Nez Perce–Clearwater National Forests
Forest Plan Assessment

Socioeconomic Climate Change Vulnerability Assessment

June 2014

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EXECUTIVE SUMMARY

This vulnerability assessment addresses the socioeconomic implications of changes to the ecosystem services provided by the Nez Perce-Clearwater (NPC) National Forests under projected future climate conditions. Socioeconomic vulnerability is the degree to which the socioeconomic system is unable to cope with the impacts of climate change (IPCC 2007) and is a function of an area's characteristics and potential changes in natural resources and ecosystems.

The Forest Service can play a critical role in shaping community vulnerability and resilience because of its responsibility for managing natural resources and through direct employment, contracts, and partnerships that benefit local economies. This assessment is intended to identify and suggest mitigation and adaptation strategies for addressing the effects of climate change on natural resources.

This assessment addresses Forest Service requirements established in the 2012 Forest Planning Rule and the Climate Change Scorecard, which direct National Forest and Grassland Units to consider vulnerability to climate change when revising their Forest Plans. This assessment complements a companion report which addresses the vulnerability of natural resources to climate change.

This assessment focuses on twelve ecosystem services identified by the NPC Forests in their forest plan revision process, and examines how changes to these ecosystem services will affect communities in the NPC analysis area, which includes Clearwater County, Idaho County, Latah County, Lewis County, and Nez Perce County. This analysis applies publicly available data and an expert elicitation process using the opinion of resource experts. The twelve ecosystem services considered in this vulnerability assessment are:

- Clean water
- Clean air
- Wood products
- Forage
- Hunting
- Wildlife viewing
- Fishing
- Cultural and heritage values
- Landslide protection
- Soil stabilization
- Flood control

Vulnerability is described in two ways: vulnerability of an ecosystem service to disruption by climate change, and vulnerability of the neighboring communities to disruptions in an ecosystem service. This assessment then rates the Forest Service's capacity to mitigate impacts to the ecosystem service and to help the community adapt to these potential changes.

The ecosystem services that are most vulnerable to climate change and have the highest adaptive capacity are the best candidates for more intensive management. Clean water, consumptive wildlife use, fishing, and landslide protection and soil stabilization are the ecosystem services deemed the most vulnerable to climate change, both in terms of the functioning of ecosystem service and how much the neighboring communities depend on it. Due to the broad geographic scale of these most vulnerable services, their adaptive capacity is relatively low. Of the twelve services considered, clean air and non-consumptive wildlife use were rated as having the highest adaptive capacity.

This assessment also discusses which ecosystem services conflict with or complement other services. For example, management to maintain clean water in the face of climate change will complement efforts to support fish populations, wildlife for consumptive and non-consumptive uses, landslide protection, and soil stabilization, but may conflict with other ecosystem services such as timber harvest and some types of recreation. Management actions must take into account these complements and conflicts, as well as the value of the service to the community, to determine which management actions to pursue.

INTRODUCTION

This vulnerability assessment addresses the socioeconomic implications of changes to the ecosystem services provided by the Nez Perce-Clearwater (NPC) National Forests under projected future climate conditions. It is intended to identify and lead to mitigation and adaptation strategies for addressing the effects of climate change on natural resources.

Socioeconomic vulnerability to climate change is the degree to which the socioeconomic system is unable to cope with the impacts of climate change (IPCC, 2007), and is a function of an area's characteristics and potential changes in natural resources and ecosystems. A companion report, *Vulnerability Assessment for Resources of the Nez Perce-Clearwater National Forests*, provides information regarding the vulnerability of the NPC Forests' natural resources.

The Forest Service can play a critical role in shaping community vulnerability, resilience, and adaptive capacity because of its responsibility for managing natural resources and through direct employment, contracts, and partnerships that benefit local economies.

In this context, socioeconomic vulnerability is a function of the sensitivity of the ecosystem service and the population of people benefitting from those services, along with their anticipated exposure to those changes and their capacity to adapt to changes. Throughout this assessment, we use the following definitions (Glick et al. 2011):

- *Sensitivity* is defined as a measure of whether and how a resource is likely to be affected by a given change in climate, or factors driven by climate.
- *Exposure* is defined as the degree of change in climate or climate-driven factors a resource is likely to experience.
- *Adaptive capacity* is defined as the ability of a resource to accommodate or cope with climate change impacts with minimal disruption.

This assessment focuses on twelve of the most vulnerable ecosystem services currently provided by the NPC Forests, and examines how changes to these ecosystem services will affect communities in the NPC analysis area, which includes Clearwater County, Idaho County, Latah County, Lewis County, and Nez Perce County. This analysis uses publicly available data and the opinions of resource experts.

Regulatory Context of this Vulnerability Assessment

Climate change enters management requirements for National Forest and National Grassland Units in two ways: the 2012 Forest Planning Rule[1] and the Climate Change Scorecard.[2] This assessment is designed to support these management requirements.

Assessing the impacts of climate change on the natural environment is an important piece of the 2012 Planning Rule. The Rule states that the responsible official shall identify and evaluate existing information relevant to the plan area for the following:

> System drivers, including disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change.

[1] Federal Register. 2012. 36 CFR Part 219. RIN 0596–AD02. National Forest System Land Management Planning, Forest Service, USDA, Final rule and record of decision. Vol. 77 (68): 21162-21276

[2] Additional details about the Climate Change Scorecard can be found here: http://www.fs.fed.us/climatechange/advisor/scorecard.html

The Planning Rule also states that these same system drivers, including climate change, should be taken into consideration when developing plan components for integrated resource management.

The Preamble to the Rule highlights the importance of assessing climate change as it relates to human population as one of the eight ways that the new Planning Rule meets the purpose and need for a new rule. The section of the Planning Rule referring to climate change states:

> Contribute to ecological, social, and economic sustainability by ensuring that all plans will be responsive and can adapt to issues such as the challenges of climate change; the need for forest restoration and conservation, watershed protection, and species conservation; and the sustainable use of public lands to support vibrant communities.

Additionally, starting in 2011, each National Forest and National Grassland Unit has been required to use the Agency's Climate Change Scorecard. The goal of the Scorecard system is to help the Forest Service create a balanced approach to addressing climate change so as to: adapt to changing conditions, mitigate climate change, build partnerships across boundaries, and prepare Forest Service employees to understand and apply emerging science. The Scorecard uses a ten-point system used to report accomplishments and plans for improvement on ten questions. Each question is scored in four dimensions related to climate change: organizational capacity, engagement, adaptation, and mitigation. By 2015, each Unit is expected to be able to answer "yes" to at least seven of the ten scorecard questions, with at least one "yes" in each dimension.

The Climate Change Scorecard element related to climate change vulnerability asks, "Has the Unit engaged in developing relevant information about the vulnerability of key resources, such as human communities and ecosystem elements, to the impacts of climate change?" The Scorecard suggests the following components of a vulnerability assessment:

> a. Identify the key resources on the Unit.
> b. Review and synthesize relevant scientific, social, and economic information to identify the sensitivity of key resources to climate change.
> c. Determine the influences and stressors on the landscape, and identify current stressors which may interact with climate change and social and economic factors.
> d. Look at historical climate data and available climate model projections for your area to determine the potential exposure of key resources to climate change.

This report, together with its companion report regarding natural resource vulnerability, responds to the requirements of the 2012 Planning Rule and addresses the Climate Change Scorecard requirements.

Approach and Goals for this Assessment

This assessment covers the five-county NPC region, and draws on readily available information, integrates into existing planning and management efforts, and identifies management goals and actions. The assessment process is informed by existing data and draws on work already completed by the Forest, including:

- A socioeconomic assessment for the plan region completed by the Regional Economist, which draws heavily from the EPS-HDT[3] and other sources,

[3] EPS-HDT is a free, easy-to-use software application that produces detailed socioeconomic reports of communities, counties, states, and regions. EPS-HDT uses published statistics from federal data sources, including the Bureau of Economic Analysis and Bureau of the Census, U.S. Department of Commerce; Bureau of Labor Statistics, U.S. Department of Labor; and others. It can be downloaded from: http://headwaterseconomics.org/tools/eps-hdt.

- The Multiple Use and Ecosystem Services chapter of the NPC Forest Plan Assessment, conducted as part of the Forest Plan update as required by the Planning Rule,
- The ecosystem services assessment conducted as part of the Forest Plan update as required by the Planning Rule,
- Projected climate change information prepared by EcoAdapt and presented at a workshop hosted by the NPC in Grangeville, Idaho in September, 2013, and
- Information collected on the vulnerability of ecosystem services during the EcoAdapt workshop held in Grangeville, Idaho in September, 2013.

Both the natural resource and socioeconomic vulnerability reports will be included as an appendix to the Forest Plan Assessment. The information in this appendix, along with the rest of the assessment, will be used to help the NPC Forests in revising the draft Forest Plan components and in the National Environmental Policy Act (NEPA) analysis of the Proposed Action and the alternatives. The vulnerability assessment can also support the ongoing Climate Change Scorecard efforts.

Outline for this Assessment

The NPC socioeconomic climate vulnerability assessment is structured in the following manner. First, we describe the vulnerability assessment methods and model used, including definitions of terms used and the ecosystem services evaluated in this assessment. The second section provides an overview of current and predicted climate conditions. Next, we provide a detailed synthesis of the community context and non-climate stressors that describes socioeconomic data and trends. The socioeconomic context helps identify weaknesses and non-climate stressors that may add to vulnerabilities caused by anticipated impacts of climate change.

The final section describes how climate change is likely to affect each ecosystem service. This section describes how and where the key ecosystem services are vulnerable, and then links these vulnerabilities to impacts on the local communities, and the likely importance of these changes based on the existing community characteristics. The assessment concludes with a discussion of adaptive capacity, particularly how much management flexibility and opportunity the Forest Service and local communities have to deal with the likely changes. The vulnerability summary is organized into a matrix that can be used to quickly assess 1) the vulnerability of ecosystem services to climate change, 2) the vulnerability of communities to changes in the ecosystem services, and 3) the management flexibility and opportunity to adapt to climate change.

VULNERABILITY ASSESSMENT MODEL AND METHODS

Terms and Definitions

Ecosystem Services: The benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005).

Exposure: A measure of how much of a change in climate or climate-driven factors a resource is likely to experience (Glick et al. 2011).

Sensitivity: A measure of whether and how a resource is likely to be affected by a given change in climate or factors driven by climate (Glick et al. 2011).

Adaptive Capacity: The ability of a resource to accommodate or cope with climate change impacts with minimal disruption (Glick et al. 2011).

Vulnerability: A function of the sensitivity of a particular resource to climate changes, its exposure to those changes, and its capacity to adapt to those changes (IPCC 2007).

