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Climate Project Screening Tool: An Aid for Climate Change Adaptation

Toni Lyn Morelli, Sharon Yeh, Nikola M. Smith,
Mary Beth Hennessy, and Constance I. Millar

Authors

Toni Lyn Morelli and **Constance I. Millar** are research ecologists, Pacific Southwest Research Station, 800 Buchanan St., Albany, CA 94710; **Sharon Yeh** is recreation, lands, and minerals program manager, Olympic National Forest, P.O. Box 280, Quilcene, WA 98376; **Nikola M. Smith** is a Presidential Management Fellow, Policy Analysis, Research and Development, 201 14th St., SW, Washington, DC 20024; **Mary Beth Hennessy** is a resource staff officer, Inyo National Forest, 351 Pacu Lane Suite 200, Bishop, CA 93514. Morelli currently is located at the University of California at Berkeley, CA 94720.

Cover Photo: Long Lake, Inyo National Forest, Toni Lyn Morelli, USFS.

Abstract

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To address the impacts of climate change, land managers need techniques for incorporating adaptation into ongoing or impending projects. We present a new tool, the Climate Project Screening Tool (CPST), for integrating climate change considerations into project planning as well as for developing concrete adaptation options for land managers. We designed CPST as part of the Westwide Climate Initiative project, which seeks to develop adaptation options for addressing climate change through science/management partnerships. The CPST lists projected climate trends for the target region and questions to be considered when designing projects in different resource areas. The objective is to explore options for ameliorating the effects of climate on resource management projects. To pilot the CPST, we interviewed 13 staff members and line officers of the U.S. Forest Service and Bureau of Land Management in the Sierra Nevada region of California. We found that a major value of the CPST was the process—with the activity of conducting the questionnaire being as important as the answers received from the staff. The CPST also serves as a priority-setting tool, allowing managers to consider effects of different actions. Finally, the CPST helps to reduce uncertainty by identifying the range of impacts that both climatic changes and management actions may have on resources. The CPST could also be modified to devise mitigation options for resource managers.

Keywords: Climate change, adaptation, land management, mitigation, Sierra Nevada.

Summary

We present a new tool, the Climate Project Screening Tool (CPST), for integrating climate change considerations into project planning as well as for developing concrete adaptation options for land managers. We designed CPST as part of the Westwide Climate Initiative project, which seeks to develop adaptation options for addressing climate change through science/management partnerships. The CPST lists projected climate trends for the target region and questions to be considered when designing projects in different resource areas. The objective is to explore options for ameliorating the effects of climate on resource management projects. The major value of the CPST is the process—with the activity of conducting the questionnaire being as important as the answers received from staff. The CPST also serves as a priority-setting tool, allowing managers to consider effects of different actions. Finally, the CPST helps to reduce uncertainty by identifying the range of impacts that both climatic changes and management actions may have on resources.

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Introduction

Climate change poses a challenge for resource managers as they review their current management practices. Adaptation to climate change, defined as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2007: 869), is a critical means of addressing climate change in the near term. Climate change adaptation is important because, owing to inherent time lags in climate impacts, the effects of increased atmospheric greenhouse gases will be felt for decades even if effective mitigation begins immediately (IPCC 2001). However, climate science is a particularly challenging field of knowledge given the level of technical expertise required to understand climate, its high degree of uncertainty, and the lack of knowledge of its effects at biologically relevant scales. Thus, climate change adaptation, although understood to be important to resource management, has not been explicitly incorporated into most national forest planning.

In response to the needs of resource managers, some decision-support tools have been developed to aid climate change planning and preparedness. These include international reports (e.g., IPCC 2007), regional reports (e.g., California Natural Resources Agency 2009), reports from federal agencies (e.g., Joyce et al. 2008), journal articles (e.g., Littell et al. 2011), Web sites (e.g., U.S. Forest Service Climate Change Resource Center; CCRC 2011), and short courses (e.g., Furniss et al. 2009). However, there remains a need for methods that help transform these scientific concepts into management actions.

Bridging the gap between the latest climate change science and on-the-ground management in the National Forest System is the goal of the Westwide Climate Initiative (WWCI) Toolkit Project, an interagency collaboration led by scientists at the Pacific Southwest, Pacific Northwest, and Rocky Mountain Research Stations. The WWCI Toolkit Project uses science/management partnerships between the western research stations and case-study national forests to develop the decision-support needed by the U.S. Forest Service (USFS) to incorporate climate change into management and planning in the Western United States (Peterson et al. 2011).

Bridging the gap between the latest climate change science and on-the-ground management in the National Forest System is the goal of the Westwide Climate Initiative.

To aid land managers in incorporating climate change adaptation into their planning and project implementation, we explored the needs of two national forests in the Sierra Nevada. We began conversations with Tahoe National Forest (TNF) staff to identify management needs and discuss tools that would be most conducive to applying climate change science to decisionmaking. Through this process, we designed a document, the Climate Project Screening Tool (CPST; see app. 1), to aid national forests in the early stages of incorporating climate concerns into operational work.

The CPST addresses ongoing or near-term projects that would benefit from review for consistency with adaptation goals.

The CPST is intended as a platform from which natural resource managers can reflect on the potential impacts of climate change on projects and consider concrete adaptation options at the pre-National Environmental Policy Act (NEPA) project planning level. Although federal agencies are currently transitioning to address climate concerns within the context of landscape- or watershed-scale assessments such as those conducted for cumulative-effects analysis and land management planning, many current projects were formulated in times before climate concerns were recognized. The CPST addresses ongoing or near-term projects that would benefit from review for consistency with adaptation goals. It acts as an audit or review tool to remind managers to consider climate change in current and impending projects; if issues arise during the review that suggest climate implications conflicting with project design, modifications to projects can be recommended to the approving decisionmaker. The CPST also serves as a review of priorities among current projects; whereas project goals and treatments may not need modification, climate concerns might trigger changes in resource allocation. Finally, some projects as originally designed might be deemed inappropriate altogether, and these would be recommended to the deciding officer for comprehensive redesign or removal from activity lists.

The CPST begins with a questionaire of projected climate change trends for the focal region, along with a breakdown of these effects in relation to each proposed project activity. The major component of the CPST is a table separated into project areas that describes projected climatic changes and lists questions to consider given the impacts of these changes on the resource. The questions are general in order to catalyze the discussion of how climate change will impact the project and modify its effects. The CPST was originally intended to determine whether ongoing or near-term projects are adequate as is, can be modified to consider climate effects, or should be delayed and reworked to incorporate climate effects. It focuses primarily on adaptation options, although it could be modified to explore mitigation options.

