Who are boundary spanners and how can we support them in making knowledge more actionable in sustainability fields?

Kristen A. Goodrich[1,2], K. Dana Sjostrom[3], Catherine Vaughan[4], Leah Nichols, Angela Bednarek[5] and Maria Carmen Lemos[6]

[1]Tijuana River National Estuarine Research Reserve, Imperial Beach, CA
[2]University of California Irvine, Irvine, CA
[3]University of Memphis, Memphis, TN
[4] International Research Institute for Climate and Society, New York, NY
[5]The Pew Charitable Trusts, Washington, DC
[6]University of Michigan, Ann Arbor, MI

Corresponding Author: Kristen Goodrich, kgoodrich@trnerr.org, 301 Caspian Way, Imperial Beach, CA 91932

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Abstract

Meeting today's environmental challenges increasingly requires individuals who are able to operate at the boundary between science and policy. This work can involve mediating, bridging, and brokering knowledge. In practice, a range of challenges limit both the capacity and number of individuals who are able to serve, and serve effectively, in these roles. We draw on recent literature to synthesize these challenges and characterize "who" boundary spanners are and what they do. Through the articulation of their unique attributes and functions, we explore opportunities for cultivating and legitimizing the role of boundary spanners, along with formalization and recognition of the profession. We reflect upon our own professional experience as boundary spanners to bring deeper meaning and understanding of how to build greater support while capturing key challenges in the field. We argue that greater acknowledgement and professionalization of boundary spanning will improve the use of science in practice and knowledge to action.

1. Introduction

Addressing problems at the intersection of human well-being, climate change adaptation, and ecosystem health requires people skilled in the art of "boundary spanning" as it relates to the linking of science and decision-making [1]. The complexity of these problems requires working across disciplines, integrating different types of knowledge (e.g., scientific, practical, and traditional knowledge), and intentional connecting science to information needs [2]–[4]. Hence, it is not surprising that a wide variety of organizations such as non-governmental organizations (NGOs), professional organizations, universities, and medical facilities are serving to connecting academic initiatives to surrounding communities and seek boundary spanners to support their goal of producing actionable knowledge for different decision contexts [5]–[7].

Boundary spanning has its advantages for the boundary spanner and those that boundary spanners work with. The documented value of bringing together diverse research teams [8] has motivated organizations and funders to expect that some scientific fields (engineers are just one such group [9]) that traditionally worked in relative isolation to now work across boundaries (e.g., cross-discipline, organizational, cultural, end-user, geographic, temporal). These researchers that value working with others and integrating ideas across disciplines produce more creative publications with greater anticipated translational impact more often than their peers [10].

Despite growing interest in the role that boundary spanners play, it is often not fully understood or legitimized. Often, boundary spanning is carried out by actors at the intersection of science and practice such as planners, managers, and scientists [11], [12], who may have neither the training nor the support to serve in this role. Indeed, working at the boundary between the production and use of science may require actors who are able to understand and navigate the incentives and information needs of different organizations, such as local governments, businesses, NGOs, resource management agencies, and funding agencies [13], [14], in some cases performing beyond their formal training and established profession. For example, urban planners in the climate adaptation realm are increasingly expected to transcend their traditional roles to effectively communicate the feasibility and benefits of climate adaptation to the public and elected officials and to connect with university scientists to co-produce usable climate information [11], [15], [16]. Similarly, scientists are increasingly expected to communicate, collaborate, and co-produce knowledge with practitioners and policy-makers beyond collecting and analyzing data and publishing, which can create an undue burden and at times result in less than desirable outcomes [14]. Moreover, developing relationships, building and facilitating efforts across networks [17], and co-producing knowledge requires more time, resources, leadership, management, and communication to bridge institutional cultures, policies, and procedures [18]. However, given that co-production results in greater knowledge use [19] we

support boundary spanning as an effective mechanism for the more meaningful use of science in practice.

