WILDLIFE

IN MANAGED FORESTS

Elk

Wildlife in Oregon's Managed Forests Outreach Project Overview

A great deal of research has been done by public and private organizations regarding wildlife and wildlife habitat in Northwest managed forests (i.e., working forests where management such as thinning, harvesting, prescribed burning and vegetation control is practiced). However, the research results and their implications have not been communicated in an accessible, systematic fashion. This publication is part of a new series from Oregon Forest Resources Institute. The Wildlife in Managed Forests Outreach Project aims to synthesize current findings and make the information available to field practitioners in forest and wildlife management and to other interested stakeholders such as conservation organizations, regulators and policy makers. In addition to publications, information will be disseminated through workshops, tours and conferences.

Project Partners include:

- Defenders of Wildlife (DOW)
- National Council for Air and Stream Improvement (NCASI)
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Department of Forestry (ODF)
- Oregon Forest Resources Institute (OFRI)
- Oregon State University College of Forestry (OSU-CoF)
- The Nature Conservancy (TNC)
- U.S. Forest Service Pacific Northwest Research Station (USFS-PNW)
- U.S. Geological Survey Forest and Rangeland Ecosystem Science Center (USGS-FRESC)
- Weyerhaeuser Company

For copies of this report or further information, contact:

Oregon Forest Resources Institute
317 SW Sixth Avenue, Suite 400
Portland, OR 97204
(971) 673-2949
1-800-719-9195
www.oregonforests.org

Printed on recycled paper

WILDLIFE
IN MANAGED FORESTS

ELK

Prepared for the Oregon Forest Resources Institute

by

Gail Wells

Gail Wells Communications

Corvallis, Oregon

Project Manager

Mike Cloughesy

Director of Forestry

Oregon Forest Resources Institute

Contents:

Introduction

Extensive research conducted in the past three decades has yielded much information on the natural history, habitat requirements and ecological role of North American elk (*Cervus elaphus*). This paper provides an overview of that knowledge as it applies to elk in the Pacific Northwest and specifically Oregon. We focus particularly on knowledge of elk population dynamics, herd productivity, nutritional needs and response to human disturbance—all topics of interest to land managers. This paper does not set out to be an exhaustive literature review, but rather a synthesis of the knowledge most useful to land managers in Oregon and the Northwest, together with references to relevant literature.

The majestic elk is North America's third-largest land mammal, behind grizzly bear and moose. Elk occupy a high place in the pantheon of American economic and cultural values. Native American people depended on elk meat for their food, kept themselves warm by their thick pelts, and prized their teeth and antlers for ceremonial and aesthetic purposes. In modern times Americans still value elk for their meat, hide, antlers and awe-inspiring appearance. Elk hunting and elk viewing attract many adherents and generate substantial revenues for rural communities (Wisdom and Cook 2000).

Elk also play a large ecological role. Their foraging can dramatically alter the succession of vegetation in forests and grasslands, with marked effects on other wildlife species and on basic ecosystem processes (Cook 2002). Where they share a range, elk may compete with cattle, which have similar nutritional requirements, for food (Wisdom and Cook 2000). Elk herbivory can greatly influence the successional pathway of vegetation coming in after a fire or other disturbance (Johnson and others 2005). In their wide-ranging migrations elk often cross property lines and feed on farm crops, tree seedlings and cattle pasture, causing economic loss to farmers, forest owners and ranchers.

The diets of elk, their herding and ranging patterns, life spans, reproductive strategies and sources of mortality have been observed and documented for a long time. However, because wild elk do not lend themselves easily to controlled study, much of the knowledge about elk physiology and nutrition has been inferred from short-term studies of tame animals and of other ruminants such as deer, cattle and sheep (Cook 2002).

Elk range (blue) from *Atlas of Oregon Wildlife* (Csuti and others 1997).

Elk

(Cervus elaphus)

Size: Length 84 inches (213 cm).

Diet: Trees and shrubs including trailing blackberry, huckleberry, salal, vine maple, salmonberry, Douglas-fir, western hemlock, western red cedar and grasses.

Habitat: Utilizes riparian, mixed conifer, mixed conifer-hardwood and white oak forest types and in subalpine parklands, grasslands and agriculture areas.

Preferred forest habitat age: All forest ages but most heavily associated with young stands where food is most abundant. Forested areas are used for shelter and as hiding and escape cover from predators.

Principal predators: Mountain lion, bears and people.

Reproduction: Usually gives birth to one calf a year; twins are rare.

Did you know… Oregon has two kinds of elk, the Roosevelt elk on the west side of the Cascade Range and the Rocky Mountain elk on the eastside.

Natural History

Elk are members of the Cervidae family, which comprises some 16 genera and 43 species including red deer, reindeer, mule deer, American and European elk and American moose ("Cervidae" 1999). Six subspecies of elk once occupied different North American biomes from coast to coast (Wisdom and Cook 2000). In pre-settlement times elk were common and widely distributed. However, their numbers declined dramatically as Europeans settled the Eastern seaboard and moved across the continent, and their distribution was greatly reduced as populations and whole subspecies were extirpated. Today elk populations have recovered in many areas of the United States, but their distribution is often fragmented, especially in the East.

