Nez Perce–Clearwater National Forests
Forest Plan Assessment

7.0 Multiple Use and Ecosystem Services

June 2014

Table of Contents

List of Tables

List of Figures

7.0 Multiple Use and Ecosystem Services

The Preamble of the 2012 Planning Rule for National Forest System (NFS) land management planning recognizes that ecological, social, and economic systems are interdependent and equally important; none has priority over the other. Therefore, the planning rule requires the consideration of social, economic, and ecological factors in all phases of the planning process. The rule also states that forest plans must "contribute to economic and social sustainability and must provide for ecosystem services and multiple uses in the plan area. Responsible officials will use an integrated resource management approach to provide for multiple uses and ecosystem services in the plan area, considering a full range of resources, uses, and benefits relevant to the unit, as well as stressors and other important factors." In line with this emphasis, the Planning Rule requires the Assessment to address multiple uses and ecosystem services.

Multiple use is defined by the Multiple-Use Sustained-Yield Act (MUSY) of 1960 (16 U.S.C. 528–531) as follows:

> …the management of the various renewable surface resources of the NFS so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

Additionally, the first paragraph of the MUSY Act (16 U.S.C.528) states, "Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that, it is the policy of the Congress that the national forests are established and shall be administered for *outdoor recreation, range, timber, watershed, and wildlife and fish purposes*" (emphasis added).

The 2012 Planning Rule defines ecosystem services as "the benefits people obtain from ecosystems." Healthy forest ecosystems are life-supporting systems that provide a full suite of goods and services (ecosystem services) that are vital to human health and well-being.

Though in practice the categories of multiple use listed above (outdoor recreation, range, timber, watershed, and fish and wildlife) largely fall under the broader umbrella of ecosystem services (benefits people obtain from ecosystems), the multiple use mandate under the MUSY Act of 1960 (16 U.S.C. 528–531) and the National Forest Management Act of 1976 (16 U.S.C. 1600 et seq.) requires that land management plans address multiple uses, whether or not they are identified as an important ecosystem service. Therefore, this assessment section will include assessments of the multiple use categories and any key ecosystem services that are not addressed in the multiple use section. The rest of this chapter is organized as follows: section 7.1 includes a brief introduction to the concept of ecosystem services and lists the key ecosystem services identified by the Interdisciplinary Team (IDT) and the public; section 7.2 includes the assessment of multiple uses; section 7.3 includes the assessment of key ecosystem services not already addressed in section 7.2; and section 7.4 briefly discusses other ecosystem services that were not identified as key services.

7.1 What are Ecosystem Services?

In a 2007 Pacific Northwest Research Station publication (Collins and Larry 2007), the authors describe ecosystem services as follows:

> An ecosystem services perspective encourages natural resource managers **to extend the classification of "multiple uses"** [emphasis added] to include a broader array of services or values; managing for water, wildlife, timber, and recreation addresses the need to sustain "provisioning" services, but land managers are also stewards of regulating, cultural, and supporting services, all of which are critical to human health and well-being. (See Table 7-1 for examples of these other ecosystem services.)

Table 7-1. Ecosystem services examples

<table>
<tr><td rowspan="3">Supporting Services,
such as
pollination, seed dispersal, soil formation, nutrient cycling, biodiversity, ecosystem resilience</td><td>Provisioning Services, such as
Clean air and fresh water
Energy and minerals
Fiber and forage
Food (game animals, fish, plants)
Biochemicals, natural medicines, pharmaceuticals</td></tr>
<tr><td>Regulating Services, such as
Long-term storage of carbon
Climate regulation
Water filtration, purification, and storage
Soil stabilization
Flood control
Disease regulation</td></tr>
<tr><td>Cultural Services, such as
Aesthetic values
Educational values
Spiritual and cultural heritage values
Recreational experiences and tourism opportunities</td></tr>
</table>

Source: Millennium Ecosystems Assessment 2003

The requirements for plan components for ecosystem services in the 2012 Planning Rule are found in the section on social and economic sustainability and in the section on multiple use:

> 36 CFR 219.8(b): The plan must include plan components, including the plan area's contribution to social and economic sustainability, taking into account…(4) Ecosystem services
>
> § 219.10 Multiple use. While meeting the requirements of §§ 219.8 and 219.9, the plan must provide for ecosystem services and multiple uses, including outdoor recreation, range, timber, watershed, wildlife, and fish, within Forest Service authority and the inherent capability of the plan area as follows: (a) Integrated resource management for multiple use. The plan must include plan components, including standards or guidelines, for integrated resource management to provide for ecosystem services and multiple uses in the plan area.

The benefit to people (i.e., the goods and services provided) is what differentiates ecosystem services from the ecosystem itself. As stated in Kandziora et al. (2013), the “significance of human well-being lies in the concept and definition of ecosystem services itself, since there are no services without humans benefitting from the functions and processes that generate them.” Additionally, though management actions (fire suppression, fuel treatments, etc.) and infrastructure (such as trails and roads) may also provide benefits to the public, the benefits are not provided by the ecosystem itself and therefore are not considered “ecosystem services.” To help clarify the differences, Figure 7-1 shows the connections between ecosystem processes, functions, and structures; ecosystem services; benefits to people; management actions; and threats and drivers.

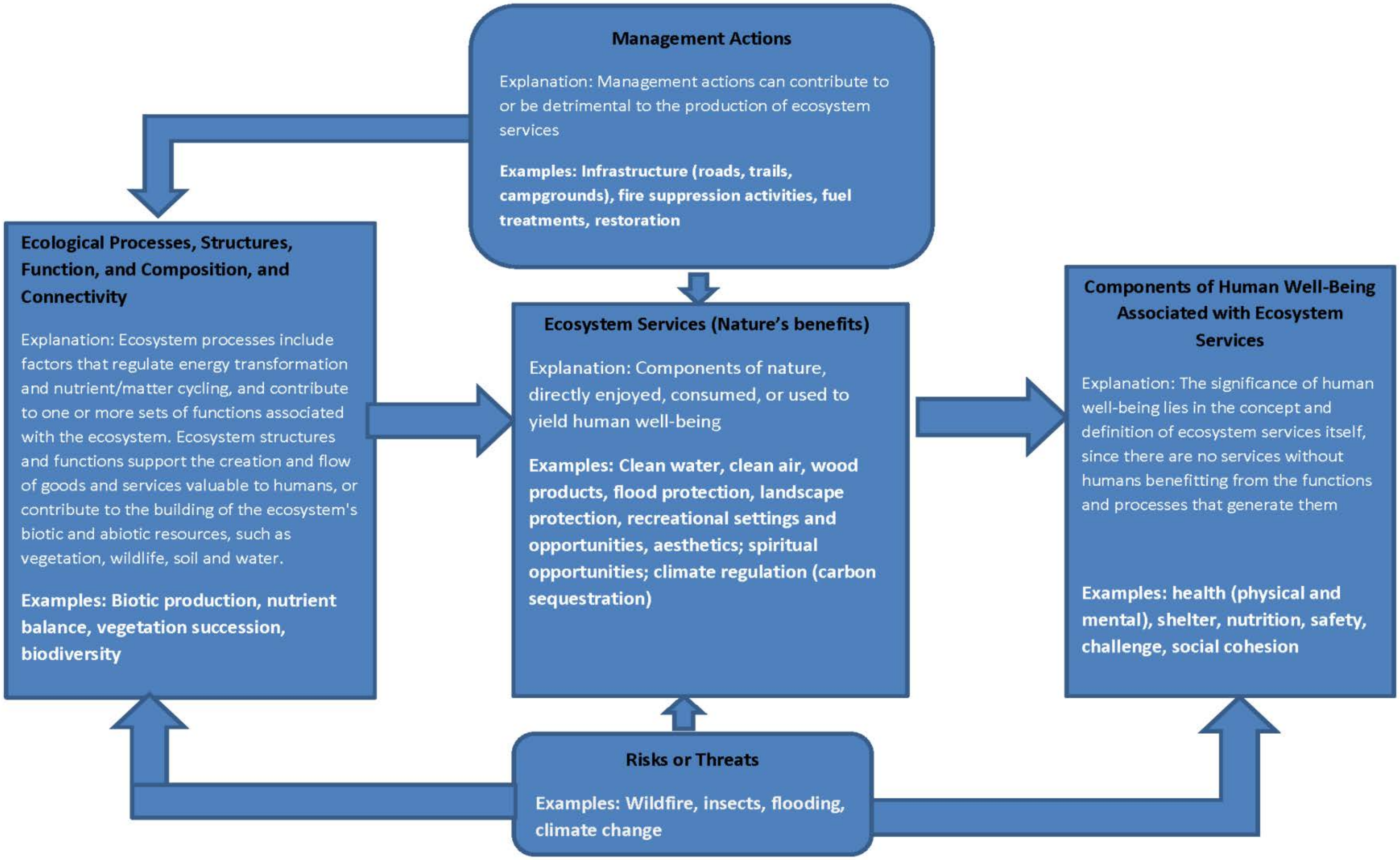

Figure 7-1. Relationship of ecosystem service components (Source: Diagram based on information provided in MEA 2003, Boyd and Banzhaf 2007, Kandiziora 2013)

7.1.1 *The Role of Biodiversity*

In discussions about ecosystem services, the question often arises whether biodiversity should be considered an ecosystem service. The term “biodiversity” combines 2 words: “biological” and “diversity.” Biodiversity refers to all the variety of life that can be found on Earth (plants, animals, fungi, and microorganisms); the term also refers to the communities that these organisms form and the habitats in which they live (Convention on Biological Diversity 2013). Most studies acknowledge that biodiversity probably plays a significant role in directly providing goods and services as well as regulating and modulating ecosystem properties (Balvanera et al. 2006), but the idea of biodiversity as an ecosystem service is more controversial. Benays et al. (2009) state the following: “[D]espite being the focus of major research attention, the relation between biodiversity and provision of ecosystem services remains uncertain.” (Kandziora et al. 2013) make a different assessment: “In other studies, biodiversity has been mentioned as an ecosystem service itself, which it is obviously not.”

Others take a broader view of the role of biodiversity in the delivery of ecosystem services. Mace et al. (2013) state the following:

> Biodiversity has multiple roles in the delivery of ecosystem services, as a regulator of ecosystem processes, as a service in itself and as a good. Effective ecosystem management now, but even more in the future as pressures intensify, will require identifying and analyzing all roles both for the optimization of ecosystem service delivery and for the conservation of species, habitats and landscapes.

Mace et al. (2013) believe these three roles of biodiversity contribute to the complex ways in which biodiversity enhances human well-being. Combinations of biotic and/or abiotic components that help regulate ecosystem processes are viewed as an important benefit of biodiversity; however, they state that this definition or role may not account for other benefits, such as bird species richness. Viewing biodiversity as an ecosystem service takes into account the fact that “both genetic diversity (or surrogates, such as wild species richness or phylogenetic diversity) and wild species diversity (implicitly including genetic and phylogenetic diversity) directly contribute to ecosystem goods, such as wild medicines, genetic material for crops, etc.” They (Mace et al. 2013) also argue that biodiversity can be viewed as a good because many components of biodiversity have cultural value and retaining a full complement of wild species is important to many people.

In the context of Forest Plan revision on the Nez Perce–Clearwater National Forests (Forests), biodiversity’s many roles in contributing to human well-being are appreciated and acknowledged. However, explicitly accounting for the ways in which people value biodiversity, or assessing how management actions may affect those values, is not feasible as part of the forest planning process. For that reason, any analysis or assessment of biodiversity will be handled in the ecological sustainability sections of this Assessment.

7.1.2 *Key Multiple Uses and Ecosystem Services for the Nez Perce–Clearwater National Forests*

Every National Forest or National Grassland provides important ecosystem services; however, describing or analyzing every ecosystem service is not feasible. Current direction (proposed directives) is to identify those ecosystem services that are most important to people in the broader landscape and that would be most affected by the land management plan. Through the collaborative process, the IDT worked with the public to identify an initial list of ecosystem services that are provided by the Forests. The IDT then refined this list, using the two criteria listed above. The refined list includes the following ecosystem services:

- Clean water (discussed in section 7.2, Multiple Uses)
- Clean air (discussed in section 7.3, Key Ecosystem Services)
- Wood products (discussed in section 7.2, Multiple Uses)
- Forage (discussed in section 7.2, Multiple Uses)
- Fish and wildlife (discussed in section 7.2, Multiple Uses)
- Cultural/heritage values (discussed in section 7.3, Key Ecosystem Services)
- Aesthetics (discussed in section 7.3, Key Ecosystem Services)
- Recreation opportunities (discussed in section 7.2, Multiple Uses)
- Soil stabilization and landslide protection (discussed in section 7.3, Key Ecosystem Services)
- Carbon sequestration and climate regulation (discussed in section 7.3, Key Ecosystem Services)
- Flood control (discussed in section 7.3, Key Ecosystem Services)

7.2 MULTIPLE USES

7.2.1 *Outdoor Recreation*

Recreation on the Forests is an important use of the National Forest by both local residents and nonlocal visitors. Chapter 9 of the Assessment contains a full discussion of recreation resources on the Forests. Below is a summary of the importance of recreation settings and opportunities. Hunting and fishing are discussed in section 7.2.5.

Recreational opportunities and settings are an important cultural service provided by the Forests. The term “cultural services” refers to the intangible benefits people receive from ecosystems, including nonmaterial spiritual, religious, inspirational, and educational experiences (Kandziora et al. 2013). Recreation on the Forests is characterized by the vast, wild, and remote forest landscapes (recreation settings) that support nature-based (water, snow, fisheries, wildlife) recreation activities and opportunities. These opportunities and settings provide people with a variety of benefits: relaxation/recreation; physical, mental, and/or spiritual health; experiencing nature, landscapes, and/or their own or other people’s cultures; environmental/outdoor education; eco/adventure/nature-based tourism; opportunities to socialize; and challenge and competition (SEQ 2013). The benefits people obtain from recreating in a natural environment are subjective and highly personal, with different people obtaining different benefits from the same piece of land or forest attribute. Chapter 9 of this Assessment provides detailed information about the Forests recreation settings and opportunities (9.1.2.3), services (9.1.2.6), access (9.1.2.7), and facilities (9.1.2.8).

7.2.1.1 Geographic Scale

The Forests contribute in unique and distinctive ways to the recreation settings and opportunities available in the region. While many Idaho forests are accessible from interstate highways or are adjacent to urban areas (e.g., Boise, Idaho Falls, and Coeur D’Alene), the Forests are more remote and serve smaller, more rural communities (e.g., Grangeville, Riggins, Orofino, Elk City, Moscow, and Lewiston, all in Idaho; and Clarkston, Washington).

Visitors to the Forests come from near and far, with 65%–70% of visitors travelling from within a 100-mile radius to access the Forests. This radius includes all of the communities within and adjacent to the Forests, and more distant communities such as Lewiston, Coeur D'Alene, Cottonwood, McCall, Boise, Meridian, and Caldwell, Idaho; Clarkston, Colfax, Spokane, and Pullman, Washington; and Lolo and Missoula, Montana. Visitors to the Nez Perce National Forest are primarily from Grangeville, Idaho (40%); Lewiston, Idaho (15%); and Kooskia, Idaho (9%). Visitors to the Clearwater National Forest are primarily from Missoula, Montana (26%); Moscow, Idaho (17%); and Lewiston, Idaho (16%). Two to four percent of visitors on both forests are from outside of the United States (NVUM 2006a,b, 2011a,b).

Chapter 9, Recreation, provides substantial information on the recreational opportunities and settings available on the Forests.

7.2.1.2 Conditions, Trends, and Drivers

See Recreation, Chapter 9, section 9.2 (Informing the Assessment), and Socioeconomic Conditions and Trends, Chapter 6, section 6.9.1 (Forest-based recreation), for conditions, trends, and drivers related to recreation.

7.2.1.3 Ecosystems and Recreation

The health and resiliency of the Forests' natural resources are critical to the sustained delivery of nature-based recreation settings and opportunities. See Chapter 1 of the Assessment and section 9.1.2.1 (Sustainable Recreation) for information about the ecosystems supported recreation settings and opportunities.

7.2.1.4 Influence of non-National Forest System Lands or Conditions

For information on the social, economic, and ecological conditions affecting the Forests' recreation programs, see section 9.1.2.

7.2.1.5 Importance to People in the Analysis Area and the Broader Landscape

The State of Idaho markets itself with the slogan "Adventures in Living" (www.visitidaho.org). The wildlands and wild rivers of the Forests are critical to delivering recreation adventures to residents, local communities, and visitors. Although visitors from distant regions and other countries do come to follow the National Historic Trails, raft on the rivers, or hire outfitters to hunt in the Wilderness, the communities and the vast recreation settings of the Forests remain relatively undiscovered due to the rugged and remote nature of the area. Nationally, the Forests have one of the lower visitation levels of National Forests in the lower 48 states (NVUM 2006a,b). Forest visitation is primarily local and regional, with almost 50% coming from within 50 miles of the Forests (local visitors are those travelling 50 miles or less to get to the forest (NVUM 2006a,b).

The Forests serve as a backdrop, workplace, and playground for the small rural communities of central Idaho. Deeply rooted in the cultures and traditions of Native American tribes and early Euro-American settlers, the recreation settings and opportunities of the Forests are enhanced by the many visible and accessible remnants of the past. A network of historic trails and roads gives visitors a chance to follow in the footsteps of the Native Americans, the Lewis and Clark Expedition, and miners in search of gold. Historic cabins and lookouts continue to serve as overnight destinations for present-day visitors. This rich heritage, combined with the Wilderness, wild rivers, incredible scenery, rich salmon fishery, and diverse game species of the Forests, characterizes the area's sense of place and contributes to a way of life for inhabitants.

The Forests' recreation programs contribute to the economic sustainability of central Idaho's rural communities. The economic contribution analysis (see section 6.10) completed for this Assessment indicates that recreation, hunting, and fishing by nonlocal visitors account for an estimated 98 jobs and $2.1 million in total labor income in the 5-county analysis area. Recreation spending (including hunting and fishing) by local residents is associated with another 37 jobs and $853,000 in labor income. The remoteness of the Forests' recreational settings encourages visitors to stop and buy groceries, gas, and other supplies before entering the Forests. Necessary supplies may include items that support visitors' OHV, stock, backpacking, boating, or biking experiences.

Jobs and revenue are also generated via outfitter-guide operations and other recreation special uses. These jobs may or may not be included in the economic contribution results because of the way the data are collected. The economic contribution of recreation was computed using visitation numbers and spending patterns collected in the National Visitor Use Monitoring surveys done periodically for each National Forest, and these surveys do not collect information specific to the outfitter and guide industries or other special uses. On the Forests, 59 special use permits have been issued for outfitter and guide operations (33 on the Nez Perce National Forest and 26 on the Clearwater National Forest); these permits are associated with an annual average of 7,169 service days.

Although no information is available on the actual economic contribution of outfitter and guide operations on the Forests, some studies have looked at the impacts statewide. A fairly recent study (Nickerson et al. 2007) conducted in Montana looked at the economic impact of the 998 outfitters in Montana in 2006. Nickerson et al. estimated that approximately 1,956 direct jobs (outfitters and guides) and 634 indirect and induced jobs were associated with the outfitting industry. The indirect jobs are a result of other businesses providing supplies and services to the outfitting industry. The induced jobs are a result of employees of both the outfitters and the supporting businesses spending a portion of their income in the local economy.

In addition, some of the unique attributes of the Forests support the potential for communities to host events to attract visitors for the benefit of some of the local communities. For example, the local economies along the Lewis and Clark Trail had an estimated increase of at least $27 million during the 4 years of the Expedition's bicentennial. A survey of travelers in 2005 conducted by the Idaho state tourism office revealed that, of the travelers whose primary reason for visiting Idaho was the bicentennial, 61% came from states other than Idaho, Washington, Oregon, Montana, and California (the top states of origin for travellers in Idaho, overall).

Chapter 6, section 6.6.5 (Economic Conditions and Trends—Recreation) and section 6.10 (Economic Contribution of the National Forests to the Analysis Area), contains additional information on the importance of recreation to the local economies.

7.2.1.6 Effects from Forest Management Actions

Two management tools are employed to protect the natural and cultural resources of the Forests: 1) interpretation and education programs and 2) law enforcement. Although both management tools influence visitor behavior, law enforcement is typically a reactive approach, while interpretation and education programs are designed to create appreciation and understanding as a way to encourage voluntary compliance and deter behavior that would result in negative resource impacts.

Chapter 9, section 9.2 (Informing the Assessment), contains more information on management actions that can affect recreational opportunity and settings.

7.2.1.7 Information Needs

No information needs have been identified.

7.2.2 *Range*

Range has been, and continues to be, an important use of National Forest lands. Although rangeland provides a variety of ecosystem services, such as wildlife habitat, recreation (including that associated with wildlife), watershed functions, carbon sequestration, and biodiversity conservation, these lands have primarily been managed for forage. Under the Milleneum Ecosystem Assessment (MEA) classification system, forage is a provisioning service. Provisioning services include all tangible products from ecosystems that humans make use of for nutrition, materials, and energy. These products can be traded and consumed or used directly (Haines-Young and Potschin 2010); they are divided into the main subcategories of food, materials, and energy (Kandziori 2013). For a thorough discussion of the many ecosystem services provided by rangelands, see Maczko and Hidinger (2008).

7.2.2.1 Geographic Scale

Livestock grazing is permitted on designated grazing allotments within the Forests. Active grazing allotments occupy 474,709 acres within the Nez Perce National Forest (21.3% of NFS lands) and 132,533 acres within the Clearwater National Forest (7.8% of NFS lands) (Figure 7-2 and Table 7-2).

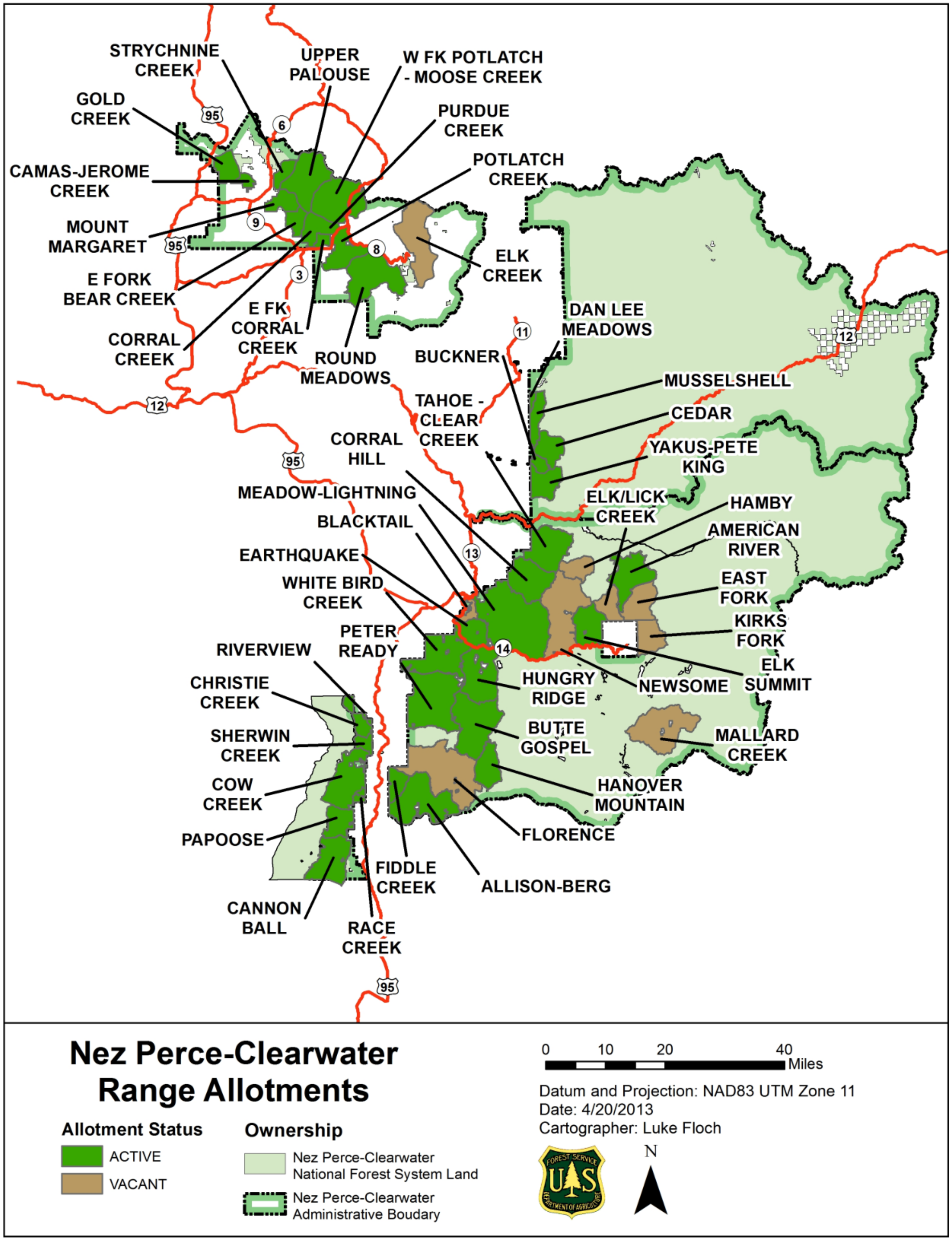

Figure 7-2. Nez Perce–Clearwater range allotments

Table 7-2. Grazing allotments within the plan area

	Nez Perce National Forest	Clearwater National Forest
Grazing Permittees (Permit Entities)	25	13
Active Allotments	21	16
Active Allotment (total) (acres)	476,528	212,527
Active Allotment (Forest Service) (acres)	474,709	132,533
Active Allotment Waived (private) (acres)	810	79,994
Vacant Allotments	8	0
Closed Allotments	4	3

7.2.2.2 Conditions, Trends, and Drivers

Grazing

Within the Nez Perce National Forest, 25 permittees are authorized to graze livestock on 21 allotments. Records for the Nez Perce National Forest for 2011 report 4,433 head of cattle and 2,301 head of sheep were permitted to graze at various times throughout the year, with the primary grazing season of June 1 through September 30. The cattle grazing program averaged approximately 16,665 head months annually from 2009 to 2011. The sheep grazing program was 1,239 head months in 2011, and horses averaged approximately 127 head months.

Within the Clearwater National Forest, 13 permittees are authorized to graze livestock on 16 allotments. Records for the Clearwater National Forest in 2011 indicate 1,053 head of cattle were permitted to graze at various times throughout the year on NFS lands, with the primary grazing season of June 1 through September 30. The Clearwater National Forest program consists solely of cattle allotments, averaging approximately 5,366 head months of authorized grazing annually from 2009 to 2011.

These head month numbers are all down, except for horses, from the numbers reported in the 2004 Social Assessment, which reported data for 2002–2004. At that time, for the Nez Perce National Forest, 20,000 head months were authorized for cattle annually and 10,000 for sheep; and approximately 6,000 head months of cattle grazing were authorized on the Clearwater National Forest.

The Nez Perce National Forest has one domestic sheep allotment, the Allison-Berg Allotment. In 2009, the term grazing permit to Carlson Company was modified due to potential conflicts between domestic sheep grazing and native bighorn sheep. The permit modification states that domestic sheep grazing will not be authorized until an appropriate analysis of the law (the National Forest Management Act [NFMA] and National Environmental Policy Act [NEPA]) examines this potential conflict.

Livestock grazing is likely to be sustained within the plan area over the next 20 years. The amount of livestock grazing may decline to some degree, due to reduced forage capacity (invasive weeds and timber canopy closure) and tighter administrative constraints for protection and enhancement of threatened, endangered, and sensitive species habitat and other resource concerns such as water quality. The section below includes further discussion of the stability or resiliency of the ecosystems connected to rangelands.

7.2.2.3 Ecosystems and Grazing

The term "rangeland" is often applied to suitable and capable lands within a grazing allotment that produce forage for livestock and wildlife. Rangeland comprises a variety of vegetation types, including many timbered plant communities, grasslands, shrublands, and riparian areas. Range condition is an assessment of the current health of the plant communities, often expressed as the degree of similarity or dissimilarity of current plant composition and abundance compared to potential or natural/historic conditions.

Specific information regarding range conditions within the plan area is limited. Intensive collection of vegetation plot data occurred in 2005 for the Island Ecosystem Analysis at the Watershed Scale (USDA Forest Service 2008b) area, located between the Salmon and Snake rivers. Analysis of these data, which may typify range conditions in the Salmon River canyons, determined that approximately 52% of sampled areas retain high native species integrity. However, a significant portion of the assessment area is highly susceptible to invasive weeds, and a high risk of continued weed expansion exists. Vegetation plots showed grassland integrity to be low (approximately 25% of samples). Low-integrity grasslands and the presence of invasive species suggest that the grasslands are in very poor to perhaps fair condition and in an early or very early ecological condition.

Grasslands, shrublands, and transitory range typically produce abundant forage; potential resource impacts from livestock grazing are more frequently encountered in riparian areas. Instream habitat condition data were also collected in 2005 for the Island EAWS area. Sampling included a variety of parameters used to determine if streams met the Forest Plan Standards (as amended by PACFISH). Several reaches of Deer Creek, Johnson Creek, Joe Creek, Christie Creek, and Sherwin Creek were determined to exceed the standards for width/depth ratio, percent cobble embeddedness, percent fines, and bank stability. These streams do not meet the PACFISH Grazing Management standards (USDA Forest Service 2005) and were also determined to be Functioning at Risk with Static Trend by an interdisciplinary team conducting Proper Functioning Condition (PFC) assessments.

An assessment being conducted in the Clearwater drainage of the Nez Perce National Forest (Eastside Assessment) reveals that of 44 benchmark areas in the plan area, 17 are currently meeting the desired conditions, 24 are moving toward meeting the desired conditions, and 3 are not meeting or moving toward the desired conditions.

Newsome and Red River EAWS conducted in the Clearwater drainage of the Nez Perce National Forest conclude the following: "Data on the impacts of grazing in the watershed is limited." Grazing in the watersheds usually occurs near roads and results in localized impacts. Professional knowledge of the area suggests that cattle do not have a large impact on vegetation. The Red River EAWS determined that the level of grazing has recently declined from loss of forage, primarily because of fire suppression and the advancement of succession, which causes a decline in undergrowth and forage. This change has shifted grazing out of early seral habitat and into road corridors, seeps, and native meadows. In addition to the changes in the forage base, operational expenses have increased as the cost of public land grazing has risen. Most of the grazing in the Red River EAWS planning area occurs on private land. Although actual data are limited, rangeland condition on the Clearwater National Forest is thought to be similar to conditions described above for the Clearwater drainage of the Nez Perce National Forest.

In some grazing allotments, perennial grassland vegetation has declined as annual grasses, such as cheatgrass, have expanded. More recently, exotic annual grasses are being replaced by even more aggressive invasive weeds. This decline in vegetation, from native perennial grasses to exotic annual grasses to invasive weeds, has resulted in the significant decline of livestock-usable forage; in some areas, usable forage has dropped from roughly 250 to 100 to 25 pounds per acre. Some weed-infested areas no longer produce adequate usable forage to be considered "capable" for livestock grazing. Table 7-3 provides an example from the Christie/Sherwin Allotment analysis, illustrating the decline in animal unit months (AUMs) that has been caused by site conversion to "weedy" species.

Table 7-3. Christie Creek and Sherwin Creek Allotment unsuitable acreage, and Animal Unit Months (AUMs) lost due to conversion from cheatgrass to "weedy" species

Allotment	Pasture	Weedy Acreage	Animal Unit Months Lost
Christie Creek	Rhett	83	11
	Christie Creek	106	11
	Deer Creek	151	20
Subtotal		**340**	**42**
Sherwin Creek	Lower Center Ridge	238	32
Total		**578**	**74**

Timber canopy closure and conifer encroachment into meadows, shrublands, and grasslands have reduced usable forage throughout the plan area. Timber canopy closure and conifer encroachment have reduced forage availability by at least 21% over the past 60 years on the Christie Creek Allotment on the Nez Perce National Forest. Analysis of grazing allotments within the Clearwater River portion of the Nez Perce National Forest indicates grass/forb understory is decreasing in plantations of ponderosa pine and Douglas-fir due to canopy closure. Range managers suggest that this trend in timber canopy closure and the resulting loss of forage have occurred over a majority of the more timbered allotments for both the Nez Perce National Forest and the Clearwater National Forest.

Over the next 20 years, certain environmental influences will probably continue to negatively impact range condition and forage production. Invasive weeds will likely continue to spread and increase in abundance and density. Timber canopy will continue to close, and existing grasslands/shrublands will see additional conifer encroachment and conversion to a timber-dominated community. Transitory range acreage will fluctuate: timber stands will become more open due to harvest, insects, and/or fire; with time and succession, overstory canopies will close in once again.

Emphasis on protecting habitats for threatened, endangered, and sensitive fish, plants, and animals will require intensive livestock management and may necessitate fewer permitted livestock numbers or a shortened season of use to mitigate impacts.

7.2.2.4 Influence of non-National Forest System Lands or Conditions

Cattle and horses that graze the National Forests during the summer months are provided forage from private lands during late fall, winter, and early spring. Forage from private lands during this period is in the form of native grass pasture, irrigated pasture, hay, and fall crop residue. The availability of private lands in the surrounding area that can provide summer forage is somewhat limited (Richard Spenser, District Conservationist, NRCS, and Jim Church, Range Scientist, University of Idaho Extension, pers. comm.). Productive lands associated with the Camas and Palouse prairies are generally used for crops, including spring/winter wheat and canola. Grasslands associated with the canyon breaks of the Salmon River, Snake River, and Clearwater River are generally obligated to cattle grazing. These grasslands generally produce forage at less than their full potential, due to the abundance of exotic annual grasses and other invasive weed species. When the opportunity for grazing on private land does become available, the grazing is considerably more expensive, $14–$16 per AUM, than grazing under Forest Service permits, which costs about $1.00 per AUM (Jim Church, Range Scientist, University of Idaho Extension, pers. comm.).

Idaho Department of Lands (IDL) issues 20-year leases for livestock that graze on lands managed by the IDL. Grazing fees for 2014 are $6.46/AUM and may fluctuate annually. Upon expiration, a grazing lease is available for issuance through a formal bidding process, with the highest bidder obtaining the lease for the next 20-year period (Bannar, Idaho Department of Lands. pers. comm.)

Potlatch Corporation also issues leases for livestock grazing on the lands they manage. Grazing fees associated with a Potlatch Corporation for 2014 are $7.50/AUM. Once issued, a Potlatch Corporation grazing lease does not have a specified expiration date. A person granted a grazing lease from the Potlatch Corporation retains the lease until the lease holder or Potlatch Corporation determines the current lease arrangement is no longer desirable. Opportunities for a person to obtain a new lease with the Potlatch Corporation are limited (Steigers, Potlatch Corporation, pers. comm.).

The Bureau of Land Management, similar to the Forest Service, issues term grazing permits on the federal lands they manage. Grazing fees associated with a BLM grazing permit for 2014 are about $1.00 AUM. To acquire a BLM grazing permit on public lands, the applicant must own or control private property that has been recognized as base property. This typically happens when an existing base property is sold or leased to a new individual. After buying or leasing a base property, the new owner applies to the BLM for the grazing permit attached to the property. Assuming all the qualifications are met and that the permit is in good standing, the BLM will process the application and award the grazing permit to the new owner/controller of the base property.

7.2.2.5 Importance to People in the Analysis Area and the Broader Landscape

Nearly 19% of the land in the 5-county analysis area is agricultural land, ranging from a low of 4.4% in Clearwater County to a high of 80.3% in Lewis County. For the analysis area, the largest numbers of farms (40%) are classified as “other crop farming,” which includes other crops not listed in the table or farms where no single crop or family of crop(s) accounts for one-half or more of the establishment’s agricultural production. However, the second largest farm type is “beef cattle, ranch and farms,” which accounts for 21% of the farms in the area. The grazing program on the Forests is relatively small compared to some other forests in the Northern Region. However, according to the Interior Columbia Basin Ecosystem Management Project (ICBEMP), Economic and Social Conditions of Communities (ICBEMP 1998), Grangeville, Orofino, White Bird, Riggins, Elk City, Kamiah, Kooskia, and other communities supported by the Forests rely on forage produced on NFS lands for approximately 4%–6% of the total forage base of their respective counties. This percentage is similar to that of other places in the West, as expressed below (excerpted from Skags 2008):

> The USFS has estimated that less than 10% of total national forage consumption by domestic livestock is provided by public lands (USDA–USFS, 1989b). Torell, Fowler, Kincaid, and Hawkes (1996) estimated that 15% of the nation's beef cows and 44% of the sheep and lambs were produced on public land ranches, that approximately 5% of the nation's grazing capacity comes from BLM and USFS lands, and that 4% of the forage for the nation's beef cow herd is supplied by these lands. While neither the overall national beef cow herd nor the national beef supply is greatly dependent upon public rangelands, many individual ranching operations in the inter–mountain West are almost 100% dependent upon total annual or seasonal forage provided by publicly–owned rangelands. Torell, Fowler, Kincaid and Hawkes (1996) also concluded that 41% of beef cows in the eleven western states grazed on federal lands for part of the year, and that 19% of the total annual forage demand in the region was met from federal land.

An analysis of the economic contribution of programs on the Forests indicates that the grazing programs contribute approximately 90 jobs and $1.3 million in labor income to the 5-county analysis area; see Chapter 6, section 6.10 (Social and Economic Conditions and Trends).

7.2.2.6 Effects from Forest Management Actions

The extent of available forage as a component of multiple use (range) could be affected by several future management actions initiated by the Forests. The intensity, duration, and timing of livestock grazing could significantly affect resource conditions, including forage plant health and sustainability, riparian condition and function, and soil productivity and stability. The administration of livestock grazing by the Forests to ensure the maintenance of resource conditions will continue. Management standards and constraints governing permitted livestock grazing are expected to become more stringent to comply with sensitive species requirements and water quality standards.

Conifer canopy closure, conifer/shrub encroachment into grasslands, and the spread of invasive weeds all have the ability to significantly reduce available forage for livestock. The degree to which future management actions address each of these ecological processes will in turn influence the potential loss or increase in available forage.

Permitted livestock numbers are expected to decline slightly over the next 10–20 years within the plan area, due to more stringent management constraints and due to loss of forage brought about by conifer canopy closure, invasive weed spread, and encroachment of conifers into grassland communities.

7.2.2.7 Information Needs

No information needs have been identified.

7.2.3 *Timber*

The original mission of the Forest Service focused on protecting water and timber (Kline and Mazzota 2012), and timber harvest continues to be an important use of many National Forests. A viable forest industry also provides capacity to undertake forest restoration activities that require a trained workforce and mills to process resulting wood products (Smith et al. 2011). Timber harvested on National Forest lands provides a variety of wood products, such as sawlogs, veneer logs, house logs, and cedar products, as well as logs used for pulpwood, posts and poles, firewood, furniture logs, and energy wood logs.

7.2.3.1 Geographic Scale

Forests nonreserved timberland is located in 3 Idaho counties: Clearwater County, Idaho County, and Latah County. The Forests timber-processing area (TPA) was defined by the Bureau of Business ad Ecoomic Research as the 9-county area including Adams, Benewah, Clearwater, Idaho, Latah, Lewis, Nez Perce, Payette, and Valley counties in the state of Idaho (Figure 7-3). Within the TPA, 32 facilities were operating as of 2011: 16 sawmills, 5 cedar products manufacturers, 7 log home manufacturers, 1 post and small pole plant, 1 plywood plant, 1 utility pole plant, and 1 furniture manufacturer (McIver et al. 2012).

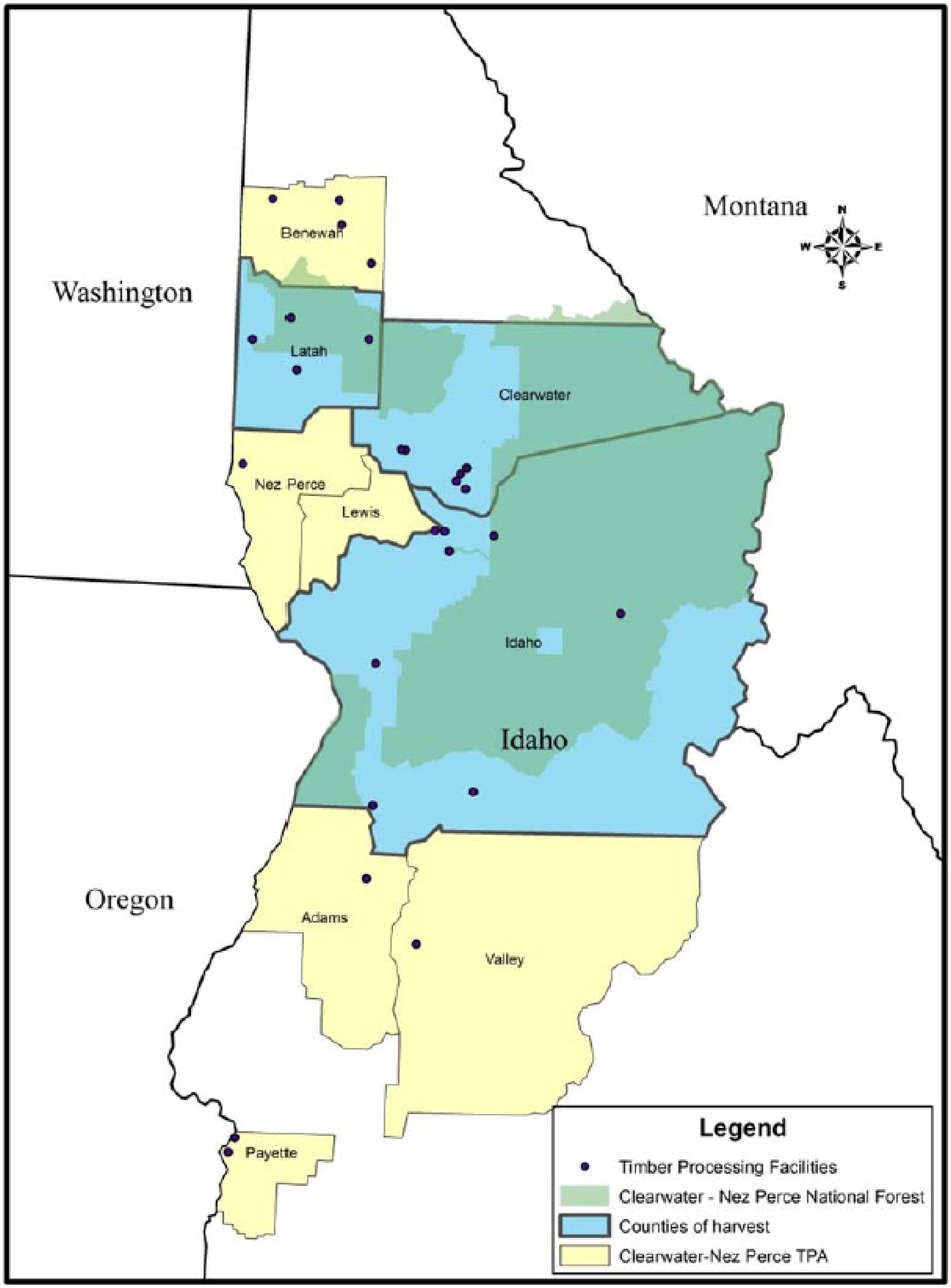

Figure 7-3. Nez Perce–Clearwater National Forests timber-processing area (Source: McIver et al. 2012)

7.2.3.2 Conditions, Trends, and Drivers

Forest Current Conditions

Forest Inventory and Assessment (FIA) plots have been installed on the Forests. Approximately 300 plots occur on each Forest, for a total of more than 600 plots. FIA is a nationwide project that inventories forest conditions and updates that inventory every 10 years. Table 7-4 and Table 7-5 summarize this information for the Forests. As of the 2007 field season, forty percent of the plots have been remeasured and the most recent data compiled to develop these existing conditions.

Table 7-4. Nez Perce–Clearwater National Forests, current size class and species composition

Size Class	Percent of National Forest Area	Species Composition (Plurality)
Nonforest	5	Grasslands, permanent shrublands, rock, water
Nonstocked	4	Seral shrub and forb species
Trees <5 inches dbh	3	Spruce/subalpine fir, Douglas-fir, grand fir, lodgepole pine, western larch
Trees 5–9 inches dbh	10	Lodgepole pine, spruce/subalpine fir, Douglas-fir, grand fir, western redcedar
Trees 9–14 inches dbh	32	Grand fir, spruce/subalpine fir, Douglas-fir, lodgepole pine
Trees 14–21 inches dbh	33	Grand fir, subalpine fir/Engelmann spruce, Douglas-fir, lodgepole pine, ponderosa pine, western redcedar
Trees >21 inches dbh	12	Grand fir, ponderosa pine, western redcedar, subalpine fir/Engelmann spruce, Douglas-fir

Source: Nez Perce and Clearwater National Forests Hybrid Forest Inventory and Assessment data collected from 2000 to 2002 and from 2004 to 2007

Table 7-5. Nez Perce–Clearwater National Forests, existing vegetation composition by species or species mix

Species	Percent
Grand fir	15
Grand fir mix	9
Subalpine fir	8
Subalpine fir mix	6
Western larch and mixes	2
Whitebark pine and mixes	<1
Lodgepole pine	9
Lodgepole pine mix	4
Engelmann spruce	3
Engelmann spruce mix	4
Ponderosa pine	4
Ponderosa pine mix	2
Douglas-fir	8
Douglas-fir mix	9
Western redcedar	3
Western redcedar mix	3
Mountain hemlock	1
Forbs	1
Shrubs	3
Nonforest	5

Source: Nez Perce and Clearwater National Forests Hybrid Forest Inventory and Assessment data collected from 2000 to 2002 and from 2004 to 2007

Insects and diseases have been present as long as these Forests have existed and continue to affect forest composition and structure. Mountain pine beetle have been seriously affecting mature lodgepole pinethat are older than 80 years or over 7 inches in diameter (dbh). Douglas-fir beetle have been a constant, low-level presence in Douglas-fir forests, particularly where the trees are large (>21 inches dbh) or overcrowded and stressed. That stress may be the result of stand density or root rots affecting the trees. Root rots—primarily *Armillaria* and *Schweinitzii*—affect many species but are particularly damaging to grand fir, Douglas-fir, and young ponderosa pine. Other root rots are also found on the forest, though less commonly. White pine blister rust has almost eliminated western white pine from the forest and is currently decimating whitebark pine.

