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Understanding Perceptions of Climate Change Scenario Planning in United States Public Land Management Agencies

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ABSTRACT

As climate change increasingly challenges the capacity of traditional decision-making modalities to contend with mounting complexities and uncertainties, natural resource management agencies have increasingly turned to nontraditional modes of planning and decision-making such as 'futuring. Futuring methods, such as scenarios, have been increasingly utilized around the world. In the US, however, there has been a limited uptake of these tools across public land management and a preference for more traditional forecasting tools. This article explores some possibilities about why this is the case and aims to identify potential pathways forward. Drawing on 28 exploratory interviews with public land managers from the US Forest Service and others, a variety of benefits to scenario use were identified including: (1) mitigation of climate skepticism; (2) more robust capture of uncertainty, complexity, and the potential for surprise posed by climate change; and (3) potential for social learning. Barriers identified included: (1) difficulty in understanding the process, (2) bureaucratic concerns about time, staffing, and funding, and (3) a lack of an agency 'champion'. However, concerns about the epistemological and institutional fit of nontraditional planning and decision-making tools like scenario processes predominated across the interviews. Interviewees also identified what we call 'streamlining' and 'mainstreaming' as potential pathways to integrate scenario processes into planning and decision-making.

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Introduction

Increasingly, public land managers are being charged with integrating climate change considerations into their planning and decision-making. However, the manifold social, political, and economic implications of climate change as well as the profound ecological consequences of its impacts, have challenged managers in a variety of ways

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(Laatsch and Ma 2015). Fundamentally, climate change challenges the capacity of traditional decision-making modalities to contend with the proliferating complexities and profound uncertainties that stem from a changing climate (Millar, Stephenson, and Stephenson 2007). Bengston (2019) describe show these challenges have prompted natural resource management to turn to nontraditional modes of planning and decision-making such as various forms of what has been called 'futuring', including the use of scenarios.

Futuring methods, and more specifically scenarios, have been increasingly utilized around the world, though their integration with management practice and decision-making has been uneven (Yung et al. 2019; Elsawah et al. 2020). Emerging out of business and military planning, scenario-based futuring methods provide a way to integrate complex uncertainties and the potential for surprise into planning and decision-making by exploring multiple possible futures (Börjeson et al. 2006). Scenario processes come in a variety of shapes and forms ranging from highly-quantitative, probabilistic scenario modeling to highly qualitative, possibilistic scenario-based planning activities (Amer et al. 2013). In the context of public land management, scenarios have been utilized in numerous arenas across scales from the global level to on-the-ground efforts in project planning by individual agencies, particularly in international forestry and conservation efforts. The highly varied uses of scenarios and the inherent mutability of scenario process design offers substantial value to managers as a means to deal with the increasingly complex and uncertain nature of a climate changed future.

However, there has also been an uneven uptake of scenario-based processes across public land management, particularly at the US federal level, and a preference in some resource management arenas for more traditional forecasting tools. Understanding why scenarios are utilized in some contexts and not others is critical given the rapid changes precipitated by a radically altered climate system. In order to address this lacuna, we conducted interviews with managers and researchers primarily in the United States Department of Agriculture Forest Service (FS) but also in the United States National Park Service (NPS) and with NGO and university researchers who have worked collaboratively with these agencies, to explore their perceptions of the utility of scenario processes in public land planning. We found that a range of factors shape how managers perceive scenarios, affecting their use. Drawing on these interviews, we discuss various strategies for integrating scenarios into planning.

The Potential of Scenarios for Integrating Climate Change into Management

Climate change has challenged public land managers in a multitude of ways but as Dillard et al. (2008, 2) argue, "without fully integrating considerations of climate change impacts into planning … [they] may no longer be able to fulfill their mission." Public land management agencies have responded to this challenge by taking steps to integrate climate change into policy, planning, and project design, though, as noted above, these efforts have been limited, highly varied, and/or inconsistent (Halofsky et al. 2018). Further, managers have confronted a substantial array of barriers to integrating climate change into planning (see Eisenack et al. 2014 for definitions of barriers, constraints,

and challenges), from lack of national leadership to a lack of appropriate tools (see Laatsch and Ma 2015).

Nelson et al. (2016), for instance, found that Canadian managers face knowledge, financial, capacity, and institutional barriers. Further, their interviewees perceived that some professionals are more receptive than others to the planning implications of climate change. Similar to concerns detailed by Biesbroek et al. (2018), they found that managers conveyed concerns about a lack of 'best practices' and standards for successful integration of climate change into planning, as well as the lack of time and capacity to develop those standards. Research in the US context has also revealed the absence of clear, consistent policy direction and concomitant investments in funding and personnel (Archie et al. 2012; Burch 2010; Biesbroek et al. 2018; McNeely 2017; Lonsdale et al. 2017). In a survey of western US federal land managers, Kemp et al. (2015) found that many managers believe that climate information is delivered at an inappropriate scale for planning and decision-making, both spatially and temporally.