The two major elk subspecies in the West are the Roosevelt elk and the Rocky Mountain elk. Roosevelt elk were historically distributed along a north-south strip extending from north of Vancouver Island to the Klamath Mountains and from the Pacific Ocean to the western face of the Cascade Range. Rocky Mountain elk were historically distributed in a wide swath along the spine of the Rockies from the Canadian border through southern Utah and Colorado (Wisdom and Cook 2000).

The majestic elk is the third largest land mammal in North America.

By the late 19th and early 20th centuries these two subspecies also had been reduced to scattered pockets. However, in contrast to the others, they have since expanded enough in population, through both natural increase and, in some places, transplantation (Washington State Herd Plan 2002), to regain significant fractions of their historical distribution. The territory now occupied by Roosevelt elk stretches north and south nearly as far as in presettlement times, although the east-west distribution is narrower. Similarly, Rocky Mountain elk occupy a narrower strip of the same north-south axis that once made up their territory.

Herding and Migration

Elk are social animals, forming herds that can range in size from a few dozen animals to hundreds or thousands. Most herds are migratory; their seasonal ranges may encompass areas as large as 300,000 hectares (about 750,000 acres), including the summer and winter ranges and the territory in between (Wisdom and Cook 2000). A typical annual migration takes an elk herd from its summer range higher in the mountains, consisting mostly of publicly owned, less-developed land, to its lower-elevation winter range, often consisting of more-developed land segmented into smaller private parcels.

Herds of migratory elk concentrated on winter range are typically composed of both males and females and may contain a thousand or several thousand animals. Non-migratory elk or elk on summer range tend to be in smaller herds and composed of females and calves and a few young males.

Diet

Like cattle and sheep, elk are ruminants, meaning they have the capability to digest and extract nutrition from fibrous plant matter. Elk are moderately tolerant of roughage in their diet, and thus they occupy a middle range relative to deer, which require less-fibrous forage with more-concentrated nutritional quality, and to cattle, which tolerate less-nutritious fibrous matter better than do elk (Wisdom and Cook 2000).

This middle range contains a wide variety of plants. Elk are opportunistic feeders, able to eat and digest a diverse suite of plants that may be perennially or seasonally available as they make their migratory rounds. However, they show strong preferences for certain more-nutritious plant species if they can find them. We will address nutritional needs in greater detail beginning on page 9.

Reproduction

Elk reproduce polygamously in a “harem” system (Wisdom and Cook 2000). Male elk gather a group of females and mate with them in the fall (the fall rut). After a gestation averaging 255 days, cows give birth to usually a single calf, rarely twins or triplets. Calves are born in early summer, when the warmer weather increases their survival chances, and also when mothers are more likely to have the nourishment they need to support the considerable energy demands of lactation. The birthweight of calves is highly variable, depending largely on maternal nutrition during the latter months of pregnancy (Hal Salwasser, personal communication). Calves weighing less than 15 kilograms (about 33 pounds) at birth are less robust, and calves weighing less than 12 kilograms (about 26 pounds) face reduced odds of survival (Wisdom and Cook 2000).


Cow elk in summer range.

Female elk are capable of reproducing at 1 year of age, but only if their nutrition has been adequate to bring them to 65-75 percent of adult body mass by the time of the fall rut. Most female elk achieve adequate body size for breeding by 2.5 years of age, and they can continue with annual breeding for another decade or so. Pregnancy rates begin to decline at about 12 years of age.

Habitat Requirements

Adequate habitat for elk meets two basic needs: food and security. Adequate nutrition means enough forage of adequate nutritional quality, enough water and a spatial arrangement of these elements such that elk can take advantage of them across their seasonal ranges. Adequate security means thick enough vegetative cover to enable elk to hide or escape from humans or predators at least some of the time (Wisdom and Cook 2000).

Current Condition of Elk Populations in the West

While many populations of elk are increasing (Jackson 2005), productivity of elk herds in many parts of the West has declined since the 1960s (Johnson and others 2005), suggesting that herds may be approaching or exceeding carrying capacity of their habitats (Cook 2002). Productivity of a herd is defined in terms of three basic variables: pregnancy rates (percentage of cows pregnant after the fall rut), calf production (number of calves born per 100 females) and calf recruitment (number of calves recruited into the herd per 100 females) (Wisdom and Cook 2000).

According to data from the Oregon Department of Fish and Wildlife, elk numbers in Oregon have increased more than 29 percent in the past 20 years, from 92,000 in 1984 to about 119,000 in 2004. That number is divided about evenly between Rocky Mountain and Roosevelt elk (Jackson 2005). Numbers of elk hunters have also increased significantly in recent decades. ODFW figures put the number of elk hunters statewide at about 140,000 in 1997, up from just above 10,000 in 1940. However,

Food and security are important for healthy elk populations.

calf recruitment has declined in many areas since the 1960s (Johnson and others 2005). In some herds in northeastern Oregon, recruitment is down from 50 calves per 100 females to 20 calves per 100 females.

