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Scenic Vistas and the Changing Policy Landscape: Visualizing and Testing the Role of Visual Resources in Ecosystem Management

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Abstract: *The Northwest Forest Plan applies a shift in policy to national forests in the U.S. Pacific Northwest, with implications for other public landscapes. This shift offers potentially strong scenic implications for areas that have historically emphasized clearcutting with little visual impact mitigation. These areas will now emphasize biocentric concerns and harvests formed accordingly. Public perceptions of a simulation of this landscape transformation indicate that it offers to improve the beauty of large vistas. Changes in small vistas and harvests nearer to viewers will still require visual management. Implications for policy stability and the management of forest aesthetics are discussed.*

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Sometimes the beauty of a landscape can play a key role in important events. This occurred in the Cascade Mountains of Washington and Oregon from 1986 to 1994 by way of the notorious spotted owl controversy (Durbin 1996). Much of the forest covering those mountains, especially those in private hands, had long been managed primarily to convert the cornucopia of big trees to commercial wealth. In the 1980s, this emphasis moved with unprecedented intensity to the national forests that cover a large portion of these mountains. Extensive areas of national forest were planned

for complete harvest in clearcut blocks over time to be replaced with plantations. The result was a landscape dominated by clearcuts and plantations growing in clearcuts: a public landscape less beautiful than before.

When legal and political events responded to this landscape and the policies that produced it, its scenery came into play. Affective perceptions of landscapes can have strong emotional impacts (Ulrich 1986; Wohlwill

1976). These perceptions often form the basis of peoples' environmental ideology or issue-specific political perceptions, irrespective of other, more analytical issues (Sullivan and Masters 1988). Negative responses to forests dominated by clearcuts (Bliss 2000)—in contrast to the aesthetic appeal of old-growth forests—helped nationalize the spotted owl conflict against the old policy (Dietrich 1992). These aesthetic perceptions contributed to the making of new policy that will make a new landscape. Will this new policy landscape produce more negative responses and opposition?

A Landscape of Conflict

The northern spotted owl controversy centered on the old-growth forests of western Washington and Oregon and northern California. While the legal points of contention dealt mainly with saving the owl and other old-growth-dependent wildlife from endangerment (Bonnert and Zimmerman 1991; Watson and Muraoka 1992), the controversy was intensified by the traumatic economic impacts on timber-harvest-dependent communities (Corn 1989; Lee et al. 1990; Greber et al. 1990). As the conflict raged, images of subject national forest landscapes were prominent in the war for public opinion. Photos of clearcuts, often many at once, appeared in countless books, pamphlets, and articles. A few promi-

nent examples included Fritz (1989), *The Oregonian* newspaper (1990), and DeVall (1994).

The ecological impacts of these practices merged with their aesthetic impacts in determining a major policy change. The current resolution of the spotted owl controversy effected a shift in the landscape sought by policy, illustrated in Figure 1. Clearcuts are to be replaced by regeneration harvests!¹ These harvests are elements of New Forestry (Kohm and Franklin 1997) emphasizing concerns about ecological health and natural disturbance patterns rather than the more-economically driven ideal of a repeated rotation of harvests over time around areas of national forest (Fedkiw [1998?]). This new policy is more biocentric (Franklin 1994) and

may also change the landscape in visibly extensive and intensive ways, with the potential again for adverse affective perceptions.

The more biocentric management choices and resulting landscape forms prescribed by the new policy may produce scenery that elicits few adverse responses. These landscapes might not require scenic mitigation in the ways that previous, more economic-centered choices did. Perhaps in time, landscape ecologists and wildlife biologists might come to replace landscape architects as the de facto "natural" purveyors of forest scenery.

Alternatively, the substitution of more ecologically correct landscape forms for older more anthropocentric ones is not assured to be more

