Strategies for Incorporating Climate Change into Public Forest Management

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By analyzing interview and survey data from 1,640 US Department of Agriculture (USDA) Forest Service employees across three management levels, we assessed their perceptions, actions, concerns, and needs regarding incorporating climate change into managing the National Forests. We found that regional- and forest-level employees tend to think climate change presents new challenges and requires new approaches to address it, whereas on-the-ground managers tend to view it as a buzzword and want more flexibility to continue doing what they do. We found that forest managers have been engaged in conversation and thinking about climate change but few on-the-ground actions. Our study suggests a need for incorporating local staff knowledge into agency decisionmaking, establishing common ground within the agency by promoting climate change initiatives in the context of enhancing forest resilience, providing more scale-relevant data, research, training, and guidance, and developing strategies that enable forest managers to address management challenges that interact with climate change.

Keywords: adaptation, global warming, forest policy, decisionmaking, public land management, USDA Forest Service, United States

Previous researchers have examined climate change impacts on forest composition, disturbance regimes, and forest resilience (e.g., Bentz et al. 2010, Marlon et al. 2012, Fettig et al. 2013, Rogers et al. 2013, Bollenbacher et al. 2014). Within the context of managing the National Forests in the United States, the US Department of Agriculture (USDA) Forest Service’s Washington Office has developed three major policy documents to address climate change: “Strategic Framework for Responding to Climate Change,” “National Roadmap for Responding to Climate Change,” and “Performance Scorecard for Implementing the Forest Service Climate Change Strategy” (see Sidebar 1 for details). All three key policy documents acknowledge the challenges and barriers the USDA Forest Service faces and recognize, in particular, that climate change response is not about adding on an entirely new climate change program, but rather about building climate change considerations and activities into our existing programs. (USDA Forest Service 2011, p. 24)

With respect to implementation, the Forest Service requires all National Forest and Grassland Units to report their accomplishments and plans for improvement using a performance scorecard that contains 10 questions regarding climate change-related organizational capacity, engagement activities, and mitigation and adaptation efforts. The Forest Service expects that 100% of National Forest and Grassland Units should be able to answer “yes” to at least 7 of the 10 questions in the performance scorecard by 2015 (USDA Forest Service 2011). The baseline assessment conducted in 2011 showed that 16% of all units were able to answer “yes” to 7 questions (Cleaves 2011). The percentage increased to 40% in 2012 and to 49% in 2013 (Cleaves 2013). More effort is needed to help half of the National Forest and Grassland Units improve their ability to implement Forest Service climate change policies and to effectively manage the National Forests and Grasslands under climate change.

A few studies have suggested that federal natural resource agencies, including the Forest Service are generally struggling with implementing their own climate change adaptation policies and plans (e.g., Jantarasami et al. 2010, Berrang-Ford et al. 2011, Archie et al. 2012, Ellenwood et al. 2012). A number of barriers that hinder general adaptation implementation and specific adaptation strategies (e.g., assisted species migration) have been identified from the agency perspective, including a lack of climate infor-
ation at relevant scales, uncertainties about future climatic conditions, lack of operating procedures, budget constraints, and multiple or conflicting values within an agency and the society (Koontz and Bodine 2008, Archie et al. 2012, Ellenwood et al. 2012, Bierbaum et al. 2013, Williams and Dumroese 2013). More research is needed to examine these barriers from the perspective of on-the-ground forest managers, because they are responsible for addressing climate change in their management practices on a day-to-day basis, and to identify the tools and resources that will enable forest managers to better adapt to the changing climate. Moreover, a recent survey of forestry professionals shows that perceptions on climate change correlate with willingness to undertake some forestry adaptation and mitigation practices (Lenart and Jones 2014).

Building on the existing literature, our research uses the Forest Service as a case study to examine how federal natural resource agency practitioners view climate change and its interaction with other forest management challenges, how they address climate change in their current work, and how they perceive barriers to and opportunities for adapting to climate change. Our study also compares agency employees’ perspectives across the hierarchical agency structure (i.e., Ranger District, National Forest, and National Forest System Region). By studying employees at different levels within the Forest Service, our study provides generalizable insights into the internal struggles of large, hierarchical natural resource agencies with respect to addressing management and conservation challenges associated with climate change.

