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Climate Change Adaptation Strategies for Resources of the Nez Perce-Clearwater National Forests

A report to the Nez Perce-Clearwater National Forests and U.S. Forest Service Northern Region

EcoAdapt

April 2015

Cover photo: U.S. Forest Service

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Table of Contents

List of Tables

1. Introduction

EcoAdapt led a two-day workshop entitled *Climate Change Adaptation Planning for Nez Perce-Clearwater National Forests* on November 12-13, 2014 at the Nez Perce National Forest Supervisor's Office in Grangeville, ID.[1] Approximately 23 Nez Perce-Clearwater National Forests staff participated in the workshop (see individual adaptation sections for list of participants).

This report focuses on the second in a series of two workshops on climate change vulnerability assessment and adaptation planning for Nez Perce-Clearwater National Forests. The first workshop (*Vulnerability Assessment Workshop for Nez Perce-Clearwater National Forests),* held September 10-11, 2013 in Grangeville, ID, included a review of climate trends for the Nez Perce-Clearwater region; an introduction to vulnerability assessment methodology; and vulnerability assessment application for a suite of species, habitats, and ecosystem services chosen prior to the workshop.[2]

The vulnerabilities of 28 ecosystems and species were evaluated during the first workshop and included eight ecosystems:

- aquatic,
- coastal disjunct,
- dry forest,
- grassland,
- mixed mesic,
- riparian,
- subalpine, and
- wetlands/moist meadows/groundwater-dependent ecosystems).

Twenty species were also evaluated during the workshop, including:

- aquatic species,[3]
- Canada lynx/wolverine (assessed together),
- Coeur D'Alene and Idaho Giant salamanders,
- dry forest birds,[4]
- fisher,
- mountain goat,
- red alder,

[1] Information from the workshop such as the agenda, presentations, handouts, readings, and other resources can be found at: http://ecoadapt.org/workshops/adaptation-nezperce-clearwater

[2] Information from the workshop such as the agenda, presentations, handouts, readings, and other resources can be found at: http://ecoadapt.org/workshops/va-workshop-npcw.

[3] Aquatic species considered as part of this assessment included: Fall and Spring Chinook salmon, steelhead, cutthroat trout, westslope cutthroat trout, bull trout, and interior redband trout.

[4] Dry forest bird species considered as part of this assessment included: flammulated owl, Lewis's woodpecker, pygmy nuthatch, and white-headed woodpecker.

- Spalding's catchfly, and
- whitebark pine.

Results of the focal resource vulnerability assessments including vulnerability summaries, vulnerability assessment methodologies, and downscaled climate information is included in the report, *A Climate Change Vulnerability Assessment for Resources of Nez Perce-Clearwater National Forests* (EcoAdapt 2014).[5] The vulnerabilities of local communities as well as important regional ecosystem services are discussed in a companion report prepared by Headwaters Economics.[6]

Adaptation Planning Workshop Background

Purpose

The purpose of the workshop was to bring together resource specialists from Nez Perce-Clearwater National Forests to explore the potential impacts of climate change on management goals and activities, and to identify possible adjustments to existing goals or actions to enhance effectiveness given climate change. The two-day workshop included:

(1) a review of projected climatic changes for the Nez Perce-Clearwater region,
(2) a review of the vulnerability assessment workshop held in September 2013,
(3) the generation of adaptation strategies and tactics designed to reduce vulnerabilities or increase resilience of important forest resources, and
(4) an initial prioritization of adaptation tactics including when and where to implement.

Eight key resource areas were identified for the workshop:

- Forested vegetation
- Non-forested vegetation
- Wildlife
- Hydrology
- Fisheries
- Recreation
- Cultural/Heritage
- Ecosystem services

Goal

The main goal of the adaptation planning workshop was to create an opportunity for resource managers, planners, and others from Nez Perce-Clearwater National Forests to review the results of the vulnerability assessment; discuss their options for managing resources in the face of climate change; and improve understanding of how vulnerability and adaptation information can be integrated into management operations.

[5] http://bit.ly/NPCW_Vulnerability_Assessment
[6] http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3804265.pdf

Outcomes

Over the course of two days, participants worked through an interactive process to identify adaptation strategies and tactics for important forest resources. Workshop outcomes included:

1. Identification of resource linkages and cross-sector issues, including direct and indirect effects of resources on one another.
2. Identification of current management goal(s) and activity(ies) and evaluation of vulnerabilities given climatic and non-climatic stressors.
3. Generation of adaptation strategies and tactics for a given resource area that can be implemented to help achieve management goals in the face of climate change.
4. Comparison of adaptation tactics across resource areas and discussion around potential conflicts – for example, if adaptation tactic X (identified for one resource area) is implemented here, how may it affect other neighboring resource areas?
5. Prioritization of adaptation tactics for implementation.

Approach

The workshop was designed to include a mix of conceptual and scientific presentations, interactive planning through small group dialogue, and large group discussions and brainstorming. The objective was to provide participants with key background information; create an opportunity for people to identify adaptation tactics for a given resource area; and improve awareness about how implementation of one management tactic for a resource area (e.g., forested vegetation) may have direct and/or indirect effects on another resource area (e.g., hydrology).

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2. Workshop Methodology: Presentations and Activities

The workshop was comprised of a short series of presentations followed by a number of activities including small working groups and large group discussions. Presentations and activities are summarized below.

Presentations

Overview of Vulnerability Assessment Workshop and a review of natural resource vulnerabilities for the Nez Perce-Clearwater region

Jessi Kershner, EcoAdapt

Jessi provided a review of the Nez Perce-Clearwater vulnerability assessment, including how focal resources (i.e., ecosystems, species, ecosystem services) were selected, the vulnerability assessment methodology followed during the Vulnerability Assessment Workshop held in September 2013, and the results of the final vulnerability assessment report. Jessi also outlined how the vulnerability assessment information can be applied in management operations and help address specific Climate Scorecard elements.

Review of socioeconomic and ecosystem service vulnerabilities for the Nez Perce-Clearwater region

Keith Stockmann, U.S. Forest Service

Keith provided an overview of the socioeconomic vulnerability assessment for Nez Perce-Clearwater National Forests, including an overview of community and ecosystem service vulnerabilities.

Introduction to climate change adaptation

Rachel M. Gregg, EcoAdapt

Rachel presented an overview of climate change adaptation, including discussing the difference between mitigation and adaptation; outlining resistance, resilience, and response adaptation strategies; defining adaptation tactics and providing examples of possible tactics; and describing a number of different case studies of adaptation in action. Rachel also highlighted a number of key considerations including: (1) the need for managers to focus on what they currently do and adjusting that for the reality of climate change; (2) identifying a clear purpose or goal; (3) considering multiple time scales; and (4) recognizing unintended consequences or effects on other sections.

Planning issues to direct revision or amendment of an existing land management plan

Rachel M. Gregg, EcoAdapt

Rachel presented an example of how climate change information can be incorporated into land management plan revisions or amendments. In her presentation, Rachel focused on how the Bureau of Land Management (BLM) and Forest Service (FS) are addressing the potential expansion of non-native annual grasses and the associated loss of sagebrush habitats as a result of climate change. Specifically, Rachel identified the following ways in which climate change was integrated:

- **Flexibility**. The BLM and FS highlighted the need to reevaluate decisions and adjust management accordingly to better cope with uncertain future conditions.
- **Future conditions**. The BLM and FS identified native seed collection as a management action necessary to support the re-establishment of sagebrush cover and desirable understory plants. When determining native seed species for restoration, climate change is to be considered both in terms of the resilience of native seed species to future conditions and in terms of which native seed areas to target for collection first (i.e., because they occur in a fire-prone area).

Activities

The workshop included a number of different activities ranging from small working group activities on a given resource to large group discussions on resource linkages and potential conflicts among resources. Activities are described in more detail below.

1. **Resource linkages and cross-resource issues (large group discussion)**
   Participants were asked to consider the ways in which resources directly and indirectly affect one another during a large group discussion. The group would select a given resource (e.g., fisheries) and identify the other resources that can affect fisheries (e.g.,

hydrology, grazing) as well as the other resources that fisheries can affect. The purpose of this activity was to improve understanding of cross-resource issues and how resources influence one another.

2. **Generating adaptation strategies and tactics for current and/or future management activities (small working groups)**
   Participants were divided into small working groups based on area of expertise. Within these working groups, participants identified current management goals and activities, explored potential climatic and non-climatic vulnerabilities, and generated a number of adaptation strategies and tactics designed to address vulnerabilities.

3. **Exploring synergies and conflicts among terrestrial or freshwater adaptation strategies and tactics (medium working groups)**
   Participants from terrestrial resource groups (i.e., forested vegetation, non-forested vegetation, wildlife, recreation) and freshwater resource groups (i.e., hydrology, fisheries) came together to share the adaptation strategies and tactics developed in their small working groups. The purpose of this activity was to begin to identify adaptation options recommended by multiple resource areas, and to recognize any potential conflicts between adaptation tactics.

4. **Discussing direct and indirect effects of adaptation tactics on other resources (large group discussion)**
   Participants from each resource area (e.g., fisheries, forested vegetation) were encouraged to share their top adaptation strategies or tactics. The larger group then discussed potential conflicts with other resources if that adaptation strategy or tactic was implemented. The purpose of this discussion was to improve understanding of adaptation tactic implementation tradeoffs, and to identify the ways in which the tactic could be modified to incorporate other resource considerations.

5. **Developing adaptation strategies and tactics for ecosystem services (small working groups)**
   Participants were asked to review potential management strategies identified as part of the socioeconomic vulnerability assessment, and expand upon them and/or develop new adaptation strategies and more specific adaptation tactics designed to address vulnerabilities for each ecosystem service. In particular, participants were asked to identify potential implementation constraints or unintended impacts of other resources on a given ecosystem service. Ecosystem services considered in this activity included: clean air, clean water, cultural and heritage values, forage, recreation, and timber.

6. **Prioritizing adaptation tactics for implementation (small working groups)**
   Participants reconvened in their small working groups to prioritize adaptation tactics for implementation. As part of this activity, participants were asked to consider where and how they would implement the tactics, as well as identify collaboration and capacity

needs. In particular, participants were encouraged to identify the other resource areas to collaborate with in order to avoid potential conflicts or unintended impacts.

7. **Sharing top adaptation tactics (large group discussion)**
   Participants from each resource area – forested vegetation, non-forested vegetation, recreation, wildlife, hydrology and fisheries, cultural and heritage values – shared their top adaptation tactics, including implementation details with the larger group.

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3. Forested Vegetation

Participants:	Michael Brumbaugh	Kris Hazelbaker
	Katie Chambers	Barry Ruklic
	Susan Harries	Rob Schantz

Introduction

The following section presents climate change adaptation planning results for forested vegetation. The results summarize discussions and activities completed by participants during the workshop. We first present current management **goals** identified by participants. The purpose of identifying management goals is to provide a foundation for evaluating whether and how climate change might affect the ability to achieve a given goal, and to develop adaptation options for addressing vulnerabilities. For each management goal, participants identified potential vulnerabilities and/or opportunities presented by climate change. This activity was followed by the generation of broad adaptation **strategies** and more specific adaptation **tactics** designed to address vulnerabilities for each management goal. We then present a table linking vulnerabilities to management goals, adaptation strategies, and tactics generated by participants. The purpose of this table is to summarize the ability of adaptation tactics to ameliorate the effects of climatic and non-climatic stressors on a given resource area. Following the identification of adaptation strategies and tactics, we explore potential effects, both direct and indirect, of other resources on forested vegetation and vice versa. As part of this discussion, participants highlighted adaptation tactics that may have potential conflicts with other resources. Lastly, we present an in-depth exploration of adaptation tactics, including where, when, and how to implement those tactics as well as collaboration and capacity needs.

Defining Terms

Goal: A desired result for a given resource.

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

Current Management Goals and Potential Vulnerabilities

Workshop participants identified three key current management goals for forested vegetation:

(1) restore whitebark pine habitat,
(2) improve forest health through insect and disease risk management, and
(3) maintain ash cap soil productivity.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to these current management goals for forested vegetation. Potential climatic and non-climatic vulnerabilities identified include:[7]

- Warmer temperatures
- Drought
- Reduced soil moisture
- Altered species composition
- Altered wildfire regimes
- Insect and disease outbreaks

Adaptation Options to Ameliorate Impacts

In response to these vulnerabilities, participants developed a number of adaptation strategies and tactics designed to reduce vulnerability or increase resilience of forested vegetation. Workshop participants identified the following adaptation strategies for current management goals of forested vegetation:

Goal: Restore whitebark pine habitat.

Adaptation strategy: Increase resilience of whitebark pine to climate change by improving regeneration.

Goal: Improve forest health through insect and disease risk management.

Adaptation strategy: Reduce stand densities and improve resilience and forest health in the face of changing climate conditions.

Adaptation strategy: Favor fire-adapted, drought-resistant, and/or shade-intolerant species likely to be more resilient to changing climate conditions.

Adaptation strategy: Restore historic species composition and structure in the mixed mesic forest type to increase resilience to root diseases and bark beetles, which may increase under climate change.

Goal: Maintain ash cap soil productivity.

Adaptation strategy: Continue to maintain ash cap soil productivity to help ensure healthy, productive stands with projected loss of soil moisture as a result of climate change.

Participants also identified a suite of adaptation tactics. Table 1 highlights these adaptation strategies and tactics, and classifies them as either likely or not likely to ameliorate impacts of a given climatic or non-climatic stressor on forested vegetation. These classifications are based on expert opinion.

[7] These vulnerabilities were also identified in the Nez Perce-Clearwater National Forests Vulnerability Assessment report.

Participants of the forested vegetation group identified several top adaptation tactics including:

- thinning,
- commercial regeneration harvest, and
- prescribed burning and managed wildfire.

Thinning

Within dry forest ecosystems, participants recommended thinning to promote pine species and reduce grand fir and Douglas fir. Within mixed mesic ecosystems, participants recommended targeted thinning to promote western larch, ponderosa pine, and white pine over grand fir and Douglas fir. Targeted removal of grand fir and Douglas fir was recommended because these two species may be more susceptible to warming temperatures, drought, and root disease, all of which are projected to increase in the future as a result of climate change. Participants recommended thinning in front country areas and in stands with species other than Douglas fir, and suggested avoiding management activities in landslide-prone areas. In the backcountry, participants recommended thinning in non-wilderness areas combined with managed wildfire.

Regeneration harvest

Regeneration harvest was identified as a recommended tactic in grand fir dominated stands, as it was thought to be one of the only viable options for managing this species. However, regeneration harvest presents a major conflict for hydrology and fisheries as it can increase the risk of peak flow (i.e., more runoff from upland areas into aquatic system) and/or increase sedimentation and erosion damage in aquatic systems. Participants discussed the possibility of creating a mosaic of smaller canopy openings in grand fir dominated stands as an alternative to regeneration harvest. Roads to support forested vegetation management activities were also identified as a key threat to aquatic systems and species.

Table 1. Summary of adaptation strategies and tactics and their ability (indicated by an "X") to ameliorate effects of climatic and non-climatic stressors on forested vegetation.

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates increasing temperatures	Ameliorates increasing water stress	Ameliorates insect and disease impacts	Ameliorates altered fire regimes
Restore whitebark pine habitat	Increase resilience of whitebark pine by improving regeneration	Plant blister rust-resistant whitebark pine trees			X	
		"Daylight" thin areas around new plantations and other areas where competition occurs	X	X	X	X
		Use prescribed burning to remove competitive species		X	X	X
Improve forest health through insect and disease risk management	Reduce stand densities and improve resilience and forest health	Thin overstocked stands (commercial and pre-commercial), and increase plant spacing in new stands	X	X	X	X
		Reduce invasive weeds				X
		Plant seral species and increase species diversity; reduce shade-tolerant species	X	X		
		Establish burning intervals in ponderosa pine habitats	X	X	X	X
	Favor fire-adapted, drought-resistant, shade-intolerant species	Plant ponderosa pine as opportunities arise on dry habitat types	X	X		X
		Implement regeneration harvests in grand fir and cedar forest types to allow regeneration of western white pine, western larch, and ponderosa pine	X	X	X	X
		Promote wildland fire to manage vegetation outside of suitable lands		X		X
		Thin (either pre-commercial or commercial) in mixed species stands to favor white pine, western larch, and ponderosa pine	X	X	X	X
	Restore historic species composition and structure in the mixed mesic forest type to increase resilience to root diseases and bark beetles	Utilize improvement cuts (i.e. thinning) focused on retaining/promoting western larch, white pine, and ponderosa pine	X	X	X	X
		Use regeneration cuts - seed trees, shelterwood, or clearcut with reserves - to retain existing and/or plant new western larch, white pine, and ponderosa pine	X	X	X	X

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates mixing of top soil and sub-soils	Ameliorates reduced soil moisture	Ameliorates erosion and soil nutrient loss
Maintain ash cap soil productivity	Continue to maintain ash cap soil productivity to help ensure healthy, productive stands with projected loss of soil moisture as a result of climate change	Shift harvest activity towards stands on ash-capped soils	**X**	**X**	**X**
		Reduce loss of ash-capped soils during management activity and infilstructure		**X**	**X**
		Reduce soil compaction during harvest management activity		**X**	**X**

Resource Direct/Indirect Effects

During the workshop, participants were asked to consider the ways in which other resources (e.g., wildlife habitat, fire) affect forested vegetation, both directly and indirectly, as well as the ways in which forested vegetation affects other resources. Figure 1 below summarizes the direct and indirect effects of other resources on forested vegetation, as well as the direct and indirect effects of forested vegetation on other resources.

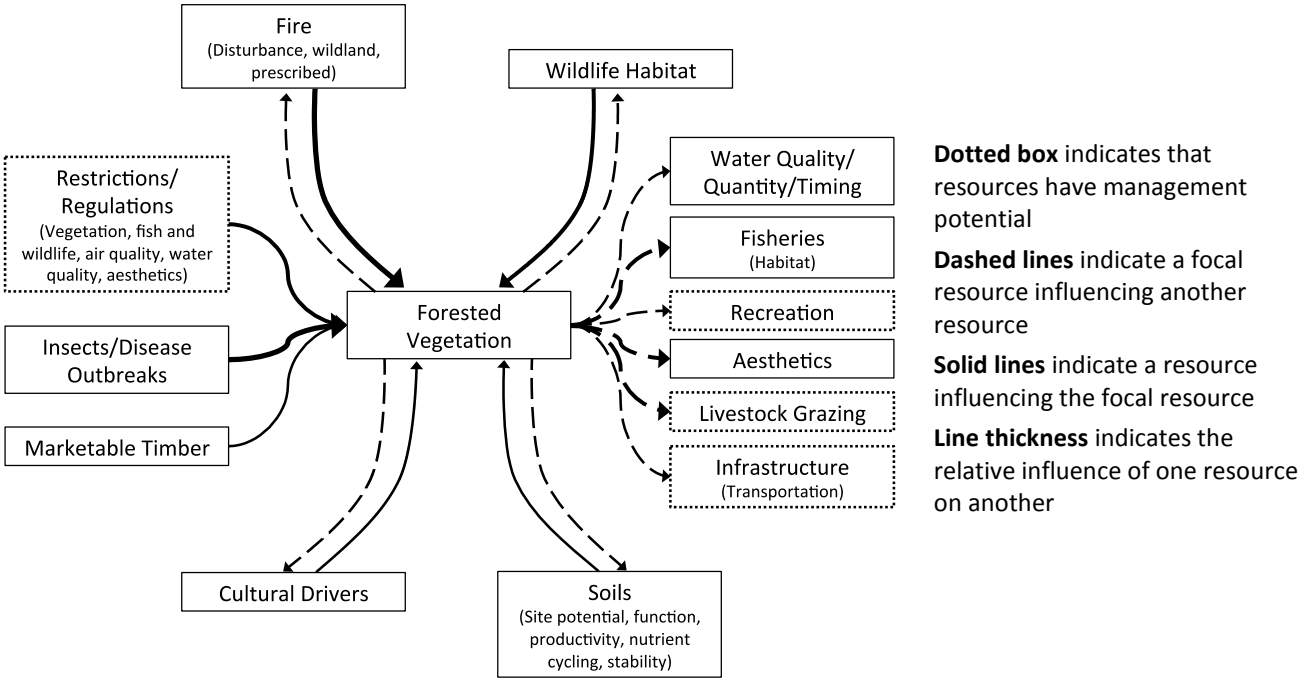

Figure 1. Exploration of direct/indirect effects of other resources on forested vegetation, as well as the direct/indirect effects of forested vegetation on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

In addition to exploring direct/indirect effects, participants were asked to consider potential conflicts that could arise when implementing specific adaptation tactics. Specifically, what potential conflicts could arise with other resources if adaptation tactic X is implemented? The discussion centered on two adaptation tactics: thinning and regeneration harvest in forested vegetation, with major conflicts identified for aquatic systems and species.

Participants identified two potential major impacts of thinning and regeneration harvest on aquatic systems and species: (1) increased sedimentation and erosion, and (2) loss of canopy cover and shading in riparian areas. Specifically:

- Thinning can cause loss of canopy cover, exacerbating peak flow damage to aquatic systems and species due to increased runoff. This impact would likely be exacerbated if regeneration harvest was applied instead.

- Creation of infrastructure (i.e., roads) required for large-scale thinning or regeneration harvest projects can increase erosion and sedimentation issues in aquatic systems due to decreased soil stability.
- More canopy openings due to regeneration harvest projects could inadvertently encourage the creation of additional roads and/or increase density of roads on forestlands, with subsequent impacts on soil stability and erosion potential.
- Thinning in riparian areas may lead to loss of canopy cover and shading important for helping offset increasing stream temperatures. Thinning should be avoided in riparian areas whenever possible, with site-specific exceptions (e.g., campgrounds, administrative sites).

