)
Unity of purpose	The organization has a vision that fosters a shared expectation of outcomes. Group members understand the link between their own work and the organization’s expectations and are committed to them.	<ul style="list-style-type: none"> Organizational goal-setting Understanding of risks and consequences of failures 	Brown et al. (2017), McManus et al. (2008), Walpole et al. (2020), Weick and Sutcliffe (2001)
Self-organization	Self-organized networks function productively within the organization in ways that build institutional memory, fill gaps in formal responsibilities, and provide backup capacity.	<ul style="list-style-type: none"> Level of shared responsibility Detection of trends/emerging challenges (SA, CR) 	Clement et al. (2016), Virji et al. (2012), Watkins et al. (2013)
Decision-making	Group members have the appropriate authority to make decisions related to their work and level of expertise. Authority is clearly delegated to enable a crisis response.	<ul style="list-style-type: none"> Devolved decision-making (SA) Informed decision-making (SA) 	Virji et al. (2012), Watkins et al. (2013)

Table 4. Assessment criteria for functions associated with an organization's internal resources (IR). Criteria also linked to other functions are noted in parentheses: CR, change readiness; ER, external relations; LG, leadership and governance; SA, situation awareness.

Function	Characteristics of a Resilient Organization	Criteria	Sources
Technical capacity	Collectively, group members have sufficient skill and knowledge, as well as necessary equipment, to fulfill their restoration commitments. They are encouraged to broadly “tap” the expertise that exists across the organization and to build their own expertise.	<ul style="list-style-type: none"> • Development of best practices (SA) • Clarity of roles and responsibilities • Training to develop internal expertise • Knowledge acquisition (ER, SA) • Access to essential resources 	Catalano et al. (2019), Dhakal (2011)
Prevention of silos	Mechanisms exist to minimize isolation among groups within the organization so there is awareness of related skills, knowledge and activities in other “silos.” Contact is maintained among groups with distinctive cultures, that is, discipline- or geographic-based teams.	<ul style="list-style-type: none"> • Knowledge sharing (SA) • Internal communications (SA) • Mechanisms to avoid silos 	Catalano et al. (2019), McManus et al. (2008)
Innovation and creativity	The generation of new ideas, along with ensuring the flow of available information throughout an organization is encouraged and rewarded. The organization facilitates Innovation and creativity during highly uncertain periods.	<ul style="list-style-type: none"> • Translation of vision to actionable plans • Promotion of innovation, creativity and excellence 	McManus et al. (2008), Nerfa et al. (2021), Peters et al. (2015)
Administrative competence	The organization effectively secures and manages its human and financial resources and seeks new resources in advance of gaps of either.	<ul style="list-style-type: none"> • Acquisition of essential human and financial resources • Management of human and financial resources (ER) • Risk management (resources) • Buffering (organizational-level contingency planning) (CR) 	Clement et al. (2016), Dhakal (2011), Haveman and Wetts (2019), Lamb (2014), Nerfa et al. (2021), Peters et al. (2015), Reid et al. (2017), Virji et al. (2012)

Change Readiness. Whether an organization can continue to thrive under a different future reality depends on its capacity for strategic planning, adaptability and transformability (Table 6). Strategic planning that considers potential alternate futures and how to navigate each is beneficial for developing responses to major uncertainties (sensu Peterson et al. 2003). For restoration organizations, the potential for widespread social unrest, drastic political change, and emerging climate hazards are examples of uncertainties that require change readiness in order to persist. Adaptability is the capacity for individuals in the organization to manage change with intent so that it has enhanced (vs. diminished) opportunities (Gooch & Warburton 2009; Peters et al. 2015). Transformable organizations have the capacity to create the fundamentally new system, if the existing system is unsupportable (Walker et al. 2006).

Using the Framework

Diagnostic assessment requires collecting input from a large portion of the individuals in an organization. This input is interpreted

to identify strengths, weaknesses, opportunities, and threats (i.e. “SWOT” analysis common to strategic planning) and formulate operational guidance. In general, feedback is elicited by seeking responses to one to several questions focused on each of the criteria in assessment frameworks. In other sectors, the design of the survey instrument (e.g. questionnaire or other process) ranges from being highly customized for a particular organization to being standardized for use across organizations with a similar purpose (e.g. Stephenson et al. 2010; Brown et al. 2017).

