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Forest managers' response to climate change science: Evaluating the constructs of boundary objects and organizations

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ABSTRACT

Land managers lack locally relevant climate change science and are urgently calling for research to inform management. We conducted four climate change workshops in the U.S. northern Rocky Mountains and applied multiple methods of inquiry to understand whether the boundary organization (workshops) and objects (climate change science products) were perceived as credible and useful. Perceived credibility and usefulness increased overall, and regional-scale hydrologic information was deemed most useful. Regression models found that intention to use climate change science was predicted by usefulness, credibility, and organizational barriers. We discuss the importance of uncertainty, visualization, and best practices for effective climate change deliberation using boundary objects and organizations at the research–management interface.

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1. Introduction

Climate change represents one of the greatest challenges to land management and society. There is strong evidence of climate changes that have impacted biophysical systems in the past, as well as how these challenges are anticipated to impact our future (Environmental Protection Agency, 2010). They are expected to further alter the mountainous ecosystems of the U.S. northern Rocky Mountains and continue to affect the people who depend on them for ecosystem services and livelihoods. Land management agencies will not be able to fulfill their missions to promote sustainability without integrating climate change impacts into management plans and actions. With rapid biophysical changes already occurring in these forests, the United States Forest Service (USFS) and other stakeholders are increasingly seeking to understand and mitigate the effects of a changing climate. Historical data from the northern Rockies region have indicated moderately to highly significant shifts in vegetation growing-season length,

annual temperature, amount of forest area burned, lilac phenology, mountain bluebird phenology, precipitation intensity, timing of streamflow, and April 1st snowpack levels – many of which could have important consequences for how our forests, fires, and other natural resources are managed in the future (Klos et al., 2015). Although forest managers are mandated to use climate change science in their management planning, few managers in the northern Rockies have been found to be actively using this information because of perceived barriers in information quality and quantity (Kemp et al., 2015). Effective action depends on having open and reasoned discussions among land managers and researchers in order to understand the implications of climate change and potential mitigation actions (Hall et al., 2012; Dietz, 2013). Recent research has called for communication efforts to shift messages about climate change from a frame of “uncertain science” and a “Pandora’s Box” toward new cognitive reference points that connect climate change to something locally specific the audience already values or understands (Nisbet and Kotcher, 2009). To answer this call in a forest management context, we engaged forest managers in a deliberative and interactive way with the intent of strengthening the overlap between regional climate change research and end-user information needs and improving forest adaptation to climate-related impacts.

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In the fall of 2012, our interdisciplinary research team of biophysical and social scientists conducted a series of climate change workshops (CCWs) focused on conveying locally relevant information on shifts in forested landscapes due to changing climate. The CCWs facilitated the exchange of current climate change knowledge across research and management boundaries in the U.S. northern Rocky Mountains. Our CCWs were designed to communicate abstract concepts of climate change impacts at regional and local scales by synthesizing historical data and visualizing model-generated forecasts of future changes to forest and water resources.

To assess how participants' attitudes and beliefs changed as a result of CCW participation, we applied a pre-test/post-test, mixed methods approach. This study contributes to both theory and practice of boundary objects and organizations by carefully analyzing constructs that have been posited as leading to more effective decision outcomes. Additionally, we incorporated ideas from social learning theory to develop activities likely to enhance collective understanding in the application of science to practice, including visualization techniques. The objectives of this study were to: (1) describe the background and need for using boundary objects and organizations, including the hypothesized effects of CCW participations and relationships between boundary constructs; (2) explore how the workshops and tools were constructed and evaluated within a boundary theory context; and (3) evaluate the observed change as a result of CCW participation, the relationships between variables, and the overall effectiveness of our boundary objects and the CCWs as a mechanism for the rapid transmission and use of climate change science in land management decisions.

1.1. Background and need for boundary organizations and boundary objects

The process by which research communities establish relationships with the worlds of land management and policy is commonly referred to as boundary work (Gieryn, 1983; Clark et al., 2010). Boundaries are symbolic distinctions that categorize objects, people, practices, and even time and space (Lamont and Molnár, 2002). Boundaries have been addressed in two ways: through the concepts of boundary organizations and boundary objects.

Boundary organization theory offers one approach to understanding and enhancing interactions between the different worlds of specific groups or organizations. Boundary organizations – institutions or settings that facilitate knowledge and information exchange among scientists, decision-makers, and land managers – can facilitate a multi-directional flow of information between science and management at multiple scales (Cash and Moser, 2000). The primary assumptions of boundary organizations set forth by Guston (2001) are: (1) they exist at the frontier of the science and management communities but are accountable to both; (2) they involve participation by land managers/policymakers and researchers, as well as professionals who mediate between them; and (3) they provide opportunities for the co-production of boundary objects, which are tools that serve useful function to multiple professional worlds. In the context of climate change, research specific to boundary organizations is relatively new, but important, because the pace of climate change research is growing. Land managers need information specific to their regions, and boundary work provides a mechanism for integrating academic research products with practical land management needs.

In a separate line of work, researchers have explored boundary objects – hybrid, flexible, and portable tools that help people from multiple sectors negotiate knowledge transfer between the science, management, and policy realms (White et al., 2010; Cutts et al., 2011). Model-based decision support tools have

become popular as boundary objects that connect natural resource sciences and decision-makers, because models provide a means for visualizing complex information and exploring different management scenarios (White et al., 2010). We defined our boundary organization as the CCW as a whole, and the boundary objects were the climate change information, including modeling tools, used during the CCW.

Despite the interest in and promise of boundary organizations and objects, the different types, natures, and effects of boundary objects in natural resource management are poorly understood (White, 2011). Cash et al. (2003) identified three elements integral to linking knowledge and action for environmental decision-making: credibility, salience, and legitimacy. **Credibility** involves the scientific adequacy of the technical evidence and arguments. This has been qualitatively assessed in terms of perceived scientific accuracy, validity, technical evidence, data quality, calculations, and visual display (White et al., 2010). **Salience** (or usefulness) is the perception of whether the boundary object has the ability to meet the needs of decision-makers. **Legitimacy** reflects perceptions that the production of information and technology has been respectful of the divergent values and beliefs of stakeholders. In our study, these constructs were evaluated in terms of both the CCW organization and individual boundary objects.

Institutional environments also affect the capacity to use climate change science in land management. Agency policies, directives, diverse priorities, time, funding, politics, and litigation are a few potential barriers that may supersede the previously described variables related to boundary objects and organizations (Jantarasami et al., 2010; Archie et al., 2012). The more barriers a person perceives, the lower his/her intention to use climate change research in land management.

Our pre- and post-workshop interviews and questionnaires were designed to evaluate the effect of the boundary organization and objects, and explore the hypothesized relationships between the factors that predict likelihood to use climate science in forest management. The specific hypotheses we tested were the following:

H1. Perceptions of (a) the usefulness and (b) credibility of climate change science in forest management will significantly increase as a result of participating in the CCWs.

H2. Greater perceived credibility will be associated with greater perceived usefulness of climate change science in forest management decisions.

H3. Greater perceived usefulness will be associated with greater intention to use climate change science in future forest management.

H4. Greater perceived organizational barriers will be associated with (a) lower perceived usefulness and (b) lower intention to use climate change science in forest management decisions.

H5. The effect of credibility and organizational barriers on behavioral intention will be mediated by the perceived usefulness of the science.

H6. Participation in the CCW will result in a positive overall evaluation of the credibility, salience, and legitimacy of the boundary organization.

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