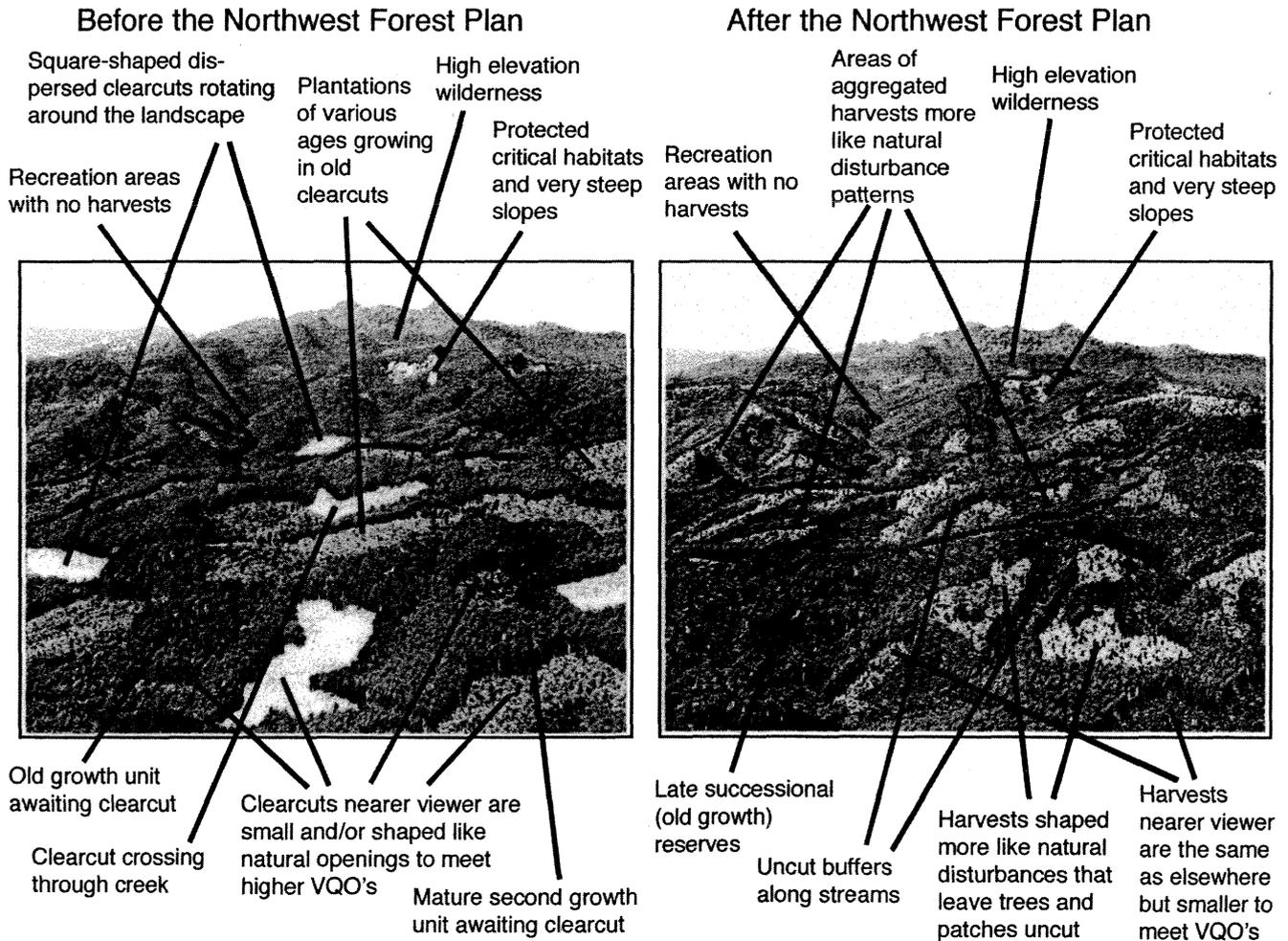


Figure 1. Iconographic comparison of the idealized policy landscapes before and after the spotted owl controversy. Illustrations by Pat Curran.

aesthetically successful. The controlled design of harvests in these actively managed, nonwilderness landscapes may still be needed to some extent to better express peoples' cultural expectations of nature (Nassauer 1995). If so, landscape architects should still play an important aesthetic role in national forest planning.

People's perceptions of the beauty of the new versus old landscapes of the spotted owl controversy need to be explored. How much visual resource management is needed within ecosystem management? An investigation is presented here which attempts to visualize this shift in the "policy landscape" in actual scenes and to explain the public's aesthetic responses to it.

Forest Aesthetics and the Shifting Policy Landscape

Aesthetic issues fostered by clearcuts have long played a key role in the evolution of management policy for U.S. national forests. The visual spoils created by "cut and run" loggers first captured the attention of the American public more than a century ago and contributed substantially to the creation of national forests (Cox 1985; Dana and Fairfax 1980; Horwitz 1974).² Like the national parks, the reassignment of unregulated commons areas into public reserves led to public expectations for the protection of health and beauty (Bonnicksen 1990; Huth 1972). Unlike the national parks, which typically emphasize scenic enjoyment, the legislation founding the national forests, and the forestry culture of management that followed, centered instead on a more homocentric, utilitarian and conservative doctrine of sustained resource yield (Behan 1978; Horwitz 1974). From the beginning there have been conflicts between public and professional perceptions of national forest landscapes.