Elk populations have declined 25 percent in the Clearwater River basin in Idaho, 50-70 percent in the area north of Mount Rainier, 30-50 percent in the area south of Mount Rainier, and 30 percent in the Blue Mountains in Washington (Johnson 2005).[1] Because calf recruitment is a strong indicator of population trend, it is reasonable to assume that these declines are linked to the lowered rates of calf recruitment observed (Cook and others 1999), and that the current trend of increasing populations may not continue (Salwasser 2005).

Elk and Forest Management

Challenges for Managers

Elk, being so closely interwoven into human-dominated landscapes, are an intensely managed wildlife species. Land managers face the challenge of maintaining elk populations at levels high enough to provide hunting and viewing opportunities, but not so high as to cause undue economic damage to private landowners (Johnson and others 2005), hinder profitable timber management or risk declining vigor of elk populations as they approach ecological carrying capacity.

There are many uncertainties. The interplay of physiological and environmental factors governing productivity of elk herds makes it hard to know which factors to manipulate, and how much to manipulate them, to achieve a desired result in a given situation. There are no simple cause-effect relationships.

Many studies, for example, indicate that forest management produces good forage for elk and deer (Wisdom and others 2005), but that is not a hard-and-fast rule. Several studies addressing how timber harvest changes habitat conditions (e.g., Hershey and

[1] *The 2002 Washington Dept. of Fish and Wildlife report puts the North Rainier decline at 46% (http://wdfw.wa.gov/wlm/game/elk/northrainier_final.pdf, p. 8).*

Density-Dependent and -Independent Factors in Elk Productivity

Nutrition, probably the most important factor in reproductive success in elk and other ungulates, is considered a density-dependent factor in population growth—that is, its effects increase with increased density of an elk population in a given area (Johnson and others 2005). Density-dependent factors (disease is another) tend to stabilize populations by regulating the size of herds.

Hunting, human disturbances, unusually cold winters and other stochastic events, and (sometimes) predation are considered density-independent factors. Because their impact falls equally on more-dense or less-dense herds, they tend to limit the size of a herd without regulating it, and therefore to destabilize populations.

Leege 1976, Lyon 1976, Miller and Krueger 1976, Svejcar and Vavra 1985) have yielded variable results and conclusions. The different types of responses measured, and the different temporal and spatial scales at which they were measured, undoubtedly contributed to these differences. The confounding effects of other human activities associated with timber harvest, notably the increased presence of humans because of increased road access, probably also played a part. Nevertheless, the fact that these studies have come to different (albeit complementary) conclusions illustrates the difficulty of establishing clear relationships between timber harvest and elk response in the presence of so many interlocking variables (Wisdom and others 2005).

Factors in Elk Productivity

The main factors affecting elk productivity are nutrition, climate and weather, hunting, other human disturbances (such as logging, the presence of roads and human recreation in the forest), predation and, to a lesser extent, disease. All these factors have a bearing on the reproductive success of a herd (Johnson and others 2005, Wisdom and Cook 2000).

Nutritional status is a key factor in the welfare of individual animals and hence herd productivity (Johnson and others 2005), but it is affected by other factors in complicated ways (Cook 2002).[2] A herd's nutritional status is governed by type and availability of suitable forage, which is in turn influenced by weather and climate conditions (mainly temperature and precipitation), seral stage of vegetation, size of the herd relative to the resources of the range, season of the year and multi-year patterns of moisture and drought.

The stress of human disturbance, whether intermittent, such as hunting, or pervasive, such as the presence of open roads, is also a major factor affecting elk productivity. Elk expend energy in avoiding these disturbances, leaving less energy for maintenance of body tissues and for reproduction (Rowland and others 2005).

[2] *"The literature is replete with examples of pathways through which nutrition influences demography and productivity of ungulate (hoofed animal) populations. Much of this work is piecemeal and often contradictory, but general patterns and conclusions seem evident" (Cook 2005).*

Predators such as cougar, black bear and wolf can have highly variable effects, depending on how abundant the predator animals are relative to their prey and also on whether predation alters age distribution within an elk herd enough to affect population growth (Johnson and others 2005).