Expert Elicitation Process

This assessment used a collaborative, expert elicitation-based approach that involved representatives from the NPC Forests and the USFS Northern Regional Office. Expert elicitation is a systematic approach to formally evaluate uncertain scenarios, and has a long history in conservation and regulation. This approach is effective where there is substantial uncertainty about current system functions or future projections, as well as a reservoir of detailed knowledge and expertise. Expert elicitation also has the benefits of being lower cost, relatively rapid, and encouraging ownership and buy-in. Further, the scientists and specialists who participated in this process had extensive knowledge about the ecology, management, and threats to the NPC Forests' ecosystems and species, and also comprise many of the professionals who will use the results of the assessment.

A climate vulnerability assessment workshop was held in Grangeville, Idaho in September 2013 as part of the process of assessing how ecosystem services might be affected by climate change. The workshop included a review of current knowledge and understanding of climate trends (current, historic, projected future) for the NPC region, followed by work sessions and facilitated discussions aimed at assessing vulnerabilities of ecosystems and ecosystem services to climate change. The workshop was facilitated by EcoAdapt, who also presented climate projections for the NPC region. Representatives from the NPC Forests and the USFS Northern Regional Office used these data to assess likely vulnerabilities of species, ecosystems, and ecosystem services to climate change. Using the vulnerability assessment model described below as a guide, workshop participants applied their knowledge and expertise about a selected ecosystem service to evaluate its vulnerability to climate and non-climate stressors. Vulnerabilities of ecosystem services are described in this report; vulnerabilities of ecosystems and species are described in a companion report produced by EcoAdapt.

The resource specialists at the workshop were asked to complete worksheets that drew on the climate projections and their expert knowledge to assess the potential vulnerabilities to climate change of the ecosystem services identified in the ecosystem services assessment.

Ecosystem Service Selection Process

Healthy forest ecosystems are life-supporting systems that provide a full suite of goods and services, vital to human health and well-being. There is a great deal of overlap between ecosystem services and the typical multiple use resource categories described in the Multiple Use Sustained Yield Act of 1960 (16 U.S.C. 528–531). As stated by Collins and Larry (2007), "An ecosystem services perspective encourages natural resource managers to extend the classification of multiple uses to include a broader array of services or values." Ecosystem services can be grouped into four general categories: provisioning, regulating, cultural, and supporting. Provisioning services provide products such as food and water; regulating services moderate natural processes such as water purification and flood control; cultural services contribute non-materially to the well-being of people, including spiritual enrichment and recreation; supporting services underlie basic natural processes, including nutrient cycling and providing habitat. Managing for water, wildlife, and timber addresses the need to sustain provisioning services, but land managers are also stewards of regulating, cultural, and supporting services, all of which contribute to human health and well-being.[4]

Since ecosystem services and multiple uses provide an array of benefits to people in the local area, as well as the broader population, they are important for understanding the vulnerability and resiliency of people and the economy in the face of climate change.

Though every National Forest or Grassland Unit provides a suite of important ecosystem services, it is not feasible to describe or analyze every single ecosystem service. Instead, for Forest Plan revisions under the 2012 Planning Rule, it is suggested that Units undergoing revision identify those ecosystem

[4] See the Multiple Use and Ecosystem Services Chapter of the NPC Assessment for further information on multiple uses and ecosystem services, as well as the different categories of ecosystem services.

services that 1) are most important to people in the broader landscape and 2) would be most affected by the land management plan. Through the NPC Forest Planning collaborative process, the Interdisciplinary Team (IDT) worked with the public to identify an initial list of ecosystem services that are provided by the Forests. The IDT refined this list, using the two criteria listed above. These ecosystem services are important for understanding the vulnerability and resiliency of people and the economy in the face of climate change. Data and analysis come from information compiled by the NPC planning IDT team members and EcoAdapt.

Ecosystem Services List

The twelve ecosystem services considered in the vulnerability assessment process include:

- Clean water
- Clean air
- Wood products
- Forage
- Hunting
- Wildlife viewing
- Fishing
- Cultural and heritage values
- Landslide protection
- Soil stabilization
- Flood control

For additional information on these ecosystem services, see Chapter 7 (Multiple Use and Ecosystem Services) of the NPC Assessment, which describes the multiple uses and ecosystem services on the NPC Forests and their importance to people. Clean water, wood products, forage, fish and wildlife, and recreation opportunities are all discussed in that section of the NPC Assessment. Clean air, cultural and heritage values, soil stabilization and landslide protection, carbon sequestration and climate regulation, and flood control are discussed in the ecosystem services section.

Vulnerability Assessment Model

In the context of climate change, the vulnerability assessment model used in this process is comprised of three components: sensitivity, exposure, and adaptive capacity. Within each of the three components, experts evaluate their confidence in their assessment. Together, these three components and associated confidence evaluations determine overall vulnerability and confidence for each ecosystem service (Figure 1).

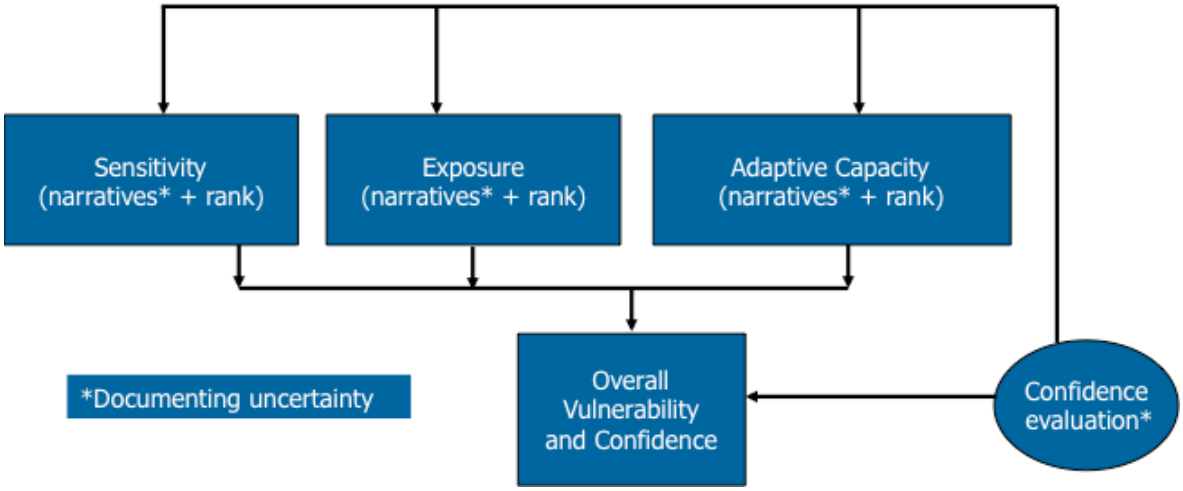

Figure 1. Structure of the vulnerability assessment model

Vulnerability is the degree to which a system, whether an ecosystem or a human community, is susceptible to, or unable to cope with, adverse effects of change, including climate variability and extremes. Vulnerability is a function of sensitivity, exposure and adaptive capacity. Sensitivity and exposure are almost inseparable properties of a system and are dependent on the interaction between the characteristics of the system and on the nature of the climate impacts. For this assessment, we evaluate sensitivity and exposure together, using the term "sensitivity." Adaptive capacity is evaluated separately.

There are two aspects of overall vulnerability: ecosystem service vulnerability and community vulnerability. The vulnerability of an area's ecosystem services is a function of their sensitivity to climate change, as well as to non-climate stressors that affect the services' baseline functioning. Community vulnerability is influenced by how much the community depends on the ecosystem services for jobs, income, recreation, cultural uses, and public health and well-being. Non-climate stressors that affect baseline socioeconomic conditions will also contribute to community vulnerability.

Each component of vulnerability – sensitivity and adaptive capacity – is rated. An accompanying narrative provides the rationales and assumptions underlying the ratings and confidences assigned to each variable. Sensitivity and adaptive capacity components are broken down into specific elements better suited to assessing the vulnerability of particular ecosystem services for this report.

Sensitivity is composed of four elements: 1) sensitivity to climate (e.g., temperature and precipitation), 2) climate-driven changes (e.g., snowpack, soil moisture, low flows), 3) future climate exposure, and 4) non-climate stressors.

Adaptive capacity is composed of three elements: 1) the value of the service to consumers or beneficiaries, 2) social and economic elements that may make a community more able to adapt to

changing levels of that service, and 3) the likelihood that management could alleviate climate impacts on the service.[5]

For each component of vulnerability, experts assigned one of seven ratings (Very High, High, Moderate-High, Moderate, Low-Moderate, Low, or Very Low). The ratings for each component were then assigned a corresponding numeric score from one to seven, which was averaged to generate an overall rating. Each component of vulnerability was also assigned one of five confidence ratings (High, Moderate-High, Moderate, Low-Moderate, or Low), which rated experts' confidence in their evaluation of the vulnerability components. Confidence ratings for each vulnerability component were averaged to generate an overall confidence score.

The user of these vulnerability assessment results is encouraged to pay close attention to the description and individual ratings of sensitivity and adaptive capacity for each ecosystem service, rather than just overall vulnerability ratings. Familiarity with each vulnerability component in addition to a resource's overall rating allows resource managers to better adapt their management plans as new information, such as improved climate change forecasts, is available. This finer level of understanding better supports why a particular resource is vulnerable and what management actions may reduce vulnerabilities.

Further, the elements of adaptive capacity may not be independent. For example, clean water is an important service provided by the NPC Forests to neighboring communities, but management strategies to improve water quality may interfere with harvesting wood products, another important ecosystem service provided by the NPC Forests. Managers should consider these tradeoffs as they develop adaptation strategies and management options for a particular resource.

CLIMATE CHANGE OVERVIEW

Climate modelers have projected major changes in temperature and precipitation across the five-county NPC analysis area over the next century. The NPC Forests are heterogeneous, spanning over 4 million acres, with jagged peaks of the Bitterroot Mountains, deep canyons of the Salmon, Selway, and Lochsa Rivers, coniferous forests, grasslands, and prairie. Due to its heterogeneous landscape, climate-related changes are expected to vary spatially across the analysis area. Consequently, ecosystem service sensitivity and vulnerability will also vary geographically and temporally over the coming century.

Over the next century, annual temperatures across the NPC region are expected to increase above the baseline average for 1916-2006 by approximately +2˚C by 2040 and +4˚C by 2080 (Littell et al. 2011; Table 1). Exact precipitation patterns in the future are uncertain, but in general summer is projected to be drier while spring, winter, and fall are predicted to be wetter relative to historic averages (Littell et al. 2011). Precipitation is likely to fall more often in the form of rain rather than snow, which would decrease seasonal snowpack and increase flood risk. Warmer temperatures in the summer and fall would increase evapotranspiration rates, causing reduced soil moisture and more severe summer low flows in rivers. Warmer and drier conditions would increase the likelihood of wildfire ignitions and large, severe wildfires across the NPC region.