The Monongahela Controversy and the National Forest Management Act.

This conflict of perceptions found its first clear expression in the Monongahela controversy of the late 1960s and early 1970s (Bonnicksen

1990). The Monongahela controversy also sparked a revolution in national forest policy, due largely to negative public reaction to extensive clearcutting in the National Forest with that name in West Virginia. Until then, the Forest Service and the forestry profession had been generally averse to clearcutting because of its association with earlier, "uncivilized" cut and run practices, and had primarily employed selective cutting systems (Horwitz 1974; Matthews 1935). Clearcutting began to occur more and more after World War II due to utilitarian sustained-yield calculations, economic pressures for greater harvests, and as a means to regenerate desired commercial tree species (Dana and Fairfax 1980).

Aesthetic issues raised in the Monongahela controversy contributed to passage of the National Forest Management Act (NFMA) of 1976 (LeMaster 1984; Wilkinson and Anderson 1987). This new policy also arose from a protracted attempt to reconcile a general cultural versus a specialized, utilitarian view of the environment (Bennett 1976). The ugliness of clearcutting and claims of what it belies about natural resource damage played a key role (Wood 1971; Hays 1987; Hirt 1994). Each side of the conflict attempted to enforce its values by institutionalizing them in law and practice. Winning the public relations battle was critical leverage upon the final outcome. NFMA established the rules of multiple use national forest planning, which, among other things, sanctioned clearcutting but constrained it to "silviculturally optimal" situations (Peterson 1984; Wilkinson and Anderson 1987). The NFMA also included language to protect biodiversity and to limit harvest sizes and visual impacts, calling for "cuts . . . shaped and blended to the extent practicable with the natural terrain" (16 USCA 1604g3Fiii).

Aesthetics and the National Forest Management Act.

In response to the NFMA, the Forest Service and the academic

community undertook extensive forest aesthetic research (Ribe 1989). This work confirmed the general, and especially nonrural, public's preference for naturally appearing landscapes with "scenic" qualities (McCool et al. 1986; Magill 1992), consistent with American aesthetic traditions (Huth 1972; Rees 1975).

The Forest Service instituted the Visual Management System (VMS) to assign a visual quality objective (VQO) to every area of land, setting a level of scenic protection. The VMS established procedures for visual landscape protection and impact mitigation to meet VQO standards in the design of projects affecting scenery, including clearcuts and other kinds of timber harvests (USDA Forest Service 1974).³ The VMS established criteria for judging the visual impact of projects as to whether they meet different VQO standards. Hence, VQOs measure—using the same terminology—either the desired scenic quality for a place or the level of scenic impact a project actually achieves, with the intention of having the two match. These policies and practices placed aesthetics on the agenda in forest management decisions. They became major vehicles for the employment of landscape architecture in the design of whole national forest plans and projects (Smardon 1986).

The NFMA governed more than twenty years of national forest planning, often making clearcuts the most visible and remunerative element of the effected landscapes (Mohai 1995; O'Toole 1988).⁴ Where clearcuts have been favored, the NFMA has had the pervasive effect of limiting their size, dispersing them, effecting more natural-appearing clearcut designs in more scenic and visually sensitive places, and excluding them from the most visually sensitive places. After the NFMA, the potential for major new controversy and policy change was largely exhausted (Hays 1987), and this new national forest landscape became the substrate for public opinion, nascent dissatisfactions, and local controversies (Hirt 1994).

The implementation of NFMA placed scenic beauty, as measured by

the VMS, into a larger rational forest-planning paradigm. Through scientific management, this paradigm optimizes individual resource values by experts, which are then collectively optimized by public feedback, linear programming, and executive decisions (USDA 1991; Behan 1997). As with any resource, the visual quality objective (VQO) the VMS might identify for an area may then be traded off by planners or by a computerized multiresource optimization favoring, for example, more harvests than the scenically optimal VQO would indicate (O'Toole 1988).

The Northwest Forest Plan.