Consequently, managers have stated that their climate change efforts are mostly reactive or "check-the-box" tasks (Kemp et al. 2015) and that management plans often neglect climate change (Brice et al. 2020). Organizational culture, rapidly shifting national politics, and inflexibility due to legal requirements and litigation have shaped these reactive stances (Burch 2010; Kemp et al. 2015; Smith and Travis 2010). This is further complicated by managers' perceptions of science requirements in planning and decision-making. According to Timberlake and Schultz (2019, 1030) managers feel that, in order to act confidently on climate change, they need "targeted scientific information in order to devise appropriate management actions, identify priority resources and locations for intervention, and inform decision-making." Nelson et al. (2016) concur, reporting that managers overwhelmingly agreed (89% of respondents) that the highest priority is the need for "clear science". Contributing to this, peer-reviewed research often fails to clearly explain how to apply findings (Brice et al. 2020). However, given the uncertainties in downscaled projections of local climate change impacts and the uncertainties about international mitigation efforts, it is perhaps not surprising that Archie (2014) found that 81% of federal land managers in the US reported that current uncertainty in climate science was *the* major hurdle to action.

These uncertainties come in a range of forms beyond the typical model uncertainty communicated in global scenarios. As Beisbroek et al. (2011) describe, a host of uncertainties abound, including 'epistemic uncertainty' (i.e. knowledge about future climate), 'natural stochastic uncertainty' (i.e. knowledge of the range of variability), 'human reflexive uncertainty' (i.e. knowledge about future human action and values), and 'substantive uncertainty' (i.e. uncertainty about the quality and credibility of data). For example, there is continuing uncertainty about future GHG emissions, downscaled patterns of precipitation, impacts to individual species, and the nature and timing of ecosystem regime shifts. In decision-making contexts, Kemp et al. (2015) found that "uncertainty about the potential impacts of climate change led many of [their] interviewees to focus on general goals or outcomes rather than specific management strategies." Hoogstra and Schanz (2008) also found that forest managers in Europe downplayed and ignored uncertainties in favor of known risks despite their long planning horizons.

This inability to address complex and compounding uncertainties in the high stakes context of climate adaptation is arguably *the* most problematic barrier to integrating climate change into public lands planning (Yousepfour and Hanewinkel 2015). As such, Price and Isaac (2012) argue that "new approaches to long-term planning that recognize climate uncertainty and dynamic change in climatic conditions are needed". Scenarios, for example, have been increasingly embraced as a pathway for tackling the fundamental problem of uncertainty in the context of climate change. For our purposes, we define 'scenarios' simply as qualitative descriptions of plausible, alternative future conditions, and 'scenario planning' as the use of scenarios in strategic decision-making. Qualitative scenarios can also include quantitative information and can draw from quantitative modeling (Yung et al. 2019). In public land management circles, scenarios often refer to such models where input variables are manipulated within ranges to demonstrate a range of future probabilities. However, as scenario typologies abound (see Börjeson et al. 2006), and though probabilistic scenario models are important, we use a more encompassing definition that highlights the varying uses of qualitative and quantitative data along with stakeholder engagement to produce multiple, *plausible* futures.

This broader definition of scenarios remains, as Bengston (2019) point out, largely "invisible" to most natural resource scientists and managers despite widespread use in certain contexts, including the National Park Service Climate Change Response Program (see NPS 2021). A highly mutable and flexible method within the larger field of 'futuring' or 'strategic foresight,' possibilistic scenarios represent a departure from probabilistic risk-based decision-making models (Yung et al. 2019; Wyborn et al. 2021). As Bengston (2019) notes, probabilistic methods focused on single temporal chains of cause-and-effect may be insufficient to deal with the degrees of uncertainty and complexity facing managers. Further, they argue that "the accuracy of traditional forecasting methods has repeatedly been shown to be poor at best when applied to complex social-ecological systems" (2019:10). In contrast, possibilistic scenarios are particularly adept at accounting for surprise and highly uncertain trajectories of drivers and feedbacks and the black box 'slipperiness' of human behavior (Wellstead, Howlett, and Rayner 2013; Yung et al. 2019; see also Beisbroek et al. 2011 regarding 'human reflexive uncertainty'). Despite these benefits the use of scenario-based planning in US resource management contexts is uneven.

For instance, although the National Park Service has embraced the use of scenarios (NPS 2021) and the USDA Forest Service Resources Planning Act Assessment of 2020 provides a number of scenario tools (Joyce and Coulson 2020), there is a limited (though growing) number of published public lands cases for managers to draw on as models for planning and decision-making (for some examples, see Murphy et al. 2016; Murphy et al. 2017; Glick et al. 2011; Clifford et al. 2020; Cross et al. 2012; Wyborn et al. 2015; Chapin et al. 2010). In the United States National Park Service (NPS) scenario processes have been institutionalized through the Climate Change Response Program. However, agencies like the US Forest Service (FS) have not exhibited consistent or widespread use of these techniques, despite investment in valuable research clusters like the USFS Strategic Foresight Group. Instead, planners have increasingly relied on climate change vulnerability assessments and the Climate Change Response Framework to integrate climate vulnerability information and adaptation actions into planning processes (Timberlake and Schultz 2019; Ontl et al. 2020).

Globally, scenarios have become de rigeur within larger efforts such as the Millennium Ecosystem Assessment, the Intergovernmental Panel on Biodiversity and Ecosystem Services Nature Futures framework, and the Intergovernmental Panel on Climate Change emissions concentration pathways or Shared Socio-Economic Scenarios. At a smaller scale, scenario tools are increasingly utilized in participatory and collaborative planning contexts internationally (see Oteros-Rojas et al. 2015 for a review). However, even in efforts like this, scenarios are often used in very specific ways despite the flexibility of the method. In a survey of a 129 scenario-based projects led by European resource management agencies, Hoogstra-Klein, Hengeveld, and de Jong (2017) found that the vast majority were largely quantitatively driven, non-participatory, and single-factor (e.g. a single species or resource rather than a landscape or ecosystem) or single-future focused. They also note that these non-participatory, single-factor, single-future approaches are insufficient to deal with the uncertainty, complexity, and long-term consequences of climate change.