[5] Sensitivity elements for ecosystem services were informed by Glick et al. (2011), Manomet Center for Conservation Sciences (2012), and Lawler (2010), and developed by EcoAdapt. The worksheets used to evaluate adaptive capacity and management potential were developed by Headwaters Economics and the Forest Service Regional Economist.

Table 1. Historic and projected climate changes for the Columbia Basin (Littell et al. 2011). Historic changes in temperature and precipitation are from 1950-2006. Projected changes for the 2040s and 2080s were calculated by comparing projections with baseline values (from 1916-2006). April 1 Snow Water Equivalent (SWE) is a measure of the amount of water contained in snowpack. Combined flow includes both runoff and baseflow.

Climate Variable	Historic change (1950–2006)	Projected change (2040s)	Projected change (2080s)
Tmin	+1.0˚C	-	-
Tmax	+1.0˚C	-	-
Average annual temp	-	+1.8˚C to +2.7˚C	+2.7˚C to + 4.6˚C
Precipitation	-3.6mm	-2% to +4%	-5% to +2%
April 1 SWE	-	-21% to -36%	-42% to -46%
July 1 soil moisture	-	-36% to -42%	-28 to -35%
Combined flow: DJF	-	+9% to +46%	+7% to +40%
Combined flow: JJA	-	-23% to -27%	-34% to -45%
Combined flow: MAM	-	+0.7% to +15%	+1% to +17%
Combined flow: SON	-	-3.4% to +42%	-16% to +40%

For an in-depth discussion of the likely impacts of climate change on the NPC region, see the EcoAdapt report, *Vulnerability Assessment for Resources of the NPC Forests*.

COMMUNITY CONTEXT AND NON-CLIMATE STRESSORS

This section describes socioeconomic data and trends for the planning area. The socioeconomic context helps identify non-climate stressors that may make communities more vulnerable to climate change impacts or affect their ability to adapt.

The analysis area for this report consists of five counties in North Central Idaho that are adjacent to, or in the immediate vicinity of, the NPC Forests. These five counties are Clearwater County, Idaho County, Latah County, Lewis County, and Nez Perce County. Collectively, these counties form District 2 within the organization of Idaho counties; they were the counties included in the 2004 Social Assessment; and they make up the regional economy of North Central Idaho (CEDA, 2012). Though the NPC analysis area has several medium-sized cities (Lewiston in Nez Perce County and Moscow in Latah County), it is primarily rural. These larger cities are located farther from the main body of the NPC Forests' land, while mostly smaller towns are in close proximity to the main National Forest lands in the region.

Rural communities have several important characteristics that, in general, differ from those of more urban communities. Some of these characteristics can decrease a community's ability to adapt to change (Lal et al 2011).

- Rural communities have fewer people and smaller economies, and tend to be isolated from larger population centers and their markets, making economic development more difficult. Isolated counties can be less prosperous, making them more vulnerable to the effects of climate change on natural resources.
- Rural communities tend to be poorer than urban communities, and unemployment is often higher in rural areas; both of these facts suggest a higher sensitivity to the adverse impacts of climate change and a lower capacity to cope with those impacts.
- Higher poverty and unemployment in rural communities mean that many of these counties depend on government transfer payments such as Medicare and welfare. This dependence adds to the vulnerability of rural areas, unless government transfer payments can keep up with increasing needs resulting from climate change, such as health care and natural disaster mitigation and recovery.
- Rural communities often have less diverse economies, with greater economic dependence on natural resources. Changes in climate that affect these natural resources could be extremely disruptive to the economies.
- Dependence on federal land payments, such as 25% Funds Payments, Secure Rural School Payments, and Payments in Lieu of Taxes (PILT), also add to a community's vulnerability as the future of these payments is uncertain.
- Outdoor recreation spending and jobs can be important to the economy of rural areas. If climate change reduces or shifts recreation-related opportunities to other areas, some rural communities could experience disproportionate economic impacts.
- Rural communities often have older populations, which are more vulnerable to the health-related impacts of climate change, and rural residents often have less access to health care resources.
- Within rural areas, Native American communities may be particularly vulnerable to climate change, due to their cultural and subsistence ties to natural resources and traditional ways of collecting and sharing resources.

Scale and Isolation

Across western counties, there are varying degrees of economic opportunity. Where a county lies on an opportunity spectrum can be a function of both its size and its connection to larger markets. Rural communities like those found in the NPC analysis area (with the exception of Lewiston) have fewer people (U.S. Department of Commerce, 2012a) and smaller economies than metropolitan or micropolitan communities, whether measured in terms of employment or income (U.S. Department of Commerce, 2012). When these smaller communities are also far from larger population centers and markets, they tend to have fewer options for economic growth and diversification.

Using the typology developed in Rasker et al. (2009), Nez Perce County, where Lewiston is located, is the only county in the NPC analysis area classified as "metropolitan." This type of county tends to have a more resilient economy and have higher earnings and income, with faster population, income, and job growth, higher educational attainment, lower dependence on retirement income and government transfer payments, and higher employment in manufacturing and services. Latah County, which is adjacent to Lewiston, is classified as "connected." This type of county is rural but benefits from proximity to a larger population center and access to larger population centers and markets. This type of county tends to perform economically more like a metropolitan community and can be more resilient in the face of climate change circumstances. The remaining three counties – Clearwater, Idaho, and Lewis Counties – all qualify as "isolated" rural communities, with socioeconomic conditions that make them particularly vulnerable to economic change, including changes in climate that affect natural resources, infrastructure, and human health. Communities with fewer economic opportunities may be less able to afford adaptation strategies such as more rigorous water treatment, less resilient to the impacts of climate change on infrastructure, and less able to shift their economies to a new mix of industries.

Employment and Income

The Intergovernmental Panel on Climate Change (IPCC) identifies the following significant features of adaptive capacity: wealth; technology; information and skills; infrastructure; institutions; and equity (Smith et al., 2001). Wealthier communities tend to have greater access to technology, information, developed infrastructure, and stable institutions, and thus have a higher adaptive capacity. Although rural communities generally have a lower cost of living, they also tend to be poorer than urban communities, with higher unemployment (U.S. Department of Commerce, 2012), suggesting a higher sensitivity to the adverse impacts of climate change and a lower capacity to cope with those impacts.

The socioeconomic data indicate that all counties in the analysis area tend to have low income, fairly high unemployment, and a large number of children and individuals in poverty, indicating vulnerability to climate change. This is particularly true of Idaho County and Clearwater County.

Per capita income in the state of Idaho is substantially lower, on average, than for the nation as a whole. In 2010, per capita income in Idaho was $32,904, compared to the national average of $41,198. Four of the five counties in the analysis area (all except Lewis County) had per capita income levels that were substantially below the national average of $41,198 in 2010, including Idaho County ($28,406), Clearwater County ($30,584), Latah County ($31,600), and Nez Perce County ($36,926). (See Section 6.5.7 in the NPC Assessment for more information on employment and income.)

Unemployment rates have been especially high in Clearwater County and Idaho County. Between 1997 and 2011, the average annual unemployment rate in Clearwater County was 2nd in the state, at 11.9 percent (compared to the state average of approximately 5%), followed by Idaho County at 8.9 percent, which ranked 6th in the state. The other three counties have not experienced the high levels of unemployment seen in Clearwater County and Idaho County. Lewis County averaged 5.4 percent and

ranked 24th; Nez Perce County averaged 4.5 percent and ranked 34th; and Latah County averaged 4.1 percent and ranked 38th. (See Section 6.5.7 in the NPC Assessment for more information on unemployment.)

Data on the poverty status of families and children in the analysis area counties in 1989, 1999, and 2010 show that Idaho County ranks 7th in the percentage of all persons in poverty and 5th in children in poverty for all counties. Despite some changes in rankings for the five counties in the analysis area, all five counties had an increase in the percentage of people and children in poverty from 1999 to 2010, as did the state of Idaho and many places in the U.S. In the analysis area, in 2010, the percentage of all people in poverty ranged from a low of 12.5 percent in Nez Perce County to a high of 28.6 percent in Lewis County. Idaho County, Clearwater County, and Lewis County all had more than a quarter of children under the age of 18 living in poverty in 2010. (See Section 6.7 for more information on poverty.)

Government Transfer Payments

Higher unemployment and poverty in rural NPC communities means that many of these counties depend on government transfer payments such as Medicare and welfare. All types of transfer payments have increased substantially in the five-county analysis area since 1998, as is the case in most counties in the U.S. In fact, the biggest percent change in non-labor income (which includes dividends, interest, and rent, as well as transfer payments) was in transfer payments, which include age-related payments (e.g., from Social Security and Medicare) and income maintenance payments. With the exception of Lewis County, the largest increase, in percentage terms, occurred in income maintenance payments, which rose by 217 percent in Latah County, 167 percent in Nez Perce County, 131 percent in Clearwater County, and 87 percent in Idaho County. In Lewis County, the increase in income maintenance payments was just 121 percent, with the increase in age-related payments being larger (U.S. Department of Commerce, 2012). As lawmakers seek to limit the federal government's budget, and particularly mandatory spending programs, the growing dependence on government transfer payments as an income source increases the economic vulnerability of the five-county area. (See Section 6.7 for more information on transfer payments.)

Federal Land Payments

As with dependence on government transfer payments, dependence on federal land payments can reduce a community's adaptive capacity if these payments do not keep up with a community's increased need for additional revenue or if other county revenue sources decline, making these payments a bigger portion of county revenue. Additionally, climate change impacts can affect these payments if they are tied to resource extraction activities and changes in those resources occur. Currently counties receive three types of federal land payments: payments in lieu of taxes (PILT), revenue-sharing payments, and Secure Rural Schools Act payments. Though many of these payments are not directly tied to resource extraction activities at this time due to the passage of the Secure Rural Schools Act in 2000, this Act is once again due to expire at the end of FY 2014.

The uncertainty around land payment legislation makes it difficult for counties to plan long-term budgets. Idaho and Clearwater Counties are particularly dependent on these payments, indicating a greater vulnerability for these counties relative to the other counties in the analysis area.

PILT funds derive from a 1976 law (Public Law 94-565) that provides funds to local governments in proportion to the amount of federal lands within their jurisdiction in order to partially compensate counties for their inability to derive property taxes from federal lands. In 2012, Idaho County ranked 5th ($1.56 million) among Idaho counties in terms of the amount of money received from annual PILT payments, receiving $1.56 million. Clearwater County ranked 20th ($557,000), Latah County ranked 32nd ($237,000), and Nez Perce County ranked 40th ($75,942) in 2012 PILT payments.

