

Chapter 1: Introduction

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The Northern Rockies Adaptation Partnership (NRAP) is a science-management partnership among the Forest Service, U.S. Department of Agriculture (USFS) regional offices and national forests (mostly in the Northern Region, and small portions of the Intermountain and Rocky Mountain Regions); USFS Pacific Northwest and Rocky Mountain Research Stations; Glacier, Yellowstone, and Grand Teton National Parks; Great Northern and Plains and Prairie Potholes Landscape Conservation Cooperatives; Department of the Interior North Central Climate Science Center; Greater Yellowstone Coordinating Committee; Oregon State University; and EcoAdapt.

Initiated in 2013, the NRAP is a collaborative project with the goals of increasing climate change awareness, assessing vulnerability, and developing science-based adaptation strategies to reduce adverse effects of climate change and ease the transition to new climate states and conditions (see <http://adaptationpartners.org/nrap>). Developed in response to proactive climate change strategies of the USFS (USDA FS 2008, 2010b,c), and building on previous efforts in national forests (Halofsky et al. 2011; Littell et al. 2012; Raymond et al. 2013, 2014; Rice et al. 2012; Swanston and Janowiak 2012; Swanston et al. 2011), the partnership brings together resource managers and research scientists to plan for climate change in the Northern Rockies.

Climate Change Response in the Forest Service and National Park Service

Climate change is an agency-wide priority for the USFS, which has issued direction to administrative units for responding to climate change (USDA FS 2008) (table 1.1). In 2010, the USFS provided specific direction to the National Forest System in the form of the National Roadmap for Responding to Climate Change (USDA FS 2010c) and the Performance Scorecard for Implementing the Forest Service Climate Change Strategy (USDA FS 2010c). The goal of the USFS climate change strategy is to “ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources” (USDA FS 2010c). To achieve this goal, starting in 2011, each national forest and national grassland began using a 10-point scorecard system to report accomplishments on 10 elements in 4 dimensions: (1) increasing organizational capacity; (2) partnerships, engagement, and education; (3) adaptation; and (4) mitigation and sustainable

consumption. Progress toward accomplishing elements of the scorecard must be reported annually by each national forest and grassland; all units are expected to accomplish 7 of 10 criteria by 2015, with at least one “yes” in each dimension.

Similarly, the National Park Service (NPS) Climate Change Response Strategy provides direction for addressing the effects of climate change on NPS lands (NPS 2010) (table 1.2). The strategy has four components to guide NPS actions: science, adaptation, mitigation, and communication. The science component involves conducting and synthesizing research at various scales, monitoring trends and conditions, and delivering information to resource managers and partners. It also provides the scientific basis for adaptation, mitigation, and communication. Adaptation involves developing capacity within the agency to assess climate change scenarios and risks and implementing actions to better manage natural and cultural resources as well as infrastructure for a changing climate. Mitigation efforts focus on reducing the agency’s carbon footprint and enhancing carbon sequestration. Finally, the strategy requires the NPS to take advantage of agency capacity for education and interpretation to communicate the effects of climate change to NPS employees and to the public. Park rangers and other employees are encouraged to engage visitors about climate change, because national parks are visible examples of how climate change can affect natural and cultural resources. The similarity of USFS and NPS climate response strategies facilitated coordination between the two agencies.

The NRAP is built on existing efforts in ecosystem-based management and ecological restoration to address climate change and put these efforts in a broader regional context in the Northern Rockies. Restoration is a priority in most national forests in this region, particularly related to hazardous fuels reduction in dry forests (stand density reduction plus surface fuel removal, often with prescribed burning), and restoration of riparian areas to improve hydrologic and biological function. The NRAP works in conjunction with these management priorities to access the best available science on climate change effects and implement climate change adaptation plans.

In 2010, a climate change report was developed for the Kootenai and Idaho Panhandle National Forests planning effort (USDA FS 2010a). At the time, this was the most comprehensive climate change vulnerability assessment and adaptation document compiled for the Northern Region. Although this report addressed many issues, it did not include nonforest vegetation, cultural resources, recreation resources, or ecosystem services. The Northern Region

Table 1.1—U.S. Forest Service policies related to climate change.