In this paper, we describe the components of the CPST and explain how to use it. To illustrate the tool's development as well as its use, we present background and results from discussions with two case study forests, the TNF and the Inyo National Forest (INF). Finally, we provide general recommendations from the case studies regarding climate adaptation options as well as how best to implement the CPST.

Methods

CPST Structure

The CPST is delineated as follows: (1) a broad view of climate trends focusing on the effects most likely to have relevance to the project, (2) the impacts relevant to the project activities and goals and their target species and resources, (3) key questions for managers to address when considering these impacts, and (4) a decision point as to whether the project should continue and, if so, with or without modification (see app. 1).

General climate change trends for the focal region—
Information about projected climate and ecosystem responses can be gathered from many sources and summarized for key indicators of relevance to the local national forest. The scientific literature was our primary source for this information, although internal reports and discussion with local climate scientists helped to identify projections that were most applicable to the local region. The purpose of this summary is to give managers a broad sense of anticipated and ongoing changes in climate and related ecological responses for the region of their management unit.

Questionnaire (part of the CPST table)—
(see excerpt of CPST in fig. 1, along with a breakdown of these impacts relevant to each activity in app. 1, table 2, column 2)

***Project activity*—**A list of typical project types was developed using TNF's Schedule of Proposed Actions (SOPA) as a guide. We then asked TNF resource specialists to verify that the CPST framework was relevant considering their future projects. To apply the tool to their local management unit, users can replace general categories with specific proposed projects.

We chose terminology for the CPST that is used commonly in the National Forest System and thus would be familiar to staff members. Although we recognize that the use of some of these terms (e.g., restoration) is under discussion for redefinition given a climate-change context, we maintain their use for purposes of clarity and ease of communication. Here, restoration refers to the reestablishment of processes or ecosystem services, not a return to an historical time point or even historical range of variation. Thus, "meadow restoration" can be thought of as restoring the processes and benefits of a functioning meadow system.

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete)	Continue with project?
Meadow restoration	Trends: Reduced snowpack; longer, drier summers; decreased water quality as a result of watershed erosion and sediment flow Local impacts: Vegetation and wildlife species movement; reduced water storage in soils; changed hydrologic regimes; increased severity of fire effects/more sediment loss; reduced plant and animal diversity	• How will longer, drier summers and a reduced snowpack affect the water source for the meadow (snowmelt, spring, rainfall driven)? • How will the topography surrounding the meadow be vulnerable to increased sedimentation in light of extreme weather/fire events? • Is the project located at the edge of the range of suitability in climate/topography/elevation gradient? • How are relevant threatened, endangered, and sensitive species likely to be impacted by hydrologic and climate change? Is this area critical as a refugium site? • How should the recommended season of use change for recreation and grazing, if at all? • With drying conditions, will this only be a short-term solution? If so, what is the plan for longer term management for this species/area? • Why is this the right time and location for this project given the climate trends? • How will the proposed project help offset the projected impacts due to climate change?		☐ Yes without modification ☐ No ☐ Yes with modification:

Figure 1—Example section from the Climate Project Screening Tool.

***Climate change trends and local impacts*—**The second column refines the general statements about climate change and ecological responses to the specific project activity. This information can be derived in cooperation with scientists and managers. From the general review of climate trend projections and resource responses, those elements most relevant to the project type are identified for further consideration. The local impacts focus on effects at a scale that is relevant to project design and highlight appropriate changes to the project.

***Key questions for managers*—**The purpose of this column is to facilitate thinking about the potential impacts of climate change on a particular project type. Questions can be created collaboratively to address parameters that determine the nature, timing, and extent of an action on a particular site. In our case study, these questions were developed through meetings with TNF resource specialists from relevant program areas to understand the project planning process, including key data and indicators that are used to guide project design. Initially, questions were chosen for their apparent importance and implication to national forest lands and resources, and considering current information suggesting that these factors are (1) most robustly projected, and (2) likely changing the most. We later refined the questions and used them in interviews with the INF.

The response narrative is the centerpiece of the CPST, where managers record their answers to the questions and their thinking about the inter-action between climate change and the project.

***Response narrative*—**The response narrative is the centerpiece of the CPST, where managers record their answers to the questions in the third column and thus their thinking about the interaction between climate change and the project. Users are encouraged to use and document sources for their answers.

***Continue with project?*—**The last column is where the user concludes whether to proceed with, modify, or cancel the project given the response narrative. It is intended as a recommendation to the decisionmaker regarding whether or not climate change impacts are likely to be substantial enough to require modification to the proposed activities, insignificant enough to proceed as originally designed, or if the project cannot be modified, to consider relevant climate change effects and thus should be withdrawn. Documentation of one of the three recommendations can then become part of a public report on how resource managers considered climate change prior to project implementation.

CPST Implementation

After developing the CPST on the TNF, we tested it through several conversations with resource specialists regarding current projects focused on thinning for fuels reduction, timber salvage, and a plan to reduce grazing. We then revised the tool and presented it to 11 staff members (“users”) from the INF and Bureau of Land

Management (BLM) field office in Bishop from June through August, 2009. We used the latest two (January 1–June 30, 2009) SOPA reports for the INF to identify any projects that fit under the CPST headers (app. 1), regardless of planning status (e.g., in progress, on hold). Users were chosen either from the project contact listed on the SOPA or through staff recommendations. We conducted in-person conversations with users focused on these specific SOPA projects as well as similar past or planned projects within the user's resource area. Conversations were conducted primarily one on one, although occasionally two users were interviewed simultaneously. Statements in appendix 2 are summaries of paraphrased or directly quoted user responses from the conversations conducted by Yeh and Smith (TNF) and Morelli (INF).

For the Response Narrative (app. 1, table 2, column 4), we recorded users' responses to Key Questions (app. 1, table 2, column 3) and to followup questions that resulted from the conversation. We grouped Response Narrative answers by project activity, synthesizing to improve clarity and avoid repetition. These results are presented in appendix 2, with the Meadow Restoration and Stream Restoration categories combined, the Road (Decommissioning and Maintenance and Construction) categories combined, and no responses for the generalized Reforestation/Restoration category. These results represent statements from the users and were not further edited except for review of facts and occasional correction of obvious science-based errors or misinterpretations. Finally, we identified important adaptation options from recurring user responses. These key recommendations are summarized by project activity (with caveats as described) in table 1.