Assessments can be undertaken for individual organizations or as an external assessment of multiple organizations. Not surprisingly, published academic literature mostly reports on external assessment of multiple organizations, because the domain of researchers is to seek generalizable knowledge, that is, new insights based on data from many organizations (e.g. Gooch & Warburton 2009; Clement et al. 2016; Walpole et al. 2020). However, for an individual organization to directly benefit from an assessment, it must yield a specific diagnosis and offer guidance for improvement. Two approaches have been used to assess individual organizations: broad surveys and facilitation.

Table 5. Assessment criteria for functions associated with an organization's capacity for external relations (ER). Criteria also linked to other functions are noted in parentheses: CR, change readiness; IR, internal resources; LG, leadership and governance; SA, situation awareness.

Function	Characteristics of a Resilient Organization	Criteria	Sources
Partnerships and collaborations	The organization extends the reach of its restoration work through productive partnerships and collaborations. Organization does not become overly dependent on one or few partners, avoiding conflicts of interest.	<ul style="list-style-type: none"> • Goal-setting for projects • Management across different cultures and norms • Diversified network 	Dhakal (2011), McManus et al. (2008), Nerfa et al. (2021), Walpole et al. (2020), Watkins et al. (2013)
Capacity gap-filling	The organization has well-functioning working relationships with other organizations that provide essential supplies, services, or local knowledge, complementing their own capacity.	<ul style="list-style-type: none"> • Contracting capacity • Established relationships for back-up capacity • Management of human and financial resources (IR) 	Catalano et al. (2019), Stephenson (2008), Peters et al. (2015), Virji et al. (2012)
Professional and policy influence	The organization broadly and positively influences restoration standards and/or opportunities because of the quality of its work and expertise of its members.	<ul style="list-style-type: none"> • Recognition of organization's work • Individual experts' influence beyond organization • Organizational awareness of political and power environment 	Peters et al. (2015), Clement et al. (2016)

A broad survey approach relies on collecting input from many individuals using a questionnaire. For example, New Zealand resilience assessment surveys consist of a set of questions related to each indicator (Stephenson 2008). This approach is an efficient way to collect input from many individuals, maximizing the anonymity of respondents and minimizing the influence of group dynamics in the information used for the assessment. However, the information from questionnaire-based processes can be adversely affected by disassociating input from collective sense-making and by differences in how individuals interpret questions (or the criteria).

McManus et al. (2008) developed a facilitated process for assessments of individual organizations that included four components: (1) building awareness of the need for organizational capacity and resilience; (2) selection of essential organizational indicators; (3) identification and prioritization of organizational vulnerabilities (i.e. those with the highest likelihood of causing problems during a crisis); and (4) formulating solutions. Each component of the process depends on group-based input and problem-solving using a combination of questions and problem-solving scenarios. Simple "consequence scenarios" featuring different kinds of disruptions offer organizations a mechanism for identifying potential consequences, formulating their responses, and determining what changes in their functions could make them more change-ready. An assessment process based on facilitated group problem-solving is more time- and expertise-demanding than one based on broad surveys.

However, this approach helps build awareness in the organization of its capacity and resilience during the information gathering stage of the assessment. The interpretation of results and formulation of solutions also emerge from the group, perhaps increasing the likelihood of adoption and lessening the risks of relying on an external expert, knowledgeable about survey research but not doing ecological restoration.

Maximizing the Relevance of Assessments for the Restoration Sector

Ensuring the relevance of restoration organization assessments needs to consider that organizations in this sector are distinctive from many others upon which the organizational resilience literature is based. The following five issues, not typical of many other sectors but inherent to restoration, need to be addressed when devising assessment tools. For each, diagnostic criteria (with functions) in the FARO framework (Tables 2–6) are noted in parentheses.

Restoration typically requires a longer-term commitment to achieve recovery than funding sources provide. Restoration organizations work to achieve aims that often require decades, despite constraints created by short-term funding cycles and a tendency for funders to prefer new projects (Reid et al. 2017; Galatowitsch & Bohnen 2020; Nerfa et al. 2021). Even though most initial funding arrangements for ecosystem restoration are a few years in duration, restored ecosystems are likely to

Table 6. Assessment criteria for functions associated with an organization's change readiness (CR). Criteria also linked to other functions are noted in parentheses: ER, external relations; IR, internal resources; LG, leadership and governance; SA, situation awareness.