More flexible, stakeholder engaged scenarios and scenario planning, however, could be a valuable method for addressing the uncertainty and high complexity in long-term climate adaptation planning. Yet, there is no research examining the uptake of this tool in US public land management. Complicating this further is that, even with the increasing number of case studies describing the use of scenarios in public land planning and decision-making, very little is known about how scenarios are perceived by the public land managers who use them. In response to this gap, we explored managers' perceptions of scenarios and, drawing on their experiences, what they saw as the benefits and drawbacks associated with their use. This research also illuminated how current planning platforms and decision-making processes are challenged by the uncertainties of a changing climate as well as the potential of scenarios to address that uncertainty. Building on these initial findings, we discuss the institutional fit of scenario planning within public land management agencies, and how these processes might be better designed for these decision spaces. Addressing this is critical because, as Nelson et al. (2016) point out, managers are on the front lines of climate change, and, consequently, understanding how the perceptions of managers and the institutional situatedness of management shape the possibilities for planning is paramount.

Methods

To better understand perceptions and use of scenarios in public land management agencies, we conducted 28 in-depth interviews over a six-month period in 2018. We utilized a chain-referral process to identify a diverse range of interviewees who had participated in one or more scenario processes, with an initial focus on USFS employees (see Table 1 below for a list of interviewees and their characteristics). Through the process we broaden our sample to 28 interviewees including 21 individuals from the USDA Forest Service (FS); three from the Department of Interior including the National Park Service and Bureau of Land Management; and four nonfederal experts from academia and non-governmental management who have extensive experience conducting scenario planning with federal land managers. Within the sample of interviewees from the USDA Forest Service, four were from Research and Development (FS Research) and seventeen were managers from National

Table 1. List of interviewees and background characteristics.

Interviewee	Experience	Organization	Position	Scale
1	Expert	Academia	Climate scientist	Local
2	Expert	Academia	Social scientist	Regional
3	Some	DOI-BLM	Manager	Regional
4	Expert	DOI-NPS	Policy	National
5	Some	DOI-NPS	Climate specialist	Regional
6	Expert	Federal agency	Policy	National
7	Minimal	FS NFS	Planning	Regional
8	Minimal	FS NFS	Manager	Local
9	Minimal	FS NFS	Manager	Local
10	Some	FS NFS	Climate specialist	Regional
11	Minimal	FS NFS	Planning	Regional
12	Minimal	FS NFS	Manager	Local
13	Minimal	FS NFS	Ecologist	Regional
14	Some	FS NFS	Social scientist	Local
15	Minimal	FS NFS	Manager	Local
16	Minimal	FS NFS	Ecologist	Regional
17	Minimal	FS NFS	Manager	Local
18	Minimal	FS NFS	Biologist	Regional
19	Minimal	FS NFS	Ecologist	Regional
20	Minimal	FS NFS	Manager	Local
21	Minimal	FS NFS	Policy	National
22	Some	FS NFS	Climate specialist	Regional
23	Some	FS NFS	Climate specialist	Regional
24	Expert	FS Research	Ecologist	Regional
25	Some	FS Research	Biologist	Regional
26	Expert	FS Research	Economist	Regional
27	Some	FS Research	Climate specialist	Regional
28	Expert	Non-governmental	Ecologist	Local

FS NFS: Forest Service National Forest System; DOI-NPS: Department of Interior, National Park Service; DOI-BLM: Department of Interior, Bureau of Land Management.

Forest Systems (NFS). Moreover, the sample included personnel at varying levels of management (i.e. individual units, regions, and national headquarters) and varying degrees of experience with scenarios. Some interviewees, for example, are recognized 'experts' in scenario planning with experience both participating in scenario processes and designing them. Others had either experience participating in multiple processes, categorized as 'some', or if they had only a single experience, categorized as 'minimal'.

Several of the authors (Murphy et al. 2017) conducted 1–2 hour phone interviews using a semi-structured interview guide to ensure consistency and comparability across interviews (see supplement 1). Interview questions covered experiences with scenarios, perceptions about the benefits and challenges of using scenarios in planning and decision-making contexts, comparisons with other tools like vulnerability assessments, and prospects for scenarios in future planning activities. Interviewers used probes to ensure coverage of the questions, though interviewees were given wider berth to expound on their responses.

Interviews were then transcribed and read by the whole team. Following that initial read, we collaboratively developed a coding scheme with operationalized definitions to facilitate consistency across the team. Many of the codes we developed were a priori and derived from the interview guide. Additional codes were generated from the initial read through and discussed amongst the team. Interviews were then collaboratively coded in Dedoose, a collaborative cloud-based qualitative data analysis program. Excerpts were then organized by code and the team members reviewed these excerpts for internal consistency and adherence to the coding scheme. Following this, individual

members of the team each analyzed an individual code (i.e. excerpts), applied thematic sub-codes in order to characterize the data, and then drafted a preliminary analysis. These were shared across the team for review and analytical discussion. Subsequently, each team member narrowed to the most salient findings. These are presented below.

Results

Below we describe interviewees' experiences with scenario processes, the benefits and challenges associated with scenarios they described, and their suggestions for integrating scenarios into public land planning and decision-making. For most of the responses included below we do not identify the interviewee except where that identity provides additional context.