Results

We interviewed 13 USFS and BLM staff members and line officers located on the TNF and the INF. Most conversations focused on specific projects taken from the most recent SOPA report. The focus on the SOPA report was designed to develop adaptation options for ongoing or impending projects. However, many of the projects on the most recent SOPA report were already underway or were no longer being considered. In reality, ongoing projects were not likely to be modified as they had already been through the NEPA process and were time-sensitive. Therefore, although the SOPA project was used to start the interview, most discussions quickly generalized to similar projects that may occur in the future.

Appendix 2 contains a summary of these interviews, grouped by project area. The following is from the section on grazing:

> Meadow restoration through temporarily reduced grazing can increase water storage, allowing for future grazing operations and mitigating for

Table 1—Recommendations for climate change adaptation by project area from the Climate Project Screening Tool case study forests

Project area	Recommendations for climate change adaptation
Fuels Management	• Conduct more thinning in the form of repeated treatments over time in one area. • Support the development of a fuels market, e.g., a biofuels plant. • Consider higher elevation sites or riparian areas as future targets for fuels treatment. • Learn about historical fire regimes in riparian systems. • Shift harvesting schedules and prescribed burns forward or backward considering earlier snowmelt, etc. • Consider the effects of altered burn season on wildlife, e.g., earlier burns may interfere with breeding birds. • Increase safeguards against fire going out of prescription since season is becoming less predictable, e.g., later and less snow. • Conduct more detailed watershed analysis to consider increased sedimentation and water temperature. • Salvage dead wood to limit the spread of future insect outbreaks and reduce the chance of wildfire. • Educate the public about the need for thinning and prescribed burns to reduce air quality issues, wildfire risk, and spread of invasive species and to increase forest resilience to climate change.
Restoration	• Choose aspen treatment areas for multiple management objectives: reduce wildfire risk, address bark beetle infestation, increase water retention, etc. • Increase stream bank building, replace old structures, and stabilize stream banks with vegetation to restore drying streams. • Increase the flood plain by reducing the stream width, with larger built flood plains to accommodate extreme weather. • Select project sites strategically to concentrate on meadows and streams that will not dry out. • Consider how to manage new habitat created by changing climate, e.g., in areas that were permanent snow fields. • Develop/use techniques that can withstand an extreme event even if it happens soon after the project's completion. • As appropriate, reduce grazing near streambanks, especially late in the season. • Move hiking trails out of meadows to increase resilience. • Consider possible new approaches to conserving threatened, endangered, and sensitive species, e.g., manage some habitats as climate refugia. • Regarding Sierra bighorn sheep (*Ovis canadensis sierra*), increase focus on the availability of quality winter forage and seasonality of breeding and fawning, as these could change under warming conditions; other requirements, such as mineral licks and specific topography, are unlikely to change. • Evaluate dates of hunting season and tag limits.
Grazing	• Consider temporarily reducing grazing levels and shifting grazing levels, especially to earlier in the season, to increase meadow resilience. • Reconsider the standard benchmarks used for grazing decisions, e.g., breeding dates, as wildlife adapt to changing seasons. • Update inventories and protocols that determine the extent of suitable range as conditions change. • Consider future water availability under drying climates when determining allotments. • Review and revise the Watershed Condition Inventory and Hydrologic Function Protocol. • Consider potential disease issues and the shift of wildlife breeding, birthing, forage seasons, and distribution.

Table 1—Recommendations for climate change adaptation by project area from the Climate Project Screening Tool case study forests (continued)

Project area	Recommendations for climate change adaptation
Road Maintenance, Construction, and Decommission	• Consider the potential impacts of the increasing rate of extreme weather events such as severe flooding when planning road maintenance, construction, and decommission. • Capitalize on wildfire and other disturbance as a time to increase the resilience of infrastructure, such as upgrading culverts to accommodate higher runoff.
Recreation planning	• Consider the effects of higher social densities, changes in use patterns (e.g., higher elevation) and marginal permittee operations. • Consider greater stress on ground water when planning campgrounds (or upgrades) or reviewing special use permits. • Develop safe places and viable escape routes for fire emergencies or extreme weather, e.g., flash floods. • Consider imposing greater fire restrictions in campgrounds as fire risk increases.
Mitigation	• Amend special use permits to include sustainability contract language, e.g., require recycling, renewable energy use. • Educate the public to increase efficiency and reduce waste, e.g., solar power on forest buildings, hand out a compact flourescent bulb to every visitor, post green checklists, develop mass transit options, use efficient toilets.

anticipated drying conditions. If meadows are shrinking due to climate change, then grazing might be a less suitable use of rangeland. However, if restoration efforts are successful, grazing could still remain viable. Grazing allotments on the INF already consider watershed conditions and wildlife use. Allotments can be closed but only for legal and project-defensible reasons, such as the impact on threatened and endangered species. In general, in many INF allotments, allowable use is being reduced based on monitoring and condition assessments and a need to improve vegetative and hydrologic conditions. Grazing reduction is occurring on the TNF to allow for re-vegetation and hydrologic restoration.

Grazing seasons may change owing to the anticipated shorter growing season. With shorter growing seasons, utilization levels might still be appropriate if the season was moved earlier, or if meadow restoration efforts are successful. The standard benchmarks that are used for these decisions, for example sage grouse breeding season is June 15, may need to be reconsidered as wildlife adapt to changing seasons. Utilization levels also depend on the species mix of forage. Inventories and protocols that determined the mapping of suitable range may need to be updated to take climate change and local ground conditions into consideration. If spring arrives earlier, the schedule might be moved forward to take advantage of the new growth. Likewise, cattle might need to be taken off earlier than usual if summers are drier. Water availability is considered when determining allotments but not future water availability under drying climates. Meadow restoration efforts can help offset the impact of climate change by increasing the amount of water storage and availability. The Watershed Condition Inventory and Hydrologic Function Protocol are from 1995 and would benefit from review and updating. Finally, there are wildlife disease transfer concerns which climate change may exacerbate.

We also synthesized 35 project recommendations (table 1) for climate change adaptation by resource area that we identified from the CPST conversations (app. 2). For example, recommendations resulting from the grazing conversations included adjustments to project siting and timing and updates to protocols to reflect changing conditions. Some of the key ideas were to support actions that were already being conducted by land managers, but could benefit from increased focus or increased resources. Ideas ranged from specific (e.g., review and revise the Watershed Condition Inventory and Hydrologic Function Protocol) to more general (e.g., develop/use techniques that can withstand an extreme event even if it happens soon after the project's completion). Some suggestions could be enacted by staff members themselves (e.g., select project sites more strategically to concentrate on meadows and streams that will not dry out), whereas others were beyond the individual staff member's mandate (e.g., support the development of a fuels market, e.g., a biofuels plant) and thus could be considered recommendations to the regional or national leadership of the USFS.

