Social Science to Improve Fuels Management: A Synthesis of Research on Aesthetics and Fuels Management

Wildland Fire Behavior & Forest Structure

Environmental Consequences

Economics

Social Concerns

Preface

This document is part of the Fuels Planning: Science Synthesis and Integration Project, a pilot project initiated by the USDA Forest Service to respond to the need for tools and information useful for planning site-specific fuels (vegetation) treatments projects. The information addresses fuel and forest conditions of the dry inland forests of the Western United States: those dominated by ponderosa pine, Douglas-fir, dry grand fir/white fir, and dry lodgepole pine potential vegetation types. Information was developed primarily for application at the stand level and is intended to be useful within this forest type regardless of ownership. Portions of the information also will be directly applicable to the pinyon pine/juniper potential vegetation types. Many of the concepts and tolls developed by the project may be useful for planning fuels projects in other forest types. In particular, many of the social science findings would have direct applicability to fuel planning activities for forests throughout the United States. As is the case in the use of all models and information developed for specific purposes, our tools should be used with a full understanding of their limitations and applicability.

The science team although organized functionally, worked hard at integrating the approaches, analyses, and tools. It is the collective effort of the team members that provides the depth and understanding of the work. The science team leadership included Deputy Science Team Leader Sarah McCaffrey (USDA FS, North Central Research Station); forest structure and fire behavior—Dave Peterson and Morris Johnson (USDA FS, Pacific Northwest Research Station); environmental consequences—Elaine Kennedy-Sutherland and Anne Black (USDA FS, Rocky Mountain Research Station); economic uses of materials—Jamie Barbour and Roger Fight (USDA FS, Pacific Northwest Research Station); public attitudes and beliefs—Pamela Jakes and Susan Barro (USDA FS, North Central Research Station); and technology transfer—John Szymoniak (USDA FS, Pacific Southwest Research Station).

This project would not have been possible were it not for the vision and financial support of Janet Anderson and Leslie Sekavec from the Washington Office Fire and Aviation Management staff.

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Welcome

This is one of several publications to be developed by the public attitudes and beliefs team of the Fuels Planning: Science Synthesis and Integration Project. To gather information relevant to public attitudes and beliefs about fuels planning, we posed six questions. These questions were developed around the tasks and challenges faced by fuels treatments planners:

- What information and tools are available to help land managers and communities collaborate in developing fuels treatments programs?
- What information and tools are available to help managers work with communities to communicate the risk and uncertainty of fuels treatments projects?
- What information and tools are available to evaluate the social acceptability of fuels treatments?
- What information and tools are available to encourage more active involvement of private property owners in the fuels management process?
- What information and tools are available to help us understand and evaluate the social impacts of wildfire?

Teams of scientists from universities and public agencies across the country were formed to address each question. Collectively we became known as the social science teams. Each team had approximately 8 weeks to produce a synthesis of science relevant to its questions and an annotated bibliography that supports the synthesis.

While the focus of the national project was on the dry inland forests of the Western United States, the research synthesized by the social science teams was not limited geographically. We felt the research question being addressed was more important than the location of the research. In addition, we felt that research addressing the human dimensions of a variety of management objectives is potentially applicable to fuels management. For example, we assumed that information and tools developed in Minnesota to bring together communities and agencies in addressing watershed management collaboratively, across boundaries, are applicable to fuels management.

In this publication we present the findings of the synthesis on the aesthetic impacts of fuels treatments. Manager fact sheets are available online at:
http://www.fs.fed.us/fire/tech_transfer/synthesis/social_science_team/fact_sheet_ss.htm

Further information on the larger project is available online at:
http://www.fs.fed.us/fire/tech_transfer/synthesis/synthesis_index

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Executive Summary

Fuels management, like many other aspects of forest management on public land, can be highly controversial. The public's concern that forest thinning projects will significantly impact the scenic beauty of the forests in which it recreates and resides is often a root cause of this controversy. Given that the public's acceptance of forest management practices, including fuels reduction, is heavily based upon the visual appearance of the forest (Ribe 2002), fuels managers can improve their chance of success by incorporating aesthetic considerations into management decisions. In fact, a visually preferred landscape can be the natural outcome of fuels treatments if managers understand the important characteristics that shape the public's landscape preferences. Fortunately for forest planners and managers, a large body of research has explored the impact of forest management, particularly timber harvests, on forest aesthetics. This report summarizes the existing body of research on aesthetics and forest management, and suggests strategies for managers and planners to use in applying this research information to fuels management. The goal of this report is to help managers reduce fuels hazards in a manner that respects, or even improves, the scenic beauty of the forest.

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A review of the research on forest aesthetics shows considerable consensus about what the public considers to be a scenic forest (e.g., Gobster 1994, Kaplan and Kaplan 1989). These research findings also have been relatively consistent across a wide range of forest types in North America and Europe where the majority of research has been conducted. Thus, while every forest is unique, some consistent themes in the research have been found from the arid Southwest's ponderosa pine forests to the South's pine plantations and the Midwest's deciduous hardwood forests. Several important conclusions from the forest aesthetic research apply to fuels management:

- **Large mature trees** are an important part of scenic beauty and should be retained in forest thinning projects.
- **Forests with more open structure** that allows visual access through the understory are considered more scenic than forests with extremely dense understory vegetation.
- **The amount of tree thinning** that can occur without significant impacts to scenic beauty varies by forest type and topographic area. Large clearcuts are considered to have a negative affect on scenic beauty in almost all forest types. However, researchers have found that partial clearing of up to 50 percent of trees in a dispersed pattern may be visually acceptable in moderately sensitive areas, especially if large trees are preserved.

- **Downed wood** from timber harvesting and tree thinning is considered ugly and has a negative impact on scenic beauty. Removing dead wood or chipping onsite can greatly increase scenic ratings for tree thinning projects.
- **Low-intensity prescribed fire** can actually improve scenic beauty, but may have short-term negative visual impacts, such as dead wood and scorched trunks.

Managing for aesthetics as part of fuels management falls under the umbrella of general forest planning policy and guidelines. This report provides an overview of the USDA Forest Service's Scenic Management System, which helps planners and managers identify existing scenic landscapes and evaluate the sensitivity of these areas to management decisions. Another important management tool, the Recreation Opportunity Spectrum, can help managers determine the impact of fuels reduction projects on recreation activities.

Although there is much agreement across many different groups of people about what is considered scenic, forest managers and other natural resource experts often differ markedly from the general public in their perceptions of clearcutting, tree thinning, and other management practices. Forest managers often consider the scenic impacts of such management to be much less negative than does the public, which may suggest why there is such controversy over forest thinning and other timber management projects. Thus, forest planners and managers need to involve the public in planning fuels management projects.

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The final section of this report is comprised of strategies for managing fuels and visual quality. These strategies are organized around the three stages of fuels management—planning, implementation, and monitoring—and are summarized below:

1. Planning

- **Use a multidisciplinary team for fuels management** including landscape architects to help evaluate the visual impacts of management proposals.
- **Plan locations of fuels treatments** to avoid impacts to sensitive areas, such as near existing homes or along scenic roads and ridgelines.

- **Create natural boundaries for management areas.**
- **Use visual assessment tools** to evaluate the visual sensitivity of existing landscapes and management proposals.
- **Involve the public in the planning process.**

2. Implementation

- **Protect and retain mature trees** by removing only enough large trees to open the canopy when necessary.
- **Use tree thinning to improve visual access through the understory** by removing between 25 and 50 percent of the smaller diameter trees depending on location and forest type.
- **Mitigate the visual impacts of prescribed fire** in sensitive areas by pre-burn clearing around the base of large trees and timing burns for fastest revegetation.
- **Use "cues to care" to show that the forest is actively being managed**, such as seeding fuels breaks with wildflowers and thinning trees to frame views from trails.
- **Involve volunteers in fuels management projects.**

3. Monitoring

- **Cleanup woody debris and slash from tree thinning** by removing woody debris from the site, mulching, or burning brush piles.
- **Enhance revegetation of disturbed areas**, such as access roads and staging areas, through fertilizing and seeding.
- **Provide information about fuels management** through interpretive signs and brochures that show the target landscape and timeframe for regeneration after treatment.
- **Practice adaptive management** because after fuels treatments the forest may require periodic thinning to retain views and manage fuels.

Introduction

Catastrophic forest fires in the past decade have increased the public's awareness of wildland fire danger and put pressure on public agencies to revise land management strategies. The fire suppression practiced by the USDA Forest Service from its beginnings has given way to policies that acknowledge fire as a natural process that must be managed and accommodated within larger forest planning goals (Pyne 2003). However, the transition from overgrown forest landscapes, resulting in part from decades of fire suppression, to landscapes that can tolerate regular prescribed or natural fire has required a strong shift in forest management and will require extensive fuels modification of the Nation's forests (Pyne 2003). Many forest managers have begun planning and implementing fuels management plans as part of the larger forest planning process. This has included efforts such as salvage logging after major wildfires, prescribed burning, extensive thinning of overgrown forests, as well as traditional methods such as creation of shaded fuel breaks.

Many of our fire-dependent forest landscapes are over-grown and present high fire risk—they will require significant management action before they can tolerate regular prescribed or natural fire.

Photo credit: T. Daniel

However important fuels management is for restoring ecological health and improving public safety, especially at the wildland-urban interface, it is not without controversy (Mendez *et al*. 2003). Forest thinning projects, including salvage logging, to lessen fuels loads have been criticized and litigated by many environmental organizations as having detrimental environmental and aesthetic impacts (Associated Press 2003, Robbins 2003). Therefore, forest managers engaged in planning and implementing fuels management programs need to learn why the public might be opposed to fuels management efforts and to develop strategies to address those concerns. This paper will cover one aspect of fuels management—the visual impact—and describe strategies to plan and manage fuels treatments in a way that minimizes or even enhances the scenic beauty of the forest.

Why should forest managers care about aesthetics? Forest managers are increasingly being charged to manage the forest for multiple benefits (Kimmins 2002). Although there is certainly a wide range of constituent groups, from environmental organizations to hunters and industry representatives, that weigh in on forest planning and management decisions, studies suggest that the general public embraces a multiple-use perspective on forest management (Gan *et al*. 2000, Ribe 2002). The importance of managing forests for timber, as well as other nontimber uses, has been recognized in many regions and forest types

(Gan *et al*. 2000, Gobster 2001a). Nontimber uses include wildlife habitat, hiking, camping, hunting, wildlife and bird watching, and aesthetics (USDA Forest Service 1986, Clark and Stankey 1979). For the public who visit the forests, scenic beauty is an important aspect of its experience (Ribe 1994, USDA Forest Service 1995). Therefore, incorporating aesthetics into forest management is becoming increasingly important (Bacon and Dell 1985; Litton 1968, 1972; Ribe 1989; Tlusty and Bacon 1989).

Despite the multiple-objective approach to forest management that is generally preferred by the public, all forest uses are not necessarily equal. Aesthetics in particular is one use that may appear as an ephemeral or ambiguous goal to many land managers. However, professional foresters are becoming aware that landscape aesthetics has a critical influence on the public's response and support for management decisions. As stated by Richard Lewis, president of the American Pulpwood Association in an article by forester Geoffrey T. Jones (1995: 13):

> *Don't ignore forestry esthetics. Money spent to improve the appearance of harvesting and forest management must be viewed as a necessary investment to ensure that we'll be allowed to practice forestry in the twenty-first century.*

Forestry professor Hamish Kimmins (2002), in his study of the evolution of forest management, proposed that forestry is now entering a period of "social forestry," which uses ecologically based ecosystem management to promote multiple values including aesthetics, water, recreation, and conservation.

The impact of the public on promoting these social values cannot be underestimated by forest planners, especially those engaged in fuels management. Negative public opinion can affect legislation, which in turn affects forest planning and management operations (Jones 1995, Schuh 1995). One study in British Columbia found that the higher the aesthetic value people placed on the forest, the more they opposed particular types of timber management such as clearcuts (Tindall 2001, 2003). Furthermore, the public is motivated by aesthetics in its support for funding forest planning and management, including fighting forest fires (Fanariotu and Skuras 2004).

Forest thinning projects, including salvage logging, to lessen fuels loads have been criticized and litigated by many environmental organizations as having detrimental environmental and aesthetic impacts.

Aesthetics also is important for forestry management because the public often judges the ecological health of a forest by its appearance. Management that creates a messy, erosive, or unhealthy appearing forest will be considered poor (Gobster 1995, Jones 1995.) In fact, one large-scale study in the Pacific

Northwest found that the public equated forest scenes that were more visually pleasing with more acceptable forest management practices. As suggested by the study's author, Robert Ribe (2002: 757), many people may consider that "scenic beauty is a proxy for acceptable management."