Experience Using Scenarios

Though all of our interviewees had experience with scenarios, most described themselves to be "in the learning process," emphasizing that climate change required exploration of a wide variety of tools with scenario processes being just one. Even some of the National Park Service interviewees with extensive scenario experience stated that they were still learning how to design an effective process. One NPS employee characterized this current experimental mood stating:

> We should be exploring a variety of tools … we need to embrace the fact that we are in an exploratory era of years and need to be open to a variety of methods. And just try them, they all have their individual strengths and none of them are perfect. So, I think it behooves us to use the suite of tools that we have and then do our best to learn from them.

Across the sample, interviewees had worked with a wide range of scenario processes and consequently, the term "scenarios" meant different things to different people. To some it simply meant being attentive to different, plausible futures during the planning process. To others it referred to the specific carbon emission pathways, while others used it to refer to any exploration of uncertainty. Some, for example, distilled the process into "if you sit down and think, 'If I do this, how will it affect that?' On whatever it is, is really to me, scenario planning." Many interviewees noted that scenarios were employed principally for this reason, because they allowed managers and others to "think through cause-and-effect chains" and "see a logical materialization of what the implications of those scenarios are." This made scenarios critical to the learning process necessary for planning in the context of climate change.

Interviewees also discussed important elements of scenario design. In terms of scope, some processes focused very narrowly on a single resource or sets of resources, such as water, while others focused on management units or landscapes, such as sagebrush ecosystems. Reflecting on their experience with multiple scenario processes, one interviewee commented on a regional scenario process as being "fast but not as deep," while they described another process that focused on a single resource as deep but excessively time consuming. Another interviewee, with extensive experience in scenario planning, stated that differences in timescale affected the scenario development process. One process, they argued, was largely "static," with a limited time horizon of 5–10 years, while other

processes had more distant time horizons. In some cases, interviewees described processes that generated 3–5 scenarios and then averaged them quantitatively in order to plan for an "average" or "most likely" scenario, which reflects some misunderstanding about the definition of scenarios more generally. Alternatively, some interviewees described building in-depth, qualitative descriptions of a range of plausible futures.

Overall, interviewees' descriptions of scenarios and scenario processes differed considerably and ranged across a spectrum of 'types' from probabilistic, model-driven scenario processes to narrative-driven, qualitative scenario processes. Though in practice scenario processes often employ a mix of these types, the distinction was elucidated by an external expert who identified "at least two flavors of scenario planning." They stated:

> One is almost like a technologically driven scenario planning. It's very predictive, it's very formulaic, it's model driven. The other is developed through a collaborative process. There's a give and take between those conversations and some modeling that's done in response to, or to substantiate what's coming out of those conversations. In that second family, that second approach, you don't defer to what comes out of the models. We use a collaborative process and modeling in an integrated, iterative manner.

Interviewees' responses revealed that many processes fell somewhere along this spectrum from designs tending toward a high reliance on quantitative logics and drivers (e.g. with considerable concern about the bounds of probability and adherence to global climate models) to others that were more dependent on discursive dynamics between participants. The latter tended to rely more on qualitative logics and drivers derived through iterative, conversation between stakeholders (including but not limited to biophysical scientists). For example, some processes used limited, expert-led discussion to set the parameters for scenario modeling, while others used variable outcome models to stimulate discussions about the future.

It must be noted that interviewees also approached the scenarios from different perspectives and these consequently framed their experiences. For example, some interviewees explicitly discussed the how scenarios integrate both quantitative and qualitative logics. For example, one interviewee said that scenarios are uniquely able to "marry art and science," combining qualitative and quantitative data, to allow for dialogue that is informed by science. In fact, several interviewees used the phrase "art and science" to describe the scenario process. But other interviewees had a clear preference for certain kinds of scenario processes over others or other, risk-based tools such as modeling over scenarios. This predisposition colored not just their own experience with scenario planning but also their perceptions of the benefits and challenges of scenario planning. This is important because these epistemological poles imply very different kinds of "world-making" (Vervoort et al. 2015). In our sample, most interviewees had experience with some variation of qualitative scenario processes and, as an important caveat, much of what follows reflects that experience.

Benefits of Scenario Use

Interviewees described the benefits of scenarios in a number of ways. Many noted that climate skepticism in particular was assuaged by the scenario planning process. One FS employee explained:

> Even if someone came into the room with doubts about climate change, we could say 'but it's possible that this might happen.' People could shake their head and say, 'yeah, you're right, it's possible.' If it's possible, let's create this scenario and talk about what might happen.

Another interviewee stated that by describing scenarios as "only possibilities … not predictions of the future" facilitators created a "non-threatening environment."

In addition, many interviewees focused on the ability of scenarios to address two key concerns about integrating climate change into planning: uncertainty and complexity. As one interviewee described: "I think it's just a good way to deal with uncertainty, in a way that's intuitive." Another FS employee stated, "it was just revealing to us, even just as a working group of experts, not necessarily on the ground practitioners, that there was real value in considering those multiple scenarios." An external expert explained that when they brought this process to managers, scenarios provided an opportunity to move beyond the perceived impasse posed by future uncertainty. They stated:

> That was, I think, a really important step because going into the meeting there certainly were some individuals … who were inclined to say, 'Well you can't even predict whether precipitation is going to go up or down,' so sort of like 'we don't know anything, well what's the point of even trying to think about this issue.'