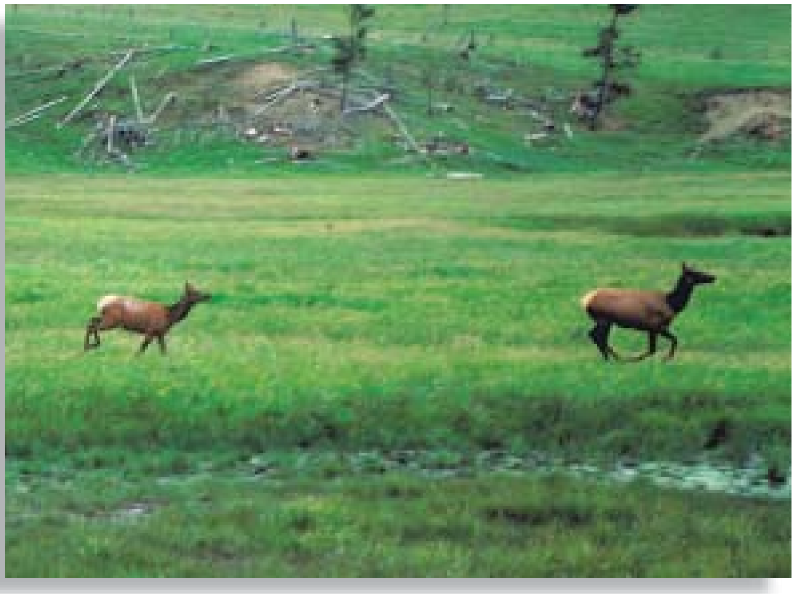
Of all these factors, nutrition and human disturbance are the two most strongly influenced by forest management. Therefore, in the next few paragraphs we will discuss nutritional matters and human disturbances in some detail.

Nutrition

The general nutritional requirements for elk are summarized in requirements for metabolizable energy (ME) and crude protein (CP).[3] Metabolizable energy is expressed as kilocalories per kilogram (kcal/kg) of metabolic weight.[4] Crude protein is expressed as grams per kilogram (g/kg) of metabolic weight.

The requirements of elk for both ME and CP vary depending on season of the year. According to a methodology developed by Cook (2002), an adult female, non-pregnant and non-lactating, requires just under 10,000 kcal of ME in early summer and just under 12,000 kcal in mid-summer through fall; her requirement then drops to just above 10,000 kcal throughout the winter. Her crude protein requirement is similarly seasonal: a non-pregnant, non-lactating animal needs about 300 kg of CP in early spring and about 550 kg in mid-summer; the requirement tapers to about 400 kg in the fall and falls a little more in the winter (Wisdom and Cook 2000).

Pregnancy and lactation greatly increase nutritional requirements. A pregnant female in early spring needs an additional 4,000 kcal of energy, and a lactating cow in early summer needs an addition 9,000 kcal—almost double the requirement of a non-lactating animal. The CP requirement is also almost doubled, to about 900 kg in mid-summer.



Nutrition and stress are key factors in elk productivity.

[3] *Elk also require certain minerals in their diets. Estimates of mineral needs are taken from guidelines for cattle because such information is generally not available for elk. For more about mineral needs and more detail about ME and CP requirements, see Wisdom and Cook 2000.*

[4] *Metabolic weight is assumed to be 75 percent of body mass. The term denotes tissues in the average elk's body that are metabolically active. See Wisdom and Cook 2000.*

Nutritional needs become even higher if the previous winter was harsh; an additional 2,000 kcal of ME and an additional 100 kg of CP are needed through the summer months to replace a 25 percent body-mass loss that could occur in winter in a lactating cow. ME and CP requirements taper off through the summer and into the fall as calves are weaned and as animals become less metabolically active (Wisdom and Cook 2000; Cook 2002).

Inadequate maternal nutrition in winter and spring, especially in late spring when the greatest fetal weight gain occurs, results in low-birthweight calves, which are less likely to survive (Thorne and others 1976). Summer nutrition affects the growth and development of calves (Cook and others 1996), both through effects on maternal lactation and on weight gain of calves after they are weaned, and it plays a large role in their subsequent size, vigor and survival chances. Forage quality in late spring and summer is key to successful reproduction (Hal Salwasser, personal communication).

Recent studies of elk populations in Oregon and Washington have confirmed the complexity of wildlife habitat relationships. Here scientists are measuring body fat as means of determining the general nutritional health of the elk under various forest conditions. As with all animals, good food produces healthy elk.

Elk prefer certain highly nutritious and palatable plant species when they can get them. These species, mostly in the forage classes of grasses, sedges, annual forbs and deciduous shrubs, provide a more concentrated source of energy than the less-preferred ferns, evergreen shrubs and conifers (Cook 2005).

Observing the forage preferences of cow-calf pairs in enclosure pens on industrial timberlands in a variety of habitats, Cook (2005) found that the elk selected deciduous shrubs such as bigleaf maple, hazelnut and cascara and forbs such as Queen’s cup beadlily, northern bedstraw, false Solomon’s seal and oxalis. They avoided most conifers, evergreen shrubs such as salal, Oregongrape and rhododendron, and sword and deer fern. Neutral species—plants they neither preferred nor avoided—included most grasses, alder, elderberry, salmonberry, many forbs, and lady fern.