Scenic beauty also has an economic value. Studies have shown that forests considered more scenic have a higher economic value and that this value is related to large-scale panoramic views of the forest (Fanariotu and Skuras 2004). Although economists strive to put a dollar amount on the aesthetic and other noncommodity values of natural resources, such as forests, anecdotal evidence related to property values, vacation destinations, and even advertising reveals that people are willing to pay top dollar to enjoy, reside near, and visit scenic natural resources, including the Nation's national forests.

The goal of this paper is to provide forest planners and managers with strategies for planning and implementing wildland fire and fuels management projects in a more visually sensitive manner based on social science research. This paper is divided into five sections. The first section introduces the topic and describes why aesthetics is an important consideration for forest planners and managers. The second section gives an overview of the theories for predicting scenic beauty/landscape aesthetics and describes methodological approaches for understanding landscape preference. The third section highlights empirical research findings from landscape aesthetics that have focused on forest landscapes and management. The fourth section describes visual resource management approaches developed by Federal agencies. The paper concludes with strategies for planning, implementing, and managing wildland fire and fuels reduction projects that preserve and even improve the visual quality of the forest.

Forest planners and managers who are less interested in the theoretical issues may want to read the final section first to learn some practical ideas for managing wildland fuels with aesthetics in mind.

Forest planners and managers who are less interested in the theoretical issues may want to read the final section first to learn some practical ideas for managing wildland fuels with aesthetics in mind. For those who wish to gain a better theoretical background, the first four sections review the theories, research, and forest policy that support these strategies.

Many of the theories and examples presented in this synthesis complement the discussion found in "Social Science to Improve Fuels Management: A Synthesis of Research on the Social Acceptability of Fuels treatments" (Daniel *et al*., 2005). As discussed in that synthesis, scenic beauty often serves as a proxy for social acceptability, which increases the importance of this concept to social assessments.

Theories to Predict Landscape Beauty

Researchers have developed several theoretical models to predict visual preference (as reviewed by Ruddell *et al*. 1989 and Zube *et al*. 1982), including aesthetic theory (Litton 1968, 1972), the psychological/cognitive approach (Kaplan and Kaplan 1989), the psychophysical approach (Daniel and Boster 1976), and the affective/emotional approach (Ulrich 1983). Although these models have different theoretical and disciplinary backgrounds, at their root they have the common goal of answering the following questions:

- Which landscapes do people consider to be visually pleasing?
- Does landscape preference vary widely by individuals or are there certain landscapes or places that the majority of people consider to be beautiful or aesthetically pleasing?
- Are there landscape features, types, composition, and characteristics that are common to these preferred landscapes? Which features are the more important predictors of visual preference, and which are less important?
- How can the results of visual assessment studies be used to inform landscape planning and management?

Scenic beauty research had a tremendous growth in the mid-1960s with the advent of the environmental movement and accompanying legislation (Arthur and Boster 1976, Arthur *et al*. 1977, Daniel and Vining 1983, Zube *et al*. 1982, 1987). This section will review the different theories and methods used to study landscape aesthetics.

The visual resource management approaches used by Federal agencies are influenced by line, pattern, contrast, balance, and other aspects of landscape aesthetic theory.

Photo credit: D. Peterson

Landscape Aesthetic Theory

Litton (1968, 1972 c.f. Murtha and Greco 1975) used landscape aesthetic theory, which comes from the fields of art criticism and landscape architecture, to suggest that the primary factors that affect landscape recognition are form, space, and time. The importance of form recognition has been central in cognitive theory. Humans recognize objects and landscapes by mentally remembering their outline. Litton suggested that secondary factors that affect landscape recognition are observer position, distance, and sequence. Line, pattern, contrast, balance, harmony, and other aspects from aesthetic tradition have influenced much of the visual resource management and assessment approaches within Federal agencies (Smardon 1986; USDA Forest Service 1974, 1995; USDI Bureau of Land Management 1980). This theory usually relies on experts trained in landscape architecture or other design fields to evaluate the landscape for its scenic beauty (Daniel and Vining 1983, Zube *et al*. 1982). These expert-driven approaches will be described later in more depth.

Other researchers have taken a more empirical approach from the fields of psychology and sociology to study landscape aesthetics. Researchers from cognitive psychology have studied how people perceive landscapes as well as other objects. Visual recognition and affective response are almost immediate with most visual stimuli (Zajonc 1980). People decide almost instantaneously whether they like a particular place and whether they consider it aesthetically pleasing. Thus, many approaches to studying landscape aesthetics have participants rate slides or photographs as surrogates to judge scenic landscapes (Daniel and Boster 1976, Kaplan and Kaplan 1989). Using photographs in lieu of actual site visits has been proven to be an efficient and reliable approach (Daniel and Boster 1976, Kaplan and Kaplan 1989, Kellomaki and Savolainen 1984). Furthermore, using photographs or other visual images allows researchers to learn new information that is difficult to obtain using written survey questions alone (Tahvanainen *et al*. 2001).

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Psychophysical Approach: Scenic Beauty Estimation Method

Many research studies on forest aesthetics have used a psychophysical approach to predicting scenic beauty that was pioneered by Daniel and Boster (1976). Called the Scenic Beauty Estimation Method, this approach uses physical characteristics of a forest derived from vegetative sampling to predict scenic beauty. Photographs are taken of forest stands and then are rated for scenic beauty by study participants. The location of each photograph is carefully selected, and detailed forest data are taken from the area shown within the scene, such as number of trees, total basal area, percentage of shrub and herb cover, and amount of dead wood. In general, a regression analysis or other statistical technique is used to determine which of these physical characteristics are more significant for predicting the scenic ratings given to each scene. Originally, the Scenic Beauty Estimation Method was implemented on small sites (e.g., 1 acre), but Brown and Daniel (1986) showed that it could be applied to the forest stand by sampling multiple sites within the same stand.

One positive aspect of this approach is that it uses forest science data that are available to forest managers and produces results in terms that many forest managers can readily translate into management decisions (Arthur 1977, Daniel and Schroeder 1979, Ruddell *et al*. 1989). Although the Scenic Beauty Estimation Method focuses heavily on prediction, it does not reveal much information about why people may like certain forests or compositions more than others (Ruddell *et al*. 1989). Critics also have suggested that this approach is too specific to a particular forest type, such as the ponderosa pine forests of northern Arizona where much of this work has been done (Ribe 1990). However, more recent studies have used the psychophysical approach in northern hardwood forests (Pings and Hollenhorst 1993, Ribe 1990), boreal forests (Haider and Hunt 2002), and southern pine-oak forests (Ruddell *et al*. 1989). Another criticism of the psychophysical method is that the majority of studies have looked at pictures taken within the forest (Haider and Hunt 2002). Few of these studies have looked at views from road corridors or trails where most people actually view the forest. Schroeder and Daniel's (1980) study of road corridors and a recent shoreline study by Haider and Hunt (2002) are notable exceptions. In addition, many of the studies have looked at the near-view and not at views or vistas, because of the difficulty, time, and expense in obtaining forest data on larger landscapes. Unfortunately, the impact of timber harvesting and other disturbances occurs at this larger scale.

Cognitive Approach

Environmental psychologists Rachel Kaplan and Stephen Kaplan (1989) make the point that landscape preference is about meeting human needs. They argue that humans are visual creatures that rely on the environment around them for information on which to base decisions for planning and taking action. This cognitive approach "describes how people evaluate and organize visual information" (Ruddell *et al*. 1989: 396). This information-processing view of human cognition and perception has led the Kaplans to create a theoretical framework to understand landscape preference.

Anyone who has been lost in the woods understands rather quickly the vital importance of making sense of one's surroundings and making the correct choices to find one's way back to familiar territory.

The Kaplans' framework incorporates two essential human needs: the desire to understand and make sense of the world around us and the desire to explore and gain new knowledge (Kaplan and Kaplan 1989, Kaplan *et al*. 1998). Anyone who has been lost in the woods understands rather quickly the vital importance of making sense of one's surroundings and making the correct choices to find one's way back to familiar

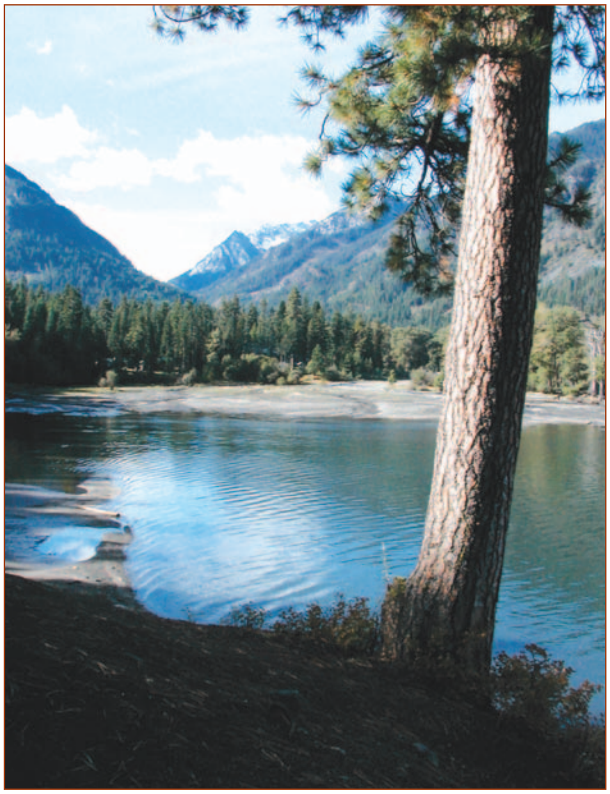

Photo credit: P. Jakes

People prefer more visually complex scenes, with bodies of water and changes in elevation being important elements of many landscapes considered beautiful.

territory. Thus, understanding is about feeling secure as well as being able to predict what may be ahead. Exploration has to do with the human need to learn more about our surroundings. Thus, environments that can be explored both physically and cognitively are preferred. The fascination that people have with natural elements and surroundings certainly appears to be something that is hard-wired into our psyche, and it is one aspect that people appreciate about natural settings, including forests (Kaplan *et al*. 1998). And nature, including forests, has been found to help people recover from stress and mental fatigue (S. Kaplan 1995, Kaplan *et al*. 1998).

The Kaplans' landscape preference matrix was derived from a myriad of studies conducted in collaboration with many colleagues, as well as other researchers who used a similar approach. Many of these studies are described in "The Experience of Nature" (1989). The studies rely on people's ratings of photographs or slides of natural and built environments. On the surface, the initial approach of having the public rate scenes is similar to Daniel and Boster's (1976) Scenic Beauty Estimation Method. However, there are important distinctions between these two approaches in how the researchers attempt to predict what people will consider visually pleasing. While the psychophysical approach relies on physical measurements of the actual setting, the Kaplans' approach uses category-identifying statistics to determine which type of settings are grouped together statistically, such as dense forests or open meadows. The researchers then interpret the content and composition of these scenes. (See Kaplan and Kaplan 1989 for a detailed description of their Category Identifying Methodology).

By analyzing the types of natural scenes that people rate highly for visual preference, the Kaplans developed four factors that describe preferred settings. Two factors relate to understanding coherence and legibility—and two others relate to exploration—complexity and mystery. "A coherent setting is orderly: it is organized into clear areas" (Kaplan *et al*. 1998: 14). It allows one to make sense of the setting by the way it is organized, by repeating elements, such as trees of the same type or a limited amount of different patterns or textures. Legibility has to do with finding one's way in the environment. Landscapes that have landmarks, such as a distinctive tree, topography, or landform, help people orient themselves, which can encourage them to explore the setting without fear of getting lost.

The Kaplans' research also suggests that people prefer more visually complex scenes, as opposed to more monotonous ones. One might think of a mono-culture of young pines in a plantation compared to a mature diverse pine forest. However, complex natural settings may have a richness of textures and plant material, but still may not be visually coherent. Visually chaotic settings, such as overgrown areas, are usually not preferred. The final factor, mystery, is about settings that encourage people to explore further. The classic example of mystery is the winding trail or road that gives one a glimpse of what may be ahead but beckons one to see what is around the bend. Mystery is related to the amount of visibility and trail layout especially in forested settings (Hammitt and Cherem 1980; Herzog 1984, 1988). More open forests that allow views through them are more preferred than those with dense vegetation at eye level. In the following section, we will describe how these findings relate to forest settings.

Landscapes that have landmarks, such as a distinctive tree, topography, or landform, help people orient themselves, which can encourage them to explore the setting without fear of getting lost.