Another interviewee explained this benefit by comparing the relative ability of adaptive management to deal with uncertainty versus scenario planning: "adaptive management works when you actually control the outcome but if you're not in control then you need to flip over to scenario planning."

Several interviewees noted that scenarios are able to address uncertainty because they more clearly make the underlying assumptions explicit. Contrasting scenario methods to vulnerability assessments, one interviewee noted: "the vulnerability assessment implies … conditions that are forcing you to think about vulnerability … what I could see scenarios doing is making those assumptions explicit before you jump into vulnerability." In other words, scenarios could, in their mind, precede vulnerability assessments by exploring and making explicit the underlying conditions of vulnerability. Further, another interviewee highlighted the way scenario methods use a wider array of data and information to make these assumptions explicit, saying "It doesn't try to boil things down to numbers that oftentimes … take on a validity that masks the underlying assumptions and they don't always remember what the assumptions were." Another interviewee made a similar argument but from a different perspective stating: "no one is good at modeling or understanding the effect of structural changes." For them, as an economist, the base assumptions that lie behind vulnerability assessments could be an entry point for scenarios given the high degree of uncertainty about future economic, political, or social change. Moreover, they found scenarios were useful because they allow one to identify those changes that were the most "meaningful" in a particular context or economic sector.

Other interviewees spoke to the ability of scenarios to simultaneously capture and reduce the complexity of real-world decision-making. Elaborating on this, an interviewee stated: "it's just more of a structure to it, to walk through defined scenarios and then ask specific questions around that particular scenario. Rather than trying to think through the full spectrum of projections all in one bucket." Scenarios, some noted, have

a recognizable "richness" and "solidness" that eludes other decision-making and planning processes. One interviewee referred to this as "painting a picture." In many cases, the scenarios that these interviewees described included detailed narratives outlining the specific changes that might unfold in a particular place in the context of climate change. For example, how more frequent and prolonged droughts could influence wildland fire in ways that might prompt shifts from forests to shrublands, favor certain invasive species, and impact forage availability. The key feature is that scenarios explore these logic chains across multiple possible futures rather than one. Scenarios, one interviewee pointed out, "allow(ed) them to start to talk about some specifics and frame something clearer, [and] then ask how is the environment, and how is society, and how is the economic world going to potentially change in response. So that solidness of something to speak to is good." In other words, the open and integrated 'if-then' sequences that play out across a range of futures avoids the climate reductionism found in risk-based models.

Further, another interviewee conveyed that, combined with the variety of perspectives in a multi-stakeholder context, scenarios become richer and fuller descriptions of a 'world' through integration of multiple forms of knowledge. According to them, "when you create it together you might have the forester who has one perspective but then because you've brought all these different groups together to talk about it and co-create this narrative, this scenario, it becomes very rich." Another interviewee pointed out how this allowed the scenarios to consider a wider array of causes and effects, saying "the resource response leads to a whole cultural response. I think that actually just helps reinforce the value of scenarios, to be able to ask even further how it's influencing people." Making these kinds of social-ecological connections and linkages, "leads to some real realities for the planner." In other words, scenarios move beyond the reductionism of modeling discrete, decontextualized variables to more real world-like sets of connections and linkages.

Yet, even though scenarios can, in effect, narrow the range of possibility, interviewees also described the way that scenarios, by capturing complexity, promoted broad, "expansive thinking" that encouraged "exploratory," "outside the box" ways of considering and addressing impacts and future responses. One FS employee recalled a scenario planning workshop with tribal resource managers: "when we had these meetings we often heard 'Oh, I never talked to our health department (before)' … that was powerful." In other words, the scenario process allowed decision-makers and stakeholders to find new and surprising connections.

Moreover, scenario processes allowed for more creative ways of thinking about the future. One interviewee described this by saying: "You create a space where people can bring up what I might call outlandish or unusual ideas." Several interviewees noted the exploratory, brainstorming nature of scenario processes as a positive. One stated: "by the time we had spent something like an hour brainstorming how we would actually get through this idea that seemed laughable at the start seemed achievable." Ultimately, as another interviewee described, "there are individuals in each workshop that you can really tell the light bulb went off and they become quite enthused over this different way of thinking."

Lastly, the exploratory potential and richness of scenarios were also complemented by what one interviewee called "social learning." A number of responses spoke to the collaborative, communicative, and participatory benefits that scenario planning processes can provide. Interviewees highlighted the way scenarios function as an "icebreaker" and can take something like climate change and make it "less overwhelming." As one external expert, and former Bureau of Land Management employee, observed:

> … it provides a safe place for conversation and discussion especially in terms of recent events, the discussion of taking action in response to changes in climate or drought have been difficult for land managers. They have felt that it was not a safe topic to pursue. And scenario planning exercises give them the ability to look beyond the crisis to the future and ask questions.

In a similar vein, others noted how scenario processes allowed diverse participants to work across multiple forms of knowledge and to develop "a common understanding" and get "on the same page." For example, another interview described how they "saw groups of people who typically have a different view of the world seeing things similarly because it [climate change] was stripped of, for a moment anyway … of political or social context." Similarly, a different interviewee noted the "team-building potential" of scenario processes, while another elaborated saying "it's not the destination, it's the journey." In many ways, these are also benefits derived from multi-stakeholder collaboration, but because scenarios address multiple futures and directly recognize the world as uncertain, the trust-building and mutual learning is additionally powerful in those contexts because it recognizes that plurality from the outset.