Many decisions governed by the NFMA led to the spotted owl controversy, which was resolved, at least for now, in the Northwest Forest Plan (NFP) (USDA and USDI 1994a; 1994b). After protracted conflict, two failed attempts to write a legally and politically acceptable recovery plan for the owl, Congressional failure to find a solution through new statutory law, and the direct involvement of the president, vice president, and Cabinet officials (Durbin 1996), the NFP was enacted as case law under the NFMA by executive order (Clinton and Gore 1993). The NFP provided the basis for lifting an injunction against all timber sales in the range of the northern spotted owl by bringing national forest plans into compliance with the biodiversity provisions of the NFMA and the Endangered Species Act (Yaffee 1994). The financial and policy prominence of the Pacific Northwest's forests within the Forest Service, along with parallel legal issues affecting national forests elsewhere, make the NFP nationally important (Fedkiw [1998?]).⁵

The NFP covers a very large region. It allocates land to categories with prescriptive limitations and standards for management.⁶ It was developed mainly by scientists prescribing habitat management patterns throughout 24 million acres within 19 national forests and seven Bureau of Land Management districts. The NFP is summarized in Vogt et al. (1997). It is a compromise that promises more timber harvests than the more biologically conservative op-

tions initially proposed but not accepted by the Clinton Administration (Durbin 1996; St. Clair 1993).

The NFP is a pioneering example of the new "ecosystem management" approach to federal forest planning (Thomas 1994). It represents a distinct shift in management away from the rational decision paradigm employed previously (Robertson 1991; 1992). Advocates for ecosystem management hold that the primary aim of resource management is maintaining ecological health; that decisions be derived from holistic science integrated across a range of scales and disciplines toward socially defined goals; and that decisions be collaborative through adaptive management and continuous institutional learning (Vogt et al. 1997).

Aesthetics and the Northwest Forest Plan.

The landscapes that the NFP and this new paradigm produce should be quite different from those generated by the old paradigm (Figure 1). Just what they will actually be and look like is uncertain. Because the NFP is case law under the NFMA and the National Environmental Policy Act, all the same areas that have been afforded various degrees of scenic protection by the VMS, and now the SMS (USDA Forest Service 1995b), retain the same protections. The NFP does not allow harvests where NFMA did not. Ecosystem management *should* change how scenic management plays out on the landscape, especially where scenic protections have been and remain weakest.

The prospect for a new aesthetic with new public land management paradigms offers a wealth of opportunities to explore ways to integrate ecological health with beauty. This study does not attempt a creative exploration of this relationship. Instead, it takes advantage of the highly prescriptive nature of the NFP at larger scales to forecast, with substantial confidence, what an actual landscape could look like under a

fully implemented NFP if it were to play out as expected upon its promulgation.⁷ Other studies must consider the more detailed scale and robust integration of ecology and aesthetics.

When viewed from a distance, expected forest patterns are well defined by the NFP through its land designations. Local Forest Service decisions will effect these patterns in smaller ways, such as the identification of key areas of old-growth forests, observed northern spotted owl breeding centers, and other unique habitats to be protected. Under the NFP, extensive "owl dispersal areas" maps are overlaid upon NFP land designations where maintenance of forest canopy closure levels is a goal. Watershed analyses and the survey and management of sensitive species are a prerequisite to harvests and other management projects. These procedures will largely determine the actual pattern and rate of landscape change over time.

Social analyses, including aesthetics, were not central to the NFP's formulation or implementation (Clark and Stankey 1994).⁸ Economic considerations have not played substantially—compared to their historic role—in the NFP's implementation, but have instead informed and affected its formulation in a general, political sense (St. Clair 1993; Yaffee 1994). The NFP does incorporate policy direction and values priorities that the general public supports (Steel et al. 1994). The NFP calls for research about the plan's social impacts, including those affecting visual resources (USDA et al. 1993, p.VIII-24).

Research Outline

How much might a primary intention to maintain the ecological health of national forests be a substitute for scenery management? Obviously, the actual appearance of landscapes produced by ecosystem management could vary considerably with different scenic results (Karjalainen and Komulainen 1999), so it is unlikely ecologists will ever be given *carte blanche*. The question therefore had to be explored by reference to an actual landscape and the scenic consequences of ecosys-

tem management policies and practices that reasonably could be applied. A case study landscape was selected, its future simulated, people judged the scenic beauty of that landscape change, and explanations of that change were sought.

Case Study.