Another well-known theory of landscape preference is geographer Jay Appleton's Prospect-Refuge Theory (1975). Appleton argued that people prefer landscapes that allow them to see into larger areas, such as a meadow, but that also give them a refuge like the forest edge. Like Stephen Kaplan and Rachel Kaplan (1982), Appleton argued that there is an evolutionary reason for humans' preference for these settings. However, Appleton did not conduct empirical research studies to support his hypothesis, although it has been supported in the visual preference studies of Kaplan and Kaplan (1989) and others (Herzog 1984, 1988; Ruddell and Hammitt 1987).

Aesthetics and Affective Response

Other researchers, such as geographer Roger Ulrich, have studied human affective response to visual stimuli by showing people scenes of natural and built environments and measuring their physiological responses, such as heart rate or brain waves. Ulrich (1983) proposed that visual stimuli change people's emotional response and lead to a particular behavior. These studies have found that scenes of nature including forests and water can elicit pleasant feelings and help to lower stress (Ulrich 1983, 1986). More developed scenes, such as urban environments or interiors, do not have the same positive effects and can even increase stress (Ulrich 1983, 1986). This research, along with the work of others (Kaplan and Kaplan 1989) points to the restorative benefits of natural settings, including forests.

People code their responses to an environment with an affective response (Kaplan and Kaplan 1982). Some environments are perceived as positive and others as negative. Further, people can develop an emotional attachment to places including forests and other natural areas (Ryan, 2000, 2005; Schroeder 2002). Forests are perceived as special places across a wide range of geographic settings from urban forests to wilderness areas. The aesthetic beauty of forests is one aspect of why people consider the forest to be a special place. Schroeder (2002) found that for visitors to forests in the Great Lakes region, "the experience of beauty went beyond pretty scenery to involve a deeper emotional response to the aesthetic character of the setting" (p. 12). Forest planners and managers need to understand that the public may have strong emotional connection to particular areas within a forest, which may be significantly altered by fuels management.

This section has shown that researchers have used a variety of approaches to study landscape preference and visual quality. Each of these theoretical frameworks has been backed by a large number of empirical studies. The next section will synthesize the results of these studies as they apply to forest aesthetics. Because few studies have looked explicitly at the visual impacts of fuels reduction treatments, this review will focus on the broader topic of forest aesthetics and timber management. In many instances, fuels reduction treatments such as thinning, salvage logging, and fuel breaks fall under the larger rubric of timber management.

Landscape Preference in Forested Ecosytems: Research Findings

General Landscape Preferences

One landscape preference issue that researchers initially grappled with was generalizability. Does visual preference for natural landscapes vary widely by individual background, cultural differences, or upbringing? Many landscape preference studies have shown striking uniformity in the type and composition of landscapes people find visually appealing and those they do not (Daniel 2001, Gobster 1994, Kaplan and Kaplan 1989, Kaplan *et al*. 1998, S. Kaplan 1987, Ribe 1989). Moreover, these general findings have been relatively consistent across many different forest ecosystems in North America and Europe where most of the research has been conducted. As summarized by landscape architect Paul Gobster (1994), there are four common aspects of visually preferred settings:

1. Large trees
2. Herbaceous, smooth groundcover
3. Open midstory canopy with high visual penetration
4. Vistas with distant views and high topographic relief

Many studies have shown that people prefer large mature trees (Brown and Daniel 1986; Cook 1972; Haider 1994; Haider and Hunt 2002; Herzog 1984, 1988; Ribe 1990; Schroeder 1989; Schroeder and Daniel 1981; Silvennoinen *et al*. 2001). Likewise, forests with many closely spaced small trees often receive lower scenic ratings (Brown and Daniel 1986). For example, Schroeder and Daniel (1981) found the number of large ponderosa pine trees (greater than 16 inches diameter at breast height) had a significant positive impact on scenic beauty ratings. Although the definition of mature trees varies by forest type, these research findings strongly suggest the importance of retaining some larger trees in fuel hazard reduction projects.

Landscapes usually considered less visually appealing are wide-open areas with uniform or monotonous vegetation. Conversely, extremely dense vegetation, especially at eye

__Dense vegetation lowers scenic beauty.__ High density forest stands, such as this ponderosa pine and oak woodland in the low elevations of California's Sierra Nevada Mountains, are typically perceived to be low in visual quality and yet are high in hazard fuel danger. Note that the area in the foreground has already been cleared as part of hazard fuels mitigation near the Crescent Cove picnic area in the Stanislaus National Forest.

level, also is not preferred (Kaplan and Kaplan 1989, Kaplan *et al.* 1998). In forestry terms, areas with low visual quality would include wide-open areas caused by extensive clearcuts or windthrow and forests with dense, even-aged tree stands as characterized by early stages of regeneration after timber harvest (Anderson 1978, Brush 1979, Magill 1994). However, some types of timber harvesting that involve selective cutting and thinning can actually improve visual quality.

Visual Access

The amount of visual access, or how far one can see into a forest, also has been found to be a significant predictor of landscape preference (Gan *et al.* 2000, Herzog and Leverich 2003, Ruddell *et al.* 1989). The importance of a more open forest composition has been found in studies that have correlated scenic beauty with actual physical characteristics of the forest by using Daniel and Boster's (1976) psychophysical model (Brown and Daniel 1986, Patey and Evans 1979, Ribe 1990, Ruddell *et al.* 1989, Schroeder and Green 1985), as well as studies using a more cognitive or psychological approach (i.e., Herzog and Kropscott 2004, Herzog and Leverich 2003, Kaplan and Kaplan 1989, Ruddell and Hammitt 1987). In other words, there is a strong inverse correlation between tree stand density and scenic beauty. As the density of smaller trees increases, visibility and scenic beauty decrease (Brown and Daniel 1986, Buhyoff *et al.* 1986, Ribe 1990, Ruddell *et al.* 1989, Silvennoinen *et al.* 2001). However, the relationship between tree density and scenic quality is not a simple mathematical equation but is influenced by the composition of the forest (Kaplan and Kaplan 1989). For example, forest stands with a variety of tree sizes and ages can often have a higher density of trees without lower scenic quality (Buhyoff *et al.* 1986, Hull *et al.* 1987). In fact, an increase in the number of larger trees is often associated with an increase in scenic beauty ratings (Silvennoinen *et al.* 2001). The key factor is the amount of visual access (R. Kaplan 1985a).

Visual access in forest settings also is an important part of legibility, and a good predictor of visual preference.

One study of pine and oak forests in east Texas found that the ability to see into a forest is a stronger predictor of scenic beauty than other physical measures of the forests, such as number of downed trees and number of small trees in the stands (Ruddell *et al.* 1989). Similar results were found in a more recent study of loblolly pine regeneration in the Southeastern United States (Gan *et al.* 2000) where the most preferred scenes were those of a mixed-aged stand with good visual penetration. Visual access in forest settings also is an important part of legibility, and a good predictor of visual preference (Herzog and Kropscott 2004, Herzog and Leverich 2003).

Openings in an otherwise enclosed forest are often perceived to be aesthetically pleasing (Brush 1976, 1979; Kaplan *et al*. 1989). Likewise, many people prefer the forest edge adjacent to meadows and other small openings, which has ramifications for forest thinning and harvesting and for fuels modifications along trail corridors (Brush 1979, Ruddell and Hammitt 1987).

Small openings in the forest with scattered trees are visually preferred. *This scenic open meadow was the result of a wildland fire in the Santa Fe National Forest of New Mexico. The same effect can be created through fuels mitigation projects that clear small forest stands and brush.*

Being able to see longer distances increases users' perceptions of safety, particularly in urban forests (Nasar *et al*. 1988, Schroeder and Anderson 1984, Talbot and Kaplan 1984), while dense vegetation, along with other signs of neglect such as litter and graffiti, often increases the public's perceptions that an area may be unsafe (Schroeder and Anderson 1984; Yokohari *et al*., in press).

The only situation where dense trees are more visually preferred is when forests are viewed from lakes and other waterbodies. In two separate Canadian studies, denser forests along shorelines received higher preference ratings than more open forests (Haider and Hunt 2002, Miller 1984).

Forest Composition

Some research suggests that certain ecosystem types are visually preferred over others and that these preferences are irrespective of the biodiversity or ecological health of the system (Haider 1994, Kellomaki and Savolainen 1984, Sinton and Giner 1979). In a study of shoreline forests in northern Ontario, Haider and Hunt (2002) found that red and white pine ecosystems and hardwood-dominated ecosystems were preferred over other boreal species, including jack pine and black spruce. Other studies in northern hardwood forests have found that small stands of distinctive trees such as aspen or birch are visually preferred (Kearney 2001, Kellomaki and Savolainen 1984, Ribe 1990, Silvennoinen *et al*. 2001). Other researchers have found that shrub-dominated wetlands and marshes are perceived to be less visually pleasing than water-dominated ecosystems or even forests (Ellsworth

1982; Hammitt and Cherem 1980; Ryan 2000, 2005). Drier, more scrubby appearing forests also are often perceived to be of lower visual quality than more lush appearing forest (Williams and Cary 2002). Within a particular ecosystem type, there also can be variation based upon forest composition. For example, studies have shown that people prefer mixed-aged forest stands more than even-aged pine plantations (Gan *et al*. 2000). These insights can be useful for wildland managers who need to understand the baseline visual preference for the particular ecosystem in which they are working.

Forests that have larger numbers of herbaceous plants on the ground level are more preferred (Brown and Daniel 1986, Ribe 1990, Schroeder and Daniel 1981). This is especially true if the ground vegetation is lower and smoother appearing (Kaplan and Kaplan 1989, Kaplan *et al*. 1998). In some instances, fuels reduction such as in prescribed burning can increase the number of low herbaceous plants that are part of these visually preferred settings (Patey and Evans 1979, Ribe 1990, Taylor and Daniel 1984).

In many instances, forests with larger trees, lower understory, and good visibility are old-growth forests (Haider 1994, Ribe 1990), which suggests there may be some visual preference reasons, in addition to ecological reasons, for the public's demands to preserve old-growth areas.

Topography

Many studies have shown that people find vistas with varied topography, such as mountains, to be scenic (Gobster 1994, Haider and Hunt 2002, Kaplan and Kaplan 1989, Zube 1976). In fact, the expert-based visual resource management approaches, such as the Scenic Management System (USDA Forest Service 1974, 1995) and the Visual Resource Management System (USDI Bureau of Land Management 1980), give high scenic ratings to areas based upon slope and topography. Topography also provides a challenge for visual resource management because hillsides and steeper areas are more visible from different vantage points. Thus, forest management activities, such as thinning and clearcuts that change the landscape significantly are more obvious than they would be in flatter areas (Bradley 1996, Palmer *et al*. 1993). Heavy erosion caused by heavy logging on steep slopes also is perceived negatively, which suggests an interaction between perceived ecological health and aesthetics (Magill 1994).

Heavy erosion caused by heavy logging on steep slopes also is perceived negatively, which suggests an interaction between perceived ecological health and aesthetics.

Landscape Change and Aesthetics

Natural Disturbance

In general, natural forest disturbances that result in extensive areas of dead or dying trees (Haider and Hunt 2002, Ribe 1990), such as the destruction of the forest by fire or flooding, are perceived negatively (Daniel 2001; Fanariotu and Skuras 2004; Gobster 1994, 1995). For example, unburned pine forests receive higher ratings on scenic quality than burned areas (Scott 1998, Taylor and Daniel 1984). Insect-damaged forests received negative ratings, especially when survey participants were informed beforehand of the cause of the deforestation and leaf-color change (Buhyoff *et al*. 1979, 1982; Hollenhorst *et al*. 1993). However, natural disturbance that is less severe, such as less intense fires that burn the understory but do not kill mature trees, often creates more preferred forests, especially over time (Patey and Evans 1979, Taylor and Daniel 1984).

Photo credit: V. Sturtevant

In general, disturbances such as wildland fire that result in extensive areas of dead or dying trees are perceived as having a negative impact on visual beauty.

Human Intervention

Many early visual preference studies found that people generally prefer more natural, unbuilt settings to developed areas such as urban settings (Kaplan and Kaplan 1989, Kaplan *et al*. 1972, Orland 1988, Zube 1976). In fact, one study showed that simply labeling a scene as human influenced, such as “tree farm” versus “forest growth,” lowers landscape preference ratings (Hodson and Thayer 1980). However, human development of the landscape is not always perceived negatively. Pastoral farming scenes receive some of the highest preference ratings (Brush 1979, Ryan 1998, Schauman 1988).

Human development in more natural forested settings has received mixed reactions. Smaller buildings and other improvements, such as boardwalks, perceived to be compatible with the natural setting actually increase visual preference in many natural areas (Hammitt 1981, Kaplan and Kaplan 1989, Kaplan *et al*. 1998). In fact, the presence of a few homes at the wildland-urban interface did not lower scenic ratings for forested scenes in the Colorado Front Range (Vining *et al*. 1984). However, the same study showed that, as perceptions of housing density within forested subdivisions increased, scenic ratings decreased. Similar findings also have been found in more open grassland areas (Orland 1988).

