RESEARCH REPORT

Climate-Friendly Park Employees: The Intermountain Region's climate change training assessment

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Abstract

The National Park Service Intermountain Region (IMR) partnered with the University of Arizona to assess climate change training needs for more than 5,000 IMR employees. We identified baseline climate knowledge characteristics: ability to discern between climate variability and trends, understanding of key phenomena (e.g., El Niño), correct identification of observed impacts, but little knowledge of climate projections for the region. Employees identified challenges for implementing a training program: adequate communication technology, adequate funding, clear guidance on actions and policy changes, and communicating with climate change skeptics. Employees recommended that training connect global changes to regional impacts and local solutions and demonstrate relevance to job duties. Interviewees preferred interactive, hands-on learning experiences, but agreed to use electronic media given budget constraints. They identified information overload as a problem, suggesting information be packaged in frequently asked questions, briefs, and videos. We recommend a modular program, leveraging existing, well-vetted information resources. We evaluated more than 150 Web sites and found online training for climate change literacy, but a lack of training on mitigation and adaptation. We present a training decision tree and sample curricula.

Key words: climate change literacy, communication, Intermountain Region

THE INTERMOUNTAIN REGION (IMR) OF THE NATIONAL Park System is one of the most diverse areas administered by the National Park Service (NPS), with more than 90 park units encompassing coastal, desert, mountain, and prairie ecosystems. Climate change and vanishing landscapes were among the top five IMR challenges enumerated in an internal report (NPS 2009). To prepare for these challenges, the Intermountain Region engaged University of Arizona scientists to assess needs for workshops and training to provide IMR employees with information they could use to manage resources, mitigate greenhouse gas emissions, and plan for adaptation to climate changes. University and NPS investigators refined the project scope and agreed upon the following goals: (1) assess the climate change knowledge of a sample of IMR employees; (2) determine the content, design, and communication media of potential training modules for employees; (3) develop a road map linking current and expected climate change information needs; and (4) determine how best to leverage existing climate change information resources and reconcile information from different sources.

Methods

To evaluate climate change literacy and training preferences, the team codeveloped a 21-question structured online survey, using Likert-scale, multiple preference, and open-ended questions, followed by an 18-question semistructured interview protocol. The interviews were conducted after analysis of the survey, and interview questions were informed by survey results and knowledge gaps. Out of 5,379 IMR employees who were invited to participate, 609 (12.6%) responded to the survey. The sample represented 31 workforce roles, defined by amalgamating 166 unique NPS occupational series. Some roles, such as facilities management, interpreters, and natural resources IMR personnel, were overrepresented, whereas responses from IMR administrative assistants, motor vehicle employees, park guides, and park rangers/law enforcement were underrepresented. Our survey analysis does not account for the effects of nonresponse bias; thus, caution should be applied when extrapolating the results to the entire population of IMR employees.[1] For the interviews (n = 15), NPS team members selected key informants across a spectrum of job roles to fill in gaps in the surveys and to provide input from senior management. Interview questions focused on aspects of a training program, including recommendations on how the Intermountain Region should fund climate change training, and major challenges faced by NPS with respect to climate change.

[1] The sample used in this study did not account for bias created by self-selection of survey respondents. To evaluate the representativeness of the sample, we compared the percentage of the full IMR workforce in each of the 31 workforce roles with the percentage of the sample in each of the 31 workforce roles. We found that 23 of the 31 workforce roles (74.2%) in our sample were within 3% of the full workforce, a reasonable representation of the workforce categories. For the following workforce roles, there were differences greater than 3% between the full workforce and our sample: administrative assistance/office support (4.6%), facilities management (–7.3%), interpreter (–12.5%), laborer (3.9%), motor vehicle/automotive (14.2%), natural resources (e.g., biologist, ecologist, geologist, meteorologist) (–3.7%), park guide (3.4%), park ranger/law enforcement (13.6%). (Negative numbers indicate that we oversampled in these workforce roles.) Caution should be applied when extrapolating the sample results to the entire population; results are least robust in representing workforce categories with large differences.

Table 1. Number and percentage of IMR survey respondents identifying climate change definitions

Definition/Answer Option	Adaptation	Exposure	Mitigation	Resilience	Vulnerability	Percentage Correct
An intervention to reduce the rate of emission or increase the rate of absorption of greenhouse gases	33	8	**535**	2	2	92
An adjustment in natural systems in response to a changing climate in order to moderate adverse impacts	**528**	8	27	15	1	91
Degree to which a system can rebound or recover from a disturbance or stimulus such as climate change	15	5	5	**546**	8	94
Degree to which a system is susceptible to and unable to cope with adverse effects of climate, including climate change, climate variability, and extremes	2	11	4	9	**554**	96
Degree, duration, or extent to which a system is in contact with a climatic disturbance	4	**553**	4	5	14	95

Notes: Correct responses are in boldface type. Sample size = 582.