The case study landscape needed to represent places where public perceptions could prove decisive for the NFP, namely those that aroused the most disaffection in the past and could benefit from scenic improvement. These are the most intensively harvested, scenically damaged landscapes, which have been assigned low visual quality objectives. They represent extensive areas of the federal lands in the Cascade Mountains. These intensively harvested areas are not usually near major highways or popular recreation areas. They were therefore allocated to low VQOs in the hope that their low scenic quality would not be so visible as to adversely effect support for land management plans and policy. But, their scenery is highly visible from airplanes and found its way into photographs affecting policy.

The NFP and ecosystem management might offer a scenic improvement to these intensively managed, less attractive landscapes. In areas with low VQOs, harvest designs driven by biological goals and guidelines but little affected by visual quality goals might be more scenically acceptable. In these landscapes, the NFP has the effect of reducing the amount and intensity of timber harvesting compared with past interpretations of NFMA. It offers to convert a pattern of many, dispersed, and size-limited clearcuts into one of fewer, more concentrated, less-than-complete clearcuts subject to unchanged NFMA size limits (Figure 1). The aesthetic merit of this change is uncertain. It may not produce the degree of naturalism the public prefers (Magill 1992), and it is not certain that landscapes designed for biological purposes will find public favor (Gobster 1994).

A case study landscape was selected that had historically low VQOs.⁹ This study therefore did not

consider how the NFP might effect scenic quality in other kinds of landscapes afforded higher VQO protections where visual change may be less significant. The researchers instead aimed to investigate the prospects for major scenic change due to NFP policies before they have a chance to play out on the landscape.

The future landscape therefore had to be simulated. It is impossible to predict the exact evolution of a national forest landscape. There are too many complexities, continuously changing uncertainties about interactive management decisions, local and national politics, and natural events such as climate change, disease, fire, and flood. Even detailed discretionary decisions, such as exactly where a timber harvest will be placed and how it will be designed many years in the future, are unpredictable and could prove scenically important.

Landscape forecast. The solution to this impossibility of precise prediction was to make the best possible forecast of how the NFP and ecosystem management could reasonably be expected to shape the study landscape. The emphasis was only on forecasting the type and resolution of landscape changes needed to investigate how NFP policies will effect changes in vista views. This forecast was not designed to be valid for testing any other question, such as the effects of landscape patterns on ecosystems, and was made according to the understanding and expectations of policies at one point in time, spring 1995. To serve the study's purpose and investigate the scenic impact of NFP harvest prescriptions and patterns, the forecast assumed that the volume of harvests then expected would actually happen. The strongest basis for prediction was the map of NFP land designations and the constraints and guidelines applied to their management.

Two key decisions were applied to forecasting landscape changes to enhance the general applicability of the study. First, major natural distur-

bances were not taken into consideration because they are the exception in most of the regional NFP landscape. Second, the pattern of changes sought to be generic to the NFP in order to represent how similar landscapes might look region-wide. This decision meant the local watershed plan for the case study landscape (USDA Forest Service 1995a) was substantially ignored when its application would tend to produce scenic results due to local interpretations of management philosophy and policy. That local plan was used, however, whenever it served to improve the landscape change forecast within *general* NFP policy, such as how timber harvests may more likely be placed in response to conditions such as pine marten habitats, rock outcrops, or unstable soils found throughout the Cascade Mountains. The local plan also helped to clarify ambiguities in NFP policy, such as how to meet canopy closure standards when these were contingent on local conditions.

Scenic Change. Once the future NFP landscape was forecast and modeled, photo-simulations of it were produced for a variety of scene types. These represented, as authentically as possible, the landscape 20 years after the NFP's promulgation.¹⁰ These simulations served as stimuli, along with the original existing-conditions photos, to elicit public perceptions and measure changes in potential beauty due to the NFP.¹¹ The observed changes in perceived scenic beauty were then analyzed using assessments from the visual resource management systems used by the Forest Service.¹² This analysis was conducted to understand the degree to which landscapes derived from the NFP may prove unattractive or not, and why. No other nonscenic implications regarding the merits or content of ecosystem management were sought.

This study sought only to predict empirically measured changes in people's average perceptions of scenic beauty. These changes were explained by changes in measurements of the visual management system content inside photos, as the independent variables. These visual man-

agement content measures were derived from expert judgments of VQOs and from digital analysis of contrasts in the photographs.