New roads that are part of logging operations or other construction activities are perceived negatively especially in hilly topography where road cuts are more evident (Bradley 1986). However, scenic forest roads designed to fit into the natural topography and landscape are often highly rated, depending upon the visual quality of the adjacent landscape (Kaplan 1977).

Forest management has received mixed results in impacting the visual quality of the landscape. Early studies suggested that managed forests where trees have been removed or thinned are preferred to unmanaged, densely stocked forests (Brush 1979, Patey and Evans 1979). Furthermore, in both urban and suburban settings, more managed or even park-like natural areas are preferred over those that appear wild, overgrown, or unmanaged (Bixler and Floyd 1997, Talbot and Kaplan 1984). However, as will be discussed in the following section, the visual impacts are strongly affected by the type and extent of timber harvesting, tree regeneration, ecosystem type, and amount of prescribed fire.

Timber Harvesting and Thinning

Researchers have focused their efforts on studying the effects of timber harvesting, particularly clearcutting, on scenic values, rather than directly on fuels management. These studies are relevant for fuels management because many fuels reduction activities include thinning forests, removing ladder fuels, salvage logging after wildland fire, and harvesting trees to create fire breaks. Not surprisingly, most studies have found that clearcuts lower scenic beauty, especially when contrasted with more natural areas (Brown and Daniel 1987, Brunson and Shelby 1992, Brush 1976, Magill 1994, Pings and Hollenhorst 1993). Furthermore, as the percentage of clearcut increases, scenic ratings or visual quality decreases (Brunson and Shelby 1992, McCool *et al*. 1986, Palmer *et al*. 1993, Paquet and Belanger 1997, Pings and Hollenhorst 1993, Ribe 1999, Vodak *et al*. 1985). However, the visual impacts of clearcuts and other timber harvesting vary by the size, shape, and location of the forestry activities.

These studies are relevant for fuels management because many fuels reduction activities include thinning forests, removing ladder fuels, salvage logging after wildland fire, and harvesting trees to create fire breaks.

One study that simulated different clearcutting alternatives in the White Mountain National Forest of New Hampshire found that midsized clearcuts (10-14 acres) were preferred to either large clearcuts or many smaller, concentrated cut areas (Palmer *et al*. 1993). Furthermore, "recent clear-cuts in the middle-ground have less scenic impact the farther away they are from the viewer" (Palmer *et al*. 1993: 86). In general, scattering clearcut areas across the larger landscape is preferred over concentrating clearcuts (Bradley 1996, Brush 1979, Palmer *et al*. 1993, Schuh 1995). Again, location matters: the more distant the clearcut the less negatively it is perceived (Bradley 1996, Miller 1984). Small clearcuts that had timber slash removed were perceived to be more scenic than an unthinned stand in one study in Finland (Tahvanainen *et al*. 2001).

This shaded fuel break near Roslyn, Washington illustrates how tree thinning can have a positive impact on scenic beauty. Researchers have yet to determine how much thinning can occur before scenic beauty is compromised.

The results of these studies suggest that, in visually sensitive areas, minimal harvesting should be practiced. However, in moderately sensitive areas, researchers have found that partial clearing of up to 50 percent of trees, using silviculture practices such as shelterwood cuts, crop trees, and thinning, may be visually acceptable (Paquet and Belanger 1997, Pings and Hollenhorst 1993, Vodak *et al*. 1985). One study in the Pacific Northwest found that, when only minimal numbers of trees were retained for ecosystem management goals (e.g., 85 percent tree removal), the public perceived this management technique as negative as clearcutting (Ribe 1999). Another study found that, while old-growth forests were perceived as most scenic, patch-cuts that removed approximately one-third of the trees were also judged to be acceptable (Brunson and Shelby 1992). However, even if judged acceptable, even minimal clearcutting can lower visual quality (Paquet and Belanger 1997).

In contrast to clearcutting and other harvesting of large numbers of mature trees, tree thinning has a much more positive impact on scenic beauty, especially when smaller trees are removed to lower stand density (Hull and Buhyoff 1986, Tahvanainen *et al*. 2001). Researchers have grappled with the issue of how much tree thinning or harvesting can occur before scenic beauty is compromised. Studies have compared scenic beauty ratings to the residual basal area per acre after tree thinning. Target levels to retain scenic beauty have varied by forest type. For example, in a study of southern pine stands, Hull and others (1987) found that older tree stands were considered more scenic and could accommodate a greater tree density up to a maximum of 180 square feet of basal area per acre. In eastern hardwood forests, Vodak and others (1985) recommended thinning to 75 square feet of basal area per acre to maintain scenic beauty. As might be expected, studies in the arid Southwest found much lower basal areas to be considered scenic (Schroeder and Daniel 1981).

Brush clearing also can improve scenic beauty ratings. Patey and Evans (1979) found that visually preferred sites in eastern Tennessee hardwood forests had only 10 percent of the herbaceous stems per acre as less preferred sites.

Photo credit: V. Sturtevant

Residual woody debris is one of the most significant predictors of negative perception of scenic beauty. The slash from this fuels treatment on the Colville Reservation in Washington has been piled for burning.

Rather than recommending specific volumes of wood to remove from a particular forest type, the research findings suggest that forest managers need to look at the existing forest type and stand volume. In general, thinning of up to 25-30 percent of dispersed basal area has been found to have moderate impacts on scenic beauty ratings (Paquet and Belanger 1997; Pings and Hollenhorst 1993; Ribe, in press; Vodak *et al*. 1985). It may be possible to thin up to 40-50 percent of a stand area, especially if larger trees are retained (Buhyoff *et al*. 1986, Paquet and Belanger 1997, Pings and Hollenhorst 1993, Ribe 1989, Vodak *et al*. 1985). Unfortunately, fuel thinning projects may have to rely on the sale of larger timber to fund thinning of smaller diameter trees, but the removal of large trees can have a negative impact on a forest's scenic beauty. The shape of the harvest unit also affects visual preference: rectilinear or straight-edged harvest units are perceived more negatively than those with more natural edges (Bradley 1996, Schuh 1995). Harvest units that blend into adjacent natural areas and mimic natural clearings or balds are perceived much more positively by the public (Bradley 1996, Karjalainen and Komulainen 1999, Palmer *et al*. 1993).

Topography also has a major impact on visual quality of timber management. Timber harvests on steep terrain, especially cutting below where people are viewing the forest, are particularly visible and perceived negatively. Tree harvests along ridgelines that create obvious breaks in the treeline are also perceived negatively (Bradley 1996, Karjalainen and Komulainen 1999, Schuh 1995).

Downed Wood

The public's perceptions of timber harvesting are negatively affected by the residual woody debris such as slash. Many studies using the psychophysical approach have shown that the amount of dead woody material is often one of the most significant predictors of negative scenic ratings for forest scenes, regardless if the tree mortality is caused by logging or natural forces (Arthur 1977, Brown and Daniel 1986, Haider 1994, Haider and Hunt 2002, Hull and Buhyoff 1986, Pings and Hollenhorst 1993, Ribe 1990, Schroeder and Daniel 1981, Vining *et al*. 1984, Vodak *et al*. 1985). In a study of timber cutting in upstate New York, Echelberger (1979) found that the degree of orderliness of timber harvesting (i.e., amount of

Timber harvests on steep terrain, especially cutting below where people are viewing the forest, are particularly visible and perceived negatively.

residual material) appeared to influence visitors' impressions of timber harvesting regardless of the type of practice. However, the specific volume of downed wood associated with less scenic forests varies by forest type and is not specifically reported in many studies. Studies do report that the greater the volume of large downed wood, the greater the impact on scenic beauty. Visible tree stumps from timber harvesting are also disliked (Daniel and Boster 1976 c.f. Ribe 1989). Thus, foresters should consider post-harvest cleanup as an essential part of the harvest in visually sensitive areas.

It is important to remember also that the scenic impacts of timber slash are only temporary and must be weighed against other management objectives (Brush 1979, Vodak *et al*. 1985). As found in a study of timber management in loblolly pine stands by Hull and Buhyoff (1986: 284), "the initial negative scenic impacts of thinning caused by the accumulation of down wood can be offset by the later positive scenic impacts caused by the decrease in stand density." Thus, removing slash through chipping, mulching, or piling and burning can be an effective way to reduce woody debris (Ribe 1989). This is especially important in more arid regions where decomposition and growth of new vegetation occur much more slowly to aid in hiding slash than in more humid regions.

Tree Regeneration

Focus groups with local citizens have found that clearcuts are perceived negatively many years after logging (Schuh 1995). Furthermore, other studies have found that recent clearcuts are perceived more negatively than areas with new tree regrowth (Magill 1994, Palmer *et al*. 1993). In some instances, once a cutover area has greened-up through new grass and shrub revegetation, visual appreciation increases, especially if this regrowth is perceived as a meadow or other natural condition (Anderson 1978, Magill 1994). Again, the more mature the new stand of regenerating forest, the more the increase in visual preference (Magill 1994, Palmer *et al*. 1993, Paquet and Belanger 1997). Unfortunately, it can take quite a long time for a forest to look mature which means the negative visual impacts may last quite awhile (Daniel 2001). In fact, one study in eastern hardwood forests found that the time after clearcutting, even up to 25 years of tree regeneration, had no significant impact on scenic ratings (Pings and Hollenhorst 1993).

It is important to remember also that the scenic impacts of timber slash are only temporary and must be weighed against other management objectives.

Increasing the time between thinning rotations may improve scenic beauty by allowing more large mature trees to develop (Hull and Buhyoff 1986, Hull *et al*. 1987). However, rapid tree regeneration of many small trees and shrubs, especially after thinning, can also negatively impact scenic beauty. For example, in eastern hardwood forests, tree thinning can result in rapid growth of new trees and shrubs that block visual penetration, which is less preferred (Brush 1976). This suggests that management may need to adapt to the actual speed and location of new growth and be modified for fuels reduction and visual quality accordingly.

The public often perceives forest management that is not scenic to also reflect poor management or ecological health (Nassauer 1995, Ribe 2002). However, in some instances, clearcuts and severe burns that open up large areas of early successional vegetation actually increase biodiversity of particular species such as birds (Botkin 2001).

Prescribed Fire and Fuels Reduction

Prescribed fire is one of the central management techniques in reducing fuel loads and restoring ecosystem health (Pyne 2003, Turner *et al*. 1994). However, few studies have looked directly at the visual impact of fuels reduction and related ecosystem management tools. While prescribed burning can mimic natural disturbance, like a wildland fire it can leave a forest blackened and charred and is perceived negatively by the public (Gobster 1999, Scott 1998, Taylor and Daniel 1984). Even low-intensity prescribed fire to

Managing prescribed fire and visual quality. *Low-intensity prescribed fire, such as this one in Yosemite National Park, can help restore native ecosystems, but may lower scenic beauty ratings until the burn area has greened up (below). Also note that scorched trunks, such as those shown in the closeup photograph (right), will also lower scenic ratings of the forest.*

clear understory vegetation can leave scorched earth and charred trunks. The long-term remnants of fire, such as scorched trunks, are perceived negatively long after the rest of the forest has greened up (Brush 1979, Cotton and MacBride 1987; Scott 1998). This is especially true with more severe fires that may kill more of the overstory trees (Taylor and Daniel 1984).

The target ecosystem of prescribed fire and fuels management may be one that is more preferred once the visual signs of burning have been masked by new vegetation. For example, in a study of visual preference for a range of northern hardwood ecosystem types, Ribe (1990) found that the oak savanna maintained by prescribed fire received the highest scenic ratings. Patey and Evans (1979) also found pine and hardwood forests in eastern Tennessee that were managed by prescribed fire to be preferred over unmanaged forests. Taylor and Daniel (1984), in a study in the ponderosa pine ecosystem of northern Arizona, found that low-severity fires actually increased scenic beauty ratings, especially a year or two after the fires, but high-severity crown fires decreased them. These researchers attributed this to the fact that prescribed fire cleared out some of the dense understory vegetation, opened up views into the forest, and increased the herbaceous ground cover. Many similar fire-dependent ecosystems that create open forests or savannas are also highly visually preferred (Kaplan and Kaplan 1989, Patey and Evans 1979, Scott 1998).