During the discussion, participants prioritized regeneration harvest (compared to thinning) as the major conflict for aquatic systems and species. Participants also identified the need to introduce more resilient species to vegetation management activity areas (e.g., regeneration harvest, thinning) and catastrophic burn areas. For additional potential conflicts identified in the literature, please see the Conclusions section of this report.

Implementation of Adaptation Tactics

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for forested vegetation, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.
- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas

with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.

- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 2-4 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for forested vegetation. Each table is structured to provide:

1. A current management goal
2. Potential climatic and non-climatic vulnerabilities and/or opportunities that affect the success of achieving the management goal
3. A broad adaptation strategy
4. Multiple adaptation tactics
5. An evaluation of tactic effectiveness, feasibility, timeframe, and implementation scale
6. A description of where and how to implement and collaboration and capacity needed to move forward with implementation

This workshop activity was intended to generate a range of recommended adaptation tactics that could be implemented both now and in the future. The resulting tactics are not comprehensive, and users of this report are encouraged to explore additional adaptation tactics that may help reduce vulnerabilities, increase resilience, or capitalize on opportunities presented by climate change in forested vegetation.

Table 2. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the forested vegetation goal "Restore whitebark pine habitat". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Restore whitebark pine habitat

Potential vulnerabilities/opportunities:

- Increased temperatures
- Decreased snowpack
- Altered species composition

Adaptation strategy: Increase resilience of whitebark pine to climate change by improving regeneration

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Plant blister rust-resistant whitebark pine trees	High	High	Near	Project	**Where:** At higher elevations, north aspects, lower elevation sites with microclimates that could support WBP, and areas that have demonstrated previous robust growth **How:** Identify suitable locations and carry out planting efforts	**Internal collaboration:** Fire, seasonal/ permanent staff, nursery, engineers **External collaboration:** Contractors **Local group help:** Volunteer organizations (YCC) **Capacity needed:** Funding, infrastructure, and stand exam data
"Daylight" thin areas around new plantations and other areas where competition occurs	Mod	High	Near-Mid	Project	**Where:** Primarily in lodgepole pine dominated areas **How:** Mechanical treatments	**Internal collaboration:** Fire, wildlife (potential Clarks nutcracker conflict), recreation, hydrology, fisheries, and engineering **External collaboration:** Contractors **Capacity needed:** Funding, stand exam data, staff

Use prescribed burning to remove competitive species	High	High	Near	Project	**Where:** In areas where there is sufficient moisture to allow for prescribed burning **How:** Identify suitable sites for prescribed burns based on soil moisture	**Internal collaboration:** Fire, soils, recreation, wildlife, and engineering **Capacity needed:** Funding, staff, stand exam data

Table 3. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the forested vegetation goal "Improve forest health through insect and disease risk management". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Improve forest health through insect and disease risk management

Potential vulnerabilities/opportunities:

- Decreased precipitation and increased temperatures may decrease seedling survival
- Increased temperatures could limit shade-tolerant species
- Increased temperatures could increase risk during prescribed burning and/or affect burning window length
- Climate change may increase insect and disease risk faster than treatments can address it
- Increased fire may provide for more regeneration needs than seed/seedling supply can address

Adaptation strategy: Reduce stand densities and improve resilience and forest health in the face of changing climate conditions

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Thin overstocked stands (commercial and pre-commercial), and increase plant spacing in new stands	High	High	Near-Long	Program (Watershed Assessments)	**Where:** Areas expected to have decreased snowpack and water-holding capacity **How:** Mechanical treatments	**Capacity needed:** Funding or market for material **External collaboration:** Wood products industry to enhance wood product markets
Reduce invasive weeds	Mod	Mod	Near-Long	Project	**Where:** no answer **How:** Include prevention strategy in all projects; inventory regularly to detect new populations and species, and eradicate low-density populations	**External collaboration:** State agencies and private landowners **Capacity needed:** Funding for inventory and treatment

Plant seral species and increase species diversity; reduce shade-tolerant species	High	Mod	Mid-Long	Project	**Where:** Target areas at risk to wildfire and/or insect disease outbreaks; under-stocked areas **How:** Harvest and plant with wider spacing; consider planting ponderosa pine in under-stocked areas; remove shade tolerant species during burning or pre-commercial thinning	**Capacity needed:** Funding for I&D inventory and fuel loading data collection; seed availability limits capacity (have capacity for double what we do now if seed is available)
Establish burning intervals in ponderosa pine habitats	High	High	Near-Long	All	**Where:** Lower elevation and big game winter ranges **How:** Time burns to reduce risk	**External collaboration:** Private landowners with property adjacent to forest
Adaptation strategy: Favor fire-adapted, drought-resistant, and/or shade-intolerant species likely to be more resilient to changing climate conditions						
Adaptation tactic	**Effectiveness**	**Feasibility**	**Timeframe**	**Implementation scale**	**Implementation (where/how)**	**Collaboration & capacity**
Plant ponderosa pine as opportunities arise on dry habitat types	High	High	Near-Mid	Project	**Where:** On breaklands, grand fir habitat types on uplands **How:** Include or increase amount of ponderosa pine in planting mixes on those sites	**Internal collaboration:** Increasing ponderosa pine is compatible with most other resources **Capacity needed:** Infrastructure exists to do this, having an adequate supply of ponderosa seed may be limiting
Implement regeneration harvests in grand fir and cedar forest types to allow regeneration of western white pine, western larch, and ponderosa pine	High	Mod	Near-Mid	Project and Program	**Where:** On uplands/ breaklands where mixed mesic forests exist; DFCs help identify specific needs **How:** Coordinate with fish/hydrology and wildlife expertise to maintain habitat; coordinate with scenic integrity goals	**Internal collaboration**: Fisheries, hydrology, and wildlife **External collaboration:** Regulatory agencies regarding listed species **Capacity needed**: Funding and additional staff to accommodate proposed increased activity

Promote wildland fire to manage vegetation outside of suitable lands	Mod-High	High	Near-Long	Program	**Where:** Wilderness areas and Idaho Roadless Rule lands **How:** Continue current prescribed burn program and wilderness fire program	**Internal collaboration:** All resource areas associated with planning prescribed fire **External collaboration**: Coordinate with air quality monitoring group **Capacity needed**: Adequate personnel; main limitation is the timing of suitable burning windows
Thin (either pre-commercial or commercial) in mixed species stands to favor white pine, western larch, and ponderosa pine	Mod	Mod	Near-Long	Project and Program	**Where:** Dry sites where ponderosa pine is a part of the forest composition; mixed mesic sites where ponderosa pine, western larch, or white pine are a significant part of the stand composition; lodgepole pine stands where western larch is a significant part of the stand composition **How:** In young stands, pre-commercially thin to favor ponderosa pine, western larch, and white pine; in older stands, pre-commercially thin where ponderosa pine, western larch, or white pine make up at least half of full stocking	**Internal collaboration:** Wildlife and NEPA specialists **Capacity needed:** Funding and additional staff to accommodate proposed increased activity
Adaptation strategy: Restore historic species composition and structure in the mixed mesic forest type to increase resilience to root diseases and bark beetles, which may increase under climate change						
Adaptation tactic	**Effectiveness**	**Feasibility**	**Timeframe**	**Implementation scale**	**Implementation (where/how)**	**Collaboration & capacity**

Utilize improvement cuts (i.e. thinning) focused on retaining/promoting western larch, white pine, and ponderosa pine	High	High	Near-Long	Project	**Where:** In roaded and semi-roaded front country, mainly grand fir habitat types; upland sites, and potentially Riparian Conservation Areas; stands average ≥ 60ft^2 basal area in western larch-ponderosa pine **How:** Timber sale or stewardship contracting authorities	**External collaboration:** Will likely have high acceptance among collaborative groups **Capacity needed:** Additional staff for silviculture diagnosis, stand exam data, and timber preparation
Use regeneration cuts - seed trees, shelterwood, or clearcut with reserves – to retain existing and/or plant new western larch, white pine, and ponderosa pine	High	Mod	Near-Long	Project	**Where:** Stands dominated by grand fir, Douglas fir, western hemlock, or cedar **How:** Timber sale or stewardship contracting authorities	**External collaboration:** Will likely have lower acceptance among environmental collaborative groups **Internal collaboration:** Soils, fisheries, and hydrology **Capacity needed:** Timber preparation and seed inventories

Table 4. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the forested vegetation goal "Maintain ashcap soil productivity". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Maintain ash cap soil productivity

Potential vulnerabilities/opportunities:

- Stands growing on ash cap soils will be less vulnerable to climate change due to higher water holding capacity and nutrient availability than non-ash capped soils

Adaptation strategy: Continue to maintain ash cap soil productivity to help ensure healthy, productive stands with projected loss of soil moisture as a result of climate change

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Shift harvest activity towards stands on ash-capped soils, which have higher water-holding capacity	High	High	Mid-Long	Forest Plan	**Where:** Stands growing on ash capped soils **How:** This is primarily already being done by default because these soils are producing healthy timber products	**Internal collaboration:** Silviculture, soils (ash cap and soil moisture maps), and harvest management
Reduce loss of ash capped soil during management activity and infilstructure, and maintain trees on landslide prone areas	High	High	Near	Project	**Where:** Landslide prone areas **How:** This tactic is primarily already being done	**Internal collaboration:** Silviculture and road engineering
Reduce soil compaction during harvest management activity	High	High	Near	Project	**Where:** High harvest traffic locations/ management activity **How:** Promote the use of slash barriers on soils by harvest contractors to protect soil from compaction	**Internal collaboration:** Harvest management

4. Non-Forested Vegetation

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Introduction

The following section presents climate change adaptation planning results for non-forested vegetation. The results summarize discussions and activities completed by participants during the workshop. We first present current management **goals** identified by participants. The purpose of identifying management goals is to provide a foundation for evaluating whether and how climate change might affect the ability to achieve a given goal, and to develop adaptation options for addressing vulnerabilities. For each management goal, participants identified potential vulnerabilities and/or opportunities presented by climate change. This activity was followed by the generation of broad adaptation **strategies** and more specific adaptation **tactics** designed to address vulnerabilities for each management goal. We then present a table linking vulnerabilities to management goals, adaptation strategies, and tactics generated by participants. The purpose of this table is to summarize the ability of adaptation tactics to ameliorate the effects of climatic and non-climatic stressors on a given resource area. Following the identification of adaptation strategies and tactics, we explore potential effects, both direct and indirect, of other resources on non-forested vegetation and vice versa. As part of this discussion, participants highlighted adaptation tactics that may have potential conflicts with other resources. Lastly, we present an in-depth exploration of adaptation tactics, including where, when, and how to implement those tactics as well as collaboration and capacity needs.

Defining Terms

Goal: A desired result for a given resource.

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

Current Management Goals and Potential Vulnerabilities

Workshop participants identified five key current management goals for non-forested vegetation:

(1) meadow restoration to improve soil moisture, seasonal flow, and vegetation for wildlife and plants,
(2) maintain Spalding's catchfly habitat,
(3) use genetically appropriate material in restoration and revegetation efforts,

(4) maintain or improve existing meadow and grassland habitats, and
(5) maintain soil carbon in grasslands.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to these current management goals for non-forested vegetation. Potential climatic and non-climatic vulnerabilities identified include:[8]

- Warmer temperatures
- Drought and decreased precipitation
- Altered stream flows (e.g., reduced low flows, increased peak flows)
- Increased susceptibility to invasive species
- Increased fire frequency and severity

Adaptation Options to Ameliorate Impacts

In response to these vulnerabilities, participants developed a number of adaptation strategies and tactics designed to reduce vulnerability or increase resilience of non-forested vegetation. Workshop participants identified the following adaptation strategies for current management goals of non-forested vegetation:

Goal: Meadow restoration to improve soil moisture, seasonal flow, and vegetation for wildlife and plants.

Adaptation strategy: Plan and prepare for less summer precipitation, vegetation change, and less annual stream flow in meadow habitats.

Adaptation strategy: Restore meadows to secure favorable flows in headwater channels that would have subsequent benefits to downstream fisheries reaches.

Goal: Maintain Spalding's catchfly habitat.

Adaptation strategy: Manage/protect Spalding's catchfly while planning for increased wildfire frequency and intensity due to climate change.

Goal: Use genetically appropriate material in restoration/revegetation efforts

Adaptation strategy: Use genetically appropriate material in restoration/revegetation efforts to prepare for shifting plant communities as climatic conditions change.

Goal: Maintain or improve existing meadow and grassland habitats.

Adaptation strategy: Maintain or improve meadow and grassland habitats and species diversity in order to enhance resilience in the face of altered timing and amount of precipitation and snowpack.

[8] These vulnerabilities were also identified in the Nez Perce-Clearwater National Forests Vulnerability Assessment report.

Adaptation strategy: Improve education about- and removal of- weeds in grassland and meadow habitats.

Goal: Maintain soil carbon in grasslands.

Adaptation strategy: Manage forest densities to reflect future savannah shift.

Adaptation strategy: Restore grassland ecosystems to historical ranges.

Participants also identified a suite of adaptation tactics. Table 5 highlights these adaptation strategies and tactics, and classifies them as either likely or not likely to ameliorate impacts of a given climatic or non-climatic stressor on non-forested vegetation. These classifications are based on expert opinion.

Participants of the non-forested vegetation group identified several top adaptation tactics including:

- forest-wide mapping of current and projected soil moistures,
- removing trees encroaching on grasslands, and
- enhancing invasive weed management.

Forest-wide mapping of current and projected soil moistures

Within non-forested ecosystems, participants recommended mapping current and future soil moisture conditions for the NPCW National Forests to guide management planning. This management action has implications spanning multiple resource areas (e.g., forested vegetation, soils, hydrology) that could assist managers in selecting appropriate species to match current and future conditions. In particular, participants highlighted the need to identify potential areas of refugia for some species and/or establish areas of concern for monitoring or to prioritize for management action.

Removing trees encroaching on grasslands

Concurrent to mapping soil conditions across the forest, participants identified removing encroaching trees to be imperative for grassland restoration. This management action would serve to reduce fire intensity in historical grassland areas by reducing fuel loading and establish a fire regime that is representative of grasslands. Additionally, removal of encroaching trees in grasslands coinciding with archaeological sites would reduce the risk of fire and tree-fall damage at these culturally important sites.

Enhancing invasive weed management

Enhancing invasive weed management was identified as a recommended tactic in meadows, grasslands, and locations harboring Spalding's catchfly populations. Specifically, participants identified the need to work in cooperative management areas to increase capacity and improve effectiveness, prioritize target areas, and implement invasive weed management at a large scale. Because disturbances (e.g., fire, recreation, building projects) enhance conditions for weed expansion, this tactic may become increasingly important across resource areas. Further, climate change may allow for weed expansion into higher elevations where not historically

present. Participants suggested considering two forms of invasive weed management: preventative and post-hoc treatment. For example, preventative treatments, such as fuels management, could be applied at higher elevations to mitigate potential weed expansion. Additionally, preventative treatments could be prioritized in areas with weeds capable of high dispersal efficacy or in areas with listed native species. In post-disturbance areas (e.g., following fire), alternative weed management tactics would be applied. Lastly, participants noted that many Best Management Practices (BMPs) currently exist for invasive weed management, but that these practices may need to be re-evaluated or new implementation approaches developed.

Table 5. Summary of adaptation strategies and tactics and their ability (indicated by an "X") to ameliorate effects of climatic and non-climatic stressors on non-forested vegetation.

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates increased temperatures	Ameliorates increasing water stress	Ameliorates decreased stream flows	Ameliorates increased peak flows	Ameliorates increased fire frequency and severity	Ameliorates invasive species susceptibility
Maintain soil carbon in grasslands	Manage forest densities to reflect future savannah shift	Map soil moisture climate risk and refugia areas		X			X	
		Thin forest densities to reflect future potential habitat shift		X				
		Re-establish fire return intervals in savannah systems		X			X	
	Restore grassland ecosystems to historic ranges	Map soil mollic layer		X			X	
		Reduce conifer encroachment		X				
		Apply biochar to grassland ecosystems to increase water holding capacity and carbon storage		X				
Maintain or improve existing meadow and grassland habitats	Maintain or improve meadow and grassland habitats and species diversity in order to enhance resilience in the face of altered timing and amount of precipitation and snowpack	Manage livestock grazing to reduce impact on vulnerable environments		X	X	X		X
		Prevent or remove invasive species		X				X
		Plant a variety of diverse species to deal with drier or wetter conditions	X	X			X	X
	Improve education about and removal of weeds in grassland and meadow habitats	Renew emphasis on Cooperative Weed Management Areas		X			X	X
		Develop an educational program for livestock permittees on new science/management		X			X	X
		Increase weed identification trainings and use Best Management Practices		X			X	X
		Create/designate weed cleaning stations		X			X	X

Use genetically appropriate material in restoration/revegetation	Use genetically appropriate material in restoration/revegetation efforts to prepare for shifting plant communities as climatic conditions change	Plant appropriate seed mixes for project location	X	X			X	X
		Favor increases in native species that are adapted to habitat change or disturbance	X	X			X	X
		Maintain intact habitats to serve as source areas for seed and diversity	X	X			X	X
Maintain Spalding's catchfly habitat	Manage/protect Spalding's catchfly while planning for increased wildfire frequency and intensity due to climate change	Control invasive weeds at all known sites of Spalding's catchfly; prioritize by weed density and species		X			X	X
		Control/manage livestock grazing in and around catchfly habitat by fencing or pasture management		X			X	X
		Re-establish native species following weed control and/or livestock exclusion		X			X	X
Meadow restoration to improve soil moisture, seasonal flow, and vegetation for wildlife and plants	Plan and prepare for less summer precipitation, vegetation change, and less annual streamflow in meadow habitats	Use prescribed fire to maintain or change species composition		X			X	
		Plant or seeding of species that tolerate higher temperatures or need less water	X	X			X	X
		Change use and timing of grazing system rotation pastures		X	X			X
	Restore meadows to secure favorable flows in headwater channels and thus downstream in fisheries reaches	Reactivate meadow channels and plug (and pond) old ditches on meadow perimeter		X	X	X		
		Encourage beaver activity (e.g., relocate beaver, moratorium on trapping, enhance beaver habitat)		X	X	X		
		Change grazing plans to minimize channel/meadow damage		X	X	X		X

Resource Direct/Indirect Effects

During the workshop, participants were asked to consider the ways in which other resources (e.g., wildlife habitat, fire) affect non-forested vegetation, both directly and indirectly, as well as the ways in which non-forested vegetation affects other resources. Figure 2 below summarizes the direct and indirect effects of other resources on non-forested vegetation, as well as the direct and indirect effects of non-forested vegetation on other resources.

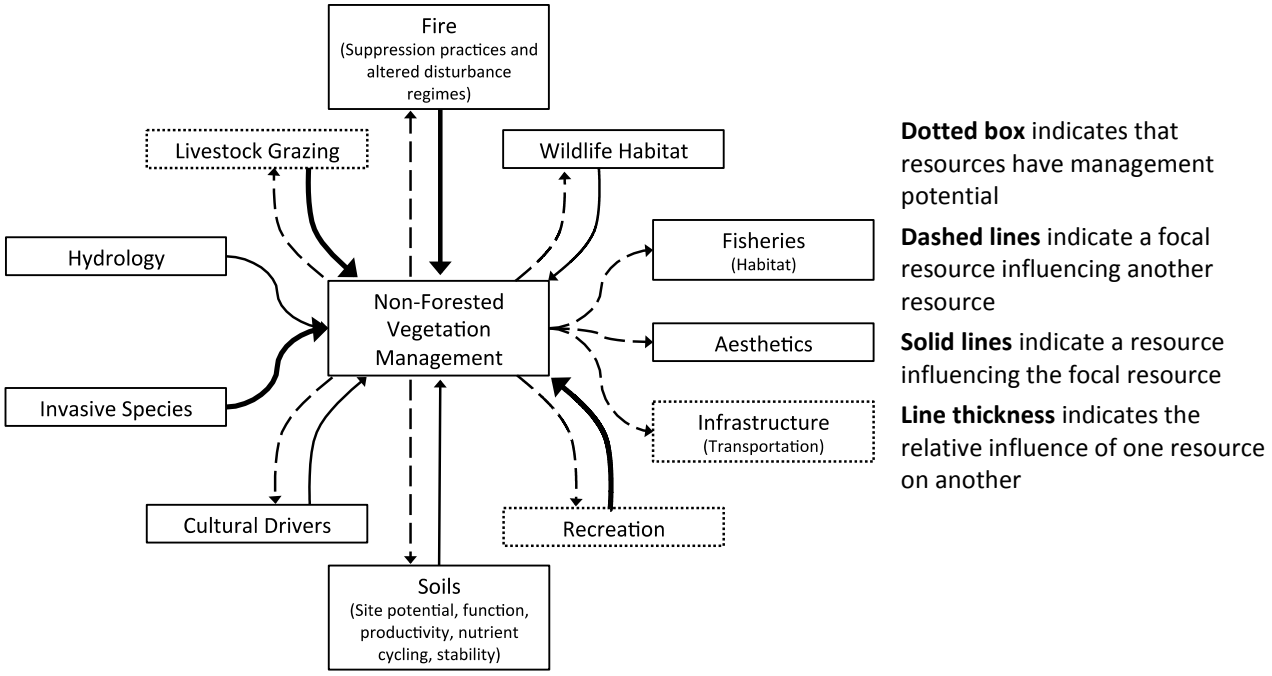

Figure 2. Exploration of direct/indirect effects of other resources on non-forested vegetation, as well as the direct/indirect effects of non-forested vegetation on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

In addition to exploring direct/indirect effects, participants were asked to consider potential conflicts that could arise when implementing specific adaptation tactics. Specifically, what potential conflicts could arise with other resources if adaptation tactic X is implemented?