This focus on changes in public perception presents two important implications for those familiar with visual resource management. First, the investigation of public perceptions means that local, activity-specific, or historically derived perceptions were not considered, important as they are. This means that the visual sensitivity element of the VMS (USDA 1974) or the constituent analysis element of the SMS (USDA 1995b) was not involved in this research. Second, the dependent variable measure of scenic beauty was empirically derived from people's perceptions, not from compliance with or the validity of the VQO standards assigned to the study landscape. The researchers asked whether the NFP might produce improved scenic beauty in spite of low VQO standards. Consequently, the research does not consider the VQO levels assigned as a management goal for the landscape, except as an initial case study selection criterion. Those intended planning VQOs are of no further interest; neither are the visual variety classes and sensitivity levels that determined the VQOs assigned by the Forest Service. Importantly, this means that all further references to VQOs refer only to independent variable measures of what VQO scenic standard scenes or timber harvests actually meet. These future references to VQOs do *not* refer to the visual quality standard that has been or ought to be assigned to any landscape as a management objective.

The study derived and analyzed scenic perceptions of one simulated, authentic pattern of landscape change to explore the potential scenic impact of NFP policies. This investigated one important aspect of the social acceptability of the Forest Service's new management paradigm. It had a lesser, more pragmatic purpose: National forests implementing the NFP, with budget cuts associated with very reduced timber harvests, have laid off many landscape architects. This is justified in part on an assumption that NFP-style har-

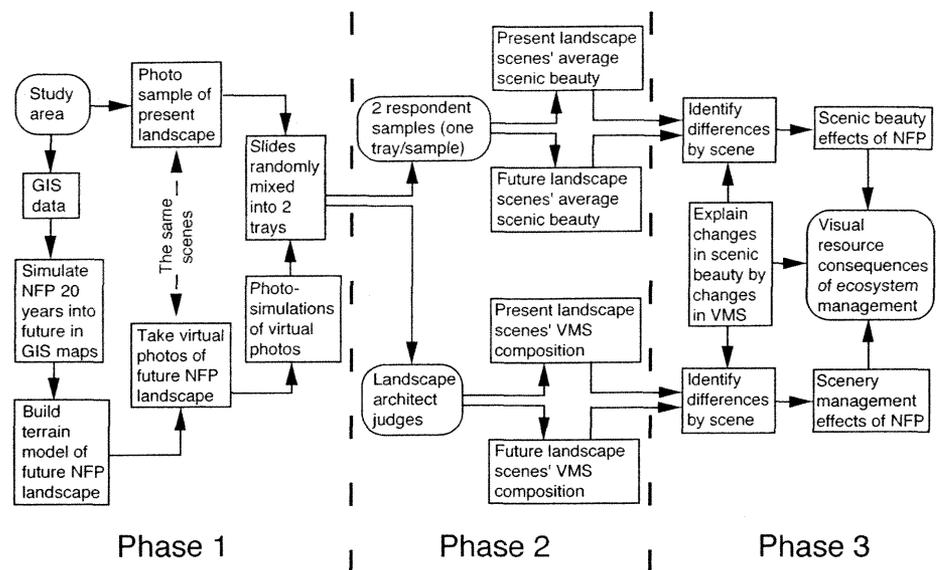


Figure 2. Experimental design process.

vests may not need as much visual mitigation, at least at middle and background distances (Apostol and Greene 1998).

Methods—Introduction

This study used a general approach to comparing landscapes with different impact patterns suggested by Orland (1994) and Nassauer (1990), and implemented for timber harvest patterns by Palmer et al. (1995). It adds elements from the forest plan simulation methods of Shang (1994) with the plan-image public survey methods of Swaffield and Fairweather (1996).

The research design is outlined in Figure 2. The first phase generated photo-simulations of future forest conditions illustrating how a national forest may look under the NFP. In the second phase, the pre-NFP and future-simulated scenes were evaluated for scenic qualities by public surveys and landscape architecture experts. Phase Three investigated how changes in the scenes' visual management content, due to NFP-style management, corresponded to changes in their perceived scenic beauty. The first phase

was meant to enable the main investigations in the second and third phases, rather than to be a definitive visualization of the NFP landscape.

Phase One Methods: Visualizing and Modeling Policy-Induced Change.

Simulating future forest cover. A portion of the Upper Clackamas River Basin in the Mount Hood National Forest was the study landscape (Figure 3). It was selected as representative of national forest areas in the Cascade Mountains that have been managed primarily for timber harvests with lower VQOs, with landscape patterns redirected by the NFP. Its forest cover is now highly fragmented from dispersed clearcutting, with the exception of the riparian forests along the Clackamas National Wild and Scenic River in the valley bottom (Figure 4).