Table 2. Number and percentage of IMR survey respondents identifying adaptation and mitigation examples

Example/Answer Option	Adaptation	Mitigation	I don't know	Percentage Correct
Replacement of an agency's fleet of conventional vehicles with gas-electric hybrids	113	**430**	10	78
Maintain healthy, vigorous trees and minimize severe disturbance by fire, insects, and disease in order to keep carbon stored in forests	**226**	304	18	56
Passage of cap-and-trade legislation to limit greenhouse gas emissions	62	**451**	34	82
Putting additional resources into preserving and protecting cultural landscapes from climate-related degradations	**239**	286	23	44
Changing home lawn-watering schedules to conserve water	**328**	215	8	60
Restoration of streamside vegetation to enhance groundwater infiltration and increase base flow	**210**	325	14	38
Promote connected landscapes to aid species in migration	**320**	203	27	58

Notes: Correct responses are in boldface type. Sample size = 553.

Survey and interview results

Climate literacy

Most respondents (83%) rated themselves as having fair or good knowledge of climate change. Poor or very poor climate literacy self-ratings suggest areas to which IMR should devote special attention; the majority of these came from administrative assistants, office staff, budget and accounting, contracting and purchasing, facilities management, human resources, park manager, park ranger, and law enforcement. Most respondents correctly identified climate change impacts observed in the Intermountain Region, but could not correctly identify projected changes for the region. More than 90% of respondents correctly identified definitions of key terms, such as "greenhouse effect" and "mitigation of and adaptation to climate change" (table 1); far fewer correctly matched seven examples of actions with the terms "mitigation" and "adaptation" (table 2).

Survey results also indicate the need for training on distinctions among climate variability, climate trends, and weather. For example, weather includes atmospheric phenomena and changes on timescales of minutes to days, such as thunderstorms, weather fronts, and tropical storms. Climate variability describes phenomena and changes on timescales of months to decades; examples of variability include seasonal drought caused by recurring phenomena, like La Niña, or multidecade wet or dry periods caused by long-term variations in ocean-atmosphere circulation, such as the Pacific Decadal Oscillation (Mantua and Hare 2002). Climate

Table 3. Climate change training job categories, rationales, and abbreviated curricula

Job Category	Training Rationale	Sample Curricula
Operations and administration	Inform mitigation behavior; prepare for casual public engagement	Basic climate literacy; NPS climate change policy and actions; workplace mitigation actions; procedures for addressing questions from the public
Interpretation and education	Primary public interface; support mitigation compliance efforts; train other employees	In-depth climate literacy; NPS climate change policy and actions; workplace mitigation actions; adaptation planning and actions; in-depth procedures for addressing questions from the public
Research scientists	Inform research practice and methods; inform development of science information for mitigation and adaptation decision making; lay groundwork for collaboration with other scientists; prepare for casual public engagement	Technical climate literacy; science to support mitigation planning; adaptation planning and actions; procedures for addressing public questions
Planners and engineers	Inform mitigation compliance and development of adaptation strategies; inform approaches for addressing uncertainty in decision making; prepare for casual public engagement	Technical climate literacy; mitigation planning and compliance regulations; in-depth adaptation planning and actions; frameworks for addressing uncertainty in decision making; procedures for addressing public questions
Managers	Depending on level of management: inform mitigation and adaptation strategy, policy, and program development; inform approaches for addressing uncertainty in decision making; prepare for public engagement; prepare for partnerships and collaboration	In-depth climate literacy; mitigation planning and compliance regulations; in-depth NPS climate change policy and actions; adaptation planning and actions; frameworks for addressing uncertainty in decision making; in-depth procedures for addressing public questions

trends would include phenomena such as regional or global temperature increases; when, for example, a sustained trend of increasing temperatures is overlaid on variability, the severity of multidecade droughts can increase through earlier melt of winter snowpack and increased evapotranspiration.