Potential conflicts that arise from non-forested vegetation practices are largely associated with invasive weed management and maintaining Spalding's catchfly populations. Invasive weed management can lead to restrictions in livestock grazing and recreational activities, with the intent of reducing potential vectors of invasive species and limiting disturbance to avoid invasive species establishment and expansion. Proposed management for Spalding's catchfly populations may exclude livestock grazing from certain grassland locations. More specifically:

- Livestock and some recreational activities (e.g., OHV use, hiking, camping) can directly disperse invasive propagules to new areas.

- The presence of Spalding's catchfly at a location may result in the exclusion of livestock grazing.
- Heavy use from recreational activities and livestock grazing can degrade habitats, increasing their susceptibility to establishment by invasive species.
- Recreational activities increase the risk of anthropogenic fire ignitions through OHV use, chainsaw/generator operation, and campfires, potentially promoting fire-facilitated weed establishment and expansion.

During the discussion, participants stressed the role of fire on invasion risk and the need for post-fire invasive weed management to prevent weed spread and establishment. Additionally, participants identified disturbance and transportation corridors as important dispersal mechanisms for weeds. Similar to the post-fire response, participants highlighted the need to respond to weed establishment in disturbance areas.

Implementation of Adaptation Tactics

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for non-forested vegetation, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.
- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.

- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 6-13 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for non-forested vegetation. Each table is structured to provide:

1. A current management goal
2. Potential climatic and non-climatic vulnerabilities and/or opportunities that affect the success of achieving the management goal
3. A broad adaptation strategy
4. Multiple adaptation tactics
5. An evaluation of tactic effectiveness, feasibility, timeframe, and implementation scale
6. A description of where and how to implement and collaboration and capacity needed to move forward with implementation

This workshop activity was intended to generate a range of recommended adaptation tactics that could be implemented both now and in the future. The resulting tactics are not comprehensive, and users of this report are encouraged to explore additional adaptation tactics that may help reduce vulnerabilities, increase resilience, or capitalize on opportunities presented by climate change in non-forested vegetation.

Table 6. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the non-forested vegetation goal "Maintain Spalding's catchfly habitat". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Maintain Spalding's catchfly habitat

Potential vulnerabilities/opportunities:

- Increased risk of severe fire activity
- Increased dependency on native grasslands for forage due to post-fire conversion in conifer
- Decreased dependency on native grasslands for forage due to increased forage availability in burn areas

Adaptation strategy: Manage/protect Spalding's catchfly while planning for increased wildfire frequency and intensity due to climate change

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Control/manage livestock grazing in and around catchfly habitat by fencing or pasture management	High	High	Near	Program and Project	**Where:** Suitable (and feasible) catchfly population areas identified by the range manager **How:** Identify the feasibility of managing livestock to meet catchfly objectives by pasture management; use exclusion fencing as a last resort; prioritize by accessibility by livestock	**Internal collaboration:** Range manager **External collaboration:** USFWS regarding catchfly recovery plan **Capacity needed:** Funding, particularly for fence construction and maintenance
Control invasive weeds at all known sites of Spalding's catchfly; prioritize by weed density and weed species	Moderate	Moderate	Near-Mid	Program	**Where:** Control invasive weeds at all known catchfly population sites **How:** Prioritize by vulnerability, weed density, and weed species; consult and collaborate with range manager and invasive weed manager	**Internal collaboration:** Invasive weed and range managers **External collaboration:** USFWS regarding recovery plan for Spalding's catchfly **Capacity needed:** Funding to weed program

Table 7. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the non-forested vegetation goal "Use genetically appropriate material in restoration/revegetation efforts". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Use genetically appropriate material in restoration/revegetation efforts

Potential vulnerabilities/opportunities:

- Changes in precipitation and/or temperature may decrease species' suitability to occupy particular sites
- This may increase opportunity for weed spread as these highly adaptable species displace declining native species

Adaptation strategy: Use genetically appropriate material in restoration/revegetation efforts to prepare for shifting plant communities as climatic conditions change

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Plant appropriate seed mixes for project location	Moderate	High	Mid-Long	Program and Project	**Where:** Forest-wide application; particularly in the canyon grasslands **How:** Collect and bank seed from a variety of species and a range of habitats and elevations; build seed bank at a nursery and promote use; work with resource areas where conflicts may arise (e.g., due to funding or capacity)	**Internal collaboration:** Work with resource areas where potential conflicts may occur; genetic analysis dependent upon research branch of FS **Capacity needed:** Funding, internal capacity; analysis, collection, and implementation dependent on funding and work force constraints
Favor increases in native species that are adapted to habitat change or disturbance	High	High	Mid-Long	Program	**How:** Identify and increase specific native weedy species to serve as a cover; some of these species are less palatable to livestock (may not be preferred by range managers) however, use of these species will aid in weed reduction and long-term maintenance of desirable communities	**Internal collaboration:** Work with resource areas where potential conflicts may occur; genetic analysis dependent upon research branch of FS **Capacity needed:** Funding, internal capacity; analysis, collection, and implementation dependent on funding and work force constraints

Maintain intact habitats to serve as source areas for seed and diversity	Moderate	Moderate	Mid-Long	Program	**Where:** Areas large enough to support seed collection and maintain natural resistance to weed invasion **How:** Weed management and reduction of tree encroachment; collaborate with weed and vegetation managers to align treatment priorities as vegetation treatments could contribute to increased invasions; treatments need to be carefully limited to target species; alter grazing management if necessary and/or potentially assign area designations (e.g., RNA, botanical areas; requires resource vetting)	**Internal collaboration:** Weed, range, and/or vegetation managers **External collaboration:** Local special interest groups and academic interests may be helpful in locating/documenting these areas **Capacity needed:** Funding and increased workforce

Table 8. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the non-forested vegetation goal "Maintain or improve existing meadow and grassland habitat". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Maintain or improve existing meadow and grassland habitats

Potential vulnerabilities/opportunities:

- May need to plant more diverse species due to wetter or drier conditions
- As precipitation changes, water table levels will fluctuate
- May need to alter timing/rotation of livestock grazing due to changing climate conditions
- As habitats are impacted by climate change, may have more threatened and endangered species or protected habitats
- New invasives may arise (will need to attack new invaders)
- Treatment with chemicals may have shorter application window

Adaptation strategy: Maintain or improve meadow and grassland habitats and species diversity in order to enhance resilience in the face of altered timing and amount of precipitation and snowpack

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Prevent/remove invasive species	Moderate (new invaders)	Moderate (funding is a major concern)	Near-Mid	Program and Project	**Where:** Cooperative weed management areas, areas of new disturbance, and areas with few weeds (keep them weed free) near roads, trails, recreation sites, grazing allotments, meadows, and grasslands **How:** Focus on treating new invaders and/or systematically identify, prioritize, and treat established invasives	**External collaboration:** Partner with counties, tribes, user groups, BLM, CBC, state agencies, private landowners, conservation agencies, IDOT, and research entities **Capacity needed:** Funding for equipment and staff
Manage livestock grazing to reduce impact on vulnerable environments	High	Moderate	Near-Mid	Program and Project	**Where:** Prioritize xeric, lower elevation allotments that may be more susceptible to drought and/or fire **How:** Work with permittees to alter	**Internal collaboration:** Coordinate with other resource groups such as fisheries (spawning timing and location), wildlife (calving), botany, and

					the timing, location, and level of grazing; implement pasture rotation (i.e., alternate/swing pastures) and/or use vacant allotments; adjust rotation schedule, improve fencing, and utilize riders as upland conditions change	fire (e.g., timing of prescribed burning - spring) **Capacity needed:** Funding and additional staffing to monitor utilization and forage conditions

Table 9. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the non-forested vegetation goal "Maintain soil carbon in grasslands". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Maintain soil carbon in grasslands

Potential vulnerabilities/opportunities:

- Invasive species' site potential increases with higher summer soil moisture deficit and/or higher and more frequent fires
- Site limitations and potential shifts in vegetation composition
- Higher grazing pressure with less productivity on site due to higher summer soil moisture deficit

Adaptation strategy: Manage forest densities to reflect future savannah shift

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Map soil moisture climate risk and refugia areas	Moderate	High	Near	Program and Project	**Where:** Forest-wide **How:** Create a forest-wide model to identify high and low areas of concern	**External collaboration:** NRCS, Intermountain Forest Tree Nutrition Cooperative (IFTNC), and current partners working on this effort
Thin forest densities to reflect future potential habitat shift	High	Moderate	Near-Mid	Project	**Where:** Focus on risk areas identified in the soil moisture climate risk and refugia map, WUI areas (e.g., front range/canyons), and accessible areas **How:** Treat mechanically, with prescribed fire, mastication, and/or biofuel/biochar	**Internal collaboration:** Fuel managers, range specialists, permittees, and timber/silviculture **Capacity needed:** Could incorporate into forest program of work if staffing is maintained or increases, or if priority is given.
Re-establish fire return intervals in savannah systems	High	Moderate	Near-Mid	Project	**Where:** Accessible areas with priority in WUI and wilderness/roadless areas **How:** Prescribed fire in accessible areas with priority in WUI; managed	**External collaboration**: State agencies and private landowners, community groups, and wildlife organizations/ agencies in areas of WUI and

					wildfire for resource benefit in wilderness/roadless areas	winter range **Capacity needed:** Additional staffing

Participants of the non-forested vegetation group identified a number of additional adaptation strategies and tactics, however participants were unable to develop implementation plans for these tactics in the time allotted.

Table 10. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the non-forested vegetation goal "Meadow restoration to improve soil moisture, seasonal flow, and vegetation for wildlife and plants". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Meadow restoration to improve soil moisture, seasonal flow, and vegetation for wildlife and plants

Potential vulnerabilities/opportunities:

- Decreased summer precipitation
- Increased max air temperature
- Decreased annual snowpack
- Decreased low flows and stream flow
- Increased runoff peak
- Longer time when channels run dry

Adaptation strategy: Plan and prepare for less summer precipitation, vegetation change, and less annual stream flow in meadow habitats

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Use prescribed fire to maintain or change species composition	Project	Near	Meadow areas at pre-determined elevation
Plant or seeding of species that would tolerate higher temperatures or need less water	Project	Near-Mid	Meadow areas with altered vegetation from past management actions
Change use and timing of grazing system rotation pastures	Project	Near-Mid	Meadows and watershed areas leading to meadows in allotments

Adaptation strategy: Restore meadows to secure favorable flows in headwater channels and thus downstream in fisheries reaches

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Reactivate meadow channels and plug (and pond) old ditches on meadow perimeter	Project	Near	Target flashy meadow systems with steelhead; increase number of projects; aggressively pursue funding
Encourage beaver activity (e.g., relocate beaver, moratorium on trapping, enhance beaver habitat)	Project and Program	Near-Mid	Target headwater streams (work with IDFG on MOU)
Change grazing plans to minimize channel/meadow damage	Project and Program	Near-Mid	Utilize pasture management, fencing, and off-site watering; focus on meadow/channel grazing in meadow systems

Table 11. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the non-forested vegetation goal "Maintain Spalding's catchfly habitat". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Maintain Spalding's catchfly habitat			
Potential vulnerabilities/opportunities: • Increased risk of severe fire activity • Increased dependency on native grasslands for forage due to post-fire conversion in conifer • Decreased dependency on native grasslands for forage due to increased forage availability in burn areas			
Adaptation strategy: Manage/protect Spalding's catchfly while planning for increased wildfire frequency and intensity due to climate change			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Re-establish native species following weed control and/or livestock exclusion	Project	Mid	Areas of successful weed treatment, areas with better soils and exposure, and areas less susceptible to re-invasion by weeds

Table 12. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the non-forested vegetation goal "Maintain or improve existing meadow and grassland habitats". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Maintain or improve existing meadow and grassland habitats

Potential vulnerabilities/opportunities:

- May need to plant more diverse species due to wetter or drier conditions
- As precipitation changes, water table levels will fluctuate
- May need to alter timing/rotation of livestock grazing due to changing climate conditions
- As habitats are impacted by climate change, may have more threatened and endangered species or protected habitats
- New invasives may arise (will need to attack new invaders)
- Treatment with chemicals may have shorter application window

Adaptation strategy: Maintain/improve existing and/or historic meadow/grassland habitats and species diversity in order to enhance resilience in the face of altered timing and amount of precipitation and snowpack

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Plant a variety of diverse species to deal with drier or wetter conditions	Project	Near-Mid	Prioritize meadows and grasslands that are most at risk; also prioritize those that have had long term traditional cultural harvest of plants/roots

Adaptation strategy: Improve education about and removal of weeds in grassland and meadow habitats

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Renew emphasis on Cooperative Weed Management Areas	No answer provided	No answer provided	No answer provided
Develop an educational program for livestock permittees on new science/management	No answer provided	No answer provided	No answer provided
Increase weed identification trainings and use Best Management Practices	No answer provided	No answer provided	No answer provided
Create/designate weed cleaning stations	No answer provided	No answer provided	Train/educate sale administrators and CORS on inspecting equipment (i.e., to make sure it is weed-free)

Table 13. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the non-forested vegetation goal "Maintain soil carbon in grasslands". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Maintain soil carbon in grasslands

Potential vulnerabilities/opportunities:

- Invasive species' site potential increases with higher summer soil moisture deficit and/or higher and more frequent fires
- Site limitations and potential shifts in vegetation composition
- Higher grazing pressure with less productivity on site due to higher summer soil moisture deficit

Adaptation strategy: Restore grassland ecosystems to historic ranges

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Map soil mollic layer	Project and Program	Near	Forest-wide mapping potential
Reduce conifer encroachment	Project	Near-Mid	Accessible areas, front range
Apply biochar to grassland ecosystems to reduce conifer encroachment	Project	Near-Mid	Accessible areas/mobile pyrolysis for biomass utilization and bioenergy

5. Wildlife

Participants: Guy Wagner

Introduction

The following section presents climate change adaptation planning results for wildlife. The results summarize discussions and activities completed by participants during the workshop. We first present current management **goals** identified by participants. The purpose of identifying management goals is to provide a foundation for evaluating whether and how climate change might affect the ability to achieve a given goal, and to develop adaptation options for addressing vulnerabilities. For each management goal, participants identified potential vulnerabilities and/or opportunities presented by climate change. This activity was followed by the generation of broad adaptation **strategies** and more specific adaptation **tactics** designed to address vulnerabilities for each management goal. We then present a table linking vulnerabilities to management goals, adaptation strategies, and tactics generated by participants. The purpose of this table is to summarize the ability of adaptation tactics to ameliorate the effects of climatic and non-climatic stressors on a given resource area. Following the identification of adaptation strategies and tactics, we explore potential effects, both direct and indirect, of other resources on wildlife and vice versa. As part of this discussion, participants highlighted adaptation tactics that may have potential conflicts with other resources. Lastly, we present an in-depth exploration of adaptation tactics, including where, when, and how to implement those tactics as well as collaboration and capacity needs.

Defining Terms

Goal: A desired result for a given resource.

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

Current Management Goals and Potential Vulnerabilities

Workshop participants identified three key current management goals for wildlife:

(1) prevent bighorn sheep from experiencing disease-related die-offs,
(2) enhance elk winter range, and
(3) increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to these current management goals for wildlife. Potential climatic and non-climatic vulnerabilities identified include:[9]

- Habitat loss
- Disease outbreak
- Reduced viability of populations
- Decreased snowpack
- Declining soil moisture

Adaptation Options to Ameliorate Impacts

In response to these vulnerabilities, participants developed a number of adaptation strategies and tactics designed to reduce vulnerability or increase resilience of wildlife. Workshop participants identified the following adaptation strategies for current management goals of wildlife:

Goal: Prevent bighorn sheep from experiencing disease-related die-offs.

Adaptation strategy: Separate bighorn sheep from domestic sheep and goats.

Goal: Enhance elk winter range.

Adaptation strategy: Enhance large mammal winter range by increasing abundance and nutritional quality of forage species.

Goal: Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat.

Adaptation strategy: Increase spatial extent of quality snowshoe hare habitat.

Adaptation strategy: Maintain connectivity and integrity of lynx habitat into the future considering the impacts of climate change.

Participants also identified a suite of adaptation tactics. Table 14 highlights these adaptation strategies and tactics, and classifies them as either likely or not likely to ameliorate impacts of a given climatic or non-climatic stressor on wildlife. These classifications are based on expert opinion.

Participants of the wildlife group identified several top adaptation tactics including:

- reduce potential for interactions between bighorn sheep and domestic sheep/goats,
- fuels treatments, and
- enhance and maintain habitat characterized by persistent snowpack.

[9] These vulnerabilities were also identified in the Nez Perce-Clearwater National Forests Vulnerability Assessment report.

Reduce potential for interactions between bighorn sheep and domestic sheep/goats
Participants identified interactions between domestic sheep and goats as an important vector of disease transmission for bighorn sheep. To address this, participants recommended not renewing domestic sheep or goat grazing allotments coinciding with bighorn sheep habitat, requiring double-fencing around small domestic sheep and goat operations adjacent to bighorn sheep habitat, and eliminating goat-packing within bighorn sheep habitat. These tactics would be implemented at the program and project levels and require external collaboration with other land jurisdiction agencies (e.g., BLM, adjacent USFS lands), sheep and/or goat livestock stakeholders, and trail users (recreationalist and recreation professionals) to be implemented effectively.

Fuels treatments
Wildlife participants indicated that various fuels treatment methods would promote winter range quality for large mammals. Specifically, participants identified mechanical vegetation treatment, prescribed burning, and managed wildfire as important techniques to enhance the quality of forage species in winter ranges. Mechanical vegetation treatment would be particularly useful in situations where the impacts of fire are undesirable or unsafe, such as in areas where soils are thin or human structures are present. Participants noted that thinning to restore open areas of ponderosa pine supports favorable vegetation species for elk. Prescribed burning and managed wildfire in critical elk hotspots would be effective in areas with appropriate soil, fuel, and development conditions. However, participants noted that it is important to ensure that the period between burns not be too short (i.e. < 5 years) at a given location.

Enhance and maintain habitat characterized by persistent snowpack
To maintain and increase the spatial extent of quality snowshoe hare and lynx habitat, participants identified tactics specific to areas above 4000 feet in elevation. In particular, participants identified the need to develop models projecting the future distribution and persistence of snowpack in important lynx and snowshoe hare areas to aid in planning. Additionally, participants noted that pre-commercial thinning in subalpine fir, Engelmann spruce, and lodgepole pine forests above 4000 feet should be avoided, and multi-storied stands of these tree species should be maintained as critical habitat for both lynx and snowshoe hare.

Table 14. Summary of adaptation strategies and tactics and their ability (indicated by an "X") to ameliorate effects of climatic and non-climatic stressors on wildlife.

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates habitat loss	Ameliorates disease outbreak	Ameliorates population viability declines	Ameliorates decreased snowpack	Ameliorates increasing water stress
Prevent bighorn sheep from experiencing disease-related die-offs	Separate bighorn sheep from domestic sheep and goats	Prevent domestic sheep or goat grazing in bighorn habitat (i.e., do not renew allotments)	X	X	X		
		Require double-fencing of small domestic sheep and goat operations adjacent to bighorn habitat	X	X	X		
		Eliminate goat-packing in bighorn sheep ranges		X	X		
Enhance elk winter range	Enhance large mammal winter range by increasing abundance and nutritional quality of forage species	Utilize mechanical vegetation treatment	X		X		X
		Implement prescribed burning	X		X		X
		Manage wildland fire for resource benefits	X		X		X
Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat	Increase spatial extent of quality snowshoe hare habitat	Develop models predicting future changes in snowpack distribution and persistence	X		X		
		Avoid extensive pre-commercial thinning in snowshoe hare habitat likely to be used by lynx	X		X	X	
		Save multi-storied stands above 4000 ft in subalpine fir, Engelmann spruce, and lodgepole pine stands	X		X	X	
	Maintain connectivity and integrity of lynx habitat into the future considering climate change	Identify potential habitat linkages to ensure future lynx movements	X		X	X	
		Avoid creating large openings in habitat linkage areas (e.g., coordinate with potential timber sales and veg management)	X		X	X	
		Close roads and/or restrict vehicle speeds within habitat linkage areas	X		X		

Resource Direct/Indirect Effects

During the workshop, participants were asked to consider the ways in which other resources (e.g., vegetation management, fire) affect wildlife, both directly and indirectly, as well as the ways in which wildlife affects other resources. Figure 3 below summarizes the direct and indirect effects of other resources on wildlife, as well as the direct and indirect effects of wildlife on other resources.