Policy	Description
Forest Service Strategic Framework for Responding to Climate Change (USDA FS 2008)	Developed in 2008, the <i>Strategic Framework</i> is based on seven strategic goals in three broad categories: foundational, structural, and action. The seven goals are science, education, policy, alliances, adaptation, mitigation, and sustainable operations. Like the challenges themselves, the goals are interconnected; actions that achieve one goal tend to help meet other goals. The key is to coordinate approaches to each goal as complementary parts of a coherent response to climate change. All seven goals are ultimately designed to achieve the same end (the USFS mission): to ensure that Americans continue to benefit from ecosystem services from national forests and grasslands.
USDA 2010–2015 Strategic Plan (USDA FS 2010d)	In June 2010, the U.S. Department of Agriculture released the <i>Strategic Plan</i> that guides its agencies toward achieving several goals including Strategic Goal 2—Ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources. This goal has several objectives. Objective 2.2 is to lead efforts to mitigate and adapt to climate change. The performance measures under this objective seek to reduce greenhouse gas emissions by the U.S. agricultural sector, increase the amount of carbon sequestered on U.S. lands, and bring all national forests into compliance with a climate change adaptation and mitigation strategy. The USFS response to this goal includes the <i>National Roadmap for Responding to Climate Change and Performance Scorecard</i> .
National Roadmap for Responding to Climate Change (USDA FS 2010c)	Developed in 2011, the <i>Roadmap</i> integrates land management, outreach, and sustainable operations accounting. It focuses on three kinds of activities: assessing current risks, vulnerabilities, policies, and gaps in knowledge; engaging partners in seeking solutions and learning from as well as educating the public and employees on climate change issues; and managing for resilience in ecosystems and human communities through adaptation, mitigation, and sustainable consumption strategies.
Climate Change Performance Scorecard (USDA FS 2010a)	To implement the <i>Roadmap</i> , starting in 2011, each national forest and grassland began using a 10-point scorecard to report accomplishments and plans for improvement on 10 questions in four dimensions: organizational capacity, engagement, adaptation, and mitigation. By 2015, each was expected to answer “yes” to at least seven of the scorecard questions, with at least one “yes” in each dimension. The goal was to create a balanced approach to climate change that includes managing forests and grasslands to adapt to changing conditions, mitigating climate change, building partnerships across boundaries, and preparing employees to understand and apply emerging science.
2012 Planning Rule (USDA FS 2012)	The 2012 Planning Rule is based on a planning framework that will facilitate adaptation to changing conditions and improvement in management based on new information and monitoring. There are specific requirements for addressing climate change in each phase of the planning framework, including in the assessment and monitoring phases, and in developing, revising, or amending plans. The 2012 Planning Rule emphasizes restoring the function, structure, composition, and connectivity of ecosystems and watersheds to adapt to the effects of a changing climate and other ecosystem drivers and stressors, such as wildfire and insect outbreaks. A baseline assessment of carbon stocks required in assessment and monitoring will check for measureable changes in the plan area related to climate change and other stressors. Requirements of the Roadmap and Scorecard and requirements of the 2012 Planning Rule are mutually supportive and provide a framework for responding to changing conditions over time.

also funded the University of Washington, Climate Impacts Group to provide datasets of historical (1916–2006) and future (2040s, 2080s) downscaled climate and hydrologic data for the Upper Missouri River and Columbia River basins (Littell et al. 2011).

Building on these downscaled data, the Northern Region developed climate change “primers” to help assess and evaluate regionally specific climate-related trends. Primers for wildland fire, watershed ecology, forest regeneration, and forest landscapes were in progress when the NRAP was begun and have been incorporated into this publication. In addition to these primers, the Northern Region is currently

developing a watershed-based climate change vulnerability assessment using downscaled regional water and stream temperature data for the Lolo National Forest; the assessment focuses on bull trout (*Salvelinus confluentus*) and includes a preliminary discussion of the western pearlshell mussel (*Margaritifera falcata*), water supply, and forest infrastructure (USDA FS 2015).

The NRAP also incorporates existing Northern Region efforts to consider and address climate change effects in management operations. In 2011, the Northern Region developed an Integrated Restoration & Protection Strategy that provided a framework for climate change adaptation

Table 1.2—National Park Service policies related to climate change.

Policy	Description
National Park Service Climate Change Response Strategy (NPS 2010)	Developed in 2010, the <i>Climate Change Response Strategy</i> is designed to guide management actions and collaboration, from the national to park levels, to address the effects of climate change. The <i>Response Strategy</i> is based on four components: science, mitigation, adaptation, and communication. These components provide a framework for consistent, legal, and appropriate management decisions. The <i>Response Strategy</i> calls for a scientific approach to updating interpretations of previous policy and mandates in order to uphold the mission of the NPS in the face of new conditions created by climate change.
A Call to Action: Preparing for a Second Century of Stewardship and Engagement (NPS 2011)	A <i>Call to Action</i> outlines themes and goals for the second century of stewardship and engagement of the NPS. The plan provides actions for the achievement of each goal before the NPS centennial in 2016. Under the theme of preserving America's special places, the plan sets the goal for management of resources to increase resilience to climate change stressors. Specific actions include revised management objectives, increases in sustainability, and changes in investments.
Green Parks Plan (NPS 2012b)	The <i>Green Parks Plan</i> (GPP) outlines how the NPS will achieve the commitment set in <i>A Call to Action</i> , to "Go Green." An overarching vision and strategy for sustainable management in the future, the GPP is based on nine strategic goals that focus on the effects of park operations on the environment and human welfare. The goals are to continually improve environmental performance; be climate friendly and climate ready; be energy smart; be water wise; develop a green NPS transportation system, buy green and reduce, reuse, and recycle; preserve outdoor values; adopt best practices; and foster sustainability beyond NPS boundaries.
Revisiting Leopold: Resource Stewardship in the National Parks (NPS 2012c)	In August 2012, the NPS released <i>Revisiting Leopold</i> , intended as an updated interpretation of the guiding document <i>The Leopold Report</i> (Leopold et al. 1963). Members of the current NPS Science Committee were tasked with revisiting three questions: (1) What should be the goals of resource management in the national parks? (2) Which policies for resource management are necessary to achieve these goals? (3) Which actions are required to implement these policies? The interpretation presents general principles and guidance for the enlarged scope of all natural and cultural resources of the NPS. The committee stresses that the NPS needs to act quickly on structural changes and long-term investments in management in order to preserve resources through the uncertainties of environmental change.
Climate Change Action Plan 2012–2014 (NPS 2012a)	The 2012 <i>Climate Change Action Plan</i> builds on the 2010 <i>NPS Climate Change Response Strategy</i> to communicate how the NPS can respond to climate change at different geographic scales. The plan outlines parameters for introducing science, adaptation, mitigation, and communication actions to address climate change. The plan also identifies high-priority actions for addressing climate change in NPS operations, and describes how to anticipate and prepare for future changes.