Fire risk has also risen in the past few decades and is often tied to insects and diseases that have left dead wood in the forest, thereby increasing fuel loads.. But fire risk is also a function of fire suppression, which has allowed forests to become denser and have continuous canopy levels. Homes and businesses close to the forest have increased the risk that fires pose to human lives and property.

Timber Management Levels and Trends

In the past several decades, the proportion of timber harvest in the state of Idaho attributable to NFS lands has diminished greatly. In 1979, 46% of the timber harvested in the state of Idaho came from NFS lands. By 2006, timber harvested on National Forest lands amounted to only 7% of the total harvest in Idaho (Brandt et al. 2012).

The total harvest from all lands in the 3 counties containing nonreserved timberland (Clearwater, Idaho, and Latah counties) was 84.3 million cubic feet (MMCF) in 2006 (Brandt et al. 2012). Six percent (4.8 MMCF) of the timber harvest in this 3-county area originated from the Forests. Most (98%) of the timber harvested from these counties consisted of green (live) trees. The species composition of the harvested volume in this 3-county area was true firs (40%), Douglas-fir (25%), western redcedar (19%), and ponderosa pine (5%). Western hemlock comprised 4% of the harvest, while western larch, lodgepole pine, western white pine, Engelmann spruce, and other species combined to comprise the remaining 7%. Sawmills and veneer/plywood plants received about 91% of the timber harvested from these counties. Log home manufacturers, post and small pole plants, and other mills received <2% of the timber harvest volume. Pulp and paper mills utilized 7% of the 2006 harvest from the 3-county region (Brandt et al. 2012). The 2011 harvest was estimated to be approximately 60.7 MMCF. The contribution by the Forests was estimated to be approximately 16% of the total harvest by all ownerships.

Timber management levels in the plan area are described by the sold volume for the past 10 years, as represented in Table 7-6. Figure 6.22 in the Social and Economic Conditions and Trends section displays a longer time series of timber harvest for the Forests, 1989–2011. The 1990s saw a sharp decline in the volume harvested for both National Forests. For the Clearwater National Forest, the harvest volume peaked in 1990 at 147.7 MMBF and was at its lowest point in 2008, at 7.3 MMBF. The Nez Perce National Forest’s peak harvest occurred in 1989 at approximately 100 MMBF, and harvest volume was at its lowest point in 2006, at 4.8 MMBF.

Table 7-6. Level of timber management in the plan area

Fiscal Year	Clearwater National Forest	Nez Perce National Forest	Combined
	Volume Sold (MMBF)	Volume Sold (MMBF)	Volume Sold
2011	35.9	15.6	51.5
2010	23.4	15.2	38.6
2009	22.9	16.8	39.7
2008	27.9	11.0	38.9
2007	19.8	19.5	39.3
2006	10.4	37.7	48.1
2005	11.3	22.3	33.6
2004	30.0	7.4	37.4
2003	29.6	15.9	45.5
2002	5.9	20.5	26.4

The supply and demand for timber is driven by regional, national, or global issues. Local drivers are small in scope and scale and generally have inconsequential effects on the overall market for timber and/or lumber products. Export demand, housing starts, and home improvement trends are examples of larger (national and global) issues that affect the supply and demand for timber. Local environmental issues, as well as involvement by local interest groups, have some impact on the supply of federal timber to the market within the plan area. Appeals have delayed projects, or reduced the extent of proposals. (See sections 6.6.2 and 6.9.4 for more information related to timber trends.)

7.2.3.3 Ecosystems and Timber

The largest factor reducing the stability and resiliency of the Forests over the past 100 years has been the introduction of white pine blister rust. This disease has virtually eliminated western white pine from the Forests and left grand fir, Douglas-fir, western redcedar, and western hemlock as the major components of the Forests. Those species are much more susceptible to root disease and insect infestations, and the result has been lower productivity on the lands that once supported vast stands of valuable white pine. Apart from that change, ecosystem drivers continue to affect the Forests much as they have for centuries. Soils are productive, and forests regrow quickly following disturbance. Climate varies over time but still supports the forests that are found here, which are adapted to the climatic variations that occur. More details can be found in section 1.1 of the Assessment.

7.2.3.4 Influence of non-National Forest System Lands or Conditions

The majority of the timber harvested in the 5-county area comes from private and state lands; thus, the demand for timber from the Forests is affected by the supply of timber from other sources. Section 7.2.3.2 contains a discussion of drivers and trends that affect the ability of the Forest Service to provide timber.

7.2.3.5 Importance to People in the Analysis Area and the Broader Landscape

Forest products, including biomass and forest management, are reported by the Clearwater Economic Development Association as a “cluster” of industries that is or could be important to the area’s economic growth. However, from 1990 to 2006, the number of primary wood products facilities in the state of Idaho fell from 172 to 97, and the number of workers in Idaho’s wood and paper product industries fell from 18,440 to 15,050. Employment data since that time indicate that by 2010, employment had fallen to <10,000 workers, with a slight increase in employment occurring in 2011. For the 5-county analysis area, the largest decline (relative to 1998) occurred in Clearwater County, where employment in 2009 had fallen to less than a quarter of its 1998 level. Timber-related employment in Idaho County and Lewis County fell about 30%–40% since 1998, while employment in Latah County and Nez Perce County changed little.

However, despite these declines, the 5-county study area still derives around 10% of its employment from the timber-related sectors of the economy. Lewis County had the highest percent of employment in timber-related industries in 2009, at 21.5%, and both Clearwater and Nez Perce counties depend upon timber for >10% of their employment. For Clearwater County, timber-related employment was primarily associated with forestry and logging, while timber-related employment in Lewis and Nez Perce counties was derived primarily from the sawmill and pulp and paper sectors. Compared to jobs in many other sectors of the economy, jobs in the forest products industry pay above-average wages ($47,000 per year compared to the average annual wage of $35,582 in the 5-county area). (See section 6.6, for more information on employment trends)

Milling infrastructure within the plan area has remained relatively intact over the past decade. Bidding competition for timber sales and stewardship contracts has remained high. Similarly, the capacity for logging and restoration services exists at a level adequate to accomplish Forest objectives (McIver et al. 2012). Capacity includes mills within and adjacent to the plan area, as shown in Table 7-7 and Table 7-8.

Table 7-7. Mills within the plan area

Mill	Location
Idaho Forest Group	Grangeville, Idaho
Blue North	Kamiah, Idaho
Idaho Forest Group	Lewiston, Idaho
Tri-Pro	Orofino, Idaho
Empire	Weippe, Idaho
Bennett Lumber Products	Princeton, Idaho
Idaho Cedar Sales	Troy, Idaho

Table 7-8. Mills adjacent to the Plan area

Mill	Location
Tamarack	New Meadows, Idaho
Stimpson	St. Maries, Idaho
Stimpson	Plummer, Idaho
Idaho Forest Group	Chilco, Idaho
Guy Bennett Lumber	Clarkston, Washington
Pyramid	Seeley Lake, Montana
Tricon	Superior, Montana
Tricon	St. Regis, Montana

According to the economic contribution analysis conducted for this Assessment (see Chapter 6, section 6.10), the annual timber program on the Forests contributes approximately 324 total jobs and $13.2 million in labor income.

Consumption of manufactured wood products is projected to show only modest growth through 2060, while the consumption of wood for fuel is expected to increase substantially. How this trend affects the area surrounding the Forests depends on factors such as the price difference between wood fuel and fossil fuels; technological changes; and changes in regulations or incentives (Skog et al. 2012).

Firewood gathering for home heating is an important activity in the local areas. The firewood itself provides an inexpensive heat source, and gathering the firewood is often a family recreational activity. Small commercial firewood operations also meet a need for firewood among people who cannot gather their own wood.

7.2.3.6 Effects from Forest Management Actions

Timber management primarily revolves around fuel reduction in the wildland-urban interface (WUI) and in non-WUI areas. Although watershed and wildlife habitat improvement are primary benefits (purposes) at times, they are usually secondary benefits that accrue from accomplishing vegetation restoration objectives.

Where timber management is an option, on the roaded portions of the forest, it can provide opportunities to reestablish early seral species such as ponderosa pine, western white pine, and western larch, which have been declining in abundance. Timber management can also restore forest structure where historically 1- and 2-storied forests now have a continuous canopy from ground to treetops. Where forest densities are higher than historic levels and put trees at risk for damage from insects and disease, timber harvest can reduce densities and decrease risk.

Timber management has the potential to 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 2–5 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, helping the trees gradually achieve resistance and resilience.

7.2.3.7 Information Needs

No information needs have been identified.

7.2.4 *Watershed: Water (Supply and Quality)*

Protecting the nation's water supply has always been an important part of the Forest Service's mission, and managing the forests for watershed purposes is recognized as an essential multiple use. Water supply is also important from an ecosystem services perspective, as stated in Smith et al. (2011):

> Fresh water is one of the most valuable ecosystem services provided by forests. Forested land absorbs rain, recharges underground aquifers, cools and cleanses water, and sustains watershed stability and resilience (USDA Forest Service 2000). Water provided by forests supports vegetation, supplies fresh drinking water, sustains agricultural production, enables power generation, and creates habitat for aquatic species with subsequent economic, recreational, and cultural benefits (Postel and Carpenter 1997).

Forests and other mature ecosystems generally improve water quality in a catchment (Brauman et al. 2000). Two-thirds of the nation's clean water supply comes from precipitation that is filtered through forests and ends up in streams. Root systems stabilize soils and allow water to filter through various layers of soil before entering groundwater. Through this process, toxins, nutrients, sediment, and other substances can be filtered from the water (Hanson et al. 2010).

A substantial amount of information on water resources and water quality can be found in Chapter 2, section 2.3, of this Assessment. Below is a brief summary of that information as it relates to the ecosystem service of water quality and quantity.

7.2.4.1 Geographic Scale

Providing and filtering clean water are accomplished naturally in the plan area at multiple scales, depending on the location of the point of diversion.

7.2.4.2 Conditions, Trends, and Drivers

Disturbances, including forest fires and roads, are the primary source of sediment loading in the Salmon River subbasin (Goode et al. 2011). The current strategy is to ensure that Forest Service management actions continue to provide water quantity and quality that support recreational uses, healthy riparian and aquatic habitats, the stability and effective functioning of stream channels, and the ability to route flood flows. Approximately 1,443 miles of stream segments within the Forests have been listed as impaired or not meeting Idaho Department of Environmental Quality (IDEQ) standards (IDEQ 2011). Of the 7,700 miles of streams on the Forests, nearly one-third of the total mileage has yet to be assessed for water quality.

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.

Numerous stressors have affected, currently affect, and are likely to continue to affect water quality in the plan area. In addition to natural sources of water pollution (e.g., landslides, erosion, wildfire, fish, and wildlife), many historic and ongoing activities can detrimentally affect water quality, including road building, timber harvesting, prescribed fire, pesticide and herbicide use, recreation, grazing, and mining. In 2011, the Forest Service assessed watershed conditions, using the watershed condition framework (WCF) methodology (Potyondy and Geier 2011). The Forests were found to have a total of 80 watersheds with at-risk or impaired function (see Figure 17 in section 1.3).

The length of time that a particular activity affects water quality also varies with land use and site-specific characteristics. For example, sediment yields or concentrations after timber harvesting typically decrease, while changes in nutrient concentrations occur in relatively brief pulses (Stednick 2000).

The Forests to Faucets project (Weidner and Todd 2011) uses a GIS to model and map the land areas across the United States that are most important to surface drinking water sources; the project also uses GIS to identify forested areas important to the protection of drinking water and areas where the quantity and quality of drinking water supplies might be threatened by development, insects and diseases, and wildland fire. The project is centered on 3 core objectives:

1. Assess subwatersheds across the United States to identify those most important to surface drinking water.
2. Identify forested areas that protect drinking water in these subwatersheds.
3. Identify forested areas where future increases in housing density, insects and disease, and wildland fire may affect the quantity and quality of surface drinking water in the future.

Results of the Forests to Faucets project indicates that the Nez Perce–Clearwater National Forests have moderate importance for delivery of drinking water from surface waters originating on the Forests (Figure 19, section 2.3). 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 5-county analysis area are expected to continue to increase. With any increase in population, the demand for both consumptive and nonconsumptive water uses is expected to increase. Changes in water availability, due to the effects of climate change, are also expected. 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 would 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.

7.2.4.3 Ecosystems and Water

The hydrologic cycle is highly coupled, so modifying one part of the system is likely to affect other parts that may be far removed in time and space. Failure to recognize the close coupling of surface water and groundwater systems and resources has created problems in water allocation and environmental protection (Swanson et al. 2000). Natural and anthropogenic processes that severely disturb soils and vegetation (such as roads, fire, and harvesting of forests) can affect drinking water quality. Effects of these disturbances on downstream water quality depend on the severity of disturbance to vegetation and soil, the timing of precipitation in relation to vegetation disturbance, and the propensity of the landscape and ecosystem to produce compounds that degrade water quality (Swanson et al. 2000). Resiliency depends on the extent and severity of the disturbance, and the rate at which systems recover from disturbances. However, recovery rates are very difficult to define (MacDonald 2000). In most cases, the effect of a given management activity will diminish over time. A more rapid (relative to allowing the activity to recover on its own) recovery rate for these activities can be achieved through implementation of integrated restoration projects, best management practices (BMPs), or mitigation efforts. Unfortunately, relatively few data are available on recovery rates for different processes and resources; therefore, multiple recovery rates may need to be defined to accurately assess the impact of various management activities. Recovery rates will also vary with site characteristics and extrinsic factors, such as climate, and this uncertainty directly limits the accuracy of recovery rate predictions (MacDonald 2000). The ecological sustainability of watersheds on the Forests is described in section 1.3.

7.2.4.4 Influence of non–National Forest System (NFS) lands

The 220 watersheds (6th field HUC) managed by the Forests contain approximately 4.8 million acres, of which approximately 85% are managed by the Forests. Within individual 6th field HUC watersheds, the Forests manage 6%–100% of the watershed area. Ownership of non-NFS lands is highly diverse, including state, county, and other federal agencies (e.g., BLM), timber companies, and individuals. Management objectives and practices on non-NFS lands are also highly diverse, ranging from conservation easements and active restoration to industrial land management.

The Forests have very limited authority to influence management practices on non-NFS lands within and adjacent to the plan area. Where appropriate, the Forests use partnerships (e.g., with the Nez Perce Tribe) and the Wyden authority[1] in stewardship contracts to dedicate appropriated

[1] The Wyden 'authority' is derived from the Wyden Amendment (Public Law 109-54, Section 434), which authorizes the Forest Service to enter into cooperative agreements to benefit resources within watersheds on National Forest System lands. Agreements may be with willing Federal, Tribal, State, and local governments, private and nonprofit entities, and landowners to conduct activities on public or private lands for the following purposes: protection, restoration, and enhancement of fish and wildlife habitat and other resources; reduction of risk for natural disaster where public safety is threatened; or a combination of both.

funding to accomplish projects that are consistent with Forest management objectives. Management activities on non-NFS lands within the plan area influence the types and extent of activities that the Forests can conduct on NFS lands. Every land management activity requires an environmental assessment according to NEPA; NEPA also requires that the assessment include activities on non-NFS lands within the cumulative watershed effects (CWE) area. These requirements limit the Forests' ability to conduct management activities to mitigate for expected CWEs, especially in areas where non-NFS lands occupy a substantial proportion of the watershed.

7.2.4.5 Importance to People in the NPCW Analysis Area and the Broader Landscape

Water withdrawals on the Forests are primarily for municipal water and domestic drinking water. Many local, downstream communities have identified beneficial uses derived from water generated from the plan area; and are concerned that their beneficial uses can be adversely affected by upstream management practices. Water from the Clearwater and Salmon rivers feeds the larger Snake and Columbia River systems. On the larger systems, numerous dams provide flood control and hydropower; notable water-based recreation (e.g., fishing, boating, and swimming) is associated with the backwater created by these dams. Multiple water withdrawals exist for private use (private drinking water, small agriculture/gardens, watering of livestock). No large-scale agricultural operations divert water from the Forest. No consumptive commercial uses currently exist.

The Forests recognize 3 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 the surface water originating within the Forests.

In 2003, the City of Elk River, Idaho, began diverting water from Elk Creek 0.25 miles downstream from the Forest boundary, having previously used groundwater wells. The water is treated by a slow sand filter and disinfection and delivered to approximately 100 connections. The Forest Service manages 79% of the watershed above the intake.

The town of Clearwater diverts water (via a concrete dam in Wall Creek in the Nez Perce National Forest) into a holding tank with a special use permit for the intake. The water is treated with a direct-pressure mixed-media filter and chlorine. This water is provided to 96 households. The Forest Service manages 100% of the watershed above the intake.

The town of Elk City diverts water from Big Elk Creek downstream from the Forest boundary. About 100households are provided by the Elk City Water District. The Forest Service manages the majority of the watershed above the intake.

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.

In addition, the water that originates on the Forests provides many other important benefits, including recreational opportunities (see Chapter 9), aesthetics (see section 7.3.5), fishing opportunities (see section 7.2.5), and water for fish and wildlife (see section 1.3), livestock watering, and irrigation. Although no large hydropower facilities exist on the Forests, several small, low-head diversions that have local hydropower uses do occur. Numerous facilities are located downstream on the larger river systems. Additionally, water quality and supply are important for ecological sustainability, which contributes to the many benefits and ecosystem services that people derive from National Forests.

The following opportunities exist to support economic and social sustainability through the management of water resources:

- Potential for greater water diversion to support increased demand for drinking water, domestic water needs, municipal water supplies, and downstream hydropower
- Potential for developing water storage facilities to manage the timing of stream flow to more uniformly match the periods of higher demand
- Potential for managing and manipulating vegetation for water storage and yield

7.2.4.6 Effects from Forest Service Management Actions

Land use practices in forests and grasslands can introduce contaminants to water. However, when these practices are applied over large areas, at low intensity, they can produce water that is cleaner than that produced by more-intensive land use practices. At the local level, forest and grassland management may cause significant problems for drinking water sources. For example, high-intensity activities such as logging, mining, or urban-style development in forests can cause considerable pollution, as can uncontrolled events such as floods, landslides, or accidental chemical spills. At the regional level, contaminants from forests and grasslands, even at low concentrations, are part of the overall, cumulative load of water pollution (Ryan 2008).

A large volume of scientific research discussing the effects of land management activities on hydrologic processes and water resources is available (Conroy 2005). Due to the large land base that the Forest Service manages, having monitoring data for every type of project in every land type is very difficult. Therefore, hydrologists commonly use predictive models to evaluate the effects of land management activities (see section 2.3.2.3).

Past forest achievements meant to improve water quality conditions include riparian plantings to increase streamside shade; erosion control by decommissioning and reconstructing streamside roads; culvert replacement or removal; riparian area fencing; and mining reclamation. In 2011, 4 watersheds were designated as priority restoration watersheds: Upper Little Slate Creek, Upper Elk Creek, Upper Clear Creek, and Fishing Creek. A watershed restoration action plan (WRAP) was developed to designate the essential projects necessary for restoring each of these watersheds to a better condition. This effort is part of the WCF, which provides the method to improve the way the Forest Service approaches watershed restoration. The WCF method allows the Forest to select watersheds that are a priority for restoration, then identifies an integrated suite of restoration activities in each priority watershed, and then schedules the restoration activities such that the whole watershed is improved when the essential projects are completed. The method provides measurable results and completion timeframes so that Congress, the Forest, and the public have a common understanding of what is meant by terms like “whole watershed restoration”.

In addition to these priority restoration watersheds, the Forests have ongoing partnership restoration projects with the Nez Perce Tribe that include most of the Middle Fork Clearwater, South Fork Clearwater, Lochsa, and Selway River basins. The Forests also administer the Collaborative Forest Landscape Restoration Program (CFLRP), which includes most of the Middle Fork Clearwater and Selway River basins. These large-scale restoration efforts provide annual improvements to these watersheds.

7.2.4.7 Information Needs

Drivers

- More-accurate information is needed on the rates of effectiveness of best management practices at reducing pollutant delivery to waters.
- Scaled, site-specific information is needed on the expected effects of climate change on water yield and availability.
- More-accurate information is needed on population trends and likely demands for consumptive water uses.

Stability or Resiliency

- Better understanding is needed of overall cycling and routing of water, dissolved constituents, soil, and sediment in natural and managed watersheds. Studies to gain this understanding need to be framed so that questions such as the following can be addressed:
- How has management of ecosystems and water systems altered natural, historical water flow regimes, biogeochemistry, and sediment routing?
- How have past alterations of these systems altered the systems' ability to meet objectives for water supplies, ecosystem health, and other goods and services, and what effects will prospective future alterations have on these systems?
- How might climate change alter these systems (Swanson et al. 2000)?

Influence of Non–National Forest System Lands

- A more accurate database of management activities on non-NFS lands, with frequent updating, is needed.
- An assessment of effectiveness of BMPs used on private lands is needed (current assessments mostly look at implementation rates and relative effectiveness).

Monitoring

- A backlog of monitoring data needs to be entered into databases, summarized, and analyzed. Several types of monitoring data are available that would be useful for this analysis, including BMP effectiveness monitoring data, stream flow/sediment transport data, climate data, and stream temperature data.

7.2.5 *Fish*

Consumption of and activities associated with wildlife and fish are an important multiple use of the Forests. As an ecosystem service, fish and wildlife provide a variety of benefits to the public:

1. Fish and wildlife are consumed as food, making them an important provisioning service provided by the Forests.

2. Fish and wildlife have numerous recreational and cultural uses. They are hunted for sport, viewed by recreationists, and are an important cultural resource for the Nez Perce Tribe.
3. People also hold a variety of non-use values for wildlife and fish. These may include existence value (people value the fact that wildlife and fish exist, even if they are never seen), bequest value (even people who do not use wildlife or fish recognize that future generations may value and use this resource), or option value (people recognize that certain fish or wildlife species that are not used now may have important uses in the future).

7.2.5.1 Geographic Scale

Streams and lakes on the Forests support many species of fish that are valued by the public for a wide variety of consumptive and nonconsumptive uses. The Forests support several nationally renowned nonconsumptive recreational fisheries, which include the Lochsa and Selway rivers and Kelly Creek (North Fork Clearwater subbasin). Kelly Creek in its entirety and portions of the Lochsa and Selway rivers are managed by the State of Idaho as catch-and-release waters, allowing use of artificial flies and lures only. The outcome of this special management attention on the Forest is blue-ribbon fisheries for westslope cutthroat trout that attract national attention.

Sport fisheries for smallmouth bass and kokanee thrive in Dworshak Reservoir; cutthroat trout and rainbow trout are also present in fishable numbers. Dworshak Reservoir, the Little North Fork Clearwater River, the North Fork Clearwater, and other tributaries are also a stronghold for bull trout. The Clearwater National Forest supports much of the spawning habitat available to kokanee and adfluvial cutthroat trout, as well as fluvial and adfluvial bull trout, in the North Fork Clearwater system. Many mountain lakes on both Forests provide angling opportunities for cutthroat, rainbow, and brook trout; some of those lakes are stocked by the State of Idaho.

The Forests also contain a substantial portion of the spawning and rearing habitat available to anadromous steelhead trout and chinook salmon in the Snake River basin. These species support economically and socially significant sport fisheries on the Forest and compose a large portion of the total returns of adult anadromous salmonids in the Snake and Columbia River basins. The sport fisheries for spring and fall chinook salmon and steelhead trout in the Snake, Clearwater, and Salmon rivers have been identified as an important component of the economic well-being of small, upriver communities such as Riggins, Orofino, and Kooskia.

Conditions, Trends, and Drivers

A complete discussion of conditions and trends for threatened and endangered fish species, including steelhead trout, spring/summer chinook salmon, fall chinook salmon, and bull trout, can be found in Chapter 5 of this Assessment. A complete discussion of conditions and trends of aquatic species of conservation concern, including spring chinook salmon (Clearwater basin), westslope cutthroat trout, interior redband trout, and Pacific lamprey, can be found in Chapter 5.

Trends for other fish that are important to people, such as nonnative brook trout, kokanee, hatchery rainbow trout, and smallmouth bass, are generally considered stable. Because of possible adverse effects to native species, no Forest Plan components seek to expand the range or increase the abundance of nonnative fish. However, the State of Idaho may propose additional management actions, such as brook trout suppression to promote native species; development of additional fishing ponds; stocking hatchery trout where adverse effects to native species would not occur; and managing kokanee and smallmouth bass in Dworshak Reservoir to increase their number and size.

Ecosystems and Fish

The ecosystems that help maintain the fish population are described in detail in Chapter 1 of this Assessment.

Influence of non-National Forest System Lands or Conditions

The Idaho Department of Fish and Game (IDFG) manages fish both on and off the Forests. IDFG sets limits on the number of fish harvested, species harvested, season of harvest, and gear types for game fish. IDFG has established fishing seasons and harvest regulations for native game fish that occur on the Forests, which include spring chinook salmon, fall chinook salmon, steelhead trout, westslope cutthroat trout, mountain whitefish, and bull trout. Some nonnative game fish on the Forests are also important to people; these fish include eastern brook trout, smallmouth bass, kokanee, and hatchery-origin rainbow trout.

Importance to People in the Analysis Area and the Broader Landscape

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. Salmon and steelhead fishing contribute substantially to the local economies of communities such as Riggins, Orofino, and Kooskia. Fishing is also important to numerous commercial outfitting enterprises. Trout, kokanee, and bass fishing in Dworshak Reservoir also contributes to the economies of Orofino, Pierce, Weippe, Elk River, and other communities, as does fishing in the North Fork Clearwater River and its tributaries. Although outfitted fishing is not permitted in mountain lakes, rivers, and streams on the Forests (except for the mainstem Salmon River), fishing is permitted incidental to other outfitted activities such as whitewater rafting and horse pack trips into the wilderness.

An IDFG survey determined that anglers spent $87 million in the IDFG Clearwater Region in 2003, the preponderance ($69 million) of which was spent in 3 counties—Idaho County, Clearwater County, and Nez Perce County—where steelhead and salmon make up the largest portion of the fishery. The 2 expenditure categories with the largest expenditures were round-trip transportation and food and beverages. In Idaho County, average spending was approximately $346 per trip, with trips lasting on average 2.3 days. In Clearwater County, average spending in 2011 was approximately $281 per trip, with an average trip length of 2.1 days. In addition, fishing licenses and permits purchased in those 2 counties totaled around $639,000. These dollar amounts do not include the value of anadromous fish to downstream economies in Washington and Oregon. The health of downstream fisheries relies in large part on habitat and water quality supplied by the Forests.

With the variety of fishing opportunities available, fishing remains stable throughout the area. Fishing effort may have increased since the late 1990s, due to stronger returns of hatchery spring chinook salmon and, most recently, establishment of a sport fishing season for fall chinook salmon in response to increasing numbers of that species. Nez Perce Tribe members are permitted to sell a portion of their allocated catch, and some members of the tribe have come to rely on this source of income during the spring and early summer.

Fish on the Forests also provide uses that do not involve angling and harvest. People enjoy viewing and photographing spawning chinook salmon in the late summer, when they are readily visible; an interpretive site was constructed in Red River in the early 1990s to accommodate this activity. Others travel to Selway Falls specifically to view, photograph, and videotape adult salmon and steelhead jumping the falls in the spring and early summer. For other people, the knowledge that wild salmon and steelhead continue to return to streams in Idaho to spawn is an intrinsic value that is important, even if the fish are never seen or the area is never visited. For others still, all native fish have intrinsic value, regardless of whether they are seen, fished for, caught, considered a game fish, or otherwise assigned a human value; people value these fish simply because they are part of the natural ecosystem.

Anadromous fish are an integral part of the culture, history, and tradition of the Nez Perce Tribe and many other tribes. The value of these fish to indigenous peoples and their culture cannot be overemphasized. Currently, anadromous fish in or originating in the waters of the Forests are used for subsistence and religious purposes by the Nez Perce Tribe and other tribes throughout the Columbia River basin.

Effects from Forest Management Actions

Please see the Aquatic Ecosystems and Watershed sections of this Assessment for more information.

Information Needs

No information needs have been identified.

7.2.6 *Wildlife*

7.2.6.1 Bighorn Sheep

Importance in the Planning Area

Rocky Mountain bighorn sheep provide a popular viewing opportunity along some river corridors in the Planning area. Bighorns also provide a very limited, but highly sought after hunting opportunity in Idaho, with only a handful of permits allotted each year. Special auction tags and lottery-style sales of a single bighorn sheep hunting permit annually provide tens of thousands of dollars to Idaho Department of Fish and Game (IDFG) research and management for bighorn sheep every year. The auction tag sold for as high as $120,000 in 2009 and has averaged $82,450 per year over the last 10 years. The lottery tag raised $57,982 in 2009 and has averaged $62,031 per year over the last 10 years.

Using information extrapolated from a Wyoming willingness to pay study, O’Laughlin and Cook (2010) estimated one typical bighorn sheep unit with 5 tags to be worth $482,100 total economic value in 2008 dollars. Indirect income generated from sheep hunting activities includes monies spent by hunters on travel, food, lodging, outfitters and guides, and possibly taxidermists. Estimates for guided bighorn sheep hunts in Idaho range from $6,100 to $8,600 (USDA Forest Service 2010). Although the economic value of bighorn sheep has not been studied or quantified specifically for Idaho, we expect that benefits similar to those identified by O’Laughlin and Cook (2010) occur for direct and indirect revenues and other economic indicators.

Many people who have no interest in hunting bighorn sheep are very interested in learning more about them by observing them in the wild. The outdoor recreation industry capitalizes on this interest. For example, river rafting and jet boat touring companies frequently use the opportunity to view bighorn sheep to promote their trips. With such widespread fascination with this animal, Bighorn sheep are among Idaho's most treasured wildlife species.

Status and Trends

In Idaho, bighorn sheep exist in both small isolated populations and in interconnected metapopulations. For management purposes, the IDFG has divided these populations and metapopulations into 22 Population Management Units (PMUs). In south central and southwestern Idaho, about 1,000 California bighorn sheep occur in 6 PMUs. Bighorn sheep were completely extirpated from this part of the state; and current populations are the result of 11 translocations from outside Idaho and 18 in-state translocations between 1963 and 2004. Rocky Mountain bighorn sheep occur in 16 PMUs in central and southeastern Idaho. Eighteen translocations from out of state and 17 in-state translocations conducted between 1969 and 2005 successfully restored bighorn sheep to historically occupied habitat.

The largest native populations of Rocky Mountain bighorn sheep are in the Salmon River drainage, largely within the Plan Area.

Bighorn sheep habitat on the Forest is generally associated with the Idaho Batholith Breaklands in the Salmon and Selway River Basins. Bighorn sheep typically inhabit rugged, rocky grasslands and open forests from low elevation river canyons to alpine areas. Although elevational migrations are generally common with bighorn sheep, most bighorns in the Planning Area remain in the river canyons year round, with the possible exception of bighorns in the Selway drainage. Although bighorn sheep are gregarious, males and females inhabit different areas throughout most of the year. Females and juveniles prefer steeper "escape terrain" while adult males often select gentler topography with more forage (Bleich et al. 1997).

Since 1995, all bighorn sheep populations have undergone surveys, most at approximately 3-year intervals. Some survey intervals vary—performed annually in select locations like Hells Canyon and in 6-year intervals in other locations. Four bighorn sheep PMUs contain a total of approximately 400 bighorn sheep on lands managed by the Forest; these include the Lower Salmon, Lower Panther-Main Salmon, Selway, and Hells Canyon PMUs.

Three hundred and seventy bighorn sheep occur along the Salmon River in areas managed by the Forest (IDFG 2010a, 2013); these populations are connected to the Middle Fork Salmon PMU to the south, one of Idaho's largest bighorn sheep populations. A small population of at least 30 sheep is located on the Forest in the Upper Selway River; this population is contiguous with the West Fork Bitterroot, Montana bighorn sheep population where 120 sheep were observed in the most recent survey (2006; MDFWP 2010). Approximately 150 bighorn sheep occur west of the Forest in Hells Canyon PMU (IDFG 2010a); these are connected to bighorn sheep populations across the Snake River in Oregon and Washington.

All 4 bighorn populations in the Plan Area are currently stable to declining (IDFG 2010a, 2013). Although fewer than 500 bighorn sheep currently occupy the Forest and adjacent areas in Idaho, a conservative analysis suggests that the habitat could support 2,000–3,000 animals (IDFG 2010a).

Issues

The primary limiting factor for Rocky Mountain bighorn sheep in the Plan Area is disease, although other factors, including predation and habitat degradation, can also be important.

Bighorn sheep are susceptible to diseases carried by healthy domestic sheep and goats and other nonnative caprids (e.g., mouflon). Domestic sheep, goats, and other exotic relatives of bighorn sheep (*caprinae*) carry diseases that are lethal to bighorns and can have lasting effects on population performance (WAFWA 2007, CAST 2008, Schommer and Woolever 2008). Bighorn sheep in the Salmon River and Hells Canyon PMUs experienced high rates of mortality in all-age pneumonia outbreaks in the 1980s and 1990s, likely originating from contact with domestic sheep. Those populations have not recovered. Bighorn populations are currently limited by low lamb survival primarily due to pneumonia-caused mortality (IDFG 2010a). Disease transmission to bighorn sheep can be controlled by maintaining separation between bighorn sheep and domestic sheep, goats, and other exotic caprids. (Refer to USFS modeling “step down tool” for analysis.)

Although disease is currently thought to be the primary reason for low bighorn sheep numbers, other factors may contribute, including vegetation changes caused by increases in noxious weeds. Frequent fires have had beneficial effects by reducing conifer encroachment and rejuvenating grasses and forbs; however, fire and other disturbances may also have the negative impact of facilitating the invasion of noxious weeds. Noxious weeds could reduce habitat suitability for sheep, although further information is needed on utilization of noxious weeds by bighorn sheep.

Predation is also a factor in limiting bighorn sheep numbers. Bighorn sheep coevolved with native predators, including gray wolves, coyotes, and mountain lions; however, predation, particularly by mountain lions, can cause declines in small populations (Sawyer and Lindzey 2002, IDFG 2010a).

7.2.6.2 Black Bear

Importance in the Planning Area

Black bears are found throughout the Planning Area, although suitable and occupied habitat is patchy in some areas. Black bears are important as both a target species for hunters and as a predator that may influence populations of large ungulates, like elk and deer that are also popular hunted species.

Some public demand exists to view black bears in their natural environment. As a result, the Idaho Department of Fish and Game (IDFG) has decided to provide black bear viewing opportunities in portions of some Game Management Units (GMUs) where the following occurs (IDFG 1998):

- Area closures on black bear hunting currently exist
- Road access is in close relative proximity to open habitats so that black bears can easily be seen
- Conflicts with other resource users in the area are minimal

Biology

In 1972, the IDFG initiated a black bear research project to collect biological data for a comprehensive management program. Six black bear populations were studied. These studies were designed to determine the status of each population, although data were also collected on food habits, physical conditions, denning requirements, activity patterns, and habitat use patterns. Research information collected from black bear populations in lightly hunted and heavily hunted areas was used by IDFG biologists to develop harvest criteria and to interpret harvest data collected through the mandatory check program.

Detailed information about black bear biology in Idaho can be found in a book authored by John Beecham and Jeff Rohlman titled, *A Shadow in the Forest—Idaho's Black Bear*. The University of Idaho Press published this book in 1994.

Black bear distribution in Idaho corresponds closely to the distribution of coniferous forests. North of the Snake River plain they are found throughout the forested mountains and foothills. Few black bears occur south of the Snake River, except in southeastern Idaho. About 75% of black bear habitat in Idaho is administered by the U.S. Forest Service; 20% is controlled by private interests; and the rest is administered by other agencies, such as the Bureau of Land Management, Idaho Department of Lands, and IDFG. Idaho has approximately 30,000 square miles of black bear habitat.

Although it is difficult to estimate the size of black bear populations, IDFG research has shown that black bear densities vary among areas in Idaho. The black bear social system limits density to 1.5 to 2 black bears per square mile in the best habitats. However, even in good quality habitats, many factors can influence the size of the black bear population in any given year. For instance, several years of poor berry crops can result in reduced cub production and increased mortality of subadult black bears. Heavy hunting pressure can also reduce the population below the carrying capacity of the habitat.

Extensive studies of black bear food habits throughout their range clearly show that vertebrates, primarily deer and elk, make up less than 2% of a bear's yearly diet. Although black bears rarely prey on adult deer or elk, they do prey on deer and elk fawns and calves in localities where favorable conditions exist for taking that prey. The fact that black bears prey on deer fawns and elk calves has never been in dispute; however, the effect of that predation on populations of deer and elk remains a major topic for debate.

Predator-prey interactions are extremely complex and involve many factors such as weather conditions, status of the prey population, availability of alternate prey, presence and density of other predators, and habitat conditions. As a result, it is difficult to determine what the effect of predation may be in any specific situation. In situations where the prey population is at or near the carrying capacity of its habitat, predation on deer or elk neonates probably has very little effect on prey population size or growth rate; and efforts to regulate predator numbers will not result in a larger prey base. However, when adverse weather, habitat degradation; or other conditions result in a prey population decline, predation may increase the rate of decline and result in a lower population level than would occur in the absence of predation. If issues of scale, logistics, and economics allow, reducing predator numbers in this situation may decrease the rate of decline and provide some benefit to the prey population.

Black bears in Idaho are long-lived; they mature late (4–7 years old), and they have low reproductive rates. Short-term changes in the size of black bear populations are related to changes in birth rates associated with the availability of nutritious foods, especially late summer and fall berry production. Long-term trends are directly related to changes in habitat quantity and quality.

Forest management practices, wildfires, and plant succession influence black bear habitat quality. The black bear's diet is primarily grasses and forbs during the spring and early summer. By mid-July, they begin adding fruits such as huckleberries, wild cherries, buffalo berries, hawthorn, and mountain ash to their diet. Approximately 10% of the black bear's annual diet is animal matter; insects comprise about 9% and vertebrates make up the remaining 1%. In many situations, partial removal of the forest overstory helps the black bear because it opens up the forest canopy and allows for increased plant production on the forest floor. However, openings and increased human access into black bear habitats makes black bears more vulnerable to hunters, offsetting the benefits of logging activity.

IDFG-sponsored research on black bear habitat patterns suggests that the following actions will maintain or enhance black bear habitat in areas where logging has been proposed (IDFG 1998):

- Minimize soil disturbance in areas where berry-producing shrubs are abundant by using rubber-tired vehicles or logging over snow cover.
- Use selection cuts to maintain black bear security cover. Retain 40–70% canopy coverage when huckleberry (*Vaccinium* sp.) is abundant in the understory.
- Maintain relatively dense pole-sized timber stands in the overall vegetative mosaic on north and east aspects for use as bedding areas.
- Retain some mature trees in logged areas to enhance their use by female black bears with cubs.
- Maintain aspen stands in the overall vegetative mosaic.
- Broadcast-burn slash or leave it untreated and minimize soil scarification to prevent damage to rhizomatous food plants.
- Create leave patches or leave strips within cutting units for security cover. Clear-cuts should be small and have irregular borders to provide security cover.
- Maintain a mix of different-aged cutting units to influence black bear density and distribution in an area.
- Logging roads should be located out of creek/river bottoms where significant black bear foods occur.
- Area closures to motorized vehicles should be implemented to reduce black bear
- mortality rates and increase habitat effectiveness.

Habitat loss and fragmentation due to human encroachment also has a subtle, yet permanent, impact on the long-term viability of black bear populations. Ultimately, the accelerating pace of habitat fragmentation and loss may dictate how long we can maintain black bear populations in some areas of the state.

Idaho Department of Fish and Game Black Bear Population Management

In those portions of the state where black bears thrive and populations are stable or expanding, and where black bear predation may be adversely affecting big game populations, IDFG employs harvest as a tool to maintain black bear population numbers to manage predation to help meet big game management goals. This is the case in the Plan Area: IDFG has been using long hunting seasons and liberal harvest to try to reduce black bear predation on elk, particularly in the Selway and Lolo Game Management Zones.

The vulnerability of black bear to harvest varies greatly because of differences in habitat and access. Bears are less vulnerable where cover is dense and expansive. They are particularly vulnerable in high road areas and habitats that provide only patches of security cover. This often results in populations with fewer adult black bears, especially males.

The sex and age of a black bear also affects its vulnerability to harvest. Adult males are typically most vulnerable because they are bold (often use open areas) and have larger home ranges. Consequently, the adult male segment of a population is the first to be reduced under hunter pressure. Subadult males are slightly less vulnerable. Females are least vulnerable, especially if accompanied by cubs. A low percentage of adult males (≥5 years old) in the harvest may be an indication of over-harvest.

Hunting pressure affects harvest rate, which, in turn, impacts age structure, sex ratios, and densities of black bear populations. As harvest rates increase, the proportion of subadult black bears (those less than 4 years old) in the harvest typically increases, whereas the proportion of adult males declines. At higher harvest levels, the proportion of females in the harvest increases; and harvest may result in a population decline if a large area is affected or if no reservoir areas exist nearby to produce dispersing subadult black bears. In reservoir areas, black bear populations are limited by the capacity of the habitat to support black bears and their social structure. Some species compensate for excessive adult mortality by producing more young. However, black bears do not respond in this manner. In fact, high adult mortality results in a younger age population and lower productivity (average number of young per litter). Young male black bears disperse from their mother's home range when they are 1.5 to 2.5 years old and often travel long distances to occupy vacant habitat. However, young female black bears rarely disperse far. As a result, black bear populations far from reservoir areas are slow to recover from over-harvest.

The ages of black bears captured during IDFG-sponsored research projects indicated that lightly hunted populations had a high ratio of adults to subadults (70:30), a high percentage of adult males (35%), and a median age of 7.5 years. Data collected from heavily hunted populations showed adult:subadult ratios favoring subadults (40:60), fewer adult males (21%), and a median age of 2.5–3.5 years. Studies of black bear populations in Alaska, Virginia, and Arizona showed similar relationships between lightly and heavily hunted populations. IDFG research demonstrated that age and sex data derived from trapping was closely correlated with that from the harvest. It follows, therefore, that harvest criteria have potential for monitoring population status.

History, Status, and Trends

The IDFG has relied on two primary methods to collect black bear harvest data: 1) a mandatory hunter check-in report program implemented in 1983 and 2) until 1996, an annual telephone harvest survey. The mandatory check-in report program requires the hunter to bring the skull and hide of their harvested black bear to an official checkpoint within 10 days of the kill date and to fill out a harvest report form. In most cases, a premolar tooth is extracted from the skull to determine the age. Pertinent data including kill date, location of kill, and method of take are recorded on the harvest form. Compliance with the mandatory report program is unknown.

A telephone survey of hunting license holders, discontinued in 1996 due to funding cutbacks, provided a second estimate of the black bear harvest. This survey contacted approximately three percent of the black bear tag holders and provided information from both successful and unsuccessful hunters. A statewide harvest estimate, recreation days, and hunter success rates were estimated.

Black Bear Population Status and Trends Based on Idaho Department of Fish and Game Bear Management Zones in the Plan Area

No easy or inexpensive methods exist for assessing the status of black bear populations. Therefore, IDFG biologists rely on harvest data to evaluate the status of black bear populations and the effectiveness of management actions. IDFG tracks and reports black bear harvest and populations trends by Data Analysis Unit (DAU); DAUs are comprised of one or more GMUs.

Black Bear DAU 1E

Black Bear DAU 1E includes IDFG GMUs 8, 11, 11A, and 13. Small portions of GMU 8 and 13 are located within the Plan Area; Units 11 and 11A are not in Plan Area.

DAU 1E is predominantly private land. The climate in this DAU ranges from hot and arid along the river breaks, to cooler and moister at the higher elevations. Agricultural crops and sheep and cattle allotments are plentiful and characterize this DAU. Timbered habitat is clumped and interspersed with expansive grasslands along the Salmon, Snake, and lower Clearwater River breaks. Old homesteads and dispersed fruit trees provide black bears with plentiful fall foods in some areas. Some of the largest black bears in the region are typically harvested in these GMUs.

Hunters in DAU 1E harvested a total of 80 black bears during 2011, compared to 83 black bears harvested during 2010, and a 3-year average of 80 bears harvested. Females accounted for 34% of the 2011 harvest.

Because most of the black bear habitat in DAU 1E is privately owned and in steep canyons, harvest is not evenly distributed. Hound hunting is difficult and may conflict with private landowners due to fragmented ownership. In addition, there is a lack of evenly dispersed, quality black bear habitat leading to the potential for over-harvest in portions of these isolated and/or fragmented habitats.

The current black bear management plan specifies that DAU 1E is to be managed for harvest at the “heavy” level (IDFG 1998); harvest criteria did not meet objectives for the 2009–2011 seasons.

Much of the land in GMUs 8, 11, 11A, and 13 is either agricultural or river breaks, resulting in patchy, isolated black bear habitat. Consequently, most black bear harvest occurs along major road, river, and creek corridors at higher elevations. Many of the young black bears harvested are probably dispersing to new territories, with adult black bears using better quality habitats away from roads. It is likely that, without much new road access, harvest will continue to reflect young dispersing black bears. The 3-year (2009–2011) harvest was 39% female and might indicate that females were usually selecting more isolated areas, thus reducing the likelihood of mortality. The majority of black bears in any cohort being harvested in this DAU historically are 1-, 2-, and 3-year-old dispersing males.

Status and Trends—The black bear population in DAU 1E appears to be stable.

Issues—There are no current concerns about black bear populations in DAU 1E.

Black Bear DAU 1F

DAU 1F is comprised of GMUs 14, 15, 16, and 18. This DAU is about 80% USFS land within the Plan Area and 20% private and state lands. Much of the area has high road densities, has been logged, and is easily accessible. Few areas within these GMUs provide core security for black bears.