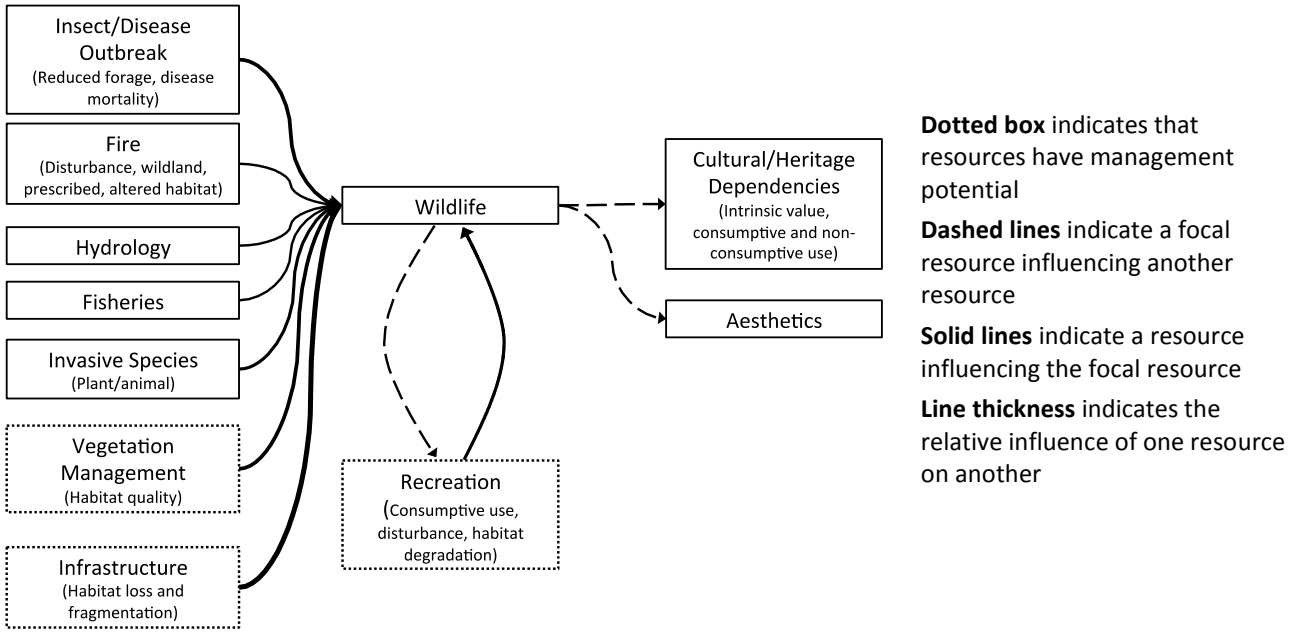

Figure 3. Exploration of direct/indirect effects of other resources on wildlife, as well as the direct/indirect effects of wildlife on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

In addition to exploring direct/indirect effects, participants were asked to consider potential conflicts that could arise when implementing specific adaptation tactics. Specifically, what potential conflicts could arise with other resources if adaptation tactic X is implemented? Development (e.g., residential areas, roads) was one potential conflict identified for wildlife, in particular, development that occurs in key habitat linkage areas (e.g., riparian corridors). An additional conflict may arise from policy changes related to domestic sheep and goat restrictions. More specifically, participants identified the need for external collaboration to avoid conflicts with stakeholders related to policy changes associated with not renewing grazing allotments for sheep and goats in bighorn sheep habitat, requiring double fencing on sheep and goat operations adjacent to bighorn sheep habitat, and eliminating goat-packing in bighorn sheep habitat.

Implementation of Adaptation Tactics

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for wildlife, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.
- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.
- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 15-18 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for wildlife. Each table is structured to provide:

1. A current management goal
2. Potential climatic and non-climatic vulnerabilities and/or opportunities that affect the success of achieving the management goal
3. A broad adaptation strategy
4. Multiple adaptation tactics
5. An evaluation of tactic effectiveness, feasibility, timeframe, and implementation scale
6. A description of where and how to implement and collaboration and capacity needed to move forward with implementation

This workshop activity was intended to generate a range of recommended adaptation tactics that could be implemented both now and in the future. The resulting tactics are not comprehensive, and users of this report are encouraged to explore additional adaptation tactics that may help reduce vulnerabilities, increase resilience, or capitalize on opportunities presented by climate change on wildlife.

Table 15. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the wildlife goal "Prevent bighorn sheep from experiencing disease-related die-offs". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Prevent bighorn sheep from experiencing disease-related die-offs						
Potential vulnerabilities/opportunities: • Species composition may change • Breaklands could expand into domestic allotments						
Adaptation strategy: Separate bighorn sheep from domestic sheep and goats						
Adaptation tactic	**Effectiveness**	**Feasibility**	**Timeframe**	**Implementation scale**	**Implementation (where/how)**	**Collaboration & capacity**
Prevent domestic sheep or goat grazing in bighorn habitat (i.e., do not renew allotments)	High	High	Near	Program (permit renewal)	**Where:** Bighorn habitat on the lower Salmon River and adjacent areas such as Hells Canyon	**External collaboration:** BLM, Payette and Wallowa-Whitman NFs, IDFG, Wild Sheep Foundation, wool growers
Require double-fencing of small domestic sheep and goat operations adjacent to bighorn habitat	Moderate	Moderate	Near	Project	**Where:** Small ranches and residential areas where domestic sheep are raised for 4-H and/or hobby-farms adjacent to bighorn habitat.	**External collaboration:** Homeowners, small ranchers, hobby farms, local jurisdictions, county and state agencies
Eliminate goat-packing in bighorn sheep habitat	Moderate	Moderate	Near	Program	**Where:** Wilderness trail systems in bighorn habitat	**External collaboration:** Trail users, recreation professionals

Table 16. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the wildlife goal "Enhance elk winter range". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Enhance elk winter range

Potential vulnerabilities/opportunities:

- Declines in elk numbers
- Increased fuel loads and fire intensity
- Reduced soil moisture
- Narrow opportunity windows
- Changes in species' diversity and/or abundance

Adaptation strategy: Enhance large mammal winter range by increasing abundance and nutritional quality of forage species

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Utilize mechanical vegetation treatment	Moderate	Moderate	Near	Project	**Where:** In areas of winter range where fire would be undesirable (e.g., where soils are thin or sensitive) or unsafe (i.e. near houses) as well as roaded front range and critical elk hot spots **How:** Mechanical treatment	**External collaboration:** IDFG biologists, academic researchers **Capacity needed:** Funding - Rocky Mtn Elk Foundation
Implement prescribed burning	Moderate	Moderate	Mid	Project and Program	**Where:** Elk high-use areas; where soil conditions allow and fuel conditions are adequate; unroaded/ economically critical elk hotspots **How:** Fire interval should not be too frequent	**External collaboration:** Rocky Mtn Elk Foundation, IDFG, academic researchers
Manage wildland fire for resource benefits	Moderate	Moderate	Near	Forest Plan and Program	**Where:** In wilderness and roadless areas, as well as approved areas in the front country.	**External collaboration:** TWS, Rocky Mtn Elk Foundation, IDFG, outfitters, recreationalists

Table 17. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the wildlife goal "Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat						
Potential vulnerabilities/opportunities: • Species composition change • Decreasing snowpack						
Adaptation strategy: Increase spatial extent of quality snowshoe hare habitat						
Adaptation tactic	**Effectiveness**	**Feasibility**	**Timeframe**	**Implementation scale**	**Implementation (where/how)**	**Collaboration & capacity**
Develop models predicting future changes in snowpack distribution and persistence	High	Moderate	Near	N/A	**Where:** Focus on areas above 4000 ft elevation in subalpine forested habitat (subalpine fir, Engelmann spruce, lodgepole pine) and in lynx analysis units	**External collaboration:** Rocky Mtn Research Station, USGS scientists, academic climate scientists
Avoid extensive pre-commercial thinning (PCT) in snowshoe hare habitat likely to be used by lynx	High	Moderate	Near	Project	**Where:** Areas above 4000 ft in subalpine fir, Engelmann spruce, and lodgepole pine forests	**Internal collaboration:** Forest and district silviculturalists; communication with on-the-ground crews essential **External collaboration:** USFWS ESA office (Section 7 consultation)
Save multi-storied stands above 4000 ft in subalpine fir, Engelmann spruce, and lodgepole pine stands	Moderate	Moderate	Near	Project	**Where:** Multi-storied stands **How:** Multi-storied classification determined by the district wildlife biologist in consultation with USFWS	**Internal collaboration:** District biologists and silviculturalists; communication with contractors essential **External collaboration:** USFWS ESA office
Adaptation strategy: Maintain connectivity and integrity of lynx habitat into the future considering climate change						

Identify and protect potential habitat linkages to ensure future lynx movements	Moderate	Moderate	Near-Mid	Forest Plan, Program, and Project	**Where:** Areas below and above 4000 ft that could potentially facilitate lynx dispersal; linkage areas should be densely forested and provide adequate prey abundances **How:** Identify potential habitat linkages through modeling and ground-truthing; avoid creating large openings in habitat linkage areas (coordinate with potential timber sales and veg management) and close roads and/or restrict vehicle speeds within habitat linkage areas (consider as part of future travel plan)	**External collaboration:** Other forest owners and highway departments; key crossings may need management actions such as lower speed limits, signage, etc.

Table 18. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the wildlife goal "Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Increase lynx principal prey populations and maintain connectivity and integrity of lynx habitat			
Potential vulnerabilities/opportunities: • Species composition change • Decreasing snowpack			
Adaptation strategy: Maintain connectivity and integrity of lynx habitat into the future considering climate change			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Avoid creating large openings in habitat linkages	Forest Plan, Program, and Project	Near-Mid	Coordinate with potential timber sales and vegetation management
Close roads and/or restrict vehicle speeds in habitat linkages	Project	Near-Mid	Integrate into future travel plan

6. Hydrology and Fisheries

Participants:		
	Anne Hall Conner	Allison Johnson
	Jan Curtis-Tollestrup	Andre Snyder
	Jennie Fischer	Katherine Thompson
	Taylor Greenup	Chris Wolffing

Introduction

The following section presents climate change adaptation planning results for hydrology and fisheries. The results summarize discussions and activities completed by participants during the workshop. We first present current management **goals** identified by participants. The purpose of identifying management goals is to provide a foundation for evaluating whether and how climate change might affect the ability to achieve a given goal, and to develop adaptation options for addressing vulnerabilities. For each management goal, participants identified potential vulnerabilities and/or opportunities presented by climate change. This activity was followed by the generation of broad adaptation **strategies** and more specific adaptation **tactics** designed to address vulnerabilities for each management goal. We then present a table linking vulnerabilities to management goals, adaptation strategies, and tactics generated by participants. The purpose of this table is to summarize the ability of adaptation tactics to ameliorate the effects of climatic and non-climatic stressors on a given resource area. Following the identification of adaptation strategies and tactics, we explore potential effects, both direct and indirect, of other resources on hydrology and fisheries and vice versa. As part of this discussion, participants highlighted adaptation tactics that may have potential conflicts with other resources. Lastly, we present an in-depth exploration of adaptation tactics, including where, when, and how to implement those tactics as well as collaboration and capacity needs.

Defining Terms

Goal: A desired result for a given resource.

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

Current Management Goals and Potential Vulnerabilities

Workshop participants identified two key current management goals for hydrology and fisheries:

(1) plan vegetation management activities to avoid or minimize negative impacts to water or soil resources, and
(2) restore degraded stream channels.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to these current management goals for hydrology and fisheries. Potential climatic and non-climatic vulnerabilities identified include:[10]

- Warmer temperatures
- Altered timing of precipitation
- Increased rain-on-snow events
- Altered hydrograph (runoff timing and changing flow amounts)
- Increased erosion and sedimentation

Adaptation Options to Ameliorate Impacts

In response to these vulnerabilities, participants developed a number of adaptation strategies and tactics designed to reduce vulnerability or increase resilience of hydrology and fisheries. Workshop participants identified the following adaptation strategies for current management goals of hydrology and fisheries:

Goal: Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources.

Adaptation strategy: Enhance stream and floodplain connectivity and reduce sediment impacts to improve aquatic habitat, aquatic organism passage, and hydrologic functions in the face of changing climate conditions.

Adaptation strategy: Focused design of harvest, fire, and road activities to moderate effects of increased rain-on-snow events.

Goal: Restore degraded stream channels.

Adaptation strategy: Restore meadows, riparian areas, and degraded streams to secure favorable flows in headwater channels – and thus downstream receiving waters – and to maintain stream network connection and transport of water, sediment, and wood to improve habitat resilience.

Adaptation strategy: Maintain and improve conditions to regulate stream temperatures to moderate effects of climate change.

Although not associated with a current management goal, participants identified an important new adaptation strategy to incorporate into management operations now.

Adaptation strategy: Designation of refugia watersheds and establishment of refugia for at-risk species.

Participants also identified a suite of adaptation tactics. Table 19 highlights these adaptation strategies and tactics, and classifies them as either likely or not likely to ameliorate impacts of a

[10] These vulnerabilities were also identified in the Nez Perce-Clearwater National Forests Vulnerability Assessment report.

given climatic or non-climatic stressor on hydrology and fisheries. These classifications are based on expert opinion.

Participants of the hydrology and fisheries groups identified several top adaptation strategies and tactics including:

- designating refugia watersheds,
- road decommissioning,
- upgrading culverts, and
- stream and floodplain restoration.

Designate refugia watersheds

Participants identified designation of refugia watersheds as a top adaptation strategy for fisheries, and recommended the strategy be incorporated into the forest plan to maintain and/or improve the status of at-risk species (i.e., cold water fish species). Additionally, it was thought that this strategy could be used as a tool to prioritize restoration work. Specific tactics identified under this strategy included restoration-based actions (e.g., road decommissioning, infrastructure upgrades), vegetation management restrictions and/or consideration of at-risk fisheries species when planning vegetation management activities, and actions emphasizing conservation and/or enhancement of existing habitat (e.g., improving stream connectivity, maintaining or enhancing stream temperature regime, and minimizing impacts from changes in peak flows). Participants also thought that developing projected vegetation maps could help identify potential future changes in watershed refugia quality. Participants also suggested using the refugia watersheds as study areas to examine how vegetation develops over the next 100 years, with the goal of developing a strategy for vegetation management (e.g., mosaic of species and ages to increase diversity and resilience) that benefits both terrestrial and aquatic systems and species. Lastly, participants identified the need to develop an integrated restoration proposal for watersheds that incorporates both aquatic and terrestrial watershed condition classifications. Participants noted that they are waiting for guidance on the terrestrial portion of Watershed Condition Framework from the Washington Office; aquatic guidance for Watershed Condition Classification has already been developed. Participants recommended identifying a pilot watershed to test the integrated restoration proposal once developed.

Participants of the fisheries group recommended using bull trout as a model species for this adaptation strategy, as bull trout are a highly vulnerable cold water species due to temperature increases and habitat loss from climate change. A small number of bull trout habitat areas are projected to be suitable in the next 100 years, thus limiting conservation options for this species to actions that protect existing habitat/preserve refugia. Participants suggested creating an inventory of where bull trout are currently located on the forests as an initial step toward designating refugia watersheds.

Road decommissioning

Participants identified the need for an integrated roads analysis in order to select possible roads, trails, and/or railroads for decommissioning. The integrated roads analysis should consider the following characteristics:

- Vegetation management access
- Placement of sensitive landforms (e.g., soil, climate impacts)
- Placement within streamside areas
- Recreational access to dispersed sites
- Risk from projected increases in rain-on-snow events

Participants also highlighted that road, trail, and/or railroad decommissioning should be prioritized by impacts to water resources. Refugia watersheds were identified as a place to potentially focus efforts, although participants noted that an adaptive monitoring plan and timeline should be created for decommissioning (e.g., identifies where/what to decommission now, in 10 years, in 25 years, etc.).

Upgrade culverts
Participants recommended culvert upgrades to adequate sizes (i.e., ensure they are sized for projected changes in peak flows) as an adaptation tactic for hydrology and fisheries, as these upgrades provide aquatic organism passage and connectivity. Participants also recommended removal of culverts from stored or decommissioned roads as well as the placement of new culverts or crossings where needed. Recommended implementation areas for this tactic included watersheds with projected increases in rain-on-snow events and in designated refugia watersheds.

Stream and floodplain restoration
Participants recommended restoration of stream channels that have been impacted by historic mining, ditching, and infrastructure activities (e.g., placer mining, straightening and diking for railroad and road construction), particularly in areas where ESA fisheries habitat exists. Additionally, efforts to restore wetland hydrology in meadow systems are also an important restoration focus to enhance water storage, slow runoff, and enhance both terrestrial riparian and aquatic habitat. These efforts would contribute towards stream and floodplain connectivity, and improve riparian and hydrologic conditions that regulate stream temperatures.

Table 19. Summary of adaptation strategies and tactics and their ability (indicated by an "X") to ameliorate effects of climatic and non-climatic stressors on hydrology and fisheries.

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates base flow decreases	Ameliorates peak flow increases	Ameliorates increasing stream temperatures	Ameliorates erosion/ sedimentation
Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources	Enhance stream connectivity and reduce sediment impacts to improve aquatic habitat, aquatic organism passage, and hydrologic functions	Increase infrastructure capacity	X	X		X
		Decommission roads/trails/railroads	X	X		X
		Evaluate and monitor canopy removal effects on aquatic/riparian areas	X	X	X	X
	Focus design of harvest, fire, and road activities to moderate effects of increased rain-on-snow events	Identify elevation bands that will likely be susceptible to rain-on-snow events		X		X
		Compile research on runoff response in rain-on-snow environments in order to develop guidance on maximum canopy opening sizes and flow response expectations	X	X		X
Restore degraded stream channels	Restore riparian areas, meadows, and degraded streams	Modify grazing plans to minimize channel/meadow damage	X	X	X	X
		Facilitate beaver occupancy and/or activity	X	X	X	X
		Restore stream channels and floodplains	X	X	X	X
		Increase floodplain and channel roughness	X	X	X	X
	Maintain and improve stream temperature	Improve grazing practices to decrease stream width:depth ratios	X	X	X	X
		Limit or eliminate riparian grazing to promote shrub/tree growth for increased shade and reduced bank erosion	X	X	X	X
		Limit or eliminate vegetation removal in riparian areas and set standard distance from streams beyond which vegetation removal can occur	X	X	X	X
Manage forest resources following watershed objectives	Designate refugia watersheds	Establish guidelines to prioritize watershed restoration/conservation	X	X	X	X
		Limit vegetation management in Riparian Conservation Areas	X	X	X	X
		Improve inventory & monitoring of invasive species				

Resource Direct/Indirect Effects

During the workshop, participants were asked to consider the ways in which other resources (e.g., roads/infrastructure, vegetation management) affect hydrology and fisheries, both directly and indirectly, as well as the ways in which hydrology and fisheries affect other resources. Figures 4 and 5 below summarize the direct and indirect effects of other resources on hydrology and fisheries, as well as the direct and indirect effects of hydrology and fisheries on other resources.

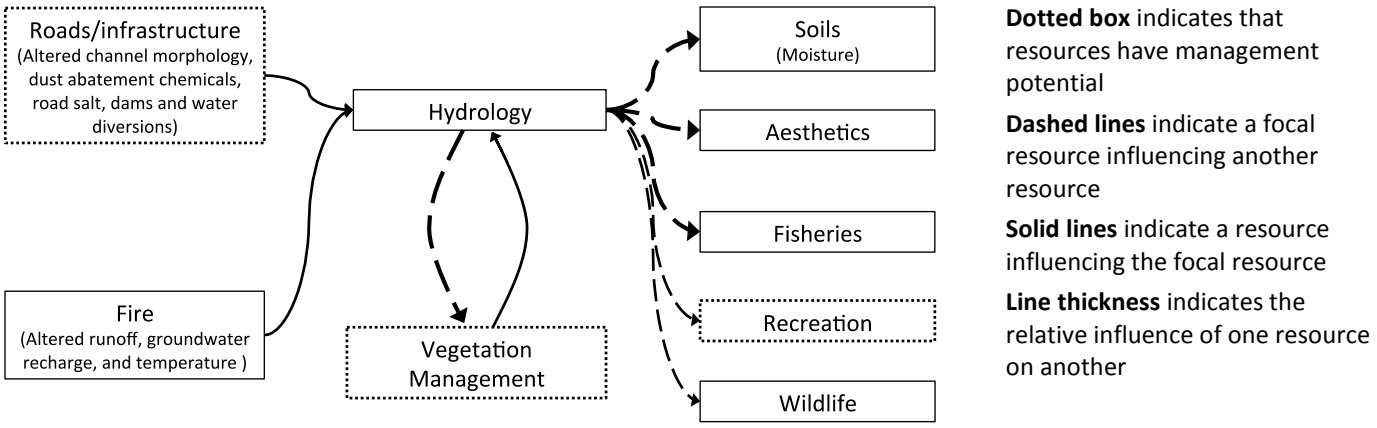

Figure 4. Exploration of direct/indirect effects of other resources on hydrology, as well as the direct/indirect effects of hydrology on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

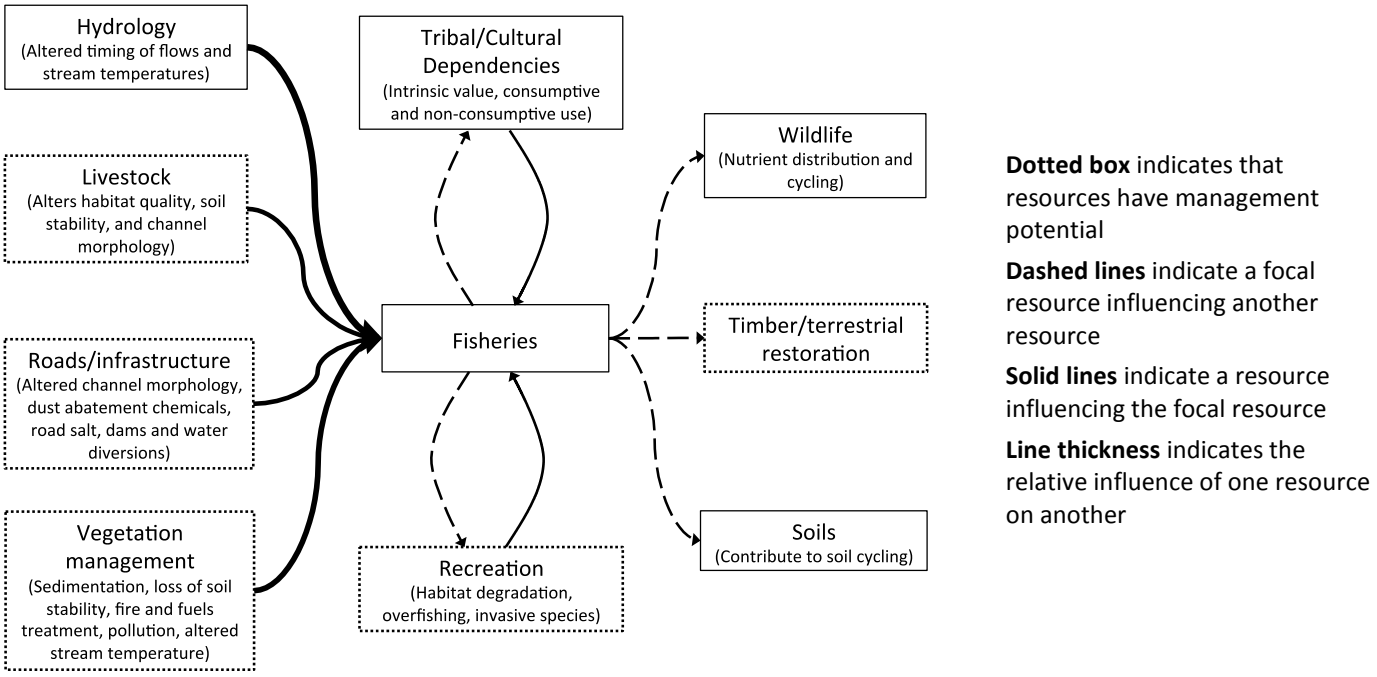

Figure 5. Exploration of direct/indirect effects of other resources on fisheries, as well as the direct/indirect effects of fisheries on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

In addition to exploring direct/indirect effects, participants were asked to consider potential conflicts that could arise when implementing specific adaptation tactics. Specifically, what potential conflicts could arise with other resources if adaptation tactic X is implemented? The discussion centered on road/trail/railroad decommissioning, with major conflicts identified for vegetation management and cultural resources.