Function	Characteristics of a Resilient Organization	Criteria	Sources
Strategic direction	Thrust of the organization is guided by a robust strategic plan that considers potential alternate futures.	<ul style="list-style-type: none"> Organizational goal-setting (LG) Simulation of disruptions Organizational strategic planning Leadership succession planning (LG) 	Brown et al. (2017), Catalano et al. (2019), Nerfa et al. (2021)
Adaptability	Group members can manage major changes forced by external circumstances so that the organization's opportunities are not diminished and perhaps even enhanced.	<ul style="list-style-type: none"> Communications during disruptions Buffering (organizational-level contingency planning) (IR) Change management 	Gooch and Warburton (2009), Peters et al. (2015), Walker et al. (2006)
Transformability	The organization has the capacity and culture to undertake the deliberate interventions needed when it must fundamental change.	<ul style="list-style-type: none"> Detection of trends/emerging challenges (SA, LG) Capacity for organizational transformation Pro-active posture 	Gooch and Warburton (2009), Walker et al. (2006)

persist for longer periods if the responsible organizations sustain their stewardship for many years (even decades for forests) until the ecosystem functions are sufficient for self-regeneration (Holl & Howarth 2000; Reid et al. 2017; Nerfa et al. 2021). Administrative competence (IR), collective sense-making (SA), leadership (LG), filling resource gaps (ER), and adaptability (CR) are likely to be key indicators for understanding the extent to which an organization can successfully manage this misalignment (Nerfa et al. 2021). For example, organizations needing to cover the fixed costs of their operations, including employee salaries and office leases, may put a high premium on securing many short-term grants, even if the consequence is to initiate many projects that will be prematurely abandoned. Indicators that an organization has the capacity and commitment to stay with projects for ecologically critical time-frames depend on its ability to secure resources but as importantly on the extent to which meeting operational overhead (i.e. fixed costs) does not detract from following through on restoration commitments.

Strong and varied externalities frequently affect restoration outcomes. The extent to which an organization can efficiently restore a self-sustaining ecosystem in a particular location is often highly contingent on circumstances beyond the boundaries of the project site. An organization's level of situation awareness, that is, the extent to which they demonstrate an awareness of expected risks and manage those expected risks, such as newly invading species, emerging diseases, or shifting economic or demographic pressures, is crucial to their capacity to productively pursue restoration (Galatowitsch & Bohnen 2020). Because many factors central to the outcome of ecological restoration are beyond the sphere of control of an organization,

adaptability and transformability (CR), as well as innovative problem-solving (IR) and contingency planning (CR), are especially important indicators of their capacity/resilience (Black et al. 2011; Galatowitsch 2012). Accelerated climate change and multiple stressors associated with global change more generally seem certain to increase the importance of externalities and so the need to understand an organization's level of change readiness to manage these risks.

Restoration is pursued by a wide range of organizations, some with diverse purposes. Restoration projects may be undertaken by groups of people from one organization, more or less focused on restoration, or may be a combined force from many organizations (Fig. 3). Some restoration-focused organizations undertake many projects while others, often "friends groups," exist solely to steward one-few restoration projects. Compared to other sectors, restoration organizations vary tremendously in size, the extent to which they are composed of paid professional staff versus volunteers, whether they are governmental or non-governmental, and if they are profit-based companies or non-profit organizations. Barriers to knowledge sharing and learning (SA), for example, are likely to be fundamentally different for an organization with expertise-based subgroups of professionals than for an organization of similar size but primarily volunteer-based, which should be reflected in the indicators used in the assessment. Moreover, some approaches for a function like knowledge-sharing and learning that might be a barrier for one kind of organization (i.e. volunteer-based) might be beneficial for another (i.e. professional subgroups).

Large organizations whose primary purpose is not restoration-focused may support one or more sub-groups that are restoration-focused. For large organizations with a highly

varied mission (like many large government agencies), it is important for this assessment to define the group of people with significant restoration responsibilities as the functional organization. How the organization is defined will affect how best to assess various indicators of Leadership and Governance, as well as how to scope indicators of Internal Resources versus External Relations. For example, the extent to which a small, regionally based team undertaking a restoration project can access critical resources from across their organization (e.g. prescribed burn “bosses,” data management experts) needs to be illuminated in order to diagnose limitations to successfully undertake restoration projects (Galatowitsch & Bohnen 2020).