(Bollenbacher et al. 2014; USDA FS 2011). In addition, periodic Northern Region restoration and resilience reports provide baseline information on vegetative characteristics to better understand the effects of adaptive management (USDA FS 2014).

Most previous efforts to consider climate change effects and adaptation strategies in the Northern Rockies have focused on vegetation and aquatic resources. The NRAP broadens these efforts to develop a synthesis for a more comprehensive list of resource values, and to develop adaptation strategies for resources that have not been emphasized in management operations.

Science-Management Partnerships

Previous efforts in the Pacific Northwest and beyond have demonstrated the success of science-management

partnerships for increasing climate change awareness among resource managers and adaptation planning on Federal lands. Olympic National Forest and Tahoe National Forest initiated the first science-management partnerships for developing adaptation options for individual national forests (Littell et al. 2012). The Olympic climate change study assessed resource vulnerabilities and developed adaptation options for Olympic National Forest and Olympic National Park on the Olympic Peninsula in Washington (Halofsky et al. 2011). Similar to efforts on the Olympic Peninsula, the North Cascadia Adaptation Partnership assessed vulnerabilities and formulated adaptation options for two national forests and two national parks in Washington (Raymond et al. 2014).

In collaboration with three management units in California—Tahoe National Forest, Inyo National Forest, and Devils Postpile National Monument—the USFS Pacific Southwest Research Station held climate change education workshops and developed the Climate Project Screening

Tool in order to incorporate adaptation into project planning (Morelli et al. 2012). In response to requests from Shoshone National Forest in northern Wyoming, the USFS Rocky Mountain Research Station synthesized information on past climate, future climate projections, and potential effects of climate change on the multiple ecosystems within the forest (Rice et al. 2012).

In the largest effort to date in the eastern United States, the USFS Northern Research Station, in collaboration with the Chequamegon-Nicolet National Forest in northern Wisconsin and numerous other partners, conducted a vulnerability assessment for natural resources (Swanston et al. 2011) and developed adaptation options (Swanston and Janowiak 2012). Another joint national forest and USFS research vulnerability assessment effort focused on the vulnerability of watersheds to climate change (Furniss et al. 2013). Watershed vulnerability assessments, conducted on 11 national forests throughout the United States, were locally focused (at a national forest scale) and included water resource values, hydrologic reaction to climate change, watershed condition, and landscape sensitivity. The assessments were intended to help national forest managers identify where limited resources could be best invested to increase watershed resilience to climate change.

The processes, products, and techniques used for several studies and other climate change efforts on national forests have been compiled in a guidebook for developing adaptation options for national forests (Peterson et al. 2011). The guidebook outlines four key steps to facilitate adaptation in national forests: (1) become aware of basic climate change science and integrate that understanding with knowledge of local conditions and issues (review), (2) evaluate sensitivity of natural resources to climate change (rank), (3) develop and implement options for adapting resources to climate change (resolve), and (4) monitor the effectiveness of on-the-ground management (observe) and adjust as needed. The NRAP is focused on implementation of the principles and practices in the guidebook.

The Northern Rockies Adaptation Partnership Process

The NRAP region includes 15 national forests, 7.8 million acres of wilderness, and 3 national parks across the USFS Northern Region and the adjacent Greater Yellowstone Area. The region covers 183 million acres (fig. 1.1), spanning northern Idaho, Montana, northwestern Wyoming, North Dakota, and northern South Dakota. To facilitate analyses and interpretations, the NRAP assessment is divided into the following five subregions:

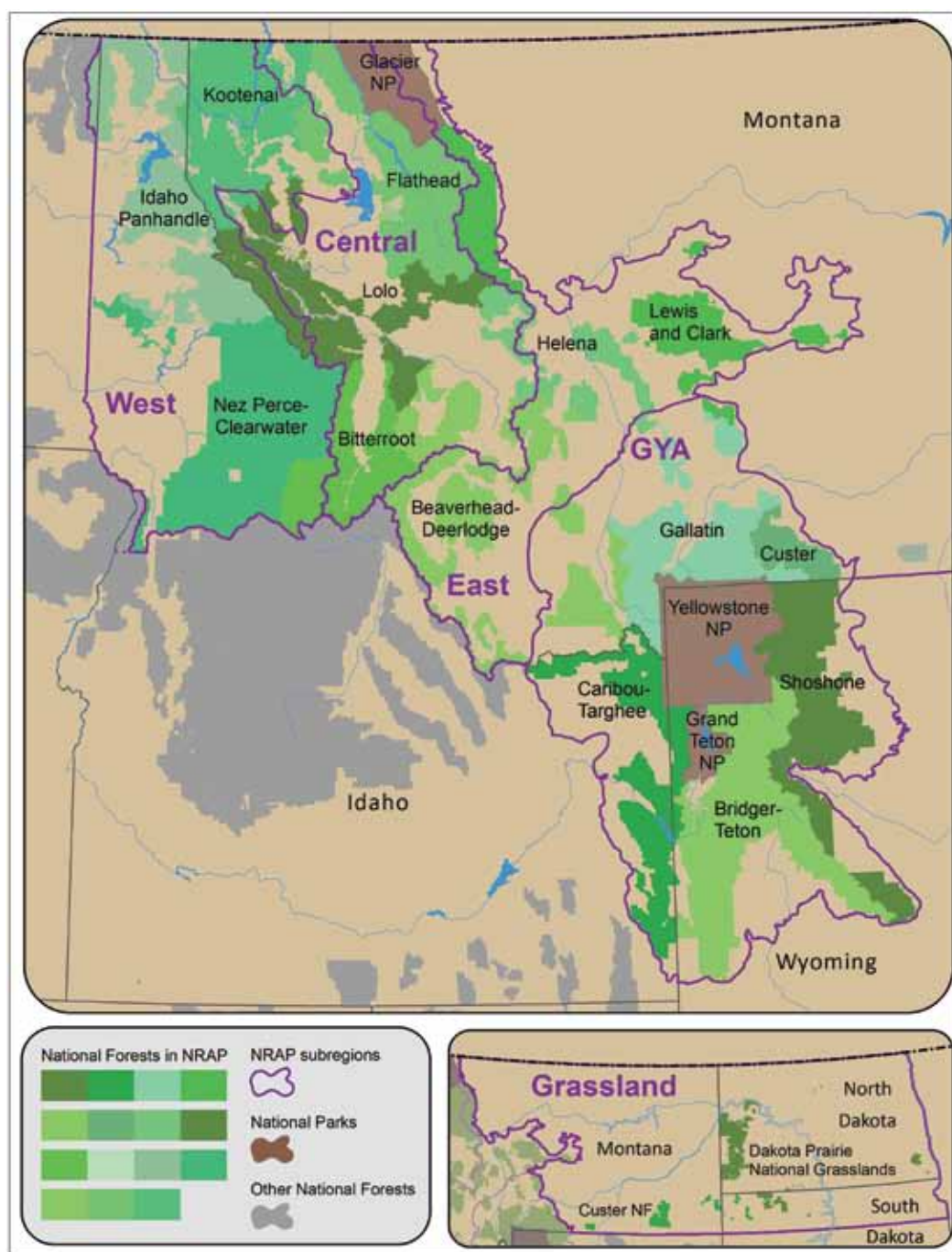
- **Western Rockies:** Idaho Panhandle National Forest, Kootenai National Forest, Nez Perce-Clearwater National Forest, Glacier National Park
- **Central Rockies:** Bitterroot National Forest, Flathead National Forest, Lolo National Forest
- **Eastern Rockies:** Beaverhead-Deerlodge National Forest (eastern portion), Custer National Forest (eastern portion), Gallatin National Forest (northern portion), Helena National Forest, Lewis and Clark National Forest
- **Greater Yellowstone Area:** Bridger-Teton National Forest, Caribou-Targhee National Forest, Shoshone National Forest, Gallatin National Forest (southern portion), Custer National Forest (western portion), Beaverhead-Deerlodge National Forest (western portion), Grand Teton National Park, Yellowstone National Park
- **Grassland:** Custer National Forest (part), Dakota Prairie National Grassland

The NRAP process includes: (1) a vulnerability assessment of the effects of climate change on hydrology and roads, fisheries, wildlife, forest and nonforest vegetation and disturbance, recreation, cultural resources, and ecosystem services; (2) development of adaptation options that will help reduce negative effects of climate change and assist the transition of biological systems and management to a warmer and otherwise changing climate; and (3) development of an enduring science-management partnership to facilitate ongoing dialogue and activities related to climate change in the Northern Rockies region. These resource sectors were selected based on their importance in the region and current management concerns and challenges.

Vulnerability assessments typically consider exposure, sensitivity, and adaptive capacity (Parry et al. 2007), where exposure is the degree to which the system is exposed to changes in climate, sensitivity is an inherent quality of the system that indicates the degree to which it could be affected by climate change, and adaptive capacity is the ability of a system to respond and adjust to the exogenous influence of climate. Vulnerability assessments can be both qualitative and quantitative and focus on whole systems or individual species or resources (Glick et al. 2011). Several tools and databases are available for systematically assessing sensitivity (e.g., Lawler and Case 2010; Luce et al. 2014) and vulnerability (e.g., Potter and Crane 2010) of species.

For the NRAP, we used scientific literature and expert knowledge to assess exposure, sensitivity, and adaptive capacity to identify key vulnerabilities for the identified resource areas. The assessment process took place over 16 months, and involved monthly phone meetings for each of the resource-specific assessment teams. Each assessment team refined key questions that the assessment needed to address, selected values to assess, and determined which climate change impact models best informed the assessment. In some cases, assessment teams conducted spatial analyses or ran and interpreted models, selected criteria with which to evaluate model outputs, and developed maps of model output and resource sensitivities. To the greatest extent possible, teams focused on effects and projections

Figure 1.1—Project area for the Northern Rockies Adaptation Partnership (NRAP) (map by Robert Norheim, University of Washington).



specific to the NRAP region and used the finest scale projections that are scientifically valid (Littell et al. 2011).

By working collaboratively with scientists and resource managers and focusing on a specific region, the goal of NRAP was to provide the scientific foundation for operationalizing climate change in planning, ecological restoration, and project management (Peterson et al. 2011; Raymond et al. 2013, 2014; Swanston and Janowiak 2012). After key vulnerabilities were identified for each resource sector, five workshops were convened in October and November 2014 in Bismarck, North Dakota; Bozeman, Montana; Coeur d'Alene, Idaho; Helena, Montana; and

Missoula, Montana, to present and discuss the vulnerability assessment, and to elicit adaptation options from resource managers (see Appendix 1A for workshop participants).