In particular, two potential conflicts arose around decommissioning: (1) railroad grades as a cultural resource, and (2) access to areas of potential greater fire risk. Participants noted that some railroad grades are considered a cultural resource, and cannot be decommissioned (i.e., there will likely be site-specific exceptions for railroad decommissioning depending on cultural importance). It may also be important to maintain access to fire-prone areas, particularly those areas with projected fire risk. Participants recommended either upgrading infrastructure in these areas or removing culverts and decommissioning roads but maintaining the road prism for long-term storage (i.e., hydrologically disconnect roads) in the event the road needs to be re-commissioned in the future.

Implementation of Adaptation Tactics

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for hydrology and fisheries, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.
- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.

- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 20-24 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for hydrology and fisheries. Each table is structured to provide:

1. A current management goal
2. Potential climatic and non-climatic vulnerabilities and/or opportunities that affect the success of achieving the management goal
3. A broad adaptation strategy
4. Multiple adaptation tactics
5. An evaluation of tactic effectiveness, feasibility, timeframe, and implementation scale
6. A description of where and how to implement and collaboration and capacity needed to move forward with implementation

This workshop activity was intended to generate a range of recommended adaptation tactics that could be implemented both now and in the future. The resulting tactics are not comprehensive, and users of this report are encouraged to explore additional adaptation tactics that may help reduce vulnerabilities, increase resilience, or capitalize on opportunities presented by climate change for hydrology and fisheries.

Table 20. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the hydrology and fisheries goal "Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources

Potential vulnerabilities/opportunities:

Water quality

- Increased rain and rain-on-snow events at higher elevations leading to higher surface erosion potential
- Need more specific and robust identification and implementation of BMPs for harvest, fire and road activities to minimize surface erosion and sedimentation

Water quality/runoff processes

- Increased probability of rain-on-snow and associated higher peak flows in 1st order basins; this leads to channel impacts and risks to road/trail crossings
- Increased erosion and sedimentation leads to the need for proper sizing of road crossings and evaluation of canopy removal effect on peak flows

Soil productivity

- Warmer temperatures and less snow could lead to shorter & less secure frozen-over snow operating conditions; this could lead to an increase in adverse impacts during insufficient freezing and snow cover

Stability

- Increased rain-on-snow at higher elevations in smaller basins leads to increased potential for landslides and erosion

Adaptation strategy: Enhance stream connectivity and reduce sediment impacts to improve aquatic habitat, aquatic organism passage, and hydrologic functions

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Ensure infrastructure (e.g., roads, trails, stream crossings) has increased capacity, frequency, and is in good condition for aquatic organism passage	High	High	Near	Project	**Where**: In watersheds identified as key aquatic refugia and potential rain-on-snow areas **How**: Inventory infrastructure and conditions; inventory fish and aquatic habitats in areas where risk may increase; once areas identified, prioritize infrastructure replacement/ removal/ retrofitting first by fish and then by engineering needs and costs	**Internal collaboration**: Fisheries, hydrology, engineering **External collaboration**: Nez Perce Tribe, IDFG, FWS, IDEQ, DOT (state and federal), NMFS **Local group help**: trail/bridge maintenance **Capacity needed**: Funding - RAC, CFLRP, BPA

Focus on decommissioning of roads, trails, and railroad features to reduce erosion and impacts from rain-on-snow events	High	Mod-High	Near	Forest Plan and Project	**Where**: Key aquatic refugia watersheds and areas within future elevation bands of rain-on-snow event risk; also focus on areas with high road density, landslide prone areas, or feeder/secondary roads adjacent to streams where re-routing or decommissioning is likely to be supported **How**: Inventory roads, trails, and railroads, and complete an integrated roads analysis (employ LIDAR); decommission structures (i.e., roads, trails, railroads) to restore and improve upland and instream conditions in high road density watersheds and/or adjacent to stream and within Riparian Conservation Areas	**Internal collaboration**: Fisheries, hydrology, engineering **External collaboration**: Nez Perce Tribe, IDFG, FWS, IDEQ, DOT (state and federal), NMFS **Local groups**: OHV groups, IDPR, recreational groups **Capacity needed**: Funding - RAC, CFLRP, BPA
Evaluate canopy removal effects and potential for increased mass erosion and channel impacts due to decreased soil moisture, loss of root strength, and higher peak flows	Mod	Mod	Near-Mid	Project and Forest Plan	**Where**: Areas of increased rain-on-snow bands, areas of increased soil moisture **How**: Modify vegetation management treatment methods in key refugia watersheds, landslide prone areas with high number of future rain-on-snow bands (elevated risk at higher elevations than historic observations)	**Internal collaboration**: Fisheries, hydrology, vegetation management **External collaboration**: Collaborative groups (e.g., Clearwater Basin Collaborative), Nez Perce Tribe, Resource Advisory Committee

Limit vegetation management (silviculture, timber, fuels) in Riparian Conservation Areas	High	High	Near-Long	Forest Plan	**Where:** Forest-wide **How:** Develop components in Forest Plan revision to exclude mechanical treatments in Riparian Conservation Areas unless it can be demonstrated that the proposed activity is needed to improve stream temperature, sediment, large woody material, and/or channel morphology based on peer-reviewed science; also, create a framework on how to conduct activities and outline conditions under which proposed activities are effective	**External collaboration**: NMFS and USFWS **Capacity needed:** Additional research on fuel and vegetation treatments in Riparian Conservation Areas to demonstrate activities result in long-term improvement in stream attributes most affected by climate change (e.g. temperature, streamflow)

Table 21. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the hydrology and fisheries goal "Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Restore degraded stream channels

Potential vulnerabilities/opportunities:

- Changes in hydrograph and timing of precipitation could affect success of restoration
  - Possible solutions: include inner low-flow channel in designs to help maintain year-round flow and aquatic habitat; increase floodplain roughness to dissipate higher peak flows; consider excavating deeper pools where appropriate to allow for groundwater infiltration/maintenance of cool water
- Increased temperatures could affect revegetation success and/or heighten spread of invasive species
  - Potential solutions: develop summer watering strategy for 1-3 years post-planting; inventory and monitor invasive species distribution and continue implementing and strengthening measures to prevent distribution/proliferation

Adaptation strategy: Restore meadows, riparian areas, and degraded streams to secure favorable flows in headwater channels - and thus downstream receiving waters - and to maintain stream network connection and transport of water, sediment, and wood

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Modify grazing plans to minimize channel/meadow damage	Mod-High	Mod	Near-Long	Program	**Where:** Grazing allotments with riparian/wetland meadow areas **How:** Conduct permittee outreach and education on importance of meadow restoration, improve pasture management and/or fencing, provide off-site watering, and evaluate animal unit months (AUM)	**Internal collaboration:** Program Manager coordination with Range and Watershed staff **External collaboration**: Conservation districts, Stockman Association, USFWS, NOAA, Nez Perce Tribe
Encourage beaver activity where it is not likely to spread brook trout habitat	High	Mod	Near-Long	Program	**Where:** Areas that are conducive to beaver habitation, areas unlikely to spread brook trout, or impact major road infrastructure **How:** Create a map identifying appropriate beaver habitat (low gradient channels with abundant forage; avoid areas prone to flooding	**External collaboration:** IDFG, conservation districts, USFWS, NOAA, Nez Perce Tribe, Stockman Association (w/grazing allotments), local wildlife groups

					and areas with brook trout); import/ translocate beaver into suitable areas, create appropriate habitat, and utilize the 'beaver deceiver' program where conflicts may exist with infrastructure; prevent beaver trapping in prime beaver habitat areas and engage in public education and outreach	
Restore stream channels and floodplains	High	Mod	Near-Long	Project and Program	**Where:** Historic mining areas, disturbed meadows, and riparian roadways **How:** Prioritize locations by fisheries, water quality concerns, and feasibility	**External collaboration:** Nez Perce Tribe, conservation districts
Increase floodplain and channel roughness to help dissipate the anticipated increase in runoff (e.g., due to increased rain and rain-on-snow events)	Mod-High	Mod	Near-Long	Project and Program	**Where:** Low gradient channels where woody materials might occur naturally; streams along major roadways where decommissioning not feasible **How:** Install floodzone/ bioengineered surfaces (e.g., vegetation incorporated with wood and/or rock to harden channels) along streams adjacent to main travel ways	**External collaboration:** Nez Perce Tribe, conservation districts
Improve inventory and monitoring for aquatic invasives	Mod	High	Long	Forest Plan and Project	**Where:** Forest-wide **How:** Complete mapping of distribution of non-native fish (e.g. brook trout) and begin monitoring to detect changes in distribution (i.e. is range expanding?); develop contingency plan to address changes	**External collaboration:** IDFG and other state agencies; the state program currently funded by requiring invasive species sticker for boats **Local groups:** Sportsman groups can assist with distributing

					or new invasions; increase public awareness and propose actions the public can adopt to reduce risk (e.g., inspect, clean, dry) of introducing non-natives (e.g. zebra mussel)	outreach materials (e.g. public education bumper stickers- "Don't move a mussel")

In addition to adaptation strategies and tactics adjusted for current management goals, the hydrology and fisheries groups identified an important new adaptation strategy to incorporate into management operations now.

Table 22. Additional adaptation strategy, adaptation tactic, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs identified for fisheries. Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated.

Adaptation strategy: Designation of refuge watersheds and establishment of refugia for at-risk species						
Adaptation tactic	**Effectiveness**	**Feasibility**	**Timeframe**	**Implementation scale**	**Implementation (where/how)**	**Collaboration & capacity**
Include management designations in Forest Plan revision: set of watersheds with a restoration/ conservation priority with components specific to those watersheds	High	High	Long	Forest Plan	**Where:** Forest-wide **How:** Designate aquatic restoration priorities in the revised Forest Plan and integrate those designated watersheds with vegetation and fuels restoration priorities to avoid conflicts at project scale; watershed designation by consensus of groups identified as external collaborators	**External collaboration:** ESA regulatory agencies (USFWS, NMFS), Nez Perce Tribe, IDFG

A number of additional adaptation strategies and tactics were identified for hydrology and fisheries, however participants were unable to develop implementation plans for these tactics in the time allotted.

Table 23. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the hydrology and fisheries goal "Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Plan vegetation management activities to avoid or minimize negative impacts to water or soil resources

Potential vulnerabilities/opportunities:

Water quality

- Increased rain and rain-on-snow events at higher elevations leading to higher surface erosion potential
- Need more specific and robust identification and implementation of BMPs for harvest, fire and road activities to minimize surface erosion and sedimentation

Water quality/runoff processes

- Increased probability of rain-on-snow and associated higher peak flows in 1st order basins; this leads to channel impacts and risks to road/trail crossings
- Increased erosion and sedimentation leads to the need for proper sizing of road crossings and evaluation of canopy removal effect on peak flows

Soil productivity

- Warmer temperatures and less snow could lead to shorter & less secure frozen-over snow operating conditions; this could lead to an increase in adverse impacts during insufficient freezing and snow cover

Stability

- Increased rain-on-snow at higher elevations in smaller basins leads to increased potential for landslides and erosion

Adaptation strategy: Focus design of harvest, fire, and road activities to moderate effects of increased rain-on-snow events

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Identify elevation bands that will likely become more susceptible to rain-on-snow events	Program	Near	Forest management areas
Compile research on runoff response in rain-on-snow environments in order to develop guidance on infrastructure opening sizes and flow response expectations	Program	Near	Forest management areas

Table 24. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the hydrology and fisheries goal "Restore degraded stream channels". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Restore degraded stream channels

Potential vulnerabilities/opportunities:

- Changes in hydrograph and timing of precipitation could affect success of restoration
    - Possible solutions: include inner low-flow channel designs to help maintain year-round flow and aquatic habitat; consider excavating deeper pools where appropriate to allow for groundwater infiltration/maintenance of cool water
- Increased temperatures could affect revegetation success
    - Potential solution: develop summer watering strategy for 1-3 years post-planting

Adaptation strategy: Maintain and improve stream temperature

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Improve grazing practices to decrease stream width:depth ratios	Program	Near-Mid	Degraded riparian/wetland meadow reaches
Limit or eliminate riparian grazing to promote shrub/tree growth for increased shade and reduced bank erosion	Program	Mid	Degraded riparian/wetland meadow reaches
Limit or eliminate vegetation removal in riparian areas and set standard distance from streams beyond which vegetation removal can occur	Forest Plan	Immediate-Near	Increase protection for low-order stream reaches to maintain stream temperatures across all headwater reaches; no short-term decrease in existing shade

7. Recreation

Participants: Diana Jones

Introduction

The following section presents climate change adaptation planning results for recreation. The results summarize discussions and activities completed by participants during the workshop. We first present current management **goals** identified by participants. The purpose of identifying management goals is to provide a foundation for evaluating whether and how climate change might affect the ability to achieve a given goal, and to develop adaptation options for addressing vulnerabilities. For each management goal, participants identified potential vulnerabilities and/or opportunities presented by climate change. This activity was followed by the generation of broad adaptation **strategies** and more specific adaptation **tactics** designed to address vulnerabilities for each management goal. We then present a table linking vulnerabilities to management goals, adaptation strategies, and tactics generated by participants. The purpose of this table is to summarize the ability of adaptation tactics to ameliorate the effects of climatic and non-climatic stressors on a given resource area. Following the identification of adaptation strategies and tactics, we explore potential effects, both direct and indirect, of other resources on recreation and vice versa. As part of this discussion, participants highlighted adaptation tactics that may have potential conflicts with other resources. Lastly, we present an in-depth exploration of adaptation tactics, including where, when, and how to implement those tactics as well as collaboration and capacity needs.

Defining Terms

Goal: A desired result for a given resource.

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

Current Management Goals and Potential Vulnerabilities

Workshop participants identified one key current management goal for recreation:

(1) Develop resilient timber stands within developed recreation sites to maintain aesthetically pleasing areas that are safe to occupy in the long-term.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to this current management goal for recreation. Potential climatic and non-climatic vulnerabilities identified include:

- Warmer temperatures
- Altered timing of peak flow and runoff

- Reduced snowpack
- Reduced soil moisture and precipitation
- Increased fire frequency and severity
- Increased susceptibility to and frequency of disease outbreak
- Increased susceptibility to invasive species

Adaptation Options to Ameliorate Impacts

In response to these vulnerabilities, participants developed adaptation strategies and tactics designed to reduce the vulnerability of recreational activities to climatic change. Workshop participants created the following adaptation strategy for the current management goal identified for recreation:

Goal: Develop resilient timber stands within developed recreation sites to maintain aesthetically pleasing areas that are safe to occupy in the long-term.

Adaptation strategy: Create resilient forest stands within existing developed recreation sites.

Although not associated with a current management goal, participants identified a number of additional adaptation strategies to incorporate into management operations now.

Adaptation strategy: Use constructed features to protect vulnerable resource areas being used for dispersed recreation sites.

Adaptation strategy: Enhance forest visitor education/enforcement to improve knowledge of site protection measures.

Adaptation strategy: Decommission/revegetate dispersed sites with unacceptable impacts.

Adaptation strategy: Provide high quality winter sports opportunities given high year-to-year snow variability.

Adaptation strategy: Plan for fishing and water-based recreation peaking at different periods than those traditionally found on the forest.

Adaptation strategy: Plan for changes in use related to hunting opportunities due to shifting weather patterns and habitat, species availability, and hunting regulations.

Participants also identified a suite of additional adaptation tactics. Table 25 highlights these adaptation strategies and tactics, and classifies them as either likely or not likely to ameliorate impacts of a given climatic or non-climatic stressor on recreation. These classifications are based on expert opinion.

Participants identified several top adaptation strategies and tactics for recreation including:

- planning for changes in use associated with seasonal weather shifts; altered timing and quantity of peak flows, low flows, and runoff; and altered timing of wildlife availability;

- enhancing forest visitor education/enforcement to improve knowledge of site protection measures; and
- decommissioning/revegetating dispersed sites with unacceptable impacts.

Planning for changes in use associated with seasonal weather shifts; altered timing and quantity of peak, low flows, and runoff; and altered timing of wildlife availability
Participants identified altered timing of seasonal weather patterns, flow regimes, and wildlife availability (i.e., large game mammals) as important components for planning recreational activities within a climatic context. More specifically, participants noted that facilities should be managed to accommodate potential changes in seasonal use, such as locations accommodating changes in timing of fishing and water-based recreation and winter snow-sports. Facilities also need to be managed to accommodate projected shifts in visitor use due to changes in snowpack elevation or periods of high flows. Additionally, participants identified a need to collaborate with Idaho Fish and Game to develop flexible hunting seasons that consider changes in seasonal weather patterns and balance periods of high visitor use and periods of high hunter use.

Enhancing forest visitor education/enforcement to improve knowledge of site protection measures
Participants identified enhancing forest visitor education and improving enforcement of regulations as important to limit resource damage at high use recreation areas. Specifically, it may be important to provide resource protection messages and information about dispersed camping on the forest website. Participants also recommended providing site-specific information (e.g., regarding management activities) and focusing law enforcement contact at high-use areas to promote behavior modification.

Decommissioning/revegetating dispersed sites with unacceptable impacts
At dispersed recreation sites, participants recommended decommissioning and revegetating highly impacted sites. Participants noted that it is particularly important to concentrate on streambank stabilization by planting vegetation. Participants suggested mechanically decompacting high use areas and decommissioning access routes to allow for revegetation. Participants also recommended continued monitoring and evaluation of dispersed sites to increase detection of unacceptable impacts.

Table 25. Summary of adaptation strategies and tactics and their ability (indicated by an "X") to ameliorate effects of climatic and non-climatic stressors on recreation.