### Methods

Our study area is the Intermountain West Region of the United States, comprising Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. In terms of the National Forest System Regions, our study area includes parts of Regions 1, 2, 3, and 4 (Figure 1). After obtaining relevant institutional review board approval, we collected qualitative interview and quantitative survey data. We first conducted 12 semistructured, key-informant interviews in 2013 to gain a basic understanding of Forest Service employees’ views on forest management in the face of climate change. Our interviewees included three Forest Service employees from district offices, two from National Forest Supervisor’s offices, four from regional offices, and three from the Washington Office and the Rocky Mountain Research Station. They were identified by searching Forest Service websites and talking to other forestry researchers working in the region. Each interview was conducted via telephone or in person, and was audio-recorded with the permission of the interviewee. Building on the key-informant interview data, we developed a survey instrument and administered it via online software Qualtrics following the tailored design method (Dillman et al. 2008). The survey addressed the following topics (see Supplement 1 online for details): (1) forest management challenges facing forest managers within the national forest system, (2) perceptions of climate change and how it interacts with forest management, (3) climate change-related policies and guidance, (4) perceived barriers to and opportunities for integrating climate change considerations into the management of national forests, and (5) communication of climate change information within the agency. We intended the survey to be a census of all eligible Forest Service employees in the Intermountain West Region instead of a sampling-based survey. We identified eligible Forest Service employees as anyone who has

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**Sidebar 1. Key Policy Documents adopted by the USDA Forest Service Washington Office in Response to Climate Change.**

The Strategic Framework for Responding to Climate Change sets seven general goals to address climate change, including advancing science, enhancing adaptive capacity, promoting mitigation, integrating policies, promoting sustainable operations, enhancing education, and establishing alliances (Dillard et al. 2008).

The National Roadmap for Responding to Climate Change was developed to guide the Forest Service in achieving these goals, centered on three types of actions: assessing risks, vulnerabilities, policies, and gaps in knowledge; engaging partners and educating public and employees; and managing for resilience through adaptation, mitigation, and sustainable consumption strategies (Tkacz et al. 2011).

The Performance Scorecard for Implementing the Forest Service Climate Change Strategy was developed to maintain accountability and to measure progress toward the goals and objectives set forth. Starting in 2011, each National Forest and Grassland unit is required to report annually their accomplishments and plans for improvement using a 10-question Performance Scorecard that covers four dimensions: organizational capacity, engagement, adaptation, and mitigation (USDA Forest Service 2011).

**Natural resource agency staff at different management levels may conceptualize and approach climate change differently. Understanding how they perceive and address climate change in their work is important for informing future policy development and implementation and climate change-related communication within the agency. Instead of emphasizing how climate change presents new conditions and issues unlike the past, effort is needed to help on-the-ground managers understand how climate change relates to the management challenges concerning them and how they could account for climate change when addressing those challenges. Using widely supported concepts (e.g., forest resilience and ecosystem management) to frame and communicate climate change-related initiatives can help agency staff at different management levels create a shared vision. On-the-ground managers value scale-relevant climate data and applied, site-specific research. In-house scientists could potentially address this need if provided with sufficient incentives and directions. Natural resource agencies will also benefit from using advanced information technologies (e.g., webinars and videoconferences) to help managers obtain new knowledge, exchange information, and learn from and be empowered by their peers. Finally, innovative strategies may be needed to give on-the-ground managers more leeway to use their discretion and more flexibility to carry out large-scale management projects within the context of climate change.**