The short-term scenic benefits of prescribed fires also were found in an earlier study in ponderosa pine that looked at the scenic impacts of burning slash after forest thinning (Anderson *et al*. 1982). The study found that, initially, the forest treated with prescribed fire was perceived more negatively than the area in which the dead wood and slash were allowed to remain on the ground. The clearing and prescribed fire removed 44 percent of all woody material on the experimental site. However, after one growing season, the burned site was rated to be much more scenic than the control plot with its remaining woody debris. At the end of the 5-year period, the two sites were rated virtually equal in appearance. This study showed that prescribed burning of slash can increase scenic beauty in the short term by removing woody debris, which is considered unsightly by forest visitors, and by enhancing regeneration of the understory. However, prescribed fire must be thorough enough to remove dead woody debris. A study in Montana found that partially burned woody slash lowered scenic beauty ratings up to 15 years after timber harvesting because the larger

A study in Montana found that partially burned woody slash lowered scenic beauty ratings up to 15 years after timber harvesting because the larger woody debris had not decomposed yet, while areas where dead woody debris had been removed after timber harvesting received more positive scenic ratings.

woody debris had not decomposed yet, while areas where dead woody debris had been removed after timber harvesting received more positive scenic ratings (Benson and Ullrich 1981).

In one of the few studies that compared the fuels reduction, economic costs, and aesthetic perceptions of fuels reduction treatments, Scotts (1998) found that the minimal impact treatment (i.e., light thinning from below with slash piled and burned) was the most aesthetically preferred in ponderosa pine forests. Revenue production (i.e., moderate thinning of mature, commercial-grade trees) produced the most income, reduced fire hazard, and received moderately high aesthetic ratings. Forest restoration treatment (i.e., light thinning and wholesale prescribed burn) was the most effective for reducing fire hazard, but rated lower aesthetically due to fire scars. Interestingly, the untreated forest stands received only mid-level aesthetic ratings, which further supports the notion that fuels management can increase scene beauty ratings. The aesthetic consequence of not managing fuel loads was very apparent in this study; a control area burned by wildland fire and then salvage logged received the most negative aesthetic ratings. This study also is important because it found that fuels reduction could generate income as well as improve forest health. An earlier study by Brown (1987) also suggested that retaining some herbaceous ground cover by restricting grazing may be a more cost effective way to promote scenic beauty than not harvesting commercial-grade trees.

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Tree harvesting and other fuels management operations may have other positive economic impacts. One study of small residential properties in the Lake Tahoe basin of Nevada and California found that tree thinning was associated with increased property values (Thompson *et al*. 1999). The reason for this may be that tree thinning increases aesthetics and lowers fire risk.

Work with the Public

The Importance of Context in Fuels Management

The public's response to any new natural or human-created disturbance to the forest will depend upon the surrounding context (Brunson 1993, Kneeshaw *et al*. 2004, Wohlwill 1979, Wohlwill and Harris 1980). A clearcut within an industrial forest will be perceived much differently from a clearcut in an old-growth forest. Murtha and Greco (1975) outlined five different forest types or systems that will affect aesthetic values:

1. fiber forestry—trees as a crop, often in geographically remote areas
2. agricultural forestry—trees within an agricultural matrix of fields and crops, including windbreaks and woodlots
3. recreational forestry—trees as a landscape within which recreation takes place
4. urban/suburban forestry—trees as an amenity where aesthetic values are at a premium
5. general forestry—forests that may combine a range of the above four types

Forest ownership is another important contextual issue. Small private landowners who hold the majority of forested land in some regions, such as the Eastern United States, are often more concerned about aesthetics rather than economic gain (Jones 1995, Ryan *et al*. 2002). This also is true for landowners, such as farmers who own woodlots and windbreaks the Midwestern United States (Erickson *et al*. 2002, Ryan *et al*. 2002).

Fuels management near where people live or recreate will heighten scrutiny for management activities (Brunson 1993, Kneeshaw *et al*. 2004). Research has shown that people are especially fond of natural areas, particularly those near their homes or those that are more familiar (Kaplan *et al*. 1998, Ryan 2002, R. Kaplan 1985b). In fact, residential satisfaction surveys have found that having nature near one's home is extremely important in where people choose to live (Kaplan *et al*. 2004, Kearney 2002, Marans and Vogt 2001, Ryan 2002). This is especially true at the wildland-urban interface where some of the most serious fuels management must occur and where managers face the strongest opposition to management practices the public considers to lower the visual quality of the forest (Shelby *et al*. 2004).

Expertise and Environmental Attitudes

Researchers have found that environmental attitudes and expertise can affect landscape preference. In particular, people with different levels of natural history knowledge, environmental expertise, or even environmental attitudes generally agree about which places are extremely scenic (Kaplan *et al*. 1989, Kaplan and Herbert 1987, Ribe 2002, Ryan 2000, Zube 1976). However, groups do differ about landscapes that are less beautiful, such as those that exhibit more human intervention like timber harvesting, or that appear drier, scrubbier, or rougher (Orland 1988, Williams and Cary 2002). Expertise allows people to distinguish nonnative vegetation such as pine plantations from other natural areas and subsequently rate them lower for scenic value (Kaplan and Herbert 1987). In most instances, scenes such as

In particular, people with different levels of natural history knowledge, environmental expertise, or even environmental attitudes generally agree about which places are extremely scenic.

Photo credit: P. Jakes

Fuels management near where people live will be more highly scrutinized and calls for increased care.

clearcuts are rated low on scenic beauty by both professional foresters as well as environmentalists, but professionals often rate such scenes higher than any other group, including the general public (Anderson 1978, Magill 1994, Ribe 2002). Furthermore, many professional foresters or those who favor resource production find clearcuts and other intensive timber practices to be more acceptable than the general public or environment advocates (McCool *et al*. 1986, Ribe 2002). These same differences between experts and nonexperts appeared in a study of urban forests where the invasive understory shrubs had recently been cleared to increase ecological health and appeared messier because of the woody debris. Those with more natural history knowledge rated scenes of this type of ecosystem management higher than the general public (Ryan 2000, 2005).

Thus, it is important that forest managers not rely on their own standards of what is aesthetically pleasing, because those standards may not reflect those of the public (Anderson 1978, Andersson 1994, Arthur 1977, Haider 1994, Kaplan *et al*. 1998, Ribe 2002, Zube 1976). Those with strong environmental protection attitudes may have a higher standard for acceptable forest beauty. However, "managers should also not assume that they must always meet the high scenic beauty standards of acceptable management advocated by resource protection constituencies. Other constituencies will accept somewhat lower levels of beauty" (Ribe 2002: 776 c.f. Magill 1992).

Providing ecological information about ecosystem management increased acceptability ratings by office workers and decreased the ratings by college students.

Expertise also comes in the form of local knowledge (Kaplan *et al*. 1998). Local residents who have engaged in ecological stewardship, such as promoting native plant material, may be more amenable to ecosystem management. In a study in Australia, Williams and Cary (2002) found that landowners who engaged in biodiversity protection activities gave higher ratings to all native landscapes, even those that were generally less preferred, such as Casuarina woodlands that appeared dry, twiggy, and fire-damaged. In many instances, the public preferred landscapes such as open or grazed woodlands that were rated lower for ecological quality by expert ecologists. For forest managers, it would be interesting to know how to create a more informed appreciation for ecologically diverse, but visually less appealing ecosystems.

The Role of Information

Forest planners and managers have often relied on environmental education to inform and convince the public about particular forest management decisions. "Managers are often more intent on changing public opinion than management practices; both are required" (Magill 1992). Research has shown that information can have a positive impact on attitudes and visual preferences (Anderson 1981, Buhyoff *et al*. 1979, Hodgson and Thayer 1980, Kearney 2001, Ribe 1999). However, the public's visual preferences are often very resistant to change (Daniel 2001), which suggests that conveying environmental information in a readily understood and accepted manner is a complex task and is affected by the existing information and values that people have (Brunson and Reiter 1996, Kaplan *et al*. 1998, Tindall 2001)

Several researchers have looked specifically at how providing information about ecosystem management affects landscape preference and aesthetic appreciation. Kearney (2001) found an increase in acceptance and visual quality ratings for clearcuts in upper midwestern forests when the public was shown pictures of the resulting ecosystem that benefited birch and jack pine regeneration. Likewise, a study in the Pacific Northwest by Ribe (1999) found that providing information about the ecological benefits of minimal green-tree retention cutting increased the public's acceptance for photosimulations of this silviculture practice. However, in this study, information increased acceptance for this practice, but not, scenic beauty ratings. In other words, acceptance for ecosystem management may be influenced by ecological information, while visual preference is more resistant to change.

When scenes were labeled as "wilderness area" or "national park," they received higher scenic ratings, and when the same scenes were labeled as "leased grazing areas" or "commercial timber stands," they received lower ratings.

An earlier study by Taylor and Daniel (1984) about the effects of prescribed fire on scenic beauty supports this notion that visual preference is difficult to change. This study in the ponderosa pine forests of northern Arizona found that providing information about the benefits of prescribed fire did not increase scenic beauty ratings or recreation acceptability ratings for burned forests. However, the study did find that providing educational information increased the public's acceptance of using prescribed fire to manage underbrush. Again, this study shows the visual impacts of fire may be too strong to overcome with information.

Brunson and Reiter (1996), who conducted a similar study about preferences for different timber harvesting practices in Douglas-fir forests of the Pacific Northwest, found that providing information about the ecological benefits had unintended consequences on scenic beauty ratings within different subgroups. Providing ecological information about ecosystem management increased acceptability ratings by office workers and decreased the ratings by college students. These authors suggest that information about ecosystem management needs to be written carefully to avoid miscommunication.

Educational activities such as this field trip can change attitudes about fuels management, but visual preferences are very difficult to change.

Photo credit: P. Jakes

When viewing management practices, the general public may not always reach the correct conclusions about the cause of the disturbance or the management intention. For example, Magill (1994) found that areas of natural disturbance were perceived to be the result of logging activity. In other instances, regeneration after harvesting when perceived as a natural meadow or young trees was perceived positively, but areas of clearcuts were perceived negatively. Anderson (1978) also found that clearcuts were perceived much more negatively than wildlife areas or abandoned farm fields. Miller (1984) found that local residents could distinguish clearcuts from natural balds in forested shoreline of British Columbia and perceived them more negatively than did tourists who could not distinguish the natural clearings from clearcuts.

Likewise, a study in a Maryland State park found that clearcuts were recognized more readily by local residents and by those with more knowledge about timber management (Becker 1983). However, unlike the study in British Columbia, those who recognized the clearcuts were actually more supportive of this type of timber management. The distinction appears to be that clearcuts in the Maryland example were very small, appeared irregular, retained some trees, and had 5 years of tree regeneration to hide the logging slash. Thus, the logging created the smaller forest openings that are generally appreciated (Brush 1976, 1979) more than entire hillsides of cutover areas.

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Buhyoff *et al*. (1979) found that giving people information about insect damage in southern pine forests lowered their preference for scenes that showed this damage. However, when no information was provided, the insect-damage scenes were actually rated higher, possibly because viewers liked the orange colors in the trees. Replication of this study in insect-damaged forests of the Colorado Front Range found similar results: moderately damaged forests were perceived neutrally or slightly more positively by uninformed viewers, but giving viewers information about the insect damage lowered scenic beauty ratings (Buhyoff *et al*. 1982). However, in areas with more spectacular mountain scenery and topography, insect damage had less negative influence, presumably because the dominant peaks and mountain ridges provided scenic value regardless of negative changes to the forest cover.

Unfortunately, ecologically healthy ecosystems and the processes to sustain them are not always perceived as aesthetically pleasing or even as good management by the general public.

Another study that looked at the visual impacts of gypsy moth infestation in eastern hardwood forests found similar results of providing information to viewers (Hollenhorst *et al*. 1993). To the uninformed viewers, scenes with low levels of gypsy moths and tree mortality actually were perceived as more scenic than those with no infestation. The researchers attribute this to the fact that small levels of tree mortality increased small forest openings, sunlight, and presence of flowering shrubs.

Viewers also may be informed about the management context and objectives. Anderson (1981) found that scenic beauty ratings for ponderosa pine forests were sensitive to land use labels. When scenes were labeled as “wilderness area” or “national park,” they received higher scenic ratings, and when the same scenes were labeled as “leased grazing areas” or “commercial timber stands,” they received lower ratings.

Development of an Ecological Aesthetic

Changes in forest management and biological sciences have led the USDA Forest Service and other government agencies to embrace ecosystem management as the latest over-arching approach to organizing, planning, and implementing management decisions. An important goal of ecosystem management is to integrate ecological principles, including the temporal aspects of nature, into management decisions. Fuels management, including reintroducing fire into the forest, can be an important step in restoring an ecosystem’s natural processes. Unfortunately, ecologically healthy ecosystems and the processes to sustain them are not always perceived as aesthetically pleasing or even as good management by the general public (Gobster 1994, 1995, 1999; Nassauer 1995, 1997; Ribe 1999, 2002; USDA Forest Service 1995, Williams and Cary 2002). Humans are visual creatures; we judge an environment by what we see (Kaplan and Kaplan 1989, S. Kaplan 1987). Furthermore, people’s aesthetic perceptions of the scenic beauty of the environment seem to be resistant to influence by intervention such as environmental education (Daniel 2001). USDA Forest Service landscape architect Paul Gobster (1994, 1995) argues that people's judgments about what is a healthy or beautiful landscape are culturally derived and are often based on a static view of landscape management. In fact, until the last 25 years or so, even ecologists tended to see the environment as "a steady state community" instead of one "characterized by change rather than consistency" (Botkin 2001: 112).