Hunters in DAU 1F harvested a total of 140 black bears during 2011, compared to 180 in 2010, and a previous 3-year average of 160. A little more than half of the black bears (51%) harvested were taken during the fall. The 2009–2011 harvest criteria indicated that the percent females in the population (34%) did not meet IDFG bear management target criteria of >40%. The percentage of males ≥5 years old (32%) exceeded the IDFG target of <25%.

Status and Trends—Prior to 1993, black bear harvest had increased in DAU 1F, probably as a result of increased road densities into previously roadless areas. In response, the previous IDFG Black Bear Management Plan (1992–2000) (Beecham and Zager 1992) adopted changes in hunting seasons and hunting techniques permitted to reduce black bear harvest and improve black bear population demographics, as well as to maintain hunting opportunity with a variety of hunting techniques. Black bear populations appear to have responded to those restrictions and are stable or increasing. The 2000–2010 black bear plan calls for maintaining heavy harvest levels, though current actual harvest is at the moderate level.

Issues and Concerns—Most of DAU 1F is on National Forest lands with high road densities. Although black bear harvest criteria indicate moderate to high harvest levels in recent years, the high-quality black bear habitat in this DAU should allow black bear populations to be maintained at desired levels in reserve and roadless areas.

Black Bear DAU 2A

DAU 2A is comprised of IDFG GMUs 10 and 12. This DAU probably contains the most productive black bear habitat in the Planning Area. High moisture, abundant berry producing shrubs, dense forests, and roadless areas allow for relatively high-density black bear populations. However, liberal hunting seasons since the late 1970s have possibly kept black bear populations below achievable levels.

The 1999–2010 Black Bear Management Plan recognizes DAU 2A as having productive habitat able to maintain high levels of harvest (IDFG 1998). DAU 2A may serve as a reservoir of black bears for surrounding GMUs receiving higher harvest pressures (e.g., GMU 10A). Harvest occurs mainly on major road and river corridors in DAU 2A. The bag limit was increased to 2 black bears per year, both to take advantage of high black bear numbers to enhance hunter opportunity as well as to reduce the bear predation within elk productivity research study area boundaries.

In 2011, a total of 286 black bears were harvested in DAU 2A, compared to 307 in 2010, and a previous 3-year average of 281. Seventy-eight percent of these black bears were harvested during the spring. Thirty-one percent of all black bears harvested were females. Age criteria set under the current management plan allow for increased harvest since IDFG black bear plan goals identify this DAU to be harvested at the “heavy” range to reduce predation on large ungulates. Harvest values were below management criteria, falling within the “moderate” range for the 2009–2011 harvest period.

A record 12 depredation complaints were recorded during fall 1998, an indication of a poor huckleberry crop in DAU 2A. No depredation complaints were recorded in DAU 2A in 2011.

Status and Trends—The DAU is characterized by roadless habitats, public land, healthy black bear populations, and liberal hunting seasons. Harvest is moderate in the male component with 29% more than 5 years old for 2009–2011 average, exceeding the desired objective <25%. The adult female segment remains secure in the roadless segments of the DAU, with percent females harvested (31%) below the desired objective of >40%.

DAU 2A has potential for high black bear numbers because of the quality habitat. Harvest was reduced dramatically from 1993–1996 under the previous Black Bear Management Plan, but has been increased dramatically since 1998 due to liberalized hunting seasons. The black bear harvest more than doubled in 1998, and has remained at a high level since. Because black bear populations appear to be healthy, and elk populations are declining in these Units, increased harvest of black bears is desirable to address concerns about elk calf recruitment.

Issues and Concerns—None

DAU 3A

DAU 3A is comprised of IDFG GMUs 16A, 17, 19, and 20. The northern portions of this DAU receive substantial rainfall and provide some of the best black bear habitat in the DAU. Most of DAU 3A lies within wilderness and has relatively abundant black bear habitat. The habitat within wilderness is varied, with a range from poor- to high-quality habitat available throughout the year and over a variety of aspects and elevations. Because of low hunting pressure and restricted access, IDFG believes black bear populations are probably quite healthy.

This DAU probably serves as a reservoir of black bears for surrounding GMUs that are more heavily harvested. IDFG manages DAU 3A to maintain or increase historic harvest levels and distribution, although adjustments will be implemented to conform to statewide management direction. The bag limit for this DAU was doubled in 1999, both to take advantage of high black bear numbers and to increase hunter opportunity and to reduce predation affecting low elk calf recruitment.

In 2011, 121 black bears were harvested in DAU 3A compared to 130 in 2010 and the previous 3-year average of 131. It should be noted that the 192 bears harvested in 2003 and the 193 in 2004 are more than double the number killed in this DAU in any year prior to 2003; the increase in harvest is the result of an outfitter area overlap program that resulted in a substantial increase in hunter participation in this predominantly wilderness DAU. Of the 121 bears harvested in 2011, 29% were females. Forty-seven percent of the males harvested during the 2009–2011 reporting period were ≥5 years old compared to the desired objective of 25%–35% being ≥5 years old.

The black bear population data for DAU 3A suggest that a small proportion of the overall population is harvested. Age structures and harvest criteria indicate this population was the most lightly harvested DAU in the region.

Status and Trends—The black bear population in this DAU is healthy and stable. Additional management (harvest) may be desirable to manage bear predation on elk calves.

Issues and Concerns—None

7.2.6.3 Elk

Elk are one of Idaho’s most iconic wildlife species. The elk hunting tradition is part of the social and cultural fabric in Idaho going back generations. It is one of the most highly sought after big game animals in the state, generating more than $70 million annually in direct hunter expenditures like fuel, meals, and lodging (Cooper et al. 2002) and in excess of $6.15 million in license revenue annually statewide (IDFG 2007). National Forest System lands in the Plan area comprise substantial portions of Clearwater and Idaho counties; the combined economic impact of elk hunting in these two counties alone was in excess of $27.6 million in 2007.

Elk horn hunting, scouting, and viewing are also popular and traditional activities in Idaho.

History and Background

Elk occur in varying densities across every habitat type in the Planning area. Historically, elk herds were more scattered and population numbers in the Planning area were probably lower than they are today. Accounts from the Lewis and Clark expedition and trappers during the height of the fur trade generally suggested populations of elk were scattered and only locally abundant in the northern portions of the state. Populations also were further reduced during the unregulated hunting of the late 1800s and early 1900s as miners, trappers, loggers, and other settlers heavily utilized ungulates for food.

In northern Idaho, landscape changes occurred during the early 1900s, when extensive wildfires created a mosaic of shrub fields and forested habitats, leaving extensive brush-fields abundant with forage for elk. Logging also contributed to diversifying what was historically a predominately forested landscape, creating large areas of early seral habitat rich with browse. Elk flourished with the higher quantity and quality of habitat available. In north central Idaho, elk populations peaked in the 1950s. Elk herds declined, however, through the latter part of that decade and the 1960s and 1970s, partially due to maturation of brush-fields and declines in forage availability, logging and road-building activity that increased vulnerability of elk to hunters, and loss of some major winter ranges. As the newly created early- to mid-seral habitats aged and succession continued to move toward a climax condition, habitat potential declined and elk populations declined in response. To counter that drop, the Idaho Department of Fish and Game (IDFG) replaced an either-sex hunting regime with an antlered-only general hunting season in 1976. Elk herds then began rebuilding in response to revised harvest management and continued to rebuild until the late 1980s or early 1990s, when herds again began to decline in response to increasing loss of early seral habitat.

Issues

No single factor impacts elk more than habitat. As with all wildlife species, elk need adequate amounts of food, water, cover, and space throughout their lives to survive. These fundamental requirements change throughout the year as elk move across the landscape to use winter, summer, and transitional ranges. Positive or negative impacts to these seasonal habitats impact the distribution and abundance of elk. In general, decreased habitat diversity and structure results in fewer areas that can inclusively meet the needs required during the annual cycle of healthy elk herds.

Natural resource issues that alter elk habitat, such as wildfire and drought, are common throughout the western United States and impact a suite of wildlife species across the landscape. Human-caused impacts to elk habitats can also influence the ability of a habitat to sustain elk populations throughout the year. IDFG’s Elk Management Plan (cite) has identified six primary habitat issues affecting elk: invasive plants, wildland fires, timber and rangeland management, ecological succession, human development, and energy development.

Invasive Plants and Noxious Weeds

Invasive plants and noxious weeds are plants that are not native to Idaho and cause harm to people or the environment. These plants have an advantage because the insects, diseases, and animals that would normally control them are not found locally. Because these plants have no natural controls in Idaho, they are able to spread at alarming rates. Invasive and noxious weeds are moving into valued ecosystems and reducing and replacing native plants. The Bureau of Land Management estimates 4,600 acres of native habitats on federal land in the West are lost each day to weed infestation (BLM 2011).

Infestations of invasive plants and noxious weeds have major impacts on ecological conditions that support the existence of wildlife. For example, invasive plants and noxious weeds reduce and even replace native or desirable non-native plants and ultimately reduce wildlife forage, alter thermal and escape cover, change water flow and availability to wildlife, and may reduce territorial space necessary for wildlife survival. This disruptive process ultimately affects the quantity and quality of available habitat and will reduce elk populations. (See section 3.0 for the status of invasive weeds on the Forests.)

IDFG has identified a number of management priorities to combat the effects of invasive plants on critical elk ranges (IDFG 2013):

- Prevent establishment of potential invaders
- Characterize and eradicate new invaders
- Reduce the spread of weeds by treating transportation corridors and areas of concentrated human activities, such as roads, trails, campgrounds, trailheads, parking lots, gravel pits, and satellite infestations of established invaders
- Contain locally established invaders
- Reduce the density or slow the spread of widespread established invaders
- Require the use of weed-free hay on public lands
- Inventory and map current noxious weed infestations
- Monitor sites for effectiveness of control actions
- Restore areas to prevent the re-establishment of noxious weeds and improve habitat quality of areas currently infested with weeds

Fire

Wildfire is a major ecological force that helps maintain historical plant communities. Today, few factors play as critical a role in elk habitat condition and health as wildfire. Historically, wildfires helped maintain a mosaic of plant communities across the landscape. The mosaic of successional stages of vegetation post-fire provided excellent forage and cover for elk. However, current wildfire frequencies are significantly different than historical regimes throughout many of the plant communities occupied by elk (Miller and Rose 1999). In general, current wildfire return intervals are too frequent in low elevation shrub-steppe communities and too infrequent in mid- to upper-elevation shrub and aspen/conifer communities to create or maintain optimal elk habitat.

For several years following a fire, growth of many preferred elk forage species is enhanced by an increase in nutrients (Asherin 1973, Leege 1968, DeByle et al. 1989). Prescribed burning of shrubs in grand fir and Douglas-fir forests increased forage by reducing the height of tall shrubs and promoting growth of preferred forage species (Lyon 1971, Leege 1979). See section 3.0, Wildland Fire.

Timber and Grazing Management

Timber harvest can have both positive and negative impacts on elk. Timber harvest and the roads associated with logging cause surface disturbance to soils and ground litter, altering the amount of coarse woody debris on the forest floor. Disturbed soils along roads and in logged areas are prime spots for invasive weeds to colonize. An increase in the number of roads amplifies elk vulnerability due to the increase in human activity. Loss of security cover due to timber harvest causes elk to become more vulnerable to predators and hunters (Christiansen et al. 1993). On the other hand, timber harvest can increase the quantity of nutritional forage (Collins and Urness 1983); changes in forage relate to the inverse relationships between forest cover and understory vegetation production (McConnell and Smith 1970). Timber harvest has the best potential to benefit elk when few new roads are built or roads are closed once harvest is complete, adequate security cover is preserved, and the size of the openings are considered (Lyon and Christensen 2002).

Livestock grazing is ubiquitous in Idaho rangelands and in many parts of the Planning Area. Livestock grazing systems are designed to benefit livestock; but if designed and managed properly, they can also benefit wildlife habitat. Improper grazing management negatively affects wildlife production, plant vigor, water quality, and soil erosion and productivity. Timing of livestock grazing, especially cattle grazing, can impact elk use of habitat as elk distribution changes in response to the presence of cattle (Stewart et al. 2002), and as elk and cattle are selecting for some of the same resources during late summer (Coe et al. 2001). Some studies have suggested that livestock grazing can have a positive effect on forage conditions (crude protein, digestibility) for elk when the timing, intensity, and duration of livestock grazing are controlled. Other studies, however, do not show improvements. See section 1.1.1, Nonforested Vegetation.

Ecological Succession

Elk tend to be most productive in habitats that have a mosaic of plant successional stages. Evidence suggests that this is due to associated vegetation diversity and availability of high-quality forage. The challenge is that nature is dynamic and plant communities do not remain in a single successional state. Thus, the ability of a landscape to support elk varies with these changes in habitat. (See section 1.1 of this Assessment for more information regarding vegetation and its natural range of variability.)

Elk diets vary seasonally and annually due to nutritional demands, plant phenology, and weather patterns. Elk consume both herbaceous and woody plants (Cook 2002). Elk prefer grass and forbs during the summer because of their digestibility and nutrient content, but may consume a large proportion of shrubs (Cook 2002). High elevation meadows and riparian areas are preferred summer habitats (Adams 1982). Good summer nutrition is important for the survival of cow and calf elk over winter (Cook et al. 2004). When nutrition during the summer and autumn is poor, cow elk are likely to breed later than cows with good body condition or not at all (Cook et al. 2001). Woody shrubs are eaten by elk throughout the winter. However if summer habitat conditions do not allow elk to obtain good body condition by autumn, even elk occupying high-quality winter range may not survive the winter (Cook 2011). The body condition of elk in the autumn is dependent on the quality of summer habitat and not on the body condition of the individual in the prior spring (Cook 2011).

Typically most of the edible biomass in late successional or climax forest systems is out of reach of terrestrial herbivores. In mature coniferous forests of the Rocky Mountains, more than 99% of total aboveground vegetation biomass may be tied up in trees (Wallmo 1981); shrubs and herbaceous plants make up less than 1% of the total vegetation biomass in these late-seral systems (Gary 1974, Landis and Mogren 1975). Forage supply is inversely related to the amount of tree overstory in forested habitats (Folliott and Clary 1972). However, some xeric forest habitat types maintain forage availability with overstory canopies. Mature forest can also be beneficial to elk when mature stands are associated with mid-seral stands in areas that elk frequent during late summer and early fall prior to and during the early breeding season.

In general, managing habitats in a mosaic of plant successional stages will prove most beneficial to elk. Overall plant diversity and forage is higher in recently disturbed areas. Exceptions to this might be on certain winter ranges where shrubs can take much longer to regenerate. Habitat disturbance is crucial to maintaining high-quality elk habitat. Traditionally, different fire cycles and human disturbance, such as logging, resulted in higher elk densities than occur in many areas today. In the short term, weather patterns can affect elk populations, but landscape-scale habitat changes will impact long-term trends (see section 1.1 of this Assessment).

Human Development

The primary effects of human development on elk are habitat loss and habitat fragmentation. Development includes residential, commercial, agricultural, energy, infrastructure, and other human activities. Effects can be direct, like loss or destruction of habitat, or indirect, like displacement of wildlife from otherwise suitable habitat caused by disturbance associated with human activity. Human development in elk habitat can also lead to and exacerbate depredation of crops and residential landscaping and similar human-wildlife conflicts, thereby lowering social tolerance and ultimately elk populations.

The U.S. Census Bureau reported that Idaho is the fourth fastest growing state in the union. The total population of Idaho increased 21.1% between 2000 and 2010. A Geographic Information System-based analysis of human population growth in Idaho was recently completed using census data and a projected housing density model was developed by D. Theobald of Colorado State University. This analysis included housing density projections through the year 2030. The analysis indicates that most future human settlement in Idaho will be clustered in several general areas of the state, including the Palouse area, which abuts a portion of the Planning area and contains elk summer and winter range. Elk populations that have already been adversely affected by past and current development are further threatened by predicted rapid human population expansion and associated development.

Energy Development and Mining

Increasing human populations create more demand for energy development and raw materials from mineral extractions. Energy development common to Idaho includes hydro power, wind power, oil and gas development, and transmission corridors. The impacts of energy development and mining on elk habitat are expected to increase as development continues into the future. The Plan area is currently not an active area for energy development, and mining is limited largely to small operations; however, future demands for energy or minerals may bring new pressures on elk habitat.

Exploration, construction, and production phases of energy development and mineral extraction can cause direct loss of habitat (USDI 1999). Wind turbine bases, oil and gas platforms, transmission line corridors, and the roads associated with development replace what was once wildlife habitat.

Energy development and its infrastructure can lead to disturbance that impedes key habitat functionality by altering wildlife access to or use of habitat and by causing avoidance and stress (Cox et al. 2009). Increased vehicle and human traffic, equipment noise, and noises related to mining or drilling operations can lead to elk avoiding preferred habitat. The increase in human activity along roads built for energy development and mining can lower elk survival through injury or death due to a vehicle collision, poaching, and harassment from a variety of increasing recreational activities, such as Off Highway Vehicle (OHV) use (Cox et al. 2009, Dzialak et al. 2011, Webb et al. 2011). Large-scale wind energy projects have the potential to displace elk from important seasonal habitats (USFWS 2011). Transmission corridors and associated roads can cause direct mortality and reduce available habitat due to fragmentation (Cox et al. 2009).

The issues identified in the IDFG Elk Management Plan are similar to those described by Christensen et al. (1993), who said habitat effectiveness should be used in forest plan revisions as an indicator of ability and distribution of quality habitats to support elk. Habitat effectiveness addresses the ability of habitat to meet elk needs for growth and welfare (Lyon and Christensen 1992). The most notable forest management practices that influence habitat effectiveness are motorized access, availability and distribution of suitable and adequate forage, the extent and connectivity of cover, and spatial relationships with intermingled ownerships (Christensen et al. 1993).

Issues, Stressors, Concerns

Winter forage Availability within Plan Area is Below Natural Range of Variability

Winter is typically the most crucial season affecting elk survival. Elk winter in areas that provide access to shrub and grass forage capable of sustaining individual survival and herd reproductive fitness through the winter (Citation from EMP). Nearby thermal cover, provided by overhead canopy, may also be important, especially in severe winters. Winter ranges in the Planning Area are typically associated with breakland landscapes. The recommended standard for effective elk habitat is a ratio of 40% hiding and thermal cover to 60% forage—with a forest canopy closre of >70% to achieve optimum thermal cover (Black et al. 1976; Thomas et al. 1976). Thermal cover, as a required component of elk habitat, has been questioned in recent studies (Cook et al. 1998).

The winter range maps used for this analysis were produced for the 2007 draft Forest Plan utilizing a Rocky Mountain Elk Foundation winter habitat model that used aspect and elevation to identify winter habitat. This winter range maps was further refined by Forest Service and IDFG biologists based on firsthand knowledge and experience of elk winter habitat use in the Planning area.

Elk Habitat (browse) is Below Desired Conditions

The availability, distribution, and quality of suitable browse is below desired conditions and trending downward on a substantial portion of the lands on the Nez Perce–Clearwater National Forests. Factors contributing to these conditions include a combination of advancing forest succession on winter, calving, and breeding ranges; and a lack of fire to regenerate quality winter browse. In bunchgrass winter ranges of the Salmon River basin, preferred winter bunchgrass forage species are threatened by invasive plants and noxious weeds. Managing forest conditions and treating invasive weeds would promote well-distributed patches of desired browse and grass habitats required to meet high-energy demands.

Summer range includes the habitat used by elk from about late green-up (May) until they move to winter ranges, but prior to the hunting season (Christensen et al. 1993). Recent research indicates that quality of summer and fall ranges largely determines the condition of an elk heading into winter and whether that elk can survive winter (Cook et al. 2004). A relatively small difference in forage quality consumed by elk in summer and autumn can have strong effects on fat accretion, timing of conception, probability of pregnancy of lactating cows, calf growth, yearling growth, and yearling pregnancy rates. Forest management focus is on maintaining the ability of the habitat to meet elk needs for forage, water, security, or space, as well as protecting special features like licks and wallows.

In Forest Plan revisions, habitat effectiveness should be used as an indicator of ability and distribution of quality habitats to support elk (Christensen et al. 1993). Habitat effectiveness addresses the ability of habitat to meet elk needs for growth and welfare (Lyon and Christensen 1992). The most notable forest management practices that influence habitat effectiveness are motorized access, availability and distribution of quality forage, the extent and connectivity of cover, and spatial relationships with intermingled ownerships

Human Disturbance and Displacement (loss of habitat or habitat availability)

Geist (1978) defined harassment on wildlife as actions that may only cause arousal in one situation, but may lead to panic, exertion, or death in another situation. He suggested that harassment was most damaging when animals were in poor condition and when disturbance was frequent and unpredictable.

Disturbance may have both immediate and long-term effects on wildlife. The reactions of animals to disturbance can cost calories of energy and grams of nutrients (Moen 1973), which also may have a physiologic effect on individuals. The immediate response of many animals to disturbance is a change in behavior, such as cessation of foraging, fleeing, or altering reproductive behavior (Knight and Cole 1991). Over time, energetic losses from flight, decreased foraging time, or increased stress levels come at the cost of energy resources needed for an individual’s survival, growth, and reproduction (Geist 1978). At the population level, physiological response may result in reduced productivity (Yarmoloy et al.1988). A single disturbance event per day can elicit a flight response in elk (Wisdom et al. 2004).

Summer nutrition is critical for the capability of cow elk to produce healthy calves (Canfield et al. 1999). Although winter conditions stress elk and other ungulates, the availability, distribution, and access to quality summer habitats is critical to building body fat sufficient to survive the winter and produce healthy calves. Human disturbance has the potential to displace elk from preferred habitats during these critical periods and compromise their ability to survive and reproduce, potentially affecting populations (Canfield et al. 1999). Behavioral responses of elk to human disturbance include greater use of cover (Irwin and Peek 1983), increased movements (Cole et al. 1997), and avoidance of roads (Rowland et al. 2000). Human disturbance is likely to be most detrimental if it is frequent and unpredictable (Knight and Gutzwiller 1995).

When elk are displaced into poor-quality habitats, they may expend more energy on thermoregulation or be forced to use poorer quality forage (Cassirer et al. 1992). Displacement of elk into poorer habitat might be equally or more detrimental than increased energetic costs caused by movement (Hobbs 1989). The increased energy expense of moving away from disturbance, coupled with a loss of forage intake, could have population-level impacts, especially if the areas they occupy to escape disturbance offer reduced forage quality. Cook et al. (2004) suggested if elk body fat was reduced below 9% as the animal enters winter, the probability of that animal not surviving winter increases. Limiting motorized access into elk habitat is a management tool that could increase survival and reproduction of some elk populations. When roads/trails are closed, elk reduce daily movement and have smaller home ranges. By reducing energy expenditures, elk can increase fat reserves, survival rates, and productivity (Cole et al. 1997).

Roads and Trails

Access into elk habitat has long been an issue facing wildlife managers. Historically, access was created as roads were built into forested habitats for timber production. Those new roads allowed more hunters to access elk habitat. Concurrent declines observed in bull:cow ratios in many elk herds led to concerns and research regarding the effects of access and roads on elk vulnerability and habitat security. Wildlife managers have identified elk habitat security and vulnerability as important issues.

Motorized access into elk habitat, which was previously an issue with hunters during the fall season, now occurs year-round and presents a host of new issues. Modern OHVs allow recreationists access to elk habitats that were once secure. And use of motorized roads and trails is no longer limited primarily to hunting seasons, but now occurs year-round.

Many trails originally used for stock and hiking are now accessible to motorized users. Additionally, motorized users can access more terrain per day, thereby potentially impacting more than other forms of recreational travel (Wisdom et al. 2004). Growing demands for back-country recreation can increase the cumulative effects on elk biology and their seasonal habitats. Understanding how motorized recreational activities potentially influence elk and habitat use is necessary to evaluate management options and make informed management decisions.

Habitat adjacent to roads and trails that are open to motorized travel is avoided by elk; and motorized disturbance increases daily movements by elk. Declines in elk populations could occur if elk avoidance of roads and motorized trails result in decreased diet quality for the animals, displacement from necessary security or thermal cover, or other impacts. Although social and biological trade-offs associated with open roads and motorized trails vary, the increase in number of traffic and people due to increased access is almost always detrimental to elk. Access management and mitigation for the negative impacts of roads and trails on elk will be a challenge for managers to address in the future. Generally speaking, it is not the physical footprint of roads and trails that affect elk, rather it is the motorized traffic and human disturbance associated with roads and trails that elk avoid (Wisdom et al. 2005).

Although the impacts are often similar, the effects of motorized disturbance on elk can be divided into two general categories: vulnerability to harvest and hunting pressure, and disturbance or displacement from preferred habitat. Both categories affect elk biology and behavior.

Vulnerability

Elk usually move away from human disturbance when harassed; however, during the hunting season, elk remaining in roaded areas encounter more hunters over a longer period of time than elk occupying more secluded habitats (Hurley and Sargeant 1991; Leptich and Zager 1991). Roads built into elk habitat for timber management and other activities increase hunter access and, subsequently, increase elk vulnerability to harvest (Leptich and Zager 1991, Unsworth and Kuck 1991). Increased motorized access and vulnerability affects elk population structure. Leptich and Zager (1991) documented higher bull mortality rates (62% mortality) in highly roaded areas in Idaho compared to areas with few roads (31% mortality). In the highly roaded area, no bull lived past 5 years, whereas the area with few roads had bulls living in excess of 10 years. In highly roaded areas, fewer than 10 bulls existed per 100 cows; however, closing roads boosted sex ratios to nearly 20 bulls per 100 cows. Unroaded areas had almost 35 bulls per 100 cows.

Access management is a tool that wildlife managers can employ to maintain healthy elk populations and maintain public hunting opportunities without restricting seasons (e.g., controlled hunts, weapon restrictions, shorter seasons, or seasons during a less desirable time of year). Reduced disturbance by motorized vehicles, reduced hunter densities in non-motorized areas, and potentially greater success rates can provide a higher quality hunting experience for many hunters (McLaughlin et al. 1989). Without access management, elk populations generally develop undesirable sex and age structures. These, in turn, require increasingly complex and restrictive hunting regulations and, ultimately, loss of opportunities for hunters, watchers, and other non-consumptive users of the elk resource (Leptich and Zager 1991).

A direct correlation exists between road access and the number and age of bulls in a population: Bender and Miller (1999) demonstrated that limited entry hunts allow significantly greater bull survivorship into prime age classes than general season hunts. When older bulls are present in a population, cow elk conception dates are earlier and more synchronous, resulting in calves being born earlier and over a shorter time period each spring. This, in turn, may provide a number of survival benefits (Noyes et al. 1996). A synchronous birth pulse results in fewer calves taken by predators in the spring. Calves born later in the year will subsequently be smaller entering winter and more susceptible to predation and starvation. The breeding age of bulls affects elk productivity in a similar fashion.

Disturbance by Hunting

In addition to harvest mortality, increased vulnerability to hunting pressure has indirect impacts on elk populations. Hurley and Sargeant (1991) noted that elk near open roads increased their use of dense cover during hunting seasons, and Batcheler (1968) documented that red deer (an elk) similarly restricted themselves to the cover of substandard habitat in response to hunting pressure. Batcheler (1968) likewise noted declines in productivity of red deer related to hunting pressure. Squibb et al. (1986) documented that heavy hunting pressure delayed conception dates of elk.

Motorized Disturbance and Displacement

Motorized off-road vehicle travel on public lands is among the fastest growing forms of outdoor recreation in the United States (Cordell et al. 2005). Of the 8 National Forests in Idaho, English et al. (2004) reported the Clearwater National Forest ranked first in estimated ATV participation, accounting for approximately 20% of total recreation visits to the Forest. In addition to increased numbers, ATVs have capabilities that allow access to remote landscapes.

The effects of motorized access on elk have been extensively studied. A preponderance of field studies indicates motorized travel elicits both behavioral and physiological responses in elk. As human populations and technology increase, recreational use of roads and trails dissecting summer and winter habitat is occurring with increasing frequency, intensity, and duration. The preponderance of evidence in the literature indicates that this increased access will have significant adverse impacts on elk unless managed carefully.

The cumulative effects of predation and reduced access to quality foraging habitats are believed by biologists to be the most significant contributing factors retarding recovery of struggling elk population over much of the National Forest managed landscape. Human disturbance associated with roads and trails cause elk to vacate otherwise suitable habitat to avoid human activity; the period of time before elk return to vacated habitat depends on the severity and duration of the disturbance, but could be months or years (Lyon 1983). Elk habitat is reduced not only by the amount of land taken by the road or trail proper, but also because elk avoid the areas adjacent to such roads (Lyon 1979, Lyon 1983). Ward et al. (1980) demonstrated that even productive habitats may be abandoned by elk if human disturbance is excessive.

In areas with high road densities, elk exhibit higher levels of stress and increased movement rates (Rowland et al. 2005). Increased movement increases the vulnerability of elk to predation or harvest (Hurley and Sargeant 1991). The energetic cost of moving away from disturbance associated with roads and trails may be substantial (Cole et al. 1997) and could limit population productivity or reduce an elk's ability to withstand winter by depleting fat reserves (Cook et al. 2004). The displacement of elk away from roads and trails may cause substantial reductions in habitat utilization. Population level impacts could occur if elk are forced into marginal habitats to avoid disturbance. Morgantini and Hudson (1985) that elk diets chagned from primarily grazing to browsing when disturbed during the hunting season. Such a human-caused shift away from a preferred diet could have a negative impact on elk survival and reproductive performance during severe winters. Kuck et al. (1985) also reported that cow elk and their calves readily abandoned traditional calf-rearing areas when faced with repeated human disturbance. Cow/calf pairs experiencing disturbance treatments moved more frequently, used larger areas, and reduced selection of normally preferred habitats.

Numerous studies (Frair et al. 2008, Sawyer et al. 2007, Rowland et al. 2005, Christensen et al. 1993, Lyon 1983, Lyon and Jensen 1980, Thomas 1979) have demonstrated that elk avoid areas near open roads. Christensen et al. (1993) recognized that influences of motorized vehicle travel can reduce the amount of available habitats on elk summer range. The degree of impact to elk from habitat displacement varies with location, hunting pressure, and relative importance of habitats into which motorized access and human disturbance intrudes. Studies indicate that elk respond less to constant non-stopping vehicle traffic than to slow vehicle traffic that stops periodically (Ward 1976, Leege 1984). The greatest negative responses to recreational activities (either motorized or non-motorized) for several ungulate species were attributed to unpredictable or erratic occurrences (Canfield et al. 1999).

Elk strongly selected habitat increasingly distant from roads open to motorized traffic at the Starkey Experimental Forest and Range in northeast Oregon (Rowland et al. 2000, 2004). Lieb (1981) found elk preferred areas with low noise levels, and Edge (1982), Hershey and Leege (1982), and Marcum (1975) reported that elk avoided roads with the greatest traffic rather than roads themselves. Avoidance of open roads was greatest when cover was absent, during hunting season, and on high-standard primary roads (Lyon et al. 1985). Limited vehicle traffic behind closed gates has been demonstrated to reinforce avoidance behavior (Lyon 1979b).

Rowland et al. (2005) concluded that reduction in effective habitat for elk is the ultimate effect of elk displacement; however, substantial reductions in elk habitat use are typically confined to less than 1/2 miles from an open road. Declines in elk habitat use have been reported within 0.25–1.8 miles of open roads (Lyon and Christensen 2002). Elk appear to need more space where more roads exist. Cole et al. (1997) reported that elk responded to limited road access by reducing core area and home range sizes and decreasing daily movements.

Elk generally show the strongest avoidance response to motorized travel compared to other types of recreation. Elk are more likely to take flight, at a greater rate of movement and duration and at a greater distance, from motorized than non-motorized off-road recreation (Naylor et al. 2009; Preisler et al. 2009). Elk disturbed by human activity typically move to denser cover or beyond a topographic barrier (Lyan and Canfield 1991; Hurley and Sargeant 1991). When exposed to repeated disturbance from traffic, elk are known to travel farther and continue to avoid areas near motorized trails or roads (Czech 1991).

Recent elk research addressing motorized recreation has made a direct connection between ATVs and impacts to elk (Vieira 2000, Wisdom et al. 2004, Wisdom 2007, Preisler et al. 2006, Grigg 2007). Canfield et al. (1999:6.16–6.17) and Toweill and Thomas (2002:808) determined the effects of motorized trail use are similar to the effects of open roads. Wisdom (2007) reported that repeated exposure to ATVs over 3 years increased elk avoidance of ATV trails during periods of both ATV use and non-use. Rowland et al. (2004), found that elk select habitat or cover away from roads. In southwestern Montana, elk responded to motorized access by requiring summer home ranges two to three times larger than expected (Grigg 2007) and Peek et al. (1982) suggested that high levels of human disturbance may result in the abandonment of home ranges by elk. Displacement from habitat near roads open to motorized travel reported by Lyon et al. (1985) and Rowland et al. (2000) is likely to be continuous as long as the roads are open to motorized traffic.

Topography may affect impacts of motorized activities on elk behavior. Montgomery et al. (2013) demonstrated notable differences in the way elk responded to roads: by road type, between sexes, and across seasons. The influences associated with road traffic were more noticeable within the core of elk home ranges. Their analysis demonstrated that visibility from roads should be considered in addressing elk management strategies. Frederick (1991) and Edge and Marcum (1991) also concluded that topography can influence elk habitat use near roads. Edge and Marcum (1991) reported that radio-collared cow elk in western Montana showed displacement from sources of human disturbance to be more pronounced when activities occurred on ridge tops or in simple bowl-shaped basins without internal ridges. They also reported that topographic barriers to disturbance sources (road traffic) consistently had higher probabilities of elk use during the calving and summer seasons.

The factors that cause elk to respond to motorized traffic are often ambiguous or poorly understood. Wisdom et al. (2005a) and Preisler et al. (2006) found in some circumstances that, at least one-third of the time, elk failed to take flight when close to off-road activity. They reasoned that local topography and/or cover, or possibly other factors, may provide the security necessary for elk to remain static. Documented examples exist where elk have found refuge from hunting pressure in National Parks and urban areas (Thompson and Henderson 1999) and have become habituated to human disturbances associated with roads (Frair et al. 2008, Cassirer et al. 1992, Schultz and Bailey 1978, McKenzie 2001).

Wisdom et al. (2005) suggested that potential effects to elk disturbance, when compared to other forms of recreational travel, were greater with motorized recreation. The conclusion was based on the capability of ATV to travel greater distances on any given outing. Wisdom et al. (2005) recommended restricting motorized travel where routes dissect seasonally critical habitats; . providing elk habitat security by protecting whole areas rather than using individual route closures; designing routes to secure large patches of undisturbed habitat; and seasonal closures of seasonally critical habitats.

Disturbance Effects during Critical Times

Disturbance and displacement of elk from critical habitat or during times when elk are especially vulnerable will exacerbate impacts. Elk cannot compensate for disturbance on important seasonal ranges. Road and trail restrictions during critical times of the year can be beneficial management tools.

Winter Range

Because forage quality and quantity is reduced during winter, increased energy expenditures by elk may impact mortality. Also, because elk are concentrated into more restricted space, the opportunity for disturbance is increased and the effects of disturbance magnified. Limiting human disturbance can eliminate unnecessary energy expenditures of elk during winter (Parker et al. 1984). In Austria, red deer reacted to hunting disturbance by changing locations, and after persistent disturbance, abandoned traditional wintering areas for the year.

Calving/rearing Habitat

Elk calving usually occurs from early May into mid-June throughout the Northwest (Raedeke et al. 2002); June 1 appears to be a relatively common average calving time in the Planning Area (IDFG). However, it is important to note that 40%–60% of all calves may be dropped toward the end of that period, thereby moving peak calving toward the latter half of the calving season or mid-June (Raedeke et al. 2002).

Weaning of elk calves after birth generally requires 8–12 weeks. Until calves are weaned, they are unable to survive on their own and a calf will die if permanently separated from the cow before it is fully weaned. Temporary separation of cow and calf during weaning can lead to reduced condition and lowered survival of calves. Juveniles 8 weeks postpartum may be developed into fully functional ruminants; but development of rumination patterns similar to adults requires another 4 weeks or so (Cook 2002). Condition of calves contributes to their survival; and disturbance during these early life stages may not only result in reduced condition, but also increased predation on calves (IDFG 2013).

Elk calving occurs widely across the landscape. Typically, however, elk select habitats that provide hiding cover for the calf, nutritious forage, proximity to water, and are transitional from winter to summer range. Elk do not show fidelity to specific calving sites; however, elk return to areas offering preferred conditions year after year, thus establishing preferred or traditional calving areas. Calving typically depends on the availability of succulent and nutritious vegetation related to the receding snowline and plant phenology (Skovlin et al. 1982) Distance of forage from the forest edge and ecotones are also important to provide early cover for calves and a transition from forest to forage (Johnson 1951; Reichelt 1973). Elk typically give birth in the timber and move to open grazing areas several days post-birth. Phillips (1974) reported that calving elk in the Sawtooth National Forest selected timber with a 20–60% (average 37%) overstory for calving. Slope is probably not critical for calving areas, but elk do select gentler slopes for calving/rearing (Skovlin et al. 1982); slopes of 20–40% are typical. Leege (1984) reported calving in the Plan Area on 15% slopes.

Preferred or traditional elk calving areas were mapped based on conditions described in the literature for the Nez Perce–Clearwater National Forests using slopes less than 40%; generally with a south-southeast aspect; and elevation below 5,000 feet. Forest, IDFG, and other biologists with knowledge of the Plan area and elk calving behavior in the area identified or modified mapped areas based on their local knowledge and experience.

To ensure the healthy development of an elk fetus, cow elk must minimize energy costs that exceed those required for maintenance (Geist 1978). Thus, human disturbance may cause cow elk to move from or abandon favorable habitats, and such displacements have the potential to affect the health of a population. Geist (1971) suggested that prolonged, frequent, and unpredictable human disturbance could severely alter behavior, reduce calf survival, or contribute to cows aborting their fetus. Kuck et al. (1985) documented that disturbed elk will abandon traditional calving areas and move into smaller, less favorable habitats; a shift into poorer quality habitats could result in reduced calf survival or aborted fetuses.

Disturbed elk and calves increase daily movements, exposing them to predators, reducing fat reserves, and reducing survival in winter (Peek et al. 2002, Raedeke et al. 2002). Phillips and Alldredge (2000) documented declining calf:cow ratios when cow elk were displaced by humans during calving season. Water and riparian areas are important to lactating elk (McCorquodale et al. 1989), but in Idaho many roads and trails follow the linear nature of the drainages in the bottom of canyons, thus subjecting elk to unnecessary disturbance/harassment during this critical time of year. Shively et al. (2005) observed reduced productivity of elk during calving season when disturbed by humans and recommended seasonal closures, or at least restrictions, on recreational activities during calving seasons.

Elk select habitat for calving and rearing that will provide suitable cover and forage for both mother and calf. Elk calving areas with highly digestible forages may be limiting (Leege 1984). Seasonal forage quality and quantity are essential to animal fitness and herd productivity (Nelson and Leege 1982, Irwin and Peek 1983, Hobbs and Swift 1985, Marcum and Scott 1985, Merill and Boyce 1991, Cook et al. 1996).

Geist (1982) suggested that female ungulates differentially selected habitats that maximized offspring survival. Open habitat components in June can be expected to have a higher quantity and quality of forage (Irwin 1976, Lyon and Jensen 1980). Schlegel (1986) reported that radio-collared calves moved to forested habitats on cooler, north aspects in July. Calves were not observed on summer range in Idaho's Selway country until July 4 (Young and Robinette 1939). Cow-calf groups used more heavily forested habitats at intermediate to higher elevations during July in western Montana (Marcum 1975).

Further, increased movements and displacement to more marginal habitats could theoretically increase exposure to predation. Kuck et al. (1985) reported that vulnerability to predation may be increased through any combination of nutritional stress or abandonment. Most predation on elk calves occurs within one month after birth (White et al. 2010). Predation accounted for 47% of elk calf mortality on Coolwater Ridge in the Lochsa drainage of north central Idaho (Schlegel 1986). Zager et al. (2007) reported that predators killed 55% of all marked elk calves during the summer on the Lochsa, and 39% of elk calves during the same period on the South Fork of the Clearwater River in Idaho.

Elk calf survival greatly influences population trends. Elk herds in north central Idaho generally have the lowest calf:cow ratios statewide. White et al. (2010) indicated that declines in elk populations in north central Idaho are likely influenced by the complex and confounding interactions of habitat limitations (primarily forage availability and quality) and predation. In some, but not all, elk management units, calf recruitment and survival rates of adult cow elk are currently below the threshold necessary for population stability or growth.

In the case of limited key habitats, such as elk calving areas, it may be that the only option available to protect elk recruitment is to seasonally restrict motorized traffic. Approximately 58,171 acres of elk calving areas are mapped in the Plan area, and of this area, only 17,107 acres (approximately 30%) are located within elk security areas. Approximately 243 miles of road and motorized trails transect mapped calving habitat on the Forests.

Motorized disturbance presents a potential stressor to the productive capability of struggling central Idaho elk herds. Reproductive success of elk could be compromised where human disturbance displaces elk from calving areas and restricted winter habitats (Geist 1982, Skovlin 1982). Leege (1984) recommends restricting human activities on established elk calving and rearing areas in northern Idaho. Phillips (1998) recommended that recreational traffic be routed away from areas in which elk are known to calve. To ensure that adequate areas of calving habitat remain undisturbed, Phillips and Alldredge (2000) suggested maintaining low trail densities in traditional calving areas and selective use of calving-season closures. Shively et al. (2005) recommended selective closures, or at least restrictions on recreational activity during calving season.

In 2010, IDFG reviewed available literature and recommended to Clearwater National Forest what IDFG termed "marginally protective" seasonal restriction to motorized access from May 1 to August 1 adjacent to or through key elk calving grounds. IDFG's recommendation used a least-conservative estimate of 8 weeks postpartum for calves to become fully functional ruminants and a June 1 median for the calving (IDFG letter to Brazell, date; IDFG comments re DRAMVU). An independent wildlife review by Hershey (2011), commissioned by the Clearwater National Forest for travel management planning, recommended permanent closure of elk calving areas to motorized use based on the same sources.

Summer–Fall

Biologists have long understood the importance of limiting disturbance on winter range or during calving season. However, recent research indicates that quality of summer and fall ranges largely determines the condition of an elk heading into winter and whether that elk can survive winter (Cook et al. 2004). A relatively small difference in forage quality consumed by elk in summer and autumn can have strong effects on fat accretion, timing of conception, probability of pregnancy of lactating cows, calf growth, yearling growth, and yearling pregnancy rates. Effects of summer-autumn nutrition on fat accretion of cows and growth of calves significantly influenced their survival probability under harsh winter conditions. Cameron et al. (1993) determined that the probability of a successful pregnancy in caribou is largely predetermined at breeding, based on the autumn condition of the cow, and that early calf survival is influenced by maternal condition during late pregnancy. The scientific literature indicates that access restrictions to avoid displacement of elk from preferred habitats may be justified during the summer and autumn months (IDFG 2013).

Access management is often used to address increased vulnerability, declining habitat security, and declining habitat effectiveness. For instance, road and trail restrictions were frequently used on old logging roads to reduce vulnerability. Now OHV use on roads and trails are the greater concern as logging activities have been reduced on federal timber lands over the last 20 years and OHV use has continued to increase exponentially (IDFG 2013). However, both types of motorized disturbance must be considered.

Access and Recreation

“Security is important to elk year-round, and should be one of the basic tenets of elk habitat management” (Allen 1977). Security areas are those where elk are free from disturbance or can retreat when disturbance occurs on their usual range. Security is the product of a combination of factors that allow elk to remain in a specific area while under stress from hunting (Christensen et al. 1993) or other human disturbance. A suitable security area, as defined by Hillis et al. (1991) is 250 or more acres, having a non-linear shape, and being more than 0.5 mile from open roads. Hillis et al. (1991) also determined that more than 30% of a landscape should be dedicated to security.

Road and off-road trail density and pattern are important in determining the security an area provides to elk (Basile and Lonner 1979, Unsworth et al. 1998, Rowland et al. 2000).). Open roads decrease (size and effectiveness of) elk security areas and increase elk vulnerability (Leege 1984). Pedersen (1978) found that elk were unable to find secure habitat in heavily roaded and fragmented areas. Lyon (1979) suggested that security areas should provide a line-of-sight topographic barrier, be inaccessible to motorized traffic, and be at least as large as the area disturbed (Lyon 1979).

Roaded landscapes may contain few patches of forest cover large enough to function effectively as habitat for elk (Leege 1984 and Rowland et al. 2000). Roads, open or closed, dissect landscapes of forest and interior habitats into smaller patches of increased edge habitat. Declines in elk habitat use have been reported within 0.25–1.8 miles of open roads (Lyon and Christensen 2002). In addition to disturbance caused by traffic, roads remove about five acres of productive elk habitat per mile (Leege 1984). Lyon (1983) stated that the best method for attaining full use of habitats appears to be effective road closure.

Road closures are often used to increase elk security. Bull elk vulnerability has been documented to be highest in areas with open roads and lowest in roadless areas (Leptich and Zager 1991, Unsworth and Kuck 1991, Leckenby et al. 1991). Reducing open road density typically improves habitat effectiveness for elk during summer and may increase elk survival during hunting seasons (Leptich and Zager 1991, Vales et al. 1991). Irwin and Peek (1979) found that road closures allowed elk to stay in preferred habitats longer while elk in roaded areas were displaced. In western Montana, Marcum (1975) reported that elk use following road closures appeared about equal to that in similar unroaded areas. Edge (1982) reported that closed and lightly traveled roads were not avoided by elk in Chamberlain Creek. In Montana, Basile and Lonner (1979) reported that road closures reduced *en masse* elk movements to less accessible areas.

Lyon (1984) found a 53% reduction in elk use of habitat within the first 660 feet from a road and a reduction of use of habitat up to 28% at one mile from a road. The degree of disturbance and the amount of habitat affected varied by the density of vegetation adjacent to the road and whether hunting was occurring. Lyon (1979) reported that undisturbed timber and long distances across undisturbed drainages were not as effective as topography in reducing the distances elk moved away from human disturbances associated with logging. The distance from an open road avoided by elk has been reported as between 0.25 and 1.8 miles.

