Ecological Economics 143 (2018) 153–160

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Ecosystem Services as Boundary Objects for Transdisciplinary Collaboration

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ARTICLE INFO

Article history:
Received 31 March 2017
Received in revised form 29 June 2017
Accepted 14 July 2017
Available online xxxx

Keywords:
Transdisciplinary research
Collaboration
Standards
Cultural services
Provisioning services
Regulating services
Boundary objects

ABSTRACT

The ecosystem services (ES) framework has potential to bring transdisciplinary teams together to achieve societal goals. Some label ES as "boundary objects" that help integrate diverse forms of knowledge across social groups and organizational scales. However, this classification masks complexities that arise from unique characteristics of ES types (i.e., provisioning, regulating, and cultural), which influence their ability to function as boundary objects. We argue that interpretive flexibility and material structures interact in distinct ways across ES types throughout a boundary object "life cycle." Viewing a 2015 U.S. federal memorandum as a catalyst, we critically evaluate the evolution of ES and its role as a boundary object. We propose that provisioning and regulating services are transitioning out of boundary object status, moving into a more standardized state. However, we anticipate that cultural services may continue to behave as boundary objects if collaborators maintain them as such. This shift in the functionality of ES as boundary objects is an important consideration for future research that attempts to reach across social worlds and disciplinary perspectives. We urge collaborations to rely on the most relevant disciplinary knowledge, rather than allowing the ease of standardized solutions to dictate the boundary of a given problem.

1. Introduction

The ecosystem services (ES) concept was developed to bridge the natural and social sciences and position ecosystem functions and structures as beneficial to society (Ehrlich and Ehrlich, 1981). This framework provided a common language for communicating across disciplines and increasing public engagement in environmental issues (Braat and de Groot, 2012). Borne from the concern that environmental legislation was increasingly contentious and unable to mitigate human impacts on the environment (MEA, 2005), this research approach presented an alternative to top-down environmental regulation. That is, ES were originally intended to facilitate collaborative management and provide a shared framework for assessing the values of ecosystems while incorporating those values into market decisions (Costanza et al., 1997; Daily, 1997).

The ES framework offers a common language for communicating across research disciplines, among environmental managers, and through global markets. However, critics have argued that the ES framework as a communication tool has become overshadowed by economic thinking (Bateman et al., 2013), making it more susceptible to the commodification of goods and services bought, sold, and traded for environmental protection (Gómez-Baggethun et al., 2010; Kosoy and Corbera, 2010). The operationalization of the ES concept is as much a political process as an economic one, which is complicated by the fact that academics, policy-makers, and the public may not clearly understand the relationship between markets and institutions (Norgaard, 2010). Although it behooves researchers to develop shared and pluralistic understandings the

Abbreviations: ES, ecosystem services; EPA, Environmental Protection Agency; FRMES, Federal Resource Management and Ecosystem Services; FEGS, Final Ecosystem Goods and Services; IPBES, Intergovernmental Platform on Biodiversity and Ecosystem Services; NAICS, North American Industrial Classification System.

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http://dx.doi.org/10.1016/j.ecolecon.2017.07.016
0921-8009/

ES framework (van Riper et al., 2017), some degree of standardized methods for measurement and valuation are needed in order to move from theory to practice. Standardization facilitates implementation, yet efforts to standardize both the concept and practice of the ES may diminish its ability to function as a communication device for bridging social worlds and disciplinary perspectives.

A growing number of studies have framed ES as "boundary objects" owing to tensions surrounding their interpretive flexibility (e.g., Abson et al., 2014; Kenter, 2016; Kull et al., 2015; Schröter et al., 2014). We believe this body of work is informative but incomplete, because it fails to engage with the dynamic nature, scale, and scope of the boundary object concept. Consequently, we provide a comprehensive definition and offer examples that describe the boundary object concept and "life cycle." Specifically, we argue that parts of the ES concept are transitioning out of boundary object status due to ongoing standardization and classification based on agreed-upon rules and definitions aimed at reducing inconsistencies and potentially conflicting practices. We then consider how the characteristics of ecosystem service types (i.e., provisioning, regulating and cultural) enable certain services to continue to operate flexibly. Provisioning, regulating and cultural services warrant particular attention due to their tangible and intangible qualities, as well as their importance in the economic valuation process, which may facilitate standardization. We conclude by exploring the implications of discussing ES in terms of boundary objects for transdisciplinary collaboration.