It is important to note that the points in table 1 were not, in most cases, presented as explicit recommendations from staff members, but arose from the repeated questions and conversations on the topic. However, all of the ideas are from staff members and are not based on input from the interviewer, beyond some simple rewording.

The CPST is process-oriented, whereby the activity of going through the questionnaire is as important as the answers themselves.

Discussion

We found that the CPST is process-oriented, whereby the activity of going through the questionnaire is as important as the answers themselves. In considering the general implications of climate change for their resource area, staff brainstormed how these climate-change effects would manifest at the project site and reassessed the assumptions and objectives they used to determine current practices. The CPST is also a priority-setting tool, allowing managers to consider effects of different actions and direct management accordingly. Finally, the CPST, by exploring local climate change effects, helps lower uncertainty by identifying the range of impacts that management actions may have on resources.

Feedback obtained after conversations on the TNF and the INF indicated that staff members considered the CPST a useful thought exercise. Even within an interview, we observed that the CPST was successful in helping staff members think through the process of incorporating climate change adaptation into project planning. Specifically, our conversations facilitated identification of potential climate change issues and options in different project areas. Our project was limited in its scope and the time availability of the users; as a result, some ideas were not expressed and some issues were not addressed. Nevertheless, key recommendations for resource management in the face of climate change emerged from the conversations (table 1).

One benefit of the CPST process was the advantage gained in filling out the questionnaire in conversational style. Although these case studies employed research scientists to conduct conversations with one or two resource specialists, we designed the response narrative to be completed by local resource specialists or interdisciplinary teams. Results indicate that the process of working through the questions as a team will be a productive exercise. As the CPST was designed to be used by staff within a local management unit or possibly extended to a regional level, ideally pairs or teams of staff members would fill out the questionnaire together, thus maintaining the conversation and mutual brainstorming element of the process.

Through the platform of the CPST, staff members were able to devise new activities that could help with climate change adaptation for their individual projects. More commonly, users identified current management practices that could benefit the resource if they were applied more frequently or slightly differently. Results indicate that the national forests are already conducting certain management practices that would incidentally benefit the resource in terms of climate change adaptation. For example, increasing forest resilience, generally used to maintain stand viability and decrease wildfire risk, is considered one of the primary climate change adaptation options for land managers (Millar et al. 2007). Thus the CPST could be used to prioritize ongoing practices for further funding and staff time.

A potential issue with the CPST framework was the limit imposed by using the latest SOPA reports. The SOPA report was chosen as a framework because it allowed the users to consider the CPST questions in a tangible context that we believe was a benefit to the process. However, some of the SOPA projects were already completed, and others were likely to go ahead regardless because of timing and implementation needs. In addition, the SOPA report may exclude some recent short-term projects. In future use, the CPST would benefit from implementation at the project planning stage, to incorporate adaptation options pre-NEPA.

Another concern is that issues that are broader in temporal or spatial scale or that span several resource areas may not be covered by focusing on a single project. For example, a discussion about restoring a specific stand of aspen (*Populus tremuloides* Michx.) may not consider the effect that herbivore populations shifting in response to changing climate may have on aspen regeneration. Many users appeared to have a narrow focus on their project area, either reflecting a shortcoming of the CPST as written or a true lack of the broader context by staff members. Users can take the initiative to modify the CPST questions to address these issues for their own project area. Moreover, the CPST can easily be adjusted to address climate change adaptation at the programmatic level. There is also room to add additional sections to the CPST, such as a project activity row for minerals (i.e. oil and gas).

Through our interviews, ideas arose for increasing the sustainability of operations, a current emphasis for the USFS. Users expressed that there is a great opportunity in talking with the public to introduce climate change mitigation ideas and to encourage the public to be better consumers and environmental citizens. One user suggested that there is a role for USFS to educate the public to increase efficiency and reduce waste by using solar power on forest buildings, handing out a compact flourescent bulb to every visitor, posting "green" checklists, developing mass transit options, and using more efficient toilets. More directly related to land management, users suggested the possibility of amending special use permits to include sustainability contract language, for example, requiring recycling and renewable energy use. Although the CPST is currently written for developing adaptation options, there is potential for it to be modified to focus on mitigation of climate change. This could eventually create a platform for joining the related climate change initiatives of adaptation and mitigation.

The CPST is currently hard copy (i.e., app. 1). To expand its availability and use, it could be converted to interactive software. Efforts are ongoing in Region 5 (Pacific Southwest Region) and Region 9 (Eastern Region) of the USFS to present and distribute the CPST. Furthermore, the recently introduced "Performance Scorecard for Implementing the Forest Service Climate Change Strategy" requires action on adaptation efforts that are directly addressed by the CPST. As climate change considerations become part of the federal mandate, we hope that the CPST will be used by USFS, National Park Service, and other land managers to incorporate climate change adaptation thinking into project planning (see Peterson et al. 2011). The CPST could be used (1) during pre-NEPA discussions and priority setting, (2) when developing project implementation and prescriptions, and (3) as an aid to resource specialists to prepare for discussions with the public about projects and justification. The results published here can act as a starting point for examples of adaptation, and also could be modified to explore mitigation options.

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Appendix 1: Climate Project Screening Tool

Developed by: Connie Millar, Sharon Yeh, Nikola Smith, and Toni Lyn Morelli
Product of the Westwide Climate Initiative Climate Toolkit Project
U.S. Forest Service

The Climate Project Screening Tool (CPST) is intended to help integrate climate change considerations at the pre-National Environmental Policy Act project planning level. The tool (table 2) uses a questionnaire with questions that both are broad and general in nature to help begin the discussion of how the project might impact climate change, or how climate change will impact the project. There are no correct or incorrect responses. Instead, this tool allows you to document whether or not climate change was considered in a project and whether or not the project will aid in climate adaptation efforts.

Directions for using the CSPT (table 2):
Please refer to the list of general climate change trends (below) for background information and identify the appropriate project activity that your management unit is considering. To provide a frame of reference in thinking about the subsequent questions, applicable climate change trends and local impacts are identified for each project activity in the second column. With your planning team, work through the key questions in the third column to identify potential climate change implications. Record your responses in the fourth column. The final step is to document how your responses impact the project. Does the project still make sense given climate change considerations? If so, should any modifications be made to the project plan? These decisions can be documented in the last column.