Goal	Adaptation Strategy	Adaptation Tactic	Ameliorates invasive species	Ameliorates increasing water stress	Ameliorates altered flow regimes	Ameliorates reduced snowpack	Ameliorates impacts to recreation	Ameliorates increased fire frequency and severity
Develop resilient timber stands within developed recreation sites to maintain aesthetically pleasing areas that are safe to occupy in the long-term	Create resilient forest stands within existing developed recreation sites	Develop plans to initiate phased replacement/regeneration of existing forest stands within recreation sites		X				X
		Increase coniferous and deciduous species' diversity by removing high-risk trees within sites and revegetating with more resilient species		X				X
		Control invasive weeds and introduce xerographic native shrubs in developed sites across the forest	X	X				X
		Review timber stands adjacent to developed sites to identify high risk areas for fire/catastrophic conditions and begin thinning and selective removal of material to promote resilience in campground WUI		X				X
Not identified	Plan for changes in use related to hunting opportunities due to shifting weather patterns/ habitat, species availability, and hunting regulations	Adjust facilities to accommodate changes in use					X	
		Improve wildlife habitat in areas that can accommodate visitor use					X	
		Work with IDFG to develop hunting seasons that consider changing weather conditions					X	
Not identified	Provide high quality winter sports opportunities	Develop overflow areas to accommodate increased use if lower elevation sites are snow-free (e.g., Missoula)				X	X	

	given high year-to-year snow variability	Improve grooming at high use sites to provide high quality winter use for a longer period of time				**X**	**X**	
		Improve visitor information about changing recreation opportunities					**X**	
Not identified	Plan for fishing and water-based recreation peaking at different periods than those traditionally found on the forest	Extend use seasons to accommodate changing time frames of peak flow			**X**		**X**	
		Improve communication tools for forest visitors to alert them to changing conditions			**X**		**X**	
		Change timing for outfitters to provide outfitted services to visitors as peak use changes			**X**		**X**	
Not identified	Enhance forest visitor education/ enforcement to improve knowledge of site protection measures	Post resource protection messages on website associated with information about dispersed camping					**X**	
		Provide information at specific sites receiving the greatest impact						
		Enhance law enforcement/visitor contact/outreach to begin behavior modification						
Not identified	Decommission/ revegetate dispersed sites with unacceptable impacts	Plant vegetation in areas of user impacts; concentrate on streambank stabilization			**X**			
		Decompact previous user impact areas and decommission access routes						
		Monitor and evaluate dispersed site impacts and identify areas with unacceptable impacts						
Not identified	Use constructed features to protect vulnerable resource areas	Provide hardened sites at critical areas of concentrated use					**X**	

	being used for dispersed recreation sites	Provide sanitation and fire protection in areas of concentrated use to provide healthy and safe opportunities					**X**	**X**
		Create barriers to prevent use of areas that have critical resources that cannot be protected by hardening						
Ensure high quality, aesthetically pleasing developed camping opportunities	Develop fire protection zones adjacent to existing developed sites (campground WUI)	Identify areas for thinning/selective tree removal						**X**
Not identified	Adjust timing of recreation resources to account for changes in duration of seasonal activities[11]	Alter permitted river-based activities with changes in water flows and timing			**X**		**X**	
		Prepare for less snowfall and shorter duration of winter-season recreation					**X**	
		Provide additional opportunities to accommodate increased demand and concentration of use in dispersed/developed sites					**X**	

[11] Adaptation strategies and tactics are discussed in more detail in Ecosystem Services section of this report.

Resource Direct/Indirect Effects

During the workshop, participants were asked to consider the ways in which other resources (e.g., hydrology, vegetation management) affect recreation, both directly and indirectly, as well as the ways in which recreation affects other resources. Figure 6 below summarizes the direct and indirect effects of other resources on recreation, as well as the direct and indirect effects of recreation on other resources.

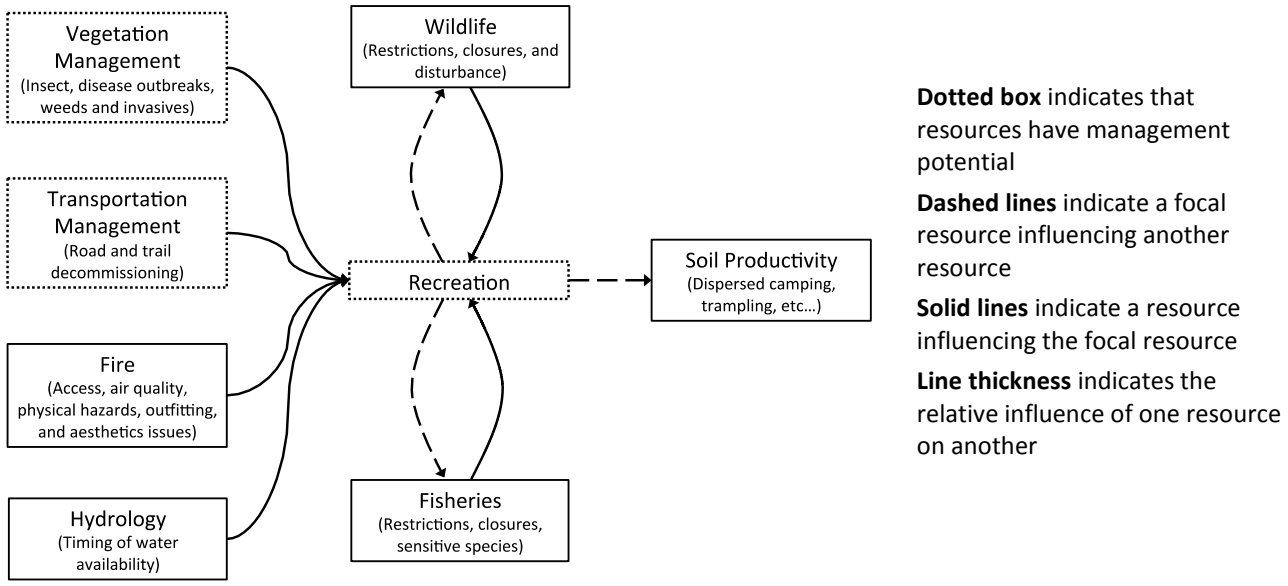

Figure 6. Exploration of direct/indirect effects of other resources on recreation, as well as the direct/indirect effects of recreation on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

In addition to exploring direct/indirect effects, participants were asked to consider potential conflicts that could arise when implementing specific adaptation tactics. Specifically, what potential conflicts could arise with other resources if adaptation tactic X is implemented? Participants did not indicate any resource conflicts associated with the proposed adaptation tactics.

Implementation of Adaptation Tactics

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for recreation, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or

unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.

- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.
- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 26-29 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for recreation. Each table is structured to provide:

7. A current management goal
8. Potential climatic and non-climatic vulnerabilities and/or opportunities that affect the success of achieving the management goal
9. A broad adaptation strategy
10. Multiple adaptation tactics
11. An evaluation of tactic effectiveness, feasibility, timeframe, and implementation scale
12. A description of where and how to implement and collaboration and capacity needed to move forward with implementation

This workshop activity was intended to generate a range of recommended adaptation tactics that could be implemented both now and in the future. The resulting tactics are not comprehensive, and users of this report are encouraged to explore additional adaptation tactics that may help reduce vulnerabilities, increase resilience, or capitalize on opportunities presented by climate change for recreation.

Table 26. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the recreation goal "Develop resilient timber stands within developed recreation sites to maintain aesthetically pleasing areas that are also safe to occupy in the long term". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Develop resilient timber stands within developed recreation sites to maintain aesthetically pleasing areas that are also safe to occupy in the long term

Potential vulnerabilities/opportunities:

- Changing use patterns
- Drought-intolerant conifer species at developed sites
- Changes in site attractions (e.g., water features, hunting, fishing, etc.)

Adaptation strategy: Create resilient forest stands within existing developed recreation sites

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Develop vegetation management plans directing phased replacement/ regeneration of existing forested stands	Moderate	High	Near-Mid	Program	**Where:** Sites where forest stands contain large percentages of shade intolerant species that may already have insect/disease issues **How:** Work with regional forestry/pathologist experts to develop vegetation management plans with phased priorities to create more resilient stands; review all sites and prioritize according to level of use and severity of problem	**Internal/external collaboration:** Forestry and pathologist experts
Remove high-risk trees within site and revegetate with resilient species/diversity of coniferous and deciduous species	Moderate	Moderate	Near-Mid	Program and Project	**Where:** Areas with highest use and greatest severity of problem stands **How:** Work with foresters and timber sale administrators to identify best, phased process for group removal; also use individual removal; replant areas within recreation sites with drought-tolerant/disease-resistant species	**Internal collaboration:** Foresters and timber sale administrators

Control invasive weeds and introduce xerographic native shrubs in developed sites across the forest	Moderate	Moderate	Near-Mid	Program	**Where:** Developed sites **How:** Introduce over time, continue adding planting options and weed control methods in each vegetation management plan; work with the nursery to develop planting stock for each specific site to meet long-term needs; initiate an annual program to implement a few new sites each season	**Internal collaboration**: Nursery
Review timber stands adjacent to developed sites to identify high risk areas for fire/catastrophic conditions and begin thinning and selective removal of material to promote resilience in campground WUI	Moderate	Moderate	Near-Long	Project	**Where:** Forest-wide, beginning in areas of high, concentrated use with high stand composition of grand fir and Douglas fir **How:** Work with timber and fire counterparts to identify areas for thinning and selective removal; consider phased small timber sales to remove areas of high concern	**Internal collaboration:** Timber, fire

A number of additional adaptation strategies and tactics were identified for recreation, however participants were unable to develop implementation plans for these tactics in the time allotted.

Table 27. Adaptation strategies, tactics, and tactic applications developed to address potential changes in dispersed recreation as a result of changing climatic conditions. Implementation scale, and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were evaluated for each tactic.

Potential future change: Dispersed recreation increases in riparian areas as people seek out cooler, moister environments			
Potential vulnerabilities/opportunities: • Most riparian areas are vulnerable to human impacts and concentrated use, especially during drought conditions			
Adaptation strategy: Use constructed features to protect vulnerable resource areas being used for dispersed recreation sites			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Provide hardened sites at critical areas of concentrated use	Project	Near-Mid	Harden parking areas if needed to protect vegetation (i.e., prevent unwanted "spread")
Provide sanitation and fire protection in areas of concentrated use to provide healthy and safe opportunities	Project	Near-Mid	Install both temporary and long-term sanitation and fire protection facilities
Create barriers to prevent use of areas that have critical resources that cannot be protected by hardening	Project	Near-Mid	Install natural rock and log barriers if possible. If required, block access to routes using constructed features such as gates
Adaptation strategy: Enhance forest visitor education/enforcement to improve knowledge of site protection measures			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Post resource protection messages on website associated with information about dispersed camping	Program	Near-Long	Create message and add to recreation info on website
Provide information at specific sites receiving the greatest impact	Project	Near-Long	Create resource protection signs and install them at specific concentrated use areas
Enhance law enforcement/visitor contact/outreach to begin behavior modification	Project and Program	Near-Long	Begin focused enforcement at high risk areas
Adaptation strategy: Decommission/revegetate dispersed sites with unacceptable impacts			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Plant vegetation in areas of user impacts; concentrate on streambank stabilization	Project	Near-Long	Acquire native species' plant materials and plant at high priority sites
Decompact previous user impact areas and decommission access routes	Project	Near-Long	Mechanically decompact impacted soil areas and access routes

Monitor and evaluate dispersed site impacts and identify areas with unacceptable impacts	Program	Near-Long	Monitor and update existing dispersed site database

Table 28. Adaptation strategies, tactics, and tactic applications developed to address potential changes in recreational seasons and opportunities as a result of changing climatic conditions. Implementation scale, and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were evaluated for each tactic.

Potential future change: Altered recreation seasons, opportunities, and/or timing of used as a result of future climatic changes			
Potential vulnerabilities/opportunities: • Extend/alter activity seasons to accommodate future changes			
Adaptation strategy: Provide high quality winter sports opportunities given high year-to-year snow variability			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Develop overflow areas to accommodate increased use if lower elevation sites are snow-free (e.g., Missoula)	Project	Mid-Long	Plan and construct flexible parking areas that can be expanded as needed
Improve grooming at high use sites to provide high quality winter use for a longer period of time	Project	Near	Coordinate with partners to provide better grooming resources
Improve visitor information about changing snow opportunities	Project	Near	Improve website communication and site signage to provide high quality information
Adaptation strategy: Plan for fishing and water-based recreation peaking at different periods than those traditionally found on the forest			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Extend use seasons to accommodate changing time frames of peak flow	Program and Project	Near	Open campgrounds earlier and provide critical services during peak use
Improve communication tools for forest visitors to alert them to changing conditions	Program	Near	Improve information provided through website and frontliners
Change timing for outfitters to provide outfitted services to visitors as peak use changes	Project and Program	Near-Long	Coordinate with outfitters and change administrative plans if needed
Adaptation strategy: Plan for changes in use related to hunting opportunities due to shifting weather patterns and habitat, species availability, and hunting regulations			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Adjust facilities to accommodate changes in use	Project	Near-Mid	Decommission unused areas and improve/expand new focal areas
Improve wildlife habitat in areas that can accommodate visitor use	Project	Mid-Long	Complete vegetation management projects that improve habitat in front country areas

Work with IDFG to develop hunting seasons that consider changing weather conditions	Program	Mid-Long	Look at areas of high visitor use and balance hunting season

Table 29. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., where tactic could be most appropriately applied due to specific management, ecological, or site conditions) for the restoration goal "Ensure high quality, aesthetically pleasing developed camping opportunities". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Ensure high quality, aesthetically pleasing developed camping opportunities

Potential vulnerabilities/opportunities:

- Changing use patterns
- Drought-intolerant conifer species at developed sites
- Changes in site attractions (e.g., water features, hunting, fishing, etc.)

Adaptation strategy: Develop fire protection zones adjacent to existing developed sites (campground WUI)

Adaptation tactic	Implementation scale	Timeframe	Tactic application
Identify areas for thinning/selective removal	Project	Near-Long	Develop long term restoration/hazard management for areas adjacent to campgrounds

8. Ecosystem Services

Introduction

The following section presents climate change adaptation planning results for ecosystem services. Ecosystem services considered as part of this section include:

- Aesthetics
- Clean air
- Clean water
- Cultural values
- Forage
- Recreation[12]
- Timber

The results for each ecosystem service summarize discussions and activities completed by participants during the workshop. For each ecosystem service, participants first identified potential vulnerabilities and/or opportunities presented by climate change. Participants then reviewed the potential management strategies identified in the Nez Perce-Clearwater (NPCW) National Forests Socioeconomic Climate Change Vulnerability Assessment. Following this review, participants could select management strategies from the NPCW Socioeconomic Vulnerability Assessment and expand upon them and/or develop new **adaptation strategies** and more specific **adaptation tactics** designed to address vulnerabilities for each ecosystem service. Following the identification of adaptation strategies and tactics, participants generated more detailed tactic implementation plans, including where, when, and how to implement those tactics as well as potential constraints and unintended impacts of other resources on implementation. Lastly, participants explored the potential effects, both direct and indirect, of other resources on a given ecosystem service and vice versa.

Defining Terms

Adaptation strategy: General statements of how to reduce vulnerabilities or increase resilience of current management goals.

Adaptation tactic: Specific actions that facilitate progress towards achieving an adaptation strategy.

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[12] Recreation was also considered as an ecosystem service during the workshop. Participants for this group differed from those involved in the Recreation section of this report. The purpose of this separate evaluation was to consider those management actions identified in the Nez Perce-Clearwater National Forests Socioeconomic Climate Change Vulnerability Assessment (part of the Forest Plan Assessment).

Aesthetics

Adaptation Options to Ameliorate Vulnerabilities

Adaptation strategies and tactics for aesthetics were not considered during the workshop due to lack of participant expertise. Readers of this report are encouraged to review the Aesthetics section of the NPCW Socioeconomic Climate Change Vulnerability Assessment.

Resource Direct/Indirect Effects

While participants were unable to develop adaptation strategies and tactics for aesthetics, they did consider the ways in which other resources (e.g., grazing, mining) affect the provisioning of aesthetics, both directly and indirectly, as well as the ways in which aesthetics affects other resources. Figure 7 below explores the direct and indirect effects of other resources on aesthetics, as well as the direct and indirect effects of aesthetics on other resources.

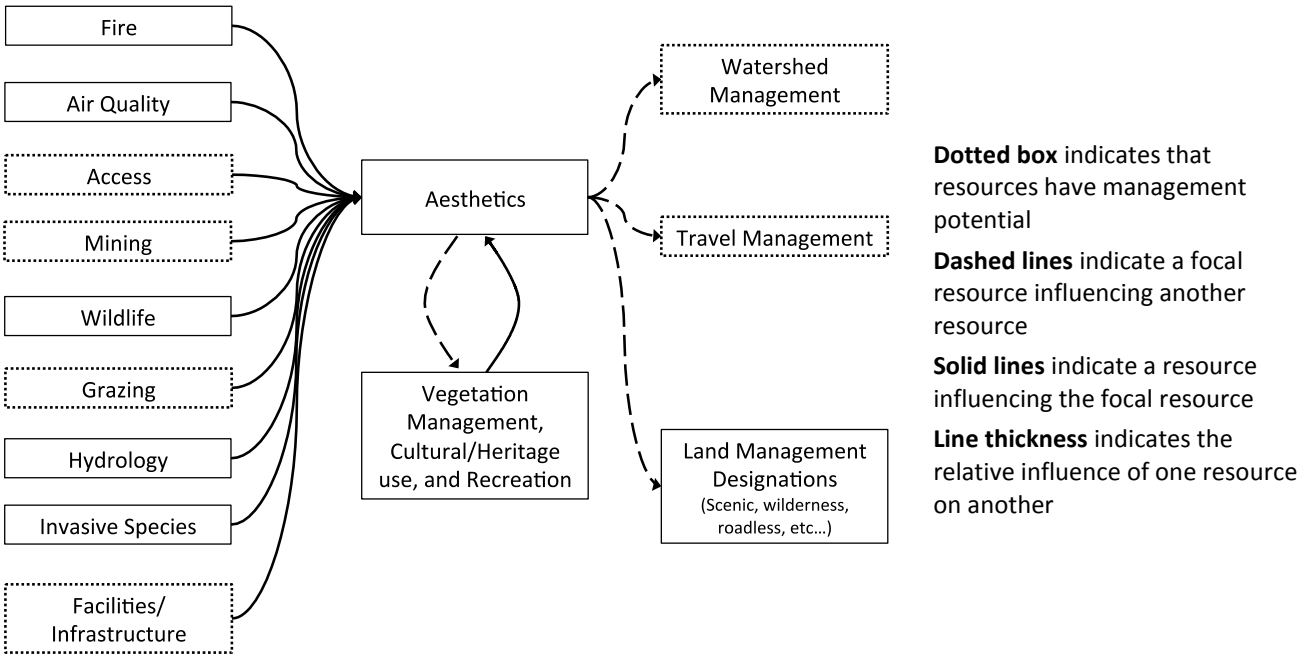

Figure 7. Exploration of direct/indirect effects of other resources on the provisioning of aesthetics, as well as the direct/indirect effects of aesthetics on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

Clean Air

Adaptation Options to Ameliorate Vulnerabilities

The key vulnerability identified for clean air was related to the occurrence, intensity, and frequency of wildfires. In response to this vulnerability, participants recommended pursuing the adaptation strategies developed as part of the NPCW Socioeconomic Climate Change Vulnerability Assessment. These strategies include:

1. Continue to coordinate with the full range of agencies and other stakeholders working to improve and/or maintain air quality.
2. Prescribed burning to reduce wildfire risk, timed to minimize impacts to air quality.
3. Mechanical fuel treatments, where appropriate, to remove hazardous fuel buildups and reduce risk of wildfire and smoke.

Participants suggested several additions to the existing strategies, particularly related to mechanical fuel treatments. Specifically, participants noted that mechanical fuel treatment economic feasibility needs to be improved; for example, by:

- Improving equipment, or
- pooling resources across landowners (i.e., private, tribal, state, federal) to increase the scale of mechanical fuel treatments.

Potential constraints to implementing these strategies include high cost and need for manpower and specific equipment. Participants also suggested shifting the wood products industry to use alternative raw material (e.g., smaller diameter trees). In order to make this happen, participants recommended conducting a market analysis to identify prospective alternative raw materials and promoting education (i.e., to wood products industry) on what other materials are available. Participants also suggested increasing salvage efforts of wood products after large die-offs (e.g., beetle-killed or burned trees), although this wood needs to be salvaged quickly before it degrades and becomes economically unviable.

Resource Direct/Indirect Effects

Participants were unable to consider direct and indirect effects of other resources (e.g., vegetation management, wildfire) on clean air and vice versa in the time allotted.

Clean Water

Adaptation Options to Ameliorate Vulnerabilities

Key vulnerabilities identified for clean water included:

- higher stream temperatures leading to increased algal blooms, altered runoff regimes, and earlier runoff peaks;
- increased El Nino events leading to lower mean annual water yield;
- more precipitation falling as rain rather than snow; and
- decreased flow in summer.

In response to these vulnerabilities, participants identified a number adaptation strategies and tactics. For each tactic, participants also identified possible constraints and unintended impacts.

Adaptation strategy: Meadow and wetland restoration to protect water quality.[13]

Adaptation tactics: Reintroduce beavers, riparian fencing, and soil decompaction.

[13] These adaptation strategies were also identified in the Nez Perce-Clearwater Socioeconomic Climate Change Vulnerability Assessment.

Unintended impacts: Less forage for livestock, although over the long-term it could benefit livestock forage if habitat conditions improve.

Adaptation strategy: Reduce the effects of wildfire in watersheds to increase resilience.[3]

Adaptation tactics: Implement tactics identified under "meadow and wetland restoration", particularly within degraded watersheds.

Constraints: Possible restrictions on vegetation management activities (e.g., thinning) and/or production of roads; there may also be limited access to areas due to road decommissioning.

Adaptation strategy: Implement best management practices for timber, grazing, recreation, and fire suppression to maintain and/or improve water quality. [3]

Adaptation tactics: Improve and/or build stronger BMPs and increase riparian conservation areas.

Unintended impacts: May lead to restrictions or closures for campgrounds or grazing allotments.

Adaptation strategy: Prevent negative impacts from recreation activities.

Adaptation tactics: Reduce mud-bogging.

Adaptation strategy: Increase complexity of river channels to reduce flow speed.

Adaptation tactics: Increase large woody debris, rock structures, and fencing.

Unintended impacts: Large woody debris can create problems for bridges and road infrastructure, or adjacent infrastructure. Additionally, it may require increased infrastructure maintenance.

Adaptation strategy: Maintain and/or improve stream temperatures, where possible.

Adaptation tactics: Improve grazing practices and increase fencing, plant vegetation to provide overhanging shade, and monitor groundwater to identify its influence on streams both now and with future climate changes.