Counties also receive "revenue-sharing" payments from the federal land management agencies. Before the passage of the Secure Rural Schools Act, the funds counties received were a portion of the gross revenues generated by timber harvest, grazing, mining, and other uses of the federal lands within their jurisdictions. Originally, these "Payments to States" or "Revenue-Sharing Payments" to counties were based on a 1908 law that allocated 10 percent of the gross revenues generated from the federal lands within their jurisdictions to the counties. The Weeks Act of 1911 increased payments from 10 percent to 25 percent. These "25 percent monies" were mandated to be used for schools and roads. From 1991-2000, Idaho County had the highest average payment ($3.3 million) in the state; Clearwater County was 8th ($770,000); Latah County was 14th ($210,000); and the other two counties in the analysis area were near the bottom of the ranking (averaging less than $1,000 in payments).

With diminishing commercial use of federal lands, in 2000 President William Clinton signed the Craig-Wyden bill, which became the Secure Rural Schools and Community Self-Determination Act (PL 106-393). The purpose of this legislation was to address declining amounts of the 25 percent monies. For Clearwater County and Idaho County, these payments are substantial. Between 2000 and 2008, Clearwater County received on average about $1.4 million and Idaho County $6.7 million. In 2008, the formula for computing these payments changed (and was retroactive to 2008). This change more than doubled the amount that Idaho County received, which grew from $5.2 million in 2007 to $11.8 million in 2008. Clearwater County saw a small increase in payment in 2008; Latah County's payments decreased; and Nez Perce County's small payments nearly doubled. Lewis County receives no SRS Act payments.

The importance of these payments to some of the analysis area counties is illustrated by comparing SRS Act payments to total county general revenue. For example, the 2007 Census of Government indicates that Clearwater County's general revenue in 2007 was slightly more than $8 million and Idaho County's was $11.8 million. Total federal land payments, which include SRS, PILT, and other payments, made up 21 percent of the general revenue in Clearwater County and 59 percent in Idaho County in 2007.[6] (See Section 6.6 of the NPC Assessment for more information on federal land payments.)

Natural Resource Dependence and Economic Diversity

Wildland dependency is a measure of a community's reliance on industries tied to the natural resource-base. Wildland dependency is calculated as the percentage of a county's total labor income (employee compensation and proprietor income) earned in five wildland resource areas: timber, mining, grazing, recreation and wildlife, and federal wildland-related employment (e.g., jobs with the Forest Service or Department of the Interior agencies) (Gebert and Odell 2007). The National Forest-Dependent Rural Communities Economic Diversification Act of 1990 (Public Law 101-624) defines a county as "wildland dependent" if 15 percent or more of the total county labor income (including direct, indirect, and induced labor income) comes from industries associated with forest resources.

Changes in natural resources due to climate change can make counties that are dependent on these resources vulnerable to the impacts of climate change. In 2010, four of the five counties in the analysis area (all but Latah County) met the definition of "wildland dependent," with more than 15 percent of total county labor income coming from wildland-based sectors in the economy. Clearwater County had the highest dependence on wildland-based sectors at 31.4 percent, followed closely by Idaho County at 31.1 percent. The dependency of Lewis County and Nez Perce County were somewhat lower at 25.3 percent and 20.9 percent, respectivity. Latah County did not meet the 15 percent criteria, at 8.9 percent. Timber-related income accounted for the majority of the dependency, followed by government employement in federal land management agencies. (See Section 6.5.8 for more information on wildland dependency)

[6] This is the latest year for which comprehensive federal land payment data are available.

Travel and Tourism

Public lands can play a key role in contributions to local employment by providing opportunities for recreation. Communities adjacent to public lands can benefit economically from visitors who spend money in hotels, restaurants, ski resorts, gift shops, on outfitters and guides, and elsewhere. EPS-HDT provides information on travel- and tourism-related sectors of the economy. The information in the EPS-HDT report does not provide an exact measure of the size of the travel and tourism industry; nor does the report measure the type and amount of recreation that occurs on public lands. However, the information can be used to understand whether travel- and tourism-related economic activity is present, how it has changed over time, and whether differences exist between the five counties making up the analysis area. As defined by EPS-HDT, travel and tourism consist of sectors that provide goods and services to visitors and to the local population. These industry sectors include retail trade; passenger transportation; arts, entertainment, and recreation; and accommodation and food.

A substantial number of jobs in the five-county analysis area are associated with industries connected to travel and tourism. Around 19 percent of total private employment[7] in the five-county area is in industries connected to travel and tourism, with the majority of the jobs associated with the accommodation and food sector. The five counties in the analysis area vary in the percent of total private employment occurring in travel and tourism sectors, ranging from 13.5 percent for Lewis County up to 26.6 percent for Latah County. Though these jobs are associated with low average wages ($17,000 per year, compared to the five-county average annual wage of $35,582), they are important to the local economies, and impacts due to climate change could affect the amount of employment in these sectors. (See Section 6.5.5 in the NPC Assessment for more information.)

The National Visitor Use Monitoring Survey estimates that approximately 300,000 visitors recreate on the NPC Forests annually. These visitors spend money in the local economy on a variety of items, including food, gas, and sometimes lodging. Economic analysis done for the NPC Assessment indicates that recreation (including hunting and fishing and visits by local as well as non-local residents) on the Forests contributes approximately 135 jobs and $3 million in labor income annually. (See Section 6.8.1 for more information related to recreation on the Forests and Section 6.9 for information related to the economic contribution of recreation and other NPC programs.)

Age of the Population

The elderly are more susceptible to health-related impacts of climate change such as diminished air quality and extreme heat events. The data once again indicate that Idaho County and Clearwater County are more vulnerable than the other counties in the analysis area due to a higher proportion of elderly. However, except for Latah County, which includes the student population at the University of Idaho in Moscow, all five counties in the analysis area had higher median ages than either the nation or the state of Idaho in 2012. Clearwater County had the highest median age, at 50 years; Idaho County and Lewis County were close behind at 48 years; and Nez Perce County's median age was 41 years. Additionally, except for Latah County, the change in the median age from 2000 to 2012 was greater than it was for the state or the nation, with the largest increase occurring in Clearwater County, where the median age increased by 18.7 percent. With the exception of Latah County, the age distribution of the counties in the analysis area is shifted toward an older overall population than the state and the nation, with more of the population above age 44. (See Section 6.4 in the NPC Assessment for more demographic information.)

[7] Total private employment does not include employment in government, agriculture, or railroads, or the self-employed, because these are not reported by County Business Patterns.

Native American Communities

The Nez Perce people are intimately tied to the lands of the NPC Forests. Nearly the entire planning area falls within what the Indian Claims Commission has determined to be the Nez Perce Tribe's area of "exclusive use." The Nez Perce Treaty of 1855 reserved the rights for Nez Perce people to continue to hunt, fish, gather, and pasture on "open and unclaimed" lands, later clarified by the courts to include public lands now managed by the Forest Service. In order for tribal members to hunt, fish, or gather, healthy and sustainable populations of game, fish, roots, berries, and medicinal plants must be present. All these resources could be negatively impacted by climate change. In four of the five counties in the analysis area (all but Latah County), a relatively high percentage of the population classify themselves as Native Americans; the percentages are larger than those of the nation or the state, as high as 5.6 percent in Nez Perce County. Due to the impact on resources that are particularly important for subsistence and cultural uses, these individuals may be more adversely affected by climate change than the broader population.

VULNERABILITY ASSESSMENT RESULTS

The impacts of climate change can be broadly grouped under three headings (Lal et al. 2011a,b) : ecological, social, and economic. In terms of ecosystem services, the three are intricately related. Changes in ecosystem structures, processes, and functions due to climate change can alter the goods and services provided by these systems and the social and economic benefits that people derive from the ecosystem services. Likewise, some uses of the forest by the public can stress ecosystem structures, processes, and functions that are already being influenced by climate change, and, therefore, impact other ecosystem services.

This section focuses on the vulnerability of multiple uses and ecosystem services identified in the NPC Forest Plan assessment, as well as the possible social and economic impacts stemming from the potential ecological impacts. First, the overall vulnerability assessment is presented as a summary table that allows for a quick visual display of ecosystem and community vulnerability and where adaptive capacity is greatest. This overview is followed by a discussion of the vulnerabilities, adaptive capacity, and management potential for each ecosystem service.

Overview of Vulnerabilities and Adaptive Capacity

During the workshop, resource experts were asked to provide a narrative describing vulnerabilities, adaptive capacity, and management potential for each ecosystem service and to assign a numeric score to indicate the degree of vulnerability and their confidence in that vulnerability. The vulnerability rating scale ranged from one to seven, with seven being the highest level of vulnerability or adaptive capacity. The confidence scale ranged from one (least confident) to five (most confident). These scores were used along with the expert opinion of the socioeconomics team to come up with the vulnerability ratings for each ecosystem service as described below. The following descriptions were used to guide workshop participants as they evaluated each ecosystem service:

- *Ecosystem Service Vulnerability*: how sensitive and exposed an ecosystem service is to climate change. The score was taken from question #6 (Overall User Ranking) on the Ecosystem Service Sensitivity and Exposure Assessment worksheet.
- *Community Vulnerability*: how important the ecosystem service is to the community in terms of jobs, income, recreation, cultural uses, or public health. The score is a combination of responses to worksheet question #4 ("Sensitivity and current exposure to non-climate stressors") and the expert opinion of the socioeconomics team after considering the socioeconomic characteristics and non-climate stressors of the region.
- *Adaptive Capacity*: refers to the Forest Service's ability to change forest management, or

to work collaboratively with communities and interested parties to mitigate the impacts of climate change. The score is a combination of the responses from question #4 (Overall User Ranking) on the Ecosystem Service Adaptive Capacity worksheet and the expert knowledge of the socioeconomics team.

Figure 2 provides a summary that indicates areas of priority based on how vulnerable each ecosystem service is to climate change, how vulnerable the community is to changes in the quality and/or quantity of each ecosystem service, and the ability of the Forest Service to change forest management, or to work collaboratively with communities and interested parties to mitigate the effects of climate change. If experts provided a confidence score of three or greater, a score is displayed in Figure 2. If the confidence score was two or less, no score was assigned to ecosystem service vulnerability. In several cases, resource experts did not have sufficient information to provide a score or the outcome was highly uncertain; these items are colored grey. For both ecosystem service and community vulnerability scores, the darkest red indicates a service that is extremely vulnerable, and the darkest blue indicates an ecosystem service that is not at all vulnerable. Ecosystem services with the highest adaptive capacity are the darkest blue and the ecosystem services with the lowest adaptive capacity are the darkest red.

As an example, resource experts agreed that water quality is extremely vulnerable to climate change, assigning a vulnerability score of seven. Their confidence in the vulnerability was high. Communities in the region were also viewed as highly vulnerable to changes in water quality, and the resource experts assigned a community vulnerability score of seven. The adaptive capacity score of four indicates that resource experts felt there was a moderate level of opportunity and willingness to mitigate or adapt to changes.