2. Boundary Objects

2.1. Characteristics of Boundary Objects

Boundary objects were introduced in the field of science and technology studies to theorize how heterogeneous actors cooperate and share coexisting opinions within scientific work and society (Star and Griesemer, 1989). Boundary objects were identified as objects or ideas that emerged through collaboration and dialogue which were both adaptable to local needs yet "robust enough to maintain a common identity" (Star and Griesemer, 1989, p. 393). These objects were posited as analytical concepts used to describe interaction and translation so that groups could work together when consensus was neither possible nor desired (Star, 2010). Boundary objects are both abstract (e.g., ideas, classification systems, or concepts) and concrete (e.g., images, maps, or tools). For example, Star and Griesemer (1989) described the boundary objects produced in natural history work as simultaneously encompassing specimens, field notes, and maps while also representing "nature" as it was conceived by the diverse sponsors, theorists, and amateurs involved in their production.

Three distinguishing features of boundary objects enable them to function across multiple actors (Bowker and Star, 1999; Star, 2010; Star and Griesemer, 1989). First, a boundary object has "interpretive flexibility," meaning that it is able to satisfy the needs of users from different social worlds while facilitating communication between them (Star and Griesemer, 1989). Social worlds can be spaces where individuals communicate through shared discourse (Strauss, 1978) or broader "communities of practice" that interact in a shared cultural space (Wenger, 1998). This characteristic has been the most studied aspect of boundary objects to date (Star, 2010); however, taken alone, interpretive flexibility could be applied to a vast array of ideas or objects and may seem counterintuitive for facilitating communication. Therefore, a boundary object must secondarily address an information need arising from work processes, such as a need to classify or organize data. The boundary objects that arise from these needs in turn influence the form and structure of dialogue (Table 1; Star, 2010). Third, a boundary object is not a static concept but instead requires movement between a general, ill-structured form and local, tailored applications of a given idea (Star, 2010). Thus, the ability of a boundary object to tack back-and-forth between social worlds—to simultaneously exist in a specific state for one discipline while being universally vague across all disciplines—makes them particularly powerful transdisciplinary tools to be invoked in policy and decision-making (Star, 2010).

2.2. Types of Boundary Objects in Environmental Research

Star and Griesemer (1989) identified four distinguishable categories of boundary objects (Table 1). The first kind of boundary object is one that acts as a "repository," defined as an object for organizing and indexing information within society or scholarship. Star and Griesemer (1989) used the establishment of the Museum of Vertebrate Zoology at the University of California at Berkeley as an example to show that repositories standardize the delivery of information without restricting the ways in which users interpret and apply the knowledge provided. Similarly, boundary objects can be used to facilitate collaboration through another category termed "ideal types." By remaining vague, ideal types can be used locally while facilitating communication across a broader scale (Star and Griesemer, 1989). The biological concept of a species is an ideal type, because it enables scientists to make legible the diversity of organisms and processes. Scholars and practitioners have treated the ES concept as an ideal type to identify the diversity of benefits people obtain from the environment, which has proliferated a variety of frameworks for organizing and classifying these benefits (e.g., Díaz et al., 2015; Muhar et al., 2017; Ostrom, 2009). For example, the MEA (2005) defined ES as 'benefits obtained from ecosystems,' which allows for a broad range of interpretations across disciplines and stakeholder perspectives despite the various forms of material and non-material benefits of nature.

Boundary objects can also represent "coincident boundaries" that share the same material structure but have different content and/or interpretations depending on the perspectives of the user (Star and Griesemer, 1989). Clark et al. (2011) applied the boundary object concept to navigate what constituted useful knowledge across different communities involved in community forestry around the world. These authors highlighted the need for developing tangible boundary objects that were tailored to a specific context. Several of the products most valued by both communities and scientists were drawings, maps, and physical models of the landscape; these objects have coincident boundaries and represent the same geographic space but allow for multiple interpretations and uses by practitioners. In contrast to the coincident boundaries category, "standardized forms" are boundary objects that standardize content and streamline communication across diverse groups (Star and Griesemer, 1989). A standardized form allows information to travel without losing meaning if it maintains a specific structure across groups, while not being limited by the ways information is interpreted and applied. For example, ecological indicators may be considered standardized forms that assess ecological quality and allow for comparisons across diverse areas. However, if ecological indicators become too inflexible, they incite conflict and impede effective communication (Turnhout, 2009).

2.3. Boundary Objects as a Dynamic Process

As an analytical tool, the boundary object concept is useful for providing insight into the dynamic process of collaboration, including how it produces these objects, generates material effects, and potentially transitions into standardized "infrastructure" (Star, 2010). Infrastructures are the tools, work practices, terms, and technologies that become embedded in and support a community of practice (Star and Ruhleder, 1996; Bowker and Star, 1999). Whether or not something functions as a boundary object depends on the criteria and forms described in Sections 2.1–2.2, as well as the scale and scope of its use over time (Star, 2010). Some objects or concepts may be more useful than others and may depend on the number and diversity of actor groups engaged with its production and maintenance (Star, 2010). Boundary objects, like infrastructure, are therefore both "product and process" (Star and Ruhleder, 1996, p. 111) with conceptual and material effects that