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**Supplementary data are available with this article at http://dx.doi.org/10.5849/jof.14-128.**
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using the "Employee Search" feature on the
est. We gathered the names and job titles of all
ties/Maintenance Engineer, and HR Special-
Specialist, Policy/Litigation/Appeals/National
Sensing Specialist, Rangeland Special-
ty Specialist, Archeologist, GIS/Remote
Soils, Botany, Geology, Ecology), Air Qual-
ity Specialist, Archeologist, GIS/Remote
Sensing Specialist, Rangeland Specialist/
Manager, Education/Public Outreach
Specialist, Policy/Litigation/Appeals/National
Environmental Policy Act of 1969 (NEPA)
Specialist, Staff Scientist (e.g., Biology, Entomology,
soil quality), Air Quality Specialist, Archeologist, GIS/Remote
Sensing Specialist, Rangeland Specialist/Manager, Education/Public Outreach
Specialist, Policy/Litigation/Appeals/National
Environmental Policy Act of 1969 (NEPA)
Specialist, Environmental Engineer, and So-
cial Scientist. Examples of job titles that did
not meet our criterion included IT Specialist, Purchasing Agent, Special Agent/LEO, Facili-
ties/Maintenance Engineer, and HR Specialist.
We gathered the names and job titles of all
eagle Forest Service employees from the For-
est Service telephone directories and further
confirmed and searched for e-mail addresses
using the "Employee Search" feature on the
Forest Service website. We were not able to
obtain a telephone directory for the Bridger-
Teton National Forest and therefore did not
survey their employees. We sent out a total of
3,475 individual e-mail invitations and re-
ceived 1,623 usable responses, representing a
response rate of 47%. We used Stata 12.0 for
survey data analysis. We tested nonresponse
bias by comparing characteristics of the first
and second half of the survey respondents, as
well as by comparing those who began the sur-
vey within the first week of the invitation with
those who began during the last week before the
Internet survey was closed. No statistically
significant difference was observed with re-
spect to respondents’ perceptions of climate
change, length of employment by the Forest
Service, education background, and GS level
or which National Forest System Region or
management level they were affiliated with.
We also tested nonresponse bias by comparing
the characteristics of respondents and nonre-
spondents with respect to the categorization
of their job titles and the National Forest System
Region they were affiliated with, and no statis-
tically significant difference was observed.

Results

Profile of Survey Respondents

Of the 1,623 survey respondents, 7% were
affiliated with a regional office, 29% with a
National Forest Supervisor’s office, and
64% with a district office, reflecting the
overall composition of the Forest Service
National Forest System workforce. Respon-
dents were evenly distributed across four Na-
tional Forest System Regions (i.e., 28% from
the Northern Region, 22% from the Rocky
Mountain Region, 26% from the Southwestern
Region, and 24% from the Intermountain
Region). More than 85% of respondents had a
graduate or bachelor’s degree. The length of
respondents’ employment by the Forest Ser-
vice ranged from 1 year to 45 years with an
average of 19 years. We also asked respondents
to report their GS level, which is the predom-
inant pay scale within the US Federal Civil
Service. Higher GS levels generally indicate
higher income and more senior positions
within a federal agency. The majority of re-
dpondents (85%) fell between GS-7 and GS-
12, with 4% at GS-6 or below and 11% at
GS-13 or above. In terms of respondents’ tech-
nical background and expertise, 9% of re-
dpondents could be categorized as staff scientists,
76% as resource specialists, managers, and
技术人员, and 14% as administrators, direc-
tors, planners, public outreach specialists, or
policy specialists.

Perceptions of Climate Change and
Forest Resilience

Seventy-eight percent of respondents
considered climate change a moderate or sig-
nificant concern facing forest managers
within the National Forest System today,
and 61% thought climate change moder-
ately or significantly affects the work they
do personally. A majority of respondents (63%)
considered climate change “a new challenge
for the Forest Service, presenting new con-
ditions and issues unlike the past;” whereas
37% thought that “climate change is not a
new challenge, but mostly a new phrase or
buzzword.” In addition to the general per-
ceptions of climate change, we asked respon-
dents to identify the various forest manage-
ment challenges they face in their work from
a list of 12 items and to rate the extent to
which they think these challenges are related
to or influenced by climate change using a
4-point scale. A wide range of challenges
were selected by more than half of the
respondents, including invasive species (96%),
insect infestations (e.g., bark beetle) (96%),
soil erosion (95%), issues in wild-
land-urban interface areas (e.g., develop-
ment pressure, fire management challenges,
and recreation pressure) (94%), policy con-
straints (e.g., NEPA requirements) (93%)
changes in wildfire regimes (90%), changes
in species composition (e.g., as-
pen die back) (87%), changing weather
(e.g., increased extreme weather condi-
tions, decreased snowpack, more arid condi-
tions) (86%), stakeholder conflicts (86%)
water quantity/quality issues (84%), wildlife
habitats (83%) and lack of a good timber
market (78%). Among these identified chal-
lenges, three, in particular, were considered
strongly related to climate change. Specifi-
cally, 77% of respondents considered
changes in wildfire regimes, 70% considered