While interest is growing, the role of boundary spanner as a dedicated professional is not new. For example, historically, extension agents and crop consultants have served this function between agricultural research and farmers [20]. Boundary spanning has also been observed in other sectors such as research-practice partnerships (RPPs) in education [21] and the work of universities as anchor institutions to bridge research to support and nurture communities [6]. RPPs and anchor institutions work beyond academia to enhance social capital and aim to make a sustainable and meaningful difference in the communities around them [6], giving the boundary spanning efforts a specific goal. More recently, a different cadre of boundary spanning professionals have emerged in fields such as climate change, coastal management, and urban planning [4], [12], [22]. In the U.S., for example, these professionals work in organizations such as the National Oceanic and Atmospheric Administration (NOAA)-funded Regional Integrated Climate and Assessments (RISAs) and funding programs such as the Lenfest Ocean Program. These organizations themselves may be considered boundary organizations based on the role they – and the individuals they employ - play. For example, boundary spanners may operate at the intersection between organizations or individuals at organizations that generate new knowledge (e.g., academics at a university) and end-users who apply the knowledge to make decisions (e.g., policymakers or practitioners).

As the field and profession of boundary spanning develops, a lack of clarity of who boundary spanners are and what they do can potentially challenge their effectiveness and contribute to ambiguity in their career paths. This can happen at various points of their careers, from how their academic and/or professional training is shaped to how their organizations operate and how what they do is incentivized and evaluated. We acknowledge people in diverse fields such as science communication [23], urban planning [24], or sustainability science [25] may play boundary spanner roles, but that there may also be boundary spanners that professionally identify as such. Training and skills may have been acquired through a more standardized career path or a more pluralistic and diverse one.

Despite multiple pathways to the role, we argue that professional recognition of boundary spanning and its benefits is needed. Though to do this, it is critical to understand the demands of the role and the various challenges boundary spanners face. We see the need for boundary spanners to both carve out their niche as a distinct profession but also do so without losing the diversity of backgrounds and fields from where they come and to which they apply their knowledge and skills. Indeed, we see opportunity to develop the profession with greater intention rather than simply expecting those already explicitly or in effect serving in the role to continue doing so without specific and meaningful support.

This acknowledgement is already underway in a number of academic fields. In the context of sustainability science, for example, boundary spanning has been used as a necessary core competency in fostering well-rounded graduate students with both content and communication skill sets [26], and is recognized as a key organizational competence in professional settings [27]. This idea of brokering knowledge in this 'in between space' (i.e., boundary spanning) and acknowledging this hybridity is important for diverse careers including social sciences, humanities, artistic fields, and science and business contexts [28].

We provoke and answer the question "Who are boundary spanners?" in our paper, in part, because we as authors consider ourselves so, though, play different roles and have different functions in each of our respective careers: a training coordinator, a city planner, and project and program directors. We also - as individuals - possess different attributes that empower us in the role. In this paper, we explore the roles that boundary spanners play (what they do and how they do it), examine some of their skills and attributes described in the literature (who they are), and discuss the reasons why more is needed to support, expand and legitimize the profession. This exploration offers perspectives from the authors' diverse backgrounds in funding agencies, boundary organizations, academia and local government to reflect on the literature and context, while showing we have a personal stake in this effort. We reflexively review the boundary spanning literature and build from our collective experience to support our recommendations.