General climate change trends (e.g., Inyo National Forest)

1. Increased interannual variability in precipitation against generally warming average temperatures
2. Reduced snowpack; longer, drier summers
3. Increased likelihood of severe flood events
4. Longer fire seasons; atypical fire seasons (e.g., winter, early spring)
5. Increased fuel buildup and risk of uncharacteristically severe and widespread forest fire in traditionally fire-prone forest, woodland, and shrub types
6. Higher elevation insect and disease and wildfire events

7. Increased stress to forests during periodic multiyear droughts; heightened forest mortality
8. Increased water temperatures in rivers and lakes, lower water levels in late summer, and drying of streams and ponds
9. Decreased water quality as a result of higher temperatures, increased watershed erosion, and sediment flow
10. Loss of seed and other germplasm sources as a result of population extirpation events

Table 2—Climate Project Screening Tool

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
Thinning for fuels management	Trends: Increased fuel buildup and risk of uncharacteristically severe and widespread forest fire; longer fire seasons; higher elevation insect, disease, and wildfire events; increased interannual variability in precipitation, leading to fuels buildup and causing additional forest stress; increased water temperatures in rivers and lakes and lower water levels in late summer; increased stress to forests during periodic multi-year droughts; decrease in water quality from increased sedimentation Local impacts: Increased risk for erratic fire behavior; decreased window of opportunity for prescribed fire conditions; increased risk of fire spread in high-elevation areas; flashier, drier fuels; decreased water storage in soils	• How will the projected density of the stand after it has been thinned respond to erratic and severe wildfire events, given the projected increase in forest stress and mortality? How does the spacing between trees need to increase, if at all? • At what interval should stands be thinned to mitigate for increased forest stress and fire susceptibility or for changed growth patterns? • How does the project area include anticipated future fire-prone areas (i.e., higher elevation sites or riparian areas)? • How will the season of harvesting need to change given the reduced snowpack and extreme flood events to mitigate for ground disturbance, if at all? Will it need to change given shortening and less reliable winters? • How will the projected project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:
Prescribed fire	Trends: Increased fuel buildup and risk of uncharacteristically severe and widespread forest fire; longer fire seasons; higher elevation insect, disease, and wildfire events; increased interannual variability in precipitation, leading to fuels buildup and causing additional forest stress; increased water temperatures in rivers and lakes and lower water levels in late summer; increased stress to forests during periodic multiyear droughts; decrease in water quality from increased sedimentation Local impacts: Increased risk for erratic fire behavior; decreased window of opportunity for	• Describe options for managing the prescribed burn to mitigate the risk of increased fire vulnerability, dry fuel buildup, and risk of ignition. • Considering the increased drought conditions, how is this the best time and technique to reduce fuels or dispose of wood piles? • Will the prescribed burn area be near a water source, given increased sedimentation and water temperature concerns? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
	prescribed fire conditions; increased risk of fire spread in high-elevation areas; flashier, drier fuels; decreased water storage in soils			
Timber salvage operation	Trends: Increased fuel buildup and risk of uncharacteristically severe and widespread forest fire; longer fire seasons; higher elevation insect, disease, and wildfire events; increased interannual variability in precipitation, leading to fuels buildup and causing additional forest stress; increased water temperatures in rivers and lakes and lower water levels in late summer; increased stress to forests during periodic multiyear droughts; lower water quality from increased sedimentation Local impacts: Increased risk for erratic fire behavior; increased risk of fire spread in high-elevation areas; more large wood fuel loading on the ground; flashier, drier fuels; decreased water storage in soils; an increase in standing dead wood may promote future insect infestations	• How does the project timeline need to be altered to account for the increased forest stress and susceptibility to insects, pests and disease? Will salvaging dead wood protect stands from future insect infestations? • Are there reliable water sources nearby given predicted drought conditions? • What is the dead fuel loading on the ground, and how will it affect the soil in future fires? • How does the status of the current timber market as compared to cost of harvesting affect the profitability of the operation? Will the increase in frequency and severity of wildfire events cause an increase in timber supply? How will increased drought and potential susceptibility to pests and diseases affect the amount of salvage timber available? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:
Reforestation/ restoration	Trends: Increased stress to forests during multi-year droughts; reduced snowpack; higher elevation insect, disease, and wildfire events; fuel buildup from precipitation variability Local impacts: Increased risk of tree mortality; changes in local species composition; geographic movement of species	• Will local conditions change enough to alter the desired species composition? • How does tree planting density and spacing address anticipated water availability and mortality rates? • Are there certain species or genetic pools of native species that are well suited for anticipated vulnerabilities? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
Aspen restoration	Trends: Reduced snowpack; longer drier summers Local impacts: Reduced plant and animal species diversity; reduced water storage in soils; changed fire regimes with more severe effects	• Given the anticipated changes, how will this site be capable of retaining aspens over time? • Will aspen occupying this site be able to persist under extreme weather events? • Are there better opportunities for sustaining aspen in other locations that would provide for sustained migration? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modificaton • No • Yes with modification:
Meadow restoration	Trends: Reduced snowpack; longer, drier summers; decreased water quality as a result of watershed erosion and sediment flow Local impacts: Vegetation and wildlife species movement; reduced water storage in soils; changed hydrologic regimes; increased severity of fire effects/more sediment loss; reduced plant and animal diversity	• How will longer, drier summers and a reduced snowpack affect the water source for the meadow (snowmelt, spring, rainfall driven)? • How will the topography surrounding the meadow be vulnerable to increased sedimentation in light of extreme weather/fire events? • Is the project located at the edge of the range of suitability in climate/ topography/ elevation gradient? • How are relevant threatened, endangered, and sensitive species likely to be impacted by hydrologic and climate change? Is this area critical as a refuge site? • How should the recommended season of use change for recreation and grazing, if at all? • With drying conditions, will this only be a short-term solution? If so, what is the plan for longer term management for this species/area? • Why is this the right time and location for this project given the trends? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
Stream restoration (prevent headcutting, replace old structures, stabilize banks with vegetation)	Trends: Reduced snowpack; longer, drier summers; decreased water quality as a result of watershed erosion and sediment flow Local impacts: Vegetation and wildlife species movement; reduced water storage in soils; changed hydrologic regimes; increased severity of fire	• Describe the future range of flow. Will the hydrologic system change from a perennial to an intermittent system? • Given increase in extreme weather events, how will the hydrologic regime change? Will it go from a snowmelt system to a rain-on-snow regime? • How will water rights for the project be affected by a change in water quality and availability? • Can this project withstand extreme weather events? • How will target species be viable in the future given changes in surface water temperatures? • How is the restoration area vulnerable to increased fire events and erosion, if at all? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:
Aquatic and wildlife species restoration	Trends: Loss of seed and other germplasm sources as a result of population extirpation events; increased water temperatures in rivers and lakes and lower water levels in late summer; reduced snowpack; longer, drier summers; decreased water quality as a result of increased watershed erosion; general shifts in temperature ranges; severe widespread forest fire; longer fire seasons; higher elevation insect and disease and wildfire events Local impacts: Historical availability of food and	Aquatic • How will target species be viable in the future given changes in surface water temperatures? • Describe the future range of flow. Will the hydrologic system change from a perennial to an intermittent system? • Given an increase in extreme weather events, how will the hydrologic regime change? Will it go from a snowmelt to a rain on snow regime? Is the restoration area vulnerable to increased fire events and erosion? Terrestrial • What is the future range of habitat for the target species? Does this lie within management boundaries?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
	water sources may be altered geographically and temporally; changing forest stand structure (wildfire, species extirpation) may alter suitable habitat range	• How will target species be viable in the future given changes in food and water availability, as well as the range of future habitat? • How will breeding, fawning, and forage seasons be altered with the changing habitat and climate? Will hunting seasons need to be altered? • How will the proposed project help offset the projected impacts resulting from climate change?		
Grazing	Trends: Historical availability of forage and water sources may be altered geographically and temporally; suitable range for livestock grazing may be altered; key species for forage monitoring may change on a site-specific basis	• How should the recommended season of use change for grazing, if at all? • Are recommended utilization levels still appropriate? • Is the mapping of suitable range for the allotment still accurate? Will there be water available for this operation? Will there be suitable vegetation for forage? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modifiation:
Road maintenance and construction	Trends: Increased interannual variability in precipitation; decreased water quality as a result of increased watershed erosion and sediment flow; increased likelihood of severe flood; increased risk of uncharacteristically severe and widespread fire	• Given that hydrologic regimes may change, how are your crossings designated? How are sediment flow crossings designed and engineered to withstand the predicted changes? • How is the project located at the right location to mitigate for watershed erosion and sediment flow? • Will the proposed road design be able to withstand extreme weather events?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
	Local impacts: Changed hydrologic regimes; soil disturbance owing to increased runoff and movemeant of waterways; likelihood of road washouts and closures increase; storm events exacerbate sedimentation and erosion from burned areas	• How are current road structures and surface treatments able to withstand the increased likelihood of severe flood events and future use? • Is the surrounding topography and vegetation susceptible to increased fire vulnerability and subsequent erosion? • How will the proposed project help offset the projected impacts resulting from climate change?		
Road decommissioning	Trends: Increased interannual variability in precipitation; decreased water quality as a result of watershed erosion and sediment flow; increased likelihood of severe flood events; increased risk of severe, widespread fire Local impacts: Changed hydrologic regimes; impacts of disturbed soil may be exaggerated in changing hydrologic patterns; increased runoff and movement of waterways; roads vulnerable to washouts and closures; erosion and sedimentation areas in previously burned or disturbed sites are exacerbated; forest stress leads to invasive spread; decrease in suitable habitat for wildlife species	• Given that hydrologic regimes are changing with more frequent flood events, are assumptions regarding the hydrologic cycle (i.e., 100-year floods) accurate? • How will the road design process ensure mitigation of erosion and sedimentation? • Are road structures and surface treatments able to withstand more frequent severe flood events? • How does the decommission design account for extreme weather events? • Is the surrounding topography and vegetation susceptible to increased fire vulnerability and erosion? • How are project materials and plant sources ensured to be free of potential invasive species? • How will the proposed project help offset the projected impacts resulting from climate change?		• Yes without modification • No • Yes with modification:
Recreation planning	Trends: Lower water levels in late summer; reduced snowpack decreased water quality as a result of increased watershed	• Is the project site located adjacent to a water feature? If so, will lower water levels or frequent floods affect the proposed developed site?		• Yes without modification • No • Yes with modification:

Table 2—Climate Project Screening Tool (continued)

Project activity	Climate change trends and local impacts	Key questions for managers	Response narrative (please complete, include references where possible)	Continue with project?
	erosion and sediment flow; increased likelihood of severe floods; increase forest stress and fuel buildup; longer fire seasons Local impacts: Lower lake levels; decreased water table for campground and developed site water systems; snow range shifts; developed sites adjacent to waterways may be impacted by flood events; wildfires could damage structures	• How will reduced snowpack impact developed winter recreation such as snowparks and skiing? How does a potentially reduced season of use impact the contractual language in special use permits? • How might the transportation and access to the project site be affected by more severe flood events and increased fire risk? • How will the proposed project help offset the projected impacts resulting from climate change?		

Appendix 2: Responses to the Climate Project Screening Tool by Staff Members

Thinning for Fuels Management

Thinning helps reduce the likelihood of severe, widespread fire events, promotes a functional forest ecosystem, and thus helps the stand to adapt better in the future to a changing climate. The goal is to thin so that the stand can withstand future wildfire events where fire could play a beneficial, as opposed to catastrophic, role in the ecosystem. There are competing pressures on fuel treatment, including aesthetics and screening for campsites for privacy, as well as demand for fire risk reduction in the wildland-urban interface (WUI). There are also public concerns about too much intervention. On the Tahoe National Forest (TNF) in particular, legal and policy frameworks limit the amount that stands can be thinned. On the other hand, the largest fuels management problem on the Inyo National Forest (INF) is the lack of a market for the material, making it expensive, if not impossible, to cut and haul away the optimal amount of material. Because many areas are overgrown, it is risky to burn them. Therefore, managers are thinning to make areas more resilient to fire, but current actions may not be adequate to prevent severe wildfires in warmer and drier climates. One solution is to do repeated thinning treatments over time ("maintenance") in one area, or to increase the rate at which thinning occurs, but this is often cost-prohibitive. A biofuels plant/market would create an opportunity to do more active management.

For the most part, areas that have been unlikely to burn in the recent past (e.g., higher elevation sites or riparian areas) are not yet being considered as future targets for fuels treatment. Riparian areas are particularly difficult to manage because of watershed and wildlife issues. However, some areas, for example in the riparian zone along Sherwin Creek and the higher elevation recreation sites like June Mountain Ski Area, are being considered for fuels treatment, although not with the idea of climate change in mind. Most treatments, particularly in the southern INF, occur in the WUI, which tends to be lower elevation. Nevertheless, treatments can reach as high as 10,000 feet. It was noted that it would be useful to learn about any fire histories that have been researched in riparian systems. Finally, harvesting schedules might be shifted forward or backward, depending on seasonal forecasts; earlier snowmelt might move harvesting schedules forward.