Complex and large restoration projects often require durable partnerships of multiple organizations. Groups formed from multiple organizations may join together to achieve greater capacity to undertake a complex or extensive project. These

arrangements need to effectively function over many years or decades to achieve their restoration purpose (ER). For the purposes of an assessment, in these situations (large, complex projects) the focus needs to be primarily focused on the group of people working together to accomplish the project, even if their membership draws from different organizations. Indicator questions need to be carefully worded so their relevance under the range of alignments is clear and the resulting diagnostics are relevant. Some alignments may pose special challenges concerning specific functions. For example, as organizational complexity grows, so does the potential for confusion about decision-making (LG) as well as roles and responsibilities of group members (IR) (Galatowitsch 2012). Multi-organizational partnerships may also find it relatively challenging to achieve a shared vision for their collaborative project(s) (LG, SA) (Walpole et al. 2020).

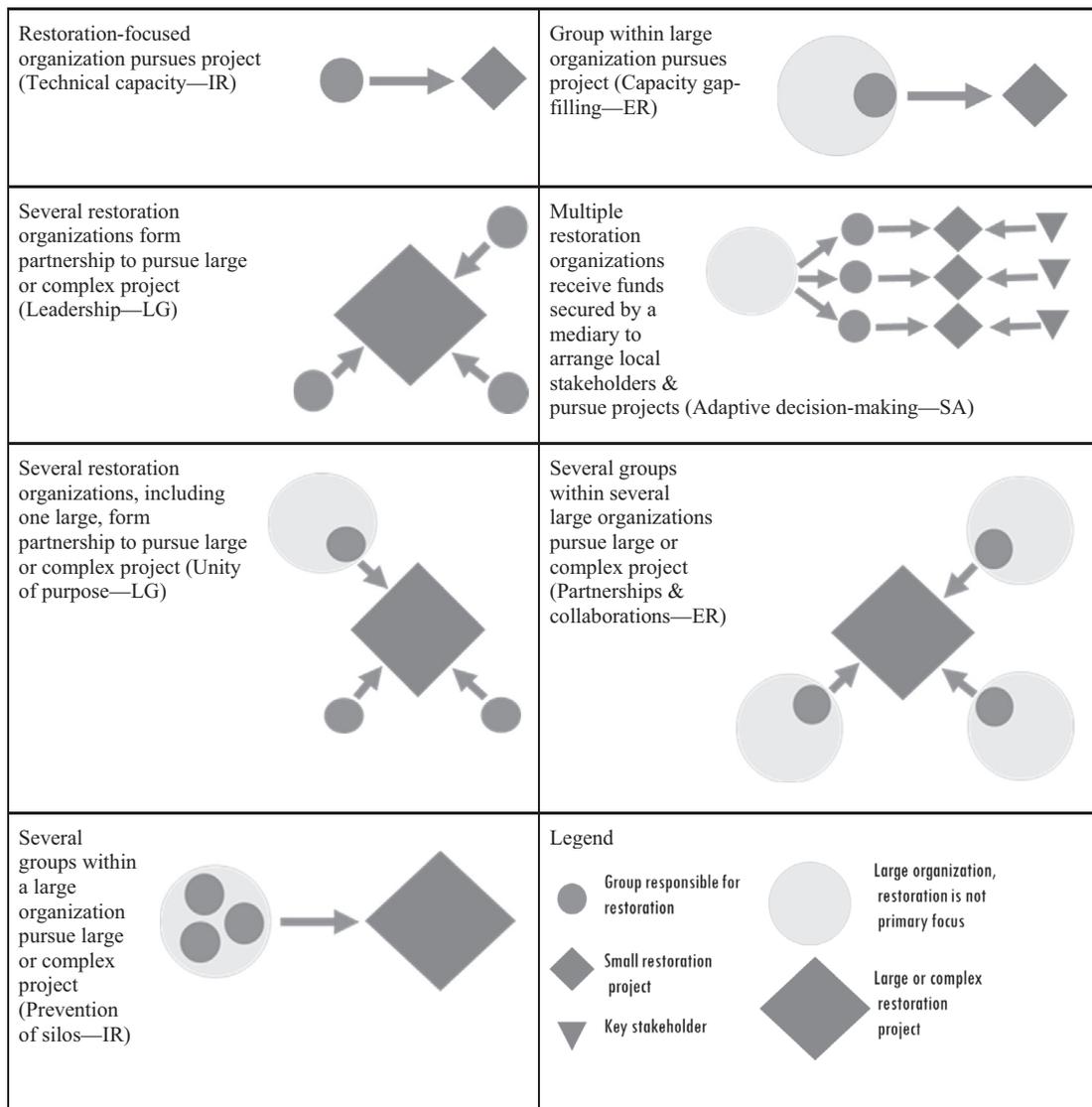


Figure 3. Some common alignments between organizations and restoration. These alignments result in different operational risks; example of a function related to an inherent risk is shown for each alignment.