Leege (1984) reported that the amount of traffic is the determining factor for how much elk use would occur in habitat adjacent to roads; however, Thomas and Toweill (1982) reported that response by elk was dependent upon a combination of factors in addition to the amount of traffic, including the kind of traffic, quality of the road, and cover adjacent to the road.

The effects of roads on security areas can be mitigated by vegetation or topography. Edge and Marcum (1991) found that topographic barriers between a road and high-use elk areas or special habitats such as calving grounds mitigated the effects of disturbance. Pedersen et al. (1979) stated that ridge lines (as topographic barriers) were of prime importance in maintaining the integrity of security areas in Blue Mountain elk summer range in northeast Oregon.

Roads associated with timber management can adversely affect elk security long after harvest. Hunters often establish motorized use patterns that persist on roads constructed and maintained for current or future timber harvest. Closed roads provide access routes for hunters into areas that would otherwise be secure (Hillis et al. 1991). Some studies have recommended closing entire areas to motorized use, as opposed to individual roads, to best maintain healthy elk populations (Hurley 1994, Burcham et al. 1998, Rowland et al. 2005). Limiting or restricting use of roads, and the duration of disturbance and activities in adjacent drainages should be considered as elk management guidelines (Lyon et al. 1985, Edge and Marcum 1991, Pedersen et al. 1979) to minimize displacement and added energy costs of movement. The final report on the 15-year Montana cooperative elk logging study recommended closing roads to provide low road densities where elk habitat quality and security are important considerations (Lyon et al. 1985). Wisdom (2007) suggested:

- Addressing the effects of ATV use on elk in the same way as roads open to motorized traffic.
- Mitigating the effects of ATV trails in concert with road mitigation to minimize effects on elk.
- Assigning area closures to all motorized vehicle uses, combined with designation of open roads and trails and all other areas closed unless designated open.
- Narrow road and trail widths to effectively mitigate motorized traffic to maintain effective use of landscapes by elk.

Elk Population Status and Trends Based on Idaho Department of Fish and Game Elk Management Zones

IDFG establishes elk population objectives and manages harvest commensurate with habitat capabilities to maximize reproductive performance and overall herd health. Elk objectives are set by IDFG for Zones. Each Zone is comprised of one or more Game Management Units (GMUs) that roughly encompass a population. Elk populations are routinely monitored by IDFG to determine whether population objectives are being met for each Zone; IDFG may revise elk management to help meet population objectives. IDFG's annual Pittman Robertson (PR) Progress Reports on elk (and other species) provide insights into past and current herd health and population trends in management Zones across the Planning area. PR Reports also identify existing and potential biological and habitat issues that may cause changes in elk populations and, subsequently, elk management.

Palouse Zone

IDFG's Palouse Zone includes game management units (GMUs) 8, 8A, and 11A. A small fraction of Unit 8 is in the Planning area; 8A is mixed Forest Service and private/State ownership; none of Unit 11A is in the Planning area.

The Palouse Zone elk herd is highly productive and has shown substantial growth over the past several decades. Habitat conditions are favorable to elk due to timber harvest creating ample early seral habitat and agricultural crops that provide high quality forage.

Elk population growth in the Palouse Zone is limited primarily by social tolerance and elk depredation on agricultural crops. The population objectives for the Palouse include an increase cow numbers over the 1999 plan, but lower than current levels. IDFG's priority for the Zone is to maintain high harvest rates and to address social tolerance issues.

Elk populations in this Zone have increased over the last 30 years due to the increased availability of agricultural crops, natural forage, and brush-fields on both summer and winter range. Additionally, mild winters throughout the 1980s likely enhanced calf survival.

The 2004 survey in GMUs 8 and 8A revealed substantial growth of the cow elk population (>50%), while bull abundance declined (-25%). The most recent survey (2009) showed continued increases in cow numbers; however, bull numbers also increased, to the point that bull objectives have been met.

Elk productivity in this Zone is very high, with calf:cow ratios in the mid 40s or higher. This results in a resilient elk population and allows for a liberal hunting season length and harvest.

Idaho Department of Fish and Game Management Objectives

IDFG elk management objectives for the Palouse Zone are to establish a population of 1,125–1,725 cows and 115–415 bulls, at ratios of 18–24 bulls:100 cows and 10–14 adult bulls:100 cows. These objectives represent a reasonable balance between depredation concerns in the area and the desire to maintain a reasonably large elk population. The objectives represent the maximum number of elk that could be sustained within the constraint of social concerns.

Status and Trends

The Palouse Zone elk herd has been increasing for 10–30 years, and presently exceeds the cow abundance objective. Adult bull abundance and ratios were low in past years, but have recently improved to the point that most objectives are being met for bulls. IDFG expects Palouse elk herds to remain healthy (IDFG, Koehler. 2014. pers comm).

Issues

This Zone contains portions of the highly productive Palouse and Camas prairies. Currently, almost all non-forested land is tilled and only small, isolated patches of perennial vegetation remain, and those are regularly burned or treated with herbicides. Farmland in GMUs 8 and 8A provides high-quality elk forage, and as populations have grown, so have the number of crop depredation complaints. Farmers recall few elk depredation problems prior to the last decade or so. Elk currently cause damage to grain, legumes, rapeseed, canola, and hay crops throughout this Zone. Most of the crop damage occurs during summer months. Damage to conifer seedlings caused by elk is a concern where reforestation projects occur on elk winter range.

Timber harvest in the corporate timber, private timber, state land, and federal land areas of GMU 8A increased dramatically through the 1980s and 1990s, mostly to capture white pine mortality and respond to increased demand for timber products. This activity created vast acreages of early succession habitat, thus expanding and improving elk habitat potential.

Access in the Palouse Zone is high. Road construction associated with timber harvest is extensive in some areas; motorized trails are also extensive. Road closures in some areas have significant potential to benefit elk through improved habitat effectiveness and reduced harvest vulnerability.

Grazing by cattle occurs on almost all of the available pasture ground and poses some competitive concerns for elk, especially during drought years.

Increasing mountain lion harvest over the last few years likely reflects increased mountain lion numbers in this Zone. Black bear numbers appear to have remained static. Wolves are typically absent in most of the Zone but are becoming more numerous.

Lolo Zone

IDFG's Lolo Zone includes GMUs 10 and 12, almost all of which are in the Planning area. The southern portion of the Zone is within the Selway-Bitterroot Wilderness Area.

Idaho Department of Fish and Game Elk Management Objectives

IDFG elk management objectives for Lolo Zone are to establish a population of 7,400–11,000 elk; having ratios of 6,100–9,100 cows and 1,300–1,900 bulls, including 725–1,200 adult bulls. Cow and bull elk abundance objectives for the Lolo Zone were established by IDFG at levels to allow growth and recovery of these depressed populations over time. These objectives were set to levels believed to be sustainable by Lolo Zone elk habitat.

Status and Trends

The current elk population in the Lolo Zone is far below the IDFG objective of 7,400–11,000 elk. Elk calf to cow ratios have continued to decline since the early to mid-1990s, and have been at levels too low to sustain elk populations. More recently, cow survival rates have also declined to problematic levels. The most recent survey in the Lolo Zone (2010) revealed 1,358 cow elk and 594 bull elk; thus, bull elk and cow elk numbers were both well below objectives.

Issues

A number of factors have been identified as contributors to the decline of Lolo Zone elk populations. Declining habitat conditions caused by a shift from early seral forest stages to much less productive mid- to late-seral stages have been a source of concern for decades. More recently, the spread of noxious weeds (especially spotted knapweed) has also contributed to the decline in elk habitat quality, particularly in the Selway Zone. A major winter event in 1996–1997, with record snowfall more than 200% of normal, caused a severe winter die-off that resulted in an exacerbation of the population decline. White et al. (2010) documented heavy predation on neonate elk calves by black bears as additive and the primary proximate mortality factor of neonate calves (age $\leq$ 90 days). Additionally, predation by mountain lions was prevalent on all age classes of elk (Zager et al. 2007a,b; White et al. 2010). Currently, wolves, which were not present during the early portion of this elk decline, are a major mortality factor on older calves ($\geq$6 months) and cow elk (Zager et al. 2007b, Pauley et al. 2009). Lower cow and calf survival due to wolves is continuing to suppress the elk population (Pauley et al. 2009, Pauley and Zager 2011, Horne 2012).

Dworshak Zone

The Dworshak Zone consists of GMU 10A. The eastern third of Unit 10A is in the Planning Area; the balance is mixed State, federal and privately managed land. Unit 10A is about three-fourths timberland and one-fourth open or agricultural land transected by canyons leading to the Clearwater River.

Idaho Department of Fish and Game Management Objectives

Objectives for Dworshak Zone are to establish a population of 2,900–4,300 cows and 600–900 bulls, with ratios of 18–24 bulls:100 cows and 10–14 adult bulls:100 cows. The Zone cow harvest strategy was modified for the 2000 hunting season to address over-harvest. The current goal is a harvest of 90–110 cow elk, which would allow the population to reach objectives over time. B-tag sales were capped beginning with the 2002 hunting season to allow the Zone to move toward bull and adult bull objectives.

Status and Trends

Historically, GMU 10A has supported a productive elk population. Elk populations in the Dworshak Zone remain stable, despite the addition of wolves to this Zone and a relatively high elk harvest. However, low recruitment and low bull numbers are a concern in this Zone.

From 1992–1996, recruitment averaged 34 calves:100 cows. From 1997–1999, recruitment dropped to an average of 19 calves:100 cows. However, the 2001 and 2007 surveys revealed increases in recruitment to 30 calves:100 cows and 26 calves:100 cows, respectively. The most recent survey conducted in 2011 indicated that cow numbers increased from 3,236 to 4,280, while the number of calves remained the same, resulting in an estimated 20 calves:100 cows.

Bull numbers are below IDFG objectives and showed continued decline in recent surveys. Low bull numbers can be attributed to high motorized access, which translates to high bull vulnerability.

Issues

The first wave of timber harvest in this Zone occurred during the early 1900s and consisted mostly of removing the most valuable timber species and largest trees. During the 1970s, timber harvest increased fairly dramatically, and new roads provided access to previously inaccessible areas. In 1971, the Dworshak Reservoir flooded approximately 45 miles of the North Fork Clearwater River corridor with slack water and permanently removed thousands of acres of prime, low-elevation winter range for big game. During the early 1970s, only a few hundred elk were observed wintering along the river under the predominantly old-growth cedar hemlock forest. The timberland is owned predominantly by Potlatch Corporation, Idaho Department of Lands (IDL), and Forest Service.

Timber harvest occurs on most available timber ground and road densities are high throughout the Dworshak Zone. High open and closed road densities contribute to high elk vulnerability and low habitat effectiveness. During the 1980s and 1990s, timber harvest occurred on almost all available State and private land as demand for timber and management of these lands intensified. Despite habitat losses to inundation by Dworshak Reservoir, extensive logging along the river corridor improved winter range in this GMU. South aspect forests were cleared to provide timber products and incidentally provided elk quality winter range.

Depredations have increased on agricultural land within the past 10 years in this Zone due to increases in both deer and elk populations and changes in land ownership that reduced hunting opportunities. Elk cause damage to grain, legumes, and hay crops within the south central portion of this Zone during summer months; occasional damage to stored hay, silage, and winter wheat occurs during winters with heavy snow accumulation. Damage to conifer seedlings by elk is a concern in the remaining portions of this Zone where reforestation projects overlap with elk winter range. Controlled antlerless elk seasons have been successful in reducing the overall level of damage in this Zone.

GMU 10A supports a substantial white-tailed deer population, few mule deer, and a small moose population. The white-tailed deer population has increased dramatically over the past 20 years. Significant competitive interactions between white-tailed deer and elk may exist. However, the form and extent of those relationships is presently unclear.

Significant livestock grazing on rangeland in the southeastern portion of the Zone impacts elk habitat potential. Most of the livestock grazing occurs on habitats used by elk exclusively during winter months. Elsewhere in the Zone, range allotments are present on summer and winter habitat.

Hells Canyon Zone

The Hells Canyon Zone is comprised of GMUs 11, 13, and 18. None of Unit 11 is within the Planning Area; a small portion at the south end of Unit 13 and two-thirds of Unit 18 are within the Planning Area.

This Zone contains large tracts of both private and publicly owned land, particularly within Unit 13 in the Planning Area. GMU 13 has been mostly under private ownership since settlement and is managed mostly for agriculture and livestock. Historically, sheepherders ran their flocks in the canyons of GMU 18 and some logging occurred in the forested areas of this GMU. GMU 18 is two-thirds public land with the remaining in private ownership, mostly located at lower elevations along the Salmon River. The majority of Hells Canyon Wilderness Area, which was designated as such in 1975, is in GMU 18.

Elk habitat productivity varies widely throughout the Zone from steep, dry, river-canyon grasslands having low annual precipitation to higher elevation forests with good habitat productivity and greater precipitation.

IDFG Elk Management Objectives

IDFG objectives for all 3 units of the Hells Canyon Zone are to establish a population of 2,000–2,900 cows and 420–610 bulls, including 240–348 adult bulls. Ratios of 18–24 bulls:100 cows are desired in GMU 1, and 30–34 bulls:100 cows in GMU 18.

IDFG management direction for the Hells Canyon Zone is to reduce the cow elk population to improve calf production, while maintaining the bull elk population at proposed objectives.

Status and Trends

Currently all of IDFG’s elk population objectives in the Hells Canyon Zone are being met or exceeded. Across the Zone, survey data indicate that cow and bull elk are increasing, with stable calf recruitment. However, the most recent surveys indicate that the Hells Canyon elk population may be at or exceeding the capacity of the habitat. IDFG increased harvest permit levels in 2009 in all Hells Canyon GMUs to slow or cap population growth, with an emphasis on reducing antlerless elk to address this concern.

Issues

Elk City Zone

The Elk City Zone is comprised of GMUs 14, 15, and 16. Land ownership in this Zone is approximately 80% public with the remaining 20% private. Most of the privately owned portions are at lower elevations along the Clearwater and Salmon rivers. Approximately 8% of this Zone is wilderness.

IDFG Management Objectives

IDFG objectives for Elk City Zone are to establish a population of 3,150–4,650 cows and 675–1,000 bulls, including 350–575 adult bulls (at ratios of 18–24 bulls:100 cows and 10–14 adult bulls:100 cows).

Status and Trends

Overall, Elk City Zone elk populations appear to be stable. IDFG's objective for cows in the Elk City Zone has been met since 2008 and cow elk numbers are stable to slightly increasing across the Zone. Numbers of bull elk are increasing toward meeting objectives. Bull:cow ratios ranged between 12.9 and 13.6 on 2000 surveys.

Historically, calf recruitment in GMUs 14 and 15 was high, averaging 38 calves:100 cows from 1987–1993. However, the 2000 surveys revealed recruitment of 25 calves:100 cows, suggesting that a decline in recruitment may be occurring. This decline is similar to what has been observed in surrounding areas. This trend in low calf recruitment continued to be evident in the 2008 surveys. Chronic low recruitment is particularly a concern in GMU 16, which averaged 19 calves:100 cows from 1990–2000 and fell to 17:100 in 2008.

Issues

Habitat productivity varies between Elk City Zone GMUs. Unit 14 habitat quality is relatively high in comparison to most other Clearwater region big game Zones. Productive conifer forests with intermixed grasslands characterize the majority of this Unit. However, Unit 15 and 16 habitat is poor primarily due to loss of early succession vegetation and increasing forest overgrowth with lodgepole pine and fir due to fire suppression during the past 40 years.

Invasive weeds, especially yellow star thistle and spotted knapweed, have increased within the past 15 years and, in some parts of the Zone, are out-competing native grasses and forbs on important elk habitats.

Road and trail densities are high within the Zone, contributing to significant big game vulnerability.

Depredations have increased within the past 10 years in this Zone due to increases in both deer and elk populations and changes in land ownership that reduce hunting opportunities. Livestock operators are concerned with elk use of pasture and rangeland forage during spring months prior to release of livestock on these grounds. Some damage to grain crops occurs during summer. Several past fencing projects have helped to reduce concerns of elk damaging stored hay during winters with heavy snow accumulation.

Livestock graze much of this Zone on both private and public land. On private land on the west side of GMUs 14 and 16, competition with domestic livestock may be significant, especially during winter.

Mountain lion and black bear abundance appears to have remained relatively stable over the past decade. Wolves are well established in the Zone; but, at the same time, harvest of wolves in the Zone is the highest in the state. Predators are a factor in determining Elk City Zone elk populations, but are not thought to be a limiting factor at this time (IDFG, Koehler, personal comm. 2014.)

Selway Zone

The Selway Zone is comprised of GMUs 16A, 17, 19, and 20. These Units are almost entirely under Forest Service management. Approximately one-half of Unit 20 lies within the Frank Church-River of No Return Wilderness; approximately three-quarters of Unit 19 are in the Gospel Hump Wilderness.

IDFG Management Objectives

IDFG elk management objectives in Selway Zone are to establish a population of 4,900–7,300 cows and 1,050–1,550 bulls, including 600–900 adult bulls. Ratios of 18–24 bulls:100 cows are desired in the short term, returning to 14–18 adult bulls:100 cows when total elk populations reach desired objectives.

Elk numbers are currently well below management objectives in the Selway Zone. The most recent Selway Zone elk survey data (2007) shows 3,381 cow elk and 934 bull elk.

Status and Trends

The elk population in the Selway Zone has a similar history to that in the Lolo Zone, and the population is following the same downward trajectory. Elk calf to cow ratios have continued to decline since the early to mid-1990s and are currently at levels too low to sustain elk populations. More recently, cow survival rates have also declined to problematic levels.

Survey data collected by IDFG in this Zone from 1987–2001, revealed both declining numbers of adult elk and declining recruitment. Declining calf recruitment was initially detected in GMUs 16A and 17 in 1995 surveys. The 1996–1997 winter was severe, with deep snow exceeding 200% of the average in some areas. These conditions apparently caused higher-than-normal winter mortality, leading to a significant decline in GMU 16A and 17 populations. Survey data in 1999 suggested a 27% decline in adult elk over both GMUs. Elk population composition surveys in GMU 17 during 2002 and 2003, and a survey in 2004 revealed stable, low recruitment at 16 calves:100 cows, but in 2005 recruitment again declined to 11 calves:100 cows. 2004 surveys in GMU 16A revealed higher recruitment than in 1999; however, 2007 surveys showed further declines in recruitment in Units 16A and 17. Low calf recruitment was not observed in GMUs 19 and 20 until 1996.

Survey data in 2001 suggested a significant decline in GMU 20 elk, but a significant increase in GMU 19 elk. However, fire activity during summer/fall 2000 may have caused many animals to move to adjacent habitat, resulting in shifts in elk distribution among GMUs 19, 19A, 20, and 20A. The 2007 survey showed declines in total numbers of elk in all the Selway Zones, inferring that shifts of the population among Zones probably accounted for increased 2001 counts in some Zones.

Issues

IDFG has identified habitat and predation as the two primary limiting factors for Selway Zone elk.

Habitat productivity varies throughout the Zone from high-precipitation forested areas along the lower reaches of Selway River to dry, steep, south-facing ponderosa pine and grassland habitat along the Salmon River. Many areas along the Salmon River have a good mix of successional stages due to frequent fires within the wilderness; however, fire suppression within portions of the Selway River drainage has led to decreasing early seral forage production for big game. Declining habitat conditions caused by a shift from early seral stages to much less productive mid to late-seral stages have been a source of concern for decades. More recently, IDFG has identified noxious weeds as the primary habitat issue in the Selway Zone, particularly spotted knapweed that has encroached upon many low-elevation areas of elk winter range, competing with native forage.

Little data exist on predation in the Selway Zone, but strong similarities of Selway elk to elk population history and trajectories in the Lolo Zone suggest that predation effects are comparable. Predation on neonate elk calves by black bears is additive and a primary cause of mortality of neonate calves (age ≤90 days). Predation by mountain lions is expected to be prevalent on all age classes of elk (Zager et al. 2007a,b; White et al. 2010). Currently wolves, which were not present during the early portion of the Selway elk population decline, are an additional mortality factor on calves older than 6months and cow elk (Zager et al. 2007b, Pauley et al. 2009). As in the Lolo Zone, lower cow and calf survival due to wolf predation is likely continuing to suppress the elk population.

Road densities are low, contributing to low vulnerability for big game. Due to the rugged and remote nature of most of the land within this Zone, human impacts have been very limited.

7.2.6.4 Furbearers

Importance in the Planning Area

Furbearers are defined as a group of mammals trapped or hunted for their fur. Furbearers provide both recreational and economic benefits to the Plan Area. Trapping and hunting of furbearers are traditional activities that can be traced to the earliest history of Idaho and the Planning Area. Some furbearers, like river otters, are also popular for viewing when the opportunity arises. Beavers create valuable habitat for fish and wildlife. On the converse, some furbearers can and do cause property damage.

Furbearers found in the Planning Area include badger, beaver, bobcat, coyote, American marten, mink, muskrat, river otter, raccoon, red fox, spotted skunk, striped skunk, and weasel. (Grey wolves are also hunted and trapped in Idaho but are managed as big game and are discussed in section 5.0) Lynx, fisher, and wolverine are also considered furbearers, but hunting and trapping for those species is currently prohibited in Idaho; those species are discussed in section 5.0.

The Idaho Department of Fish and Game (IDFG) manages furbearers primarily using licensing, harvest seasons, and harvest limits. Mandatory trapping and hunting harvest reports are used to estimate trends in furbearer populations and to determine the market value of the furbearer harvest. It is not possible from IDFG data to determine what portion of the harvest or market value comes from the Plan Area. However, it is clear from harvest reports that, by a wide margin, most of the IDFG Region 2 furbearer harvest and market value comes from Clearwater and Idaho counties. Those two counties are comprised mostly of Forest Service land, much of which provides excellent habitat for furbearers and opportunity for trapping. Latah County, which also has substantial Forest Service property, is third in both categories, but substantially less than Clearwater and Idaho counties.

The 2012–2013 total market value of all furbearers harvested in IDFG's Region 2 was $115,096; however, most of the Forest Plan Area harvest would have occurred in Clearwater and Idaho counties. The total market value of furbearers in Clearwater and Idaho counties for the 2012–2013 season was $94,746. Bobcat and marten were, by far, the most valuable furbearers in the Plan Area in 2012–2013, having combined market values from Idaho and Clearwater counties of $53,793 and $34,391 respectively (IDFG unpublished data).

History, Status, Trends

Licensed trappers are required to report to IDFG the number of wild animals they catch, kill, and pelt during the open season and the amount received for the sale of these pelts. Trappers are also required to report non-target species (any species for which the season is closed). IDFG uses this information to estimate statewide harvest of furbearers by licensed trappers, the distribution of the harvest, and the market value of the state's furbearer harvest.

IDFG harvest reports from 1993 to 2001 included questions on how many days the trapper spent afield scouting and setting or checking traps, and how many hours, on average, the trapper spent afield each day. These questions were used to gather information on trapping effort. Results of this information were then projected to estimate the statewide trapping effort both in total hours and days afield.

Beginning with the 2002–2003 trapping season, these questions were changed to include Catch-Per-Unit-Effort (CPUE). CPUE measures the harvest per unit of time and is useful in predicting population trends. It is based on the premise that as populations decline, fewer animals are available to be trapped so CPUE should decline. The inverse is also true; CPUE would increase as populations increase. CPUE is calculated by multiplying the total number of nights trapped by the average number of traps set per night (for a given species) and then dividing the number of animals trapped by this number. CPUE is recorded as animals trapped per 100 trap nights.

IDFG collected data on how many days the trapper spent afield scouting and checking traps, and how many hours, on average, the trapper spent afield each day from the 1993–1994 season through the 2001–2002 season. CPUE data has been collected since the 2001–2002 season.

Statewide population trends over the last five years are stable to increasing for muskrat, otter, and spotted skunk. Statewide population trends over the last 5 years are stable to slightly decreasing for badger, bobcat, coyote, and mink. Trends over the last five years were down for beaver, marten, raccoon, red fox, striped skunk, and weasel. Badgers, skunks, and weasels are usually trapped incidentally to trapping for other species. Some trappers trap specifically for otters, but otters are also trapped incidental to beaver trapping. Many trappers, who report harvest of badgers, skunks, weasels, and sometimes otters, do not report trap nights or traps set for these 4 species since they are trapping for other species. Therefore, CPUE may not be an accurate reflection of population trend for badgers, otters, skunks, and weasels.

Bobcats—IDFG collects additional data on bobcats. Bobcats are among those furbearers that are both hunted and trapped. Since the 1981–1982 season, trappers and hunters have been required to have all bobcats tagged by the Department within 10 days after the close of the trapping/hunting season. Trappers and hunters are required to present the pelts of all bobcats to a regional office or official checkpoint to obtain the appropriate pelt tag and complete a harvest report. Information on the harvest report includes the animal's sex, harvest location, date harvested, method of take (trapping, calling/hunting with hounds, incidental hunting), and beginning with the 2002–2003 season, CPUE. Mandatory harvest report data continue to be used to estimate the total statewide bobcat harvest by IDFG region and Game Management Unit (GMU).

Table 7-9. Annual combined furbearer catch per unit effort, 2002–2012

Trapping Season	CPUE = a/(b*c)*100
2002–2003	1.19
2003–2004	1.31
2004–2005	0.69
2005–2006	0.78
2006–2007	0.93
2007–2008	0.70
2008–2009	0.69
2009–2010	0.75
2010–2011	0.59
2011–2012	0.56
2012–2013	0.57

***River otters*—**Additional data is also collected on the river otter. The first river otter trapping season since 1972 was authorized during the 2000–2001 trapping season. A statewide quota of 100 otters was set. Once the regional quota was reached, trappers had 48 hours in which to have additional otters tagged, with a maximum allowable harvest statewide set at 121 otters. The harvest quota was changed to 102 animals for the 2002–2003 and 2003–2004 trapping seasons; and an individual trapper's quota was decreased from 5 to 2 river otters. Harvest quotas for the Planning Area have remained the same through the 2011–2012 season.

Trappers are required to have all river otters tagged by IDFG within 72 hours of harvest or to report their harvest to IDFG within 72 hours and make arrangements for tagging if special or unique circumstances exist.

Table 7-10. Bobcat catch per unit effort, 2002–2013

Trapping Season	CPUE = a/(b*c)*100
2002–2003	3.37
2003–2004	0.93
2004–2005	1.94
2005–2006	3.48
2006–2007	1.20
2007–2008	1.88
2008–2009	6.20
2009–2010	2.38
2010–2011	14.93
2011–2012	1.45
2012–2013	0.75

Issues and Concerns

Furbearers receive little, if any, consideration when designing habitat management projects (IDFG 1991). The value of beaver activity, though recognized, has not been utilized as a management tool to benefit fish and wildlife in Idaho.

Furbearers can and do cause property damage.

7.2.6.5 Moose

Importance in the Planning Area

Moose are an important big game animal in the Planning Area. Moose are managed by the Idaho Department of Fish and Game (IDFG) as a trophy big game species, using highly sought-after controlled hunts to limit harvest to allow continued expansion of populations across most of the Planning Area.

Moose in the Plan Area are in the very southern extent of their range. Their populations depend almost entirely on National Forest managed habitats. Moose in the Plan Area exhibit two life strategies: Some populations are found in climax vegetative cover. Their summer feeding habits tend to be nocturnal in open, wet meadows, while diurnal activity is limited to adjacent forested areas. Logging may reduce habitat for these populations. Winter habitat selection favors subalpine fir and Pacific yew plant communities. Other populations in the Planning Area are adapted to early seral plant communities, except in winter. Winter ranges appear to be timbered areas where yew-wood thickets are several hundred years old. These populations may be expanding in areas where extensive habitat manipulation has resulted in early seral brush-fields; however, creating openings in these timber stands through logging may impact moose by reducing or eliminating yew-wood thickets.

Status and Trends

Moose in the Plan Area are usually counted incidental to elk surveys. However, many moose are not counted because elk surveys are seldom flown at elevations where moose normally winter and because moose tend to prefer dense subalpine fir plant associations for winter habitat where they are less conspicuous. As a result, no comparative population data have been regularly collected. An aerial sightability survey of moose in Game Management Unit (GMU) 15 was attempted in 2000; however, results were unsatisfactory because of overly large confidence intervals due to the extreme correction factors applied to animals detected under heavy canopy cover.

IDFG uses mandatory harvest reports and reported non-hunting mortalities to provide limited insight into moose population status and trends. Harvest levels, hunter success, and hunter days expended are determined from mandatory harvest reports. Moose hunt controlled permit numbers are adjusted by IDFG for the Planning Area to respond to changes in hunter success rates and/or antler spread, which reflect moose population trends.

Moose populations are in serious decline in some parts of the Plan Area, particularly from the Lochsa River south, and especially in the Selway River and South Fork Clearwater River drainages (GMUs 15, 16A, 17, 19, and 20). Recent direction in the number of moose hunting permits across the Plan Area reflects the serious declines in moose populations in those Units over the past several years. Additional cuts in permits are likely in coming years.

Even as some moose populations in the Plan Area are suffering drastic declines, the population in other parts of the Plan Area appear to be increasing, apparently in response to extensive habitat alteration by silvicultural and agricultural practices that increase early seral browse favored by moose. Moose populations in these areas, however, typically have shown surges followed by declines.

Issues and Concerns

More intensive investigation of moose population levels, trends, and habitat selection and use are needed across the Plan Area.

The cause of the decline in moose in the southern parts of the Plan Area are not known at this time. Some part of the decline can probably be attributed to increased predation by wolves; however, moose populations are not showing the same rate of decline in the Lolo Zone and other northern GMUs where wolf densities and predation are higher. There is some current speculation that climate change may be contributing to impacts from parasites and diseases on moose, but confirmation is needed; research is currently being conducted in Minnesota on the effect of climate change on moose. IDFG started collecting tissue and other samples from harvested moose in 2013 in effort to find a cause for local declines.

Some moose populations may be displaced or eliminated because they cannot adapt to habitat changes, particularly where yew-wood thickets are reduced or eliminated through logging and where increased road densities make moose more vulnerable to harvest.

The effects of the recent expansion of wolves across the region on moose populations are as yet undetermined. In 2008, IDFG began monitoring moose in GMU 10 that were captured and radio-collared to determine mortality rates and causes of death in the presence of wolves. This work is being done in conjunction with ongoing wolf-elk interaction research in the Lolo Zone. A total of 12 radio collars were placed on yearling or adult moose during the 2008–2009 winter. Eleven of the 12 collared animals survived the first year. The lone mortality was a young bull that was harvested by a hunter in Hunt Area 10-3 in 2009. One additional radio collar was deployed in January 2010. Again, 11 of the 12 collared animals survived the year. The one mortality was a bull that was injured while sparring with another bull during the rut. In February 2011, an additional 22 moose were captured and radio-collared (2 bulls, 8 cows, and 12 calves). By early 2012, wolves had killed 1 adult cow moose and 6 calves. While results are very preliminary, to date wolves have not proven to be a significant cause of mortality on radio-collared adult moose. However, if early trends in wolf-caused calf mortality continue, calf survival and recruitment could become an issue.

Improvements in habitat and reductions in predation would be expected to increase white-tailed deer, mule deer, and moose populations that rely solely on National Forest habitats.

7.2.6.6 Mountain Goat

Importance in the Planning Area

Recreational opportunities associated with mountain goats include hunting and wildlife viewing, although opportunities to view and photograph mountain goats in Idaho are limited. Most people are unwilling or unable to climb into the steep and often remote country that goats occupy. The Idaho Department of Fish and Game (IDFG) has identified Mallard-Larkins Pioneer Area and Upper Trail Creek (Pope 2003) as popular with the public for mountain goat viewing in the Plan Area. Recreational interest may have adverse impacts on mountain goats because goats are sensitive to disturbance.

Mountain goats are hunted in the Plan Area, but on a very limited basis. A hunter is allowed only one opportunity to hunt for mountain goats in his lifetime but demand for a mountain goat hunting opportunity is high, with 400–500 applications submitted for the 40–50 mountain goat permits available annually statewide.

Many of the historic mountain goat hunting areas in the Clearwater region are currently closed to hunting because of low population levels or loss of mountain goats entirely from previously occupied ranges.

Biology

Mountain goats (*Oreamnos americanus*) are restricted to North America. All mountain goats are considered to be a single species. Mountain goats are not true goats, but are grouped with the ghoral and serow of Asia and the chamois of Europe into the tribe *Rupicaprini,* referred to as ”goat-antelopes” (Eisenberg 1981).

Both male and female goats have horns, although they have subtle differences in size and shape; horns are not present until 2 years of age. Adult males are generally 10–30% larger than adult females (Brandborg 1955, Houston et al. 1989) and males appear stockier or heavier in the chest and shoulders than females and the beards of males are heavier and broader than those of females. During breeding season, males urinate on themselves and paw dirt onto their body, giving them a dirty appearance. Adult males 2 years and older are normally solitary or with small groups of other males. Generally, adult animals alone and away from the nanny-kid-yearling herds are adult males, although this isn’t always the case (Smith 1988, Hibbs 1965). In some instances, the stage of hair molt can be used to determine sex and reproductive status (Brandborg 1955, Chadwick 1983). Adult males are the first to begin (usually in May) and complete shedding their winter coat, while nannies with kids are the last, often not shedding until August. Both males and females possess glands at the base of their horns thought to be used in mating behaviors (Geist 1964). Upon close examination, these glands are more prominent in males.

Nannies are dominant in mountain goat social structure.

Mountain goats typically select steep slopes and adjacent alpine areas at 4,500 to 8,000 feet in elevation, and occupy subalpine and alpine habitats where trees are either absent or scattered (Smith 1977). However, mountain goats winter near sea level in the rugged ranges of southeast Alaska and British Columbia (Hebert and Turnbull 1977), and occur at elevations >12,000 feet in Colorado’s Rocky Mountain Range (Hibbs 1967). Many goat populations have average group sizes of 5 or less (Hebert and Wood 1984, Varley 1996, Poole et al. 2000) However, goats tend to congregate in larger groups in late spring to early summer as they stage on windswept, grassy plateaus before moving to summer range at higher elevations.

Habitats selected by mountain goats are often characterized by harsh climates having frequent strong winds, high snowfall, and snow accumulations persisting more than 8 months annually. Mountain goats may move to lower elevations to escape the most severe winter weather, but often winter in small, protected micro-habitats characterized by steep snow-shedding slopes where high winds preclude snow accumulation and south-facing slopes that warm quickly when exposed to the sun. In some habitats, wind actions reduce snow cover at higher elevations, and in these areas, mountain goats may winter at higher elevations than used during summer months.

Mountain goats are intermediate browsers, feeding primarily on grasses during the summer (Laundré 1994). Alpine shrubs and browse constitute nearly half of the summer diet. Grass is also used preferentially during fall and winter when it is exposed. However, in areas where grasses are covered by snow, mountain goats readily switch to a diet of browse including mountain mahogany (*Cercocarpus ledifolius*) and conifers such as Engleman spruce (*Picea englemannii*) and subalpine fir (*Abies lasiocarpa*). Where available, mosses and lichens may also be selected (Cowan 1944, Harmon 1944, Casebeer 1948, Brandborg 1955, Saunders 1955, Geist 1971, Hjeljord 1971, Peck 1972, Hjeljord 1973, Bailey et al. 1977, Adams 1981, Adams and Bailey 1983, Fox and Smith 1988; *for reviews, see* Laundré 1994, Côté and Festa-Bianchet 2003).

Perhaps due in part to the shallow, undeveloped soils typical of many mountain goat habitats, mountain goats appear to be very sensitive to nutrition level and availability of supplemental minerals. Smith (1976) reported a correlation between female nutrition and kid:nanny ratios, and Bailey (1986) reported that availability of summer forage was related to pregnancy rate. Fox et al. (1989) reported that winter forage was critical both to adult over-winter survival and fetal development. Mountain goats may travel long distances to obtain trace minerals from the soil at natural or artificial mineral licks (Hebert and Cowan 1971, Adams 1981, Singer and Doherty 1985, Hopkins et al. 1992), and may be particularly susceptible to selenium deficiency (Hebert and Cowan 1971).

As habitat specialists, mountain goats evolved to occupy steep rocky terrain where there was little competition with other ungulates for forage and little risk from predators. However, such a predator-avoidance strategy inevitably limits the size of mountain goat populations (Geist 1982). If mountain goats are limited by distance to escape cover, only a fixed amount of habitat is available; and increases in population size must be associated with reduced resources available per animal or population density. To avoid over-crowding, mountain goats must defend individual territories. Further, to maximize reproductive fitness in a polygamous mating system, females and their offspring must be able to select the best and most secure habitats. All of these hypotheses appear to apply to mountain goat populations (IDFG 2006).

Population fitness can be optimized by strategies that include maximizing the amount of area used daily and seasonally (i.e., relatively large daily movement patterns and seasonal migrations) and behaviors that segregate areas used by females and kids from those used by males. Nursery groups made up of females and their offspring, including males to 2 years of age, typically move greater distances daily (2–5 km/day) than males (<1 km/day) (Singer and Doherty 1985, Côté and Festa-Bianchet 2003). Females were reported to move nearly twice as far each day (~1 km) as males (Singer and Doherty 1985), and to have much larger home ranges (25 km^2 compared to 5 km^2 for males) in Alberta (Côté *in* Côté and Festa-Bianchet 2003), although such a large discrepancy was not noted in some other studies (Rideout 1977, Singer and Doherty 1985).

Seasonal migrations of mountain goats have been widely reported where more-or-less continuous habitat exists. Most commonly, seasonal movements result in the animals moving to lower elevations at or just above tree-line or slopes with southern exposures (Brandborg 1955, Hjeljord 1973, Smith 1976, 1977, Rideout 1977). In coastal Alaska and British Columbia, mountain goats may descend to near sea level and winter in coniferous forests (Hebert and Turnbull 1977, Fox 1983).

In summer, males may venture into forested areas away from steep slopes to feed, while females and kids usually feed on or in immediate proximity to steep slopes used to escape potential predators. Even during winter, the sexes may separate. Males may occupy areas with deeper snow than females, and individuals of either sex may select a favorable microhabitat, like a monolith or rocky slope surrounded by timber, and over-winter individually in tiny seasonal home ranges of 0.5 to 1.5 km^2 (Keim 2004).

In addition to such repeatable movements associated with daily foraging, trips to mineral licks outside of normal home range areas, and seasonal migrations, mountain goats may make extended “exploratory” movements through unoccupied terrain. Although young males ages 1–3 are most likely to disperse into unoccupied habitats (Stevens 1983), adult animals of either sex may make such moves. These movements often take the form of searching for apparently suitable habitats visible from occupied habitat; that is, an individual animal of either sex may move from an occupied habitat to a visible rocky monolith or step slope, passing through miles of forested land to do so.

The ability of mountain goats to cross apparently unsuitable low-elevation and forested terrain to establish new populations was recently documented by Lemke (2004) in southern Montana, where mountain goats have expanded their range into a previously unoccupied area (the Gallatin Mountain Range) and southward into Yellowstone National Park in Wyoming. Another well-documented example is the colonization of the Olympic Peninsula (Houston et al. 1994).

As habitat specialists, mountain goats are superb colonizers (Kuck 1977, Adams and Bailey 1982, Swenson 1985, Kuck 1986, Houston and Stevens 1988, Hayden 1989, Houston et al. 1994, Lemke 2004). Mountain goats readily adapt to new habitats following transplants, and they readily colonize habitats formerly inaccessible because of snow and ice cover (i.e., retreating glaciers and snowfields) or vegetation (occupying burned-over habitats formerly forested). In these situations, mountain goat populations typically exhibit high pregnancy and twinning rates associated with a high plane of nutrition and high rates of survival. During the initial expansion phase of population growth, the annual growth rate in Idaho was 22% (Hayden 1989). Similarly rapid population increases following transplants have been noted in North Dakota, Oregon, Utah, and Wyoming.

The period of initial expansion is followed by a period of population stabilization as available habitat becomes fully occupied and density-dependent factors begin limiting further population expansion. This expansion is then followed typically by a phase of population decline as mountain goats become limited by food resources, predators, and diseases (Caughley 1970). Older populations persist at some “post-decline” level dictated by range conditions (Bailey 1991), weather, predators, and disease. Data from Idaho (Toweill 2004) indicates that this cycle, from transplant to post-decline, may occur over a period of 30–40 years.

Population Biology

Mountain goats breed between early November and mid-December (Geist 1964), with males moving among groups of females and tending estrous nannies for 2–3 days (DeBock 1970, Chadwick 1983). In some populations, nannies reach sexual maturity at age 2 and produce their first kid at age 3 (Peck 1972, Stevens 1980, Bailey 1991), while in other populations age at first breeding is 3 years (Festa-Bianchet et al. 1994). This delay in sexual maturity dramatically reduces the potential for rapid growth in mountain goat populations (Lentfer 1955, Hayden 1990). Twinning rates are generally low, but can be higher in expanding populations on good ranges (Holroyd 1967, Hibbs et al. 1969, Hayden 1989, Foster and Rahs 1985, Houston and Stevens 1988). Nannies rarely bear triplets (Hayden 1989, Hanna 1989, Lentfer 1955, Hoefs and Nowlan 1998).

Mountain goat kids are precocious and begin to forage and ruminate within days after birth (Brandborg 1955, Chadwick 1983). After approximately 2 weeks of seclusion, nannies with new kids form nursery groups with other nannies and kids, which often include yearlings. During this period, 2 year-old billies generally leave the nursery herd and remain solitary or form small groups of males. Kids remain with their mothers through their first winter and, although the presence of the mother is thought to increase survival of kids, orphaned kids can survive (Foster and Rahs 1982). Once sexually mature, reproductive success generally increases and peaks at 8 years of age, at which point it declines (Stevens 1980, C.A. Smith 1984, Bailey 1991).

Mortality

Mountain goats have adapted to harsh environments through a strategy that focuses more on the survival of individual goats than on production of offspring (Hayden 1990). Severe winters and their impact upon availability of winter forage and energy expenditure have been frequently hypothesized as the primary factor leading to mortality among mountain goats (Dailey and Hobbs 1989). A negative correlation has been found between snow depth and kid:adult ratios (Adams and Bailey 1982), while a positive relationship was found between reproductive rates and total winter precipitation 1.5 years prior to birth (Stevens 1983). In Alaska, severe winters were correlated with poor reproduction the following spring (Hjeljord 1973).

Documented annual mortality rates in Alaska were 29% for yearlings, 0–9% for age classes 2–8, and 32% for goats older than 8 years (C.A. Smith 1986). Goats older than 8 died primarily from predation or other natural factors, while hunting was the primary cause of mortality among prime-aged goats. Annual mortality in Alberta was 28% for yearling males and 16% for yearling females (Festa-Bianchet and Cote' 2002). Mortality of males from 4–7 years was 5% but increased dramatically after 8 years. Between ages 2 and 7, mortality of females was 6%. As a result of mortality and emigration, only 39% of yearling males were still present in the population as 4 year olds. In a rapidly growing population in Idaho, kid mortality was only 12% and yearling mortality only 5% (Hayden 1989). Forty percent mortality was documented among marked kids in the Black Hills of South Dakota; yearling and older goat mortality was estimated to be 14% (Benzon and Rice 1988).

Mortality of young goats can be high during their first winter. Kid and yearling mortality during a severe winter was 73% and 59%, respectfully, while only 27% and 2%, respectively during a mild winter (Rideout 1974). During a series of severe winters in Colorado, kid mortality reached 56% and kid:adult ratios dropped from 48:100 to 14:100 (Thompson 1981). Total population declines of 82–92% occurred following severe winters in coastal British Columbia (Hebert and Langin 1982).

Grizzly bears (Festa-Bianchet et al. 1994, Jorgenson and Quinlan 1996, Cote' and Beaudoin 1997), wolves (Fox and Streveler 1986, C.A. Smith 1986, Cote' et al. 1997), mountain lions (Brandborg 1955, Rideout and Hoffman 1975, Johnson 1983), coyotes (Brandborg 1955), golden eagles (Brandborg 1955, Smith 1976), and wolverines (Guiguet 1951) have all been identified as predators of mountain goats. In west central Alberta, juvenile annual mortality was 42%, with most mortality occurring prior to November (Smith et al. 1992). A total of 88% of this mortality was predation by wolves, grizzly bears, and mountain lions. A majority of kid mortality was attributed to grizzly bears (Festa-Bianchet et al. 1994). In Alaska, goat remains were found in 62% of wolf scats (Fox and Streveler 1986), while only 2% of wolf scats from Banff National Park in Alberta contained goat remains (Huggard 1993). In Yellowstone National Park researchers have documented 2 confirmed wolf kills of mountain goats out of approximately 3,000 confirmed kills (D.W. Smith, National Park Service, personal communication cited in IDFG 2006).

Diseases and Parasites

Very few reports document infectious diseases in mountain goats, which is probably more a reflection of how little we know of this species than its actual health status. Because of their remote habitat preferences, sick or dead goats are rarely observed or found.

Most information about the parasite fauna of mountain goats comes from work in the 1950s to 1970s on a few populations in Canada (Alberta and British Columbia) and the United States (South Dakota, Idaho, and Montana). Recent investigation into the parasite fauna of mountain goats is slim, and in fact "there is currently insufficient information available to complete an accurate [health] risk assessment for this species" (Garde et al. 2005). Parasites and other pathogens previously identified in mountain goats are summarized in the appendices of Garde et al. (2005). Recent reviews of the parasite fauna of mountain goats include Hoberg et al. (2001) and Jenkins et al. (2004).

Mountain goats may commonly share parasite species with sympatric wild ungulates, including bighorn sheep (Samuel et al. 1977). For example, *Parelaphostrongylus odocoilei*, a muscle-dwelling roundworm, may be transmitted among mountain goats, thinhorn sheep, and black-tailed deer, all of which could potentially share range in the coastal mountains of north central North America. Transmission of parasites, unlike most bacterial or viral pathogens, does not require direct contact; instead, shared range use (even seasonally) may result in transmission. This has implications for management (especially if animals are translocated), and may have significance for the health of these populations.