Training and information communication preferences

Given federal budget constraints, we examined employee training and communication preferences with respect to cost limitations. We found, in general, that employees prefer in-person training, if cost is not an issue. To maximize training effectiveness, interviewees recommended mixed-method training programs that involve hands-on learning components and interaction with fellow employees. Few employees advocated online training, unless cost limits choices. Only 7.4% of IMR employees felt their Internet access or connection speed would limit use of online training; given current resources, online training is an attractive option for initial development of a training program. These and other considerations suggest the need for a flexible program, with options that accommodate work schedule constraints, the remote locations of some employees, and technology limitations. Interviewees suggested that information overload is an issue; thus information must be tightly packaged (e.g., frequently asked questions, briefs, targeted presentations).

Survey and interview participants suggested well-sourced information that relates global to local phenomena in a manner that is relevant to job duties and individual parks. Participants urged the National Park Service to (1) provide information consistent with other federal agencies, (2) avoid duplicating training materials or classes that are already available outside the Intermountain Region or National Park Service, (3) connect with existing training and agency conferences, and (4) obtain funding for a climate change training program but not by diverting existing park budgets.

Challenges

Interviewees identified key challenges for an IMR climate change training program: inadequate information-dissemination technology and communication networks, lack of funding, need for clear guidance on actions and policy changes, developing clear and consistent messages, and communication with climate change skeptics. From 299 responses to the question "What information do you most urgently need to address climate change in your work?" we found employee disagreement on whether a climate change training program should be mandatory; resistance to a mandatory program creates an additional challenge.

Training and resources

We first assigned NPS jobs in broad categories as follows: operations and administration, interpretation and education, research scientists, planners and engineers, and managers. We then developed several tools for targeting climate change training with associated employee categories and their work-related needs. These include training rationales, core topics, and curricula that outline key concepts (tables 3, 4, 5); decision trees that associate topics

Table 4. Core topics and course descriptions for IMR climate change training

Topic and Course	Brief Course Description
Climate Literacy	
Climate Literacy 1	Climate change: linking global change to local impacts
Climate Literacy 2	In-depth evidence of change and projections of the future
Climate Literacy 3	Climate change science for scientists
Communication	
Communication 1	Procedures for addressing questions from park visitors
Communication 2	Procedures for addressing questions from policymakers, public officials, skeptics
Responses	
Adaptation 1	How can we adapt?
Adaptation 2	Adaptation strategies for implementation
Mitigation 1	What can I do (in my job)?
Mitigation 2	What can we do (NPS, region, society)?
Mitigation 3	Mitigation compliance and planning
Decisions	
Climate Change Decisions 1	Uncertainty and decision frameworks
Climate Change Decisions 2	Science to support decision making
Parks	
Parks 1	What's going on in my park?
Parks 2	What's going on in the National Park Service and in other parks?
Parks 3	In-depth information on policies, actions, and collaborations in my park and throughout the National Park Service

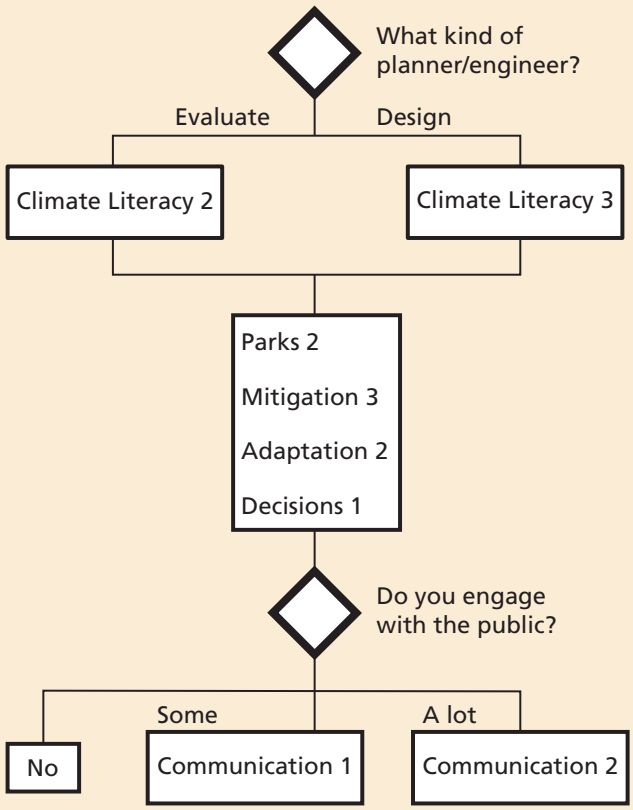

Figure 1. Sample climate change training decision tree for the planners and engineers job category.

with employee categories and suggest pathways for training (fig. 1) and criteria for vetting climate change training resources (table 6).