At least in moist west-side forest ecosystems,[5] vegetation preferred by elk tends to colonize a harvest site following clear-cutting or thinning of trees, encouraged by the increase in sunlight that reaches the forest floor. In studies of the nutritive quality of forage within industrially managed forests in Oregon and Washington at various seral stages, Cook (2005) found that clear-cutting, site preparation, planting and herbicide application produced a large flush (between 2,000 and 4,000 kg/hectare) of early-successional vegetation, with good representation of the species preferred by elk during summer and autumn. Average digestibility of forage was highest in these early years, between about 55-64 percent (although it should be noted that, even during some of those years, forage was inadequate for high-quality nutrition).

As the conifers on the site began to close canopy, the deciduous component of the vegetation dwindled, and over the next 20 to 30 years the site became dominated by less-nutritious evergreen shrubs and forbs. Digestibility declined to about 40 percent over the next two decades and then began a slight upward trend (but with much variation around the mean) over the following two decades. Forage quality remained generally poor through the mid-successional and mature forest stages.

Fire (wild or prescribed) seems to improve foraging conditions in the short term by burning off accumulated litter and making nutritious plants more accessible and increasing biomass of herbs and shrubs (Cook and others 1994, Leege 1979, Peek and others 1979, Riggs and others 1996). For example, many attribute the decline of

Cook's Three-level Nutrition Study

In a study of captive Rocky Mountain elk in northeastern Oregon, a group of researchers led by John Cook offered lactating cows diets of three levels of nutritional quality, starting in mid-summer (Cook 2005). The highest level of nutrition was selected from the livestock literature and was intended to be sufficient to avoid nutritional limitations. The lowest-level diet approximated the actual diet quality in low-elevation forests in dry years. The medium level was an average of the two.

Cows in the high-nutrition group accumulated 5 times more body fat than those in the low group through the summer. Calves born to cows in the high-nutrition group were almost twice as big as calves born to those in the low-nutrition group and had much greater probability of survival. Cows fed the low-level diet virtually stopped breeding, and their probability of survival over the winter was significantly reduced. Cows fed the medium-level diet were delayed by about 10 days in their average breeding date (Cook and others 2004).

The same research team did a second evaluation of diet quality in wild elk herds. They found "considerable evidence that nutritional condition is marginally to substantially inadequate in most herds" during most of the year, not only in winter (Cook 2005). Availability and quality of forage varies by season of the year and across the herd's range. Although most elk habitat contains abundant vegetation most of the year, it may not be of the most nutritious kind, or it may not be available in sufficient quantities when and where it is most needed. As a result, most elk in the West are at risk of under-nutrition or malnutrition in some years (Wisdom and Cook 2000).

[5] *The effect may be less pronounced in drier ecosystems (Cook 2002).*

the elk herd along Idaho's Clearwater River, once the largest herd in the nation, to a significant reduction in the number of acres burned since fire-suppression policies were enacted in the early 20th century ("Conflict on the Clearwater"). Forest managers there and elsewhere have been experimenting with a program of prescribed fires intended to mimic natural burns in some respects (Ted Lorensen, personal communication).

Prescribed fire combined with herbivory (grazing and browsing) may enhance the economic value of forest stands, due to the reduced impact of competing vegetation on the timber yield. In a study of the economic impacts of ungulate herbivory on planted forest stands in eastern Oregon and Washington, Weigand and others (1993) found that a combination of prescribed fire in site preparation, more intensive stocking management and ungulate herbivory produced the highest economic value at two of the four sites, due to increased tree growth. Sites without prescribed fire fared better when deer, elk and livestock were fenced out of the stand. The researchers concluded that ungulate herbivory "can have substantial impact on site productivity when used in conjunction with prescribed fire, stocking control and species selection."

However, forage quality does not always improve after a fire, and long-term effects of burning on forage are unpredictable and may be undesirable (Wisdom and Cook 2000). Moreover, scientists have raised doubts about large-scale attempts to use prescribed fire to return mid-seral forests to the early-seral conditions. Tiedemann and others (2000) suggest a conservative approach until the effects of prescribed fire are better understood.

More generally, the relationship between forest cover and nutritional quality of understory plants is not well established across all forest ecosystems (Cook 2002). Not all early-seral stands provide good forage. Some sites become dominated by young-successional vegetation that is of poor quality, such as bracken fern, sword fern and grasses. Others, particularly on forest industry sites, may be so intensively managed that most secondary vegetation is deliberately eliminated, leaving little for elk (Steven Mealey, personal communication). The variety of forest management strategies—different harvest, site-preparation and vegetation-control methods—together with the variety of forests in which they are practiced, can produce an array of successional trajectories (Cook 2002). It is not yet possible to predict with confidence which strategies work best on a site-specific basis to enhance big-game nutrition.

At larger scales, moreover, the link is tenuous between actual landscape condition resulting from timber harvest in a given area and actual improvements in the nutritional condition of elk inhabiting the area. In a study of timber-harvest effects on cattle and elk on the Starkey Experimental Forest and Range, Wisdom and others (2005) monitored weight gains of wild elk cows and calves before, during and after a 1992 timber harvest. They took annual measurements between 1989, when the project was laid out, and 1996, when planting was completed.