Responses to Human Disturbance

Recreational opportunities associated with mountain goat management include hunting and wildlife viewing. Demand for hunting opportunity is high, with 400–500 applications submitted for the 40–50 mountain goat permits available annually since 2000. Opportunities to view and photograph mountain goats in Idaho are limited for those unwilling or unable to climb into the steep and often remote country that mountain goats typically occupy. Viewing sites in the Plan Area include the Mallard-Larkins Pioneer Area, and Upper Trail Creek (Pope 2003). These sites are very popular with the public.

However, much winter recreation has high potential to adversely impact mountain goat populations. Mountain goats are more susceptible to disturbance by helicopters than most open-terrain ungulates; Cote (1996) reported that mountain goats exhibited overt responses to 58% of helicopter flights within 1.2 miles, and Gordon and Reynolds (2000) reported that mountain goats exhibited moderate to extreme response to helicopters during 75% of all sightings from the helicopter.

Winter disturbance is especially problematic, since mountain goats that are already stressed by cold and limited food supplies may exhibit panic, increased metabolic rates and energy expenditure, and reduced time spent feeding (Gordon and Reynolds 2000). Repeated disturbance by helicopters, snow machines, or even logging or road building (Chadwick 1983) may result in abandonment of favored habitats—steep cliffs that readily shed snow cover, allowing goats access to forage in an environment where they are normally secure from predators—potentially reducing probability of winter survival through increased energetic demand associated with feeding and increased exposure to potential predators.

Increased winter activity in the vicinity of mountain goat habitat, especially heli-skiing and over-snow travel by snowmobiles, has potential to severely reduce the amount of habitat that may be used by mountain goats (IDFG Draft Mountain Goat Management Plan 2006).

Anthropogenic disturbance of ungulates is postulated to have a variety of effects, including habitat abandonment, changes in seasonal habitat use, alarm responses, lowered foraging and resting rates, increased rates of movement, and reduced productivity (Pendergast and Bindernagel 1976, MacArthur et al. 1979, Foster and Rahs 1981, Hook 1986, Joslin 1986, Pedevillano and Wright 1987, Dailey and Hobbs 1989, Frid 1997, Duchense et al. 2000, Phillips and Alldredge 2000, Dyer et al. 2001, Frid 2003, Gordon and Wilson 2004). Non-lethal disturbance stimuli, like helicopter or snow machine activity, can impact feeding, parental care, and mating. It can also significantly affect survival and reproduction through trade-offs between perceived risk and energy intake, even when overt reactions to disturbance are not visible (Bunnell and Harestad 1989, Frid and Dill 2002). Increased vigilance resulting from disturbance may also reduce the physiological fitness of affected animals through stress, increased locomotion costs, particularly deep snow conditions during winter, or through reduced time spent in necessary behavior such as foraging or ruminating (Frid 2003). Physiological responses, such as elevated heart rates, to disturbance stimuli may not be reflected in overt behavioral responses to disturbance (Macarthur et al. 1979, Stemp 1983, Harlow et al. 1986, Chabot 1991), but are nonetheless costly to individual animals and, ultimately, to populations.

The increasing use of aircraft near occupied mountain goat habitat is of particular concern to IDFG (IDFG 2006). While the short-term, acute responses of mountain goats to helicopters has been documented (Côté 1996, Gordon and Reynolds 2000, Gordon 2003) and repeatedly observed by wildlife managers, the medium- and longer-term effects of aircraft activity on mountain goat behavior and habitat use remains unclear (Wilson and Shackleton 2001). Helicopter-supported recreation is increasing in or near occupied mountain goat habitats across North America, exacerbating concerns (Hurley 2004) regarding the long-term effects of such activity on mountain goats.

The degree to which aircraft overflights influence wildlife is thought to depend on both the characteristics of the aircraft and flight activities and species or individual specific factors (National Park Service 1994, Maier 1996 *in:* Goldstein et al. 2004). Recent studies have shown that management of approach distances may ameliorate behavioral disruption from helicopter activity (Goldstein et al. 2004). How flight vectors and topographic variables affect mountain goat short-term overt reactions to helicopters, however, remains poorly understood. The timing of disturbance is likely a key factor determining the strength of mountain goat overt disturbance reactions and the overall effect of helicopter activity on activity patterns; the potential impacts of helicopter activity on mountain goats must be considered in the context of the ecological season and time of year. Fox et al. (1989) found that winter was a period of severe nutritional deprivation for mountain goats; winter is thus of particular concern for the management of disturbance stimuli, because periods of deep snow can reduce food availability and increase locomotion costs (Dailey and Hobbs 1989). Fixed-wing aircraft and ground-based disturbances are generally thought to be less disruptive compared to helicopters (Foster and Rahs 1983, Pedevillano and Wright 1987, Poole and Heard 1998).

Ground-based recreation, particularly motorized recreation such as the use of ATVs and snowmobiles, can disrupt use of habitat by mountain goats or result in behavioral disruptions. IDFG is concerned about increasing over-snow motorized incursions into mountain goat wintering areas observed during elk survey flights. Increasing motorized winter access into winter habit has the potential to displace mountain goats from winter habitat, which is limited in the Plan Area. (IDFG, Hickey, 2014. Pers Comm)

Harvest can also affect mountain goats. Mountain goats seasonally occupy habitats associated with high timber values, particularly in coastal ecosystems (Hebert and Turnbull 1977). The most significant threat associated with forest harvesting is the removal of old and mature forest from goat winter ranges (Wilson 2004). A dense, mature coniferous forest canopy is required to intercept snow and to provide litterfall forage to sustain goats through periods of nutritional deprivation, particularly in coastal ecosystems (Hebert and Turnbull 1977). Forest harvesting may also disrupt dispersal movements, movements between seasonal ranges, and use of mineral licks accessed via traditional trails (Wilson 2004). Forest cover adjacent to traditional low-elevation trails is also considered important for visual protection from predators (Hengeveld et al. 2003).

Access to areas occupied by mountain goats via logging roads is a key factor in the success of goat hunters (Phelps et al. 1983). Proximity of roads to mountain goat habitat is the most important determinant of hunting pressure; hunters are generally deterred from hunting distances less than 2 km from roads (Hengeveld et al. 2003 *in:* Wilson 2004). The continuing expansion of roads and motorized trail networks is eroding the *de facto* protection provided by the remote terrain used by mountain goats (Wilson 2004). Increasing road access near mountain goat habitat has resulted in local extirpations due to hunting in several areas in British Columbia. Increasing road access during the 1960s in the Kootenay region, for example, led to over-hunting from which populations never fully recovered (Phelps et al. 1983 *in*: Wilson 2004). With reductions in mountain goat populations, including extirpation in certain locations, conservation efforts have resulted in hunting closures.

Although mountain goats generally inhabit remote and precipitous terrain, they also make use of critical, low-elevation features that put them in direct conflict with a number of land uses including forestry, road building, and mineral exploration. Because mountain goats travel long distances along traditional trails to access low-elevation mineral licks, industrial activity near trails and licks has the potential to disturb and displace goats from critical habitat features (Hebert and Cowan 1971, Hengeveld et al. 2003 *in:* Wilson 2004). Blasting activities associated with road construction, mineral extraction, or other industrial activities can also directly affect the suitability of mountain goat habitat by precluding use of critical escape terrain. Blasting might also disturb mountain goats during critical periods, such as kidding, or increase the risk of avalanches on winter ranges (Wilson 2004).

Mountain goats have a lower recruitment rate than other ungulates (Festa-Bianchet et al. 1994); mountain goats in some areas have been noted not to produce young until 4 to 5 years of age. Reduced fitness or vigor or indirect mortality resulting from disturbance may present a greater risk to mountain goat population viability compared to other ungulates, supporting the need for species-specific mitigation strategies to reduce disturbance effects (IDFG MGP). Previous studies have found that human displacement reduced elk reproductive success, supporting maintenance of disturbance-free areas during parturition periods (Phillips and Alldredge 2000). Nannies and kid mountain goats typically occupy remote, inaccessible portions of their home range during the kidding period in May/June (DeBock 1970, Chadwick 1973, Rideout 1978, Shackleton 1999, Gordon 2003) and may be at increased risk due to accidental mortality during this period. Because nannies are the dominant animals in the mountain goat social hierarchy and represent the potential for recruitment of new individuals into a given population (Chadwick 1973, Côté 1996), the effects of helicopter disturbance on adult female goats is of particular interest. Ungulates have been shown to be particularly sensitive to disturbance during parturition and early rearing of young (Penner 1988, Dyer et al. 2001). Given the highly synchronous birthing in mountain goats (DeBock 1970, Côté and Festa-Bianchet 2001) and the high fidelity of goats to the habitats they inhabit (Chadwick 1973, Fox 1983, Stevens 1983), development and application of mitigation measures for aerial disturbance near habitats occupied by nannies and kids should be feasible from a management perspective (Hurley 2004).

Mountain Goat Population Status and Trends Based on IDFG Goat Management Zones

IDFG goals for managing mountain goats in the Plan Area include increasing populations through conservative hunting seasons, capturing and translocation into vacant habitat or to augment existing populations, maintaining harvest and recreational opportunity, emphasizing non-consumptive values, inventorying all mountain goat populations at a maximum interval of 5 years, and collecting information on mountain goat diseases. In areas where populations have been severely reduced, no hunts will be offered until those populations recover to satisfactory levels. IDFG may utilize translocation to reestablish or augment mountain goat populations as mountain goats become available and approval with land management agencies can be acquired.

IDFG tracks mountain goat populations in designated Game Management Units (GMUs) using both population surveys and mandatory hunting reports.

GMUs 10, 12, 15, 16, 16A, and 17

Mountain goat habitat in GMUs 10, 12, 15, 16, 16A, and 17 is located mainly along the Idaho-Montana border and in rocky cliffs of North Fork Clearwater, Lochsa, and Selway river drainages. Nearly all of the land that supports mountain goats is under U.S. Forest Service (USFS) ownership and management.

Historically, mountain goats were hunted on a general-hunt basis in the Planning Area north of Salmon River. As a result, some of the easily accessible herds were over-hunted or eliminated. From 1966 to present, because of low mountain goat population numbers, all mountain goat hunts have been offered only as controlled hunts. Hunt areas were originally quite large, often including several discrete populations of mountain goats; however, in 1972, hunts were divided into smaller, more easily managed controlled hunts to regulate and to more evenly distribute hunting pressure. In general, the more accessible mountain goat populations still receive the brunt of the harvest.

Mountain goat populations are tracked by IDFG using both population surveys and harvest reports. GMUs 12 and 17 have not been surveyed since 1994 and 1996, respectively (Table 1 from PR report). A paintball, mark-resight survey of the Black Mountain (GMU 10) goat population was conducted during April and May 2010. Data from that survey suggested a slight increase in the mountain goat population since the previous survey in 2005 (Table 1). In 2005, 85 ± 17 mountain goats were observed over both hunt areas, compared to 100 ± 7 in 2010. Additionally, a survey was conducted in the old Blacklead hunt area (S.F. Kelly Creek to

Williams Creek) in GMU 10 and the Boulder Creek/Crooked Fork in GMU 12. Forty-seven goats were observed in those survey areas, compared to 136 goats observed in 1996. The decline prompted a decision to suspend future translocation removals from that area.

Mountain goat harvest levels have changed little in the Planning Area during the last 10-year period. GMU 10-2 was closed to mountain goat hunting in 1997 due to the decline in mountain goat numbers revealed by a 1996 survey. After observing substantial numbers of goats during later elk surveys, a separate goat survey of this area was conducted in 2010. Sufficient numbers of goats were observed in this area to reinstate the Unit 10-2 hunt with 2 tags.

Lack of mountain goat population growth in Hunt Area 10 will lead to more conservative and cautious management to avoid over-exploitation.

GMUs 14, 18, 19, and 20:

The deep, rugged canyons of the Snake and Salmon rivers dominate the topography of GMUs 14, 18, 19, and 20. Mountain goat populations in this area are found almost exclusively in habitat designated as wilderness managed by USFS. Mountain goats in GMU 18 are found in the Seven Devils area, while those in GMUs 19 and 20 are found on the breaks of the Salmon River in the Gospel Hump and Frank Church-River of No Return wilderness areas. Habitats in both areas are generally drier and more open than mountain goat habitat found in GMUs 10 and 17.

A paintball mark-resight survey was conducted in GMUs 18 and 22 in April and May 2007; an estimate of 194 ± 29 goats was obtained. Using the same technique in 2002 generated an estimate of 196 ± 22 goats in Hunt Area 18, both surveys suggesting a potential increase in abundance from the 1999 estimate of 171 ± 48 (Table 5). The population trend in GMUs 18 and 22 appears to be stable.

Issues, Stressors, Concerns

Mountain goats occupy a narrow habitat niche and that habitat is limited in the Plan Area; therefore, displacement of mountain goats from their habitat will have a magnified effect on the population. IDFG (Hickey, 2014. Pers Comm) has observed during elk survey flights increasing incursions of over-snow recreational traffic into mountain goat winter range in recent years. This has led to concerns that mountain goats, which are susceptible to human disturbance, may be displaced from preferred winter habitat, which is limited in the Plan Area. Similarly, helicopters are known to cause disturbance, displacement, and even goat mortality (Cote' 1996; IDFG Draft Mountain Goat Management Plan 2006).

Timber harvest and related habitat impacts and disturbance have been identified as a concern by IDFG across mountain goat ranges (IDFG Draft Mountain Goat Management Plan 2006). Most mountain goat habitat on the Nez Perce-Clearwater National Forests is in proposed wilderness or is in low-value timber, however, and is not likely to be directly impacted by harvest unless access, harvest technology, or timber demand change.

Disturbance displacement from traditional trails and licks can affect mountain goat populations (IDFG 2006). However, the location of trails and licks are not well known on the Forest. Where known or found, management impacts to licks and traditional goat trails should be avoided.

7.2.6.7 Mountain Lion

Importance in the Planning Area

Mountain lions (*Puma concolor)* are found throughout the Planning Area, although suitable and occupied habitat is patchy in some areas. Mountain lions are important as both a target species for hunters and as a predator that may influence populations of large ungulates, like elk and deer, which are also popular hunted species. Mountain lions are rarely seen in the wild, so they have little value to wildlife watchers; however, they are appreciated as a symbol of wild places and have cultural, scientific, and genetic values (IDFG 1990).

Mountain lions occupy a wide range of habitats in Idaho and across the Plan Area. Lion habitat is defined by vegetative structure, topography, prey numbers, and prey vulnerability. The energetic needs of female lions with kittens limit viable populations to areas with sufficient numbers of deer and elk. Human activities have and will continue to affect the quantity and quality of mountain lion habitat by directly and indirectly altering the structure of vegetative communities and altering the number and distribution of prey animals. Thus, land use or habitat management practices that impact ungulate prey will also impact mountain lions. Road construction and improvement likewise increases mountain lion vulnerability by increasing access into previously remote or inaccessible ungulate winter ranges.

Biology

Mountain lion populations consist of resident adult males and females, transient males and females, and kittens of resident females. Home ranges are maintained by resident lions but not by transient lions. Home range size varies by sex and age of the lion, reproductive status, season of the year, and distribution and density of prey species. Resident lions maintain contiguous but fairly distinct home ranges in winter and summer. There is usually little overlap of resident male home ranges; however, each male home range may overlap more than one female home range. Home ranges of resident females overlap to varying degrees; usually female progeny will share some part of their maternal home range. Home range boundaries are maintained by mutual avoidance and marking by scrapes and scent marks. This form of home range maintenance serves as a mechanism to limit population density.

Female mountain lions become sexually mature and breed as early as 20 months of age, but first breeding may be delayed until age 5 depending upon social status and whether or not the female has established a home range. Kittens are produced every second or third year thereafter. Litter size varies from 1–6, but 2 and 3 kittens are most common. Young remain with their mothers for 17–22 months and may be self-sufficient at 10–15 months of age. Mountain lions may breed at any time of year in Idaho, although the peak of births is in spring. Thus, at any time of year, an adult female may have kittens or yearlings dependent upon her for food and survival. If an adult female is killed, chances of survival for her offspring are greatly reduced. Female mountain lions, especially those with kittens, tend to be easier to find and kill than males. A female must continually return to her kittens, and in so doing, leaves many tracks in a localized area. Adult females are also subject to more stress and risk of injury than males because they must hunt and kill large, potentially dangerous prey animals at more frequent intervals to successfully rear their kittens.

Mountain lion population density and age composition are primarily affected by exploitation rates. Mountain lion populations in remote areas usually have low exploitation rates, low population turnover, a greater proportion of resident lions, and an older age composition. Areas that are easily accessible have higher exploitation rates, high population turnover, a greater proportion of transient lions, and hence younger age composition. Research on exploited populations adjacent to stable, lightly hunted areas, indicates that mountain lion populations comprised primarily of young (4 years and younger) individuals may reach higher densities than populations with a large percentage of mountain lions in the 5-year and older age classes due to disruption of the self-spacing aspects of mountain lion social organization. Only uniform, heavy exploitation over the entire range will depress the number of mountain lions in these situations.

Mountain lions in North America have evolved to prey on moderate-sized mammals. In areas where a variety of prey types are available, deer and deer-sized prey appear to be the staple in lion diets. Larger prey such as adult elk and smaller prey such as a variety of rodent and bird species are also regularly taken. Ungulates are likely the staple diet for mountain lions in many areas, including the Plan Area, but the extent and effects of predation are not well understood. Lion predation on ungulate populations in Idaho likely varies with the species of prey, prey numbers and recent population trends, lion numbers, the types and abundance of other prey, and the types and abundance of other predators such as wolves, coyotes, black bears, man, and grizzly bears. Predation impacts also vary with habitat and land use characteristics, climate and weather, and hunting pressure, among other influences.

The impact of mountain lions on ungulates differs under varying circumstances. The type and strength of relationships between lion predation and ungulate populations have major implications to both lion and ungulate management. Identifying and understanding these relationships in areas with different complements of ungulates, predators, and habitats are important to managing mountain lions.

The future of mountain lions in Idaho depends upon the retention of sufficiently large habitat "reservoirs" that are managed for (i.e., have strict harvest regulations) or naturally contain low road densities and limited access. These areas provide resident mountain lion populations increased security and reduced vulnerability. Travel corridors connecting these and less remote areas must also be present to facilitate dispersal to provide a continual supply of young lions to repopulate adjacent habitats that are more easily accessed and heavily exploited. Any permanent reduction of wildlife habitat will result in reduced mountain lion populations; particularly losses of deer and elk winter ranges to industrial, residential, and recreational development.

In those portions of the state where mountain lion predation, depredations, or conflicts with humans are a concern, IDFG employs harvest as a tool to maintain mountain lion populations. IDFG permits liberal harvest and harvest techniques over much of the Plan Area in an effort to reduce mountain lion numbers and limit predation on deer and elk.

Mountain Lion Population Status and Trends in the Plan Area, by Idaho Department of Fish and Game Management Unit

No reasonable, reliable field survey methods are available to closely monitor mountain lion populations over a large landscape. IDFG has tracked mountain lion populations primarily through mandatory harvest reports since 1973. More recently, lion pelts tagging was required; premolar teeth have been removed for aging since 2001.

IDFG reports harvest for Mountain Lion Data Analysis Units (DAUs), which are generally comprised of one or more Game Management Units (GMUs). DAUs are based on similar habitat types, habitat security, accessibility, lion population density, prey species availability and, often, similarity to elk zone designations.

Palouse-Dworshak Data Analysis Unit

The Palouse-Dworshak DAU is comprised of GMUs 8A and 10A. Portions of both GMUs are within the Plan Area.

Three-quarters of Palouse-Dworshak DAU is comprised of timberlands owned by Potlatch Corporation, Idaho Department of Lands (IDL), and U.S. Forest Service (USFS). Timber harvest activity has created vast acreages of early successional habitat benefiting several ungulate prey species. The remaining one-fourth of the DAU is open or agricultural lands providing high-quality forage for deer and elk at certain times of the year. The area is bisected by canyons leading to the Palouse and Potlatch rivers (GMU 8A), Clearwater River, and lower North Fork of the Clearwater River (GMU 10A). Both GMUs share a common border along the lower end of Dworshak Reservoir. High open and closed road densities throughout the DAU provide good opportunities for hunting mountain lions.

Status and Trends

The Palouse-Dworshak DAU has a long harvest season, from 30 August–31 March. Harvest has been highly variable, probably due to varied hunting conditions between years.

Due to the increase in sightings and reports of encounters during the mid-1990s in this DAU, hunting seasons were liberalized. Harvest continued to increase and reached an all-time high during the 1997 season. It is likely that, due to the dense white-tailed deer populations throughout much of this DAU, the mountain lion population expanded its range into lower elevations and took advantage of the abundant whitetail population. This could potentially account for increased observations of mountain lions in lower-elevation whitetail habitat in this DAU during the mid-1990s. Despite a longer season, harvest has remained below the 1997 peak and currently has stabilized at about half that level.

Harvest increased dramatically from 1991–1997 in GMU 10A, where the highest annual harvest in the Clearwater region has occurred every year since 1994. Although lion harvest has declined from a peak in 1997, the GMU retains a relatively high harvest level. It is unclear whether the current status is a result of a population change or variable hunting conditions. However, hunters are indicating that lion observations are becoming less frequent.

Mountain lion harvest in the Palouse-Dworshak DAU averaged 30 lions for the 2009–2011 seasons; 34 lions were harvested in the 2011 season. This is above the 1990–1992 minimum harvest objective of 21. Subadults accounted for 44% of the harvest for the 2009–2011 seasons.

Issues and Concerns

None.

Lolo Data Analysis Unit

The Lolo DAU is comprised of GMUs 10 and 12. Units 10 and 12 are entirely within the Plan Area. Habitats include dense coniferous forest and mountains with relatively high precipitation.

Lion hunter access to the Lolo DAU is extremely limited during winter months, except along State Highway 12 from Lowell to Lolo Pass and by snowmobile along the North Fork of the Clearwater River. Much of both GMUs are difficult to access during hunting seasons because of snow, mud, and steep, rugged terrain. Deer and elk populations throughout most of the DAU provide a considerable prey base; however, elk numbers have declined drastically over the past 10 to 15 years.

Status and Trends

Harvest regulations are aimed at encouraging harvest and reducing lion predation on elk and deer within these GMUs. The current Lolo DAU mountain lion harvest season is relatively long, beginning at the end of August and extending through March. Bag limits and permitted techniques are also liberal, allowing harvest of 2 lions and the use of electronic calls for hunting lions in GMU 12.

The remote nature and difficult access in this DAU result in a moderate harvest level. An average harvest of 19 lions occurred for the 2009–2011 seasons. During the 2011 season, Lolo DAU hunters harvested 22 mountain lions, which is above the 1990–1992 minimum harvest objective of 20. Subadults accounted for 33% of the harvest for the 2009–2011 seasons.

Mountain lions appear to be declining in this DAU. This is probably a result of the effects of substantial decreases in elk numbers over the past few years and, to a lesser extent, additional lion hunting pressure from reduced nonresident tag costs and the 2-lion bag limit.

Issues and Concerns

None

Hells Canyon Data Analysis Unit

Hells Canyon DAU is comprised of IDFG GMUs 11, 13 and 18. Portions of Units 13 and 18 are within the Plan Area.

Habitat in Hells Canyon GMUs varies greatly across the DAU. Steep, dry river-canyon grasslands give way to higher-elevation forests that receive greater precipitation. Road density is moderate and access is limited in many areas. This DAU contains large tracts of both privately and publicly owned land. GMU 13 is primarily under private ownership and is managed mostly for agriculture and livestock production. GMU 18 is two-thirds public land, mostly in the Hells Canyon Wilderness and National Recreation Area. All three GMUs have borders along the Snake and Salmon rivers. Healthy mule deer and elk populations, as well as some white-tailed deer, provide a prey base for mountain lions.

Status and Trends

Hells Canyon DAU currently has a long mountain lion harvest season, from September through March.

Mountain lion harvest in Hells Canyon DAU has historically been moderate. For the 2009–2011 seasons, harvest averaged 20 lions per season. Seventeen mountain lions were harvested in the 2011 season. This level surpassed the IDFG 1990–1992 minimum harvest objective of 15 per year, but represents a decline from 2009 when 25 lions were harvested. Subadults accounted for 33% of the harvest for the 2009–2011 seasons.

Little change in lion harvest has occurred in this DAU since 1998. Harvest has remained low except when favorable weather conditions have provided increased lion harvest opportunities.

Issues and Concerns

None

Elk City Data Analysis Unit

Elk City DAU is comprised of IDFG GMUs 14, 15 and 16. Land ownership in Elk City DAU is approximately 80% public and 20% private. Privately owned portions are mostly at lower elevations along the Clearwater and Salmon rivers. Approximately 8% of the DAU falls within the Gospel Hump Wilderness.

Most of the DAU is characterized by productive coniferous forests with intermixed grasslands. Logging and mining have resulted in high road densities contributing to significant big game vulnerability during hunting season. Deer and elk populations throughout most of the DAU are thriving, providing a substantial prey base for lions.

Status and Trends

The mountain lion harvest season in the Elk City DAU is from 30 August through March. The northern portion of GMU 15 was closed to mountain lion harvest from 1999 through the 2003 season for research purposes, but has been reopened. To address predation on elk, additional hunting opportunity has been offered with a 2-lion bag limit in the portion of GMU 16 north of the Selway River since the 2000 season.

During the 2011 season, Elk City DAU hunters harvested 37 mountain lions compared to the 3-year average of 34; this is the ninth consecutive season in which harvest has been below the 1990–1992 minimum harvest objective of 40 lions. Subadults accounted for 33% of the harvest for the 2009–2011 seasons. Lion harvest peaked in 1996 and has been at a lower level since that time. Some of the initial decline may be attributed to the lion harvest closure in the northern portion of GMU 15 from 1999 through the 2003 season. Hunter access is difficult in some portions of this DAU.

A decline in total mountain lion harvest in Elk City DAU was to be expected after the northern portion of GMU 15 was closed in 1999. However, an additional drop in DAU harvest occurred in 2003. This may have been related to unfavorable weather conditions or the desire by hunters to pursue lions in areas known for greater lion densities. Harvest has remained relatively constant since 2001 but below IDFG's minimum 3-year harvest goal.

Issues and Concerns

None

Selway Data Analysis Unit

The Selway DAU is comprised of IDFG GMUs 16A, 17, 19 and 20. Large portions of the Selway DAU lie within Selway-Bitterroot, Frank Church-River of No Return, and Gospel Hump Wilderness areas, as well as large roadless areas that afford limited access.

Habitats within this DAU include dense, coniferous forests within rugged mountainous terrain, as well as Ponderosa-pine savanna habitat with open understory, and steep open bunchgrass hillsides and brush-fields along the Selway and Salmon River breaks. Although some white-tailed deer habitat occurs in these GMUs, the predominant ungulates are elk and mule deer.

Status and Trends

The Selway DAU harvest season currently runs from the end of August through March. A bag limit of 2 lions has been allowed since 2000. No female harvest quotas exist.

Mountain lion harvest in Selway DAU was higher in 2000 and 2001 (39 and 33, respectively) than during most years in the recent past. The higher harvest was likely a result of the increased bag limit and season length, increased nonresident hound permits, outfitter efforts, and low snow pack. However, harvest declined substantially in 2002 and has remained low since then. During the 2011 season, Selway DAU hunters harvested 23 mountain lions compared to the 3-year average of 19 lions, which is above the 1990–1992 minimum harvest objective of 16. Subadults accounted for 14% of the harvest for the 2009–2011 seasons.

The major obstacle to harvest in this DAU is difficult hunter access. Selway DAU occupies a vast, remote area with high-quality big game range. Consequently, effects of hunting on mountain lion populations in the DAU are generally considered to be light except in those few areas with good road access or in areas where outfitters concentrate their hunting efforts.

Because these are such large GMUs with ample prey base, the mountain lion population is likely much greater than harvest indicates. This suggests an under-harvested but evidently self-regulating population.

Issues and Concerns

None

7.2.6.8 Mule Deer

Importance in the Planning Area

Mule deer are a true icon of the West, providing recreational, aesthetic, social, cultural, and scientific values for Idaho citizens. Mule deer hunting is a primary activity for nearly 150,000 hunters and is a key species maintaining the rich hunting heritage in Idaho.

Mule deer are economically important to the Idaho Department of Fish and Game (IDFG) and to many small rural economies in Idaho. Cooper and Unsworth (2000) estimated mule deer hunting resulted in direct expenditure of $42 million in trip-related expenses, not including equipment purchases. Many of these expenditures were for fuel, meals, and lodging in rural towns. Using a typical economic multiplier of 2.5 (Gordon and Mulkey 1978), the total estimated economic impact of mule deer hunting in Idaho exceeded $100 million. Additionally, more than 1,000 jobs in Idaho are directly supported by mule deer hunting-related expenditures (Cooper and Unsworth 2000). In 2006, direct revenues to IDFG from mule deer license and tag sales were nearly $6.3 million, representing nearly 20% of total license/tag revenues used by IDFG to implement important wildlife conservation programs including enforcement, population monitoring and research, and habitat conservation (IDFG).

The Plan Area is on the northern edge of good mule deer habitat; and mule deer are distributed throughout suitable habitat across that Planning Area. The largest mule deer populations within the Plan Area are in the Salmon River breaks and the “island” area northwest of Riggins.

IDFG tracks mule deer populations in Population Monitoring Units (PMUs), each of which contain a number of Game Management Units (GMUs). Aerial surveys are largely ineffective in some portions of the Plan Area due to habitat and terrain. The status of mule deer populations in those portions of the Plan Area is monitored by a combination of aerial surveys, where effective, and mandatory hunter harvest reports.

Mule deer populations in the overall Plan Area are generally stable compared to those in other parts of the state, which exhibit a wide range of variability. Mule deer populations across the region, including in the Plan Area, appear to be increasing, partly in response to very conservative harvest management (Koehler, IDFG, pers. Comm. 2013).

Population Monitoring Unit 1, Lower Salmon

Mule deer PMU 1 (Lower Salmon) is comprised of GMUs 11, 11A, 13, 14, and 18. Portions of GMUs 13, 14, and 18 are in the Plan Area; 11 and 11A are off-forest but influence mule deer populations in adjacent units.

This PMU contains large tracts of both privately and publicly owned lands. Most of GMU 13 has been under private ownership since settlement and is managed for agriculture and livestock. Historically, sheepherders ran their flocks in the canyons of GMUs 14 and 18, and logging occurred in the forested areas of these GMUs. GMUs 14 and 18 are two-thirds public lands with the remaining private land located primarily at lower elevations along the Salmon River. The majority of Forest Service Hells Canyon Wilderness Area, designated in 1975, is in GMU 18.

Mule deer populations in PMU 1 were historically low. Accounts from Lewis and Clark during the 1800s suggested that very few animals were found throughout Clearwater River country. Populations probably did not change much until the large fires of the early 1900s that converted vast expanses of unbroken forest into a mosaic of successional vegetation types, and large numbers of domestic livestock altered grass-dominated habitats into shrub cover. Mule deer populations in PMU 1 probably peaked during the 1930s–1960s as a result of new, high-quality habitat and lack of competition by other ungulates. As elk and white-tailed deer populations increased and habitat changes including succession, development, and loss of key winter ranges occurred, mule deer populations likely decreased. Information derived from estimates made by IDFG wildlife managers suggests mule deer numbers in PMU 1 declined from around 23,000 in 1960 to about 15,000 in 1990.

Habitat productivity varies widely throughout the PMU with steep river-canyon grasslands having low annual precipitation, to higher elevation forests having good habitat productivity and greater precipitation. Late successional forest cover types have become fragmented within the area. Various weeds and non-native grasses such as yellow star thistle and cheatgrass have disturbed expansive acreages of grassland cover types in this PMU. Road density is moderate and access is restricted in many areas, resulting in medium to low vulnerability of big game to hunters, especially within the Snake River and Salmon River canyons below White Bird.

Historically, sheep and cattle ranchers homesteaded the canyon lands in this PMU, while farmers settled prairie land. As settlement increased, the forested portions of the area were intensively logged, especially on private land. The forests were frequently high-graded, and existing forests still show the scars. In addition, intensive-grazing practices degraded many meadow areas and canyons, allowing the invasion of noxious weed species, especially in drier areas.

Status and Trends

Harvest and aerial survey data for PMU 1 are limited. The initiation of controlled hunts in GMUs 11A, 13, 14, and 18 in 1998 resulted in improved harvest information. GMUs 11 and 14 are the only units within this PMU having winter range surveys since 1994. An aerial survey of the White Bird trend area was conducted during the winters of 2000–2005; this survey has since been discontinued. Mule deer surveys currently employ a protocol that surveys a select sample of GMUs each year when possible, and a complete population survey approximately every 5 years. IDFG budgetary constraints and resultant re-prioritization have stalled the implementation of the recently adopted aerial survey schedule in PMU 1 to date.

During 2007, wildfires in GMUs 13 and 18 also burned large tracts of wildlife habitat, primarily on public lands. The effect of this has not been analyzed, but IDFG expects it will be years before the shrub component fully recovers and decades before conifer regeneration provides thermal and hiding cover. Accelerated noxious weed invasion is a concern in burned areas.

Poor productivity and declining mature buck numbers, a decrease in total numbers, and a 50% decrease in harvest from the late 1980s to the mid-1990s caused concern for mule deer herds in these GMUs. Aerial surveys in 1992 in GMUs 14 and 18 indicated buck:doe ratios at 7:100 and 13:100, respectively. Concerns led IDFG to implement antlered-only controlled hunts beginning in 1998 in GMUs 11, 11A, 13, 14, and 18.

A December 1999 aerial survey in GMU 14 resulted in an estimate of 2,622 mule deer with a buck:doe:fawn ratio of 18:100:50. GMU 14 was surveyed again in December 2004, producing an estimate of 2,814 total mule deer with a buck:doe:fawn ratio of 34:100:61.

The composition/trend survey conducted in December 1999 indicated a total population of 1,725 mule deer in the White Bird trend area. This represented a 26% decrease in total numbers from the same sub-GMUs flown during the early 1990s. Subsequent White Bird trend area surveys conducted during the winters of 2001–2002 and 2002–2003 indicated a stable population with increasing buck:doe (22:100 average) and fawn:doe (53:100 average) ratios. A survey conducted in 2003–2004 found similar buck:doe (23:100) and fawn:doe (47:100) ratios, affirming a stable population. However, the total population estimate increased by 54% over the 2002–2003 count, to 2,654 mule deer. It is likely that this increase can be attributed primarily to a change in deer distribution into the survey unit due to a significant snowfall event just prior to the survey rather than a true increase in the deer population. The 2005 survey yielded results similar to pre-2004 levels, with a total population estimate of 1,937 and a buck:doe:fawn ratio of 20:100:63.

Overall, based on surveys and harvest reports, mule deer populations in PMU 1 appear to be increasing.

Issues

During the winter of 2009, a species of exotic louse, *Bovicola tibialis*, was documented for the first time in Idaho. The louse was found on a dead mule deer fawn in the city of Riggins. Four deer sampled in Riggins later that spring were found to have *Bovicola tibialis;* all 4 deer had extensive, self-inflicted hair loss associated with the lice infestation. In early March of 2012, IDFG and Wildlife Services removed 60 deer in an effort to stop the spread of the louse. More than 90% of the deer were infested with *Bovicola tibialis*. Efforts were then made to treat the remaining deer within city limits. In surveys during May of 2012, *Bovicola tibialis* was found at lower densities in mule deer from other Idaho locations at Salmon, Elk Bend, Emmett, and the Andrus Wildlife Management Area (Council), indicating that the louse was not confined to Riggins. Monitoring for the presence of this louse is ongoing.

A decline in cattle grazing and successive years of drought during the late 1980s and early 1990s may have contributed to rangeland shifting from forbs to grasses, while intensive logging has created extensive brushy areas on winter ranges. These shifts in vegetation resulted in increases in white-tailed deer and elk populations, creating competition with mule deer on both winter and summer ranges.

Available mule deer winter range is being encroached upon by construction of summer homes and resorts along the Snake and Salmon rivers. Invasive weeds that out-compete desirable native mule deer forage species are a major concern in some parts of PMU1.

Currently, there are few depredation concerns involving mule deer in PMU 1.

Population Monitoring Unit 15, North Idaho

Mule deer PMU 15 (North Idaho) consists of GMUs 8, 8A, 10, 10A, 12, 15, 16, 16A, 17, 19, and 20. These GMUs have widely divergent demographic and habitat characteristics, but are grouped because they support only low numbers of mule deer in isolated pockets of suitable habitat. These Units are managed by IDFG primarily for white-tailed deer or are located in wilderness areas where most mule deer hunting is largely incidental in nature.

GMUs 10, 10A, 12, 15, and 16 are predominately timberlands, with the majority of ownership being private timber companies, state timber lands, or USFS. In 1964, most of the southern portion of GMU 12 was designated as part of the Selway-Bitterroot Wilderness. Most private ownership is at lower elevations along the breaks of the Clearwater River.

Timber harvest began in GMU 10A during the early 1900s and increased dramatically in the 1970s. In 1971, Dworshak Reservoir flooded approximately 45 miles of North Fork Clearwater River in GMU 10A and permanently removed thousands of acres of prime low-elevation big game winter range. Units 8 and 8A are mixed private and public lands, a high percentage of which is in commercial timber and agricultural use.

IDFG relies on a combination of aerial surveys and mandatory harvest reports to assess mule deer populations. Mule deer comprise less than 10% of the deer harvested in these Units within the Plan Area. Aerial surveys are not practical in most of these GMUs because mule deer are scarce and hiding cover is abundant. Aerial surveys are not conducted in some GMUs (16A, 17, 19, and 20) because of their remote wilderness setting and relatively little emphasis on the targeting of mule deer by hunters.

USFS records (citation) and the memories of long-term residents indicate that big game, including mule deer, were relatively scarce in the early 1900s. Large-scale fires between 1910 and 1931 created large brush-fields favored by mule deer. This newly created habitat, in combination with a major predator reduction program beginning in the early 1920s, allowed the sustained growth of mule deer, white-tailed deer, and elk populations. Despite a series of severe winters, mule deer populations continued to increase. By the mid-1950s, they were estimated to outnumber white-tailed deer in the central part of the PMU.

Concern about over-browsed winter ranges and an overabundance of both white-tailed and mule deer throughout the state, in general, led to aggressive management to reduce the deer population. By the early 1970s, this goal was accomplished and shorter hunting seasons were authorized.

Until the 1930s, wildfire was the primary habitat disturbance mechanism in GMUs 10, 12, and 16. Between 1900 and 1934, approximately 70% of the Lochsa River drainage was burned by wildfires. In addition, from the 1920s to 1990, thousands of miles of roads were built for timber harvest in GMUs 10, 10A, 12, 15, and 16.

GMUs 16A, 17, 19, and 20 represent much of Idaho's backcountry; a large portion of this area is designated wilderness. Because of the rugged, remote terrain and difficult access, management control of deer herds in these units is difficult at best. Weather, fire, and plant succession have ultimately played a much larger role in deer populations than efforts of wildlife managers. A mid-September to late November season has been standard in the backcountry GMUs since the 1950s. Much of the deer harvest is localized around access points such as roads and airstrips and most of the harvest is incidental to elk hunting.

Status and Trends

IDFG relies almost entirely on mandatory harvest reports to assess mule deer populations in this PMU. Mule deer are in isolated pockets of the Plan Area and hunter effort is very low. Based on the limited harvest data available, mule deer populations in this PMU are considered stable (Koehler, IDFG. Pers. com. 2014)

Issues

A large percentage of the land in PMU 15 is administered by USFS, with private lands mostly restricted to the valley bottoms. Recreation and timber management are the dominant human uses of the landscape. PMU 15 is a generally moist region with nearly continuous canopy coverage. Mule deer mix with white-tailed deer during winter, although there is a tendency for mule deer to winter at slightly higher elevations. Mule deer depredations are nonexistent.

Much of the mule deer habitat in this area is the result of large fires during the early 1900s, with some additional habitat created when large areas were block clear-cut during the 1960s. Currently, both fire and harvest are having little effect on the landscape and mule deer habitat can be expected to decline in quantity and quality as succession progresses, turning brush-fields back into timber.

Little is known about the ecology of mule deer in the heavily forested environments typical of much of this PMU. The timbered nature of the landscape, combined with the relative scarcity of mule deer, does not allow aerial surveys to be used to monitor mule deer populations in this area. However, the influence of hunting on mule deer population dynamics is believed to be minor, based on the minor influence of hunting measured on white-tailed deer populations in the same areas. The high percentage of ≥4-point bucks in the antlered harvest (~50%) is consistent with this hypothesis.

White-tailed deer, mule deer, and elk have sympatric ranges throughout the year in PMU 15. Mountain goat and moose distribution overlaps that of mule deer in some areas as well. The effects of inter-specific competition are unknown but are felt to be of minor consequence at existing population levels.

Predation can be an important factor in the population dynamics of mule deer in this PMU. Radio-telemetry studies conducted in the Priest River Basin during the late 1980s and early 1990s indicated predation was an important influence on white-tailed deer populations. Mountain lions, black bears, bobcats, coyotes, and wolves are present in PMU 15, and all prey on mule deer. A substantial increase in the mountain lion population was detected in the mid-1990s, leading to increased public concern over the impacts of predation on future mule deer populations. High participation in mountain lion hunting led to record harvests during this period but has since declined. Current mountain lion numbers are assumed to be significantly lower than those found 10–15 years ago. Wolves were reintroduced by USFWS in central Idaho in the mid 1990s and have become well established in portions of this PMU. The addition of wolves will likely have an impact on black bear, mountain lion, and coyote populations. At some level, predation could benefit deer herds to the extent that it reduces elk competition and keeps deer herds below carrying capacity where they can be more productive. However, excessive levels of predation can also suppress prey populations to undesirably low levels. At this point, it is unclear what the net impact of predation will be on mule deer with the addition of wolves in PMU 15.

7.2.6.9 White-tailed Deer

Importance in the Planning Area:

White-tail deer are one of the most sought after big game animals in the Clearwater region and in the state. Whitetails are abundant north of the Salmon River. The highest densities of white-tailed deer in the state are thought to occur in the lower Clearwater and Salmon River drainages. Harvest records from the Idaho Department of Fish and Game (IDFG) confirm this: from 1994 through 2003, Clearwater region white-tailed deer have averaged 43% of the total statewide deer harvest (WTD MP); that percentage is likely to be much higher in the Planning Area due to the high number of whitetails compared to mule deer.

White-tailed deer hunting is economically important in Idaho. Deer hunting, including both white-tailed and mule deer hunting, provided 840,000 hunter days and generated $109 million in retail sales in 2001 (IAFWA 2002). Approximately 2,000 jobs were tied directly to deer hunting in 2001 and resulted in $1.3 million in State income tax. Approximately 42% of the state’s deer hunter use days were expended in units where the majority of deer harvest was white-tailed deer (IDFG unpublished data); several of those units are within the Plan Area.

Forest Service lands in the Plan Area that are popular for deer hunting comprise substantial portions of Clearwater, Latah, and Idaho Counties. Based on Cooper et al. (2002) the combined economic impact of deer hunting in those three counties alone was in excess of $31 million in 2007.

Biology

The subspecies of white-tailed deer found in Idaho is *Odocoileus virginianus ochrourus*, the northwest white-tailed deer.

Habitat

Winter habitat use of white-tailed deer in Idaho has been described in several studies (Pengelly 1961, Owens 1981, Pauley 1990, Secord 1994). White-tailed deer are very adaptable and some differences in habitat use patterns occurred among these studies. However, synthesis of information from these studies reveals general habitat use patterns that help confirm and extend existing white-tailed deer habitat management guidelines (Jageman 1984). Weather has a strong influence on winter habitat use patterns of white-tailed deer. Mild open winters reduce environmental stress on deer; and habitat use may be more variable under these conditions. In the most severe winters, availability of key winter range habitat elements becomes critical to white-tailed deer survival.

Habitat selection can generally be related to maintenance of the animal's energy budget (Armleder et al. 1986). All deer at northern latitudes experience winter conditions in which energy losses from movement, cold temperatures, and wind chill exceed energy gains from food intake. When winter range quality is high or winter conditions are mild, energy losses only moderately exceed gains and most deer survive the winter. However, when winter ranges are in poor condition or winter conditions are severe, energy losses greatly exceed energy gains and can lead to starvation, increased vulnerability to predation, and substantial losses in deer population. Deer use both topographic and vegetative habitat features to minimize energy losses and maximize energy gains during winter by selecting areas with shallow snow, adequate food, and sufficient shelter.

White-tailed deer movement from summer to winter habitat may involve actual migration from geographically distinct seasonal home ranges or shifts in use patterns within overlapping seasonal home ranges (Pauley 1990, Secord 1994). Snow is the most influential environmental factor during winter and has a significant effect on the energy cost of locomotion. Energy cost of locomotion increases exponentially with increasing snow depth (Mattfeld 1974, Parker et al. 1984). Compared to snow-free conditions, snow accumulations of as little as 5 cm (2 in) can increase energy expenditures by 10%. When snow accumulation reaches 50 cm (20 in) energy cost of locomotion may increase to 5 times that of snow-free condition expenditures.

In winter, deer move to lower elevations, usually less than 3,000 feet. Low elevation areas generally experience less snow accumulation and milder temperatures than high elevation areas and thus help deer minimize thermoregulation and movement energy costs. Deer select southeast to southwest or west aspects in winter. These aspects receive greater solar exposure than other aspects. This allows deer to minimize energy expenditures from heat loss. Increased sunshine and associated warmer temperatures also lead to shallower snow depths, consequently reducing energy expenditures for both locomotion and thermoregulation. Further, snow depths are less on slopes than they are on level areas because the same amount of snow is distributed over a larger area on slopes relative to flat areas. When slopes become too steep, energy gains from reduced snow depths are offset by the increase in energy expenditures used to climb slopes; therefore, deer generally select slopes with grades <50% during winter (Parker et al. 1984, Pauley 1990).