Prescribed Fire

There are always concerns about a prescribed fire escaping the predetermined burn area, although increased risks under climate change are not actively being considered in all cases. For example, to address concerns about a fire jumping a road, the burn may be located where there is snow above the road. However, with warming climates, snow levels may change and even diminish.

There are, more generally, potential problems with changing seasons and later snowfall. Some see the season of fuels treatment becoming less predictable, with later and less reliable snowfall; others point out that weather is always unpredictable and managers expect interannual variability. For the most part, it is felt that the flexibility currently built into fire prescriptions for the timing of the burning will be adequate for dealing with shifting climate. For example, the prescriptions that ascertain when to burn are not date-dependent, but condition-dependent, so burns can be moved to later or earlier in the season using the current prescription. If the burn window moves much, there are other potential conflicts; for example, earlier burns may interfere with breeding birds.

In addition to the lack of a market for timber and small-diameter material around the INF, there are limitations on prescribed burns owing to public concern about air quality. There does not seem to be a sense of urgency from residents about catastrophic wildfire, seen in some other places in the Western United States, that may offset the concern about air quality. There is an opportunity here to persuade the public that there will be worse air quality concerns, as well as greenhouse gas emissions, from a large-scale wildfire.

Issues of increased sedimentation and water temperature are not considered huge concerns on the INF as most burns do not occur near fragile water sources. There is a watershed analysis conducted as part of the fuels reduction projects, but it may not show enough detail to consider increased sedimentation and water temperature.

Finally, there were concerns about the spread of invasive species (e.g., cheatgrass) in response to prescribed burns. However, the spread of invasives is likely to be less problematic with higher frequency, lower intensity fire as opposed to rare large-scale severe wildfire.

Although, for the most part, changing climates have not been actively considered in fire treatments, most fuels treatment projects seemed to meet similar goals of offsetting the projected impacts owing to climate change. In other words, there is an awareness of increased wildfire risk and thus increased need for action, even if the cause is not focused on drying and warming climates. There is an exciting vegetation management landscape analysis forthcoming for the southern half of the INF and corresponding parts of Bureau of Land Management (BLM) to consider just that. The objective is to create diverse and resilient ecosystems considering the new climate regime.

Timber Salvage Operation

On the TNF, a timber salvage operation was conducted to remove dead or downed wood. Managers salvaged the timber to limit the spread of future insect infestations. Timber salvage operations can also mitigate the impacts of climate change by sequestering carbon in wood products instead of allowing it to decompose or burn on the landscape. Moreover, salvaging dead wood may reduce high fuel loading and thus decrease the risk of large wildfires in the long term.

On the TNF, salvage operations may increase the timber supply and reduce prices on a short-term basis, but the long-term impact is negligible. Timber salvage operations occur on a small scale on the INF, especially in the south where the primary use of felled trees is for personal firewood by the public. Lack of a commercial timber or biomass market is a limiting factor for the amount of fuel treatments that are possible on the INF. A biomass pilot project would be helpful in determining whether the area could support a biomass plant.

Aspen Restoration

A forestwide condition assessment for aspen stands (*Populus tremuloides* Michx.) is currently being conducted that will identify areas where treatments can be prioritized based on needs for stand improvement. Conditions that lead to a stand's risk of loss include conifer encroachment, browsing, and campground development. Aspen treatment areas are chosen for multiple management objectives including reduction of fuel loading and beetle infestation. Treatment allows aspen to regenerate, increasing water retention in the system and supporting biodiversity. Another example is prioritizing aspen treatments in the WUI, for example, around the town of Mammoth Lakes. It is hoped that the site will be capable of retaining aspen over time, although there has not been an indepth analysis. No consideration of extreme weather events is occurring, but additional thinning, in excess of what is needed for other purposes such as bark beetle infestation, is done to increase resilience and provide for a more resilient aspen stand.

Meadow and Stream Restoration

With warming temperatures and reduced snowmelt, many meadows are starting to dry. Whether rainfall or snowmelt is more important for groundwater recharge depends on the site characteristics. Meadows that are stream-fed may experience drying from decreased and intermittent streamflow. Rain-on-snow events and extreme weather are concerns for some of the lower elevation streams. The hydrologic regime could change, with reduced waterflow in the summer. On the other hand, there may potentially be new habitat created, for example, in areas that used to be permanent snowfields.

Managers are considering climate change in meadow restoration, although grazing and aquifer depletion may also be causing drying that has been occurring for decades. There is some concern that investment in meadow restoration may be futile if streams will eventually dry out owing to climate change.

Solutions that are being considered to restore streams include increasing bank building, replacing old structures, stabilizing banks with vegetation, increasing the flood plain by reducing the stream width, potentially maintaining a smaller channel system to accommodate lower flows, although with larger built flood plains to accommodate more frequent and heavier flash floods.

In general, these actions may only be temporary solutions, but they may be better than no action in some situations. Project sites are selected opportunistically rather than strategically, focusing on those that are the least degraded, have an obvious fix, have been in the queue for years, or that involve a threatened or endangered species and thus require legal action. For example, bank incision by cattle and packstock has already reduced flow in some streams, particularly in late summer. Stream restoration at these sites provides an obvious fix to increase resilience to warming, extreme weather events, and changed precipitation patterns.

The ongoing stream restoration projects, although not specifically focused on climate change effects, nevertheless counteract warming and drying effects by increasing riparian vegetation, reducing streambank erosion, creating cold water pools, and increasing meadow storage of water. Furthermore, California golden trout are a major focus for stream restoration on the INF. Their size and reproduction are adversely affected by high water temperatures; thus, stream restoration can help offset the effects of warming climates for the golden trout. However, the restoration actions that are being implemented, at least in some cases, are not strong enough to withstand an extreme event, especially if it happens soon after the project's completion.

Grazing and recreation were not considered a major threat for most of the ongoing meadow restoration projects. In one case, it was felt that reduced grazing near streambanks would help, especially late in the season when it's dry and cattle congregate on the streambanks. At one site, there was a lot of hiking activity on the edge of the meadow, and, in some cases, through the meadow that could potentially be moved and at least formalized to protect the meadow.