They found high variability in annual weight gain in elk in both the harvested area and the fenced-off control area, but no significant difference between the two populations over the seven years of the study. The researchers suggest that the changes in animals' nutritional condition was explained more by annual variability in forage biomass and quality resulting from variable year-to-year weather than by the presence of early-seral vegetation resulting from timber harvest.

Human Disturbance

Herd of elk in a managed forest.

Roads, and also off-road recreational activities such as ATV use and mountain biking, have significant direct and indirect effects on herd productivity (Rowland and others 2005). Hunting, in fact, is the main source of mortality for adult elk (Wisdom and Cook 2000) outside national parks (Hal Salwasser, personal communication) and in the absence of predator populations (Bruce Johnson, personal communication). Elk are more vulnerable to hunters in roaded areas than in unroaded areas (Rowland and others 2005). Roads also break large tracts of habitat into smaller chunks, reduce vegetative cover used by elk for security and act as a vector for exotic plant species. All these things degrade habitat quality for elk.

The disturbance attending a timber harvest complicates assessment of gains in forage quality. In the Starkey study, the short-term disturbance from the harvest project displaced elk from the harvested areas by as much as five miles (Wisdom and others 2005). Another study on the Starkey forest found that roads are a major factor influencing distribution of elk across the landscape (Rowland and others 2005). Because elk avoid areas near open roads, they may avoid an area of abundant nutritious forage if it lies too near a road. Roads thus potentially diminish “effective habitat,” defined as the percentage of available habitat used by elk outside of hunting season (Lyon and Christensen 1992). Loss of cover associated with harvest is an important consideration, even when it is clear that timber harvest provides nutritional benefits to elk.

Elk exhibit higher stress levels and increased movement rates near roads. In addition, off-road recreation, which is increasing rapidly on public lands, also has a pronounced effect on elk behavior, causing them to flee to avoid ATVs, mountain bikes, equestrians and the like (Wisdom and others 2005). Elk can spend a substantial amount of energy avoiding pervasive human disturbances. This energy cost may not be adequately accounted for in conventional assessments of elks’ nutritional condition (Johnson and others 2005).

Thermal Cover?

Forest with certain structural characteristics used by elk for winter shelter is typically termed “thermal cover,” under the assumption that elk need it for protection from wind and cold temperatures (or excessively warm temperatures in the summer). Recent studies have challenged the assumption that such cover actually provides thermal benefits (Duncan 2000). Studies of tame elk in northeastern Oregon found no evidence that the cover provided enough warmth to enhance the animals’ condition or probability of survival (Cook and others 2004). In fact, elk in the denser forest stands lost more body mass and fat through the winter than those in more open areas.

Nevertheless, elk have long been observed to use thick stands of forest, and it is reasonable to infer they need it for some purpose, even if not a thermal purpose. Elk consistently select habitats that provide security from predators, especially from humans (Wisdom and Cook 2000). If what has been termed “thermal cover” is actually being used for security purposes, Cook and others’ (2000) findings suggest that security may be more important to elk than food in some circumstances.

SUMMARY

Elk (*Cervus elaphus*) play an important role in the ecology and the culture of the West. Elk were abundant across the North American continent in pre-settlement times, but populations were severely reduced by expanding human encroachment and urbanization in the late 19th and early 20th centuries. In the western United States, populations of two subspecies, Roosevelt and Rocky Mountain elk, have recovered a significant fragment of their former range. However, herd productivity generally is declining, suggesting that herds in many places are approaching the carrying capacity of their habitat.

Elk have large ecological and economic impacts in both undeveloped and developed areas. Elk grazing can greatly affect successional pathways of vegetation and sometimes cause economic harm to farmers and ranchers. Much is known about elk’s foraging, breeding, herding and ranging habits, but more remains to be discovered, particularly in the realm of physiology and nutritional needs.

Adequacy of nutrition is a major influence on elk productivity. Elk inhabiting a range that includes areas of abundant forage of the right kind tend to be more productive than those occupying areas with fewer food resources. Seasonal timing of food availability is also important. Not only adequate winter nutrition but adequate nutrition in late spring and summer are important for elk welfare, particularly that of pregnant and lactating cows and their calves. Other key influences on elk productivity are climate and weather, hunting, other human disturbances, predation and, to a lesser extent, disease.

Balancing resource-extraction priorities with elk habitat needs can be a challenge for land managers. Natural variations in landscape condition, climate and season can greatly influence adequacy of elk habitat and, hence, the robustness of elk populations. These natural dynamics confound and may sometimes overwhelm the effects of human manipulation. In addition, timber management may bring in roads and other human disturbances that can cause elk to meet their security needs by fleeing otherwise good foraging areas. However, certain landscape manipulations may sometimes benefit elk habitat. Specifically, timber management has the potential to improve elk habitat by promoting growth of the early-successional vegetation favored by elk. More abundant, high-quality forage tends to be available in early-successional forested areas than in mid- to late-successional forests.

Forests can be managed to help provide excellent elk habitat through timber harvest and other management activities as long as the elk's need for security is kept in balance with their nutritional needs.