Constraints: High cost of fencing and lack of clarity on installation responsibility (e.g., private, state, or federal responsibility to build and maintain fencing?) may prevent implementation. Also, fencing creates wildlife movement/dispersal barriers.

Resource Direct/Indirect Effects

Participants were unable to consider direct and indirect effects of other resources (e.g., vegetation management, transportation) on clean water and vice versa in the time allotted.

Cultural Values

Participants: Steve Lucas

Current Management Goals and Potential Vulnerabilities
Workshop participants identified one key current management goal for cultural and heritage values:

(1) Identify priority heritage assets and retain national register integrity of priority heritage assets.

As part of the workshop activities, participants identified potential vulnerabilities or opportunities posed by climatic and non-climatic stressors to this current management goal for cultural and heritage values. Potential climatic and non-climatic vulnerabilities identified include:

- Increased risk of catastrophic wildfire
- Increased flood frequency and intensity
- Altered precipitation regimes (e.g., more precipitation falling as rain rather than snow)

Participants noted that many cultural heritage sites could be affected by climate change. For example, those sites located near waterways may be imperiled due to altered hydrographs, while those sites with high fuel loads may be at increased risk of catastrophic fire.

Adaptation Options to Ameliorate Vulnerabilities
In response to these vulnerabilities, participants developed a number of adaptation strategies and tactics designed to reduce vulnerability or increase resilience of cultural and heritage resources. Workshop participants identified the following adaptation strategy for cultural and heritage values:

Goal: Identify priority heritage assets and retain national register integrity of priority heritage assets.

Adaptation strategy: Identify protective measures for sites at higher risk from climate change.

After identifying climatic and non-climatic vulnerabilities of and developing adaptation strategies and tactics for cultural and heritage values, participants were asked to select one or more tactics and expand on implementation. Specifically, participants were asked to evaluate:

- **Tactic effectiveness**. Identify the effectiveness of the tactic in reducing vulnerability.
    - *High*: activity is very likely to reduce vulnerability and may benefit additional goals; *Moderate*: activity has moderate potential to reduce vulnerability, with some risks or unintended consequences; or *Low*: activity is unlikely to reduce vulnerability or may have unintended consequences.
- **Tactic feasibility**. Identify feasibility of implementing the tactic.
    - *High*: there are no obvious barriers and it has a high likelihood of being implementable; *Moderate*: it may be possible to implement the tactic, although there may be challenges or barriers; or *Low*: there are obvious and/or significant barriers to implementation that may be difficult to overcome.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.

    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Implementation where/how.** Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints. For example, the tactic is most appropriately implemented in areas with high soil moisture holding capacity using mechanical treatments, and should be done in collaboration with wildlife biologists to avoid any potential conflicts with important habitat.
- **Collaboration and capacity.** Identify any other agencies, organizations, or people – both internal and external – needed to collaborate with in order to implement this tactic. Also identify internal capacity needed for implementation such as data, staff time and resources, funding, or policy changes, among others.

Tables 30-31 below explore the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for cultural and heritage values. A number of constraints for implementation of adaptation tactics were identified, including lack of available funding to coordinate with tribal groups, lack of available funding for monitoring, and lack of detail necessary to implement actions at a project-specific level.

Table 30. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale, where/how to implement, and collaboration and capacity needs for the cultural and heritage values goal "Identify priority heritage assets and retain national register integrity of priority heritage assets". Tactic effectiveness (likely to reduce vulnerability), feasibility (likelihood of implementation), and timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) were also evaluated for each adaptation tactic.

Current management goal: Identify priority heritage assets and retain national register integrity of priority heritage assets

Potential vulnerabilities/opportunities:

- Increased risk of catastrophic wildfire
- Increased flood frequency and intensity
- Altered precipitation regimes (e.g., more precipitation falling as rain rather than snow)

Adaptation strategy: Identify protective measures for sites at higher risk from climate change

Adaptation tactic	Effectiveness	Feasibility	Timeframe	Implementation scale	Implementation (where/how)	Collaboration & capacity
Thin around sites	High	Mod	Near	Project	**Where:** In areas with high potential for success to protect sites and reduce fuels; at sites that have been specifically excluded from vegetation management activities in the past **How:** Mechanical vegetation treatments (i.e., thinning)	**External collaboration**: Nez Perce Tribe, State Historic Preservation Office buy-in needed; policy review/buy-in needed **Capacity**: already in place

An additional adaptation tactic was identified for cultural and heritage values, however participants were unable to develop implementation plans for these tactics in the time allotted.

Table 31. Potential vulnerabilities/opportunities, adaptation strategies and tactics, and tactic implementation details including scale and application (i.e., the management, ecological, or site conditions where the tactic could be most appropriately implemented) for the cultural and heritage values goal "Identify priority heritage areas and retain national register integrity of priority habitat areas". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years) was also evaluated for each adaptation tactic.

Current management goal: Identify priority heritage assets and retain national register integrity of priority heritage assets			
Potential vulnerabilities/opportunities: • Increased risk of catastrophic wildfire • Increased flood frequency and intensity • Altered precipitation regimes (e.g., more precipitation falling as rain rather than snow)			
Adaptation strategy: Identify protective measures for sites at higher risk from climate change			
Adaptation tactic	**Implementation scale**	**Timeframe**	**Tactic application**
Inventory, monitor, and evaluate sites that may be at increased risk due to climate change	Forest Plan	Near	Implement in areas at high risk due to catastrophic wildfire

Resource Direct/Indirect Effects

During the workshop, participants also considered the ways in which other resources (e.g., fisheries or wildlife management) affect cultural and heritage values, both directly and indirectly, as well as the ways in which cultural and heritage values affect other resources. Figure 8 below explores the direct and indirect effects of other resources on cultural and heritage values and vice versa.

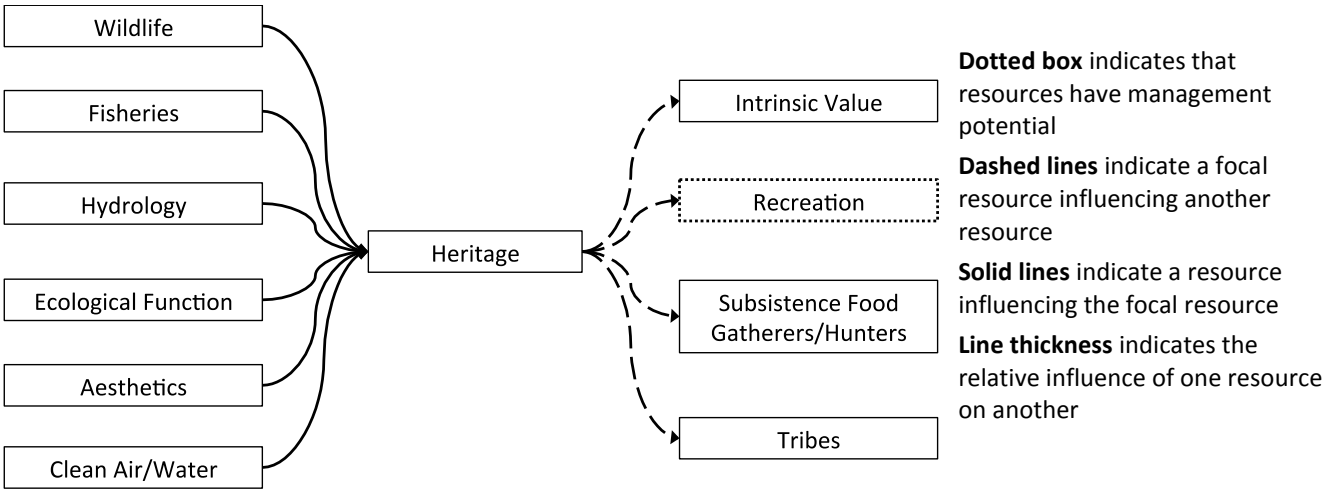

Figure 8. Exploration of direct/indirect effects of other resources on cultural and heritage values, as well as the direct/indirect effects of cultural and heritage values on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

Forage

Adaptation Options to Ameliorate Vulnerabilities

Key vulnerabilities identified for forage included:

- increased invasive species;
- increased incidence of drought may increase livestock grazing duration; and
- increased wildfire frequency and/or severity may limit grazing lots in the short-term, but increase in the long-term.

After identifying climatic and non-climatic vulnerabilities, participants were asked to develop adaptation strategies and tactics for the ecosystem service, and expand on implementation details including tactic application, timeframe, scale, possible constraints, and unintended impacts of other resources. Specifically, participants evaluated:

- **Tactic application**. Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.

- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Constraints from other resources.** Identify any constraints from other resources that may affect the ability to implement a given adaptation tactic.
- **Unintended impacts of other resources or ecosystem services.** Identify any unintended impacts of other resources on the ability to provide an ecosystem service.

Table 32 below explores the adaptation strategies, tactics, and implementation recommendations developed by workshop participants for the forage ecosystem service. In addition to the tactics identified in Table 32, participants highlighted the need to modify existing livestock fencing materials, as current materials degrade quickly and are susceptible to fire.

Table 32. Potential vulnerabilities, adaptation strategies and tactics, and tactic implementation details such as scale and application identified for the ecosystem service "forage". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years), constraints from other resources, and unintended impacts were also evaluated for each tactic.

Potential vulnerabilities: Increased invasive species, drought conditions, timing and duration of grazing, and increased fire frequency and extent could limit the use of grazing allotments in the short term.					
Adaptation strategy: Improve and/or maintain forage conditions for livestock, prioritizing adaptation tactics in low elevation grazing allotments					
Adaptation tactic	**Timeframe**	**Implementation scale**	**Tactic application**	**Constraints from other resources**	**Unintended impacts of other resources/services**
Improve invasives funding and prioritization process (CWMA) to direct invasive plant management, and utilize existing best management practices	Near	Program	Target grasslands and treat new invaders forest-wide	Aquatics: dependent on distance of chemical treatments from streams Botanicals: technicians need to know what *not* to spray (i.e., target spraying of chemicals rather than broadcast spray)	Impacted by recreation, livestock, fire management, timber, and roads
Alternate pastures and/or swing pastures to ameliorate grazing pressure during drought, or in case of fire or invasive issues	Near-Mid	Program	Analyze with allotment management plans; focus on drought-prone allotments and identify alternative areas (e.g., vacant allotments) compatible with current allotment conditions (i.e., equal forage quality)	Aquatics Wildlife (winter range) Botanicals Timber plantations Recreation	Vegetation management or prescribed fire may alter forage conditions in a positive way or make it unavailable for use
Change timing, location, and level of livestock grazing due to changing forage availability[14]	Near-Mid	Project and Program (e.g., annual operating plans)	Prioritize xeric, lower elevation allotments; changes may result from wildfire	Botany Fisheries (spawning) Wildlife (calving)	Prescribed fire, spring burning, or gates left open for hunters/recreation

[14] This adaptation strategy was identified in the NPCW Socioeconomic Climate Change Vulnerability Assessment.

Resource Direct/Indirect Effects

During the workshop, participants also considered the ways in which other resources (e.g., fire, restoration) affect the provisioning of forage, both directly and indirectly, as well as the ways in which forage affects other resources. Figure 9 below explores the direct and indirect effects of other resources on forage, as well as the direct and indirect effects of forage on other resources.

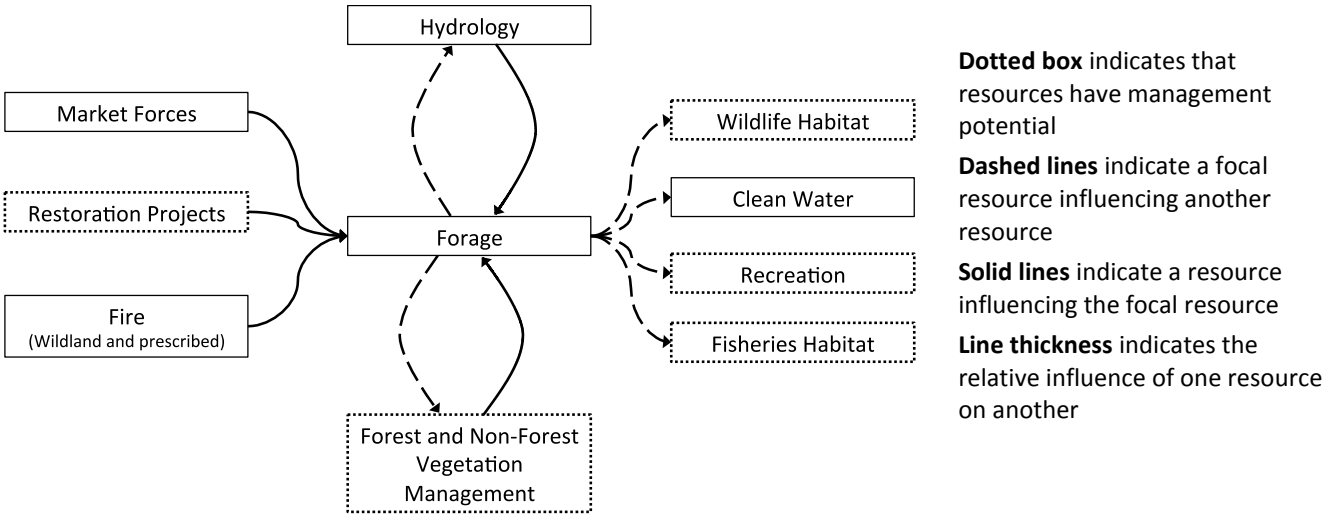

Figure 9. Exploration of direct/indirect effects of other resources on the provisioning of forage, as well as the direct/indirect effects of forage on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

Recreation

Adaptation Options to Ameliorate Vulnerabilities

Key vulnerabilities and opportunities identified for recreation included:

- increasing temperatures and longer warm weather seasons,
- decreased snowpack and shorter winter season, and
- altered hydrologic regimes.

In response to these vulnerabilities, participants reviewed and improved upon the adaptation strategies developed as part of the NPCW Socioeconomic Climate Change Vulnerability Assessment. Specifically, participants recommended splitting the management strategies into those that address summer recreation and those that address winter recreation. Table 33 below explores the additional adaptation strategies, tactics, and implementation recommendations developed by workshop participants for recreation.[15] Specifically, participants evaluated:

[15] Please see additional section on Recreation where this resource was evaluated separately (i.e., not as an ecosystem service).

- **Tactic application**. Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Constraints from other resources.** Identify any constraints from other resources that may affect the ability to implement a given adaptation tactic.
- **Unintended impacts of other resources or ecosystem services.** Identify any unintended impacts of other resources on the ability to provide an ecosystem service.

Table 33. Potential vulnerabilities, adaptation strategies and tactics, and tactic implementation details such as scale and application identified for the ecosystem service "recreation". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years), constraints from other resources, and unintended impacts were also evaluated for each tactic.

Potential vulnerabilities: Increasing temperatures and longer summer season, decreased snowpack and shorter winter season, altered hydrologic regimes, and increased duration of season and demand on dispersed/developed sites					
Adaptation strategy: Adjust timing of recreation to account for changes in duration of seasonal activities due to climate change					
Adaptation tactic	**Timeframe**	**Implementation scale**	**Tactic application**	**Constraints from other resources**	**Unintended impacts of other resources/services**
Alter permitted river-based activities with changes in water flows and timing	Near-Mid	Permitted rivers	Adjust the timing of use and numbers of permits on the Selway and Salmon rivers	Access (snow)	Wildlife Fisheries
Prepare for less snowfall and shorter duration of winter-season recreation	Mid	Areas of snowpack	Implement seasonal restrictions and area closures (e.g., limit access of high-impact recreation such as snowmobiling during shoulder seasons to limit resource damage); shift to new groomed trails to create more open access; improve network of public awareness during closure periods	Wildlife	Wildlife disturbance, soil damage during shoulder seasons, and increased concentration of use
Provide additional opportunities to accommodate increased demand and concentration of use in dispersed/developed recreation sites	Mid	Forest-wide	Create more developed sites, expand access dates, improve/add new facilities, increase education, and ensure resource protection at dispersed sites	Soils Hydrology Fisheries Wildlife Fire Others	Increased resource damage and decreased recreational experience

Resource Direct/Indirect Effects
During the workshop, participants also considered the ways in which other resources (e.g., vegetation management, transportation) affect recreation, both directly and indirectly, as well as the ways in which recreation affects other resources. Please refer to the Recreation section of this report for a summary on direct/indirect effects.

Timber

Adaptation Options to Ameliorate Vulnerabilities
Key vulnerabilities identified for timber included:

- increased frequency, intensity, and severity of wildfires;
- decreased snowpack; and
- increased insect and disease outbreaks.

In response to these vulnerabilities, participants reviewed and improved upon the adaptation strategies developed as part of the NPCW Socioeconomic Climate Change Vulnerability Assessment. Table 34 below explores adaptation strategies, tactics, and implementation recommendations developed by workshop participants for timber. Specifically, participants evaluated:

- **Tactic application**. Identify the management, ecological, or site conditions where the tactic could be most appropriately implemented and how to implement given these conditions or constraints.
- **Implementation timeframe.** Identify when the action could feasibly be implemented.
    - *Near*: 2-5 years; *Mid*: 5-15 years; or *Long*: >15 years.
- **Implementation scale.** Identify where these adaptation tactics might be best integrated into management operations.
    - *Forest plan level*: desired conditions, objectives; *Program level*: range allotment plans, travel management plans, watershed assessments; or *Project level*: prescriptions, design features, or standards or guidelines.
- **Constraints from other resources.** Identify any constraints from other resources that may affect the ability to implement a given adaptation tactic.
- **Unintended impacts of other resources or ecosystem services.** Identify any unintended impacts of other resources on the ability to provide an ecosystem service.

Table 34. Potential vulnerabilities, adaptation strategies and tactics, and tactic implementation details such as scale and application identified for the ecosystem service "timber". Implementation timeframe (near: 2-5 years; mid: 5-15 years; long: >15 years), constraints from other resources, and unintended impacts were also evaluated for each tactic.

Potential vulnerabilities: Risk of timber loss due to increased frequency, intensity, and size of wildfires; additionally, reduced snowpack may promote insect and/or disease outbreaks and alter stand composition, favoring more shade-intolerant species					
Adaptation strategy: None identified					
Adaptation tactic	**Timeframe**	**Implementation scale**	**Tactic application**	**Constraints from other resources**	**Unintended impacts of other resources/services**
Promote use and increase availability of firewood and biomass	Near-Long	Program	Improve public outreach and education on wood/biomass collection policies; educate agency personnel on potential use	Wildlife Soils	Potential conflict with nutrient cycling in soils and habitat structure for wildlife (small mammals, birds, amphibians, and insects) from removal of coarse woody debris
Conduct fuels treatments to decrease the probability of catastrophic wildfires[16]	Near-Long	Program and Project	Use mechanical treatment, targeted thinning, and prescribed fires to reduce risk of catastrophic fire	Potential conflicts with clean water and recreation	Could alter forested and non-forested vegetation management plans, as well as hydrology and fisheries
Utilize salvage burned or insect-killed timber before market value decreases[6]	Near-Long	Project	Track recently killed timber areas and opportunistically harvest prior to timber degradation and reduced market value	Market forces are difficult to affect at a local level	Could affect resident and migratory birds that rely on standing dead trees for forage and nesting habitat; also, potential impacts on small mammals, amphibians, and insects that rely on downed woody debris for critical habitat structure and movement corridors (i.e. fisher).

[16] From NPCW Socioeconomic Climate Change Vulnerability Assessment.

Resource Direct/Indirect Effects

During the workshop, participants also considered the ways in which other resources (e.g., wildlife) affect timber, both directly and indirectly, as well as the ways in which timber affects other resources. Figure 10 below explores the direct and indirect effects of other resources on forage, as well as the direct and indirect effects of forage on other resources.

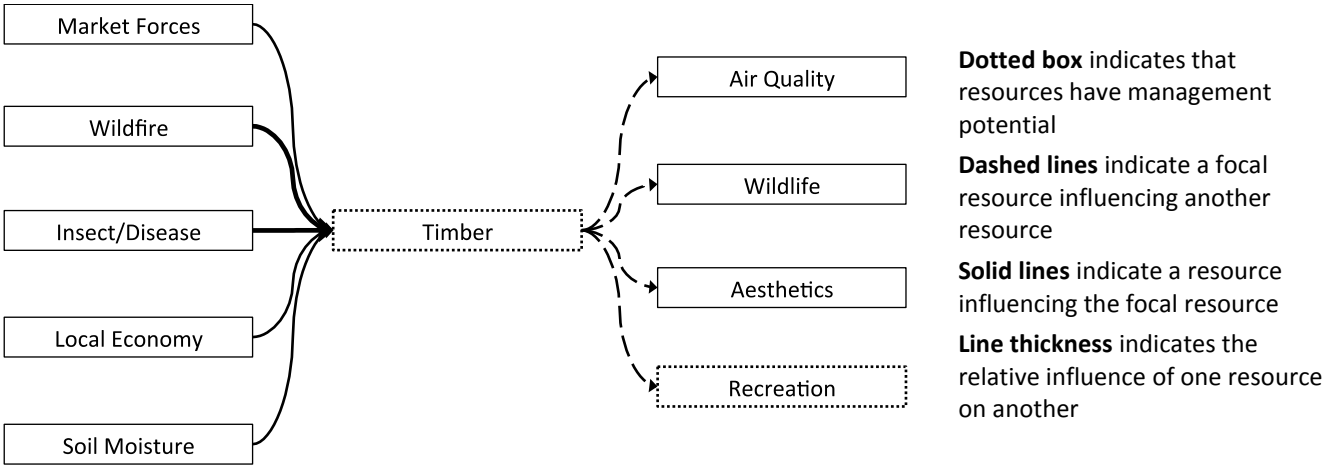

Figure 10. Exploration of direct/indirect effects of other resources on the provisioning of timber, as well as the direct/indirect effects of timber on other resources. Management potential reflects the ability of resource managers to influence impacts on a given resource.