Large-Scale Restoration Initiated by Umbrella Organizations Poses Special Operational Risks

Pursuit of restoration at a regional scale where community-based relationships with private landowners are crucial has motivated the emergence of umbrella organizations to serve as funding mediaries (Fig. 3). Typically, the umbrella group is an existing large conservation organization with the expertise and social connections to secure significant funding, with the expectation that they will facilitate the work of many projects via numerous community-based groups with ties to local landowners. If the resulting pass-through arrangements are not sound both the regional and individual project plans can be undermined by such problems as unclear roles and responsibilities, lags in responsiveness to emerging problems, lack of a consistent vision between organizational partners, and limited opportunities to address operational problems, as they arise. In addition, if a small organization develops a high dependency on a large organization, conflicts of interest could stymie openness and honesty, which could undermine restoration decision-making. The prevalence of pass-through arrangements in the restoration sector is unknown, but is likely already common and on the rise, given the need to rapidly scale-up restoration in order to achieve ambitious targets set in many parts of the world. Assessing organizational capacity and resilience for these strongly hierarchical partnerships is necessary, but challenging. It seems likely that community-based groups connected to umbrella organizations will benefit from their assessments, with special attention to the effects of pass-through arrangement on their decision-making (LG), technical capacity and capability (IR), adaptability (CR), and partnerships and collaborations (ER).

Adoption of Organizational Capacity Assessments

Moving toward a sector-wide norm where assessing organizational resilience and capacity is considered worthwhile could be advanced through various internal and external mechanisms. Because many restoration organizations depend on external funding to pursue projects (and perhaps to exist), mechanisms linked to funding decisions have the potential to be powerful accelerators.

Because a significant portion of restoration projects depend on external funding, often secured by successfully competing for limited funds administered by a third party, norms of accountability and reporting exist regarding documentation of expenditures and meeting timelines of proposed actions. Funders seeking to minimize the risk of project failure due to lack of organizational capacity could require additional documentation to consider this factor as part of project selection. A funder could (and sometimes does) require evidence of written plans or monitoring of projects during the active grant period or evidence of successful past projects. Some sectors, notably the building trades, have developed project-based certification standards for completed projects, which typically require planning and final completion audits to assess adherence to standards conducted by an organization established for this purpose. Some examples include LEED certification by the US Green Building Council and Green Globes certification by the Green Building Initiative.

Using outcomes of past projects as a primary selection factor disadvantages new organizations. An assessment devised from the framework introduced in this paper could be used to document an organization's attributes predictive of its capacity. Thus, an alternative for funders would be to adopt standards for organizational resilience and capacity assessed using standardized assessment tools.

While external standards have high potential as a catalyst, culture change within organizations may be more likely if prompted by internal aims, e.g. a desire to strengthen the organization, to demonstrate its capacity more broadly, or both (sensu McManus et al. 2008). An assessment approach that relies on facilitated group input and problem-solving offers communication and collective-sense making opportunities that have the potential to facilitate learning and promote a culture of resilience (Taylor & Van Every 2000). Open discussion, discovery of possibilities and limitations, and critique can foster the implementation of organizational change and stimulate ongoing learning (Christensen et al. 2013). A formal (vs. ad hoc) assessment of an organization's current capacity may be particularly beneficial when an organization is confronted with major changes and needs to rethink how it accomplishes its core functions. A more effective approach, however, is likely to assess resilience/capacity on a regular basis (i.e. every few years), rather than after a need for change has been recognized. As Hamel and Valikangas (2004) stated, "Strategic resilience is about having the capacity to change before the case for change becomes desperately obvious."

Of course, widespread adoption is predicated on evidence that an assessment tool yields reliable insights relative to an organization's capacity to effectively pursue restorations. In other sectors, this evidence is gathered by testing the tool on many organizations and interpreting the results relative to organizational performance to manage challenging situations (e.g. Brown et al. 2017). For the framework presented here, the next steps are to develop an instrument to gather information for the criteria (i.e. facilitation process or survey instrument), conduct assessments of a test group of restoration organization, and analyze the findings, refining the tool as needed.