Challenges To Scenario Use

Though interviewees experienced many benefits from scenario processes, they also discussed a number of challenges. Some FS interviewees argued that a major concern is that many employees simply "don't know what [scenarios] are." Conversely, one former FS manager described what they called a "paradox," in that scenario planning "can be very difficult to understand in the abstract, and yet very intuitive to understand when you're actually doing it" – but getting to that point can be a challenge. Echoing the comment about 'art and science' noted above, one interviewee stated, "I've heard people complain about scenario planning because it's too sort of qualitative and wishy washy or touchy feely or not quantitative enough." Many of the barriers became amplified by challenges associated with policy, institutional practice, and agency culture, including common bureaucratic challenges like time and money.

Many interviewees shared that resistance to scenario use within the agency was exacerbated by the perception that the 'Washington Office' (i.e., the agency's national headquarters in Washington, D.C.) had not embraced or encouraged their use. Principally, FS employees, in particular, found that there was an "absence of a scenario champion within the agency" and a "lack of clear policy about using scenario planning." Some of these concerns are connected with broader concerns about capacity. For example, as one of our interviewees noted, "in a comprehensive planning process like the one that's described by

our planning rule, climate change is one part of 15 things." They argued that adding scenario processes into this already complicated process would be overwhelming.

Interviewees also worried that decisions based on scenario processes might not hold up legally, often focusing on requirements stemming from the National Environmental Policy Act (NEPA). As one interviewee put it, managers "might not easily see scenarios as a way to fulfill their legal requirements." Further, as another interviewee said, while scenarios encourage expansive thinking about future possibilities, "NEPA isn't a place to be wild. So, the approach you should take might not include as many extremes … and I think NEPA really could get complex if you have multiple scenarios." An external expert, and former FS forest supervisor, similarly said:

> You go from four alternatives, and all the analysis with that, to four alternatives, four scenarios, now you're talking not eight, but sixteen sets. You know what I mean? [The planners are] going to run screaming from the room … it's understandably intimidating to analysts, and I don't think we have figured out whether or not that fear is as justified as they may think it is.

This highlights the challenge of integrating the "logics" of scenario processes that require confronting uncertainty and multiple futures with the "logics" of policies that require a more reductive, single future, and linear cause-and-effect thinking.

Interviewees also described other institutional challenges associated with using scenarios. One person indicated that time and capacity are limited in land management agencies and it can be difficult to demonstrate that scenario processes are going to yield relevant outcomes. This person explained, "that's really hard to track and quantify and verify" with scenarios. Partly, this is due to the ways in which scenarios are used and processes are designed. Scenarios, for instance, can be used to support planning by generating social learning or fostering collaborative cohesion, both of which are difficult to assess. They can also be used in ways that proliferate possibilities and uncertainties that defy calculability. Consequently, establishing a direct linkage between scenario processes and decision-making was seen as a substantial challenge by many interviewees. The complexity and uncertainty of the scenario process itself meant that learning something new, especially something that might challenge core assumptions about how to integrate climate change into decisions, was sometimes met with resistance. As an FS R&D employee put it,

> The single biggest impediment, that [workshop interviewees] tell us, to integrating climate in anything they do, is just time. It's something different. It's something new. It's very complex … Scenario planning often is a learning experience. It exposes vulnerabilities within an organization. It helps people explore the ways that they might approach things and how they might begin building processes and perspectives and information that will help them approach things in certain ways. Most of the people we deal with, they're not interested in that. They're like, "Okay, I don't have time for that. I need to actually plan. I need to plan, I'm working on this document right now, and I want to incorporate climate into it, but that's not about scenario planning, that's about actual planning.

In other words, in the context of uncertainty about future climate impacts and significant time constraints, investing in a process that might complicate decision-making was not necessarily seen as desirable. As another interviewee said, "staff focus necessarily on things they have to do, versus things that would be nice to do." In this sense, planning itself, and its associated products (i.e. the 'plan'), was seen as the prime goal, not necessarily planning for better outcomes or more robust planning pathways. These

comments about barriers also highlight how built-in assumptions have streamlined planning pathways in ways that likely mask core uncertainties.

This is further complicated by the institutional and legal frameworks within which decision-making takes place. For example, NEPA processes use science to reveal probable outcomes from a specific proposed management action; conversely, scenario processes reveal core uncertainties about future conditions, complicating the possible range of management outcomes and leading, it is feared, to potential legal challenges. This ability of scenario processes to open up planning to multiple, possible future pathways and the concomitant uncertainties, was seen by many as a major hurdle. A district-level FS employee interviewee wrestled with this, noting:

> I think folks are coming to terms with the fact that you can't just use the mean. You really have to think about the range, perhaps more so than the mean … [but] it's hard to think about two different futures. You'd really rather focus on one, the one that is most likely.

Further, scenario proponents suggested that it would take time to shift "agency culture," saying that "helping managers understand how to think forward while retaining what we do understand, based on historic conditions. We're in a new era and that shift is not going to be overnight." Because of these hurdles, some interviewees found that other processes for integrating climate change into planning, such as vulnerability assessments, permit a more "plug and play" approach that does not pose a threat to existing decision-making or planning processes.