Vegetative characteristics of habitat provide deer two broad categories of resources: forage and shelter. Site conditions on southerly aspects with moderate slopes as described above often result in forest stands that are more open than other sites. More sunlight reaches the forest floor in open sites, resulting in increased development of forage in the shrub layer. Conversely, these open stands have lower snow interception properties than dense stands on more level or more northerly aspects. During mid-winter when snow cover is deepest, deer often move to dense mature coniferous forest stands with canopy closure >70% even though the shrub layer is depauperate and forage availability is low on these sites (Peek 1984, Pauley 1990, Secord 1994). Pauley (1990) found white-tailed deer making extensive use of these areas in both early and late winter.

In winter, whitetails subsist almost entirely on browse. White-tailed deer will consume a wide variety of deciduous browse species but some of the more important browse species include red osier dogwood (*Cornus stolonifera*), redstem ceanothus (*Ceanothus sanguineus*), serviceberry (*Amelanchier alnifolia*), maple (*Acer glabrum*), pachistima (*Pachistima myrsinites*), willow (*Salix spp.*), and chokecherry (*Prunus virginiana*) (Pengelly 1961). As winter progresses deer also make increasing use of coniferous browse, principally Douglas-fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*) (Jageman 1984).

White-tailed deer winter habitat selection that optimizes security and thermal cover at the expense of forage availability is well documented (Ozaga 1968, Wetzel et al. 1975, Moen 1976, Boer 1978, Owens 1981). Microclimate studies of closed canopy coniferous stands have demonstrated that these stands have the narrowest thermal ranges, least wind flow, less radiant and convective heat loss, and most favorable snow conditions (Verme 1965; Ozaga 1968; Moen 1968, 1976). Availability of such closed forest stands within white-tailed deer winter ranges is an important winter habitat feature. Ideal winter range will be characterized by a high degree of horizontal diversity with both shrub and open forest habitats—with high forage densities in close proximity to dense, closed forest stands with superior shelter qualities (IDFG 2004). This habitat structure allows deer to minimize energy expenditures when moving between these areas to meet habitat resource needs in the face of changing winter snow and weather conditions.

In contrast to winter habitat use, summer habitat use by white-tailed deer has not been as well studied (Pauley 1990). White-tailed deer are highly adaptable and, in the absence of the stress of deep snow and cold temperature, they can successfully exploit a wide variety of habitat conditions including forest, shrub, agricultural, riparian, and suburban settings. Because of this adaptability, characterizing habitat use during summer is more difficult. However, habitat selection can again be related to the annual energy budget of white-tailed deer and some generalizations are possible. Whereas deer energy losses exceed energy gains through winter, summer energy gains must exceed energy losses so that deer can recover lost condition and replenish energy reserves for the upcoming winter. Although we typically think of winter range quality as the critical population "bottleneck" because this is when we observe mortality, some research has suggested adequate accumulation of energy reserves during summer is at least as critical to winter survival because the condition of deer entering winter strongly influences their ability to survive (Ozoga and Verme 1970). Summer range quality has also been linked to productivity, recruitment, and growth rate in deer (Cheatum and Morton 1946, Cheatum and Severinghaus 1950, Julander et al. 1961, and Verme 1963). Winter habitat selection emphasizes minimizing energy losses whereas summer habitat selection emphasizes maximizing energy gains. At winter's end deer energy reserves are at their annual low point and fetal development in the final trimester is placing high nutritional demands on does (Verme 1969, Moen 1973). Consequently, deer select spring/summer/fall habitats with the most nutritious forages available. Open canopy, low elevation, southerly exposed habitats are the first to be snow free and support new nutritious green forage in the spring; and whitetails demonstrate a decided shift from forested to open habitats in the spring (Garrott et al. 1987, Pauley 1990, Secord 1994).

White-tailed deer use of grass, forbs, and agricultural crop forages is higher in spring and early summer than at any other time of year (Peek 1984). Low-elevation burned areas, riparian habitats, clear-cuts, warm well-drained slopes with minimal canopy closure, and agricultural areas can all fulfill this habitat requirement. Deer often select forest ecotones adjacent to foraging areas and may limit their use to edges of these openings while avoiding interiors of large openings (Gladfelter 1966, Telfer 1974, Keay and Peek 1980). Several studies have suggested forest cutting units and prescribed burns should be restricted to not more than 20 acres in size to provide maximum benefits to white-tailed deer (Peek 1984).

As summer progresses deer initially follow spring green-up to higher elevations, make extensive use of clear-cuts, burns, and open forest areas, but eventually shift to more mesic northerly aspects and forested habitats in late summer and fall. White-tailed deer use of older timber stands and mesic sites, and reduced use of clear-cuts and open areas in late summer and fall is related to plant phenology. Dry, hot weather during July and August dries deciduous species in open areas. Freezing temperatures in October and November further diminish forage in open habitats whereas dense forest canopies maintain moist conditions and moderate temperatures resulting in greater availability of nutritious forage in these habitats (Pauley 1990). This late summer/fall shift to northerly aspects and mesic sites has been described in several studies (Shaw 1962, Owens 1981, Pauley 1990). The shift to denser forest stands may also be related to hot weather.

Canopy cover reflects solar radiation and provides cooler, more comfortable temperatures than open areas in summer (Moen 1968, 1976). However, white-tailed deer are also frequently observed bedding in open areas during summer (Pauley 1990).

Security Habitat

Habitat used by deer to avoid detection and minimize disturbance by man, his machines,

or by other animals is called hiding or security cover. Adequate security cover protects deer from energy expenditures by reducing both the need to flee and distance to flee disturbance or threat. Security habitat may also prevent direct mortality from predation or hunting by allowing deer to avoid detection. Security is typically provided by screening vegetation, screening topography, and distance from potential sources of disturbance. Hiding cover is considered to be vegetation capable of hiding 90% of a standing adult deer from a human at a distance of 200 feet during all seasons in which deer normally use the area (Jageman 1984). During fall hunting seasons, deer may use the heaviest cover available to avoid detection (Sparrowe and Springer 1970).

In contrast to elk, the effects of secondary roads or trails on white-tailed deer are not well documented. Because of their more secretive nature and smaller home ranges, white-tailed deer may be less subject to functional loss of habitat due to behavioral displacement than elk (Lyon 1979), especially where cover is dense. In contrast, road density, which is known to increase elk vulnerability to hunting season mortality (Leptich and Zager 1991, Unsworth et al. 1993, Hayes et al. 2002), likely increases white-tailed deer vulnerability to hunting season mortality. This increase is because greater road density enhances hunter distribution and deer-hunter encounter rates while eliminating refugia. Additional research is needed to illuminate importance of secondary roads on deer habitat use and survival (IDFG).

Population Dynamics

The peak of breeding of whitetails in Idaho is middle to late November, with fawns born from late May through late June. Pregnancy and fetal rates of adult does are similar to those found elsewhere, but fawn pregnancy rates in Idaho are low. Generally, reproductive rates for white-tailed deer in Idaho are not dramatically different from those of mule deer.

The survival of fawns one year is a primary influence on white-tailed deer population size the following year. Survival of fawns in Idaho is influenced heavily by energetic demands from the prior winter on the doe, by summer nutrition, by predation, and by energetic demands of their first winter. Late summer composition surveys averaged 58 fawns per 100 does during September 2001–2004.

By comparison, fall fawn ratios in Midwestern states often exceed 100 fawns per 100 does.

In contrast to populations over much of the United States, natural causes, not hunting, are the primary sources of mortality of white-tailed deer in Idaho. Even with long hunting seasons in Idaho, the annual survival of bucks is relatively high, allowing substantial numbers to reach older age classes and producing high buck:doe ratios.

Deep winter snows are a major influence on population dynamics of white-tailed deer in the northernmost portion of their distribution, including most of Idaho. During the severe 1996–1997 winter, Sime (pers. comm. 1997. Cited in IDFG Whitetail Management Plan) estimated 70% of the white-tailed deer died on her study area in northwestern Montana, including over 90% of fawns. In northern Idaho, natural mortality, including both predation and winterkill, averaged 10% annually for does, and 23% for bucks from 1986 through 1995 (IDFG unpubl. data).

Predation is an important influence on population dynamics of white-tailed deer in Idaho. The most common predators on white-tailed deer include coyotes, bobcats, black bears, mountain lions, and domestic dogs. These predators also prey upon other ungulates such as mule deer, elk, antelope, bighorn sheep, and mountain goats, as well as rabbits, hares, mice, etc.

Coyotes are the most abundant predator on deer in Idaho. In most areas, coyotes feed on a wide variety of items; however, deer are also a part of their diet, particularly during spring fawning and winter. Coyotes have been noted to be efficient predators of neonate fawns where habitat is poor. During winter, coyotes may take a number of fawns due to snow conditions and poor animal condition. Studies have shown that coyotes can cause up to 80% of fawn mortality. Because fawns die of many causes, coyote predation on fawns could be largely compensatory. Most fawns taken by coyotes in winter are in very poor physical condition and likely to die of malnutrition.

Mountain lions are likely the second most abundant predator of deer in Idaho; their primary prey are deer, elk, and smaller mammals like rabbits. Mountain lions feed on deer year round, being most efficient during winter months in deep snow conditions. Mountain lion predation on white-tailed deer changes continuously, affected by weather and changing deer population numbers, but is an important influence on white-tailed deer numbers statewide.

Little is known about black bear predation on white-tailed deer in Idaho; however, black bears have been shown to be significant predators of elk calves in spring. Predation on deer by black bears is probably highest during a fawn’s first 4 weeks, during late spring/early summer. Bears are the most effective predators when habitat is patchy and insufficient to hide fawns.

Wolves are present, but not abundant in some white-tailed deer range in Idaho (e.g., Units 8, 8A, and 14), but are abundant in other portions of the Forest. Elk are the primary prey of wolves in Idaho; but, as evidenced by the reliance of wolves on white-tailed deer in the Midwest and western Montana, wolves can subsist primarily on white-tailed deer. Currently, the impact of wolves on white-tailed deer in Idaho is likely negligible; however, their impact on white-tailed deer and other ungulate populations will increase as wolf populations expand.

White-tailed deer populations in Idaho cannot be expected to exhibit the same high growth rates observed elsewhere in their range, where predation is a minor influence. Although general predator-prey relationships are evident, no single predator species can be expected to track white-tailed deer populations closely. The influence of predation on white-tailed deer is complex, including effects of one predator species on other predators, effects from the presence of alternate prey species, and effects of changing ungulate populations on forage. It is this entire mix that determines the degree to which predators limit white-tailed deer.

Whitetails have a relatively high intrinsic rate of increase. When deer populations are at, or near, carrying capacity, predation is most likely compensatory and reducing predation will not increase deer numbers. In this case another agent such as winter mortality or disease will replace predation mortality if predation is reduced. When deer populations are below carrying

capacity predator mortality is more likely to be additive. It is often difficult to predict or even know what the current carrying capacity of a deer range is due to ever-changing habitat factors.

Disease

Disease and parasite issues in white-tailed deer can be very complex. In general, white-tailed deer are the most studied free-roaming ruminant in the United States. Extensive disease investigations and documentation have been done in most parts of the country where white-tailed deer reside. Historically, IDFG has not actively conducted targeted surveillance for disease or parasites in white-tailed deer; information about disease in Idaho is therefore limited and obtained opportunistically.

At this time, the primary disease of concern in white-tailed deer in Idaho is epizootic hemorrhagic disease (EHD). EHD is present at a low level within some white-tailed deer populations in Idaho. Serological data from mule deer and elk indicated EHD exposure in 10–20% of animals tested. White-tailed deer, as a primary host of the virus, are likely exposed at a higher rate. Several small and one large outbreak of EHD have been documented in white-tailed deer in the IDFG Clearwater Region of Idaho, which includes portions of the Forest. The most recent and largest outbreak (5,000–10,000 deer died) occurred in late summer and fall of 2003. This outbreak centered in the Kamiah area, but occurred in deer ranging from Kendrick south to Riggins and from Lapwai east to Clearwater. There have been scattered reports of EHD in the Clearwater Region since then, but no major outbreaks have been reported.

Chronic wasting disease (CWD), although not identified in Idaho, may pose problems in the future and warrants continued surveillance. A small number of samples from Idaho were evaluated for bluetongue virus with positive results (MacLachlan et al. 1992). Foreyt and Compton (1991) found no evidence of meningeal worm (*Parelaphostrongylus tenuis*, also known as “brainworm”) in northern Idaho, but a large-scale survey for this parasite is warranted to better define the current status of this parasite in the state. Other disease or parasite issues may be present or of concern and should be addressed when they become apparent or problematic (IDFG 2004, 2005).

Niche Overlap with Other Ungulates

White-tailed deer are sympatric in various parts of the state with elk, moose, mule deer, bighorn sheep, mountain goat, pronghorn, and domestic livestock. The degree of competitive influences among these species is unknown; but it is likely that either direct competition for resources, or indirect exclusionary processes, occur under some circumstances. Baty (1995) observed spatial separation between white-tailed deer and elk on winter range in northwestern Montana. White-tailed deer used small herd home ranges with abundant overstory canopy, whereas elk used large areas with sparse overhead canopy. Baty also found little overlap in food habits, with elk selecting largely for grasses, and deer selecting for browse. Food habits were similar between white-tailed and mule deer, but there was also a significant difference in preferred habitat, with mule deer occupying drier and more open sites than did whitetails. In Idaho, sites preferred by mule deer are often at higher elevations than those preferred by whitetails during all seasons.

Moose and white-tailed deer distribution overlap substantially in North America. In western United States and Canada, enough niche separation exists so neither species detrimentally affects populations of the other to any large degree. Moose appear to select habitat largely on the basis of forage quality and abundance, while cover is more of a primary factor for whitetails. In eastern United States and Canada, white-tailed deer tend to replace moose not due to competition, but due to the effects of meningeal worm. Wild sheep and goats select strongly for steep, rocky, open terrain not preferred by whitetails.

Livestock and white-tailed deer use sympatric ranges in many portions of Idaho. Domestic grazing, depending upon the situation, can either enhance or degrade white-tailed deer habitat (Matschke et al.1984). Extensive grazing of riparian areas generally reduces available habitat for white-tailed deer (Dusek et al. 1989).

Population Management

White-tailed deer populations are dependent on habitat quality and quantity. Simply stated, when high-quality habitat is abundant, reproductive rates are high, survival is high, and deer numbers will increase. As the number of deer increases, less forage is available for each individual, until eventually, reproduction slows, and survival decreases, and the herd decreases. After the population declines, there is again adequate nutrition for remaining animals, and reproduction and survival increase once again. IDFG manages hunting of whitetails to keep deer numbers sufficiently low such that reproduction and survival is high, resulting in a more stable population and a harvestable surplus of deer each year (IDFG WTP).

The forage competition model above provides a useful overall framework for a general understanding of how ungulates interact with the vegetative component of their environment. However, other factors, both density-independent and density-dependent, may influence a population more than forage competition. The two most prominent factors affecting white-tailed deer in Idaho are winter weather and predation. Various populations of white-tailed deer are regulated by different combinations of factors. A single population may be regulated primarily by forage availability one year, a combination of forage availability and winter severity the next year, and forage and predation the third. The key to managing white-tailed deer populations is in understanding the importance of these influences, our ability to modify these influences, and our ability to adapt to those influences (IDFG WMP).

Status and Trends

Unregulated harvest by miners, loggers, and other settlers during the late 1800s and early 1900s apparently resulted in very low numbers of ungulates in Idaho, including white-tailed deer. Conservative hunting seasons and high-quality habitat produced by large fires and heavy logging in the first third of the 20th century resulted in increased white-tailed deer populations (Pengelly 1961). Deer populations continued to increase until the late 1940s, when 2 consecutive severe winters reduced deer numbers throughout the state. Conservative seasons, high-quality habitat, and a pronounced predator control program combined to allow deer herds to recover quickly. White-tailed deer numbers appear to have reached a peak in the 1960s, when game managers became concerned about over-browsing of winter ranges and established long hunting seasons in order to reduce deer numbers and improve winter range quality.

White-tailed deer populations declined during the 1970s, likely as a consequence of heavy harvest and declining quality of aging stands of habitat. Populations increased again during the 1980s and early 1990s in north central and northern Idaho. The 1996–1997 winter was one of the most severe on record and white-tailed deer in portions of the Plan Area declined substantially. White-tailed deer populations have apparently increased moderately since the 1996–1997 winter. Roughly 200,000 white-tailed deer currently exist in Idaho, and populations may be approaching levels of the 1950s and 1960s in some areas.

White-tail Deer Population Status and Trends based on Idaho Department of Fish and Game Data Analysis Units

IDFG's best tool for tracking population trends in whitetails is mandatory harvest reports filed by hunters. White-tailed deer harvest is tracked and reported by DAUs, which are geographic areas selected on the basis of variation in population dynamics, agricultural considerations, habitat type and condition, hunter characteristics, and social attitudes. Each DAU is made up of one or more GMUs.

Data Analysis Unit 2

DAU 2 is comprised of GMUs 7, 9, 10, 12, 14, 15, 16, 18, 23, and 24. Of those Units, all or portions of DAU 10, 12, 14, 15, and 16 are in the Plan Area.

The majority of DAU 2 consists of coniferous forest habitat with moderate to high road densities. A large percentage of the land in this DAU is under U.S. Forest Service (USFS) ownership. In general, the northern and western portions of the DAU provide good white-tailed deer habitat, while the heavily forested and higher elevation eastern portion supports whitetails at much lower densities. The southern and western portions of this DAU are of mixed ownership, having more open rangeland and private properties at lower elevations along the Salmon River and USFS-owned coniferous forest at higher elevations.

Based on harvest reports for the past 20 years, white-tailed deer populations in all Nez Perce–Clearwater Forest management units appear to be thriving (IDFG PR Reports 1993–2013).

<u>Issues</u>

Coniferous forest, primarily under USFS ownership, is the predominant habitat type for this DAU, especially in the eastern portion. Timber harvest, wildfires, and recent prescribed fires, conducted primarily to enhance elk habitat, help provide a mixture of successional stages that also benefit whitetails.

Noxious weeds, such as yellow star thistle and spotted knapweed, are out-competing native vegetation on lower elevation spring and winter ranges and threaten to displace deer from that habitat.

Construction of new home-sites has impacted white-tailed deer habitats and limited hunter access and, consequently, management options in areas adjacent to the Plan Area.

Data Analysis Unit 3, Northern Agriculture

DAU 3 is comprised of GMUs 5, 8, 8A, 10A, 11, 11A, and 13. Portions of all of the GMUs, except Unit 5, are on or adjacent to the Plan Area. Approximately 74% of DAU 3 consists of private property, nearly equally split between dryland agriculture and coniferous forest habitats. Hunter densities, success rates, and the opportunity to harvest a mature buck white-tailed deer are amongst the highest in the state.

Habitat in this DAU is nearly ideal for white-tailed deer, and populations are thriving. The mixture of agricultural crops and coniferous forest stands has resulted in a high-density white-tailed deer population.

Issues, Stressors, Concerns

The construction of new home-sites in some portions of DAU 3 has decreased available white-tailed deer winter ranges, limited hunter access, and restricted management options.

Depredation complaints involving white-tailed deer are common in this DAU. The large private property component of this DAU has led to a number of management challenges, including depredations on agricultural crops, achieving adequate antlerless harvest, and tensions between landowners and sportsmen over access/trespass issues. Maintaining hunting opportunities on adjacent Forest Service lands is important to managing white-tailed deer populations and depredation in areas where the Forest provides the only public access.

A large-scale epizootic hemorrhagic disease (EHD) outbreak started in the Kamiah area in late July 2003. Previously, EHD had been confirmed only once in the region, that being a small-scale outbreak in 2000 near Peck. The 2003 outbreak ended with a hard frost that interrupted the *Culicoides* spp. gnat life cycle in October. While centered on the Kamiah and Kooskia area, white-tailed deer deaths caused by EHD were observed in lower elevations along the Clearwater, South Fork Clearwater, and Salmon rivers. Although actual losses will never be known, localized losses probably ranged from 20–80% in some areas. It is likely that several thousand white-tailed deer died. No major outbreaks have been detected since 2003 and white-tailed deer populations rebounded quickly; the population of whitetails is currently thought to exceed 2003 numbers.

Data Analysis Unit 4, Backcountry

DAU 4 is comprised of GMUs 16A, 17, 19, and 20. Land ownership in this DAU is greater than 99% Forest Service. Habitat varies from mesic forest conditions in the Selway River drainage to dry, open pine/grassland habitat in the Salmon River drainage. Road densities are extremely low, with most roads acting as peripheral access to the Selway-Bitterroot, Gospel Hump, and Frank Church-River of No Return Wilderness areas. This low road density contributes to relatively low deer vulnerability in the area. Hunter densities are low in this DAU. Because of the low white-tailed deer density and low hunter participation, IDFG does not conduct population monitoring or modeling for this DAU.

Little quantifiable information exists on present or historic white-tailed deer populations in this DAU. We do know that Mule deer are more abundant than white-tailed deer. The rugged and remote nature of this area will continue to limit the impacts of humans on white-tailed deer and habitat.

White-tailed deer harvest has declined in this DAU; however, IDFG believes that harvest has declined because of reduced effort, not changes in population. Most of the deer harvest in these GMUs has historically been incidental to elk hunting, and elk hunter participation has declined substantially in these backcountry units.

Issues, Stressors, Concerns

Because DAU 4 is predominately designated wilderness, very little intentional habitat management occurs. Habitat trend is largely determined by wildfire occurrence and extent. Fires have been sporadic in recent years, affecting relatively small portions of occupied habitat. Perhaps the most significant recent habitat trend in portions of the DAU has been increasing infestations of noxious weeds, which can displace desired forage and reduce available white-tailed deer habitat.

7.2.6.10 Gray Wolf

For a comprehensive chronology of events related to wolf recovery, administrative roles and authority, conservation, and management in Idaho, see the IDFG Web site[2].

Importance in the Planning Area

Wolves are one of the most important, and controversial, wildlife species in the Plan Area. As large predators, wolves can and do influence the size, composition, and behavior of large ungulates like elk, deer, and moose that are not only popular with hunters and economically important to the region and state, but are themselves manipulators of the environment.

Wolves are managed as a big game species in Idaho and are actively hunted and trapped in the Plan Area. Wolf harvest in Idaho Department of Fish and Game (IDFG) Elk City Game Management Units (GMUs) 14, 15, and 16 was among the highest in the state. Wolves harvested in Idaho County and Clearwater County—areas that mostly occupy Forest lands—had a market value of $3,710 and $1,575 in the 2011–2012 and 2012–2013 harvest seasons respectively.

Wolves are also important to wildlife advocates and wildlife watchers. Although many people participate in wildlife viewing—in 2006, 746,000 people watched wildlife in Idaho and spent $273 million while doing so (USFWS 2007*b*)—wolf viewing has yet to provide significant economic benefit in Idaho. Some Idaho outfitters have offered wolf viewing opportunities, but they indicate it was not a lucrative portion of their business. Although potential participation in wolf viewing is unknown, respondents to a random survey indicated that 42% of non-hunters would travel to see a wolf and 20% of non-hunters would pay an average of $123 to an outfitter to see a wolf (median = $100). In the same survey, 20% of hunters said they would travel to see a wolf, and on average would pay $115 to an outfitter to see one (median = $100). (Cite)

Wolves are a factor in declines of elk herds in some parts of the Planning Area, particularly in the Lolo and Selway Elk Management Zones. Declining elk numbers have resulted in economic loss to IDFG because of reductions in deer or elk tag sales in those Zones. Trends in elk populations may dictate reductions in elk hunting opportunity in those and other Zones in the near future, further reducing support for wildlife management in those areas. Also, according to outfitters,

[2] *http://www.fishandgame.idaho.gov/cms/wildlife/wolves/timeline.cfm*

changes in elk behavior attributable to wolves have negatively impacted specific outfitter operations (G. Simonds, IOGA, personal communication, cited in WMP).

Biology

The understanding of the biology, impacts, and benefits of wolves has increased since their reintroduction into Idaho. The original recovery environmental impact statement (EIS) analyzed potential impacts and benefits of 100 wolves in Idaho, a biologically recovered population target that was reached in 1998. At the end of 2007, IDFG and the Nez Perce Tribe estimated more than 732 wolves in Idaho; this is more than 7 times the number analyzed for potential impacts and benefits in the EIS. The current wolf population is estimated to be approximately 649 statewide. Due to the rugged wilderness character of much of the Plan area, accurate and reliable wolf population estimates are very difficult to obtain for several key drainages. IDFG biologists believe the wolf population in the Plan Area may have decreased slightly from the high-point estimates in 2007. Official wolf estimates are posted on the U.S. Fish and Wildlife Service Web site[3].

Distribution, Reproduction, and Population Growth

Wolves are widely distributed in Idaho from the Canadian border south to the Snake River plain. Most wolf pack territories in Idaho occur wholly or predominantly on U.S. Forest Service (USFS) or other public lands.

Of 83 packs documented in 2007, 59 produced litters (200 pups) and 43 qualified as breeding pairs. A breeding pair is defined as an adult male and an adult female wolf that have produced at least 2 pups that survived until December 31 of the year of their birth during the previous breeding season. Wolf pup counts were conservative estimates because not all pups in monitored packs were observed, and some documented packs were not visited. Documented litter size ranged from 1 to 8; average litter size, where counts were believed to be complete, was 4.1. Ten new breeding pairs were documented, and the reproductive status of 24 documented packs was either not verified or believed to be non-reproductive during 2007. The statewide wolf population increased 10% from the previous year’s estimate.

Movement of wolves and connectivity between states and provinces continues to be well documented. At least 15 documented packs use the border between Montana and Idaho and reside part-year in each state, and 2–3 other packs move among Wyoming, Yellowstone National Park, and Idaho.

Radio-collared wolves from the Boundary pack move freely among Canada, Idaho, and northwestern Montana. A Global Positioning System-collared wolf moved from just south of Banff National Park, Alberta to west of Dworshak Reservoir in the Clearwater region where it now appears to be a permanent resident. Wolves are very mobile and are now expanding their range outside of what has been considered optimal habitat. They are beginning to show up more regularly on private land with livestock grazing. Central Idaho wolf populations may be nearing saturated conditions. In this situation, territoriality and pack density limit room for additional breeding pairs so that population growth can only be accommodated through range expansion. Dispersers that survive eventually find a mate and become breeders.

[3] http://fws.gov/mountain-prairie/species/mammals/wolf/annualrpt13/reports/FINAL NRM-Sum2 2013.pdf

Mortality

Of 77 documented wolf mortalities in 2007, 67 were caused by humans, 2 were attributed to natural causes, and 8 were due to unknown causes. Of 67 confirmed human-caused mortalities, 43 wolves were killed in response to livestock depredations, 9 were illegally taken, 8 were from other human causes, and 7 were legally taken (shot by landowner while harassing or attacking livestock). These figures underestimated true mortality because only a small proportion of wolves were radio-collared. Researchers lacked the means to estimate pup mortality prior to observations at dens or rendezvous sites. In 2013, there were 473 documented wolf mortalities statewide, and 356 (99%) of these mortalities were attributed to legal harvest (IDFG 2014). Wolves were delisted by the USFWS in 2011, and the State of Idaho, in cooperation with the Nez Perce Tribe, assumed responsibility for wolf management on May 5, 2011. Since that time, gray wolves have been managed as a game species by the IDFG and Nez Perce Tribe.

Lethal removal by Wildlife Services to address livestock depredations has generally increased statewide since reintroduction. Under the Endangered Species Act, 10(j) rule (revised), livestock operators were given the option to kill wolves harassing livestock (previously, lethal removal was only allowed when wolves were observed actually attacking livestock). However, in the Plan Area, few wolves have been killed by livestock operators under the revised 10(j) rule since 2005. In 2013, only 7 documented wolf mortalities were attributed to non-hunting (i.e. livestock protection) in the Plan Area, as compared to 106 wolf mortalities attributed to legal harvest by licensed hunters (IDFG 2014).

Impacts on Big Game Populations

Wolf impacts on wild ungulate populations are variable in space, time, and magnitude. In the Lolo Elk Zone, wolf predation impacts on elk have been documented over the last few years. Based on cause-specific mortality of radio-collared elk in the Lolo Zone, wolf predation on cow elk is a significant factor in that elk population’s inability to stabilize or increase, particularly in GMU 12 (update with references from 2014 Predator Mgt Plan). Similarly, wolf predation may be causing reductions in harvestable surplus in other areas, even if elk populations are not declining.

Wolves are also likely impacting the behavior and habitat use of elk during hunting seasons, thus possibly reducing success rates for some hunters. Behavioral changes of elk, documented by researchers in the greater Yellowstone ecosystem, show elk spending more time in forested areas, on steeper slopes, and at higher elevations than before wolf reintroductions (Creel and Winnie 2005, Mao et al. 2005). IDFG will continue to closely monitor impacts of wolves on ungulates as this aspect of wolf recovery is very important to big game managers and hunters. Under the 2002 State Plan, IDFG has an obligation to ensure that wolves in increasing numbers do not adversely affect big game populations. Predation pressures on elk and deer are natural sources of mortality that are accounted for in natural systems and not problematic at some level. Predation has unknown benefits through selection processes as well as influence on populations that may be either beneficial or detrimental to the population, depending on time, location, environmental and habitat conditions, and point of view.

Wolves are effective predators and scavengers that feed primarily on large ungulates throughout their range (Murie 1944, Pimlott 1967, Mech 1970, Van Ballenberghe et al. 1975, Carbyn 1983, Ballard et al. 1987, Gasaway et al. 1992, Boyd et al. 1994). Ungulates comprise nearly all of the winter diet of most wolves. Of the ungulates killed during winter by wolves that have colonized northwestern Montana from the mid-1980s, 63% were deer (60% white-tailed deer and 3% mule deer), 30% were elk, and 7% were moose (Boyd et al. 1994, Kunkel et al. 1999). Wolves elected white-tailed deer wintering areas and selected deer over elk and moose (Kunkel et al. 1999). An established population of wolves in northwestern Montana and southeastern British Columbia was responsible for the annual mortality of 6% of female white-tailed deer and 3% of female elk (Kunkel 1997, Kunkel and Pletscher 1999).

In Yellowstone, elk made up 89% of the 449 kills made by wolves during winters 1995–1997 (Phillips and Smith 1997, Smith 1998). In 2000, 281 elk (87%), 10 bison (3%), 4 moose (1%), 5 deer (3%), 4 coyotes (1%), 1 wolf, and 17 unknowns (5%) were determined to be killed by wolves during the mid-winter observation period. Composition of elk kills was 34% calves, 34% cows, 19% bulls, and 13% unknown. Bison kills included 3 calves, 1 cow, 1 bull, and 4 adults of unknown sex. Remains of voles, ground squirrels, snowshoe hare, coyotes, bears, insects, and vegetation were also found in wolf scats (Smith 1998).

Prey selection and frequency of killing by wolves varies greatly depending on many factors including pack size; snow conditions; the diversity, density, and vulnerability of prey; and the degree of consumption of the carcasses (Kunkel 1997). Snow depth and wolf density best explained the annual variation in kill rate in northwestern Montana (Kunkel 1997). Based on studies with the most similar species and diversity of prey (Carbyn 1983, Keith 1983, Boyce 1990, Vales and Peek 1990, Mack and Singer 1992), wolves are projected to kill about 16.5 ungulates per wolf per year in Idaho, where they are expected to feed primarily on mule deer and elk (USFWS 1994).

During the first 3 years of an intensive predation study in Yellowstone, wolves killed at a rate equivalent to approximately 10.7 kills/wolf/year during early winter (Phillips and Smith 1997, Smith 1998). The rate increased to about 23.3 kills/wolf/year by late winter (Phillips and Smith 1997, Smith 1998). Elk made up 90% of the wolf kills examined. Wolves in Idaho are expected to be less reliant on elk and more reliant on mule deer and white-tailed deer compared to Yellowstone, where primary alternative prey options include bison and antelope (IDFG 2010b). However, in the first year of a winter predation study near Salmon, Idaho, deer made up only 10% of the prey killed by the Moyer Basin and Jureano Mountain wolf packs during winter, which is significantly less than their proportion of abundance (Husseman and Power 1999, Husseman 2002). Wolves selected calf elk in excess of their proportion of abundance in the population (Husseman and Power 1999, Kuck and Rachael 1999, Carbyn (1987). Wolves selected older and younger deer and elk than did hunters in northwestern Montana (Kunkel et al. 1999). Vales and Peek (1995) examined several studies that reported the age structure of deer and elk killed by wolves compared to the estimated age structure of the deer and populations In several studies wolves were documented to take old deer in excess of their proportion of abundance in the population; and they tended to take elk calves in excess of their proportion of abundance in the population ; Kunkel et al. 1999). Fifty-eight percent of elk killed by wolves near Salmon, Idaho during winter 1999 were calves (Husseman and Power 1999); whereas, calves comprised approximately 17% of the elk population in the area at that time (Kuck and Rachael 1999).

Kill rates of wolves may vary widely by area and from year to year depending upon primary prey species, prey abundance, and weather conditions, among other factors. Most often the effects on prey populations that are attributable to wolf predation are unknown because of the lack of information on population dynamics of the prey populations and the rates of other mortality sources. However, Kunkel and Pletscher (1999) documented that predation by wolves and other predators (i.e., mountain lions, grizzly bears, black bears, coyotes, and humans) on ungulate species in northwestern Montana appeared to be mostly additive to the effect of other mortality factors, and that predation appeared to be the primary factor limiting the growth of deer and elk populations.

Ecological Effects of Wolf Predation

Evidence exists in Yellowstone National Park showing that the elk population and elk use of riparian willow (*Salix* spp.) habitat have declined since wolf recovery. Reduced elk use allowed recovery of some willow habitats, thereby producing a cascade effect benefiting a wide range of animal species (Ripple and Beschta 2004). Elk carcasses resulting from wolf predation are also being used by an entire suite of scavengers and other carnivores, potentially increasing fitness of species such as grizzly bears (*Ursus arctos*), red and grey foxes (*Vulpes vulpes* and *Urocyon cinereoargenteus*), common ravens (*Corvus corax*), and bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos*) (Smith et al. 2003).

Predation studies have repeatedly shown that selection by wolves favors young, old, or physically impaired prey animals (Mech et al. 2001, Husseman 2002, Smith et al. 2003). Strong selection for disadvantaged prey may result in a mitigating effect on overall wolf impacts to prey populations due to the compensatory mortality component of wolf predation, or when wolves selectively prey on older, non-productive individuals that no longer contribute to population maintenance or growth.

Idaho Department of Fish and Game Wolf Management Goals and Objectives

IDFG currently oversees management of wolves in Idaho and coordinates among agencies to fulfill obligations under the revised 10(j) rule, Endangered Species Act, and 2010 State plan.

The goal of the IDFG plan is to ensure that populations are maintained at 2005–2007 population levels (518–732 wolves) during the 5-year post-delisting period through adaptive management under the guidelines of the 2002 State Plan. Consistent with the delisting rule, the State goal is to ensure the long-term viability of the gray wolf population. In order to ensure that the population goal is achieved, the Department will maintain ≥15 breeding pairs (floor threshold). The Department will maintain balanced wolf and prey populations and ensure genetic transfer among states by maintaining connectivity and functional metapopulation processes. The Department will also manage wolves to minimize conflict with humans and domestic animals.

Secondarily, an important component the IDFG management approach is to maintain a harvest opportunity for wolves. Ideally, wolf population objectives should also reflect ability to monitor packs, breeding pairs, and total wolves, as well as harvest and monitoring objectives in neighboring states. Therefore, the long-term objective is to maintain viable wolf populations in the state, achieve short-term harvest goals to reduce conflicts, provide annual harvest opportunity, as well as to provide for non-consumptive benefits.

Based on stakeholder input, the most important objective within the management plan will be conflict resolution when wolf populations meet or exceed the population goal of the plan. Future population goals will reflect knowledge gained each year. However, the statewide population will be managed to range between the 2005 and 2007 levels and not be allowed to fall to a level where management of conflicts has to be restricted (<15 breeding pairs). The objectives addressed above fall within 11 broad objectives identified in IDFG's strategic plan.

Status and Trends

The Idaho wolf population has continued to expand in size and distribution since initial reintroductions in 1995, reaching ESA recovery goals by the end of 2002. By 2013, there were estimated to be 659 wolves in Idaho (IDFG 2014).

Wolf monitoring and management activities have been reported by Wolf Management Zones (WMZs) since 2008. Four WMZs, each of which comprise several GMUs, are within the Planning Area, these includeall or portions of the Palouse-Hells Canyon, Dworshak-Elk City, Lolo, and Selway WMZs (IDFG 2014). Wolf population estimates are very diffiuclt to obtain because of limited access in mountainous terrain, the wide-ranging movements of the species, dynamic pack distributions and structures, and ongoing mortalities and recruitment. Therefore, the number of packs in a WMZ is a more reliable number to report, although in remote backcountry areas unknown packs may exist. Four known packs occur in the Palouse-Hells Canyon, 15 in the Dworshak-Elk City, 8 in the Lolo, and 5 in the Selway WMZs as of 2013. The overall Plan area wolf population is apparently stable but may be in the early stages of a downward trend in backcountry areas as elk populations, the main prey species, decline.

Issues and Concerns

Wolf predation remains a major concern in the Lolo and Selway Units within the Plan Area and, to a lesser extent, other Units. IDFG will continue to manage for reduced numbers of wolves in those portions of the Plan Area where wolf predation on big game populations is a concern and to maintain current populations where appropriate.

7.3 KEY ECOSYSTEM SERVICES

The multiple uses discussed in the previous section were also identified as "key" ecosystem services by both the planning team and the public. However, several additional ecosystem services that did not fit under the typical multiple use categories were also identified as "key" and are described below.

7.3.1 *Clean Air*

Clean air is an important provisioning service provided by forests. Clean air is necessary for all life on Earth, and air pollution has been associated with a range of adverse health and environmental effects, such as respiratory infections and acid rain. Trees absorb carbon dioxide through photosynthesis, intercepting airborne particles on leaf surfaces and producing oxygen for people and animals to breathe. Trees also play a critical role in capturing 6 common air pollutants and toxic gases: ground-level ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxides, and lead. The pollutants come from dust, pollen, ash, motor vehicles, power plants, and other industrial sources. A single tree in the forest can absorb 10 pounds of air pollution per year and produce 260 pounds of oxygen per year. The average person consumes 386 pounds of oxygen per year.

7.3.1.1 Conditions, Trends, and Drivers

Clean air will continue to be produced and filtered through the Forests. The major impacts to air quality in the plan area are from agricultural burning, wood smoke, and wildland fires. Agricultural burning and wood smoke are highly regulated, and the regulations are expected to become even more stringent in the future. No large industrial complexes affect the plan area, and no additional industrial complexes are expected to impact air quality in the future.

The Forests and adjacent communities generally have very good air quality. July, August, and September are the months when air quality may be impacted, although pollutants do not generally reach unhealthy levels. During these months, wildland fires, prescribed fires, and agricultural burning can adversely impact air quality for days. 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 potential air quality impacts from each prescribed burn.

Air quality impacts from wildland fires may intensify in the future if fires occur with greater frequency due to fuels buildup. Fuel accumulation in short, moderate, and long fire interval groups has occurred, creating the potential for more acres to burn at higher fire intensities. Over the last 25 years (1985–2010), the number of acres burned has been greater than the acreage that burned during the mid-20th century but less than the burned acreage that occurred during the early 20th century. The 2012 fire season broke the 1934 record for number of acres burned across the Forests.

Large fires will continue to occur on the Forests, due to increasing amounts of fuels, the number of inaccessible and/or roadless areas, the influence of the Pacific Decadal Oscillation (PDO), and the limited resources available to the Forest Service, both regionally and nationally. A comparison between PDO fluctuations and documented extreme forest wildfire years shows climatic patterns to be a major driver of severe and widespread wildfire events across forests (see section 1.1.2.2).

Warmer summer temperatures and reduced rainfall in the West are projected to extend the annual window of wildfire risk by 10%–30% (Brown et al. 2004; Westerling et al. 2006). Studies also indicate that climate change may increase summertime organic carbon aerosol concentration over the western United States by 40% and elemental carbon by 20% from 2000 to 2050. Most of this change would occur because of larger wildfire emissions; the remainder of the effects would be caused by changes in meteorology. These changes in carbon in the atmosphere would have important consequences for western U.S. air quality and visibility (Spracklen et al. 2009).

7.3.1.2 Ecosystems and Clean Air

Please see the “Air Quality” section of this Assessment.

7.3.1.3 Influence of Non–National Forest System Lands and Conditions

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 potential air quality impacts from each prescribed burn.

7.3.1.4 Importance to People in the Analysis Area and the Broader Landscape

The Forests play a role in improving local and regional air quality. Adjacent communities generally have very good air quality. However, the highly variable terrain on the Forests, coupled with high-pressure weather systems in the summer and fall, can also heavily impact air quality.

Smoke from agricultural burning and/or wildland fires can funnel into canyons and settle for days, producing unhealthy conditions in such locales. Usually, these conditions only occur for a few days at a time. However, 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 the risk of 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. Displaying data from this report, Table 7-9 shows the prevalence of lung disease in the 5-county analysis area. Approximately 14,495 people (or about 13.6% of the population) in the 5-county area have some type of lung disease.

Table 7-11. Number of people with lung disease in the Nez Perce–Clearwater analysis area

County	Total Population	Pediatric Asthma	Adult Asthma	Chronic Obstructive Pulmonary Disease (COPD)	Lung Cancer
Clearwater	8,702	128	672	474	4
Idaho	16,446	289	1,216	853	8
Latah	37,704	596	2,842	1,392	19
Lewis	3,822	71	280	199	2
Nez Perce	39,543	735	2,880	1,815	20

Source: American Lung Association 2013

Besides health-related impacts, air quality also affects the visibility and the visual aesthetics of an area. One of the key air quality related values in any wilderness is visibility, of which the Forests manage or co-manage three: the Selway-Bitterroot, Frank Church and the Gospel Hump Wilderness areas. Many forest users visit these areas solely for the scenic beauty and solitude. There are many other destinations on the forest, where users travel to enjoy the sheer scenic beauty of the forests. High mountain lakes, lookouts and ridgeline roads and trails provide many scenic overlooks throughout the forest. Some of the places that visitors travel for the scenic overlooks are: the Niimiipu National Historic Trail, Square Mountain Road and Tom Beal Park. For visitors willing to hike or ride, there are endless opportunities to discover the scenic beauty of the forest.

7.3.1.5 Effects from Forest Service Management Actions

National direction for Forest Service management actions will continue to have a profound effect on how fire and fuels are managed across the Forests. Declining fire budgets will limit suppression efforts, prescribed fire implementation, hazardous fuels planning, and wildland fire use implementation. National direction will also continue to provide Forests with more flexibility in the management of fire and fuels on the landscape. Wildland fire use, prescribed fire, and mechanical treatment of wildland fuels will continue to increase.

7.3.1.6 Information Needs

No additional information needs have been identified.

7.3.2 *Soil Stabilization, Erosion Control, and Landscape Protection*

Soil stabilization and erosion control are important regulating services. Regulating services are “the benefits people obtain due to the regulation of natural processes such as water purification and erosion control. These are the less tangible benefits people gain from ecosystems when abiotic and biotic factors are controlled and/or modified (Haines-Young and Potschin, 2010) and consequently they are not widely acknowledged by humans” (Kandziora et al. 2013).

In a recent publication, Smith et al. (2011) explain the importance of erosion control as a regulating service:

> Daily (1997) articulated the importance of these services by highlighting erosion’s costs to natural and human-made systems. They explained that “downstream costs [of erosion] may include disrupted or lower quality water supplies; siltation that impairs drainage and maintenance of navigable river channels, harbors, and irrigation systems; increased frequency and severity of floods; and decreased potential for hydroelectric power as reservoirs fill with silt” (Pimentel et al. 1995 as cited in Daily 1997). The integrity of forest soils and vegetation has considerable impact on hydrology, aquatic habitats, and economic uses of water supplies and waterways.

7.3.2.1 Conditions, Trends, and Drivers

The “Soils” section of the Assessment contains substantial information on the conditions, trends, and drivers of soil on the Forests.

For the Nez Perce National Forest, landslide-prone areas are generally located on slopes >60% and landslide deposit landtypes. During storm and flood events in 1995 and 1996, over 860 landslides occurred across the Clearwater National Forest. A survey was conducted to review these landslides, and 5 factors were identified to assess the inherent risk of landslides on the Clearwater National Forest. The 5 factors are geologic parent material, elevation, aspect, slope angle, and landform (see Table 1 in section 2.2.2.2).

7.3.2.2 Ecosystems and Soil Stabilization

Soil is flexible (it can be dug) and stable (it can withstand wind and water erosion). Soil also provides valuable long-term storage options, protecting archeological treasures and landfilling garbage generated by humans. Inherent soil properties, such as soil texture and particle size distribution, play a major role in physical stability. The need for structural support can conflict with other soil uses. For example, soil compaction may be desirable under roads and houses, but it can be devastating for the plants growing nearby. Soil has a porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots. Soils also provide anchoring support for human structures, such as buildings and roads, and protect archeological treasures. The conflict—stability and support versus plant growth capabilities—is constant when forest management decisions involve roads, skid trails, recreation trails, and forest productivity. The main forest impacts to structure and stability are mass wasting, erosion, and loss of organic matter. (See Chapter 2 for more information.)

7.3.2.3 Importance to People in the Analysis Area and the Broader Landscape

Costs associated with erosion and landslides include reduced soil productivity, damaged roads and structures, filled ditches and reservoirs, reduced water quality, and harm to fish populations.

7.3.2.4 Effects from Forest Service Management Actions

In 2010, the FSM Chapter 2550, Soil Management, was amended at the national level. The emphasis of soil management was changed from disturbance tracking to an approach focusing on long-term soil quality and ecological function. The objectives of the national direction are 1) to maintain or restore soil quality on National Forest System lands and 2) to manage resource uses and soil resources on National Forest System lands to sustain ecological processes and function so that desired ecosystem services are provided in perpetuity.

FSM 2550 identifies 6 soil functions: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. Soil is the foundation of the ecosystem; in order to provide multiple uses and ecosystem services in perpetuity, these 6 soil functions need to be active.