The ecosystem services most vulnerable to climate change, with the highest community vulnerability, and with the highest adaptive capacity will be the most productive services to target for adaptation actions. When assessing which ecosystem services to target for adaptation actions, it is important to consider additional context such as the Forest Service's ability to affect changes outside its boundaries and whether adaptation strategies enhance or harm other ecosystem services besides the target service. These concerns, along with the vulnerability and adaptive capacity findings, are discussed for each ecosystem service in the following section. Additional information drawn from the workshop narratives and the scientific literature is included in the discussion of each ecosystem service.

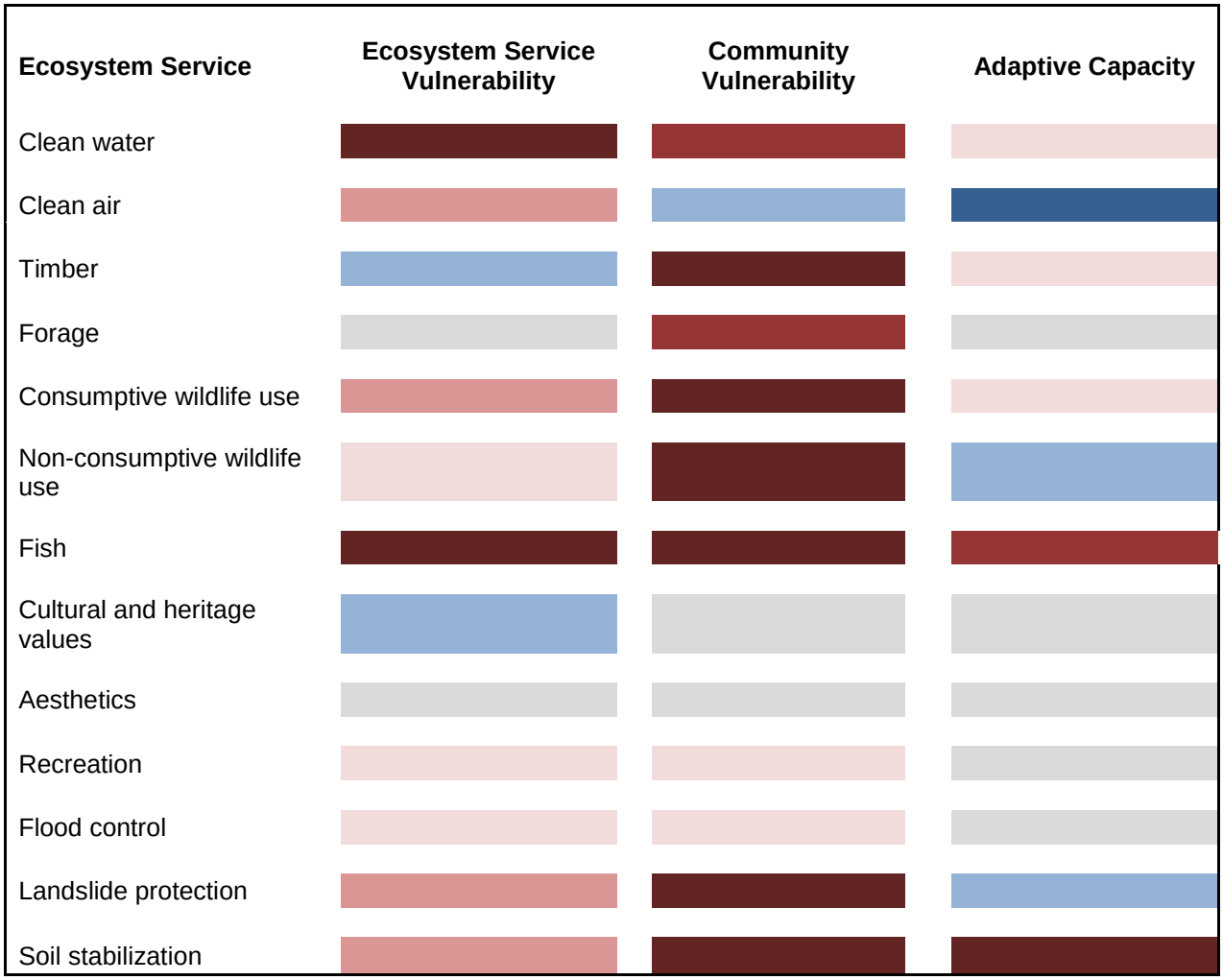

Figure 1. Socioeconomic Vulnerability Matrix for the NPC Analysis Area

Clean Water and Water Supply

Clean water stood out in the workshop and in the worksheets as one of the most vulnerable, and also most highly valued, ecosystem services. It provides benefits to towns in the region that rely on surface water for municipal use. It also benefits the recreational and consumptive fishermen who fish for trout and salmon, which require relatively high water quality to thrive. Availability of water is important not only for consumptive purposes and fishery habitats, but also for recreational activities and aesthetics, two other important ecosystem services provided by the NPC Forests. Additionally, groundwater is very important. Over 50% of the base flow in the NPC analysis area is from groundwater.

Overall, clean water vulnerability to climate change due to very high ecosystem service vulnerability and high community vulnerability. Adaptive capacity is moderate: although surface water can be treated or obtained from an alternative source for municipal users, these solutions are expensive for rural communities with small budgets.

Ecosystem Service Vulnerability

Climate-related changes likely to impact this ecosystem service are drought conditions and wildfire events; extreme weather events, leading to high flows and runoff; snowpack depth, leading to less water availability during periods of high demand in late summer and fall; and earlier snowmelt and runoff, causing increased sediment/nutrient load and cost of water treatment.

Potential increases in wildfire intensity and frequency may result in significant sedimentation events, particularly when combined with large storms and floods. Small changes in sediment load can have large impacts on water quality by reducing direct drinkability, and these impacts may well be exacerbated by drought and low flows. Although the total volume of water available is likely to remain within the historic range of variation, the timing of availability is likely to change. Warmer climate could yield greater rainfall and less snowfall, leading to greater winter runoff but decreased sustained summer flow. This timing could be problematic, because late summer and early fall are the times of greatest water demand. One study indicates that a 1-month advance in the timing of snowmelt runoff could threaten storage efficiencies for reservoirs. Besides providing water supply, reservoirs are operated for flood-protection purposes and consequently may release large amounts of otherwise useful water during the winter and early spring. In such facilities, earlier flows would place more of the year's runoff into the category of hazard rather than resource. These changes would tend to increase the length of summertime drought that is anticipated to occur in much of western North America (Stewart et al. 2004).

Changes in the amount of ground water can also have substantial impacts. Groundwater and surface water are interconnected and interdependent in almost all ecosystems. Groundwater plays significant roles in sustaining the flow, chemistry, and temperature of streams, lakes, springs, wetlands, and cave systems in many settings, while surface waters provide recharge to groundwater in other settings. Base flow is that part of stream flow derived from groundwater discharge and bank storage. River flow is often maintained largely by groundwater, which provides base flow long after rainfall or snowmelt runoff ceases. The base flow typically emerges as springs or as diffuse flow from sediments underlying the river and its banks. If the season, type and amount of precipitation changes, recharge of groundwater may change. As the demand for water increases and the base flow decreases, there will be an increase in the withdrawal of groundwater. Reduced groundwater can lead to loss of wetlands, biodiversity and long-term fresh water supply.

The degree of sensitivity and exposure was viewed as high for drought and moderate for all other impacts. Non-climate stressors to water quality include fire suppression, road building, timber harvesting, prescribed fire, pesticide and herbicide use, recreation, grazing, and mining. Particularly noted during the workshop were fire suppression, logging, and transportation-related impacts.

Community Vulnerability

Most communities in the analysis draw from surface waters for domestic use, and the added filtration and purification costs could be substantial if the water quality on public lands deteriorates. The NPC recognizes three municipal watersheds: the City of Elk River, Clearwater Water Association (Wall Creek), and Elk City Water District (American River). All but the City of Elk River have a municipal watershed protection plan developed with the Forests. The downstream communities of Kamiah, Orofino, Lewiston, Juliaetta, Konkolville, and Orofino Riverside also derive their domestic water supply directly from surface water originating within the Forests. (See Section 7.2.4 of the NPC Assessment for more information related to the public's use of water from the Forests.)

In addition to community surface water supply, groundwater drinking water sources exist for 34 campgrounds and ranger stations within the Forests' boundaries. According to Alley et al. (1999), the state of Idaho relied upon groundwater for 96% of its drinking water in 1995, the highest dependence among all of the states. In comparison, neighboring states' reliance on groundwater ranged from a low of 31% for Nevada to a high of 61% for Wyoming. More than 233 individual groundwater wells, springs, and streams in or near the Forests provide domestic water to families and ranches via wells, diversions, and spring sources. Resource management has the potential to influence drinking water quality and quantity for many users.

Results of the Forests to Faucets project (Weidner and Todd, 2011) indicate that the NPC Forests have moderate importance for delivery of drinking water from surface waters originating on the Forests (Section 2.3 of the NPC Assessment). This project also indicated that lands within the Forests have minimal threats from development, moderate to high threats from insects and disease, and moderate to high threats from wildfire.

Except in Clearwater County, populations in the five-county analysis area are expected to continue to grow. With any increase in population, both consumptive and non-consumptive water use is expected to increase.

Adaptive Capacity and Management Potential

Most of the impact and expense of adapting to diminished water quality would be borne by downstream communities that depend on municipal water originating in the NPC Forests. Workshop participants had a high degree of confidence in their assessment that clean water is a very high-value ecosystem service, and users would be moderately willing to change behavior to access clean water. While these factors point toward a higher adaptive capacity, workshop participants indicated that greater sediment loads and higher levels of pollution and coliform would increase treatment costs, and alternative groundwater sources are likely available but would be expensive to access. Since the communities in the area are relatively poor, with lower than average income and employment levels, higher costs for treatment of new water sources may be difficult to afford. The high value of clean water, combined with the high expense that communities would bear to adapt to diminished water quality, contribute to a moderate level of adaptive capacity.

By implementing best management practices (BMPs) and stream and forest restoration, the Forest Service could address many water quality issues that would affect downstream communities. Some of these management strategies, however, conflict with other users such as timber, grazing, and recreation, and are expensive to implement at a landscape-scale. BMPs also cannot mitigate natural changes such as floods, landslides, and wildfire, which would affect downstream water quality. When these factors are combined, they lead to a moderate level of management potential.