Figure 1. Study area: Intermountain West of the Continental United States, which includes
Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, but does
not include Kansas, Nebraska, North Dakota, and South Dakota.
thought that climate change scales, nearly three-quarters of respondents consider climate change considerations, and 65% considered changes in species composition to be moderately or significantly related to or influenced by climate change.

We asked respondents to indicate the extent to which “managing the National Forests to address climate change” should be prioritized by forest managers in their management activities and planning efforts” using a 4-point scale. Sixty-four percent considered it being minimally prioritized, whereas 36% considered it being moderately or highly prioritized. When asked about “in an ideal world” the extent to which “managing the National Forests to address climate change” should be prioritized by forest managers, nearly three-quarters of respondents thought that climate change should be considered a moderate or high priority. In addition, we asked respondents to think about the nature of the relationship between “managing the National Forests to enhance forest resilience” and “managing the National Forests to address climate change.” An overwhelming 95% of respondents believed that forest resilience should be moderately or highly prioritized by forest managers. And more than 60% of respondents believed that although “managing the National Forests to address climate change” and “managing the National Forests to enhance forest resilience” are not exactly the same, there is a strong relationship between the two and one cannot enhance forest resilience without addressing climate change and vice versa.

**Current Efforts, Constraints, and Opportunities for Addressing Climate Change**

We asked respondents about the activities they have engaged in with respect to dealing with and/or planning for climate change in the work they do. Among the eight items provided in the survey, 80% of respondents indicated that they have taken part in conversations about climate change, whether formal or informal. About three-quarters of respondents have thought about climate change while managing the National Forests and National Forest System (Figure 3). Among the 14 items describing opportunities within the Forest Service, eight were identified as being moderately or very helpful by more than three-quarters of respondents, including (1) having relevant climate data for a specific National Forest or Ranger District (85%), (2) more applied, site-specific research based on managers’ needs (85%), (3) the ability to do more, larger-scale management, such as thinning and prescribed burns (84%), (4) increased budget/funding (83%), (5) more research/information regarding climate change (80%), (6) more training/education about dealing with climate change and relevant management options (79%), (7) more personnel (79%), and, (8) more specific directions for on-the-ground actions/management (76%). Interestingly, no item was considered particularly unhelpful.

**Comparing Perspectives across Various Management Levels**

We observed several statistically significant differences in respondents’ perceptions of climate change, their current efforts to address climate change and perceived barriers and opportunities across three levels of agency hierarchy (i.e., Ranger District, National Forest, and National Forest System Region). Specifically, regional-level respondents were more likely to consider climate...
change a moderate or significant concern for forest managers within the National Forest System than did respondents at the forest or district levels ($\chi^2 = 23.84, P = 0.001$). Regional- and forest-level employees were more likely to consider climate change as a new challenge facing the Forest Service rather than a buzzword than were respondents at the district level ($\chi^2 = 23.56, P < 0.001$). Regional- and forest-level respondents were also more likely to think that climate change moderately or significantly affects the work they do personally ($\chi^2 = 22.20, P = 0.001$).

In terms of the general approach to addressing climate change, regional-level respondents were more likely to believe that Forest Service employees need to change the way they think about and do their jobs and that a new approach is needed for managing the National Forests to enhance forest resilience (from left to right: from the highest to lowest percentage of respondents who perceived an item as moderately or very helpful).

Some adjustments may be needed to better incorporate climate change into their management and planning considerations.