During these workshops, scientists and resource specialists presented information on climate change effects and current management practices for each of the resources. Facilitated dialogue was used to identify key sensitivities and adaptation options. Participants identified strategies (general approaches) and tactics (on-the-ground actions) for adapting resources and management practices to climate change, as well as opportunities and barriers

for incorporating these adaptation actions into projects, management plans, partnerships, and policies. Participants generally focused on adaptation options that can be implemented given our current scientific understanding of climate change effects, but they also identified research and monitoring that would benefit future efforts to assess vulnerability and guide management practices. Information from the regionwide assessment was also downscaled to identify the most significant vulnerabilities to climate change for priority resources in each subregion. Facilitators captured information generated during the workshops with a set of spreadsheets adapted from Swanston and Janowiak (2012). Initial results from the workshops were augmented with continued dialogue with Federal agency resource specialists.

This publication contains a chapter on expected climatic changes in the Northern Rockies, and one chapter for each of the resource sectors covered in the vulnerability assessment (water resources, fisheries, forested and rangeland vegetation and disturbance, wildlife, recreation, ecosystem services, and cultural heritage) (see Appendix 1B for author affiliations). Each of the resource chapters includes a review of climate change effects, sensitivities, current management practices, and results of the discussions on adaptation strategies and tactics.

Resource managers and other decisionmakers can use this publication in several ways. First, the vulnerability assessment will provide information on climate change effects needed for national forest and national park plans, project plans, conservation strategies, restoration, and analysis of environmental effects. Second, climate change sensitivities and adaptation options developed at the regional scale will provide the scientific foundation for subregional and national forest and national park vulnerability assessments, adaptation planning, and resource monitoring. We expect that over time, and as needs and funding align, appropriate adaptation options will be incorporated into plans and programs of Federal management units. Third, we anticipate that resource specialists will apply this assessment to implement climate-smart resource planning and management on lands throughout the region.

Adaptation planning is an ongoing and iterative process. Implementation may occur at critical times in the planning process, such as when managers revise USFS land management plans and other planning documents, or after the occurrence of extreme events and ecological disturbances (e.g., wildfire). We focus on adaptation options for the USFS and NPS, but this publication provides information that can be used by other land management agencies as well. Furthermore, the NRAP process can be emulated by national forests, national parks, and other organizations outside the Northern Rockies, thus propagating climate-smart management across larger landscapes (e.g., the Intermountain Adaptation Partnership in Utah, Nevada, and southern Idaho; <http://adaptationpartners.org/iap>).

All-Lands Approach to Climate Change Adaptation

The USFS and NPS climate change strategies identify the need to build partnerships and work across jurisdictional boundaries when planning for adaptation. This concept of responding to the challenge of climate change with an “all-lands” approach is frequently mentioned, but a process for doing so is rarely defined. Unique in its effort to implement an all-lands approach to adaptation for a specific region, NRAP is an inclusive partnership of multiple agencies and organizations with an interest in managing natural resources in a changing climate. In addition to representatives from the national forests, grasslands, and parks, several other agencies and organizations participated in the resource sector workshops (Appendix 1A). This type of partnership enables a coordinated and complementary approach to adaptation that crosses jurisdictional boundaries. The NRAP also provides a venue for agencies to learn from the practices of others so that the most effective adaptation strategies can be identified.

Risks and vulnerabilities resulting from climate change and gaps in scientific knowledge and policy need to be assessed. Adaptation is a prominent focus of the NRAP, with emphasis on creating resilience in human and natural systems. Communicating climate change information and engaging employees, partners, and the public in productive discussions are also integral parts of successfully responding to climate change. The need for partnerships and collaborations on climate change issues was also identified in the NRAP. Sharing climate change information, vulnerability assessments, and adaptation strategies across administrative boundaries will contribute to the success of climate change responses in the Northern Rockies.

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Appendix 1A—Northern Rockies Adaptation Partnership Workshop Participants

Bozeman, Montana, October 9–10, 2014

Vegetation

Cavan Fitzsimmons – Custer-Gallatin National Forest
 Andrew Hansen – Montana State University
 Bob Keane – USFS, Rocky Mountain Research Station
 Keith Konen – Gallatin National Forest
 Mary Mahalovich – USFS, Rocky Mountain Research Station
 Kelly McCloskey – Grand Teton National Park
 Jill McMurray – USFS, Region 1/Region 4, Air Quality
 Traute Parrie – Custer-Gallatin National Forest
 Ben Poulter – Montana State University
 Ann Rodman – Yellowstone National Park
 Julie Shea – Custer-Gallatin National Forest

Nonforest Vegetation

Diane Abendroth – Grand Teton National Park
 Walt Allen – Custer-Gallatin National Forest
 Jeff DiBenedetto – Custer National Forest
 Susan Lamont – Gallatin National Forest
 Rose Lehman – Caribou-Targhee National Forest
 Mary Manning – USFS, Region 1 Regional Office
 Matt Reeves – USFS, Rocky Mountain Research Station
 Jessi Salix – Beaverhead-Deerlodge National Forest
 Kevin Suzuki – Beaverhead-Deerlodge National Forest
 Denice Swanke – Little Bighorn Battlefield National Monument
 Travis Ziehl – Teton County

Wildlife

Polly Buotte – University of Idaho
 Jeff Burrell – Wildlife Conservation Society, Northern Rockies and Yellowstone Program
 Jodie Canfield – Gallatin National Forest
 Sue Consolo Murphy – Grand Teton National Park
 Mary Erickson – Custer-Gallatin National Forest
 Rachel Feigley – Custer-Gallatin National Forest
 Kristin Legg – Greater Yellowstone Network
 Kevin McKelvey – USFS, Rocky Mountain Research Station
 Rob Mickelson – Caribou-Targhee National Forest
 Amie Shovlain – Beaverhead-Deerlodge National Forest