Table 2

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Moderate	Water quality maintenance and improvement measures (BMPs) for timber, grazing, recreation, and fire suppression can mitigate water quality issues caused by use and/or management activities (but not likely climate induced impacts like floods, landslides, etc.) Focus on upland and stream restoration to protect water quality, which would provide mutual benefits for fisheries Reducing wildfire risk through restoration efforts and prescribed fire Potential sources of sedimentation, such as logging and transportation infrastructure, may be more important to monitor and mitigate as climate conditions change.	Conflicts with timber, grazing, and recreation Budget to pay for BMPs on a landscape scale	Fisheries also benefit from BMPs, which benefits recreational and consumptive anglers

Clean Air

Clean air was identified as a highly valuable ecosystem service with moderate to high ecosystem service vulnerability but low to moderate community vulnerability. Adaptive capacity was viewed as very high. Most air quality concerns raised in the workshop and worksheets related to the occurrence, intensity, and frequency of wildfires in the region. Smoke from eastern Oregon and southern Idaho was viewed as having greater air quality impact than fires within the region. Smoke from wildfires on the NPC Forests typically has greater impact in Missoula and Bitterroot valleys. Good air quality is important for public health, viewsheds, and recreational experiences.

Ecosystem Service Vulnerability

Clean air was identified as an area of moderate to high ecosystem service vulnerability. Most air quality concerns raised in the workshop and worksheets related to the occurrence, intensity and frequency of wildfires in the region. All participants anticipated that wildfire would become a greater management challenge in light of increasing temperatures, decreased snowpack, changes in precipitation timing, and buildup of woody fuels due to past suppression efforts. Studies indicate that climate change may increase summertime organic carbon aerosol concentration over the western U.S. by 40% from 2000 to 2050; elemental carbon over the region may increase by 20% during the same time frame. Most of this change would occur because of expected larger wildfire emissions; the rest of the increase would be due to changes in meteorology. These changes would have negative consequences for western U.S. air quality and visibility (Spraklen et al. 2009).

Non-climate related stressors mentioned in the workshop include prescribed fire and pollution sources originating off of the Forests, such as agricultural burning and smoke from wood heating.

Community Vulnerability

Clean air was identified as an area of moderate to low community vulnerability. Prevailing winds typically come from the west and as a result most smoke from wildfires on the NPC Forests tends to blow east and have a larger effect on the Missoula and Bitterroot valleys. The Forests and adjacent communities generally have very good air quality. Air quality may be affected in July, August, and September, although pollutants do not generally reach unhealthy levels. However, smoke from wildland fire, prescribed fires, and agricultural burning lingers for days during the summer months, and could impact recreational activities in the area.

The fine particles associated with smoke from forest fires can be especially problematic for those with ongoing health problems, such as lung disease or heart problems, and for the elderly, increasing their risk of hospital and emergency room visits or even death. These effects have been associated with short-term exposures lasting 24 hours or less (EPA 2003). In 2005, the state of Idaho had the 5th highest asthma mortality rate in the nation (Pollard et al. 2008). A 2013 report published by the American Lung Association (2013) provides lung disease statistics by county and state. Approximately 14,495 people (or about 13.6% of the population) in the five-county area have some type of lung disease.

Adaptive Capacity and Management Potential

Adaptive capacity is deemed very high. The IDEQ and the Nez Perce Tribe regulate agricultural burning throughout the year while working with the Western Montana/North Idaho Airshed Group to coordinate projects and control potential air quality effects from each prescribed burn. The Forests have the ability to time prescribed burns when they should have the least impact on air quality and to conduct fuel treatment designed to reduce the extent and/or duration of wildfires and the associated smoke.

Table 3

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Very High	Continue to coordinate with the full range of agencies and other bodies working to improve/maintain air quality Prescribed burning to reduce wildfire risk, timed to minimize impacts to air quality Mechanical fuel treatments, where appropriate, to remove hazardous fuel buildups and reduce risk of wildfire smoke release	Increased wildfire frequency and extent due to climate change is likely to occur despite efforts to reduce fire risk Constrained budgets for conducting hazardous fuel reduction treatments; prescribed fire can be less expensive than mechanical treatment but results in more air quality impacts • More public education and support of hazardous fuel treatments may be needed	Efforts to reduce particulates in this region could help improve air quality in the broader northern Idaho and western Montana region

Timber

Timber products are an important ecosystem service for the communities surrounding the NPC Forests and for the timber industry in Idaho. The harvesting and processing of timber creates local jobs and is part of the culture of the area. A viable timber industry also provides capacity to undertake forest restoration activities that require a trained workforce.

Overall, timber was viewed as being moderately vulnerable to climate change with moderate to low ecosystem service vulnerability but very high community vulnerability. Adaptive capacity was viewed as moderate, with some ability of the forest to manage for resilience to fires and insects and the potential for the industry to adapt to changing species mixes over time.

Ecosystem Service Vulnerability

Timber resources were seen by workshop participants to be moderately vulnerable to climate change, with the major impacts coming from wildfires, insects, and disease. Non-climate stressors identified were timber prices and the demand for timber, industry infrastructure, debates over logging on national forests, and conflicts with protecting other resource values. Current research suggests that national timber supply will expand due to climate change (Ryan et al. 2008). Regional impacts are less certain due to shifts in forest distributions and types, differences in wildfire, pest, and disease risk, and adverse effects on biodiversity. However, where increased temperature coincides with possible decreased precipitation, which is predicted in the Interior West, where the NPC Forests lie, forest growth is expected to be lower (Ryan et al., 2008). Warmer winters with more sporadic freezing and thawing would likely increase erosion and landslides on forest roads and reduce access for winter harvesting (USGCRP, 2009), increasing costs and likely reducing the supply of forest products.

Available soil water is also both a direct and indirect threat to timber. It is an indirect threat because less soil moisture increases the risk of fire, insects and disease. The direct impact occurs when a stand escapes the indirect threats, but reduced water availablity may prevent the trees from reproducing. The site may convert to grassland or shrubland, or convert from a moist habitat type to a dry habitat type.

Community Vulnerability

Community vulnerability is judged to be very high. Since the 1990s, the counties in the NPC analysis area have already seen a large drop in the number of mills and wood products employment. Although employment in Idaho's wood and paper products industry has declined from 18,440 workers in 1990 to an estimated 10,267 in 2011, many of the counties in the analysis area still derive a large percentage of their employment from timber-related industries. In 2010, Lewis County had the highest percent of employment in timber-related industries, at 21.5 percent, and both Clearwater County and Nez Perce County depended upon timber for more than 10 percent of their employment. Also, as noted earlier, all but Latah County met the definition of "wildland dependent" in 2010, with more than 15 percent of total county labor income coming from wildland-based sectors in the economy. Clearwater County had the highest dependence on wildland-based sectors at 31.4 percent, followed closely by Idaho County at 31.1 percent. The majority of the dependence comes from timber and employment in the land management agencies.

Brandt et al. (2012) state that a key reason for the declining wood products industry in Idaho is the 35 percent reduction in timber harvest largely driven by the 80 percent decline in the federal timber sale program from 1990 to 2006. For the Clearwater National Forest, the harvest volume peaked in 1990 at 147.7 million board feet (MMBF) and was at its lowest point in 2008 at 7.3 MMBF. On the Nez Perce National Forest, peak harvest occurred in 1989 at approximately 100 MMBF, and harvest volume was at its lowest point in 2006 at 4.8 MMBF. Wildfire or insect infestation due to climate change may cause further long-term reductions in timber harvest, resulting in substantial impacts on

the remaining wood products companies in the analysis area. In the short-term, harvests could increase due to the salvaging of dead or dying timber.

Adaptive Capacity and Management Potential

The FS has the ability to conduct fuel treatments, which could decrease the probability of catastrophic wildfires. Also, the FS can attempt to salvage burned or insect-killed timber before it loses market value. Timber management can improve forest resistance and resilience to stressors in areas identified for treatment, usually in the roaded portions of the forest. Timber management is a relatively slow process, taking several years from the beginning of planning to implementation. Therefore, timber management cannot respond quickly to rising threats; it works better as a long-term modification of forest composition and structure by helping the landscape gradually become more resistant and resilient.

There is also the potential for adaptations in the wood products industry, which might include using alternative species, changing the nature or location of capital and machinery, changing reliance on imports or exports, or adopting new technologies (Irland et al. 2001).

Table 4

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Moderate	Fuels treatment to reduce wildfire risk Salvaging insect-killed timber Supporting changes in the wood products industry to use alternative species	Large scape restoration projects are difficult to fund and get approved Market forces are difficult to affect at a local level Potential conflicts with clean water, recreation goals	Wildlife and fisheries may benefit from reduced wildfire threat Recreation may benefit from road improvements Local employment

Forage

Range has been, and continues to be, an important use of National Forest System lands. Although rangeland provides a variety of ecosystem services, such as wildlife habitat, wildlife-associated recreation, watershed functions, carbon sequestration, and biodiversity conservation, these lands have primarily been managed for forage.

Forage was viewed by workshop participants as having high community vulnerability but uncertain ecosystem service vulnerability. Adaptive capacity for sustaining rangelands was viewed as moderate to high if average future precipitation does not decline. However, if precipitation decreases, fewer management options are available and permitees could be negatively affected.

Ecosystem Service Vulnerability

Forage was viewed as being highly vulnerable to decreased precipitation, more intense and frequent drought, and increased wildfires. Resource specialists, however, felt that climate model forecasts of precipitation are too uncertain to judge the likely impact of climate change on forage. More precipitation can benefit forage and increase management flexibility for livestock, but a warmer, drier climate leads to reduced annual forage production and stress to riparian areas. Changes in snowpack depth, the timing of runoff, and in-stream flows were also seen as a vulnerabilities, but less so than precipitation and wildfire. Non-climate stressors identified were invasive weeds and wildfires. Wildland fire can be both a stressor and a benefit. It kills in-growth of trees, so it maintains

grasslands. Also, wildfires will likely kill trees in sites that have converted from rangeland to forest, causing them to revert to rangeland.

Community Vulnerability

Community vulnerability was viewed as high. The second largest farm type in the analysis area is "beef cattle, ranch and farms," which accounts for 21 percent (586) of the farms in the area. Although the grazing program on the NPC Forests is relatively small compared to some other Forests in the Northern Region, access to public lands for forage is central to many producers in the area. According to the Interior Columbia Basin Ecosystem Management Project (ICBEMP), Economic and Social Conditions of Communities report (ICBEMP 1998), Grangeville, Orofino, White Bird, Riggins, Elk City, Kamiah, Kooskia, and other communities in the region relied on forage produced on NPC Forests lands for approximately four to six percent of the total forage base of their respective counties. Resource specialists stated that although agriculture employs just under five percent of the workforce in the five-county area, it is more important economically in smaller communities, where it provides employment and significant cash receipts.

Adaptive Capacity and Management Potential

Due to the highly uncertain precipitation prediction for the region, workshop participants did not rate the adaptive capacity for forage. However, they did state that forage is very sensitive to changes in precipitation. More precipitation equals healthier grasslands and fewer constraints on permitees. Less precipitation equals more stressed grasslands and riparian zones, more constraints on permitees, and possibly reductions in authorized grazing. Also, emphasis on protecting habitats for threatened, endangered, and sensitive fish, plants, and animals would require intensive livestock management and may necessitate fewer permitted livestock or a shortened season of use to mitigate impacts.