Conclusions

The framework presented in this paper is based on a foundation of organizational knowledge from other sectors and illustrates the need for organizational research in the restoration sector. Organizations entrusted with responsibilities and resources to repair ecosystems have for many decades pursued their defining purpose against long odds created by a host of inherent challenges, notably the long time-frames required for ecological recovery and landscape-level stressors. The disconnect between the general perception of what restoration organizations can realistically accomplish and the reality of what happens has enabled the proliferation of policies and programs based on very short-term support, creating additional challenges for restoration organizations and potentially undermining confidence in restoration as a vehicle for effective conservation. Advancing knowledge and understanding of how organizational function affects

achievement may be a primary determinant of the extent to which ecological restoration can be considered a reliable global and local strategy for improving ecosystem services. Furthermore, if this disconnect contributes to an overall lack of accountability in the sector (which it likely does), self-correcting “feedbacks” that promote based practices in organizational management could improve restoration outcomes overall.

This framework is not an assessment tool but will hopefully be helpful for those seeking to develop diagnostic tools and methods. As highlighted in this paper, other sectors (notably natural hazard response and other public services) offer useful precedents for customization of diagnostic criteria, processes for soliciting input and interpreting results, and validation of assessment tools (Stephenson 2008; Brown et al. 2017). However, the reliability of any diagnostic tools is likely to be suspect if not supported by research on restoration organizational function, capacity, and resilience. A major dilemma for restoration ecology as a discipline is how to substantially broaden its research scope so that it more fully encompasses social sciences and serves as a catalyst for organizational studies. The recent and productive emergence of applied organizational research in business and public health is a promising trend that hopefully can be emulated.

Acknowledgments

The author would like to thank D. Larkin, K. Nelson, S. Murphy, and an anonymous reviewer who provided critical reviews of early drafts of the manuscript.