Another interesting finding relates to how respondents viewed managing for climate change versus managing for forest resilience at different management levels. Respondents associated with higher-level management were more likely to believe that the National Forests should be a priority for forest managers ($\chi^2 = 14.47, P = 0.025$), whereas respondents across the agency hierarchy (i.e., Ranger District, National Forest, and National Forest System Region) uniformly recognized the need for managing the National Forests to enhance forest resilience ($\chi^2 = 6.05, P = 0.417$).

In terms of barriers to addressing climate change, we observed statistically significant differences among respondents at different management levels with respect to 3 of the 13 items listed in our survey (Table 1). Specifically, the higher management levels respondents are associated with, the less likely they would consider the following as moderate or significant constraints: lack of mandatory requirements to address climate change ($\chi^2 = 16.04, P = 0.014$), policy requirements/litigation ($\chi^2 = 47.25, P < 0.001$), and uncertainty of future political conditions ($\chi^2 = 15.10, P = 0.020$).
Table 1. Comparison of USDA Forest Service employees’ perceptions of climate change, their current efforts to address climate change, and perceived barriers and opportunities across three levels of agency management.

<table>
<thead>
<tr>
<th>Perception of climate change</th>
<th>Regional Office</th>
<th>National Forest</th>
<th>Ranger District</th>
<th>$\chi^2$ statistic ($P$ value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change is a moderate or significant concern facing forest managers within the National Forest System.</td>
<td>89</td>
<td>82</td>
<td>76</td>
<td>23.84 (0.001)</td>
</tr>
<tr>
<td>Climate change moderately or significantly affects the work I do within the National Forest System.</td>
<td>68</td>
<td>67</td>
<td>58</td>
<td>22.20 (0.001)</td>
</tr>
<tr>
<td>Climate change is a challenge, presenting new conditions and issues unlike the past, rather than just a new phrase or buzzword.</td>
<td>74</td>
<td>71</td>
<td>59</td>
<td>23.56 (&lt;0.001)</td>
</tr>
<tr>
<td>We need to change the way we think about and do our jobs. We need a new approach in the way we manage the National Forests to really address climate change-related issues.</td>
<td>34</td>
<td>28</td>
<td>21</td>
<td>13.21 (0.001)</td>
</tr>
<tr>
<td>We do not need to change the way we think about or do our jobs. We just need the ability to continue to do what we are already doing and/or planning to do on the ground.</td>
<td>10</td>
<td>11</td>
<td>17</td>
<td>8.72 (0.013)</td>
</tr>
<tr>
<td>Managing the National Forests to address climate change should be moderately or highly prioritized by forest managers in their management activities and planning efforts.</td>
<td>82</td>
<td>77</td>
<td>69</td>
<td>14.47 (0.025)</td>
</tr>
<tr>
<td>Managing the National Forests to enhance forest resilience should be moderately or highly prioritized by forest managers in their management activities and planning efforts.</td>
<td>97</td>
<td>96</td>
<td>95</td>
<td>6.05 (0.417)</td>
</tr>
<tr>
<td>Constraint to respondents’ ability to address climate change in the work they do</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of mandatory requirements to address climate change is a moderate or significant constraint.</td>
<td>38</td>
<td>53</td>
<td>57</td>
<td>16.04 (0.014)</td>
</tr>
<tr>
<td>Policy requirements/litigation (e.g., NEPA) is a moderate or significant constraint.</td>
<td>48</td>
<td>53</td>
<td>68</td>
<td>47.25 (&lt;0.001)</td>
</tr>
<tr>
<td>Uncertainty of future political conditions (e.g., potential changes in legislation) is a moderate or significant constraint.</td>
<td>44</td>
<td>56</td>
<td>59</td>
<td>15.10 (0.020)</td>
</tr>
<tr>
<td>Opportunity that enables forest managers to better address climate change when managing the National Forests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More specific directions for on-the-ground actions/management would be moderately or very helpful.</td>
<td>69</td>
<td>75</td>
<td>77</td>
<td>12.76 (0.047)</td>
</tr>
<tr>
<td>More efficient NEPA and related requirements would be moderately or very helpful.</td>
<td>64</td>
<td>71</td>
<td>73</td>
<td>16.56 (0.011)</td>
</tr>
<tr>
<td>Ability to do more, larger-scale management (e.g., thinning, prescribed burns) would be moderately or very helpful.</td>
<td>77</td>
<td>83</td>
<td>85</td>
<td>15.31 (0.018)</td>
</tr>
<tr>
<td>More leeway for managers to use their own discretion would be moderately or very helpful.</td>
<td>58</td>
<td>65</td>
<td>75</td>
<td>36.38 (&lt;0.001)</td>
</tr>
</tbody>
</table>