2. Functions and attributes of a boundary spanner

Despite the diversity of where boundary spanners may operate, recent research suggests that specific skills, capabilities, and personality traits are important for boundary spanners and that there are relationships between these elements, hereafter called attributes, and functions that boundary spanners serve [9]. We start by elucidating the functions performed by boundary spanners to examine the relationship between key attributes and the following functions: 1) connecting producers and users of knowledge by enabling and organizing their interaction, including providing logistical, mediation, facilitation, and financial support [12], [14]; 2) reconciling and protecting interests, different motivations, and cultures at the boundary and attending to issues of equity, unequal power, inclusivity, and trust building [15], [29]; 3) acting as 'honest brokers' by specifically focusing on integrating scientific knowledge with stakeholder input and offering (or helping influence) alternative approaches [30]; 4) fostering mutual understanding among different interests while representing the interests of all (i.e., a stabilizing role at the science-policy interface) [13], [31]; 5) co-producing and disseminating materials, tools, and objects (e.g., communication and visualization resources, scenarios, models, maps, apps) that can help bridge users and producers of knowledge but also customize information to different decision contexts [4], [32]; 6) providing services, training, and complementary expertise to enhance the production of actionable knowledge [33]; and 7) supporting and fostering the creation and maintenance of knowledge networks and communities of practice that

sustain the co-production of knowledge and use [34], [35]. It is important to recognize that for successful collaboration - and how most boundary spanning endeavors begin - these activities occur as a result of deliberate attention to the end-users' questions and goals, which then focuses on learning to address those particular inquiries to address problems with local and relevant contexts [32].

The need for sophisticated boundary spanners becomes especially evident in cases that require spanning demographic boundaries such as gender, age, nationality, culture and ideology, where psychology and emotion matter [34]. The ethics of such work requires that boundary spanners account for power differentials to ensure that the less powerful are not excluded, drowned out, or harmed by the research or decision-making. Simultaneously, boundary spanners must frequently navigate imbalances between the demand for and availability of knowledge; working to maintain trust and legitimacy by ensuring the integrity and transparency of the process, interpreting scientific uncertainties, and delivering unwelcome information when necessary. Boundary spanners may gain traction from tapping into social networks among other promising technological advances that allow for connection and communication further enhancing their boundary spanning capabilities. Successful boundary spanners must also know how to understand and activate issues of identity (e.g., core values or beliefs concerning fit into social and organizational systems) [34] in their role while also being expected to exhibit the technical or domain expertise to establish legitimacy and credibility [33].

While desirable, the diversity of skills associated with all functions described above are often not explicitly taught in most mainstream pre-career academic or professional training and may be ad hoc or emergent for professionals (e.g., a knowledge producer/scientist). In addition, they are often not formally codified as a main component of their job responsibilities [9]. Despite the importance of boundary spanning in bridging science and policy, many of the skills boundary spanners utilize are learned on the job or by trial and error [2]. This further supports the notion, perhaps unfair, that boundary spanners are expected to be it all or "ambidextrous" [9, p. 399] – content experts, visionaries, communicators, analysts, and synthesizers of multiple perspectives - yet are not adequately trained and supported [36]. For example, recent research focusing on boundary spanners highlight that attributes may support the functions boundary spanners play. Although these attributes may not be innate to every boundary spanner, normative and empirical research suggests they represent desirable traits that may be considered as the field moves towards professionalization and specific training. In a qualitative systematic review of the literature, Jesiek et al. [9] identify themes across studies and develop a typology of roles, definitions and activities of boundary spanning to inform practice at the engineering interface. Table 1 summarizes two findings from their review, one related to competencies and characteristics (i.e., attributes, personality traits) and the second related to boundary spanning activities (i.e., functions, roles).

Attributes of boundary spanners		**Functions of boundary spanners**
"Communication stars" [9, p. 290]	Some attributes may support some functions while some functions may amplify attributes	Filtering
Empathy		Translating and transforming
Social capital and knowledge		Task coordination
Cross-cultural competencies		Cross-boundary organizing
Self-monitoring		Building relationships and networking
Emotional intelligence		Ensuring legitimacy
Entrepreneurship		Ambassadorial activities and political skills

Table 1. Attributes and functions adapted from a qualitative systematic review of the literature in Jesiek et al. [9].