Thermal Cover?

LITERATURE CITED

"Cervidae." *HighBeam Encyclopedia* [web]. Passage excerpted from *A Dictionary of Zoology* (1999), originally published by Oxford University Press. http://www.encyclopedia.com/doc/1O8-Cervidae.html. Consulted 04/27/07.

"Conflict in the Clearwater." [web] Idaho public television. Transcript at http://idahoptv.org/outdoors/shows/clearwater/fire.html

Cook, John G. 2005. Nutritional value of forage species for deer and elk under various forest management strategies. Presentation at the conference Relationships between Forestry, Deer and Elk in Western Oregon, Jan. 19, 2005. Oregon State University, Corvallis.

Cook, John G. 2002. Nutrition and food. Chapter 5 in *North American Elk: Ecology and Management* (Dale E. Toweill and Jack Ward Thomas, eds.). Smithsonian Institution Press, Washington and London.

Cook, John G., Larry L. Irwin, Larry D. Bryant, Robert A. Riggs, Jack Ward Thomas. 2004. Thermal cover needs of large ungulates: a review of hypothesis tests. Transactions of the 69th North American Wildlife and Natural Resource Conference.

Cook, J.G., L.L. Irwin, L. Bender, B. Johnson, and D. Boyce, Jr. 1999. Assessing landscape-scale nutritional influences on elk herd productivity in the Northwest: a proposal for east- and west-side studies. National Council for Air and Stream Improvement, La Grande, Oregon. [Cited in Johnson and others]

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

Cook, J.G., L.L. Irwin, L.D. Bryant, R.A. Riggs, D.A. Hengel, and J.W. Thomas. 1994. Studies of elk biology in northeast Oregon. National Council for Air and Stream Improvement, Corvallis, OR. [cited in Cook 2002]

Csuti, Blair, A. Jon Kimerling, Thomas A. O'Neil, Margaret M. Shaughnessy, Eleanor Gaines, and Manueloa M.P. Huso. eds. 1997. *Atlas of Oregon Wildlife*. Oregon State University Press, Corvallis.

DeCalesta, D.S., and S.L. Stout. 1997. Relative deer density and sustainability: A conceptual framework for integrating deer management with ecosystem management. *Wildlife Society Bulletin* 12:252-258. [cited in Cook 2002]

Hershey, T.J., and T.A. Leege. 1976. Influences of logging on elk on summer range in north-central Idaho. In Proceedings, Elk logging roads symposium, 73-80. University of Idaho, Moscow. [Cited in Wisdom and others 2005]

Irwin, L.L., J.G. Cook, R.A. Riggs, and J.M. Skovlin. 1994. Effects of long-term grazing by big game and livestock in the Blue Mountains forest ecosystems. USDA Forest Service General Technical Report PNW-GTR-325. Pacific Northwest Research Station, Portland, OR. [cited in Cook 2002]

Jackson, DeWaine. 2005. Population trends, management objectives, population expectations. Presentation at the conference Relationships between Forestry, Deer and Elk in Western Oregon, Jan. 19, 2005, Corvallis.

LITERATURE CITED *(continued)*

Johnson, Bruce K., Michael J. Wisdom, and John G. Cook. 2005. Issues of elk productivity for research and management. Pp. 81-93 in Wisdom, M.J, tech. ed., *The Starkey Project: a synthesis of long-term studies of elk and mule deer.* Reprinted from the 2004 Transactions of the North American Wildlife and Natural Resources conference, Alliance Communications Group, Lawrence, KS.

Leege, T.A. 1979. Effects of repeated burns on northern Idaho browse. Northwest Science 53:107-113. [cited in Wisdom and Cook 2000]

Lyon, L.J. 1976. Elk use as related to characteristics of clearcuts in western Montana. In Proceedings, Elk logging roads symposium, 69-72. University of Idaho, Moscow. [Cited in Wisdom and others. 2005]

Lyon, L. J., and A. G. Christensen. 1992. *A Partial Glossary of Elk Management Terms.* USDA Forest Service, General Technical Report INT-GTR-288. Pacific Northwest Research Station, Portland, OR. [cited in Rowland and others 2005]

Miller, R. F., and W. C. Krueger. 1976. Cattle use on summer foothill rangelands in northeastern Oregon. *Journal of Range Management* 29:367-371. [cited in Wisdom and others 2005]

Riggs, R.A., A.R. Tiedemann, J.G. Cook, T.M. Tibbs, P.J. Edgerton, M. Vavra, W.C. Krueger, F.C. Hall, L.D. Bryant, L.L. Irwin, and T. Delcurto. 1998. Modification of mixed-conifer forests by ruminant herbivores in the Blue Mountains Ecological Province. Unpublished report from USDA Forest Service Pacific Northwest Research Station, 1401 Gekeler Lane, La Grande, OR. [cited in Cook 2002]

Riggs, R.A., S.C. Bunting, and S.E. Daniels. 1996. Prescribed fire. Pp. 295-320 in *Rangeland Wildlife* (P.R. Krausman, ed.). The Society for Range Management, Denver CO. [Cited in Cook 2002]

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. Pp. 42-52 in M.J. Wisdom, tech. ed., *The Starkey Project: a synthesis of long-term studies of elk and mule deer.* Reprinted from the 2004 Transactions of the North American Wildlife and Natural Resources conference, Alliance Communications Group, Lawrence, KS.