9. Conclusions

The *Nez Perce-Clearwater National Forests Adaptation Planning Workshop* provided an opportunity for resource managers to generate potential responses to the challenges posed by climate change, identify capacity needed to implement these responses, and discuss constraints or conflicts with other resources. The adaptation strategies and tactics described in this report are key to preparing for and responding to climate change impacts by decreasing vulnerability and increasing resilience. A number of adaptation tactics developed by participants occurred in multiple resource areas. Examples include thinning, prescribed burning, managed wildfire, invasive species removal, habitat restoration, and modification of grazing allotments and permits (Table 35).

Some adaptation strategies and tactics identified by workshop participants are more feasible and have a higher likelihood of reducing vulnerability than others. Other adaptation tactics may ameliorate the effects of multiple climatic and non-climatic stressors. Adaptation tactics that intersect these two – i.e., those with higher feasibility and effectiveness, and address multiple stressors – are highlighted in Table 35. Those tactics highlighted in green have the highest implementation feasibility and effectiveness and likely ameliorate three or more climatic and non-climatic stressors. Those tactics highlighted in yellow have more moderate or moderate-high implementation feasibility and effectiveness while also helping alleviate two or more climatic and non-climatic stressors.

Table 35. Common adaptation tactics identified during the workshop and the corresponding resource area in which the tactic was proposed. The climatic and non-climatic stressors that implementation of the tactic could help alleviate as well as potential conflict areas are identified for each tactic. Those tactics highlighted in green have the highest implementation effectiveness and feasibility; those tactics highlighted in yellow have moderate or moderate-high implementation effectiveness and feasibility; implementation effectives and feasibility were not assessed for the education and outreach tactic.

Tactic	Resource Areas	Stressors Tactic Ameliorates	Potential Conflict Areas
Thin overstocked stands, areas where competition occurs, within or near recreation sites, or in high-risk areas (e.g., due to fire, insects, or disease) to favor resilient species and/or maintain or improve wildlife habitat	• Forested vegetation • Non-forested vegetation • Wildlife • Recreation	• Warming temperatures • Water stress • Altered fire regimes • Insects & disease • Wildlife habitat loss • Wildlife population viability declines	• Hydrology & fisheries • Wildlife • Ecosystem services • Soils • Recreation • Native vegetation
Use prescribed burning to remove competitive species and/or re-establish fire return intervals	• Forested vegetation • Non-forested vegetation • Wildlife	• Water stress • Altered fire regimes • Insects & disease • Wildlife habitat loss • Wildlife population viability declines	
Promote wildland fire to manage vegetation and/or maintain or improve wildlife habitat	• Forested vegetation • Wildlife	• Water stress • Altered fire regimes • Wildlife habitat loss • Wildlife population viability declines	
Prevent or remove invasive plants	• Forested vegetation • Non-forested vegetation • Recreation	• Water stress • Invasive species	• Soils • Livestock grazing • Hydrology & fisheries • Wildlife • Ecosystem services • Recreation • Native vegetation
Control or manage grazing to reduce impact on vulnerable environments or species	• Non-forested vegetation • Wildlife • Hydrology and fisheries	• Water stress • Altered flow regimes • Invasive species	• Livestock grazing

		• Wildlife habitat loss • Wildlife population viability declines • Wildlife disease outbreaks • Erosion/Sedimentation • Increasing stream temperatures	
Plant a variety of diverse species that better cope with changing conditions	• Forested vegetation • Non-forested vegetation	• Warming temperature • Water stress • Altered fire regimes • Invasive species	• Ecosystem services • Wildlife • Grazing • Soils
Restore habitats to improve resilience to changing conditions	• Non-forested vegetation • Hydrology & fisheries	• Water stress • Altered flow regimes • Erosion/Sedimentation • Increasing stream temperatures	• Vegetation management • Soils • Ecosystem services • Fisheries • Recreation
Implement education and outreach programs to share management options in the face of changing conditions	• Non-forested vegetation • Recreation	• Water stress • Altered fire regimes • Invasive species • Declines in recreation opportunities	• Aesthetics

Adaptation tactics highlighted in Table 35 could represent priority management actions for implementation, as these tactics apply to multiple resource areas, may be easiest to implement, and address several climatic and non-climatic stressors. Prior to implementation, however, resource managers may want to consider the direct and indirect effects of tactic implementation on other resources. For example, implementation of tactics such as thinning, prescribed burning, and managed wildfire may result in potential conflicts with hydrology and fisheries, ecosystem services, or recreation, among others.

Direct and indirect effects of resource areas on one another can be found in each individual resource section. In these sections, participants also highlighted potential conflicts that could arise from implementation of a given adaptation tactic. Additionally, Tables 36-40 expand upon potential conflicts among resource areas. These tables include top adaptation tactics generated by each resource area and the potential conflicts and impacts to other resources as documented in the scientific literature. For example, removal of encroaching trees on grasslands, an adaptation tactic recommended by the non-forested vegetation group, could result in soil disturbance, reduced aesthetics due to burn scars, or potential habitat degradation for woodland and non-woodland wildlife species (Table 37). Resource managers are encouraged to consider these unintended impacts of adaptation tactics on other resource areas, as well as the direct and indirect effects of resources on one another, as they revise land management plans. It may be possible to avoid many of these unintended consequences if management strategies and tactics at the plan, program, and project level are developed collaboratively with other resource areas.

Key collaborations important for successful implementation of adaptation tactics have been noted in each of the resource sections of this report. In general, participants identified the following collaboration and capacity needs:

- Financial capacity;
- Institutional capacity, particularly the need for additional staff;
- Data collection and inventory;
- Coordinating climate adaptation responses internally with other resource areas; and
- Coordinating climate adaptation responses externally across sectors, scales, and jurisdictions, and between and among individuals and organizations that may have competing interests or priorities.

Table 36. Top adaptation tactics identified by participants of the forested vegetation resource area along with potential conflicts and impacts that could arise with other resource areas if a given tactic is implemented.

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
FORESTED VEGETATION	**Thin overstocked stands**	Hydrology and fisheries	Increased sedimentation (i.e., reduced water quality)	Luce and Wemple 2001
			Destabilization of stream channels	Luce and Wemple 2001
			Elevated runoff and peak flows	Luce and Wemple 2001
			Altered snow accumulation and subsequent water yield (depending on harvest pattern)	Woods et al. 2006 and citations therein
		Wildlife	Fisher, Canada lynx: habitat fragmentation or degradation	Bull et al. 2001
			Harvest roads can fragment habitat and/or facilitate movement of some animals and plants	Luce and Wemple 2001; Switalski et al. 2007
			Habitat loss or degradation for some avian species	Sallabanks et al. 2006
		Ecosystem services	Reduced carbon storage (short- and/or long-term, depending on overall management prescription[17] and site conditions)	DeLuca and Aplet 2008; Nave et al. 2010; Reinhardt and Holsinger 2010; Stephens et al. 2012
			Reduced aesthetic quality (short-term)	Shelby et al. 2003
		Soils	Increased compaction and reduced soil stability and organic matter input, potentially leading to increased erosion and altered site productivity, soil properties, and regeneration potential	Jurgensen et al. 1997; Luce and Wemple 2001; Page-Dumroese et al. 2010 and citations therein
		Recreation	Decreased recreational quality (short-term)	Shelby et al. 2005
		Dry forest resilience	Potentially decreased resilience to disturbance if small trees are thinned	Baker and Williams 2015
	Implement regeneration harvest	Hydrology and fisheries	Elevated runoff and peak flows	Hubbart et al. 2007
			Increased sedimentation (i.e., reduced water quality)	Luce and Wemple 2001
			Altered snow accumulation and subsequent water	Woods et al. 2006 and citations

[17] Long-term carbon losses may be avoided if thinning is paired with prescribed burning or re-introduction of natural fire (DeLuca and Aplet 2008; Stephens et al. 2010). In addition, off-site storage of harvested material (e.g., wood products) may help minimize total carbon loss (Reinhardt and Holsinger 2010).

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
			yield (depending on harvest size and location)	therein
		Wildlife	Habitat fragmentation or loss for some species (e.g., black bear)	Unsworth 1984; Sallabanks et al. 2006
		Soils	Increased compaction and reduced soil stability and organic matter input, potentially leading to increased erosion and altered site productivity, soil properties, and regeneration potential	Jurgensen et al. 1997; Luce and Wemple 2001; Page-Dumroese et al. 2010 and citations therein
		Ecosystem services	Decreased carbon storage	DeLuca and Aplet 2008; Nave et al. 2010; Reinhardt and Holsinger 2010; Stephens et al. 2012
			Reduced aesthetic quality (short-term)	Gobster 1998; Shelby et al. 2003
		Recreation	Decreased recreational quality	Shelby et al. 2005
	Utilize prescribed fire or managed wildfire	Hydrology and fisheries	Decreased streambank stability	Stone et al. 2010
			Riparian area: reduced shading and increased water temperatures	Ice et al. 2004; Stone et al. 2010
			Increased sedimentation (i.e., reduced water quality)	Ice et al. 2004; Rhodes 2007; Stone et al. 2010 and citations therein
			Elevated runoff and peak flows	Luce and Wemple 2001; Ice et al. 2004; Neary et al. 2005
			Altered large woody debris recruitment	Ice et al. 2004; Stone et al. 2010
		Wildlife	Reduced forage and occupancy for avian foliage insectivores and seed specialists, but potential for increased forage and occupancy for bark-, aerial-, and ground-insectivores and cavity nesters	Russell et al. 2009
			Habitat loss or degradation for species that rely on dense understory, closed-canopy, and downed wood	Pilliod et al. 2006
		Soils	Increased erosion, decreased infiltration	Ice et al. 2004
		Ecosystem services	Reduced carbon storage and increased	Reinhardt and Holsinger 2010;

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
			atmospheric carbon emissions (short-term)	Stephens et al. 2012
			Reduced aesthetic quality	Scott 1998
			Increased chance of slope failures, with implications for recreational access, aesthetics, and water quality	Ice et al. 2004
		Recreation	Altered demand	Englin et al. 2008
			Closures and/or altered recreational access, quality, and safety	Chavez and McCollum 2004

Table 37. Top adaptation tactics identified by participants of the non-forested vegetation resource area along with potential conflicts and impacts that could arise with other resource areas if a given tactic is implemented.

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
NON-FORESTED VEGETATION	**Remove encroaching trees on grasslands**	Soil	Soil disturbance	Halpern et al. 2012; Thompson 2013
			Reduced litter (via prescribed burning)	Thompson 2013
		Native vegetation	Burning can facilitate invasive species establishment	Halpern et al. 2012
			Disturbance can favor annuals, short-lived perennials, and smaller woody species, potentially leading to shrub-dominance	Schoonmaker and McKee 1988, Halpern 1989 cited in Lang and Halpern 2007; Thompson 2013
		Aesthetics	Burn scars may be persistent	Halpern et al. 2012
		Wildlife	Potential degradation of habitat quality for both woodland and non-woodland species (impacts may vary in short- vs. long-term	Thompson 2013
		Water supply	Could cause no change and/or reduced localized water supply via increased herbaceous transpiration and soil evaporation (impacts are site-specific)	Wilcox and Thurow 2006
	Enhance invasive weed management	Soil	Unintentional impacts on soil communities	Hultine et al. 2010
			Altered nutrient cycling	Hultine et al. 2010
		Livestock grazing	Restricted range area and/or altered grazing management/timing to prevent invasive species spread and/or habitat vulnerability to invasion	DiTomaso 2000 and citations therein
			May degrade livestock forage quality or quantity	DiTomaso 2000 and citations therein; Simberloff et al. 2013
		Native vegetation	Unless prescription is highly targeted and/or paired with a post-removal re-vegetation plan for native species, exotic removal can facilitate establishment of other exotics and/or lead to no response in native vegetation; no long-term effectiveness	DiTomaso 2000 and citations therein; D'Anotnio and Myerson 2002 and citations therein; Lesica and Hanna 2004; Krueger-Mangold et al. 2006; Pearson

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
				and Ortega 2009 and citations therein; Hultine et al. 2010
			Unintentional impacts including mortality, reduced establishment, undermined productivity, altered reproductive potential, or species compositional shifts	Lesica and Hanna 2004; Pearson and Ortega 2009 and citations therein; Hultine et al. 2010
		Fisheries and hydrology	Tamarisk removal can reduce stream cover and increase sedimentation and erosion	Hultine et al. 2010
			May see no alteration in water supply and/or reduced water supply if native plants have higher evapotranspiration rates than invader	Hultine et al. 2010
		Wildlife	Unintentional habitat degradation, particularly if exotic has replaced a native species in food or habitat provision	D'Anotonio and Myerson 2002 and citations therein; Pearson and Ortega 2009 and citations therein; Hultine et al. 2010
			Altered food webs (e.g., via invertebrate introduction for biological control treatments)	Ortega et al. 2004; Pearson and Ortega 2009 and citations therein
		Aesthetics	Reduced visual quality with some treatments	Hultine et al. 2010
		Recreation	Access may need to be restricted to prevent invasive species spread	Pyke and Knick 2003
		Ecosystem services	Altered carbon cycling and storage	Hultine et al. 2010
			May reduce provision of some ecosystem services, particularly if native species are no longer able to provide service due to climate change	Eviner et al. 2012

Table 38. Top adaptation tactics identified by participants of the wildlife resource area along with potential conflicts and impacts that could arise with other resource areas if a given tactic is implemented.

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
WILDLIFE	**Reduce potential for interactions between bighorn sheep and domestic sheep/goats**	Grazing	Reduced goat/sheep range area, with potential economic consequences	Beecham et al. 2007; Clifford et al. 2009; Idaho Department of Fish and Game (IDFG) 2010; Western Association of Fish and Wildlife Agencies (WAFWA) 2012
		Recreation	Reduced goat-packing access and/or enhanced regulations	Rudolf et al. 2003; IDFG 2010; WAFWA 2012
		Vegetation/weed management	Other management actions may have to be used in place of goat/sheep grazing	WAFWA 2012
	Utilize fuels treatments to enhance winter range quality	Invasive species	Burn timing can affect invasive species establishment	Cook et al. 1994; IDFG 2010 and citations therein; Beck et al. 2012
			Mowing intact sagebrush communities may facilitate exotic annual species	Davies et al. 2012
		Native vegetation	Treatment type and subsequent impacts on seedling establishment, plant productivity and abundance, and soil fertility may vary (particularly burn frequency/timing)	Tesky 1993 and citations therein; Cook et al. 1994; IDFG 2010 and citations therein; Beck et al. 2012; Davies et al. 2012
		Wildlife	May degrade habitat quality for some species	Peek et al. 1979; Easterly and Jenkins 1991; Beck et al. 2012 and citations therein
			May alter short-term forage availability depending on range type, quality, and condition	Tesky 1993 and citations therein; Cook et al. 1994; Beck et al. 2012 and citations therein
		Recreation	Reduced access in fire areas	IDFG 2010 and citations therein
	Enhance and maintain habitat characterized by persistent	Fuel treatments	Restricted fuel treatment potential, which could elevate fire risk	USFS 2007
		Vegetation	May restrict management activities (e.g., pre-	USFS 2007

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
	snowpack	management	commercial thinning) that would help declining tree species	

Table 39. Top adaptation tactics identified by participants of the hydrology and fisheries resource area along with potential conflicts and impacts that could arise with other resource areas if a given tactic is implemented.

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
HYDROLOGY AND FISHERIES	**Designate refugia watersheds**	Timber and grazing	Access may be limited if activity is detrimental to key ecological processes related to hydrology and fish habitat quality	Rieman et al. 2000; Pacific Rivers Council and EcoNorthwest 2002
			Potential economic impacts resulting from decreased access	Pacific Rivers Council and EcoNorthwest 2002
		Recreation and fire suppression	Access may be limited if activity is detrimental to key ecological processes related to hydrology and fish habitat quality	Pacific Rivers Council and EcoNorthwest 2002
	Decommission roads	Timber and other extractive uses	Reduced access	Pacific Rivers Council and EcoNorthwest 2002; Foltz et al. 2009
			Potential economic impacts resulting from decreased access	Pacific Rivers Council and EcoNorthwest 2002
		Recreation	Reduced access	Grace III and Clinton 2007
		Fire suppression	Reduced access	Foltz et al. 2009
		Native vegetation	May restrict access to areas requiring active vegetation management	Rieman et al. 2000
			Some vegetation may need to be removed during decommissioning activity	Doyle and Havlick 2009
		Invasive species	Decommissioning activity can facilitate invasive species spread (short-term)	Pacific Rivers Council and EcoNorthwest 2002; Switalski et al. 2004 and citations therein
		Carbon storage	Short-term carbon emissions through vehicle/equipment emissions, soil loss, and vegetation clearing; net carbon savings associated with decommissioning will vary by location and decommissioning practices	Madej et al. 2012
		Water quality and supply	May cause short-term erosion, sedimentation, and sediment delivery to streams	Pacific Rivers Council and EcoNorthwest 2002; Switalski et al. 2004

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
			Not all decommissioning activities will have equal impact (i.e., costs associated with decommissioning may exceed sedimentation reduction benefits)	Luce et al. 2001
			May have variable short- vs. long-term success in restoring infiltration and water yield and reducing erosion/sedimentation	Luce et al. 2001; Switalski et al. 2004 and citations therein; Foltz et al. 2009; Daigle 2010 and citations therein
	Upgrade culverts	Invasive species	Potential for increased invasion in areas upstream from culvert, with potential implications for native salmonid health and occupancy	Fausch et al. 2006 and citations therein; Hoffman and Dunham 2007 and citations therein
		Fisheries	Culvert requirements for juvenile fish may be different than adult fish	Richmond et al. 2007
		Water quality	Short-term erosion and turbidity increase associated with activity	Switalski et al. 2004 and citations therein; Foltz et al. 2013

Table 40. Top adaptation tactics identified by participants of the recreation resource area along with potential conflicts and impacts that could arise with other resource areas if a given tactic is implemented.

	Adaptation tactic	Conflict area	Potential impacts	Literature sources
RECREATION	**Plan for changes in use associated with seasonal weather shifts; altered timing and quantity of peak, low flows, and runoff; and altered timing of wildlife availability**	Wildlife	Altered visitation timing, intensity, or spatial extent may directly or indirectly affect wildlife reproduction, habitat, or survival	Knight and Gutzwiller 1995; Hammit et al. 2015
		Soils and water quality	Increased erosion and/or compaction from extended and/or more intense trail use	Hammit et al. 2015
		Vegetation	Altered visitation timing may affect vulnerable life stages (e.g., spring growth)	Hammit et al. 2015
	Enhance forest visitor education/enforcement to improve knowledge of site protection measures	Recreation	Too much information and/or regulation can detract from experience	Hammit et al. 2015
	Decommission/revegetate dispersed sites with unacceptable impacts	Vegetation & soils	May increase use and extent of impact on remaining recreation sites (e.g., expand amount of bare ground if used more often)	Marion 1995; Hall 2001; Reid and Marion 2004; Hammit et al. 2015
			Could increase illegal site use/trail formation and disturbance impacts	Cole and Ranz 1983; Reid and Marion 2004; Cole et al. 2008; Hammit et al. 2015
			Overall resource recovery depends on recovery rate and ability to exclude recreational users	Cole and Ranz 1983; Hall 2001
		Recreation	Condensing use can degrade recreation aesthetic and visitor experience	Reid and Marion 2004; Hammit et al. 2015

The adaptation strategies and tactics in this report, as well as the process used to develop them, is intended to help the forests meet several components of the USFS Climate Change Performance Scorecard and inform revisions of their forest plan. Specifically, the adaptation workshop contributed to the forests' capacity to fulfill Scorecard element #7 - adaptation actions. Further, the adaptation strategies and tactics generated as part of this workshop will help inform revisions of draft forest plan components such as desired conditions, objectives, standards and guidelines, and potential management strategies. While adaptation strategies and tactics identified in the process are specific to the Nez Perce-Clearwater National Forests, many are applicable throughout the surrounding region and can be implemented by a variety of stakeholders.

No single adaptation strategy or tactic represents a panacea solution for all situations or places (Millar et al. 2007). As with all management actions, adaptation strategies and tactics should be tailored to particular resource locations and management contexts. Land and resource managers are encouraged to combine adaptation strategies and tactics (those detailed in this report as well as others such as those produced by the Northern Rockies Adaptation Partnership) to best meet their individual context. Although it may be appealing to only implement tactics that require little investment in capacity building, these tactics alone are unlikely to conserve key resources or ecosystem services in the face of climate change. Tactics requiring more substantial investment (e.g., financial, institutional) help improve the likelihood of success over the long term. Accordingly, managers are encouraged to implement what is feasible now while simultaneously planning and building the capacity necessary to implement those tactics that improve overall resilience and likelihood of resource persistence. Managers are also encouraged to implement tactics that address different time scales. For example, implementing those tactics now that are necessary to immediately address resource vulnerability or resilience, as well as developing implementation plans (e.g., identifying capacity needed, building partnerships) for longer-term tactics that may better position managers for an uncertain future.

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