Research has also found that some boundary spanners are "communication stars" [30, p. 290] who are highly skilled at communicating and listening [37] and exhibit cross-cultural competencies [35]. They also possess social capital and social knowledge and tend towards entrepreneurship [38]–[40]. Self-monitoring [41], [42], proactive personality [38], personality-related values [43], and empathy [44] were frequently mentioned in the literature as traits and other individual characteristics displayed by boundary spanners. Moreover, boundary spanners have perspective-taking capabilities [45] and emotional intelligence [44] with "ability to go beyond one's own personal view by simultaneously valuing others perspectives in different issues" [29, p. 15]. While all these traits may be difficult to find in any one individual, they underscore the importance of effective training as well as team-building to blend diverse and meaningful skill sets, especially when attributes may not be intrinsic or dominant in an individual or across a team. Some attributes may support a function, for example, strengths in communication may aid in functions that engage "willing cooperation" [46, p. 191]. To initiate a collaborative process, as another example, authentic exploration of the needs of those engaged is required to define the goals, requiring an empathetic orientation on the part of the boundary spanner. We note, though, that the relationship between attributes and functions is not a linear or unidirectional, as functions can also amplify attributes.

3. Challenges: A lack of training, recognition, and evaluation

Despite a growing recognition that boundary spanners are critical to the production and use of actionable scientific knowledge, a number of challenges remain. First, as detailed above, boundary spanners may be asked to play a number of roles, some of which may fall outside their area of expertise. Indeed, boundary spanners must be able to understand and synthesize many kinds of knowledge and evidence, and possess a great deal of process know-how (e.g., operating

in political contexts) [1]. Without access to training programs, and continuing education opportunities, boundary spanners, and the missions they support, may suffer [47]. Further, boundary spanners who are not able to interact with others playing similar roles may miss crucial opportunities to share knowledge and lessons learned [48], [49].

A related set of challenges stems from a lack of recognition of boundary-spanning as a discrete function and/or profession. For example, often, boundary spanning is seen as something that certain actors, such as researchers and planners, choose to do in addition to their regular duties. This means boundary spanners may not be able to devote sufficient time to other essential activities associated with their work, or to adequately develop their expertise. This lack of understanding and professional support may render many boundary spanners vulnerable both to professional uncertainty and burnout [50]. Explicit training for the functions that boundary spanners are required to master is scarce, however several organizational examples point to unique models for skill building in this area. For example, COMPASS, a boundary organization, has focused on communication as a tool to enable relationship-building, by providing support and training for scientists to craft meaningful, targeted messaging of their research for engagement efforts [23]. Through its Coastal Training Program, NOAA's National Estuarine Research Reserve System (NERRS), provides training and technical assistance for key boundary spanning functions such as facilitation, strategic planning, and project management through NOAA's Office for Coastal Management Digital Coast Program [51], [52]. While some of Digital Coast's trainings are technical in nature, many of them serve to cultivate attributes and improve job function. The Master of Arts Program in Climate and Society from Columbia University brings students with both climate and social science backgrounds together, with an aim to create translators of climate science [53]. The Bangladesh Climate Services Academy teaches food-sector decision makers how to access and use climate information for decision making, helping address food security and resilience to extreme weather events [54]. These programs, among others, are examples of boundary spanning initiatives made more formal and locally meaningful, and in doing so are helping science better address local sustainability issues.

Courses that focus on identifying, rapidly assessing and working to align different worldviews, values, priorities and frameworks - such as those offered, as an example, at the Energy and Resources Group at the University of California Berkeley - also offer invaluable skills to boundary spanners. While formal training and degree programs may help to professionalize boundary spanning work and tighten "competency gaps" [9, p. 401] between what is taught in academic programs and "the needs of employers and society" [9, p. 401], life-long learning opportunities or informal training programs may be more important forms of development and support, given the unique career paths, varied histories and knowledge, and diverse skill sets individuals bring to the work [19], [55]. Though we do not aim to prescribe specific educational pathways in this paper, we describe the above approaches such as training and coursework to

suggest that there may be opportunity for increased and possibly academic/programmatic capacity building and resulting professional pathways for the field.