and presents new conditions and issues unlike the past, more efforts may be needed to document how climate change interacts with the aforementioned forest management challenges and to identify strategies that can help forest managers better account for climate change when addressing those challenges that concern them. Another opportunity resides within forest managers’ shared vision and recognized need for enhancing forest resilience in their management activities and planning efforts. As pointed out by the previously discussed literature and by our survey respondents, one cannot enhance forest resilience without addressing climate change and vice versa. Thus, the Forest Service may want to explore ways to discuss climate change-related management and planning initiatives within the framework of forest resilience to garner support from and motivate forest managers who simply view climate change as a buzzword. An additional framework that can be adapted to discuss climate change efforts is ecosystem management. Even though the usage of the term has been reduced in the broader environmental discourse within the Forest Service, the term is still commonly used and well-recognized by forest managers (Predmore et al. 2008, Topik and Lewis 2014). Many components of the ecosystem management framework, such as larger-scale decisionmaking, understanding the interconnectedness of systems, and integrating social, economic, and ecological information into decisionmaking, are in fact particularly relevant for managing the National Forests in the face of climate change (Butler and Koontz 2005, Predmore et al. 2008).

Our study shows that current efforts for addressing climate change within the National Forest System have involved primarily engaging in conversations and thinking about climate change. Relatively little has been done on the ground with respect to adapting current management actions or making changes to the forest management plan of each National Forest and even less has been done to implement projects specially designed to address climate change. Thus, the question becomes what can be done to bring the idea of climate change from a conceptual level to a practical level within the Forest Service. If one focuses on the identified constraints to forest managers’ ability to address climate change, one may get discouraged quickly. Excessive workload, insufficient funding, and the lack of personnel, as suggested by our respondents and previous research (e.g., Archie et al. 2012), are all issues inherent to the current political and economic environments and are beyond the control of the Forest Service or any individual natural resource agency in the United States. However, as shown by our survey results, opportunities also exist for improving forest managers’ willingness and ability to address climate change. For example, the majority of Forest Service employees (71% of respondents) work for the Forest Service because they are motivated by knowing that they are working to sustainably manage and conserve the environment and natural resources. Previous research has also documented that knowing one’s work is important to the agency mission is critical to the morale of Forest Service specialists (Stern et al. 2010, Stern and Predmore 2011). Thus, future communication with forest managers should focus on helping them understand that what they do on the ground to address climate change matters to the sustainability of National Forests. In addition, the majority of Forest Service employees (76% of respondents) think that more specific, on-the-ground directions...
would moderately or significantly help forest managers address climate change-related challenges. Effort has been made recently to synthesize previously discussed strategies and approaches for forest management adaptations within the context of climate change. A list of 10 strategies and 39 more specific approaches were summarized in Janowiak et al. (2014) and can be potentially adapted at the regional or forest level to help translate broad climate change adaptation goals into implementable practices at the local level.

Our study also suggests there are a number of opportunities for supporting forest managers that may not require substantial financial investment from the agency. For example, many forest managers voiced their need for more scale-relevant climate data (e.g., National Forest) and more applied, site-specific research, which could be potentially addressed by Forest Service Research Stations across the country if appropriate incentives and directions can be provided to in-house research scientists. Moreover, many forest managers identified the need for more training about relevant management options for dealing with climate change and more specific directions for on-the-ground actions. Although few resources may be available under today’s economic environment to support employees to travel to workshops or visit demonstration sites and projects, opportunities may exist in advanced information technologies, such as webinars and videoconferences. Deliberate efforts are needed to take advantage of these information technologies and to establish platforms where forest managers can obtain new knowledge, exchange information, “see” and learn from each other’s successes and mistakes, and feel connected, supported, and empowered within a network of peers (and supervisors) within the National Forest System. These efforts may also help motivate forest managers, which is particularly important, given that some Forest Service practitioners feel that their supervisor does not care enough about climate change for them to feel motivated to do something about it, as shown by our study results. In addition to facilitating peer exchange, effective leadership can also help boost the morale of forest managers. Previous work has documented that effective leadership that is visionary, entrepreneurial, and collaborative, regardless of style, is an important predictor of effective and efficient NEPA decisionmaking process within the Forest Service (Stern and Predmore 2012) and of the adaptive capacity of an institution in general (Gupta et al. 2010).