Land use practices such as grazing, logging, and mining have been occurring on the Forests since they were established. These past forest practices have caused several impacts to soil functions (see section 1.1.2.2). In present-day forest management, soil restoration is included in the majority of projects in order to meet the desired productivity for the land. The soil functions are intertwined, sodiscussing them separately is difficult. A few impacts can impair the majority of soil functions; these impacts are compaction, erosion, and loss of organic matter. As discussed in section 1.1.2.2, past activities have caused many of these impacts. While these impacts have not been eliminated, the Forest Service has substantially decreased these types of effects through the use of current management practices. This reduction of impacts, coupled with soil restoration activities, is expected to increase the capacity of the soils to provide multiple uses and ecosystem services in perpetuity.

7.3.2.5 Information Needs

Terrestrial Ecological Unit Inventories including soil mapping have been completed on both Forests in the 1970s and 1980s. Nez Perce National Forest Soil Mapping was completed in 1981–1986 by U.S. Forest Service soil scientists and ecologists. A local forest publication of the data was printed in 1987. In 2006, National Cooperative Soil Survey (NCSS) published a copy of the survey. The survey encompasses approximately 1.3 million acres of the Forest; Wilderness areas were not mapped. The Nez Perce National Forest soil survey has been correlated and entered into the National Soil Information System (NASIS) database and the Soil Survey Geographic Database (SSURGO). Information garnered during the joining efforts showed inconsistencies within the Nez Perce National Forest survey as well as inconsistencies with the Idaho County Survey.

The Clearwater National Forest Land System Inventory was completed in 1971–1979 by U.S. Forest Service soil scientists and additional staff. A local forest publication of the data was printed in 1983. The survey encompasses approximately 1.5 million acres of the Forest; Wilderness areas were not mapped. The Clearwater National Forest soil survey is currently being correlated and entered into NASIS and SSURGO by Natural Resources Conservation Service (NRCS).

Once all of the data has been entered into national databases the next step is updating the surveys and gathering more detailed information on soil series located on the Forests. (see section 2.2.3).

7.3.3 *Carbon Sequestration and Climate Regulation*

Forests substantially mitigate the climate effects of increasing atmospheric CO_2 concentrations by removing carbon from the atmosphere and storing it as biomass. Worldwide, forests offset about one-third of global CO_2 emissions from fossil fuel combustion. U.S. forests offset about 10%–20% of U.S. fossil fuel emissions. Carbon sequestration is often viewed as either a regulating service (helping to regulate climate) or a supporting service (contributing to the production and availability of many other ecosystem services).

7.3.3.1 Conditions, Trends, and Drivers

Available information suggests that carbon stocks of the Forests have been increasing over the last several decades as the forests recover from extensive fires in the late 19th and early 20th century. The 2 Forests store approximately 312 million metric tons (Mt) of carbon (excluding soil carbon stocks) and contain approximately 0.7% of total U.S. forest carbon stocks. Wood products harvested from the Forests store an additional 6 Mt of carbon, although the size of the harvested wood products carbon pool has been declining since 2000 as a result of declining harvest levels. Net annual growth (gross annual growth minus losses due to mortality) on the 2 Forests combined is estimated to be 216 million cubic feet, which equates to an average annual increase in live aboveground carbon stocks of roughly 1.16 Mt.

The future trajectory of carbon stocks on the Forests is uncertain and will depend on the spread of root diseases, the extent and severity of future fires, tree mortality caused by bark beetles and other forest insects, the rate of tree regeneration after disturbances, and potential changes in forest productivity. Projected changes in regional climate may exacerbate many of these change agents and thus reduce the carbon stocks on the Forests. Forest management activities that reduce the potential for uncharacteristically large and severe natural disturbances and promote rapid forest regeneration after disturbances may reduce some of these potential risks to carbon stocks.

More information is available in section “Baseline Carbon” section of the Assessment.

7.3.3.2 Ecosystems, Carbon, and Climate Regulation

See section 1 of the Assessment for information related to the ecosystems helping to sequester carbon and regulate climate.

7.3.3.3 Influence of non–National Forest System Lands or Conditions

Within the plan area are large, contiguous blocks of NFS-managed lands, with relatively minor inholdings of non-NFS lands. On the scale that would be used to evaluate climate regulation, these inholdings would be of insignificant influence. For the entire region that climate regulation would be evaluated, the vast majority of lands are non-NFS lands. The Forest Service has very limited authority, if any, to influence the management of these lands. Therefore, even when activities on non-NFS lands adversely affect the Forests’ ability to provide climate regulation, the Forest Service has very limited ability to change non-NFS management practices or the effects that those practices may have on NFS-managed lands.

7.3.3.4 Importance to People in the Analysis Area and the Broader Landscape

On a global scale, the impacts of a changing climate are predicted to be overwhelmingly negative. The Intergovernmental Panel on Climate Change (IPCC) predicts a broad range of effects of changing climate, including regional warming, changes in precipitation, extremes in weather, severe drought, earlier snowmelt, rising sea level, effects on water supply, and other changes that will lead to significant alterations in ecosystems and societies. Continued emission of greenhouse gases at current rates would greatly intensify these impacts (USDA Forest Service 2008a). Carbon sequestration, and its relation to climate, has indirect impacts to people, through its relationship to weather (including temperatures) and damages that can occur due to climate change (e.g., risk of flooding from sea level rise) (EPA 2013).

7.3.3.5 Effects from Forest Service Management Actions

Within the context of public forests, individual land management actions are unlikely to have significant long-term effects on the atmospheric concentrations of CO_2 and other greenhouse gases. Without a substantial reduction in fossil fuel emissions, the impacts of projected climate change on disturbance regimes and species composition will likely overwhelm the short-term effects of land management actions. From this perspective, the primary forest management action to mitigate increasing atmospheric CO2 concentrations is the sustainable use of woody biomass to generate energy and biofuels and displace more fossil fuel–intensive construction materials (Nabuurs et al. 2007). The IPCC reached the following conclusion: “In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit” (Nabuurs et al. 2007).

7.3.3.6 Information Needs

No information needs have been identified.

7.3.4 *Cultural/Heritage Values*

The term “cultural services” refers to the intangible benefits people receive from ecosystems, including nonmaterial spiritual, religious, inspirational, and educational experiences (Kandziora et al. 2013). Under the MEA classification (MEA 2003) (Table 7-1), cultural and heritage values are included as a “cultural service”. For this planning effort, cultural and heritage values are the cultural and historic uses and resources in the planning area. The 4 direct cultural/heritage values of the plan area are heritage tourism, interpretation, education, and public partnership programs. These are the values that are further described in this section.

However, many less well-defined, and harder-to-measure, benefits or values associated with National Forests fall under the heading of cultural services. These benefits or values can include sense of place, non-use values (such as existence value), spiritual values, and using natural systems for education and scientific research.

7.3.4.1 Geographic Scale

Benefits from cultural resources primarily serve the local regional market, but national and international participation occurs in the form of volunteers in public archaeology programs and visitors to the Forests.

7.3.4.2 Conditions, Trends, and Drivers

The condition of hundreds of historic properties across the plan area varies by resource class, location, and age. Site monitoring and condition assessments of these properties show a range in condition, from “excellent” to “destroyed.” Taken as a whole, historic properties across the plan area exist in fair condition.

Table 7-12 describes the current status and trends of cultural and heritage values on the Forests.

Table 7-12. Conditions and trends of cultural and heritage values on the Nez Perce–Clearwater National Forests

Value	Condition	Trend
Heritage tourism	Fair	Declining
Interpretation	Good	Stable
Education	Fair	Declining
Public partnership programs	Good	Stable/declining

Cultural/heritage values are based on historic qualities, which are, by nature, nonrenewable. Thus, the stability and resilience of this ever-aging, fragile resource class is constantly decreasing. The Forest Service Heritage Program can ameliorate this trend, but only to the degree to which funding is available (Table 7-13).

Table 7-13. Cultural and heritage values and drivers on the Nez Perce–Clearwater National Forests

Value	Drivers
Sustainability of tribal belief systems	Ecosystem integrity, access, resource deterioration
Interpretation	Funding and public demand for historical interpretation (mining)
Education	Funding
Public partnership programs	Funding, urban orientation, resource deterioration

7.3.4.3 Importance to People in the Analysis Area and the Broader Landscape

The Forests serve as a backdrop, workplace, and playground for the small rural communities of central Idaho. Deeply rooted in the cultures and traditions of Native American tribes and early Euro-American settlers, the Forests’ recreation settings and opportunities are enhanced by the many visible and accessible remnants of the past. A network of historic trails and roads gives visitors a chance to follow in the footsteps of the Native Americans, the Lewis and Clark Expedition, and miners in search of gold. Historic cabins and lookouts continue to serve as overnight destinations for present-day visitors.

7.3.4.4 Effects from Forest Service Management Actions

Two management tools are employed to protect the natural and cultural resources of the Forests: 1) interpretation and education programs and 2) law enforcement. Although both management tools influence visitor behavior, law enforcement is typically a reactive approach, while interpretation and education programs are designed to create appreciation and understanding as a way to encourage voluntary compliance and deter behavior that would result in negative resource impacts.

7.3.4.5 Information Needs

A lack of information exists concerning sites on the Forests that have cultural and religious significance to groups such as American Indians. The role these sites play in the transmission and conduct of a group's historically rooted beliefs, custom, practices and religion are important, but cannot be protected if their presence remain unknown.

7.3.5 *Aesthetics*

Due to the natural scenic beauty of the National Forests, aesthetics is an important cultural ecosystem service associated with these landscapes. In addition, the aesthetics of an area is often associated with inspiration and art, another cultural ecosystem service. Aesthetics is "the Visual quality of the landscape/ecosystems or parts of them which influences human well-being and the need to create something, esp. in art, music and literature. The sense of beauty people obtain from looking at landscapes/ecosystems as ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, advertising and technology" (Kandzioria et al. 2013). Sometimes called visual quality, scenic character, or scenic amenity by professionals, visual appreciation of the environment is a well-recognized and accepted dimension of aesthetic appreciation (SEQ 2013). The scenic character of the Forests is described in section 9.1.2.2. The incredible scenery of the Forests contributes to community identity and sense of place; quality of life (backdrop/backyard); the tourism industry (attraction); and increased real estate values.

7.3.5.1 Geographic Scale

The Forests are part of the Columbia Rockies subregion of the Rocky Mountains character type. Rugged mountains and numerous deeply cut river canyons typify this subregion. The landscapes of the Forests begin in the jagged peaks of the Bitterroot Mountains and flow to the deep canyons of the Salmon, Selway, Lochsa, and Clearwater rivers. The high alpine areas and river canyons contain most of the distinctive or unique landscapes that contribute to the sense of place associated with the 2 Forests.

Broad coniferous forests cover the mountains that stretch from the rolling hills of the Palouse Plateau to the Camas Prairie. Mountain silhouettes, winding rivers, and vast expanses of untrammeled forests enhance the quality of life for local residents and serve as a draw for nonlocal visitors. Cultural elements such as historic cabins, lookouts, and historic Forest Service buildings enhance the visitor's experience.

A description of the scenic character of the Forests, including areas where the scenery has unique or distinctive scenic character, is included in section 9.1.2.2 of the Assessment. The landscape character is described by geographic area; distinctive features, visually sensitive travel corridors, and important cultural features of each area are also described. Maps showing the distribution of distinctive landscapes, sensitive travel corridors and use areas, and desired scenic condition are included.

7.3.5.2 Conditions, Trends, and Drivers

The current condition of the scenic character varies across the Forests. Large areas of the Forests contain naturally evolving landscapes where the scenery reveals the biophysical features and processes that occur in this geographic area with very limited human intervention. These areas include all the designated Wildernesses Areas, and several large Roadless Wilderness Areas or proposed wilderness areas. Broad natural landscapes (such as the viewshed of the Lolo Trail National Historic Landmark) have been managed to maintain the Retention and Partial Retention

Visual Quality Objectives (VQOs) laid out in the 1987 Forest Plan, and these landscapes currently have a natural-appearing character.

Other areas of the Forests located in the more heavily roaded portion of the landscape show evidence of human habitation and management. Some of these areas have openings that appear natural, while others have openings that are obviously created by humans. These openings, while obvious, do not dominate the natural character of the landscape and appear in background views or are minor components of the foreground and middle-ground views from critical travelways or recreation areas. More detailed and place-based information is provided in the Recreation Scenic Character, section 9.1.2.2).

7.3.5.3 Ecosystems and Aesthetics

The provision of water (quality and quantity) and the provision of vegetation have been identified as 2 ecosystem components that are important for providing aesthetic values (SEQ 2013). Information on these 2 important ecosystem components can be found in Chapter 1 and Chapter 2 of the Assessment.

7.3.5.4 Importance to People in the Analysis Area and the Broader Landscape

Driving for pleasure and viewing natural features are 2 of the top 5 reasons people visit the Forests (NVUM 2011a,b). Data from NVUM also reveal that the conditions of the environment and scenery are the most important components of these recreation visits. Maintaining a natural-appearing landscape character is important to ensure continued use and satisfaction of Forest visitors.

Additionally, the aesthetics or the natural resource–based amenities of an area have been shown to contribute to population growth and economic development (see section 6.6.6 for a discussion of natural amenities and the economy), as well as to housing values. In general, 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).

7.3.5.5 Effects from Forest Management Actions

Since the 1987 Forest Plan, the Forest Service has updated the analysis tool presented in the Visual Management System; the new tool isreferred to as the Scenery Management System. The new Forest Plan will be developed using the concepts and terminology outlined in this new analysis system.

Some isolated areas have human impacts that dominate the landscape to the point that these areas do not meet VQOs listed in the 1987 Forest Plan. These areas should be identified and improved through landscape restoration efforts.

7.3.5.6 Information Needs

No information needs have been identified.

7.3.6 *Flood Protection*

Flood protection is an important regulating ecosystem service provided by National Forests. Large trees, for instance, break up heavy rainfall. Organic soils and established root systems assist in absorbing water, while permeable soils allow surface water to soak in and recharge groundwater resources.

7.3.6.1 Geographic Scale

Exclusive of installing dams to regulate flow in river systems, management activities have a measurable effect on flood control at the watershed scale (5th field HUC or smaller), and the effect increases with decreasing analytic area. Although construction of a series of dams on the large river systems in the plan area is technically feasible (in fact, several large hydropower facilities already exist on the river systems connected to the plan area), this Assessment focuses on the inherent ability of the ecosystem to regulate flows rather than engineered solutions to do so.

7.3.6.2 Conditions, Trends, and Drivers

Intensive forest harvest, including clear-cutting, broadcast burning, road building, and riparian disturbance, has the potential to dramatically change the biophysical processes in watersheds. Changes in annual water and sediment yield, low flows, peak flows, and water quality metrics (e.g., temperature, chemical composition) have been observed after forest harvest and have been tied to resultant ecological effects (Grant et al. 2008).

Forest management practices are not the only causes of historical variations in peak flow and other pertinent hydrologic parameters. Urbanization, agriculture, and grazing can all influence drainage efficiency, defined as the routing and timing of water delivery to the channel and through a stream network (Tague and Grant 2004, cited in Grant et al. 2008, p. 6). Dam and reservoir operations also alter the natural hydrograph, thus complicating the interpretation of direct effects of forest management on peak flows and channels. Natural disturbances such as stand-replacing wildfires, or landslides and debris flows, can also dramatically alter hydrologic and geomorphic systems (Grant et al. 2008).

With dwindling water supplies, governments are turning to forest management as a possible means of augmenting water yield. Numerous paired watershed experiments have shown that forest harvest can increase water yields, particularly in areas where precipitation exceeds potential evapotranspiration. However, the increases in water yield from vegetation removal are often small and short-lived, and are smaller when the water is most needed, such as in dry years and in dry areas. Operationally, harvesting enough area frequently enough to cause a detectable change in water yields is difficult (Jones et al. 2009).

Diverse components factor into hydrologic and geomorphic behavior; among them are climate, biotic and geophysical processes, natural disturbances, and management practices; storage and fluxes of water, sediment, and wood; and resulting channel and water column habitat for aquatic organisms (Grant et al. 2008). Drought, outbreaks of insects and pathogens, wildfire, and ecological succession are altering forests' ability to provide abundant clean water in the headwaters of the water supply systems (Jones et al. 2009).

7.3.6.3 Influence of non–National Forest System Lands or Conditions

On non-NFS lands within the boundaries of the plan area, continuing urbanization and increasing construction of second homes in forested settings have expanded the area of WUIs, causing increased concerns about protection from forest disturbances such as wildfire and landslides (Jones et al. 2009). Management of these lands to reduce fire risk may influence flood control in some parts of the plan area, but this effect is likely to be small.

On non-NFS lands adjacent to the plan area, management activities could significantly affect flood conditions. This influence would likely increase as more watersheds are located on non-

NFS lands. In 29 of the 220 assessed 6th field HUC watersheds on the Forests, non-NFS ownership is significant, totaling >50% of the area.

7.3.6.4 Importance to People in the NPCW Analysis Area and the Broader Landscape

Because flood-related damage to homes, commercial buildings, farms, and public infrastructure is costly, the Forest's ability to reduce flood risk and severity is a socially beneficial service. In addition, floods can cause damage to the following ecosystem services:

- Water quality (floods can damage diversion and filtration structures; in addition, a temporary impairment of water quality can occur when sediment transport is high during high flows)
- Fish and wildlife (floods can temporarily displace fish, damage fish habitat, create fish habitat, and damage infrastructure that can increase the damage to fish habitat)
- Cultural/heritage values (these values can be lost if floods damage stream-adjacent structures or resources)
- Aesthetics (these values can be temporarily impaired by logjams, damage to infrastructure, reduced access to areas, and changes to viewsheds)
- Recreation opportunities (these can be reduced temporarily or permanently when floods damage roads and bridges, cutting off access to recreation areas)
- Landslide protection (floods can trigger debris torrents, exacerbating the flood damage and increasing damage to fish and wildlife species)

7.3.6.5 Information Needs

The potential for forest harvest to increase snowmelt rates in maritime snow climates is well recognized (Tonina et al. 2008). With potential changes in snowmelt rates, snow accumulation and distribution, and timing of snowmelt, all due to changing climate, vegetation management could create a synergistic effect that might substantially affect flood runoff rates.

Questions still exist about the magnitude of peak flow increases in basins larger than 10 km^2, and the geomorphic and biological consequences of these changes are not yet fully understood (Tonina et al. 2008).

The past century of forest hydrology has led to a clear understanding of the processes regulating water movement through forests and has produced general principles of hydrologic responses to harvest, roads, and application of chemicals. These principles can help manage forests for water; however, predicting the following specific effects of forest management on water quantity and quality in unmonitored basins, over long time periods or in large watersheds, is difficult (Jones et al. 2009):

- How large are the direct water yield and water quality responses to climate change (e.g., due to changes in temperature and timing, amount, and type of precipitation) compared to the indirect hydrologic responses to climate change (e.g., due to changes in wildfire and insect/disease outbreaks, or evapotranspiration) (Jones et al. 2009)?

- What are the effects of past forest management and fire suppression on current and future water yields and water quality? How have changes in domestic and native grazer populations and grazing behavior in forests affected water quantity and quality from forests? What are the long-term, large-scale effects of road networks on water quantity and quality (Jones et al. 2009)?
- How do changes in ownership affect forest management, and how do these changes affect water resources? What are the effects of the expansion of human settlements into forested areas and the consequent changes in forest management, such as thinning for fuel reduction, on water quantity and quality (Jones et al. 2009)?

7.3.7 *Other Ecosystem Services*

Several other important ecosystem services were brought up by either the public or the IDT. However, for a variety of reasons, these services did not rise to the level of key ecosystem services. Plants for medicinal and cultural uses were deemed important, but little information was available regarding the supply or the use of these plants. Similarly, mushrooms and berries are an important provisioning and recreational service provided by the Forests, but due to lack of information on either supply or use, these resources were not analyzed as a key ecosystem service. Additionally, both the public and the IDT recognized the importance of a variety of supporting services, including nutrient cycling and pollination, but the decision was made to address these services in the ecological sustainability sections of the Assessment rather than here.

7.4 LITERATURE CITED

Adams, A. W. 1982. Migration. Pages 301–321. In: Elk of North America: Ecology and management, eds. J. W. Thomas and D. A. Toweill. Harrisburg, PA: Stackpole Books. 698 p.

Adams, L. G. 1981. Ecology and population dynamics of mountain goats, Sheep Mountain – Gladstone Ridge, Colorado. Thesis. Fort Collins, CO: Colorado State University.

Adams, L. G., and J. A. Bailey. 1982. Population dynamics of mountain goats in the Sawatch Range, Colorado. Journal of Wildlife Management, 46:1003–1009.

Adams, L. G., and J. A. Bailey. 1983. Winter forages of mountain goats in central Colorado. Journal of Wildlife Management, 47(4):1237–1243.

Allen, E. O. 1977. Montana cooperative elk-logging study. Annual progress report, January 1 to December 31, 1976. Bozeman, MT: Montana Fish and Game Department.

Alley, W. M., T. E. Reilley, and O. L. Franke. 1999. Sustainability of ground-water resources. U.S. Geological Survey Circular, 1186.

American Lung Association. 2013. Estimated prevalence and incidence of lung disease. 64 p.

Armleder, H. M., R. J. Dawson, and R. N. Thomson. 1986. Handbook for timber and mule deer management coordination on winter ranges in the Cariboo Forest region. Victoria, B. C.: Ministry of Forestry. 98 p.

Asherin, D. A. 1973. Prescribed burning effects on nutrition, production and big game use of key northern Idaho browse species. Dissertation. Moscow, ID: University of Idaho.

Bailey, J. A. 1986. Harvesting mountain goats: Strategies, assumptions, and needs for management and research. Biennial Symposium of the Northern Wild Sheep and Goat Council, 5:37–47.

Bailey, J. A. 1991. Reproductive success in female mountain goats. Canadian Journal of Zoology, 69:2956–2961.

Bailey, J. A., and B. K. Johnson. 1977. Status of introduced mountain goats in the Sawatch Range of Colorado. First International Mountain Goat Symposium, 54–73.

Bailey, J. A., B. K. Johnson, R. D. Schultz, and R. Henry. 1977. Status of introduced mountain goats in the Collegiate Range of Colorado. Kalispell, MT: Northwest Section of The Wildlife Society.

Ballard, W. B., J. S. Whitman, and C. L. Gardner. 1987. Ecology of an exploited wolf population in south-central Alaska. Wildlife Monographs, No. 98. 54 p.

Balvanera, P. A., A. B. Pfisterer, N. Buchmann, J. He, T. Nakashizuka, D. Raffaelli, B. Schmid. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology Letters, 9:1146–1156.

Basile, J. V., and T. N. Lonner. 1979. Vehicle restrictions influence elk and hunter distribution in Montana. Journal of Forestry, 77:155–159.

Batchelor, C. L. 1968. Compensatory responses of artificially controlled mammal populations. Proceedings of the New Zealand Ecological Society, 15:25–30.

Baty, G. R. 1995. Resource partitioning and browse use by sympatric elk, mule deer and white-tailed deer on a winter range in western Montana. Thesis. Missoula, MT: University of Montana. 252 p.

Beecham, J. J., and P. Zager. 1992. Black bear management plan: 1992–2000. Boise, ID: Idaho Department of Fish and Game.

Benayas, J. M. R., A. C. Newton, A. Diaz, and J. M. Bullock. 2009. Enhancement of biodiversity and ecosystem services by ecological restoration: A meta-analysis. Science, 325:1121–1124.

Bender, L. C., and P. J. Miller. 1999. Effects of harvest strategy on bull demographics and herd composition. Wildlife Society Bulletin, 27:1032–1037.

Benzon, T. A., and L. A. Rice. 1988. Mountain goat status, Black Hills, SD: Biennial Symposium of the Northern Wild Sheep and Goat Council, 6:168–183.

Black, H., Jr., R. J. Scherzinger, and J. W. Thomas. 1976. Relationships of Rocky Mountain elk and Rocky Mountain mule deer habitat to timber management in the Blue Mountains of Oregon and Washington. Pages 11–31. In: Proceedings of the elk-logging-roads symposium, ed. S. R. Hieb. Moscow, ID: University of Idaho.

Bleich, V. C., R. T. Bowyer, and J. D. Wehausen. 1997. Sexual segregation in mountain sheep: Resources or predation? Wildlife Monographs, 134:50.

Boer, A. 1978. Management of deer wintering areas in New Brunswick. Wildlife Society Bulletin, 6:200–205.

Boyce, M. S. 1990. Wolf recovery in Yellowstone National Park: A simulation model. Pages 3–9 to 3–59. In: Wolves for Yellowstone? A report to the U.S. Congress, Vol. II, Research and analysis. Yellowstone National Park, Wyoming.

Boyd, D. K., R. R. Ream, D. H. Pletscher, and M. W. Fairchild. 1994. Prey taken by colonizing wolves and hunters in the Glacier National Park area. Journal of Wildlife Management, 58:289–295.

Boyd, J., and S. Banzhaf. 2007. What are ecosystem services? The need for standardized environmental accounting units. Washington, DC: Resources for the Future.

Brandborg, S. M. 1955. Life history and management of the mountain goat in Idaho. Boise, ID: Idaho Department of Fish and Game. Wildlife Bulletin, No. 2.

Brandt, J. P., T. A. Morgan, C. E. Keegan III, J. M. Songster, T. P. Spoelma, L. T. DeBlander. 2012. Idaho's forest products industry and timber harvest, 2006. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Resour. Bull. RMRS-RB-12. 45 p.

Brauman, K., G. Daily, T. Ka'eo Duarte, and H. A. Mooney. 2000. The nature and value of ecosystem services: An overview highlighting hydrologic services. Annual Review of Environment and Resources, 32:67–98.

Brown, T. J., B. L. Hall, A. L. Westerling. 2004. The impact of twenty-first century climate change on wildland fire danger in the Western United States: An applications perspective. Climatic Change, 62:365‑388.

Bunnell, F. L., and A. S. Harestad. 1989. Activity budgets and body weight in mammals: How sloppy can mammals be? Current Mammalogy, 2:245–305.

Burcham, M. G., W. D. Edge, C. L. Marcum, and L. J. Lyon. 1998. Long-term changes in elk distributions in western Montana. Pages 10–48. In: Final Report: Chamberlain Creek elk studies 1977–1983 and 1993–1996, M. G. Burcham, C. L. Marcum, L. J. Lyon, K. T. Weber, and W. D. Edge, eds. Missoula, MT: School of Forestry, University of Montana, Missoula. 260 p.

Cameron, R. D., W. T. Smith, S. G. Fancy, K. L. Gerhart, and R. G. White. 1993. Calving success of female caribou in relation to female body weight. Canadian Journal of Zoology, 71:480–486.

Canfield, J. E., L. J. Lyon, J. M. Hillis, and M. J. Thompson. 1999. Ungulates. Effects of recreation on Rocky Mountain wildlife: A review for Montana. Montana Chapter of The Wildlife Society, 6:1–25.

Carbyn, L. N. 1983. Wolf predation on elk in Riding Mountain National Park, Manitoba. Journal of Wildlife Management, 47:963–976.

Casebeer, R. L. 1948. A study of the food habits of the mountain goat (*Oreamnos americanus*) in western Montana. Thesis. Bozeman, MT: Montana State University.

Cassirer, E. F., D. J. Freddy, and E. D. Ables. 1992. Elk responses to disturbance by cross-country skiers in Yellowstone National Park. Wildlife Society Bulletin, 20:375–381.

Caughley, G. 1970. Eruption of ungulate populations, with emphasis on Himalayan thar in New Zealand. Ecology, 51:53–72.

Chabot, D. 1991. The use of heart rate telemetry in assessing the metabolic cost of disturbance. North American Wildlife and Natural Resources Conference Transactions, 56:256–263.

Chadwick, D. H. 1973. Mountain goat ecology-logging relationships in the Bunker Creek drainage of western Montana. Thesis. Missoula, MT: University of Montana. 260 p.

Chadwick, D. H. 1983. A beast the color of winter. San Francisco, CA: Sierra Club Books.

Cheatum, E. L., and G. H. Morton. 1946. Breeding season of white-tailed deer in New York. Journal of Wildlife Management, 10:249–263.

Cheatum, E. L., and C. W. Severinghaus. 1950. Variations in fertility of white-tailed deer related to range conditions. Transactions North American Wildlife and Natural Resources Conference, 15:125–134.

Christensen, A. G., L. J. Lyon, and J. W. Unsworth. 1993. Elk management in the Northern Region: Considerations in forest plan updates or revisions. Ogden, UT: USDA Forest Service. General Technical Report INT-303.

Coe, P. K., B. K. Johnson, J. W. Kern, S. L. Findholdt, J. G. Kie, and M. J. Wisdom. 2001. Responses of elk and mule deer to cattle in summer. Journal of Range Management, 54:205–205.

Cole, E. K., M. D. Pope, and R. G. Anthony. 1997. Effects of road management on movement and survival of Roosevelt elk. Journal of Wildlife Management, 61:1115–1126.

Collins, S., and Larry, E. 2007. Caring for our natural assets: An ecosystem services perspective. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Excerpt from PNW-GTR-733. 11 p.

Collins, W. B., and P. J. Urness. 1983. Feeding behavior and habitat selection of mule deer and elk on northern Utah summer ranges. Journal of Wildlife Management, 47:646–663.

Conroy, W. J. 2005. A coupled upland-erosion, instream hydrodynamic-sediment transport model for assessing primary impacts of forest management practices on sediment yield and delivery. Dissertation. Pullman, WA: Washington State University.

Convention on Biological Diversity. 2013. What is biodiversity? Available at:http://www.biodiv.be/biodiversity/about_biodiv/biodiv-what/. Accessed on: September 30, 2013.

Cook, J. G., L. J. Quinlan, L. L. Irwin, L. D. Bryant, R. A. Riggs, and J. W. Thomas. 1996. Nurtition-growth relations of elk calves during summer and fall. Journal of Wildlife Management, 60:528–541.

Cook, J. G., L. L. Irwin, L. D. Bryant, R. A. Riggs, and J. W. Thomas. 1998. Relations of forest cover and condition of elk: A test of the thermal cover hypothesis in summer and winter. Wildlife Monographs, 141:1–61.

Cook, J. G. 2002. Nutrition and food. In: North American Elk: Ecology and management, eds. D. A. Toweill and J. W. Thomas. Washington, DC: Smithsonian Institution Press. 962 p.

Cook, J. G., B. K. Johnson, R. C. Cook, R. A. Riggs, T. DelCurto, L. D. Bryant, and L. L. Irwin. 2004. Effects of summer-autumn nutrition and parturition date on reproduction and survival of elk. Wildlife Monograph, 155:1–61.

Cook, R. C., J. G. Cook, D. L. Murry, P. Zager, B. K. Johnson, and M. W. Gratson. 2001. Development of predictive models of nutritional condition for Rocky Mountain elk. Journal of Wildlife Management, 65:973–987.

Cook, R. C. 2001. Nutritional condition models for elk: Which are the most sensitive, accurate, and precise? Journal of Wildlife Management, 65:988–997.

Cook, R. C. 2011. A multi-regional evaluation of nutritional condition and reproduction in elk. Dissertation. Pullman, WA: Washington State University.

Cooper, A. B., and J. W. Unsworth. 2000. Southwest region big game modeling. Boise, ID: Idaho Department of Fish and Game. Completion Report, Project W-160-R-127.

Cooper, A. B., F. Stewart, J. W. Unsworth, L. Kuck, T. J. McArthur, and J. S. Rachael. 2002. Incorporating economic impacts into wildlife management decisions. Wildlife Society Bulletin, 30:565–574.

Cordell, H. K., C. J. Betz, G. Green, and M. Owens. 2005. Off-highway vehicle recreation in the United States, regions, and states: A national report from the national survey on recreation and the environment (NSRE). Available at: http://www.fs.fed.us/recreation/programs/ohv/OHV/final report.pdf.

Cote', S. D. 1996. Mountain goat responses to helicopter disturbance. Wildlife Society Bulletin, 24:681–685.

Cote', S. D., and C. Beaudoin. 1997. Grizzly bear attacks and nanny–kid separation on mountain goats (Oreamnos americanus). Mammalia, 61:154–157.

Cote', S. D., and M. Festa-Bianchet. 2001. Birthdate, mass and survival in mountain goat kids: Effects of maternal characteristics and forage quality. Oecologicia, 127:230–238.

Cote', S. D., and M. Festa-Bianchet. 2003. Mountain goat, Oreamnos americanus. Pages 1061–1075. In: Wild mammals of North America: Biology, management, and conservation, 2nd Edition, eds. G. A. Feldhamer, B. C. Thompson, and J. A. Chapman. London and Baltimore, MD: Johns Hopkins University Press.

Cote', S. D., A. Peracino, and G. Simard. 1997. Wolf, Canis lupus, predation and maternal defensive behavior in mountain goats, Oreamnos americanus. Canadian Field-Naturalist, 111:389–392.

Cote', S. D., A. Peracino, and K. G. Smith. 2001. Compensatory reproduction in harvested mountain goat populations: A word of caution. Wildlife Society Bulletin, 29:726–730.

Council for Agricultural Science and Technology (CAST). 2008. Pasteurellosis transmission risks between domestic and wild sheep. Ames, IA: CAST Commentary, QTA2008-1.

Cowan, I. M. 1944. Report of wildlife studies in Jasper, Banff and Yoho National Parks in 1944. Ottawa, Ontario: Canadian Department of Mines and Resources, Wildlife Services.

Cox, M., D. W. Lutz, T. Wasley, M. Fleming, B. B. Compton, T. Keegan, D. Stroud, S. Kilpatrick, K. Gray, J. Carlson, L. Carpenter, K. Urquhart, B. Johnson, and M. McLaughlin. 2009. Habitat guidelines for mule deer: Intermountain West ecoregion. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies. Available at: http://www.muledeerworkinggroup.com/Docs/IMW_Mule_Deer_Habitat_Guidelines.pdf. Accessed on: July 8, 2013.

Creel, S., and J. A. Winnie. 2005. Responses of elk herd size to fine-scale spatial and temporal variation in the risk of predation by wolves. Animal Behavior, 69:1181–1189.

Czech, B. 1991. Elk behavior in response to human disturbance at Mount St. Helens National Volcanic Monument. Applied Animal Behaviour Science, 29:269–277.

Daily, G. C., ed. 1997. Nature's services: Societal dependence on natural ecosystems. Washington, DC: Island Press. 392 p.

Dailey, T. V., and N. T. Hobbs. 1989. Travel in alpine terrain: Energy expenditures for locomotion by mountain goats and bighorn sheep. Canadian Journal of Zoology, 67:2368–2375.

DeBock, E. A. 1970. On the behaviour of the mountain goat (Oreamnos americanus) in Kootenay National Park. Thesis. Edmonton, Alberta: University of Alberta. 162 p.

DeByle, N. V., P. J. Urness, and D. L. Blank. 1989. Forage quality in burned and unburned aspen communities. Ogden, UT: U.S. Forest Service, Research Paper. INT-404.

Duchense, M., S. D. Cote, and C. Barrette. 2000. Responses of woodland caribou to winter ecotourism in the Charlevoix Biosphere reserve, Canada. Biological Conservation, 96:311–317.

Dusek, G. L., R. J. Mackie, J. D. Herriges, Jr., and B. B. Compton. 1989. Population ecology of white-tailed deer along the Lower Yellowstone River. Wildlife Monograph, 104. 68 p.

Dyer, S. J., J. P. O'Neill, S. M. Wasel, and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. Journal of Wildlife Management, 65:531–542.

Dzialak, M. R., S. L. Webb, S. M. Harju, J. B. Winstead, J. J. Wondzell, J. P. Mudd, and L. D. Hayden-Wing. 2011. The spatial pattern of demographic performance as a component of sustainable landscape management and planning. Landscape Ecology, 26:775–790.

Edge, W. D. 1982. Distribution, habitat use and movements of elk in relation to roads and human disturbances in western Montana. Thesis. Missoula, MT: University of Montana. 98 p.

Edge, W. D., and C. L. Marcum. 1991. Topography ameliorates the effects of roads and human disturbance on elk. Pages 132–137. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University.

Eisenberg, J. F. 1981. The mammalian radiations: An analysis of trends in evolution, adaptation, and behavior. Chicago, IL and London: University of Chicago Press.

English, D. B. K., S. M. Kocis, and D. P. Hales. 2004. Off-highway vehicle use on national forests: Volume and characteristics of visitors. Available at: http://www.Wildlandscpr.org/files/OHV_visitor_use_report_Aug_2004.doc.

Festa-Bianchet, M., M. Urquart, and K. G. Smith. 1994. Mountain goat recruitment: Kid production and survival to breeding age. Canadian Journal of Zoology, 72:22–27.

Festa-Bianchet, M., and S. D. Cote'. 2002. Age and sex-specific local survival in unhunted mountain goats (abstract only). Biennial Symposium of the Northern Wild Sheep and Goat Council, 13:39.

Folliot, P. F., and W. P. Clary. 1972. A selected and annotated bibliography of understory-overstory vegetation relationships. Tucson, AZ: University of Arizona, Agricultural Experiment Station. Technical Bulletin 198. 33 p.

Foreyt, W. J., and B. B. Compton. 1991. Survey for meningeal worm (Parelaphostrongylus tenuis) and ear mites in white-tailed deer from northern Idaho. Journal of Wildlife Diseases, 27:716–718.

Foster, B. R., and E. Y. Rahs. 1982. Implications of maternal separation on overwinter survival of mountain goat kids. Biennial Symposium of the Northern Wild Sheep and Goat Council, 3:351–363.

Foster, B. R., and E. Y. Rahs. 1985. A study of canyon-dwelling mountain goats in relation to proposed hydroelectric development in northwestern British Columbia. Biological Conservation, 33:209–228.

Fox, J. L. 1978. Weather as a determinant factor in summer mountain goat activity and habitat use. Thesis. Fairbanks, AK: University of Alaska.

Fox, J. L. 1983. Constraints on winter habitat selection by the mountain goat (Oreamnos americanus) in Alaska. Dissertation. Seattle, WA: University of Washington. 143 p.

Fox, J. L., and C. A. Smith. 1988. Winter mountain goat diets in southeastern Alaska. Journal of Wildlife Management, 52:362–365.

Fox, J. L., C. A. Smith, and J. W. Schoen. 1989. Relation between mountain goats and their habitat in southeastern Alaska. Portland, OR: USDA Forest Service. Gen. Tech. Rep. PNW-GTR-246. 25 p.

Fox, J. L., and G. P. Streveler. 1986. Wolf predation on mountain goats in southeastern Alaska. Journal of Mammalogy, 67:92–195.

Frair, J. L., E. H. Merrill, H. L. Berger, and J. M. Morales. 2008. Thresholds in landscape connectivity and mortality risks in response to growing road networks. Journal of Applied Ecology, 45:1504–1513.

Frederick, G. P. 1991. Effects of forest roads on grizzly bear, elk, and grey wolves: A literature review. U. S. Forest Service Publication, R1-91-73.

Frid, A. 1997. Human disturbance of mountain goats and related ungulates: A literature-based analysis with applications to Goatherd Mountain. Prepared for Kluane National Park Reserve, Haines Junction, Yukon.

Frid, A. 2003. Dall’s sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation, 110:387–399.

Frid, A., and L. M. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology, 6:11.

Garde, E., S. J. Kutz, H. M. Schwantje, A. M. Veitch, B. T. Elkin, and E. J. Jenkins. 2005. Examining the risk of disease transmission between wild Dall’s sheep and mountain goats and introduced domestic sheep, goats and llamas in the Northwest Territories. Report prepared for Wildlife Management, Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, Northwest Territories.

Garrott, R. A., G. C. White, and R. M. Bartmann. 1987. Movements of female mule deer in northwest Colorado. Journal of Wildlife Management, 51:634–643.

Gary, H. L. 1974. Canopy weight distribution affects windspeed and temperature in lodgepole pine forest. Forest Science, 20:369–371.

Gasaway, W. C., R. D. Boertje, D. V. Grangaard, D. G. Kellyhouse, R. O. Stephenson, and D. G. Larsen. 1992. The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. Wildlife Monographs, 120. 59 p.

Geist, V. 1964. On the rutting behavior of the mountain goat. Journal of Mammalogy, 45:551–568.

Geist, V. 1971. Is big game harassment harmful? Oil Week (June):12–13.

Geist, V. 1971. Mountain sheep: A study in behavior and evolution. Chicago, IL and London: University of Chicago Press.

Geist, V. 1978. Behavior. Pages 283—296. In: Big game of North America: Ecology and management, eds. J. L. Schmidt and D. L. Gilbert. Harrisburg, PA: Stackpole Books Incorporated.

Geist, V. 1982. Adaptive behavioral strategies. Pages 219–277. In: Elk of North America: Ecology and management, eds. J. W. Thomas and D. A. Toweill. Harrisburg, PA: Stackpole Books Incorporated. 698 p.

Geist, V. 1982. On population control with some reference to mountain sheep and goats. Calgary, Alberta: University of Calgary.

Gladfelter, H. L. 1966. Nocturnal behavior of white-tailed deer in Hatter Creek enclosure. Thesis. Moscow, ID: University of Idaho. 46 p.

Goldstein, M. I., A. J. Poe, E. Cooper, D. Youkey, and T. L. MacDonald. 2005. Mountain goat response to helicopter overflights in Alaska. Wildlife Society Bulletin, 33:in press.

Goode, J. R., C. H. Luce, and J. M. Buffington. 2011. Enhanced sediment delivery in a changing climate in semi-arid mountain basins. Implications for water resource management and aquatic habitat in the northern Rocky Mountains. Boise, ID: U.S. Forest Service, Rocky Mountain Research Station. Submitted for publication in Geomorphology.

Gordon, J., and D. Mulkey. 1978. Income multipliers of community impact analyses – what size is reasonable? Journal of Community Development Society of America, 9(1):86–93.

Gordon, S. M., and D. M. Reynolds. 2000. The use of video for mountain goat winter range inventory and assessment of overt helicopter disturbance. Biennial Symposium of the Northern Wild Sheep and Goat Council, 12:26–35.

Gordon, S. M. 2003. The effects of helicopter logging activity on mountain goat (Oreamnos americanus) behaviour. Thesis. Victoria, British Columbia: Royal Roads University.

Gordon, S. M., and S. F. Wilson. 2004. Effect of helicopter logging on mountain goat behaviour in coastal British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council, 14:in press.

Grant, G. E., S. L. Lewis, F. J. Swanson, J. H. Cissel, J. J. McDonnell. 2008. Effects of forest practices on peak flows and consequent channel response: A state-of-science report for western Oregon and Washington. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-760. 76 p.

Grigg, J. L. 2007. Gradations of predation risk affect distribution and migration of a large herbivore. Thesis. Bozeman, MT: Montana State University.

Guiguet, C. J. 1951. An account of wolverine attacking mountain goat. Canadian Field-Naturalist, 65:187.

Haines-Young, R., and M. Potschin. 2010. The links between biodiversity, ecosystem services and human well-being. Chapter 6. In: Ecosystem ecology: A new synthesis, eds. D. Raffaelli and C. Frid. Cambridge, England: Cambridge University Press. BES Ecological Reviews Series. 172 p.

Hand, M. S., J. A. Thacher, D. W. McCollum, R. P. Berrens. 2008. Intra-regional amenities, wages, and home prices: The role of forests in the southwest. Land Economics, 84(4): 635–51.

Hanna, J. D. 1989. Beartooth mountain goat study progress report. Laramie, WY: Wyoming Cooperative Wildlife Research Unit.

Hanson, C., L. Yonavjak, C. Clarke, S. Minnemeyer, L. Boisrobert, A. Leach, and K. Schleewis. 2010. Southern forests for the future. World Resources Institute. Available at: www.wri.org

Harmon, W. 1944. Notes on mountain goats in the Black Hills. Journal of Mammalogy, 25:149–151.

Harlow, H. J., E. T. Thorne, E. S. Williams, E. L. Beldin, and W. A. Gern. 1986. Cardiac frequency: A potential indicator of blood cortisol levels during acute and chronic stress exposure in Rocky Mountain bighorn sheep (Ovis canadensis canadensis). Canadian Journal of Zoology, 65:2028–2034.

Hayden, J. A. 1989. Status and population dynamics of mountain goats in the Snake River Range, Idaho. Thesis. Missoula, MT: University of Montana.

Hayden, J. A., G. Gadwa, G. Mcneill, J. Rohlman, and R. Shea. 1990. Mountain goat management plan 1991–1995. Boise, ID: Idaho Department of Fish and Game.

Hayes, S. G., D. J. Leptich, and P. Zager. 2002. Proximate factors affecting male elk hunting mortality in northern Idaho. Journal of Wildlife Management, 66:491–499.

Hebert, D. M., and I. M. Cowan. 1971a. White muscle disease in the mountain goat. Journal of Wildlife Management, 35:752–756.

Hebert, D. M., and I. M. Cowan. 1971b. Natural salt licks as part of the ecology of the mountain goat. Canadian Journal of Zoology, 49:605–610.

Hebert, D. M., and W. G. Turnbull. 1977. A description of southern interior and coastal mountain goat ecotypes in British Columbia. First International Mountain Goat Symposium, 126–146.

Hebert, D. M., and H. D. Langin. 1982. Mountain goat inventory and harvest strategies: A re-evaluation. Biennial Symposium of the Northern Wild Sheep and Goat Council, 3:339–350.

Hebert, D. M., and R. Woods. 1984. A preliminary analysis of intensive, unreplicated survey data for mountain goat populations in British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council, 4:506–513.

Hebert, D. M., W. M. Samuel, and G. W. Smith. 1977. Contagious ecthyma in mountain goat of coastal British Columbia. Journal of Wildlife Diseases, 13:135–136.

Hengeveld, P. E., M. D. Wood, R. Ellis, and R. Lennox. 2003. Mountain goat habitat supply modeling in the Mackenzie Timber Supply Area, north-central British Columbia. Version 1, December 2003. Peace/Williston Fish and Wildlife Compensation Program Report, Number 271.

Hershey, T. J. 2011. Implications of back-country travel on key big game summer range in the Bighorn-Weitas Roadless Area. Report for Clearwater National Forest, Idaho.