Hydrology

Karri Cary – Shoshone National Forest
 Pam Fletcher – Beaverhead-Deerlodge National Forest
 Gretchen Hurley – BLM

Richard Raione – Bridger-Teton National Forest
 Andy Ray – NPS Inventory and Monitoring
 Alex Sienkiewicz – Custer-Gallatin National Forest
 Ed Snook – USFS, Region 1 Regional Office
 Mike Tercek – Yellowstone National Park
 Dave Thoma – NPS Inventory and Monitoring
 Eric Winthers – Bridger-Teton National Forest

Fisheries

Robert Al-Chokhachy – USGS, Northern Rocky Mountain Science Center
 Shawn Anderson – Shoshone National Forest
 Scott Barndt – Custer-Gallatin National Forest
 Yvette Converse – Great Northern Landscape Conservation Cooperative/NPS
 Molly Cross – Wildlife Conservation Society
 Dave Hallac – Yellowstone National Park
 Dan Isaak – USFS, Rocky Mountain Research Station
 Jessi Kershner – EcoAdapt
 Brad Shepard – Wildlife Conservation Society
 Lisa Stoeffler – Custer-Gallatin National Forest
 Gary Tabor – Center for Large Landscape Conservation
 Michael Young – USFS, Rocky Mountain Research Station

Recreation

Krista Gebert – USFS, Region 1 Regional Office
 Virginia Kelly – Greater Yellowstone Coordinating Committee
 Megan Lawson – Headwaters Economics
 Natalie Little – USFS, Region 4
 Jane Ruchman – Custer-Gallatin National Forest
 Trey Schillie – USFS, Region 2
 Jamie Schoen – Bridger-Teton National Forest
 Travis Warziniack – USFS, Rocky Mountain Research Station

Bismarck, North Dakota, October 15–16, 2014

Nonforest Vegetation

Adnan Akyuz – North Dakota State University
 Bernadette Braun – Dakota Prairie Grassland
 Chad Prosser – Dakota Prairie Grassland
 Karen Dunlap – Dakota Prairie Grassland
 Kurt Hansen – Custer National Forest – Sioux Ranger District
 Libby Knotts – Dakota Prairie Grassland
 Mary Manning – USFS, Region 1 Regional Office
 Meghan Dinkins – Dakota Prairie Grassland

Hydrology

Babete Anderson – Dakota Prairie Grassland
Scott Barndt – Custer-Gallatin National Forest
Andy Efta – Custer National Forest
Pam Fletcher – Beaverhead-Deerlodge National Forest
Steven Krentz – USFWS, Mountain Prairie Region
Rick Nelson – Plains and Prairie Pothole Landscape
Conservation Cooperative
Mike Philbin – BLM
Karen Ryberg – USGS, North Dakota Water Science Center
Alison Schlag – Dakota Prairie Grassland
Kevin Shelley – USFWS
Robert Swithers – Dakota Prairie Grassland
Meredith Webster – USFS, Region 1 Regional Office

Missoula, Montana, October 20–21, 2014

Vegetation

Jeremy Amberson – Bitterroot Restoration Committee
Barry Bollenbacher – USFS, Region 1 Regional Office
C. Alina Cansler – University of Washington
Rob Carlin – Flathead National Forest
Gregg DeNitto – USFS, Region 1 Regional Office
Linda Donner – Flathead National Forest
Bruce Erikson – Lolo National Forest
Shelagh Fox – USFS, Region 1 Regional Office
Sheryl Gunn – Lolo National Forest
Cheri Hartless – Bitterroot National Forest
Melissa Hayes – Montana Forest Restoration Committee
LaWen Hollingsworth – Fire Modeling Institute
Melissa Jenkins – Flathead National Forest
Bob Keane – USFS, Rocky Mountain Research Station
Elaine Kennedy Sutherland – USFS, Rocky Mountain
Research Station
Jerry Kruger – Bitterroot National Forest
Heidi Trechsel – Flathead National Forest

Nonforest Vegetation

Tara Carolin – Glacier National Park
Chantelle Delay – Flathead National Forest
Gil Gale – Bitterroot National Forest
Holger Jensen – USFS, Region 1 Regional Office
Mary Manning – USFS, Region 1 Regional Office
Matt Reeves – USFS, Rocky Mountain Research Station
Susan Rinehart – USFS, Region 1 Regional Office
Karen Stockmann – Lolo National Forest

Wildlife

Len Broberg – University of Montana
Polly Buotte – University of Idaho
Renate Bush – USFS, Region 1 Regional Office
Alan Dohmen – USFS, Region 1 Regional Office
Kari Eneas – Confederate Salish and Kootenai Tribes
Greg Gustina – Lolo National Forest

Whisper Means – Confederate Salish and Kootenai Tribes
Peter Nelson – Defenders of Wildlife
Kuennen Reed – Flathead National Forest
Tom Reed – Lee Metcalf National Wildlife Refuge
Melly Reuling – Center for Large Landscape Conservation

Hydrology

Chris Brick – Clark Fork Coalition
Nate Dieterich – Flathead National Forest
Craig Kendall – Flathead National Forest
Charlie Luce – USFS, Rocky Mountain Research Station
Caryn Miske – Flathead Basin Commission
Regan Nelson – Crown of the Continent Conservation
Initiative
Amber Richardson – Bitterroot National Forest
Ed Snook – USFS, Region 1 Regional Office