The NFP land designations map is shown in Figure 5. A landform analysis was performed (Figure 6) that helped identify patterns of harvests to simulate natural disturbance patterns (Diaz and Apostol 1992). The Mount Hood National Forest provided 1992 vegetation data (Figure 7) and maps of known, threatened, and sensitive species habitats.¹³ Late successional and riparian reserves (Figure 5) were subtracted along with forests too young to har-

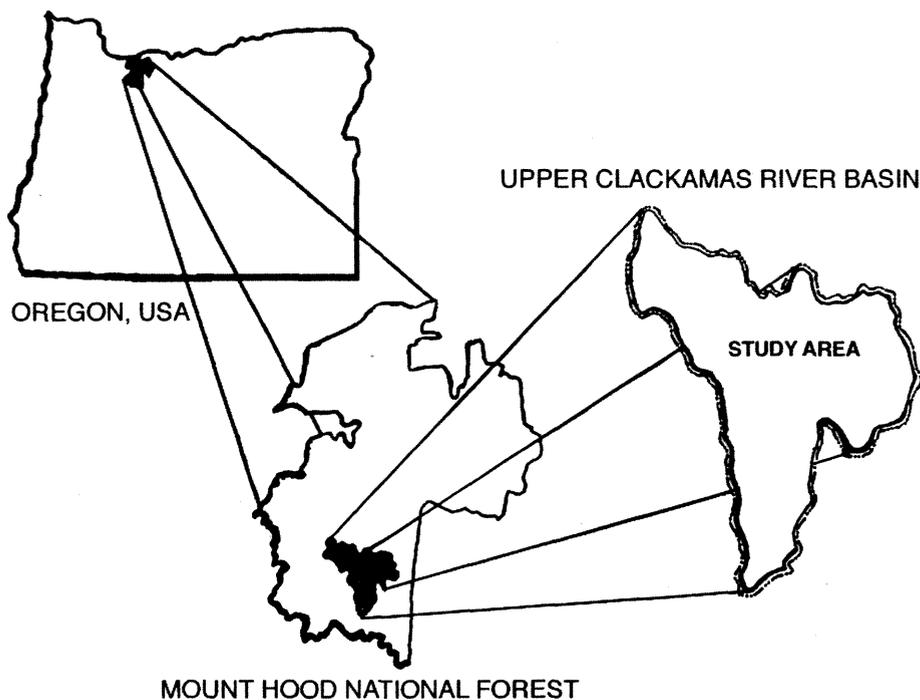


Figure 3. Regional location of the Upper Clackamas River Basin study landscape. Illustration by Karel Hendee.

vest (Figure 7), yielding the remaining “matrix lands” available for harvest (Figure 8).

The future forest cover of the study landscape was projected according to the guidelines of the NFP. New regeneration harvests were placed into the matrix lands in the vegetation GIS layer in increments representing four five-year periods of management under the NFP (Figure 9). These were placed mostly in mature, second-growth forests, in patch sizes typically fewer than 80 acres, and with 15 percent green-tree retention (USDI and USDA 1994a). The acreage of simulated harvests represented that likely to occur under the NFP.¹⁴ Simulated harvests were distributed to different sets of major watersheds in each five-year period and to different sub-watersheds within each five-year period. This was intended to simulate how cumulative hydrological impacts might be managed, as required by the NFP.

To ascertain how the study landscape might be managed under the NFP, two of the researchers observed and participated in the

Clackamas Watershed analysis and planning efforts required for the subject landscape (Ribe 1993; USDA Forest Service 1995a) and for the Fish Creek Watershed to the west (Greene 1995).¹⁵ These analyses influenced the shape and location of the simulated harvests (Figure 9) to be more plausible simulations of future management decisions under NFP guidelines.

The simulated harvest patterns included aggregation of harvest units in higher elevations and on plateaus, and shaping of harvests and collections of harvests to roughly mimic fire disturbance patterns (Morrison and Swanson 1990; Figure 6). Three-thousand-acre circles around known spotted owl breeding centers and known sensitive and threatened species habitat patches and wetlands were avoided.¹⁶ Only even-aged, regeneration harvests meeting the guidelines of the NFP were simulated (Figure 9). Thinning and other sil-

vicultural projects that would not break the forest canopy in vista views were not simulated, nor were roads since none were planned.