The evaluation of boundary spanning activities can help to document effective boundary spanning practices, identify contributions of individuals in this role, and help to diagnose situations in which they may be critical to increase the impact of science in society. And yet, the evaluation of boundary spanning work is also challenging. Measuring the outcomes associated with such a diverse range of activities (e.g., relationship management, communication) may require evaluators to define metrics for a host of non-standard indicators – including the building of trust, the fostering of equity, and the reconciliation of diverse interests [39]. Similarly, evaluations of action-related outcomes have been rare both because they are hard to document empirically [11] and because evaluation of boundary functions may involve difficult-to-measure (also, often longitudinal) metrics such as improved trust, that are not typically described in reports and published literature, unless, for example, specifically requested by funders [19]. Recently a focus on evaluating related processes such as co-production [55] can provide guidance about how to assess boundary spanning in different contexts. Yet, linking these indicators to decision-related outcomes remains challenging, particularly when multiple factors may contribute to impacts.

Despite these challenges, there are other options for capturing the contribution of boundary spanning to connecting research and practice [56], [57]. This includes, for example, analytical methods such as social network analysis, which describes relationship-building often through boundary spanning [17], [57], [58] and social experiments testing different interventions to assess knowledge uptake via boundary organizations and knowledge brokers [59], [60]. Boundary spanners themselves are also starting to share lessons learned in order to understand commonalities in practice and outcomes [11], [12], [61]. Moreover, the growing understanding that "many actors, including but not restricted to researchers, compete to present evidence and secure a policy-maker audience" [62, p. 28] coupled with evaluation options for boundary spanning expanding in other sectors (such as health and education) situates boundary spanning practice could be at an important crossroads where we begin to better characterize both its distinct contribution to the science-policy interface and how to foster its effective practice.

4. Conclusions and Recommendations

To improve our ability to respond to addressing our most urgent social-ecological challenges, we need more boundary spanning and co-production of knowledge to increase its use of science in solving sustainability problems. The rapid growth and interest in boundary spanning emerging from multiple calls for more actionable knowledge is evidence of the need for more actors who can play that role. In this review, we argue that in order to increase both the numbers of boundary spanners and their efficacy in bridging and brokering scientific knowledge, we need

not only specific resources such as training and institutional support but also better ways to evaluate their impact and legitimize their profession. Training for boundary spanning may start in graduate and doctoral programs in diverse disciplines, or perhaps (as the profession is legitimized) though its own academic endeavors, to promote the distinct body of knowledge required and develop and hone skillsets that foster meaningful collaborative practices across the knowledge production and use spectrum in later careers.

While additional research is still needed to explore and better grasp the importance and impact of spanning the divide between and among science, policy, and practice, those seeking to support work at this interface should value, develop, utilize, and evaluate best practices in collaborative processes as a means to improve boundary spanning. Boundary spanners also need institutional and professional support. This support will become increasingly critical as a growing number of academic and scientific institutions seek to build meaningful partnerships and networks with external organizations and individuals to co-produce actionable knowledge, train students and professionals, and increase funding for boundary spanning. For this to happen, boundary spanning work must be recognized as essential in the landscape of co-production, engagement, creation of actionable knowledge, training, and education. We believe that the science-policy interface is enriched when all actors involved – scientists, policy makers, practitioners, universities, funders – understand, support, and engage with boundary spanners.

The call to action is clear for the spectrum of actors supporting boundary spanners: continue to nurture the attributes inherent in individuals drawn to boundary spanning work; identify, acknowledge and promote functions unique to boundary spanning; develop training for the professionalization of such work at multiple stages of education and professional development; and fund implementation in practice. Those identifying as boundary spanners should continue to seek support among actors, including funding, and innovate in the measurement and evaluation of outcomes and meaning that comes from this work. It is critical to move from the evidence of what boundary spanning can achieve to widespread capacity building and practice. The benefits of these efforts are vast, but ultimately bring usable knowledge to the table, provide opportunity for improved relationships across sectors, enhance communication between stakeholders, and facilitate more productive collaborations in diverse fields.

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