Fisheries

Aubree Benson – Lolo National Forest
Dan Brewer – USFWS
Anne Carlson – Wilderness Society
Robert Davies – Flathead National Forest
Bruce Farling – Trout Unlimited
Wade Fredenberg – Montana Ecological Services Suboffice
Dan Isaak – USFS, Rocky Mountain Research Station
Ryan Kovach – USGS
Clint Muhlfeld – USGS, Northern Rocky Mountain Science
Center
David Schmetterling – Montana Fish, Wildlife and Parks
Erin Sexton – University of Montana
Scott Spaulding – USFS, Region 1 Regional Office
Cameron Thomas – USFS, Region 1 Regional Office
Pat Van Eimeren – Flathead National Forest
Sims Wade – Idaho Panhandle National Forest
Michael Young – USFS, Rocky Mountain Research Station

Recreation

Carl Davis – USFS, Region 1 Regional Office
Krista Gebert – USFS, Region 1 Regional Office
Michael Hand – USFS, Rocky Mountain Research Station
Cynthia Manning – USFS, Region 1 Regional Office
Marsha Moore – Flathead National Forest
Rosa Nygaard – USFS, Region 1 Regional Office
Keith Stockmann – USFS, Region 1 Regional Office
Byron Stringham – Lolo National Forest
Jeff Ward – USFS, Region 1 Regional Office
Rusty Wilder – Lolo National Forest

Coeur d'Alene, Idaho, October 23–24, 2014

Vegetation

Pat Behrens – Idaho Panhandle National Forest
Bob Boeh – Idaho Forest Group
Barry Bollenbacher – USFS, Region 1 Regional Office

Malcolm Edwards – Kootenai National Forest
 Mike Giesey – Kootenai National Forest
 Kevin Greenleaf – Kootenai Tribe of Idaho
 Jessie Grossman – Yaak Valley Forest Council
 Jason Jerman – Idaho Panhandle National Forest
 Carol McKenzie – Idaho Panhandle National Forest
 Lee Pederson – USFS, Region 1 Regional Office
 Christopher Schnepf – University of Idaho Extension
 Megan Strom – Kootenai National Forest
 Art Zack – Idaho Panhandle National Forest
 Paul Zambino – USFS Region 1 Regional Office

Nonforest Vegetation

LeAnn Abell – BLM
 Derek Antonelli – Idaho Native Plant Society
 Jennifer Costich-Thompson – Idaho Panhandle National Forest
 Valerie Goodnow – Idaho Panhandle National Forest
 Mike Hays – Nez Perce-Clearwater National Forest
 Megan Lucas – Nez Perce-Clearwater National Forest
 Mary Manning – USFS, Region 1 Regional Office

Wildlife

Polly Buotte – University of Idaho
 Jason Flory – USFWS, Northern Idaho Field Office
 Lynn Johnson – Kootenai National Forest
 Kevin McKelvey – USFS, Rocky Mountain Research Station
 Rema Sadak – Nez Perce-Clearwater National Forest
 Leona Svancara – Idaho Department of Fish and Game
 JJ Teare – Idaho Department of Fish and Game
 Guy Wagner – Nez Perce-Clearwater National Forest

Hydrology

Shandra Dekome – Idaho Panhandle National Forest
 Cara Farr – Nez Perce-Clearwater National Forest
 Laura Jungst – Kootenai National Forest
 Ed Snook – USFS, Region 1 Regional Office

Fisheries

Jim Fredericks – Idaho Fish and Game
 Greg Hoffman – U.S. Army Corps of Engineers
 Dan Isaak – USFS, Rocky Mountain Research Station
 Dan Kenny – Nez Perce-Clearwater National Forest
 Jessi Kershner – EcoAdapt
 Katherine Thompson – Nez Perce-Clearwater National Forest
 Michael Young – USFS, Rocky Mountain Research Station
 William Young – Idaho Panhandle National Forest

Recreation

Pam Fletcher – Beaverhead-Deerlodge National Forest
 Krista Gebert – USFS, Region 1 Regional Office
 Morai Helfen – Idaho Panhandle National Forest

Diane Jones – Nez Perce-Clearwater National Forest
 Timory Peel – Kootenai National Forest
 Loretta Stevens – Kootenai National Forest/Confederated Salish and Kootenai Tribes

Helena, Montana, November 4–5, 2014

Vegetation

Elisa Stamm – Beaverhead-Deerlodge National Forest
 Rob Gump – Beaverhead-Deerlodge National Forest
 Amanda Milburn – Helena National Forest
 Tanya Murphy – Helena National Forest
 Alicia Torregrosa – USGS
 Andrea Woodward – USGS

Nonforest Vegetation

Beth Anderson – Lewis and Clark National Forest
 Steve Black – Bighole Battlefield
 Tammy Cherullo – Beaverhead-Deerlodge National Forest
 Amanda Hendrix – Helena-Lewis and Clark National Forest
 Casey Johnson – Lewis and Clark National Forest
 Mary Manning – USFS, Region 1 Regional Office
 Matt Reeves – USFS, Rocky Mountain Research Station
 Steve Shelly – USFS, Region 1 Regional Office
 Rowdy Wood – Helena-Lewis and Clark National Forest

Wildlife

Bray Beltron – Heart of the Rockies Initiative
 Polly Buotte – University of Idaho
 Gregg DeNitto – USFS, Region 1 Regional Office
 Justin Gude – Montana Fish, Wildlife and Parks
 Kevin McKelvey – USFS, Rocky Mountain Research Station
 Denise Pengeroth – Helena National Forest
 Ryan Quire – Helena National Forest
 Anne Roberts – Beaverhead-Deerlodge National Forest