Moving Scenarios Forward

In addition to outlining the benefits and challenges of using scenarios in planning, interviewees also discussed possible ways to integrate them into planning practice. As one FS manager pointed out, "Our historical organizational structures aren't serving us well at this point, with massive uncertainty, and the integrated nature of all of these changes that are happening, socially, as well as ecologically." Some interviewees suggested integrating scenarios into management through what we call *mainstreaming*, i.e. the endorsement and adoption of scenario-based planning by leadership within the agencies. For instance, interviewees pointed out that scenarios would likely have a higher degree of useability if they were "championed" or mandated from the national-level.

However, many interviewees recommended targeted, slimmed-down, and/or "packaged" scenario processes or what we call *streamlining*. For example, one scenario proponent expressed "the need to come up with ways to use these techniques that are more rapid and streamlined and practical." They went on to convey that many people they worked with find the scenario process "very insightful and revealing but it does take some time and you kind of have to get all the way through the process until you get some of those 'ah-ha' moments." Important to streamlining to specific contexts would include finding synergies with other on-going or required practices. As one district-level FS line officer suggested, if scenario processes were to be used, they would have to be built into some process in which the agency is already engaged, rather than be an outside process not linked to any clear planning activities. They suggested that, in the context of limited capacity, new tools must make a clear contribution to existing

processes, though they thought larger forests with more capacity might be more open to developing and testing experimental processes.

For example, according to an interviewee, a process like scenario planning might be helpful to do in preparation for a NEPA process. In another example, two FS interviewees emphasized the potential for scenario thinking to inform future monitoring as part of an "adaptive management process." This would offer a way to manage and reduce uncertainty over time and determine, interviewees said, which scenarios were more or less likely to play out. However, they also acknowledged that with limited dollars for monitoring and assessment this was unlikely and even potentially "intimidating."

Another key question about streamlining concerned scope and scale. To start, some felt that the flexibility of scenario processes could be leveraged to tailor scenario processes to specific problems and contexts. One interviewee argued that "there's scenario planning and then there's scenario planning. You can do it with almost no budget or you could spend millions of dollars. I think it's a really flexible method." Another interviewee, for instance, recognized that flexibility as a potentially fruitful way to span the spectrum between those predisposed to either quantitative planning platforms and those open to qualitative, narrative-driven processes, noting that "different kinds of information speak to different people in different ways." They also argued that it would still be important "to marry the more quantitative with the more qualitative scenario developments and descriptions". However, we also noted some hesitancy in some interviews about streamlining. One interviewee wondered "to what extent we have a good feel for whether we can streamline and speed up the process and whether that helps or not and then also what we would potentially be compromising or losing by going through the process in a more rapid way."

In terms of scale, a number of Forest Service interviewees saw National Forest-level or Regional level planning as the most appropriate for scenario processes because of the capacity for longer-term strategic thinking and engagement with multiple stakeholders, both of which take time and investment. At the forest level, some suggested that scenario thinking would be useful for planning long-term projects, like landscape or species restoration projects. Others felt that scenario processes could lend themselves to even smaller scale project-level planning. But many interviewees had seen limited examples of scenario processes put into practice to inform planning at this scale. Complementing this discussion, two interviewees separately recognized that since scenario processes are so highly varied it would be useful to have a tool that helps planners identify when scenario processes might be appropriate and what types of processes might work best for specific contexts.

Discussion and Conclusion

This research aimed to explore public land manager perceptions of scenario processes and to shed some light on how those perceptions might affect the broad uptake of scenario processes in planning and decision-making. As our findings demonstrate, interviewees described many benefits generated by scenario processes, particularly how they address problems of uncertainty and complexity (see Table 1 for a brief summary). Scenarios, some found, minimize climate skepticism or, at a minimum, decenter it in

Table 2. Summary of findings from interview data.

Benefits	1.	Embraces uncertainty and complexity
	2.	Intuitive, conditional 'if-then' logic
	3.	Assumptions are explicit
	4.	Avoids reductionism
	5.	Open to wider set of stakeholders
	6.	Creative, 'outside-the-box' thinking
	7.	Social learning and team-building
Challenges	1.	Seen as not 'scientific' enough
	2.	Too much uncertainty and complexity
	3.	Lack of institutional support
	4.	Legal anxieties about 'defensibility'
	5.	Lack of funding, personnel, expertise, or time
	6.	Overcomplicates decisions (not reductive enough)
	7.	Absence of clear outcomes

the planning process. Some also found that scenarios capture uncertainty, complexity, and the potential for surprise. As noted above, in some cases these characteristics of scenario processes allowed decision-makers to address problems that previously appeared too challenging. Finally, unlike many other planning processes, scenarios provide exploratory, creative tools for the social learning that is fundamental to effective adaptation, particularly in collaborative, multi-stakeholder settings where uncertainties and complexities are likely to be amplified given the plurality of perspectives (Table 2).

Nevertheless, many interviewees also identified concerns about the utility of scenarios, drawing on the unique attributes of planning in the context of climate change as well more general bureaucratic concerns common to federal agencies. Concerns about staffing, time, and financing, each widely reported in the literature on barriers to climate adaptation, also challenge planning more broadly and are not necessarily unique to scenario-based methodologies (even though some scenario processes may incur a higher degree of costs in this regard). Certainly, adding planning activities to an already packed calendar with limited personnel and a constrained budget is a major concern.

Broader bureaucratic concerns can become critical in the context of hurdles related specifically to climate change. As Dilling and Lemos (2011) assert "climate science usability is a function both of the context of potential use and the process of scientific knowledge production." However, scenario processes, and other futuring methods, further complicate this dynamic because they are designed to address uncertainty in scientific knowledge itself. Consequently, epistemological debates about what counts as science (or knowledge more broadly) shape the usability of scenario processes, which differ from traditional, probabilistic modes of forecasting (Bengston 2019).