Furthermore, our study results suggest two perception gaps between higher-level and lower-level Forest Service practitioners. The first perception gap relates to how they conceptualized and approached climate change. Those at the regional and forest levels seemed to be more concerned about climate change and more likely to conceptualize it as a new challenge than did their counterparts at the district level. Consequently, these higher-level practitioners were more likely to feel a need for forest managers to rethink their job and approach it differently. This perception was not shared by district-level practitioners, who were more likely to want to be able to continue what they do and/or plan to do. The second perception gap relates to how different levels of Forest Service practitioners viewed barriers to and opportunities for addressing climate change. Forest managers on the ground seemed to be more concerned about uncertainties related to the current policy environment and future political conditions than did their higher-level fellow employees. Consequently, they were more likely to believe that opportunities for addressing climate change exist in their own jurisdiction; thus, they wanted more leeway to use their own discretion as they were once able to and more flexibility to carry out large-scale management projects. Recognizing these gaps is a step in the right direction, but more needs to be done to develop innovative strategies and structures to bridge these gaps if the Forest Service wants to enhance its ability to address climate change. Specifically, efforts are needed to facilitate effective communication across the agency hierarchy and to find middle ground where upper-level decisionmakers and local forest managers can share their vision and work together to incorporate climate change into the management of National Forests. As previously discussed, advanced information technologies may be helpful tools for on-the-ground managers to better understand the relationship between what they do or plan to do and climate change, but, more importantly, upper-level practitioners and administrators need to better understand how on-the-ground managers, who spend significant time out in the forests, see, feel, and deal with climate change. This understanding will contribute to the effective translation of current climate change rhetoric into actionable directions that are more relevant for on-the-ground managers.

Although modern-day environmental policies and the political environment may make it difficult to provide on-the-ground forest managers with more leeway to use their own discretion, there is room to develop policies and strategies to facilitate the development and implementation of larger-scale management projects within the context of climate change. For example, the Forest Landscape Restoration Act (FLRA) was passed in 2009 to fund implementation of collaboratively developed, landscape-scale restoration projects in the National Forest System. The FLRA established the Collaborative Forest Landscape Restoration Program, which has been suggested as having a positive impact on improving long-term project collaboration and experimentation with large-scale restoration (Schultz et al. 2014). A regional example is the Integrated Restoration and Protection Strategy (IRPS), a decision support tool developed, updated, and being used by the Forest Service Northern Region. As pointed out by Bollenbacher et al. (2014), planning and implementation of forest management actions were mostly focused on a particular National Forest or Ranger District before IRPS, but IRPS has enabled forest managers to assess current ecological conditions, assess future disturbances and risks, and identify and prioritize management actions on a subwatershed basis. Additional research is needed to better understand how such policies and programs came to be, how they have been implemented, and how effective they are at enhancing forest resilience over time in the face of climate change. Lessons learned will be important for informing the development of future policies and programs in other geographic regions or at other scales.

**Conclusion**

As natural resource agencies in the United States continue to face the challenge of climate change, understanding how their employees perceive and address climate change in their work becomes increasingly important for future agency management and policy development. Our research uses the Forest Service as a case study to examine how natural resource practitioners view and approach climate change, how they perceive barriers to and opportunities for adapting to climate change, and how their perspectives differ across the agency hierarchy. Our lessons learned not only contribute to Forest
Service’s continuous effort to adapt to climate change in the management of National Forests but also shed light on strategies that can be tailored by other natural resource agencies to address management challenges within the context of global environmental change.

**Literature Cited**