We recommend that all employees receive training in the core topics of basic climate literacy, NPS policies and actions in their park, and the essentials of mitigation actions that relate to their job duties. If employees interact with the public as part of their work, we recommend training in communicating climate change information.

Additional training recommendations reflect the needs of specific job categories. For example, park interpreters and educators serve as the primary NPS interface with the public and may provide climate change training to other employees. Thus we recommend that interpreters and educators receive training in more topics, including adaptation to climate change, and at a deeper level in order to effectively communicate climate change principles and answer questions from the public and fellow employees. In contrast, planners and engineers may design infrastructure, evaluate mitigation compliance actions, and develop adaptation strategies. They also may need to prepare for casual public engagement, depending on their job duties. Therefore, we recommend that planners and engineers receive deeper training in the core topics and training in adaptation and decision making under uncertainty (fig. 1), including scenario planning (Mahmoud et al. 2009) and other decision frameworks (National Research Council 2010). Climate literacy for planners and engineers includes a technical understanding of uncertainties in climate and hydrology model projections and implications for flood frequency estimation. Similarly, planners and engineers need a more technical understanding of federal regulations for compliance with environmental standards. Providing information at these deeper levels might require in-person or online training that allows for real-time interaction with the instructor.

We found substantial gaps in training on vulnerability assessment, climate change adaptation planning, and making decisions under high uncertainty.

Table 5. Sample climate literacy curricula outlines

Course	Curriculum Outline
Climate Literacy 1 **Rationale:** Basic climate change science for laypeople that highlights the connections between global-scale climate system changes and their local conditions	***Climate change: Global to local*** • What changes climate? ▪ Natural factors, greenhouse effect, past climates • Evidence of change ▪ Global temperature, oceans, snow and ice, drought, ecosystems, greenhouse gas emissions • How sure are scientists? ▪ Observations, paleoclimate, models, confidence • Local historical context ▪ Local and traditional knowledge of historical climate and extremes • U.S. initiatives ▪ National Park Service, Department of Interior ◆ Landscape Conservation Cooperatives ◆ Climate Science Centers
Climate Literacy 2 **Rationale:** More in-depth examination of climate change science, for those needing extra depth, and to support knowledge for public engagement	***In-depth evidence of change and projections of the future*** • Build on Climate Literacy 1 by adding depth and climate system detail, such as ▪ Global carbon cycle ▪ Climate system feedbacks (e.g., ice-albedo) ▪ How global atmospheric circulation affects regional climate ◆ Teleconnections (e.g., El Niño) ▪ Fundamentals of global observation networks • Basics of projected climate changes and impacts for the U.S. ▪ Regional and local observed climate change impacts and the certainty of connections between them ▪ Climate extremes and sea-level rise ▪ Why small changes matter
Climate Literacy 3 **Rationale:** Greater depth for those needing to apply climate science to research, planning, and infrastructure design	***Climate change science for scientists*** • Build on Climate Literacy 1 and 2 • Tools and resources ▪ Climate change projections and probabilities ▪ Monitoring: local and regional networks and data ▪ Climate science and service programs • Models ▪ Deconstructing the black box: How do global climate models work? ▪ Basics of integrated regional-scale modeling ◆ Hydrologic and land surface models ◆ Terrestrial processes and feedbacks ▪ Assumptions and uncertainties • Projected extremes in contrast with historical observations • Climate and hydrologic change and methods for dealing with change • Statistical and dynamic downscaling ▪ Methods and limitations • Monitoring issues ▪ Global, national, regional, and local networks ▪ Informal observations and citizen science

Web site assessment

We evaluated 155 Web sites containing climate change training, information, and resources with a focus on climate literacy, mitigation, and adaptation planning. We made a distinction between resources for training and those for information transfer. The former has a well-defined and consistent structure geared toward education, is self-contained, and provides a structured flow from topic to topic. The latter usually consists of loosely organized information and lacks a clearly defined structure for guiding users through related materials. We initially screened Web resources based on whether or not they provided training. We next evaluated Web sites and training materials using criteria (table 6) modified from a checklist developed by the Climate Literacy and Energy Awareness Network (http://cleanet.org), national leaders in climate science education. Our criteria addressed scientific accuracy, pedagogy, usability and technical quality, alignment with our audiences, and an overall rating.