Hershey, T. J., and T. A. Leege. 1982. Elk movements and habitat use on a managed forest in north-central Idaho. Boise, ID: Idaho Department of Fish and Game. Wildlife Bulletin, No. 10. 24 p.

Hibbs, L. D. 1965. The mountain goat of colorado. Thesis. Fort Collins, CO: Colorado State University.

Hibbs, L. D. 1967. Food habits of the mountain goat in Colorado. Journal of Mammalogy, 48:242–248.

Hillis, J. M., M. J. Thompson, J. E. Canfield, L. J. Lyon, C. L. Marcum, P. M. Dolan, and D. W. McCleery. 1991. Defining elk security: The Hillis paradigm. Pages 38–43. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University. 330 p.

Hjeljord, O. G. 1971. Feeding ecology and habitat preference of the mountain goat in Alaska. Thesis. Fairbanks, AK: University of Alaska.

Hjeljord, O. G. 1973. Mountain goat forage and habitat preference in Alaska. Journal of Wildlife Management, 37:353–362.

Hobbs, N. T. 1989. Linking energy balance to survival in mule deer: Development and test of a simulation model. Wildlife Monograph, 101. 39 p.

Hobbs, N. T., and R. A. Swift. 1985. Estimates of habitat carrying capacity incorporating explicit nutritional constraints. Journal of Wildlife Management, 49:814–822.

Hoberg, E. P., K. J. Monsen, S. Kutz, and M. S. Blouin. 1999. Structure, biodiversity, and historical biogeography of nematode faunas in holarctic ruminants: Morphological and molecular diagnoses for Teladorsagia boreoarcticus n. sp. (Nematoda: Osteragiinae), a dimorphic cryptic species in muskoxen (Ovibos moschatus). Journal of Parasitology, 85:910–934.

Hoberg, E. P., A. A. Kocan, and L. G. Rickard. 2001. Gastrointestinal strongyles in wild ruminants. Pages 193–207. In: Parasitic diseases of wild mammals, eds. W. M. Samuel, M. J. Pybus, and A. A. Kocan. Ames, IA: Iowa State University Press.

Hoefs, M., G. Lortie, and D. Russell. 1977. Distribution, abundance, and management of mountain goats in the Yukon. First International Mountain Goat Symposium, 47–53.

Hoefs, M., and U. Nowlan. 1998. Triplets in mountain goats, Oreamnos americanus. Canadian Field-Naturalist, 112:539–540.

Holroyd, J. C. 1967. Observations of Rocky Mountain goats on Mount Wardle, Kootenay Park, British Columbia. Canadian Field Naturalist, 81:1–22.

Hook, D. L. 1986. Impacts of seismic activity on bighorn sheep movements and habitat use. Northern Wild Sheep and Goat Council, 5:292–296.

Hopkins, A., J. P. Fitzgerald, A. Chappell, and G. Byrne. 1992. Population dynamics and behavior of mountain goats using Elliott Ridge, Gore Range, Colorado. Biennial Symposium of the Northern Wild Sheep and Goat Council, 8:340–356.

Houston, D. B., C. T. Robbins, and V. Stevens. 1989. Growth in wild and captive mountain goats. Journal of Mammalogy, 70:412–416.

Huggard, D. J. 1993. Prey selectivity of wolves in Banff National Park. Canadian Journal of Zoology, 71:130–139.

Hurley, K. P. 2004. Northern Wild Sheep and Goat Council position statement on helicopter-supported recreation and mountain goats. Biennial Symposium of the Northern Wild Sheep and Goat Council, 14:in press.

Hurley, M. A., and G. A. Sargeant. 1991. Effects of hunting and land management on elk habitat use, movement patterns, and mortality in western Montana. Pages 94–98. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University.

Hurley, M. A. 1994. Summer-fall ecology of the Blackfoot-Clearwater elk herd of western Montana. Thesis. Missoula, MT: University of Montana. 138 p.

Husseman, J., and G. Power. 1999. Summary of winter predation field studies, 1999. Idaho Dept. Fish and Game, unpubl. research report. 18 p.

Husseman, J. 2002. Prey selection patterns of wolves and cougars in east-central Idaho. Thesis. Moscow, ID: University of Idaho.

Idaho Department of Environmental Quality (IDEQ). 2011. Idaho’s 2010 integrated report. Final. State of Idaho, DEQ Boise, ID.

Idaho Department of Fish and Game (IDFG). 1990. Mountain lion management plan, 2002–2010. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 1991. Furbearer management plan 1991–1995. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 1998. Black bear management plan 1999–2010: Status and objectives of Idaho’s black bear resource. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2004. White-tailed deer management plan, 2005–2014. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2006. Mountain goat management plan. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2010a. Bighorn sheep management plan. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2010b. Wolf management plan. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2013. Elk management plan, 2014–2024. Boise, ID: IDFG.

Idaho Department of Fish and Game (IDFG). 2014. 2013 Idaho wolf monitoring progress report. Boise, ID: IDFG.

IAFWA. 2002. Economic importance of hunting in America. International Association of Fish and Wildlife Agencies, Animal Use Commission Report. 13 p.

Interior Columbia Basin Ecosystem Management Project (ICBEMP). 1998. Economic and social conditions of communities. USDA Forest Service and USDI Bureau of Land Management.

Irwin, L. L. 1976. Effects of intensive silviculture on big game forage sources in northern Idaho. Pages 135–142. In: Proceedings of elk-logging-roads symposium, ed. S. R. Hieb. Moscow, ID: University of Idaho. 142 p.

Irwin, L. L., and J. M. Peek. 1979. Relationships between road closures and elk behavior in northern Idaho. Pages 199–204. In: North American elk: Ecology, behavior and management, eds. M. S. Boyce and L. D. Hayden-Wing. Larimie, WY: University of Wyoming. 294 p.

Irwin, L. L., and J. M. Peek. 1983. Elk, Cervus elaphus, foraging related to forest management and succession in Idaho. Canadian Field-Naturalist, 97:443–447.

Irwin, L. L., and J. M. Peek. 1983. Elk habitat use relative to forest succession in Idaho. Journal of Wildlife Management, 47:664–672.

Jageman, H. 1984. White-tailed deer habitat management guidelines. Moscow, ID: University of Idaho. Forest, Wildlife, and Range Experiment Station, Bulletin No. 37. 14 p.

Jenkins, E. J., E. P. Hoberg, A. M. Veitch, H. M. Schwantje, M. Wood, D. Toweill, S. J. Kutz, and L. Polley. 2004. Parasitic fauna of mountain goats (Oreamnos americanus) in the Northwest Territories, British Columbia, and Idaho. Biennial Symposium of the Northern Wild Sheep and Goat Council, 14:in press.

Jenkins, E. J., E. P. Hoberg, and L. Polley. 2005. Development and pathogenesis of Parelaphostrongylus odocoilei (Nematoda: Protostrongylidae) in experimentally infected thinhorn sheep (Ovis dalli). Journal of Wildlife Diseases. In press.

Johnson, D. E. 1951. Biology of the elk calf, Cervus canadensis nelsoni. Journal of Wildlife Management,15:396–410.

Johnson, R. 1983. Mountain goats and mountain sheep of Washington. Olympia, WA: Washington Department of Game. Biological Bulletin, 18.

Jones J. A., G. L. Achterman, L. A. Augustine, I. F. Creed, P. F. Ffolliott, L. MacDonald, and B. C. Wemple. 2009. Hydrologic effects of a changing forested landscape—challenges for the hydrological sciences. Hydrological Processes, 23(18): 2699–2704.

Jorgenson, J. T., and R. Quinlan. 1996. Preliminary results of using transplants to restock historically occupied mountain goat ranges. Biennial Symposium of the Northern Wild Sheep and Goat Council, 10:94–108.

Joslin, G. 1986. Montana mountain goat investigations, Rocky Mountain Front, Final Report. Helena, MT: Montana Fish, Wildlife, and Parks.

Julander, O., W. L. Robinette, and D. A. Jones. 1961. Relation of summer range condition to mule deer productivity. Journal of Wildlife Management, 25:54–60.

Kandziora, M., B. Burkhard, and F. Müller. 2013. Interactions of ecosystem properties, ecosystem integrity and ecosystem service indicators—A theoretical matrix exercise. Ecological Indicators, 28:54–78.

Keay, J. A., and J. M. Peek. 1980. Relationships between fires and winter habitat of deer in Idaho. Journal of Wildlife Management, 44:372–380.

Keim, J. 2004. Modeling core wintering habitats from habitat selection and spatial movements of collared mountain goats in the Taku River drainage of northwest British Columbia. Biennial Symposium of the Northern Wild Sheep and Goat Council, 14:in press.

Keith, L. B. 1983. Population dynamics of wolves. Pages 66–77. In: Wolves in Canada and Alaska: Their status, biology, and management, ed. L. N. Carbyn. Ottawa, Ontario: Can. Wildl. Serv. Rep. Ser. 45.

Kim, Y., and R. L. Johnson. 2002. The impact of forests and forest management on neighboring property values. Society and Natural Resources, 15(10):887–901.

Kline, J. D., and M. J. Mazzotta. 2012. Evaluating tradeoffs among ecosystem services in the management of public lands. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep. PNWGTR- 865. 48 p.

Knight, R. L., and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. North American Wildlife and Natural Resources Conference, 56:239–247.

Knight, R. L., and K. J. Gutzwiller, editors. 1995. Wildlife and recreationists: Coexistence through management and research. Washington, D. C.: Island Press.

Kuck, L. 1977. The impacts of hunting on Idaho's Pahsimeroi mountain goat herd. First International Mountain Goat Symposium, 114–125.

Kuck, L., G. H. Hompland, and E. H. Merrill. 1985. Elk calf response to simulated mine disturbance in southeast Idaho. Journal of Wildlife Management, 49:751–757.

Kuck, L. 1986. Mountain goat hunting strategies in Idaho. Biennial Symposium of the Northern Wild Sheep and Goat Council, 5:63–67.

Kuck, L., and J. Rachael, editors. 1999. Idaho Department of Fish and Game statewide surveys and inventory: Elk. Boise, ID: Project W-170-R-16. Rep. Study 1, Job 1.

Kunkel, K. E. 1997. Predation by wolves and other large carnivores in northwestern Montana and southeastern British Columbia. Ph. D. Dissertation. Missoula, MT: University of Montana. 272 p.

Kunkel, K. E., and D. H. Pletscher. 1999. Species-specific population dynamics of cervids in a multipredator ecosystem. Journal of Wildlife Management, 63:1082–1093.

Kunkel, K. E., T. K. Ruth, D. H. Pletscher, and M. G. Hornocker. 1999. Winter prey selection by wolves and cougars in and near Glacier National Park, Montana. Journal of Wildlife Management, 63:901–910.

Landis, T. D., and E. W. Mogren. 1975. Tree strata biomass of subalpine spruce-fir stands in southwestern Colorado. Forest Science, 21:9–12.

Leckenby, D. A., C. Wheaton, and L. Bright. 1991. Elk vulnerability – The Oregon situation. Pages 89–93. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University. 330 p.

Leege, T. A. 1968. Prescribed burning for elk in northern Idaho. Tall Timbers Fire Ecology Conference Proceedings, 8:235–254.

Leege, T. A. 1979. Effects of repeated prescribed burns on northern Idaho elk browse. Northwest Science, 53(2):107–113.

Leege, T. A. 1984. Guidelines for evaluating and managing summer elk habitat in northern Idaho. Boise, ID: Idaho Department of Fish and Game. Wildlife Bulletin, No. 11.

Lentfer, J. W. 1955. A two-year study of the Rocky Mountain goat in the Crazy Mountains, Montana. Journal of Wildlife Management, 19(4):417–429.

Leptich, D. J., and P. Zager. 1991. Road access management effects on elk mortality and population dynamics. Pages 126–131. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University. 330 p.

Leib, J. W. 1981. Activity, heart rate, and associated energy expenditure of elk in western Montana. Dissertation. Missoula, MT: University of Montana. 200 p.

Lemke, T. O. 2004. Origin, expansion, and status of mountain goats in Yellowstone National Park. Wildlife Society Bulletin, 32(1):in press.

Lyon, L. J. 1971. Vegetal development following prescribed burning of Douglas-fir in south-central Idaho. Ogden, UT: USDA Forest Service. Research Paper INT-105.

Lyon, L. J. 1979. Habitat effectiveness for elk as influenced by roads and cover. Journal of Forestry, 77:658–660.

Lyon, L. J., and C. E. Jensen. 1980. Management implications of elk and deer use of clearcuts in Montana. Journal of Wildlife Management, 44:352–362.

Lyon, L. J. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry, 81:592–595.

Lyon, L. J. 1984. Field tests of elk/timber coordination guidelines. USDA Forest Service Intermountain Research Station. Research Paper INT-325.10 p.

Lyon, L. J., T. N. Lonner, J. P. Weigand, C. L. Marcum, W. D. Edge, J. D. Jones, D. R. McCleery, and L. L. Hicks. 1985. Coordinating elk and timber management. Final report of Montana Cooperative Elk-Logging Study, 1970–1985. Bozeman, MT: Montana Department of Fish, Wildlife and Parks. 53 p.

Lyon, L. J., and J. E. Canfield. 1991. Habitat selection by Rocky Mountain elk under hunting season stress. Pages 99–105. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University.

Lyon, L. J., and A. G. Christensen. 1992. A partial glossary of elk management terms. Portland, OR: U. S. Department of Agriculture, Forest Service. General Technical Report INT-GTR-288.

Lyon, L. J., and A. G. Christensen. 2002. Elk and land management. Pages 557–581. In: North American elk: Ecology and management, eds. D. E. Toweill and J. W. Thomas. Washington, D. C.: Smithsonian Institution Press.

MacArthur, R. A., R. H. Johnson, and V. Geist. 1979. Factors influencing heart rate in bighorn sheep: A physiological approach to the study of wildlife harassment. Canadian Journal of Zoology, 57:2010–2021.

MacDonald, L. H. 2000. Evaluating and Managing Cumulative Effects: Process and Constraints. New York, NY: Springer-Verlag. Environmental Management, 26(3):299–315.

Mack, J. A., and F. J. Singer. 1992. Predicted effects of wolf predation on northern range elk, mule deer, and moose using Pop-II models. Pages 4-41 to 4-70. In: Wolves for Yellowstone? A report to the U.S. Congress, Vol. IV, research and analysis, eds. J. D. Varley and W. G. Brewster. Yellowstone National Park, Wyoming.

MacLachlan, N. J., P. V. Rossitto, H. W. Heidner, L. G. Lezzi, T. D. Yilma, C. D. DeMaula, and D. I. Osburn. 1992. Variation amongst the neutralizing epitopes of bluetonque viruses isolated in the United States in 1979–1981. Veterinary Microbiology, 31:303–316.

Mace, G. M., K. Norris, A. H. Fitter. 2013. Biodiversity and ecosystem services: A multilayered relationship. Trends in Ecology and Evolution, 27(1):19–26.

Maczko, K., and L. Hidinger, editors. 2008. Sustainable rangelands: Ecosystem goods and services. Sustanable rangelands roundtable. SRR Monograph, No. 3. 94 p.

Mao, J. S., M. S. Boyce, D. W. Smith, F. J. Singer, D. J. Vales, J. M. Vore, and E. H. Merrill. 2005. Habitat selection by elk before and after wolf reintroduction in Yellowstone National Park. Journal of Wildlife Management, 69:1691–1707.

Marcum, C. L. 1975. Summer-fall habitat selection and use by a western Montana elk herd. Dissertation. Missoula, MT: University of Montana. 188 p.

Marcum, C. L., and M. D. Scott. 1985. Influences of weather on elk use of spring–summer habitat. Journal of Wildlife Management, 49:73–76.

Matschke, G. H., K. A Fagerstone, F. A. Hayes, W. Parker, R. F. Harlow, V. F. Nettles, and D. O. Trainer. 1984. Population Influences. Pages 169–188. In: White-tailed deer: ecology and management, ed. L. K. Halls. Harrisburg, PA: Stackpole Books. 870 p.

Mattfield, G. F. 1974. The energetics of winter foraging by white-tailed deer: A perspective on concentration. Dissertation. Syracuse, NY: State University New York. 306 p.

McConnell, B. R., and J. G. Smith. 1970. Response of understory vegetation to ponderosa pine thinning in eastern Washington. Journal of Range Management, 23:208–212.

McCorquodale, S. M., L. E. Eberhardt, and G. A. Sargeant. 1989. Antler characteristics in a colonizing elk population. Journal of Wildlife Management, 53:618–621.

McIver, C. P., C. B. Sorenson, C. E. Keegan, C. Gale, T. A. Morgan. 2012. Capacity and capability of mills in the Clearwater and Nez Perce National Forests timber processing area. Missoula, MT: Report submitted to the U.S. Department of Agriculture, Forest Service, Region 1. 9 p.

McKenzie, J. 2001. The selective advantage of urban habitat use by elk in Banff National Park. Thesis. Guelph, Ontario: University of Guelph.

McLaughlin, W. J., N. Sanyal, J. Tangen-Foster, J. F. Tynon, S. Allen, and C. C. Harris. 1989. 1987–88 Idaho rifle elk hunting study, Volume I: Results. Moscow, ID: Idaho Forest, Wildlife, and Range Experiment Station. Contribution 499.

Mech, L. D. 1970. The wolf: The ecology and behavior of an endangered species. Minneapolis, MN: University of Minnesota Press. 384 p.

Mech, L. D., and L. Boitani. 2003. Wolves: Behavior, ecology, and conservation. Chicago, IL: University of Chicago Press.

Mech, L. D., D. W. Smith, K. M. Murphy, and D. R. MacNulty. 2001. Winter severity and wolf predation on a formerly wolf-free elk herd. Journal of Wildlife Management, 65:998–1003.

Merrill, E. H., and M. S. Boyce. 1991. Summer range and elk population dynamics in Yellowstone National Park. Pages 263–274. In: The greater Yellowstone ecosystem: Redefining America's wilderness heritage, eds. R. B. Keiter and M. S. Boyce. New Haven, CT: Yale University Press. 428 p.

Millennium Ecosystem Assessment (MEA). 2003. Ecosystems and human well-being: A framework for assessment. Washington, DC: Island Press. 212 p.

Moen, A. N. 1968. Surface temperatures and radiant heat loss from white-tailed deer. Journal of Wildlife Management, 32:338–344.

Moen, A. N. 1973. Wildlife ecology: An analytical approach. San Francisco, CA: W. H. Freeman and Company.

Moen, A. N. 1976. Energy conservation by white-tailed deer in winter. Ecology, 57:192–198.

Montana Department of Fish, Wildlife, and Parks (MDFWP). 2010. Montana bighorn sheep conservation strategy. Helena, MT: Montana Department of Fish, Wildlife, and Parks.

Montgomery, R. A., G. J. Roloff, and J. J. Millspaugh. 2013. Variation in elk response to roads by season, sex, and road type. Journal of Wildlife Management, 77:313–325.

Morgantini, L. E., and R. J. Hudson. 1985. Changes in diets of wapiti during the hunting season. Journal of Range Management, 38:77–79.

Murie, A. 1944. The wolves of Mount McKinley. Washington D. C.: Government Printing Office. U. S. Natl. Park Serv. Fauna Ser. 5. 238 p.

Nabuurs, G. J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W. A. Kurz, M. Matsumoto, W. Oyhantcabal, N. H. Ravindranath, M. J. Sanz Sanchez, and X. Zhang. 2007. Forestry. Pages 541–584. In: Climate change 2007: Mitigation, eds. B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L. A. Meyer. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY: Cambridge University Press.

National Park Service (NPS). 1994. Report on the effects of aircraft overflights on the National Park System. Report to Congress, 12 September 1994.

National Visitor Use Monitoring Program (NVUM). 2006a. Visitor Use Report, Nez Perce National Forest. U.S. Department of Agriculture, Forest Service. 48 p.

National Visitor Use Monitoring Program (NVUM). 2006b. Visitor Use Report, Clearwater National Forest. U.S. Department of Agriculture, Forest Service. 48 p.

National Visitor Use Monitoring Program (NVUM). 2011a. Visitor Use Report, Nez Perce National Forest. U.S. Department of Agriculture, Forest Service. 48 p.

National Visitor Use Monitoring Program (NVUM). 2011b. Visitor Use Report, Clearwater National Forest. U.S. Department of Agriculture, Forest Service. 49 p.

Naylor, L. M., M. J. Wisdom, and R. G. Anthony. 2009. Behavioral responses of North American elk to recreational activity. Journal of Wildlife Management, 73:328–338.

Nelson, J. R., and T. A. Legee. 1982. Nutritional requirements and food habits. Pages 323–368. In: Elk of North America: Ecology and management, eds. J. W. Thomas and D. A. Toweill. Harrisburg, PA: Stackpole Books. 698 p.

Nickerson, N., C. Oschell, L. Rademaker, R. Dvorak. 2007. Montana's outfitting industry: Economic impact and industry-client analysis. Institute for Tourism and Recreation Research, University of Montana. Research Report 2007-1. 30 p.

Noyes, J. H., B. K. Johnson, L. D. Bryant, S. L. Findholt, and J. W. Thomas. 1996. Effects of bull age on conception dates and pregnancy rates of cow elk. Journal of Wildlife Management, 60:508–517.

O'Laughlin, J., and P. S. Cook. 2010. Bighorn sheep and domestic sheep: Current situation in Idaho. Moscow, ID: Policy Analysis Group, College of Natural Resources, University of Idaho. Report Number 30.

Ozoga, J. J. 1968. Variations in microclimate in a conifer swamp deeryard in northern Michigan. Journal of Wildlife Management, 32:574–585.

Ozoga, J. J., and L. J. Verme. 1970. Winter feeding patterns of penned white-tailed deer. Journal of Wildlife Management, 34:431–439.

Owens, T. F. 1981. Movement patterns and determinants of habitat use of white-tailed deer in northwestern Idaho. Thesis. Moscow, ID: University of Idaho. 48 p.

Parker, K. L., C. T. Robbins, and T. A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. Journal of Wildlife Management, 48:474–488.

Pauley, G. 1990. Habitat use, food habits, home range, and seasonal migration of white-tailed deer in the Priest River drainage, north Idaho. Thesis. Moscow, ID: University of Idaho. 152 p.

Peck, S. V. 1972. The ecology of the Rocky Mountain goat in the Spanish Peaks area of southwestern Montana. Thesis. Bozeman, MT: Montana State University.

Pedersen, R. J. 1978. Management and impacts of roads in relation to elk populations. Conference Proceedings of Recreational Impact on Wildlands. Seattle, WA.

Peek, J. M., R. J. Pederson, and J. W. Thomas. 1982. The future of elk and elk hunting. Pages 599–625. In: Elk of North America: Ecology and management, eds. J. W. Thomas and D. A. Toweill. Harrisburg, PA: Stackpole Books. 698 p.

Peek, J. M. 1984. Northern Rocky Mountains. Pages 497–504. In: White-tailed deer: Ecology and management, ed. L. K. Halls. Harrisburg, PA: Stackpole Books. 870 p.

Peek, J. M., K. T. Schmidt, M. J. Dorrance, and B. L. Smith. 2002. Supplemental feeding and farming of elk. Pages 617–647. In: North American elk: Ecology and management. Washington D. C.: Smithsonian Institution Press. 962 p.

Pedersen, R. J., A. W. Adams, and J. Skovlin. 1979. Elk management in Blue Mountain habitats. Portland, OR: Oregon Department of Fish and Wildlife. Research and Development Report W-70-R. 27 p.

Pedevillano, C., and R. G. Wright. 1987. The influence of visitors on mountain goat activities in Glacier National Park, Montana. Biological Conservation, 39:11.

Pendergast, B., and J. Bindernagel. 1976. The impact of exploration for coal on mountain goats in northeastern British Columbia. Ministry of Environment and Lands.

Pengelly, W. L. 1961. Factors influencing the production of white-tailed deer on the Coeur d'Alene National Forest, Idaho. Missoula, MT: U. S. Forest Service, Northern Region. 190 p.

Penner, D. F. 1988. Behavioral response and habituation of mountain goats in relation to petroleum exploration at Pinto Creek, Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council, 6:141–158.

Phelps, D. E., B. Jamieson, and R. A. Demarchi. 1983. The history of mountain goat management in the Kootenay Region of British Columbia. Fish and Wildlife Bulletin B-20, BC Fish and Wildlife Branch.

Phillips, G. E. 1998. Effects of human-induced disturbance during calving season on reproductive success of elk in the upper Eagle River Valley. Dissertation. Fort Collins, CO: Colorado State University.

Phillips, G. E. and W. A. Alldredge. 2000. Reproductive success of elk following disturbance by humans during calving season. Journal of Wildlife Management, 64(2):521–530.

Phillips, M. K., and D. W. Smith. 1997. Yellowstone wolf project: Biennial report 1995–1996.

Phillips, T. A. 1974. Characteristics of elk calving habitat on the Sawtooth National Forest. Range Improvement Notes, 19:1–5.

Pimlott, D. H. 1967. Wolf predation and ungulate populations. Am. Zool., 7:267–278.

Pollard J., R. Graff, N. Mauerman, T. Newby, J. Miller, I. Smart. 2008. Idaho asthma burden—Epidemiology of asthma in Idaho. Idaho Asthma Prevention and Control Program. Bureau of Community and Environmental Health, Idaho Division of Health, Idaho Department of Health and Welfare.

Postel, S., S. Carpenter. 1997. Freshwater ecosystem services. In: Nature's services: Societal dependence on natural ecosystems, ed. G. Daily. Washington, DC: Island Press. 195–214.

Potyondy, J. P., T. W. Geier. 2011. Watershed condition classification technical guide. U.S. Department of Agriculture, Forest Service. FS-978. 41 p.

Preisler, H. K., A. A. Ager, and M. J. Wisdom. 2006. Statistical methods for analyzing responses of wildlife to human disturbance. Journal of Applied Ecology, 43:164–172.

Raedeke, K., J. Millspaugh, and P. Clarke. 2002. Population characteristics. Pages 449–491. In: North American elk: Ecology and management, eds. D. E. Toweill and J. W. Thomas. Washington, D. C.: Smithsonian Institution Press.

Reichelt, L. R. 1973. Characteristics of elk calving sites along the West Fork of the Madison River, Montana. Helena, MT: Montana Fish and Game Departement. Job Final Progress Report W-130-R-4. 39 p.

Rideout, C. B. 1974a. A comparison of techniques for capturing mountain goats. Journal of Wildlife Management. 38:573–575.

Rideout, C. B. 1974b. A radio telemetry study of the ecology and behavior of the Rocky Mountain goat in western Montana. Dissertation. Lawrence, KS: University of Kansas.

Rideout, C. B., and R. S. Hoffman. 1975. Oreamos americanus. Mammalian Species, 63:1–6.

Rideout, C. B. 1977. Mountain goat home ranges in the Sapphire Mountains of Montana. First International Mountain Goat Symposium, 201–211.

Rideout, C. B. 1978. Mountain Goat. Pages 149–159. In: J. L. Big Game of North America, eds. Schmidt and D. L. Gilbert. Harrisburg, PA: Stackpole Books.

Ripple, W. J., and P. L. Beschta. 2004. Wolves, elk, willows and trophic cascade in the upper Gallatin Range of southwestern Montana, USA. Forest Ecology and Management, 200:161–181.

Rowland, M. M., M. J. Wisdom, B. K. Johnson, and J. G. Kie. 2000. Elk distribution and modeling in relation to roads. Journal of Wildlife Management. 64:672–684.

Rowland, M. M., M. J. Wisdom, B. K. Johnson, and M. A. Penninger. 2004. Effects of roads on elk: Implications for management in forested ecosystems. Transactions of North American Wildlife and Natural Resources Conference, 69:491–508.

Rowland, M. M., M. J. Wisdom, B. K. Johnson, and M. A. Penninger. 2005. Effects of roads on elk: Implications for management in forested ecosystems. Pages 42–52. In: The Starkey Project: A synthesis of long-term studies of elk and mule deer, ed. M. J. Wisdom. Reprinted from 2004 Transactions of North American Wildlife and Natural Resources Conference, Alliance Communications Group, Lawrence, Kansas.

Ryan, M., S. Archer, R. Birdsey, C. Dahm, L. Heath, J. Hicke, D. Hollinger, T. Huxman, G. Okin, R. Oren, J. Randerson, and W. Schlesinger. 2008. Land resources. In: The effects of climate change on agriculture, land resources, water resources, and biodiversity. Washington, D. C.: A report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research. 362 p.

Samuel, W. M., G. A. Chalmers, J. G. Stelfox, A. Loewen, and J. J. Thomsen. 1975. Contagious ecthyma in bighorn sheep and mountain goats in western Canada. Journal of Wildlife Diseases, 11:26–31.

Samuel, W. M., W. K. Hall, J. G. Stelfox, and W. D. Wishart. 1977. Parasites of mountain goat Oreamnos americanus (Blainville), of west central Alberta with a comparison of the helminthes of mountain goat and Rocky Mountain bighorn sheep, Ovis c. canadensis Shaw. First International Mountain Goat Symposium, 212–225.

Saunders, J. K., Jr. 1955. Food habits and range use of the Rocky Mountain goat in the Crazy Mountains, Montana. Journal of Wildlife Management, 19:429–437.

Sawyer, H., and F. Lindzey. 2002. A review of predation on bighorn sheep (Ovis canadensis). Laramie, WY: Wyoming Cooperative Fish and Wildlife Research Unit.

Sawyer, H., R. M. Nielson, F. G. Lindzey, L. Keith, J. H. Powell, and A. A. Abraham. 2007. Habitat selection of Rocky Mountain elk in a nonforested environment. Journal of Wildlife Management, 71:868–874.

Schlegel, M. W. 1986. Movements and population dynamics of the Lochsa elk herd: Factors affecting calf survival in the Lochsa elk herd. Boise, ID: Idaho Department of Fish and Game, Federal Aid in Wildlife Restoration Completion Report W-160-R subproject 38.

Schommer, T., and M. Woolever. 2008. A review of disease-related conflicts between domestic sheep and goats and bighorn sheep. Fort Collins, CO: U.S. Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-209.

Schultz, R. D., and J. A. Bailey. 1978. Responses of national park elk to human activity. Journal of Wildlife Management, 42:91–100.

Secord, M. L. 1994. Winter habitat use, migration, and spring and summer use of clear cuts by white-tailed deer in the Priest River Watershed of northern Idaho. Thesis. Missoula, MT: University of Montana. 143 p.

Seong-Hoon Cho, S., S. Kim, R. K. Roberst, S. Jung. 2009. Amenity values of spatial configurations of forest landscapes over space and time in the Southern Appalachian Highlands. Ecological Economics, 68(10):2646–2657.

Shackleton, D. M. 1999. Hooved mammals of British Columbia. RBCM Handbook Series, ISSN 1188–5114.

Shackleton, D. M. editor, and the IUCN/SSC Caprinae Specialist Group. 1997. Wild sheep and soats and their relatives: Status survey and conservation action plan for Caprinae. IUCN, Gland, Switzerland and Cambridge, UK. 390 p.

Shaw, H. G. 1962. Seasonal habitat use by white-tailed deer in the Hatter Creek enclosure. Thesis. Moscow, ID: University of Idaho. 52 p.

Shively, K. J., A. W. Alldredge, and G. E. Phillips. 2005. Elk reproductive response to removal of calving season disturbance by humans. Journal of Wildlife Management, 69:1073–1080.

Singer, F. J. and J. L. Doherty. 1985. Managing mountain goats at a highway crossing. Wildlife Society Bulletin, 13:469–477.

Skaggs, R. 2008. Ecosystem services and western U.S. rangelands. Choices, 23(2):37–41.

Skog, K. E., D. B. McKeever, P. J. Ince, J. L. Howard, H. N. Spelter, and A. T. Schuler. 2012. Status and trends for the U.S. forest products sector: A technical document supporting the Forest Service 2010 RPA Assessment. Madison, WI: U.S. Department of Agriculture Forest Service, Forest Products Laboratory. Gen. Tech. Rep. FPL-GTR-207. 35 p

Skolvin, J. M. 1982. Habitat requirements and evaluation. Pages 369–413. In: Elk of North America: Ecology and management, eds. J. W. Thomas and D. A. Toweill. Harrisburg, PA: Stackpole Books. 698 p.

Smith, B. L. 1976. Ecology of Rocky Mountain goats in the Bitterroot Mountains, Montana. Thesis. Missoula, MT: University of Montana.

Smith, B. L. 1977. Influence of snow conditions on winter distribution, habitat use, and group size of mountain goats. First International Mountain Goat Symposium,174–189.

Smith, B. L. 1988. Criteria for determining age and sex of mountain goats in the field. Journal of Mammalogy, 69(2):395–402.

Smith, C. A. 1984. Evaluation and management implications of long-term trends in coastal mountain goat populations in southeast Alaska. Biennial Symposium of the Northern Wild Sheep and Goat Council, 4:395–424.

Smith, C. A. and K. T. Bovee. 1984. A mark-recapture census and density estimate for a coastal mountain goat population. Biennial Symposium of the Northern Wild Sheep and Goat Council, 4:487–498.

Smith, C. A. 1986. Rates and causes of mortality in mountain goats in Southeast Alaska. Journal of Wildlife Management, 50:743–746.

Smith, D. W. 1998. Yellowstone wolf project: Annual report, 1997. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming. YCR-NR-98-2.

Smith, D. W., R. O. Peterson, and D. B. Houston. 2003. Yellowstone after wolves. BioScience, 53(4):330–340.

Smith, K. G. 1988. Factors affecting the population dynamics of mountain goats in west-central Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council, 6:308–329.

Smith, K. G., M. A. Urquhart, and M. Festa-Bianchet. 1992. Preliminary observations of the timing and causes of mountain goat mortality in west-central Alberta. Biennial Symposium of the Northern Wild Sheep and Goat Council, 8:293–304.

Smith, N., R. Deal, J. Kline, D. Blahna, T. Patterson, T. A. Spies, K. Bennett. 2011. Ecosystem services as a framework for forest stewardship: Deschutes National Forest overview. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Gen. Tech. Rep.PNW-GTR-852. 46 p.

South East Queensland Ecosystem Services Project (SEQ). 2013. The SEQ Ecosystem Services Framework. Available at: http://www.ecosystemservicesseq.com.au/step-5-services/recreational-opportunities.

Sparrowe, R. D., and P. F. Singer. 1970. Seasonal activity patterns of white-tailed deer in eastern South Dakota. Journal of Wildlife Management, 34:420–431.

Spracklen, D. V., L. J. Mickley, J. A. Logan, R. C. Hudman, R. Yevich, M. D. Flannigan, A. L. Westerling. 2009. Impacts of climate change from 2000 to 2050 on wildfire activity and carbonaceous aerosol concentrations in the western United States. Journal of Geophysical Research, 114(D20301):1–17.

Squibb, R. C., J. F. Kimball, Jr., and D. R. Anderson. 1986. Bimodal distribution of estimated conception dates in Rocky Mountain elk. Journal of Wildlife Management, 50:118–122.

Stednick, J. D. 2000. Timber management. In: Drinking water from forest and grasslands: A synthesis of the scientific literature. USDA Forest Service. Southern Research Station. SRS-GTR-39. 103–119.

Stemp, R. E. 1983. Heart rate responses of bighorn sheep to environmental factors and harassment. Master of Science Thesis. Calgary, Alberta: University of Calgary.

Stevens, V. 1980. Terrestrial baseline surveys, non-native mountain goats of the Olympic National Park. Seattle, WA: University of Washington. Final Report. Contract Number CX-9000-7-0065.

Stevens, V. 1983. The dynamics of dispersal in an introduced mountain goat population. Ph.D. Dissertation. Seattle, WA: University of Washington.

Stewart, K. M., R. T. Bowyer, J. G. Kie, N. J. Cimon, and B. K. Johnson. 2002. Temporospatial distributions of elk, mule deer, and cattle: Resource partitioning and competitive displacement. Journal of Mammalogy, 83:229–244.

Swanson, F. J., F. N. Scatena, G. E. Dissmeyer, M. E. Fenn, E. S. Verry, and J. A. Lynch. 2000. Watershed processes—Fluxes of water, dissolved constituents, and sediment. Chapter 3. In: Drinking water from forests and grasslands: A synthesis of the scientific literature, ed. G. E. Dissmeyer. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. Gen. Tech. Rep. SRS–39. 246 p.

Swenson, J. E. 1985. Compensatory reproduction in an introduced mountain goat population in the Absaroka Mountains, Montana. Journal of Wildlife Management, 49:837–843.

Telfer, E. S. 1974. Logging as a factor in wildlife ecology in the boreal forest. The Forest Chronicles, 50:1–5.

Thomas, J. W., R. J. Miller, H. Black, J. E. Rodiek, and C. Maser. 1976. Guidelines for maintaining and enhancing wildlife habitat in forest management in the Blue Mountains of Oregon and Washington. Transactions of the North American Wildlife and Natural Resources Conference, 41:452–476.

Thompson, M. J., and R. E. Henderson. 1999. Elk habituation as a credibility challenge for wildlife professionals. Wildlife Society Bulletin, 26:477–483.

Thompson, R. W., and R. J. Guenzel. 1978. Status of introduced mountain goats in the Eagles Nest Wilderness Area, Colorado. Biennial Symposium of the Northern North Wild Sheep and Goat Council, 1:175–197.

Thompson, R. W. 1981. Ecology of Rocky Mountain goats introduced to the Eagles Nest Wilderness, Colorado and some factors of geographic variation in the lambing season of bighorn sheep. Thesis. Laramie, WY: University of Wyoming.

Torell, L. A., J. M. Fowler, M. E. Kincaid, and J. M. Hawkes. 1996. The importance of public lands to livestock production in the U.S. Range Improvement Task Force Report #32. Las Cruces, NM: New Mexico State University. Available at: http://cahe.nmsu.edu/pubs/_ritf/report32.pdf.

Toweill, D. E., and J. W. Thomas, editors. 2002. North American elk: Ecology and management. Washington, DC: Smithsonian Institution Press. 962 p.

Toweill, D. E. 2004. Mountain goat status and management in Idaho. Biennial Symposium of the Northern Wild Sheep and Goat Council, 14:in press.

Tonina, D., C. H. Luce, B. Rieman, J. M. Buffington, P. Goodwin, S. R. Clayton, S. M. Ali, J. J. Barry, C. Berenbrock. 2008. Hydrological response to timber harvest in northern Idaho: Implications for channel scour and persistence of salmonids. Hydrol. Process, 22:3223–3235.

Unsworth, J. W., L. Kuck, M. D. Scott, and E. O. Garton. 1993. Elk mortality in the Clearwater drainage of north-central Idaho. Journal of Wildlife Management, 576:495–502.

Unsworth, J. W., L. Kuck, E. O. Garton, and B. R. Butterfield. 1998. Elk habitat selection on the Clearwater National Forest, Idaho. Journal of Wildlife Management, 62:1255–1263.

USDA Forest Service. 2000. Water and the Forest Service. Washington, DC: FS-660. 40 p.

USDA Forest Service. 2005. Aquatic restoration strategy. USDA Forest Service, Pacific Northwest Region. 28 p.

USDA Forest Service. 2008a. Forest Service strategic framework for responding to climate change. Available at: http://www.fs.fed.us/climatechange/message.shtml.

USDA Forest Service. 2008b. The island ecosystem analysis at the watershed scale. Grangeville, ID: U.S. Department of Agriculture, Forest Service, Nez Perce National Forest.

U.S. Environmental Protection Agency (EPA). 2003. Air quality guide for particle pollution. Available at: http://www.airnow.gov/index.cfm?action=pubs.aqguidepart.

U.S. Environmental Protection Agency (EPA). 2013. Final Ecosystem Services and Goods Classification System (FEGS-CS). Corvallis, OR: U.S. Environmental Protection Agency, Office of Research and Development. 101 p.

U.S. Fish and Wildlife Service (USFWS). 1994. The reintroduction of gray wolves to Yellowstone National Park and central Idaho: Final environmental impact statement. Denver, CO: U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 2011. U.S. Fish and Wildlife Service draft land-based wind energy guidelines: Recommendations on measures to avoid, minimize, and compensate for effects to fish, wildlife, and their habitats. Available at: http://www.fws.gov/windenergy/docs/Final_Wind_Energy_Guidelines_2_8_11_CLEAN.pdf. Accessed on: January 13, 2012.

Vales, D. J., and J. M. Peek. 1990. Estimates of the potential interactions between hunter harvest and wolf predation on the Sand Creek, Idaho, and Gallatin, Montana, elk populations. Pages 3–93 to 3–167. In: Wolves for Yellowstone? A report to the U.S. Congress, Vol. II, Research and analysis. Yellowstone National Park, Wyoming.

Vales, D. J., V. L. Coggins, P. Mathews, and R. A. Riggs. 1991. Analyzing options for improving bull:cow ratios of Rocky Mountain elk populations in northeast Oregon. Pages 174–181. In: Proceedings of the elk vulnerability symposium, eds. A. G. Christensen, L. J. Lyon, and T. N. Lonner. Bozeman, MT: Montana State University. 330 p.

Van Ballenberghe, V., A. W. Erickson, and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildlife Monographs, 43. 43 p.

Varley, N. C. 1996. Ecology of mountain goats in the Absaroka Range, south-central Montana. Thesis. Bozeman, MT: Montana State University.

Verme, L. J. 1963. Effect of nutrition on growth of white-tailed deer fawns. Transactions North American Wildlife and Natural Resources Conference, 28:431–443.

Verme, L. J. 1965. Swamp conifer deeryards in northern Michigan, their ecology and management. Journal of Forestry, 63:523–529.

Verme, L. J. 1969. Reproductive patterns of white-tailed deer related to nutritional plane. Journal of Wildlife Management, 33:881–887.

Vieira, M. P. 2000. Effects of early season hunter density and human disturbance on elk movement in the White River area. Thesis. Fort Collins, CO: Colorado State University.

Wallmo, O. C. 1981. Mule and blacktailed deer of North America. Lincoln, NE: University of Nebraska. 605 p.

Ward, A. L. 1976. Elk behavior in relation to timber harvest operations and traffic on the Medicine Bow range in south-central Wyoming. Pages 32–43. In: Proceedings of the elk-logging-roads symposium, ed. S. R Hieb. Moscow, ID: University of Idaho.142 p.

Ward, A. L., N. E. Fornwalt, S. E. Henry, and R. A. Hodorff. 1980. Effects of highway operation practices and facilities on elk, mule deer, and pronghorn antelope. Springfield, VA: National Technical Information Service. Report Number FHWA-RD-79-143. 48 p.

Webb, S. L., M. R. Dzialak, S. M. Harju, L. D. Hayden-Wing, and J. B. Winstead. 2011. Effects of human activity on space use and movement patterns of female elk. Wildlife Society Bulletin, 35:261–269.

Weidner, E., and A. Todd. 2011. From the forest to the faucet, drinking water and forests in the U.S. Methods Paper. USDA, Forest Service, State and Private Forestry, Ecosystem Services & Markets Program Area.

Westerling A. L., H. G. Hidalgo, D. R. Cayan, T. W. Swetnam. 2006. Warming and earlier spring increase Western U.S. forest wildfire activity. Science, 313(5789):940–943.

Western Association of Fish and Wildlife Agencies (WAFWA). 2007. Recommendations for domestic sheep and goat management in wild sheep habitat.

Wetzel, J. F., J. F. Wambaugh, and J. M. Peek. 1975. Appraisal of white-tailed deer winter habitats in northeastern Minnesota. Journal of Wildlife Management, 39:59–66.

White, C. G., P. Zager, and M. Gratson. 2010. Influence of predator harvest, biological factors, and landscape elk calf survival in Idaho. Journal of Wildlife Management, 74:355–369.

Wilson, S.F. 2004. Monitoring the effectiveness of mountain goat habitat management. Victoria, British Columbia: BC Ministry of Water, Land and Air Protection.

Wilson, S. F., and D. M. Shackleton. 2001. Backcountry recreation and mountain goats: A proposed research and adaptive management plan. Victoria, British Columbia: British Columbia Ministry of Environmental Lands and Parks. Wildlife Bulletin, No. B-103

Wisdom, M. J., A. A. Ager, H. K. Preisler, N. J. Cimon, and B. K. Johnson. 2004. Effects of off-road recreation on mule deer and elk. Transactions of North American Wildlife and Natural Resources Conference, 69:67–80.

Wisdom, M. J. N. J. Cimon, B. K. Johnson, E. O. Garton, and J. W. Thomas. 2004. Spatial partitioning by mule deer and elk in relation to traffic. Transactions of North American Wildlife and Natural Resources Conference, 69:509–530.

Wisdom, M. J., A. A. Ager, H. K. Preisler, N. J. Cimon, and B. K. Johnson. 2005. Effects of off-road recreation on mule deer and elk. Pages 67–80. In: The Starkey Project: A synthesis of long-term studies of elk and mule deer, ed. M. J. Wisdom. Reprinted from 2004 Transactions of North American Wildlife and Natural Resources Conference, Alliance Communications Group, Lawrence, Kansas.

Wisdom, M. J. 2007. Shift in spatial distribution of elk away from trails used by all-terrain vehicles. Report 1. La Grande, OR: USDA Forest Service, Pacific Northwest Research Station.

Yarmoloy, C., M. Bayer, and V. Geist. 1988. Behavior responses and reproduction in mule deer, Odocoileus hemionous, does following experimental harassment with an all-terrain vehicle. Canadian Field-Naturalist, 102:425–429.

Young, V. A., and W. L. Robinette. 1939. Study of the range habits of elk on the Selway Game Preserve. Moscow, ID: University of Idaho. Bulletin 34. 47 p.

Zager, P., C. White, and G. Pauley. 2007. Elk ecology study. Study IV. Factors influencing elk calf recruitment. Boise, ID: Idaho Department of Fish and Game Federal Aid in Wildlife Restoration Completion Report W-160-R-33.

Zager, P., C. White, G. Paulety, and M. Hurley. 2007. Elk and predation in Idaho: Does one size fit all? Transactions of the North American Wildlife and Natural Resources Conference, 72:320–338.