



Identifying climate risk perceptions, information needs, and barriers to information exchange among public land managers



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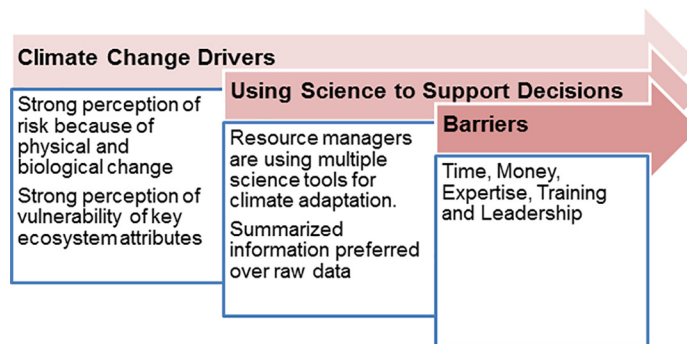
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HIGHLIGHTS

- Natural Resource managers perceive strong risks of climate change.
- Natural Resource managers strongly feel resources will be vulnerable.
- How strongly depends on the resource agency and the managed attribute.
- Resource managers report using climate science to plan actions.
- Resource specific assessments are more useful than databases or data sets.

GRAPHICAL ABSTRACT



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ABSTRACT

Meeting ecosystem management challenges posed by climate change requires building effective communication channels among researchers, planners and practitioners to focus research on management issues requiring new knowledge. We surveyed resource managers within two regions of the western United States regions to better understand perceived risks and vulnerabilities associated with climate change and barriers to obtaining and using relevant climate science information in making ecosystem management decisions. We sought to understand what types of climate science information resource managers find most valuable, and the formats in which they prefer to receive climate science information. We found broad concern among natural resource managers in federal agencies that climate change will make it more difficult for them to achieve their management goals. Primary barriers to incorporating climate science into planning are distributed among challenges identifying, receiving, and interpreting appropriate science and a lack of direction provided by agency leadership needed to meaningfully use this emerging science in resource planning.

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1. Introduction

Climate adaptation planning is a challenging undertaking for public land management agencies (Hagerman, 2016; Wall et al., 2017). Natural resource managers are constrained by the complex socio-political landscapes in which they operate (Chaffin et al., 2014; Folke et al., 2005;

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Koontz et al., 2015; Lachapelle et al., 2003). Incorporating climate change into management is also predicated on the acceptance of climate change by practitioners (Archie et al., 2012; Fazey et al., 2013), the perceived validity of the science linking the risks posed by climate change to resources managed by those practitioners (Tribbia and Moser, 2008) and stakeholder acceptance of the need for adaptation management (Bardsley and Sweeney, 2010; Bartels et al., 2013; Schwartz and Martin, 2013).

We use a 2013 survey of 930 natural resource managers in the central and southwestern US to gauge the state of climate awareness, concern and capacity among natural resource managers. Nearly one-third (28%) of all land in the United States is publically owned and managed, most of which is forested, grazing lands, or desert ecosystems (Vincent et al., 2014). Many of the resources and services provided by public lands are threatened by climate change impacts such as increased drought, fire, and disease (Baron et al., 2008; Joyce et al., 2009; Stephens et al., 2010).

Climate change poses a significant challenge for natural resource planning and management (Heino et al., 2009; Heller and Zavaleta, 2009; Lawler et al., 2010; Mawdsley et al., 2009; Millar et al., 2007; Thuiller et al., 2008). Recent climate assessments project upwards of 2 °C of warming over the next century, possibly as much as 6 °C (IPCC, 2014). This warming, along with changes in the pattern and distribution of precipitation, is expected to render major changes to the distribution of species and biomes and challenge our capacity to maintain biological diversity and valued ecosystem services (IPCC, 2014; Lawler, 2009; Parmesan, 2006; Rosenzweig et al., 2008). In light of rapid ecological change, researchers and natural resource managers are re-thinking objectives (Hobbs et al., 2014; Millar et al., 2007; Rosenzweig et al., 2008), strategies (Joyce et al., 2009; Morelli et al., 2016; Stephens et al., 2010), processes for achieving success (Cook et al., 2013; Littell et al., 2012; Roux et al., 2006; Wall et al., 2017) and institutional structures needed to embrace change (Craig et al., 2017b; Craig et al., 2017a; Koontz et al., 2015).