Most online climate literacy *training* is geared toward the public and would be suitable for "Climate Literacy 1" (table 4). We found substantial gaps in training on vulnerability assessment, climate change adaptation planning, and making decisions under high uncertainty. This suggests that the Intermountain Region should target resources toward subject areas for which there is little online training. That is, the region should develop courses and train-

Table 6. Criteria for climate change training resources

Criteria
Educational quality
Are prerequisite skills and understandings accurately indicated?
Is there any indication that common preconceptions or misconceptions are addressed?
Is there testing on the material learned?
Does the resource provide a vehicle for asking questions or seeking further information beyond the activity?
Does the resource provide clear and comprehensive guidance for teachers to effectively teach the activity? [ONLY for training the trainer]
Ease of use and technical quality
Is the resource free of distracting or off-topic advertising?
Has the Web site won any relevant awards?
Are hyperlinks functional and up-to-date?
Do hyperlinks take the learner off-site for any components of training?
Are training materials and tools freely available?
Does the resource meet technical criteria that make it ready for use?
Is necessary material available in printable handout form?
Audience
Operations and administration
Interpreters, education specialists, trainers
Planners, designers, engineers
Research scientists
Resource "on-the-ground" management
Upper management (users of executive summaries)
Overall rating of relevance
High priority (resource likely to be included in collection of excellent resources)
Medium priority (resource meets basic standards)
Low priority (resource meets basic standards, but is of lower priority)
Hold for later review (keep in pool for another review at later stage)
Excellent but incomplete (excellent and relevant, but needs improved activity sheet)
Do not include (resource does not meet basic standards)

The region should develop courses and training related to adaptation and decision making under uncertainty, rather than devote resources to basic climate literacy, for which there is abundant information and adequate training resources.

ing related to adaptation and decision making under uncertainty, rather than devote resources to basic climate literacy, for which there is abundant information and adequate training resources. Additionally the region may consider using *information* and materials from diverse sources rather than relying on structured training to meet the needs of some job categories.

Conclusions

Based on survey results, which reasonably represent close to three-fourths of the 31 workforce categories surveyed but should be applied with caution when extrapolating to the entire population of IMR or NPS employees, we found that most IMR survey respondents have a reasonable grasp of observed climate impacts and some key phenomena, but climate literacy training must emphasize distinctions between climate variability and trend-driven change, future projections for IMR parks, and nuances in terminology essential to the NPS Climate Change Response Strategy. Given time and budget constraints that limit regionwide in-person training, survey results and interviews with a selected group of IMR employees lead us to recommend flexible, low- or no-cost, modular climate change training with an initial emphasis on existing online resources. We found adequate online training resources for addressing basic climate literacy, but a lack of online training in topics such as adaptation to climate change. We developed several tools for designing climate change training, including

key topics, curriculum outlines, and decision trees for matching content with job duties.

Survey and interview results, and our observations of the rapid proliferation of climate information on the Internet and in the National Park Service, suggest the need for structures to organize information in a way that relates closely to employees' work-related duties. Challenges for implementing climate change training include keeping pace with changing information in this dynamic environment and producing IMR-specific materials. We note several opportunities to leverage federal and NPS efforts to produce, implement, and maintain information and training. These include the NPS Climate Change Response Program, Department of the Interior Landscape Conservation Cooperatives and Climate Science Centers, NOAA's Climate Service initiative, and insights produced by George Melendez Wright Climate Change Fellowship research. The upcoming U.S. National Climate Assessment (http://assessment.globalchange.gov), conducted every four years as mandated by the Global Change Research Act of 1990, will bolster the development of region-specific and up-to-date materials.

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References

Mahmoud, M., Y. Liu, H. Hartmann, S. Stewart, T. Wagener, D. Semmens, R. Stewart, H. Gupta, D. Dominguez, F. Dominguez, D. Hulse, R. Letcher, B. Rashleigh, C. Smith, R. Street, J. Ticehurst, M. Twery, H. van Delden, R. Waldick, D. White, and L. Winter. 2009. A formal framework for scenario development in support of environmental decision-making. Environmental Modelling and Software 24(7):798–808.

Mantua, N. J., and S. R. Hare 2002. The Pacific Decadal Oscillation. Journal of Oceanography 58:35–44.

National Park Service (NPS). 2009. Critical challenges and opportunities. Unpublished report. National Park Service, Intermountain Region, Lakewood, Colorado, USA. Accessed from NPS intranet 3 June 2011 at http://classicinside.nps.gov/documents/final%20for%20print-010209-lowres.pdf.

National Research Council. 2010. Informing an effective response to climate change. (Chapter 3, Decision frameworks for effective responses to climate change). America's climate choices: Panel on Informing Effective Decisions and Actions Related to Climate Change, Board on Atmospheric Sciences and Climate. The National Academies Press, Washington, D.C., USA.

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