LITERATURE CITED

- BenDor T, Lester T, Livengood A, Davis A, Yonavjak L (2015) Estimating the size and impact of the ecological restoration economy. *PLoS One* 10: e0128339. <https://doi.org/10.1371/journal.pone.0128339>
- Black S, Groombridge J, Jones C (2011) Leadership and conservation effectiveness: finding a better way to lead. *Conservation Letters* 4:329–339. <https://doi.org/10.1111/j.1755-263X.2011.00184.x>
- Brown C, Seville E, Vargo J (2017) Measuring the organizational resilience of critical infrastructure providers: a New Zealand case study. *International Journal of Critical Infrastructure Protection* 10:37. <https://doi.org/10.1016/j.ijcip.2017.05.002>
- Catalano A, Lyons-White J, Mills M, Knight A (2019) Learning from published project failures in conservation. *Biological Conservation* 238:108223. <https://doi.org/10.1016/j.biocon.2019.108223>
- Christensen L, Morsing M, Thyssen O (2013) CSR as aspirational talk. *Organization* 20:372–393. <https://doi.org/10.1177/1350508413478310>
- Clement S, Moore S, Lockwood M, Mitchell M (2017) Fit-for-purpose institutions? An evaluation of biodiversity conservation in the agricultural landscape of the Tasmanian Midlands, Australia. *Journal of Environmental Policy and Planning* 19:135–155. <https://doi.org/10.1080/1523908X.2016.1162708>
- Clement S, Moore S, Lockwood M, Morrison T (2016) A diagnostic framework for biodiversity conservation institutions. *Pacific Conservation Biology* 21: 277–290. <https://doi.org/10.1071/PC15032>
- Dhakal S (2011) The five capitals framework for exploring the state of friends’ groups in Perth, Western Australia: implications for urban environmental stewardship. *International Journal of Environmental, Cultural, Economic and Social Sustainability* 7:135–147. <https://doi.org/10.18848/1832-2077/CGP/v07i02/54902>
- Endsley MR (1995) Towards a theory of situation awareness in dynamic systems. *Human Factors* 37:32–64. <https://doi.org/10.1518/001872095779064555>
- Fabricsius C, Cundill G (2014) Learning in adaptive management: insights from published practice. *Ecology and Society* 19:190129. <https://www.jstor.org/stable/26269492>, <https://doi.org/10.5751/ES-06263-190129>
- Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of socio-ecological systems. *Annual Review of Environment and Resources* 30: 441–473. <https://doi.org/10.1146/annurev.energy.30.050504.144511>
- Galatowitsch S (2012) *Ecological restoration*. Sinauer Associates, Sunderland, MA
- Galatowitsch S, Bohnen J (2020) Predicting restoration outcomes based on organizational and ecological factors. *Restoration Ecology* 28:1201–1212. <https://doi.org/10.1111/rec.13187>
- Gooch M, Warburton J (2009) Building and managing resilience in community-based NRM groups: an Australian case study. *Society and Natural Resources* 22:158–171. <https://doi.org/10.1080/08941920801967880>
- Graham S, Metcalf A, Gill N, Niemiec R, Moreno C, Bach T, et al. (2019) Opportunities for better use of collective action theory in research and governance for invasive species management. *Conservation Biology* 33:275–287. <https://doi.org/10.1111/cobi.13266>
- Hamel G, Valikangas L (2004) The quest for resilience. *Icade. Law School Magazine* 62:355–358
- Haveman H, Wetts R (2019) Contemporary organizational theory: the demographic, relational, and cultural perspectives. *Sociology Compass* 13: e12664. <https://doi.org/10.1111/soc4.12664>
- Holl K, Howarth R (2000) Paying for restoration. *Restoration Ecology* 8:260–267. <https://doi.org/10.1046/j.1526-100x.2000.80037.x>
- Holling C (1973) Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4:1–23. <https://doi.org/10.1146/annurev.es.04.110173.000245>
- Hulme P (2014) Bridging the knowing–doing gap: know-who, know-what, know-why, know-how and know-when. *Journal of Applied Ecology* 51: 1131–1136. <https://doi.org/10.1111/1365-2664.12321>
- IPBES (2018) The IPBES assessment report on land degradation and restoration. In: Montanarella L, Scholes R, Brainich A (eds) Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services. IPBES, Bonn, Germany
- Lamb D (2014) *Large-scale forest restoration*. Routledge, London. <https://doi.org/10.4324/9780203071649>
- Linnenluecke M (2017) Resilience in business and management research: a review of influential publications and a research agenda. *International Journal of Management Reviews* 19:4–30. <https://doi.org/10.1111/ijmr.12076>
- Linnenluecke M, Griffiths A (2010) Beyond adaptation: resilience for business in light of climate change and weather extremes. *Business and Society* 49: 477–511. <https://doi.org/10.1177/0007650310368814>
- Linnenluecke M, Griffiths A, Winn M (2012) Extreme weather events and the critical importance of anticipatory adaptation and organizational resilience in responding to impacts. *Business Strategy and the Environment* 21:17–32. <https://doi.org/10.1002/bse.708>
- McDaniels T, Chang S, Cole D, Mikawoz J, Longstaff H (2008) Fostering resilience to extreme events within infrastructure systems: characterizing decision contexts for mitigation and adaptation. *Global Environmental Change* 18:310–318. <https://doi.org/10.1016/j.gloenvcha.2008.03.001>
- McManus S, Seville E, Vargo J, Brunsdon D (2008) Facilitated process for improving organizational resilience. *Natural Hazards Review* 9:81–90. [https://doi.org/10.1061/\(ASCE\)1527-6988\(2008\)9:2\(81\)](https://doi.org/10.1061/(ASCE)1527-6988(2008)9:2(81))
- Menz M, Dixon K, Hobbs R (2013) Hurdles and opportunities for landscape-scale restoration. *Science* 339:526–527. <https://doi.org/10.1126/science.1228334>
- Nelson D, Adger W, Brown K (2007) Adaptation to environmental change: contributions of a resilience framework. *Annual Review of Environment and Resources* 32:1–25. <https://doi.org/10.1146/annurev.energy.32.051807.090348>
- Nerfa L, Wilson S, Reid J, Rhemtulla J (2021) Practitioner views on the determinants of tropical forest restoration longevity. *Restoration Ecology* 29: e13345. <https://doi.org/10.1111/rec.13345>
- Ntshotsho P, Esler K, Reyers B (2015) Identifying challenges to building an evidence base for restoration practice. *Sustainability* 7:15871–15881. <https://doi.org/10.3390/su71215788>