Hydrology

David Callery – Helena-Lewis and Clark National Forest
 Larry Dolan – Montana Department of Natural Resources and Conservation
 Deb Entwistle – Helena National Forest
 Pam Fletcher – Beaverhead-Deerlodge National Forest
 Wayne Green – Lewis and Clark National Forest
 Sue Higgins – Roundtable on the Crown of the Continent
 Robert Ray – Montana Department of Environmental Quality
 Sara Rouse – Beaverhead-Deerlodge National Forest
 Ed Snook – USFS, Region 1 Regional Office
 Brian Sugden – Plum Creek

Fisheries

Jim Brammer – Beaverhead-Deerlodge National Forest
Anne Carlson – Wilderness Society
Kendall Cikanek – Lewis and Clark National Forest
Jessi Kershner – EcoAdapt
David Moser – Montana Fish, Wildlife and Parks
Lee Nelson – Montana Fish, Wildlife and Parks
Scott Spaulding – USFS, Region 1 Regional Office
Peru Suernam – Beaverhead-Deerlodge National Forest

Recreation

Patty Bates – Beaverhead-Deerlodge National Forest
Charlene Bucha – Beaverhead-Deerlodge National Forest
Elizabeth Casselli – Helena-Lewis and Clark National
Forest
Jocelyn Dodge – Beaverhead-Deerlodge National Forest
David Fothergill – Helena National Forest
Michael Hand – USFS, Rocky Mountain Research Station
Mike Munoz – Lewis and Clark National Forest
Lis Novack – USFS, Region 1 Regional Office

Acronyms

BLM: Bureau of Land Management
NPS: National Park Service
USFS: U.S. Forest Service
USFWS: U.S. Fish and Wildlife Service
USGS: U.S. Geological Survey

Organizations Represented in the Northern Rockies Adaptation Partnership

- Bitterroot Restoration Committee
- Bureau of Land Management
- Center for Large Landscape Conservation
- Clark Fork Coalition
- Climate Impacts Research Consortium
- Confederated Salish and Kootenai Tribes
- Crown of the Continent Conservation Initiative
- Defenders of Wildlife
- Department of the Interior, North Central Climate Science Center
- EcoAdapt
- Fire Modeling Institute
- Flathead Basin Commission
- Great Northern Landscape Conservation Cooperative
- Greater Yellowstone Coordinating Committee
- Headwaters Economics
- Heart of the Rockies Initiative
- Idaho Fish and Game
- Idaho Forest Group
- Idaho Native Plant Society
- Kootenai Tribe of Idaho
- Lee Metcalf National Wildlife Refuge
- Montana Department of Environmental Quality
- Montana Department of Natural Resources and Conservation
- Montana Fish, Wildlife and Parks
- Montana State University
- National Park Service
- North Dakota State University
- Oregon State University
- Plains and Prairie Pothole Landscape Conservation Cooperative
- Plum Creek
- Roundtable on the Crown of the Continent
- Trout Unlimited
- University of Idaho
- University of Montana
- University of Washington
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- Walking Shadow Ecology
- Wilderness Society
- Wildlife Conservation Society
- Yaak Valley Forest Council

Appendix 1B—Author Affiliations

Chapter 1

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Chapter 2

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Chapter 6

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Mary Frances Mahalovich is the Regional Geneticist with the U.S. Department of Agriculture, Forest Service, Northern, Rocky Mountain, Southwestern, and Intermountain Regions, Forestry Sciences Laboratory in Moscow, Idaho.

Barry L. Bollenbacher (retired), was the Regional Silviculturist with the U.S. Department of Agriculture, Forest Service, Northern Region in Missoula, Montana.

Mary E. Manning is the Regional Vegetation Ecologist with the U.S. Department of Agriculture, Forest Service, Northern Region in Missoula, Montana.

Rachel A. Loehman is a Research Landscape Ecologist, U.S. Geological Survey, Alaska Science Center in Anchorage, Alaska.

Terrie B. Jain is a Research Forester with the U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station in Moscow, Idaho.

Lisa M. Holsinger is an Ecologist with the U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory in Missoula, Montana.

Andrew J. Larson is an Associate Professor of Forest Ecology with the University of Montana, College of Forestry and Conservation, Department of Forest Management in Missoula, Montana.

Meredith M. Webster (retired), was the Regional Soil Scientist with the U.S. Department of Agriculture, Forest Service, Northern Region in Missoula, Montana.

Chapter 7

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Mary E. Manning is the Regional Vegetation Ecologist with the U.S. Department of Agriculture, Forest Service, Northern Region in Missoula, Montana.

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Kyle A. Palmquist is a Postdoctoral Research Associate with the University of Wyoming, Department of Botany in Laramie, Wyoming.

William K. Lauenroth is a Professor with the University of Wyoming, Department of Botany in Laramie, Wyoming.

John B. Bradford is a Research Ecologist with the U.S. Geological Survey, Southwest Biological Science Center in Flagstaff, Arizona.

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Chapter 8

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Mary E. Manning is the Regional Vegetation Ecologist with the U.S. Department of Agriculture, Forest Service, Northern Region in Missoula, Montana.

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Chapter 10

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Chapter 11

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S. Karen Dante-Wood is a Natural Resource Specialist, U.S. Department of Agriculture, Forest Service, Office of Sustainability and Climate in Washington, DC.

Chapter 12

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Chapter 13

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