Gobster notes that managing forests to achieve aesthetic and ecological objectives can present some inherent conflicts (1994, 1995, 1999, 2001b). For example, in many ecosystems, fire is important for ecological health, but research shows that people do not like the visual impacts of fire. Likewise, dead and dying wood is important for forest health because it restores coarse organic matter to the soil and provides habitat, but large amounts of slash and dead trees lower visual quality (Gobster 1999). Many people dislike large-scale landscape change or disruption to the natural environment, which results in widespread areas of dead or downed trees, regardless of whether the changes are caused by humans, such as logging, or natural disturbance, such as wildfires. To try to reconcile these inherent conflicts, Gobster draws inspiration from the work of the renowned ecologist Aldo Leopold. "Leopold and others have detailed important differences between a forest esthetic based on scenic perspectives and one based on ecological perspective" (1995: 8). Gobster describes Leopold's ecological aesthetic as one informed by the knowledge of ecosystem health and processes. Appreciation of landscape change is an important part of this new aesthetic that would perceive natural processes as essential to ecosystem health. The ecological aesthetic also would translate into an appreciation for the more subtle beauty in landscapes such as prairies that may appear uniform or monotonous to the untrained eye. The role of education and information is central to this informed aesthetic (Nassauer 1997, Ribe 1999, Thayer 1989).

…"cues to care" can be used to visually inform people that native landscapes are being actively restored and managed.

These issues are particularly relevant for fuels management efforts, which are often characterized by conflicts between aesthetic and ecological objectives. Early studies of timber management (such as Echelberger 1979) suggested that public opinions about timber harvesting are strongly influenced by the degree of orderliness of harvesting activities, such as the disposal of woody debris and slash. Landscape architect Joan Nassauer's research (1995, 1997) in aesthetics, landscape ecology, and landscape design showed that such "messy" ecosystems do not always fit the public's perceptions of attractive or well cared for landscapes. From this perspective, although fuels management may be designed to improve forest health, this goal is not visually conveyed to the public because treatments often, at least initially, create a messier appearing ecosystem. Thus, to encourage ecological health and restore ecosystems within urban, suburban, and rural landscapes, planners and managers must frame these "messy" ecosystems with cultural cues that connote human intention. This is especially true when managed forests are adjacent to the wildland-urban interface or other high-use areas.

Nassauer (1995) suggested that these "cues to care" can be used to visually inform people that native landscapes are being actively restored and managed. This "vivid care draws attention to the human presence in healthy landscapes in order to sustain ecological health over time. Emphasizing a benign human presence protects ecologically rich landscapes from less intelligent human control." (Nassauer 1997: 77) Her research in the Midwest found that cues to care can include mowing the edges of grassland areas, planting flowering native plants, providing wildlife feeders, creating bold patterns in the land, trimming shrubs and plants, and adding fences or other architectural details. The goal behind Nassauer's approach is to increase the public's appreciation and aesthetic acceptance for native ecosystems. In her words, "perhaps the most powerfully omnipresent form of environmental education is simply viewing the landscape" (Nassauer 1997: 78). Thus, creating an ecological aesthetic will require moving the public's aesthetic appreciation closer toward one that recognizes and understands healthy ecosystem processes and appearance (see also Gobster 1994, 1995, and 1999). Management that conveys a sense of human intention and care within a forested landscape is part of this process of developing an informed aesthetic.

Visual Resource Management Approaches

Federal land management agencies, including the USDA Forest Service (1974, 1995), USDI Bureau of Land Management (1980), and USDA Natural Resources Conservation Service (formerly Soil Conservation Service 1978), have developed visual resource management systems to address the preservation and management of scenic resources (Smardon 1986). Each of these systems was developed in the late 1960s and 1970s by landscape architects and others to categorize the scenic quality of Federal land and to assess the visual impacts of new development including timber harvesting, mining, road building, resort development, and establishment of utility line corridors. The Forest Service's Visual Management System (VMS) and the Bureau of Land Management's Visual Resource Management (VRM) system have many similar components, and in fact, have borrowed ideas from one another, such as the classification of the landscape (Smardon 1986).

Photo credit: N. Lull

Visual resource management systems have been developed to assess the scenic impacts of different management actions, including harvesting to reduce fuels.

In contrast, the Natural Resources Conservation Service's Landscape Resource Management (LRM) system is designed more for rural and suburban landscapes and thus, takes a more landscape approach than a visual one (Schauman and Adams 1979, Smardon 1986). Another important difference is in the implementation of these visual resource management systems. The Natural Resources Conservation Service typically deals with private landowners in an advisory capacity, while the Forest Service and BLM manage publicly owned land (Smardon 1986). Although each of these systems has much to offer managers who are concerned about visual resource planning, for brevity's sake the following section will focus on the Forest Service system because it is designed specifically for forest management and is most applicable to fuels reduction strategies and wildland fire management.

The USDA Forest Service's Visual Management System (VMS)

The Forest Service has embraced scenic management in a systematic manner for the past three decades. Beginning in the 1970s, under pressure from the environmental movement and spurred by environmental legislation (e.g., National Environmental Protection Act, 1969), the Forest Service (1974: 2) introduced the Visual Management System (VMS) to classify and identify scenic resources and to provide management guidelines and "quality objectives for alteration of visual resources."

In 1995, the VMS was revised to take into consideration ecosystem management and was renamed the Scenic Management System (SMS) (USDA Forest Service 1995). For the most part, the landscape inventory process and classification system have remained the same, with minor modifications to the landscape objectives terminology. The most important revision in the 1990s was to classify landscape visual character along ecosystem type and to recommend more public involvement in determining scenic ratings. This new framework also acknowledged that scenic management does not always improve ecosystems, such as wildlife habitat, and ecosystem management does not always improve scenery. For example, removing trees to open up views may have negative impacts on particular ecosystems.

Under the VMS (and subsequent SMS, 1995), all national forest land was inventoried according to its landscape character type, which was related to the physical features of the landscape: "[a]n area of land that has common distinguishing visual characteristics of landform, rock formations, water forms and vegetative patterns." (USDA Forest Service 1974: 5). Examples of these larger landscape areas include the Columbia Basin and the Northeastern Cascade Mountains in the Pacific Northwest. These areas are further broken down according to smaller landscape sub-types, such as steep mountain lands and valley floors.

This new [visual management] framework also acknowledged that scenic management does not always improve ecosystems, such as wildlife habitat, and ecosystem management does not always improve scenery.

The scenic qualities of these landscapes are then ranked according to their attractiveness and integrity. This system recognizes that "scenic attractiveness, in its purest definition, exhibits the combined effects of the natural and cultural forces in the landscape" (USDA Forest Service 1995: 1-14). However, "generally, natural-appearing landscapes are most valued" (p. 29). This method of rating scenic attractiveness is based on an expert approach from landscape architecture and aesthetics that gives the highest rating to landscapes that have "the most positive combinations of variety, vividness, mystery, intactness, coherence, harmony, uniqueness, pattern and balance" (USDA Forest Service 1995: 1-15). Landscapes are ranked Class A-Distinctive, Class B-Typical, and Class C-Indistinctive. In general, this classification system gives higher rankings to more varied and steep topography, large water bodies and rivers, and more varied or unique vegetation types. Critics suggest that the VRM overemphasizes rugged, classically scenic mountain landscapes and underrates the importance of flatter, more homogeneous landscapes such as the forests of the Upper Midwest that are still highly valued by local residents for their scenic beauty (Kaplan and Kaplan 1989).

An important next step in the visual assessment process is to determine the degree of scenic integrity, the degree of alteration or modification of the landscape character. The scenic integrity levels range from very high, where the landscape is unaltered as in a wilderness setting, to unacceptably low where the landscape character is heavily altered, as in a large strip-mine. For example, a distinctive mountain range may have large areas of clearcuts at its base, which would lower its scenic integrity. The integrity levels provide a good basis on which to judge future management activities, including fuels reduction. For example, an area heavily altered through timber harvesting (low scenic integrity) may be appropriate for similar activities.

Determining the landscape visibility and sensitivity to alteration is the next stage in the scenic assessment process. In general, the greater the number of people likely to view a landscape and the longer the duration, the more sensitive the landscape is to modification. Of particular concern are travelways such as primary highways, trails, and waterways, as well as primary use areas such as campgrounds, visitor centers, and resort areas. Landscape visibility is affected by "1) context of viewers, 2) duration of view, 3) degree of discernable detail, 4) seasonal variations, and 5) number of viewers" (USDA Forest Service 1995: 4-2). For example, hikers on a wilderness trail expect a particular context unlike that expected by skiers on a chairlift. The proximity of the viewer to the particular landscape affects the visibility and sensitivity. Thus, the classification system also gives distance classes: immediate foreground (0 feet to 300 feet), foreground (300 feet to one-half mile), middleground (one-half mile to 4 miles) and background (4 miles and greater).

VMS and its more recent version, SMS, have several important implications for wildland fire and fuels management.

Another part of the process that is important in planning fuels treatments, is mapping areas that are seen from different travelways, use areas, and other vantage points. This may be accomplished manually through the use of USGS topographic maps, aerial photography, and extensive fieldwork, or it may be done by using Geographic Information Systems (GIS) and other computer software (Orland 1994).

Once the scenic inventory and assessment are complete, the SMS can be integrated with the forest planning process that includes ecosystem management goals and objectives. This includes evaluating the impact of alternative management activities on the desired landscape character of an area. In some instances, managers may want to maintain the existing landscape character in areas that are highly scenic and that already function well from an ecosystem perspective. In other instances, managers may want to move from an existing condition, such as an even-aged pine forest that has had a history of fire suppression, to one that is being managed with prescribed fire and thinning to achieve diverse forest ages and structures. This also may help reduce fuel loading and help manage wildland fire. An important part of this process is monitoring the landscape character and scenic quality as different management activities are implemented (USDA Forest Service 1995).

VMS and its more recent version, SMS, have several important implications for wildland fire and fuels management. First, scenic classification of existing forest land can help land managers determine the sensitivity of the resources to modification and the relative ranking according to these existing systems. In some cases, after major wildland fires, the degree of scenic integrity has been so lowered that the original scenic classification of a particular area may need to be revised downward. Managers should plan fuels management work within the framework of existing scenic classifications. These existing inventories and assessments help identify which landscape units are considered more scenic and which are more sensitive because of their proximity to travel corridors and use areas. As such, the visual resource inventory can provide a great starting point and a wealth of information for planning wildland fire and fuels management work.

Where existing forest plans have not completed or updated their scenic inventory maps, land managers may consider developing an inventory and assessment process using the SMS for the areas of their forest that will receive wildland fire management.

Many of the visual resource management systems, such as the VMS and the VRM, rely on experts such as landscape architects to assess and classify landscape scenery, often according to such criteria as form, line, color, and texture. Classification by landscape design features has been found to significantly predict scenic beauty ratings (Arthur 1977). However, research has found that the public does not necessarily classify the landscape according to the agency's land classification categories based on land use and land form (McCool *et al*. 1986; Kaplan and Kaplan 1989; R. Kaplan 1977, 1985a). In other words, the public may perceive an area to encompass several landscape units, or vice versa. Thus, forest planners and managers need to survey the public's preferences as a reality check for expert-derived scenic categories. It is hoped the final classification will be based on a combination of the two approaches that will improve the planning process and potentially improve public acceptance of management decisions. The developers of the updated SMS (USDA Forest Service 1995) have taken this recommendation to heart: the system emphasizes the need to survey the public as part of the visual resource assessment process and provides a good outline of research methods to approach this issue.

> ***… research has found that the public does not necessarily classify the landscape according to the agencys land classification categories based on land use and land form.***

Recreation Opportunity Spectrum (ROS)

In addition to preserving and managing visual resources, forest planners and managers must provide recreational opportunities for forest visitors. The Recreation Opportunity Spectrum (ROS) was developed to determine management objectives for particular recreation areas (Clark and Stankey 1979). The ROS "provides a framework which allows administrators to manage for, and users to enjoy, a variety of recreation environments" (USDA Forest Service 1986: intro.). The ROS sorts all Forest Service land into six classes based upon the physical setting (e.g., size, remoteness, evidence of humans); social settings (e.g., number and type of encounters with other users): and managerial setting (e.g., facilities) (USDA Forest Service 1995.). The six ROS classes are (1) primitive; (2) semi-primitive, nonmotorized; (3) semi-primitive, motorized; (4) roaded, natural appearing; (5) rural; and (6) urban. The physical settings range from isolated wilderness areas to those with trail or road access.