- Olsson L, Jerneck A, Thoren H, Persson J, O'Byrne D (2015) Why resilience is unappealing to social science: theoretical and empirical investigations of the scientific use of resilience. *Science Advances* 1:e1400217. <https://doi.org/10.1126/sciadv.1400217>
- Peters M, Hamilton D, Eames C (2015) Action on the ground: a review of community environmental groups' restoration objectives, activities and partnerships in New Zealand. *New Zealand Journal of Ecology* 39:179–189. <https://www.jstor.org/stable/26198709> (accessed 14 Dec 2020)
- Peterson G, Cumming G, Carpenter S (2003) Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17:358–366. <https://doi.org/10.1046/j.1523-1739.2003.01491.x>
- Reid J, Wilson S, Bloomfield G, Cattau M, Fagan M, Holl K, Zahawi R (2017) How long do restored ecosystems persist? *Annals of the Missouri Botanical Garden* 102:258–265. <https://doi.org/10.3417/2017002>
- Ruiz-Martin C, López-Paredes A, Wainer G (2018) What we know and do not know about organizational resilience. *International Journal of Production Management and Engineering* 6:11–28. <https://doi.org/10.4995/ijpme.2018.7898>
- Scott W (2004) Reflections on a half-century of organizational sociology. *Annual Review of Sociology* 30:1–21. <https://doi.org/10.1146/annurev.soc.30.012703.110644>
- Seville E (2009) Resilience: great concept but what does it mean for organizations? *Tephra*, July, 9–14
- Stephenson A (2008) Benchmark resilience, sample results report. Resilient Organizations Research Programme, University of Canterbury, New Zealand
- Stephenson A, Vargo J, Seville E (2010) Measuring and comparing organizational resilience in Auckland. *Australian Journal of Emergency Management* 25:27–32. <https://search.informit.com.au/epdf/10.3316/ielapa.084594671126248>
- Suding K, Higgs E, Palmer M, Callicott J, Anderson C, Baker M, et al. (2015) Committing to ecological restoration. *Science* 348:638–640. <https://doi.org/10.1126/science.aaa4216>
- Sutcliffe K, Vogus T (2003) Organizing for resilience. Berrett-Koehler, San Francisco, CA
- Takeda M, Jones R, Helms M (2017) Promoting sense-making in volatile environments: developing resilience in disaster management. *Journal of Human Behavior in the Social Environment* 27:791–805. <https://doi.org/10.1080/10911359.2017.1338173>
- Taylor J, Van Every E (2000) *The emergent organization*. Communication as its site and surface. Lawrence Erlbaum Associates, Mahwah, NJ
- Tengblad S, Oudhuis M (2017) *The resilience framework: organizing for sustained viability*. Springer, Singapore
- Tuda A, Machumu M (2019) Institutions and adaptive capacity for marine biodiversity conservation. *Environmental Science & Policy* 100:238–246. <https://doi.org/10.1016/j.envsci.2019.03.012>
- UNESCO-International Bureau of Education (2022). Concept of governance. <http://www.ibe.unesco.org/en/geqaf/technical-notes/concept-governance> (accessed 18 Jan 2022)
- United Nations (2019) New UN Decade on ecosystem restoration offers unparalleled opportunity for job creation, food security and addressing climate change. <https://unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity> (accessed 10 Feb 2022)
- Virji H, Padgham J, Seipt C (2012) Capacity building to support knowledge systems for resilient development—approaches, actions, and needs. *Current Opinion in Environmental Sustainability* 4:115–121. <https://doi.org/10.1016/j.cosust.2012.01.005>
- Walker B, Gunderson L, Kinzig A, Folke C, Carpenter S, Schultz L (2006) A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society* 11:110113. <http://www.jstor.org/stable/26267801>, <https://doi.org/10.5751/ES-01530-110113>
- Walpole E, Toman E, Stidham M, Wilson R (2020) The science and practice of ecological restoration: a mental models analysis of restoration practitioners. *Environment Systems and Decisions* 40:588–604. <https://doi.org/10.1007/s10669-020-09768-x>
- Watkins C, Massey D, Brooks J, Ross K, Zellner ML (2013) Understanding the mechanisms of collective decision making in ecological restoration: an agent-based model of actors and organizations. *Ecology and Society* 18:32. <https://doi.org/10.5751/ES-05497-180232>
- Weick KE, Sutcliffe KM (2001) *Managing the unexpected*. Vol 9. Jossey-Bass, San Francisco, CA
- Zahawi R, Reid J, Holl K (2014) Hidden costs of passive restoration. *Restoration Ecology* 22:284–287. <https://doi.org/10.1111/rec.12098>

Coordinating Editor: Stephen Murphy

Received: 27 March, 2022; First decision: 13 May, 2022; Revised: 26 June, 2022; Accepted: 27 June, 2022