Participants also stated that permitees often operate with limited financial resources, constraining their ability to change practices, make new investments, and absorb animal unit month cutbacks.

Table 5

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
No rating	Permittees can be required to change timing, location, and levels of grazing to respond to changing forage availability	Grazing allotments can conflict with management of riparian zones and aquatic species Reducing authorized grazing could have significant, negative local economic impacts	Improving forage can support wildlife for consumptive and non-consumptive uses

Wildlife

Wildlife in the NPC Forests provides provisioning and cultural ecosystem services to the public, including consumptive uses, recreational and cultural uses, and non-use values. Consumptive uses include big game hunting, trapping for fur, predator harvest, and hunting and trapping by the Nez Perce Tribe. Recreational and cultural uses include sport hunting, wildlife viewing, and cultural resources for the Nez Perce Tribe. Non-use values include existence values (the value people place on knowing the species exist although they may never see or use them), and bequest values (the value people place on knowing the species will be present for future generations to enjoy). This section covers the impact of climate change on consumptive and non-consumptive uses of wildlife, but not on non-use values.

The public enjoys a wide variety of wildlife species found in the NPC Forests. The main game species include elk, white-tailed deer, mule deer, moose, mountain goat, bighorn sheep, cougar, black bear, forest grouse, turkey, and chukar. The main species that are trapped by the public include American marten, bobcat, and wolf. Workshop participants mentioned that people enjoy viewing many bird and wildlife species in addition to those mentioned, and that viewing wildlife was one of the top five reasons people visit the NPC Forests according the National Visitor Use Monitoring Survey (NVUM 2011a, 2011b).

At the workshop and in the worksheets, wildlife was identified as moderate to high on ecosystem service vulnerability for consumptive wildlife use and moderate for non-consumptive wildlife use; community vulnerability was rated as very high for both consumptive and non-consumptive wildlife use. Adaptive capacity varied depending upon the type of use, with consumptive use rated as moderate and non-consumptive as having moderate to high adaptive capacity.

Ecosystem Service Vulnerability

The ecosystem service vulnerability rating was heavily dependent upon the uses associated with wildlife on the forest. Hunting and trapping were seen as more vulnerable to the impacts of climate change, with warmer temperatures and less precipitation affecting hunter success and pelt quality. Some anticipated climate changes may benefit some species, for example, as more frequent wildfires open up grasslands for ungulate forage, or decreased snow depth allows for more winter forage and higher survival rates. Wildlife viewing was seen as less vulnerable to climate change impacts because it would most likely result in a different mix of species, as habitat types and species' ranges shift over time. So, if forest visitors enjoy viewing wildlife in general, viewing would not be impacted as much as if they wished to view only certain species.

Non-climate stressors also varied by the type of use. For consumptive wildlife uses, fire suppression and invasive plant species were viewed as limiting big game forage and hunting opportunities. Fire suppression was seen as benefitting furbearers, however. For wildlife viewing, the non-climate stressors perceived to have the greatest impact were: 1) hunting and trapping, which make animals more wary of humans and reduce viewing opportunities, 2) invasive species, which change the species composition and availability of forage for native wildlife, 3) OHV use, which displaces wildlife that people are interested in viewing, and 4) major transportation corridors, which act as sources of mortality and barriers to dispersal.. Other stressors mentioned included agriculture, grazing, pollution and poison, land use conversion, energy production, and logging.

Community Vulnerability

For many Tribal and non-tribal residents, hunting is integrated into the culture, serving as both recreation and subsistence. Changes to species composition, abundance, and distribution in the NPC Forests could have significant effects on many residents' way of life.

Big game hunting, primarily elk and deer, has historically attracted local, national, and international hunters. Much of the planning area is remote, requiring the use of horses and outfitting services. Declining elk populations since the 1960s have significantly affected local outfitters and businesses relying on seasonal influx of big game hunters. Hunting upland birds and trophy species such as moose, mountain goat, and bighorn sheep, and trapping are also important, but minor in comparison to big game hunting. Also, as mentioned earlier, viewing wildlife is one of the top five activities enjoyed on the forests.

Adaptive Capacity and Management Potential

Forest Service capacity to manage wildlife species is restricted to managing the habitat and not the animal populations themselves. Management actions that improve habitat for wildlife species enjoyed by the public can help maintain animal populations. Forest Service funding to plan and implement

vegetation management in remote landscapes is limited, however. Also, management actions for maintaining hunting and trapping opportunities are seen as competing with viewing opportunities, since hunting and trapping make animals more wary of humans. The human population was viewed as fairly adaptive to wildlife changes unless wildlife activities are specifically tied to certain species.

Table 6

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Moderate for consumptive use, moderately high for non-consumptive use	Prescribed burns may contribute to habitat resilience and improve upland habitat Using BMPs to minimize negative impacts from logging, grazing, and recreation Avoiding a narrow focus on a single species such as elk, to manage habitat for many species	Wildlife management is often focused on elk and hunting. Managing for other species and uses is not as common. Efforts to improve air quality by limiting prescribed fire limits ability to improve habitat for big game. Managing for wildlife may conflict with agricultural and residential land uses on neighboring private land BMPS to reduce the impacts from logging, grazing, and recreation may reduce the flow of ecosystem services from wood products, timber, and recreation.	Efforts to reduce invasive species improve forage for wildlife and grazing Thinning and restoration for habitat can also increase flow of wood products

Fish

Fish are a highly valued forest resource, benefitting anglers, the Nez Perce tribe, and local businesses. The lakes and streams of the NPC forests support many species of anadromous fish (fish born in freshwater that spend time at sea and return to freshwater to spawn) and resident fish, including several species of trout, bass, and salmon, which are valued by the public for a wide variety of consumptive and non-consumptive uses. The opportunity to fish for and harvest salmon and steelhead, as well as the catch-and-release fisheries associated with the Selway River, Lochsa River, and Kelly Creek, attract anglers locally and from across the country. Fish are also an important cultural resource for the Nez Perce Tribe. Anadramous fish were viewed by workshop participants as having a higher value than resident fish for the Nez Perce tribe and outfitters alike.

Fish as an ecosystem service were rated very high on ecosystem service and community vulnerability, and low on adaptive capacity.

Ecosystem Service Vulnerability

Fish were viewed as an very vulnerable ecosystem service, with the potential to be impacted by a wide variety of climate-related changes including stream temperatures, high flows and runoff, drought, snowpack depth, timing of snowmelt runoff, low instream flows, high lentic (still water)/lotic (running water) temperatures, wildfire, and ocean conditions. Fish were viewed as sensitive to the following non-climate stressors, in order of decreasing sensitivity: dams,

transportation corridors, mining, logging, livestock grazing, fire suppression, and recreation. Exposure was highest for recreation, fire suppression, transportation corridors, and logging.

Community Vulnerability

Workshop participants viewed community vulnerability as extremely high. Communities in the region have come to depend on the harvest of spring Chinook to fill freezers and for recreation income from salmon and steelhead anglers. Fishing for resident trout is also popular. Additionally, anadromous fish are an integral part of the culture, history, and tradition of the Nez Perce Tribe and many other tribes. Loss of this ecosystem service could severely disrupt the local way of life and economy. Some people may go fish elsewhere or seek out different type of fish, but the Nez Perce tribe has no cultural replacement option for salmon.

A 2011 Idaho Fish and Game Survey (IDFG 2011) determined that anglers spent $87 million in the Idaho Fish and Game's Clearwater Region in 2003, $69 million (79%) of which was spent in three counties—Idaho County, Clearwater County, and Nez Perce County—where steelhead and salmon make up the largest portion of the fishery. Currently, anadromous fish in or originating in the waters of the NPC Forests are used for subsistence and religious purposes by the Nez Perce Tribe and other tribes throughout the Columbia River Basin. Nez Perce Tribal members are also permitted to sell a portion of their allocated catch, and some have come to rely on this source of income during the spring and early summer.

Adaptive Capacity and Management Potential

Currently, there is significant demand for this ecosystem service by both visitors to the forest and the Tribe. Local businesses depend on fishing-related spending, and there is no substitute for the cultural importance of this resource to the Nez Perce Tribe. The FS has a strong partnership with the Tribe to promote salmon conservation, but its control over salmon and steelhead populations is limited to the temperature and quality of their habitat on public lands.

Table 7

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Low	Stream restoration projects BMPs to reduce sedimentation, support clean water, and maintain colder water temperatures Continue Dvorshak releases Continue protection of blue ribbon trout fishery Improve hatchery management Improve fish passages at dams on the Snake and Columbia Rivers Improve management of downriver commercial and sport harvests	The most effective management options are large-scale and take place downriver from the NPC Forests Practices to improve habitat conflict with mining, logging, and fuels management	BMPs for fish habitat could also improve water quality

Cultural Values

Though difficult to quantify, cultural and heritage values on the NPC Forests are viewed as an important ecosystem service for the Tribes, subsistence food gatherers and hunters, recreationists seeking adventure, solitude and the spiritual values of public lands, and those who do not visit the NPC Forests but place a high value on knowing that the Forest is there. The region is generally rural in nature and both tribal and non-tribal residents have strong connections to the National Forest. Economic sectors like grazing and timber have historically been significant economic drivers and continue to have strong cultural associations.

Ecosystem Service and Community Vulnerability

The vulnerability of these resources is tied to the landscapes where the activities and uses occur, as well as to the types of activities. The ecosystem processes that generate these cultural values are vulnerable to changes in climate that affect wildfire frequency and intensity, soil moisture, temperature, and precipitation. Cultural values are also affected by changes to grazing, fire suppression, logging, and recreation practices. Ecosystem service vulnerability was rated as moderately low, and no rating was provided for community vulnerability.

Adaptive Capacity and Management Potential

Maintaining traditional industries, activities, and access could be complicated by the increased stress added to forest resources from climate change. More attention should be paid to restoration and conservation actions that can enhance resilience and increase the ability of the public to utilize and enjoy important forest resources. No rating was provided for adaptive capacity or management potential due to the difficulty in predicting how the behavior of users might change.

Table 8

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Uncertain	BMPs for grazing and timber harvest	Management to protect spiritual and existence values of Forest may conflict with grazing and timber harvest	BMPs can also protect clean water and wildlife

Aesthetics (Scenery)

The water quality and quantity and vegetation have been identified as two ecosystem components that are important for providing aesthetic values (SEQ, 2013). The impacts of climate change on these resources are described in the Clean Water section of this report and throughout the EcoAdapt Report. No information on the impact of climate change on scenery was collected during the workshop since the recreation specialists on the NPC Forests were unable to participate.