Aquatic and Wildlife Species Restoration

The mountain yellow-legged frog (*Rana muscosa*), Yosemite toad (*Bufo canorus*), California golden trout (*Oncorhynchus mykiss aguabonita*), sage grouse (*Centrocercus urophasianus*), and Sierra bighorn sheep (*Ovis canadensis sierra)* have been the primary focus for ongoing projects on the INF. Some feel that the treatment of land to conserve threatened and endangered species is a short-term fix, but the combination of legal status and wilderness designation often greatly reduces the options for management. From a climate change perspective, a future approach could be to manage some habitats as climate refugia for potentially threatened wildlife such as the American pika (*Ochotona princeps*). Knowing the future range of wildlife would be very helpful and relevant but is currently unknown for most species.

The Sierra bighorn sheep project on the INF, an action from the species's recovery plan, was proposed and designed by California Department of Fish and Game in areas where it was felt that the population had the greatest chance for recovery and maintenance and where vegetation changes were responsible for constricting sheep to higher elevations. Basically it strives to increase access to winter habitat with reduced predation pressure from mountain lions (*Puma concolor*). Sierra bighorn sheep are shifting their range to higher elevations, most likely because of increased predation: "lions have forced them to do what climate change may force them to do in the future." The biggest problem for the species seems to be finding quality forage during the winter months; warming conditions could change this. The population seems stable, although they are not living in their optimal habitat. Some other requirements, such as mineral licks and specific topography, should not change under climate change.

The INF is also restoring habitat for sage grouse, which are currently under petition for federal listing. It has been removing conifers from sagebrush habitat since fire suppression and warming climates have contributed to their expansion over the past century. There are other threats to sage grouse habitat, including the opposing concern of too intense fires leading to sagebrush converting to cheat grass and other invasives, oil and gas leasing throughout their range, and urban and human expansion. The future range of sage grouse is unknown, except that sagebrush will be a limiting factor. There are concerns that sagebrush habitat will be converted to agriculture or lost to fire or development and that pinyon pine will expand its range and negatively affect sage grouse habitat.

The effects of changing climate on breeding, birthing, and forage seasons are unpredictable. Breeding is flexible in sage grouse so climate shifts may not be a problem. Day length may determine the sage grouse reproductive cycle; therefore, extreme weather and changing climates may create a mismatch between the food source and natural history, reducing offspring survival. Sage grouse depend on moist environments to sustain their food source, particularly in spring, when young get a protein boost from burgeoning insect populations. If there is a decrease in precipitation such that insect populations decline, there could be a reduction in sage grouse numbers. If the sagebrush move up in elevation (which is unlikely because of conifer shading), sage grouse will not follow because they do not like the cover for predators that shading creates. Sage grouse may move preferentially onto ecotypes such as those currently administered by BLM.

In the case of the Sierra bighorn sheep, the forage season is lengthening. As a result, the breeding and fawning season might change. Considerations of effects of climate change on hunting wildlife, for example, sage grouse, may be important; hunting season may need to shift or perhaps numbers allowed will need to be reduced.

Grazing

Meadow restoration through temporarily reduced grazing can increase water storage, allowing for future grazing operations and mitigating for anticipated drying conditions. If meadows are shrinking as a result of climate change, then grazing might be a less suitable use of rangeland. However, if restoration efforts are successful, grazing could still remain viable. Grazing allotments on the INF already consider watershed conditions and wildlife use. Allotments can be closed but only for legal and project-defensible reasons, such as the impact on threatened and endangered species. In general, in many INF allotments, allowable use is being reduced based on monitoring and condition assessments and a need to improve vegetative and hydrologic conditions. Grazing reduction is occurring on the TNF to allow for revegetation and hydrologic restoration.

Grazing seasons may change owing to the anticipated shorter growing season. With shorter growing seasons, utilization levels might still be appropriate if the season was moved earlier, or if meadow restoration efforts are successful. The standard benchmarks that are used for these decisions, for example, sage grouse breeding season is June 15, may need to be reconsidered as wildlife adapt to changing seasons. Utilization levels also depend on the species mix of forage. Inventories and protocols that determined the mapping of suitable range may need to be updated to take climate change and local ground conditions into consideration. If spring arrives earlier, the schedule might be moved forward to take advantage of the new growth. Likewise, cattle might need to be pulled off earlier than usual if summers are drier. Water availability is considered when determining allotments but not future water availability under drying climates. Meadow restoration efforts can help offset the impact of climate change by increasing the amount of water storage and availability. The Watershed Condition Inventory and Hydrologic Function Protocol are from 1995 and would benefit from review and updating. Finally, there are wildlife disease transfer concerns, which climate change may exacerbate.

Road Maintenance, Construction, and Decommission

Road maintenance is used to improve stream crossings, improve hydrologic function, and reduce erosion. However, increasing extreme weather effects such as severe flooding are not yet being considered. Projects are often short-term fixes, needing maintenance every 3 to 5 years, and some roads are not used often enough to justify spending the resources so they can withstand extreme weather events. Road maintenance and road repair after a wildfire is an opportunity to replace culverts and consider sizing up the culvert to accommodate higher runoffs.

Road decommissioning can act to increase resilience in a system by decreasing stressors. When roads are decommissioned, normal, not extreme, weather is considered. However, it is unclear whether there would be a different kind of treatment regardless. Finally, INF is concerned about invasive species in road decommissioning and many other projects, and it has established a strict protocol to prevent their spread.

Recreation Planning

For the most part, managers are not actively considering climate change in the context of recreation planning. However, there is precedent for such consideration as issues of water shortage are taken into account.

The effect of climate change may be to shift activity types; for example, the length of the ski season may shorten as a result of a shorter snow season. Thus there may be higher social densities, permittees may have more marginal operations, people may ski in different areas (e.g., higher elevation), or perhaps new technology will develop (along the line of wet snow skis or mountain boarding). Ground water issues could increase if snowmaking becomes more common. Some ski resorts may actually expand use if they are at higher elevations with better snow and better access than other ski lodges. For now, the potentially reduced season of use has not impacted the contractual language on the INF in special use permits, although it could change in the future.

There is a concern with having safe places for people to go or viable escape routes when there are extreme weather events or fire emergencies. Furthermore, wildfires will likely become more frequent and more severe as the environment warms and dries. The increase in severe wildfires is already causing concern among managers, although it is less of an issue on the INF than other national forests in California. In response, greater fire restrictions could be imposed, for example, more frequent use of stage 2 restrictions (no fires, even in rings). There may be awareness growing for flash floods as well, especially after wildfire, but no new action has been taken to protect the public from these increased threats.

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