In public land management this manifests primarily in an epistemological preference for quantitative data. It was clear that some interviewees were uncomfortable with, if not resistant to, decentering quantitative, probabilistic modeling as a privileged form of knowledge in planning and decision-making, even in the face of profound uncertainty and complexity. Some interviewees indicated that this discomfort emerges from their understanding of their legal responsibility and authority. This intellectual and dispositional dependency on probabilistic modeling could present a substantial hurdle to scenario use. Scenarios, because they envision multiple futures and draw on plural forms of knowledge, particularly in the qualitative, possibilistic narrative design mold, function more as a means of 'sense making' in the context of uncertainty, where knowledge

about the future is imperfect but the process itself builds increased confidence about how one might act. Addressing this quantitative bias is critical to realize the potential of scenario processes and the apparent success of the mixed use of quantitative modeling and qualitative scenario processes may offer a pathway forward.

Yet, overcoming this epistemological hurdle also requires going beyond the intellectual training and disposition of *individual* managers. What counts as actionable knowledge is, following Dilling and Lemos (2011), primarily shaped and amplified by an institutional and legal context that privileges certain kinds of knowledge and forms of decision-making. The contemporary institutional culture of public land management agencies in the US is built around an administrative and instrumental rationality that privileges traditional forms of science as the evidentiary lodestar for decision-making. Perceptions of the scientific thresholds in the legal requirements of NEPA, for example, may complicate the use of scenarios. Future-based methods like scenarios require planning for multiple futures without perfect knowledge about the efficacy of future management actions. This is in many ways contrary to the controlling logic of contemporary public land management planning which presumes a single future (ie 'future desired conditions') where proposed actions must be forecasted by sufficient scientific evidence of risks and robust models of linear cause-and-effect. Other tools like vulnerability assessments minimize these disruptions to the values embedded in NEPA logics, like "historic conditions," because these tools assume that climate change will impact particular species and ecosystems in more reductive, linear, and discrete ways.

In this context, interviewees offered two strategies for increasing the useability of scenarios: (1) streamlining and (2) mainstreaming. Firstly, a number of interviewees felt that streamlining and tailoring the design of scenario processes to a specific decision-context offered the highest value for moving forward, especially given that the agencies have limited time and money. In this context, scenario processes, like other climate change adaptation platforms such as vulnerability assessments, could better adhere to a 'plug-and-play' approach where products and outcomes of the process can be leveraged into already existing planning and decision-making processes. However, this could be problematic as the highest value in scenarios is not necessarily in producing discrete data points or reductive models of cause-and-effect, but rather in prompting participants to consider multiple futures as a means to produce robust decision-making under uncertainty and to promote social learning in highly complex social, political, and economic conditions. And yet, streamlining and tailoring for specific scales, such as forests or regions, might enable experimentation and ultimately increase use. Decisions about the appropriate scale for scenarios could be informed by the scale at which a climate-driven 'surprise' might be important or the scale at which social learning is most needed. In short, leveraging the unique benefits of scenario processes and matching those with activities where those benefits are most needed is key. This targeted approach might also help alleviate many concerns about limited agency capacity.

Beyond streamlining, even greater potential could be achieved through mainstreaming. Mainstreaming refers to the central integration of a practice in management activities either through endorsement from higher levels of authority or from repeated use.

We argue that given the challenges detailed above, mainstreaming through endorsement might expand the institutional space for managers to experiment with scenarios. However, the institutional, legal, and organizational structures that affect the feasibility of streamlining are also important to consider in mainstreaming. As Laatsch and Ma (2015, 2016) note, there may be discrepancies, for instance, in the potential for implementing certain management strategies and practices depending on an individual's situatedness within an organization; for example, such as between unit-level staff and national-level staff. In contexts where managers have a wider institutional berth to experiment with novel planning tools, there might be greater acceptance and a greater likelihood that scenarios become mainstream even without endorsement. However, this potential might be constrained by even larger organizational missions and mandates. Future research should examine how these factors impact differences in the uptake and use of adaptation planning tools like scenarios. Overall, in contexts that are more constrained, mainstreaming through endorsement or requirement might be necessary to overcome these barriers.

In conjunction with recommendations for streamlining and mainstreaming, interviewees also felt that education about scenarios and their uses would benefit many in public land management. In addition to trainings, developing reference materials such as general technical reports or 'how-to-guide' that can prescribe the array of problems and decision contexts that are best suited to scenario use and that are specific to particular agencies might help public land managers determine when scenarios would be beneficial. Additionally, hiring staff specialized in designing tailored scenario processes or other futuring methods might facilitate more widespread use. For example, the National Park Service Climate Change Response Program has created tools and guidance as well as built capacity to support park-specific scenario planning processes. This may be an effective step for other agencies like the USDA Forest Service.

Overall, even though streamlining's 'plug-and-play' approach may attenuate many of the benefits of scenarios and 'mainstreaming' requires substantial investment and coordination across organizational scales, future research and application should focus on ways to package these tools to achieve better 'institutional fit' in practice. In particular, research should encourage more reflexive studies of the use of scenarios in order better identify on-the-ground challenges and ways to overcome them. Even though these challenges may initially appear considerable, scenario process offer an array of unique and targeted benefits that should not be dismissed in our climate changed world.

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