Managing wildland fire and fuels requires that forest planners are aware of the different recreation classes for a particular area.

The visual quality of the forest affects the recreation setting. For example, areas with more visual signs of human impact, such as timber harvesting, roads, and structures, fall into more developed recreation classes. The SMS and the ROS are in many ways complementary. For example, in a primitive area, scenic integrity objectives would be very high, while moderate objectives (i.e., visible modification of the environment) would be considered unacceptable (USDA Forest Service 1995, table F-2; USDA Forest Service 1986). Similarly, in a roaded natural area, moderate modifications such as campground development would be the norm.

However, the relationship between the ROS and SMS is not always straightforward. Research has found that the vast majority of forest recreationlists, regardless of activity, prefer scenic settings (Ribe 1994). Yet, in a statewide study of Minnesota forests, Freimund *et al*. (1996) found that, while more scenic forest lands were used more by recreationlists, less attractive areas were also heavily used because they were often closer to population centers.

Managing wildland fire and fuels requires that forest planners are aware of the different recreation classes for a particular area. Primitive settings will require a much more hands off approach than other settings. In some instances, fuels management can improve recreation opportunities. For example, forest thinning and prescribed fire can increase wildlife habitat by creating forest openings and grass habitat for certain species that are hunted, such as deer, elk, and game birds. In the same way, the early successional landscapes created by thinning and logging activities are important for wildlife viewing, one of the fastest growing recreational activities in forests (Gobster 2001a). In addition, opening up views along trails, especially in densely wooded even-aged timber stands can improve the scenery along trails (Kaplan *et al*. 1998, Ruddell and Hammitt 1987). However, research also has shown that depending upon severity, prescribed fire can have negative impacts on recreation, especially on camping and picnicking, being the most sensitive recreation activities (Taylor and Daniel 1984). This is especially true immediately after the fire, before the understory has regrown.

Strategies for Fuels Management and Visual Quality

This section presents strategies for planning and managing wildland fire and fuels reduction in a manner that is more responsive to visual quality. This section relies on the findings of empirical landscape preference outlined above as well as timber management guidelines for aesthetics developed for forest managers (e.g., Bacon and Dell 1985; Bradley 1996; Gobster 1994, 1995, 1999; Jones 1995; Tlusty and Bacon 1989; and USDA Forest Service 1995). Involving the public in management that impacts the visual quality of the landscape is essential since managers' opinions about aesthetic beauty may differ from those of the general public (Dearden 1981). Furthermore, the general public increasingly is less likely to trust managers to make decisions on their own and want to be more involved in forest planning (Shindler *et al*. 1996). The importance of collaboration in fuels management is covered in detail in another social science synthesis by Sturtevant and others (2005).

The following fuels management strategies are presented in sequential order from planning, to implementation, and finally to monitoring of fuels management projects.

Planning

Integrating visual resource management with ecosystem management is the focus of the SMS (USDA Forest Service 1995). Many researchers have called for incorporating aesthetics into ecological management by helping reveal and translate management practices in a manner that is understandable and acceptable to the general public (Gobster 1994, 1995; Magill 1994; Nassauer 1995). According to Cotton and McBride (1987: 35), "Aesthetic concerns should be addressed in selecting from among ecologically acceptable alternatives."

Develop a Multidisciplinary Team

Many of the characteristics of a visually preferred landscape can be natural byproducts of fuels treatments, but this requires a multidisciplinary team that can evaluate both the ecological (i.e., hydrology, soils, vegetation) and social impacts (i.e., economic, recreation, aesthetics). Design professionals such as landscape architects should be engaged in developing burn plans, as well as other aspects of forest planning (Cotton and McBride 1987, Lucas 1997, USDA Forest Service 1995). Fuels management should be combined with other management goals including aesthetics, recreation access, water quality protection and improvement, and wildlife habitat. For instance, "skid roads can be converted into a network of recreation trails, and

Fuels management should be combined with other management goals including aesthetics, recreation access, water quality protection and improvement, and wildlife habitat.

landings can provide new wildlife habitat" (Jones 1995: 14). Removing understory vegetation can open up and frame views from recreation trails and increase the scenic value of these areas.

Determine Landscape Units

Several visual resource management approaches suggest dividing the landscape into similar units for management purposes (Bradley 1996, Schuh 1995, USDA Forest Service 1995, USDI Bureau of Land Management 1980). Fuels managers should consider landscape type, such as vegetation (e.g., ponderosa pine versus oak woodland), topography (steep slopes, canyons, and plains), and visibility from travel routes, residential areas, and recreation areas. Studying the ecological history of a site, including the history of fire in the landscape, is critical to ecosystem management (Pyne 2003). Using ecosystem units can help to coordinate visual resource management and other ecosystem management approaches (USDA Forest Service 1995). Management zones also can be tied to particular goals (Kimmins 2002). For example, managing for wildlife and fuels reduction may require retaining larger trees, while managing for commercial timber would allow for retaining fewer trees in less visually sensitive areas.

Increase Landscape Diversity/ Regions

Management activities themselves will modify and create new landscape types. For example, prescribed fire may support pine regeneration and suppress certain hardwood species. Recreation research suggests that increasing the number of different landscape types will increase visual preference and perceptions that a trail corridor is more varied and provides more recreation opportunities (Axelsson-Lindgren and Sorte 1987). The pattern, location, and timing of different management regimes can increase variability, especially in forests dominated by an even-aged timber stand. In fact, the natural forest mosaic that results from a low-intensity fire can be mimicked by creating natural appearing, smaller clearcuts and thinned areas. Increasing the number of areas or regions within a larger landscape can increase visual preference if the new areas are coherently organized and few in number (Kaplan *et al*. 1998).

Fuels management can create a natural looking forest mosaic. *The forest mosaic created by a wildfire can be simulated by clearcutting smaller openings in the forest that have more natural boundaries. This scene shows private industrial forest land in the Sierra Nevada Mountains that was salvage logged and re-planted by the owner after the Darby Fire. This private land is interspersed with USDA Forest Service land that is part of the Stanislaus National Forest, California.*

Plan Location of Fuels Management

Because visual impacts are affected by the distance of the viewer from the area, fuels managers should consider if the proposed management will occur in the foreground (0 to one-half mile), middleground (one-half to 4 miles), or background (4 miles and beyond) (Bradley 1996, USDA Forest Service 1995). Visual impacts, such as clearcuts in the middleground in steep topography, are particularly apparent because, depending upon vegetation, more of the impacted area is visible.

Context is especially important in fuels management (Kneeshaw *et al*. 2004). As suggested by Bradley (1996), managers should focus their attention on the most visually sensitive landscapes. This includes areas that are visible from roads and trails, near homes and other developed areas, or adjacent to undisturbed or wilderness settings. Fuels treatments can be tailored to have less visual impact near residential areas by using such treatments as light thinning and burning of piles of slash (Scott 1998). More extensive thinning and burning may be best suited for public land more distant from developed areas (Scott 1998). Furthermore, the overgrown nature of many fire-suppressed forests will require the use of multiple tools for hazard reduction. In many high fuel areas, tree thinning may be the most appropriate practice until enough trees have been removed to make prescribed fire safe and effective (Bacon and Dell 1985, Pyne 2003).

Shaded fuel breaks can be high in scenic beauty. *This shaded fuel break near the perimeter of the Stanislaus National Forest provides a buffer for the nearby recreation and second-home community of Hathaway Pines, California. By retaining a large number of mature trees and removing most woody debris after thinning, this fuels mitigation project has created an aesthetically pleasing forest while lowering the fire danger at the wildland-urban interface.*

Create Natural Boundaries for Management Areas

Areas to receive fuels management should blend with those that are to remain undisturbed. Research suggests that rectilinear timber harvests and other obviously human-created boundaries are perceived negatively by the public (Bradley 1996, Palmer *et al*. 1993, Schuh 1995, Tlusty and Bacon 1989), except where forests are adjacent to historic agricultural areas such as hedgerows and tree breaks (Brush 1976, 1979). Thus, prescribed fuels management including prescribed fires and thinning operations should blend naturally in more organic-shaped units.

Site Roads and Fire Breaks Carefully

For aesthetic purposes, fire breaks should be avoided on midslope conditions. Although in steep terrain fire breaks are traditionally built on ridgetops, if possible these might be avoided in areas where they are visible from higher overlooks or mountain areas. Shaded fuel breaks are one way to retain larger trees, yet reduce fire hazard near wildland-urban interface areas. Access roads for tree thinning also should be screened or located at the bottom of slopes.

Use Visual Assessment Tools

The visual assessment approaches described earlier in this paper, including the SMS (USDA Forest Service 1995), can be used to model impacts of fuels management and devise alternative scenarios as part of the planning process. Research suggests that, in hilly terrain, slope and aspect are important influences on the amount of landscape and disturbed area that may be visible to the public (Bergen *et al*. 1995, Bradley 1996). Geographic Information Systems (GIS) can be used to map the areas that will be seen from particular vantage points by generating digital terrain models (Orland 1994). Because viewpoints may be along travel corridors, like roads, trails, and waterways, or from several recreational use areas, multiple viewpoints should be assessed (Bergen *et al*. 1995, Bradley 1996, Schroeder and Daniel 1980, USDA Forest Service 1995). An assessment that gives more weight to areas with steeper slopes and particular aspects will give a more accurate measure of visibility (Bergen *et al*. 1995).

Public participation in the forest planning process, especially in small groups, can help reduce the number of appeals and can help managers identify the concerns of local residents early in the forest planning process

Incorporate Public Input

The public can be involved early in the planning process to help identify those areas that it considers to be most special and vulnerable to disturbance (Ryan 2000, Schroeder 2002). For example, a special fishing and swimming area used frequently by local residents and visitors should be managed more sensitively.

It is also critical to involve the public in planning fuels reduction strategies in order to understand public attitudes and visual preferences for the management area. By involving the public in the visual landscape assessment (i.e., rating the scenic beauty of existing and proposed management decisions using simulations), fuel managers can be better informed about visual sensitivity and likely impacts of management alternatives (Dearden 1981, Kaplan *et al*. 1989). Public participation in the forest planning process, especially in small groups, can help reduce the number of appeals and can help managers identify the concerns of local residents early in the forest planning process (Gericke and Sullivan 1994, Shelby *et al*. 2004).

Implementation

Minimize Disturbance—Protect and Preserve Mature Trees

Research has shown that people are extremely fond of large trees (Dwyer *et al*. 1991, Kaplan *et al*. 1998), as well as old-growth forests (Brunson and Shelby 1992). In addition, forests are special places to many people who frequently visit them (Ryan 2000, Schroeder 2002). Thus, fuels management should strive to protect groves of large trees, both by retaining them during thinning and minimizing fire scarring during prescribed burning (Brown and Daniel 1986, Cotton and McBride 1987, Hull *et al* 1987, Scott 1998). Care should be taken to retain attractive, straight-trunked, full-crowned trees when thinning (Bradley 1996, Cook 1972). In addition, care should be taken to maintain vegetation diversity, including "trees with visually interesting bark characteristics" (Tlusty and Bacon 1989: 139).

Increase Visual Access Through Tree and Brush Thinning

One important aesthetic goal for fuels reduction is to increase visual access into densely forested areas (Tlusty and Bacon 1989). More open forests can be created through tree thinning, uplimbing trees,

Fuels reduction projects can open up views. *A recent fuels mitigation project near the Crescent Cove picnic area of the Stanislaus National Forest frames views to the surrounding mountains. The coarse woody debris from the thinning operation, shown in the foreground, will temporarily lower scenic quality until this material decomposes or is hidden by early successional grasses and forbs.*

prescribed burning and even grazing (Brown and Daniel 1986; Brush 1976, 1979; Buhyoff *et al*. 1986; Patey and Evans 1979). Thinning can open up the forest, which can improve visibility and legibility along trails and other corridors. Research has shown that mechanical thinning of smaller diameter trees to reduce stand density can also increase scenic beauty in many forest types (Buhyoff *et al*. 1986, Hull and Buhyoff 1986, Scott 1998).