Many areas of the NPC Forests are enjoyed for their scenic beauty (see Recreation chapter). Increases in forest disturbances, such as wildfires, insects, or disease can affect viewsheds, both the character of the landscape and the vantage points from which visitors experience the scenery. This can impact recreation experiences, and perhaps visitation numbers. Driving for pleasure (i.e. to enjoy the view) is one of the top activities among visitors to the NPC Forests (NVUM 2011a, 2011b). Aesthetics and the natural resource–based amenities of an area have been shown to contribute to population growth and

economic development. Also, studies have found a positive effect on sales prices of homes located near National Forest lands (Cho et al. 2009; Hand et al. 2008; Kim and Johnson 2002). Changes in the viewsheds due to insects and disease could change the value of property in proximity to the Forests.

Table 9

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Uncertain	Restoration efforts to reduce intensity of fire, insects and disease and ensure healthy, resilient landscapes	The scale of needed restoration is beyond budget projections and workforce capability	Reduced impacts/increased resiliency of vegetation, fisheries and wildlife

Recreation

Recreation on the Forests is characterized by the vast, wild, and remote landscapes that support nature-based recreation activities that depend on water, snow, fisheries, and wildlife.

Recreation specialists on the NPC Forests were unable to participate in the climate change vulnerability workshop. The information provided below is based on the scientific literature about recreation and climate change and some input from the recreation specialists on the Forests after the workshops.

Ecosystem Service Vulnerability

Ecosystem service vulnerability is seen as moderate. Outdoor recreation activities depend on the availability and quality of natural resources such as forests, wetlands, snow, and wildlife (USGCRP, 2009). Climate change could affect recreation on the NPC Forests through three pathways: snow- and ice-dependent activities such as cross-country skiing, snowshoeing, and snowmobiling; nature-based activities such as biking, walking, and hunting; and water-related activities such as boating, fishing and camping near rivers.

Snow- and ice-dependent activities could be adversely affected by even small increases in temperature, especially in areas with marginal snow conditions. Snowmobiling, which depends wholly on natural snowfall and often occurs in lower-elevation areas, is vulnerable to decreases in snowfall.

The desirability of nature-based activities such as hiking, river visits, and sightseeing (both scenery and wildlife viewing), may increase because of small near-term increases in temperature and the gradual development of longer warm weather seasons that may lead to longer access to natural settings and landscapes. Altered biodiversity and increases in fire and insect infestations, however, could adversely affect nature tourism. Viewing of wildlife, especially in critical habitat or recommended wilderness areas, and hunting opportunities could also change as animal habitats and perhaps even the viability of some species shift due to climate change.

Lower water levels in reservoirs and rivers during the summer months could affect fishing and boating activities. However, warmer temperatures could lead to increased demand for water-related activities (Sussman et al., 2008; USGCRP, 2009) earlier in the spring and later in the fall.

Community Vulnerability

Community vulnerability is rated as moderate. In North Central Idaho, most outdoor recreation areas are located in and around National Forests which are bordered by rural communities in rural counties. Although most of the jobs associated with the recreation industry in rural areas do not pay well, these jobs can still be very important to the local economy. If climate change reduces or shifts recreation-related job opportunities to other areas, rural communities could see drops in employment. Analysis done by the National Visitor Use Monitoring Survey (NVUM 2011a, 2001b) estimates that approximately 300,000 visitors recreate on the NPC Forests annually. These visitors spend money in the local economy on a variety of items, including food, gas, and sometimes lodging. A substantial number of jobs in the five-county analysis area are associated with industries connected to travel and tourism. Around 19 percent of total private employment in the five-county area is in industries connected to travel and tourism, with the majority of the jobs associated with the accommodation and food sector (total private employment does not include employment in government, agriculture, or railroads, or the self-employed, because these are not reported by County Business Patterns). The five counties in the analysis area vary in the percent of total private employment occurring in travel and tourism-related sectors, ranging from 13.5 percent for Lewis County up to 26.6 percent for Latah County.

Fewer visitors to the NPC Forests participate in snow- and ice-based activities than nature-related activities or water-based activities, therefore the negative impacts of climate change may be less for the NPC Forests than for other National Forests with a great deal of downhill skiing or other snow-related activities. In response to the 2011 NVUM survey (NVUM 2011a, 2011b) on the NPC Forests, around 10 percent of the 293,000 visitors (29,000 visitors) indicated that the main purpose of their visit was snowmobiling or cross-county skiing.

Nature-related activities such as relaxing, viewing nature and wildlife, driving for pleasure, and hiking make up four of the top five activities on the NPC Forests (NVUM 2011a, 2011b). (Gathering forest products such as berries is the fifth activity.) Having longer seasons to enjoy this type of recreation would benefit people interested in these activities. However, increases in forest disturbances, such as wildfire or insect infestations, which may result from climate change, could decrease the benefits that people receive from these activities, so the overall effect is uncertain.

Water-based recreation activities, such as whitewater rafting and float boating, occur on the Salmon, Selway, Lochsa, and Middle Fork Clearwater Rivers. Longer seasons and more runoff could be beneficial to whitewater enthusiasts as well as to outfitters and guides. Impacts to fishing, which could be significant, are described in the Fish and Wildlife section.

Popular developed and dispersed camping sites are located on the Salmon, Selway, Lochsa and Middle Fork Clearwater Rivers and other streams in the region. Longer seasons and more runoff could be beneficial to those who camp in these sites because a water source is readily available. However, higher, earlier runoff could shift the accessibility of these sites. Some sites could be underwater and unavailable for longer periods of time in the spring, while in the late summer or fall these sites may no longer have the benefit of having an available water source.

Adaptive Capacity and Management Potential

Table 10

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Moderate	Extend/alter season of river and winter guides and permitted water/snow-based activities to coincide with changes in water flows and snow lines (elevation of snow)	Alterations may need to be evaluated on an annual basis to be responsive to unpredictable variations from year to year, as well as the evolving needs of the fisheries and other resource values	Some recreation management activities could benefit clean water and consumptive and non-consumptive wildlife

Flood Control

Flood protection is an important regulating ecosystem service provided by National Forests. Large trees break up heavy rainfall, surface duff layers encourage moisture to infiltrate the soil, soil organic matter and established root systems assist in absorbing water, and permeable soils allow surface water to soak in and recharge groundwater resources. Flood protection was viewed as important for preserving infrastructure, property, and fish habitat. Vulnerability was viewed as moderate for both climate and community. Adaptive capacity was not rated.

Ecosystem Service Vulnerability

Ecosystem service vulnerability was viewed as moderate, with the ability of the forest to provide flood protection being impacted by the amount and timing of precipitation and rain-on-snow events, high flows and runoff, and wildfires. Changes in the magnitude and frequency of extreme events are the largest factors behind future flooding frequency. Though fire suppression and dams/diversions were listed as non-climate stressors, they were identified as having positive rather than negative effects. Dams ameliorate floods by storing water. Wildfires can cause soils to be temporarily hydrophobic, or incapable of absorbing water, which leads to water collection on soil surface, increased surface runoff, and erosion in post-burn sites. Fire suppression is seen as positive since it can prevent hydrophobicity, allowing moisture to infiltrate soils and reducing runoff and erosion.

Community Vulnerability

Community vulnerability was also viewed as moderate. Continuing urbanization and increasing construction of second homes in forested settings have expanded the area of the wildland-urban interface (WUI), causing increased concerns about protection from wildfire and potential post-fire landslides and flooding (Jones et al., 2009). Compared to other western states, the percentage of WUI area with homes is relatively low for the areas surrounding the NPC Forests – 4.7 percent contained houses in 2010. For comparison, the WUI area occupied by houses was 16.3 percent for the 11 western states and 12.6 percent for the state of Idaho. Although this means lower community exposure now, as population grows and residential development in the five-county area continues to expand, exposure to floods could increase significantly.

Adaptive Capacity and Management Potential

Adaptive capacity for this ecosystem service was rated as low, but with low confidence. Participants indicated that reducing wildfire severity is the key to adaptive success for flood protection. The increase in intensity and frequency of extreme precipitation events, including more rain-on-snow events, should place greater emphasis on restoration efforts and actions to reduce wildfire severity.

Table 11

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Low	Avoiding catastrophic wildfire Dams and diversions to anticipate future events Reintroduction of beaver	Dams and diversions to manage high runoff conflict with efforts to improve fish habitat	Avoiding landslides from catastrophic wildfire may improve water quality, fish habitat, and recreation

Soil Stabilization and Landslide Protection

Soil stabilization and landslide protection were viewed as highly valuable ecosystem services to prevent damages to nature resources and to property and infrastructure. Ecosystem service vulnerability was rated as moderate and community vulnerability was rated as very high. Adaptive capacity was rated as low.

Ecosystem Service Vulnerability

The ecosystem service of soil stabilization and landslide protection was viewed by workshop participants as moderately vulnerable to climate change. Climate change would likely lead to new patterns of snow melt, runoff, soil moisture, vegetation type and wildfire that could all have adverse effects on soil stabilization and landslides. Changes in precipitation and snowpack depth were also mentioned as having a lesser impact.

Non-climate stressors contributing to vulnerability include logging, transportation corridors, and livestock grazing, and to a lesser extent invasive species, recreation and fire suppression.

Community Vulnerability

Continuing urbanization and increasing construction of second homes in forested settings have expanded the area of the wildland-urban interface (WUI), causing increased concerns about protection from forest disturbances such as wildfire and landslides (Jones et al., 2009). This along with the location of several communities in lower slope positions lead to a high vulnerability rating.

Adaptive Capacity and Management Potential

Adaptive capacity was rated as low. The expense of applying BMPs or moving transportation corridors, and hurdles to changing timing of land management activities, were all viewed as hindering adaptive capacity. There is much better adaptive opportunity while the ash cap on the soils is still present; once this is lost, stability and productivity decline substantially while stabilization becomes much more difficult and costly.

The loss of the ash cap on area soils was noted as a critical turning point after which maintaining stable soils and preventing landslides would become considerably more difficult. Along with climate impacts, there is a wide range of non-climate stressors to consider, including logging, transportation corridors, livestock grazing, invasive species, and recreation.

There is urgency for the National Forest to act early to sustain or improve soil stabilization in order to avoid more costly measures later. This should involve a mix of creating more resilience to climate-driven factors such as increased rain-on-snow events and more intense runoff patterns, and non-climate disturbance factors such as logging and grazing impacts.

Table 12

Management Potential	Potential Management Strategies and Associated Benefits	Barriers to Proposed Management Strategies	Benefits to Other Ecosystem Services
Low	BMPs for logging and grazing and other management actions Moving transportation corridors Soil stabilization on sensitive soils after wildfire	BMPs may lower grazing allotment and timber yield Moving transportation corridors is very costly	BMPs to support soil stabilization would also support clean water and fish habitat

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