Natural resource management decisions are also made challenging by the uncertainty and complexity of the societal, physical and ecological feedbacks within the projection models themselves. Much of our understanding of climate change is based on global models of climate processes. Global climate models carry significant irreducible uncertainty. Further, it is difficult to downscale these global models and their uncertainties to the local-scales that are relevant to natural resource managers (Baker et al., 2017; Franklin et al., 2013; Holden et al., 2016; Pierce et al., 2014; Schwartz, 2012). In addition, uncertainties inherent in applying climate models to biological responses are large (Dormann, 2007; Guisan et al., 2013; Schwartz, 2012). Uncertainty, alone, can lead to institutional paralysis in resource management (Alverson, 2002).

The aim of this study is to identify information that helps focus development and distribution of relevant climate science information for natural resource managers. The target audience for this study is threefold. First, we seek to inform boundary science organizations trying to create bridges between researchers and practitioners. Second, we seek to inform researchers trying to bridge the policy-implementation gap. Third, we seek to inform leadership of US federal resource agencies on the existing barriers to effectively linking science to climate change adaptation management strategies.

Our survey was distributed to natural resource managers in the federal land management agencies in order to: a) characterize the perception of land managers regarding which potential climate change impacts will most affect their ability to achieve resource management objectives b) identify the degree to which various resources are perceived to be at risk due to climate change c) identify barriers to managers receiving desired relevant climate science and d) identify the most desired types of climate science information and the most useful formats for receiving that science.

2. Methods

We partnered with the United States Department of Interior (US DOI) Southwest and North Central Climate Science Centers (SWCSC and NCCSC, respectively) to conduct this assessment across two regions of the western United States. These Climate Science Centers (CSCs) were established to act as boundary organizations (Cook et al., 2013) that bring together natural resource managers and scientists to identify climate science information needs, fund relevant research, and develop tools for the application of that scientific information to natural resource planning. However, dominant concerns of natural resource managers vary by location and the type of resources that are being managed (Rudd and Fleishman, 2014), making it difficult to identify what types of climate science are needed, and where.

We focus on the results of a web-based survey of federal resource managers in four agencies. These agencies own the majority of public land in the U.S: the Bureau of Land Management (BLM, 100 million ha), the US Forest Service (USFS, 78 million ha), the US Fish & Wildlife Service (USFWS, 36 million ha), and the National Park Service (NPS, 32 million ha) (Vincent et al., 2014). We focused our survey on managers working in California, Nevada, Utah, Arizona, Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska and Kansas. Specifically, these western states represent administrative regions within the USGS Southwest and North Central Climate Science Centers and are regions rich in public lands.

The USFS and BLM are tasked with managing lands for multiple uses, including resource extraction, sustainable use of renewable natural resources, recreation and conservation (Vincent et al., 2014). Land owned and managed by the FWS is most frequently for the purpose of wildlife management for game species (e.g., waterfowl) and conservation (Vincent et al., 2014). The NPS owns a variety of resources, but national parks are meant to be managed to keep locations of exceptional beauty in as near as possible to a pristine natural environment (Vincent et al., 2014).

2.1. The survey and surveyed population

We developed the initial draft of the survey based on our research questions and discussions with federal natural resource managers and scientists at the US DOI Climate Science Centers. The research team then refined these questions for clarity and content based on feedback from natural resource managers (primarily regional staff). A pilot version of the survey was beta-tested by natural resource managers at Sequoia Kings Canyon National Park. Thus, US DOI staff helped guide the questions, but did not design the survey. Finally, we vetted the survey through science leadership of agencies that were interested in seeing the survey and engaging with us on the methods of survey release (USFS, USFWS, NPS). Owing to US Forest Service response, some questions were not issued to USFS employees, however these questions were not included in these analyses.

Our goal was to survey natural resource managers and administrators who make decision regarding climate change adaptation or use climate science information to make natural resource management decisions. The method for identifying survey contacts varied by federal agency. We collaborated with regional staff at the NPS and USFWS identify the front line climate change managers ($n = 308$, 166 respectively). We defined front line climate change managers as employees whose normal job duties involve incorporating climate change into the resource management process. For the BLM we developed a contact list using their online employee directory ($n = 928$). For the USFS members of the National Climate Change Response Program relied on regional managers to identify appropriate recipients for the survey in their jurisdictions ($n = 462$). Owing to regional boundaries for agencies that do not coincide with those of the CSCs (or each other), we fully sampled each agency within the boundaries of each CSC, but also received

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