The number of trees that can be removed and scenic beauty still be retained will vary by forest type and location. However, in general, research suggests that removing between 25 and 30 percent of stand density will have minimal impact on scenic quality and, in some instances, up to 40-50 percent of smaller diameter trees can be removed if larger trees are retained (Buhyoff *et al*. 1986; Paquet and Belanger 1997; Pings and Hollenhorst 1993; Ribe 1989, in press; Vodak *et al*. 1985). Prescribed fire also can help clear understory vegetation to improve visual access (Patey and Evans 1979). Creating small openings in the forest through fuels management can increase visual quality (Brown and Daniel 1986; Brush 1976, 1979; Herzog and Kropscott 2004; Herzog and Leverich 2003; Kaplan *et al*. 1998), and reduce fire risk (Scott 1998).

Closed-response formats allow respondents to more quickly address a wider array of issues/questions and express themselves in ways that are readily quantified and analyzed with appropriate statistical procedures.

Sometimes, landmarks such as unique rock formations can be made visible through fuels reduction management. Landmarks also are important in enhancing wayfinding, as well as visual quality (Herzog and Kropscott 2004, Herzog and Leverich 2003, Kaplan *et al*. 1998). By retaining unique features during fuels management, such as leaving unusual snags or clearing vegetation around specimen trees, managers also can improve the trail experience by providing landmarks and unique interpretive areas (Hammitt and Cherem 1980). Opening up views in densely forested areas also can increase the sense of mystery along hiking trails and encourage visitors to explore the forest (Hammitt and Cherem 1980; Herzog 1984, 1988).

Plan for the Visual Impacts of Prescribed Burns

The visual impacts of prescribed fire can be mitigated for areas deemed to be visually sensitive. Suggestions by Christensen and others (c.f. Cotton and McBride (1987: 35) for the giant sequoia/mixed conifer forest are applicable to other forests near heavy recreation and tourist use areas:

1. Judicious preburn cutting of live trees to minimize bark char and crown scorch.
2. Removal of heavy fuels from base of all large trees in restoration area.

3. Use of single-burning front, rather than multiple-spot ignition, in simulated natural fires.
4. Manipulation of debris following burning if prescribed burning has exacerbated heavy dead fuel conditions. Additional local burning is advised to achieve fuel reduction objectives.

Slash from thinning operations also can be burned after being piled, to avoid damage to existing trees (Scott 1998). After prescribed fire has been used repeatedly as a management tool, it may be less necessary to manage the fuels to avoid bark char because the public may become more accustomed to this type of management (Wilkinson, B., personal communication, Oct. 14, 2004).

Remove coarse woody debris after thinning projects. *Piling and burning downed wood from forest thinning can help mitigate the visual impacts of fuels hazard reduction projects along more heavily used parts of the forest. These brush piles along a forest road in New Mexico's Santa Fe National Forest will be burned when there is enough snow cover on the ground to minimize fire danger.*

Reveal Ecological Practices Using "Cues to Care"

Ecological practices can be revealed by using "cues to care." Buffer strips, or "beauty strips," are a traditional forestry method to screen intensive timber harvesting from nearby scenic roads and trails or along streams and other riparian resources. To be effective for aesthetic purposes, they must fully screen the affected areas (Bradley 1996, Schuh 1995). Steep topography and ridgelines are other aesthetically sensitive areas where managers need to consider how thinning practices affect scenery (Bradley 1996, Karjalainen and Komulainen 1999, Schuh 1995). Severe thinning along scenic ridgelines should be avoided. Some researchers have argued that hiding management practices that may be perceived as unsightly is less than honest and does not help inform or educate the public about real management practices or goals. Nassauer (1995) suggests using "cues to care" to help frame otherwise messy-appearing environments with visible signs of management or human intention. For fuels management, such cues to care will depend upon the type of intervention. For example, fuel breaks could be seeded with flowering herbaceous plant material to increase their aesthetic value. Along recreation trails and scenic roads, trees could be selectively thinned to frame views (Gobster 1994, McDonald and Litton 1998). The edges of a prescribed burn could be delineated with clear boundaries adjacent to roads and other improvements. The removal of slash in areas for thinning could be more intensive near trails, viewpoints, and other use areas. Furthermore, the edges of the forest could be thinned in an intentional-appearing manner, for instance, by undulating the border to follow natural contours.

Fuels thinning and mulching can be done simultaneously. *Fuels mitigation can create a more visually preferred forest, if enough mature trees are retained and coarse woody debris is removed or mulched. Seen in the middleground of this picture, a hydraulic axe thins and mulches ponderosa pine trees as part of a hazard reduction project at the wildland-urban interface between Los Alamos, New Mexico, and the Santa Fe National Forest.*

Facilitate Public Involvement in Implementation

Involving the public in fuels management and other ecosystem management practices is one strategy to improve acceptance and appreciation for this work (Gobster 1994, 1995). Volunteer crews can help remove overgrown understory vegetation, or with proper training, can assist with tree thinning or even prescribed fire. Research with volunteers involved in other types of ecological restoration has shown that this active type of engagement increases knowledge and appreciation for local ecosystems and helps develop advocates for ecological restoration work (Ryan *et al*. 2001).

Monitoring

Clean Up Debris and Slash

The public responds negatively to downed wood, slash, and other debris from timber harvesting and thinning (Arthur 1977, Echelberger 1979, Ruddell *et al*. 1989). Thus, it is critical that fuels management consider timely removal of thinning debris as part of managing for aesthetics. This could include hydraulic mulching of woody debris, piling and burning of slash, or other techniques. Cutting tree stumps low to the ground can also minimize negative visual impacts (Daniel and Boster 1976). The amount of downed wood to remove after thinning will vary by forest type and location. However, in general, the coarser the material that remains on the forest floor, the more negative the visual impact. Research has shown that removing only part of the debris, such as incomplete burning of slash piles, can negatively affect visual quality while the woody debris decomposes, which may be slow in arid regions (Benson and Ullrich 1981). New technology such as hydraulic axes can thin trees and brush by shredding them into a fine mulch that is less visible and more easily hidden by new grass and shrub growth.

Managers need to educate the public about prescribed fire. *Informational signage is necessary to communicate the management goals behind ecosystem restoration and fuels hazard mitigation. This is especially true when the visual quality of the forest has been drastically changed by thinning and prescribed fire, as was the case here in an oak woodland restoration project in Yosemite National Park, California.*

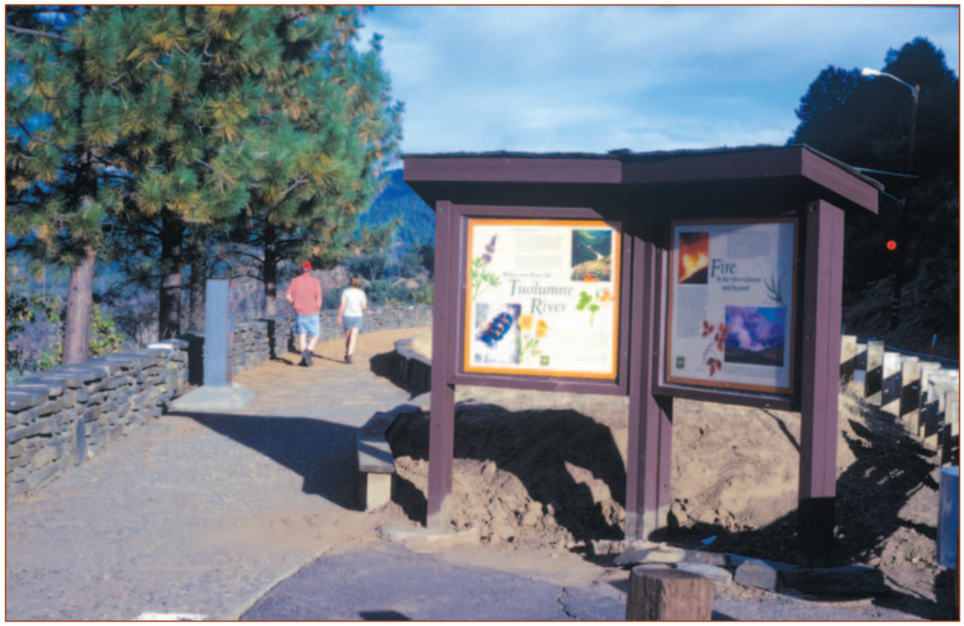
However, achieving aesthetic goals of removing downed wood may contradict other environmental goals such as maintaining snags for bird habitat (Gobster 1995). Thus, the removal of dead wood must take into account the environmental costs and may be best practiced in visually sensitive areas that are not prime habitat.

Enhance Revegetation of Disturbed Land

Fuels reduction treatments should include techniques such as fertilizing and replanting to speed up revegetation of disturbed areas, especially those that are highly visible and subject to erosion (Bradley 1996, Magill 1994). Timing fuels treatments to coincide with the beginning of the growing season is another strategy to minimize the time the cleared or burned area will be bare.

Provide Information About Management

Communicating the rationale behind fuels management is critical to increase the public's acceptance of these management practices. Signs telling the public about the goals of the project and future landscape conditions are essential for increasing public acceptance of management operations that disturb the landscape, such as prescribed fire or tree thinning (Gobster 1995, Jones 1995, Kearney 2001, Schuh 1995). In other words, signs and brochures should show not only the immediate visual impact of fuels management, but also the target landscape and associated ecological benefits (Kearney 2001). Research has shown that interpretive signs provide a more positive experience for visitors along hiking trails (Keyes and Hammitt 1984). Likewise, the Scenic Byway program could be expanded to include overlook areas with signage for interpreting ecosystem management (Gobster 1994, 1995). However, managers must realize that signage will go only so far in convincing the public that a visually messy or otherwise nonpreferred landscape is acceptable. Forestry companies have begun to create demonstration projects to help the public understand the visual impacts and economic costs of aesthetically managing timber harvests (Schuh 1995). Managers intent on fuels management should consider using demonstration projects to highlight new management approaches such as prescribed fire or selective thinning.



Scenic overlooks provide educational opportunities. *The Rim-of-the-World overlook in the Stanislaus National Forest of California showcases views to several historic burn areas and informs the public about wildland fire, forest succession, and fuels mitigation projects. Overlooks such as this can help develop an ecological aesthetic as described by Gobster (1994).*

Practice Adaptive Management

The dynamic nature of forested landscapes suggests that managers must adapt their management to changing landscape conditions. Adaptive management can help managers emulate natural disturbance and has become increasingly important for implementing large-scale forest plans (Kimmins 2002, Shindler *et al*. 1996). Because open viewsheds within forests appear to be one condition considered aesthetically pleasing in many situations, managers may consider using adaptive management to open up the forest (Ruddell *et al*. 1989). The regeneration of forests after wildfires, timber harvesting, or other disturbances creates conditions in which views become obscured by stands of dense, even-aged trees (Brush 1976). Managing viewsheds in the forest could include periodic thinning, scattered harvesting, and other techniques to create more open areas in these forests. According to Ruddell and others (1989: 409), “concrete silvicultural treatments that could enhance scenic beauty, [include] …prescribed burning of understory, ‘uplimbing’ (pruning of lower limbs on trees), and selective cutting and grazing.” Management goals of improving ecosystem health and reducing fuels loading also could be achieved with these types of management techniques.

Conclusions

Cotton and McBride (1987: 36) suggest that "scenic integrity is too serious a matter to be left to the resource scientists. Rather, design consciousness, developed through multidisciplinary involvement and utilizing ecologically acceptable alternatives within the scope of vibrant process management, could be the key to retaining public support for prescribed burning."

Like timber harvesting, implementing fuels reduction practices, including prescribed fire, tree thinning, salvage logging, and fuel breaks, requires public review and process, either formally through the NEPA process or informally through other forms of public involvement. To achieve fuels reduction goals and increase forest health, managers will need to consider the range of hydrologic, biologic, and social impacts, including aesthetics. As described in the literature, aesthetic impacts are often the catalyst for fierce public opposition. In other words, the public's acceptance of forest management practices, including fuels reduction, is based heavily on the visual appearance of the forest (Ribe 2002). Fuels managers can increase their chances of success by (1) using existing research findings such as those outlined in this paper, (2) including social scientists and landscape architects in the planning team, and (3) involving the public at all stages of the fire hazard reduction planning process. The public is passionate about the scenic beauty of its national forests. Thus, the future of the Nation's forests requires that managers plan for both ecological health and scenic beauty in the framework of fuels management.

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Photo Credits

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A series of syntheses were commissioned by the USDA Forest Service to aid in fuels mitigation project planning. This synthesis focuses on research addressing aesthetic considerations of fuels management. A general finding is that fuels management activities can contribute to the visual quality of a landscape. Topics covered in the synthesis include research findings on visual preferences in forested ecosystems, strategies for maintaining or improving visual quality through fuels management, and the planning, implementation, and monitoring of resource management to improve visual quality.

KEY WORDS: scenic beauty, visual quality, landscape aesthetics

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