Peek, J.M., R.A. Riggs, and J.L. Lauer. 1979. Evaluation of fall burning on bighorn sheep winter range. *Journal of Range Management* 32:430-432. [cited in Wisdom and Cook 2000]

Salwasser, Hal. 2005. Moving forward—some final thoughts. Presentation at the conference Relationships between Forestry, Deer and Elk in Western Oregon, Jan. 19, 2005. Oregon State University, Corvallis.

Svejcar, T., and M. Vavra. 1985. The influence of several range improvements on estimated carrying capacity and potential beef production. *Journal of Range Management* 38:395-399. [cited in Wisdom and others 2005]

Thorne, T., R.E. Dean, and W.J. Hepworth. 1976. Nutrition during gestation in relation to successful reproduction in elk. *Journal of Wildlife Management* 40:330-335. [cited in Johnson and others 2005]

Tiedemann, Arthur R., James O. Klemmedson, and Evelyn L. Bull. 2000. Solution of forest health problems with prescribed fire: Are forest productivity and wildlife at risk? *Forest Ecology and Management* 127(1-3): 1-18.

LITERATURE CITED *(continued)*

Washington State Herd Plan: North Rainier elk herd. 2002. Washington Dept. of Fish and Wildlife report, March 2002, http://wdfw.wa.gov/wlm/game/elk/northrainier_final.pdf. Consulted 04.27.07. The report gives an interesting story of the 1912-13 transplanting of Rocky Mountain elk from Montana into Roosevelt elk territory in the north Cascades (pp. 5-6).

Weigand, James F., Richard W. Haynes, Arthur R. Tiedemann, Robert A. Riggs, and Thomas M. Quigley. 1993. Economic assessment of ungulate herbivory in commercial forests of eastern Oregon and Washington, USA. *Forest Ecology and Management* 61(1-2): 137-155.

Wisdom, Michael J., and John G. Cook. 2000. North American Elk. Chapter 32 in Denarais, Stephen, and Paul R. Krausman, *Ecology and Management of Large Mammals in North America*. Prentice Hall, Upper Saddle River, NJ.

Wisdom, M.J., and J.W. Thomas. 1996. Elk. Pp. 157-181 in *Rangeland Wildlife* (P.R. Krausman, ed.). The Society for Range Management, Denver, CO. [cited in Cook 2002]

Wisdom, M.J., B.K. Johnson, M. Vavra, J.M. Boyd, P.K. Coe, J.G. Kie, A.A. Ager, and N.J. Cimon. 2005. Cattle and elk responses to intensive timber harvest. Pp. 197-216 in *The Starkey Project: A Synthesis of Long-term Studies of Elk and Mule Deer* (M.J. Wisdom, tech. ed.). Transactions of the North American Wildlife and Natural Resources Conference, Alliance Communications Group, Lawrence, KS.

Abundant forest throughout the year is important to elk.

Oregon Forest Resources Institute
317 SW Sixth Avenue, Suite 400
Portland, Oregon 97204
(971) 673-2944
1-800-719-9195
www.oregonforests.org

ACKNOWLEDGEMENTS

The Oregon Forest Resources Institute is grateful to the following reviewers: Matt Betts, OSU College of Forestry; Rick Brown, Defenders of Wildlife; Mike Cafferata, Oregon Department of Forestry; John Cook, National Council for Air and Stream Improvement; Dennis Creel, Hampton Tree Farms; Jake Gibbs, Lone Rock Timber Company; Audrey Hatch, Oregon Department of Fish and Wildlife; Bruce Johnson, Oregon Department of Fish and Wildlife; Richard Larson, Oregon Society of American Foresters; Ted Lorensen, Oregon Department of Forestry; Mike Rochelle, Weyerhaeuser Company; Pete Sikora, Giustina Resources; Hal Salwasser, OSU College of Forestry; Gary Springer, Starker Forests, Inc.; Jennifer Weikel, Oregon Department of Forestry; and Mike Wisdom, USDA Forest Service Pacific Northwest Research Station. Graphic design by Mary Gorton, Oregon Publishing & Distribution.

PHOTOGRAPHY

Michael and Josh Feinstein, cover background and Page 8
Terry Spivey, USDA Forest Service, www.forestryimages.org, cover insert and Pages 3, 5, 6 and 15
Dave Powell, USDA Forest Services, www.forestryimages.org, Page 9
National Council for Air and Stream Improvement, Page 10
Chuck Bargeron, University of Georgia, www.forestryimages.org, Page 13


OREGON FOREST
RESOURCES INSTITUTE