The 1992 GIS vegetation map (Figure 7) was advanced by 20 years to generate the simulated future landscape map. First, stand ages and structures were aged according to the vegetation GIS layer’s data dictionary as if no management or other disturbances occurred. Then the simulated regeneration harvest patterns (Figure 9) were substituted into this map to yield the simulated future forest cover map (Figure 10). This was the basis for photo simulation of future vista views.

Photographic Library Sampling. Photographs were taken throughout the study landscape at many forest openings affording vista views.¹⁷ This extensive photo sample sought to capture the entire study area and beyond in images covering a wide range of vista sizes. The sample also sought to capture as many combinations of VMS variety classes, existing harvests’ VQO classes, and sets of distance zones as possible (USDA Forest Service 1974),¹⁸ as well as other variables, such as forest age classes, slopes, solar aspects, and lighting conditions.

Final Study Scene Sample. Fifteen photos were selected for production of photo-simulations of potential future landscape conditions. This number and selection were not representative of the whole study landscape as it might be experienced by a visitor. It also was not representative of the larger, regional landscape affected by the NFP (Orland 1992), nor of all possible scenic conditions in lands where the NFP permits harvests. Instead, the selection served the narrower purpose of the study specific to the study scenes: to analyze how potential changes in scenic content due to the NFP correspond to changes in their perceived scenic beauty.

These fifteen scenes were selected to include a range of scales and landscape situations illustrative of major potential changes in the study landscape’s appearance under the NFP (Table 1).¹⁹ Photos 1 through 4 were selected to be large scale, over-view vistas from high places encom-



Figure 4. 1989 air photo of the study landscape: Moving toward a regulated forest of even-aged stands.

passing much of the study landscape from its different corners, viewed at different angles. Photos 5 through 8 were medium-scale vistas selected to represent as great a variety of vista types, combinations of distance zones, and future simulated harvest types in distance zones as could be found from the photo sample. All these medium-scale vistas included regenerating plantations in clearcuts in the middle and backgrounds. Pho-

tos 9 through 13 were small-scale vistas selected to include both areas with no new harvests (Scenes 9 and 10) and areas with new harvests. Photos 14 and 15 were selected to be very-small scale, close-up vistas of simulated regeneration harvests.²⁰

Virtual NFP Landscape Model. A three-dimensional digital terrain

model was constructed for the study area.²¹ The simulated future forest cover map (Figure 10) was draped upon this terrain model to produce a “virtual NFP landscape model” 20 years in the future (Figure 11). This model was used to take “virtual photos” from virtual camera viewpoints corresponding to the selected current-conditions photos. This virtual NFP landscape model had a sufficient resolution to display enough spatial accuracy of forest cover patterns in the virtual photos to enable authentic simulations (Bishop and Leahy 1989; Perkins 1992). The methods used were modeled on those of Bishop and Shang (1991) and Kaneda et al. (1989).

Taking Virtual Photos of the Future Landscape. For each of the current-conditions photos, a corresponding photo-simulation was needed to show the same scene 20 years in the future under the NFP. For authenticity, this required that NFP harvests be accurately sized and placed, and that plantations simulated in old clearcuts be the right ages (Perkins 1992). This was done in the small- and very-small scale photos (Table 1) using Sheppard’s (1989) manual techniques. The virtual NFP landscape model was needed to do so for the larger-scale photos. This was done by taking virtual photos of that model to match the current-conditions photos as nearly as possible, as shown at the top of Figure 12.²²

Making Photographic Simulations. The current-conditions (before NFP) study scenes on the left of Figure 13 were used to produce the corresponding after-NFP simulated scenes on the right of Figure 13. This was done by digitally layering the virtual photos of the future NFP landscape model over the corresponding current-conditions photos. The latter were then edited to include the types and scale of changes indicated by the former. When the two did not align well (due to virtual camera positioning imperfections, as in parts of Figure 12), portions of the virtual photos were aligned individually by small adjustments to scale, angle, and perspective.

The appearance of mature forest cover in place in all distance

Table 1. Selected Photographic Sample of Study Landscape.

Photo Number	Vista Scale	Distance Zones*	Characteristics selected for
1	Large	FG/MG/BG	Northwest view over study area from Peavine Mountain summit near northeast corner of study area
2	Large	FG/MG/BG	Southwest view over study area from Peavine Mountain summit near northeast corner of study area
3	Large	MG/BG	North-northwest view over study area near southeast corner of study area
4	Large	FG/MG/BG	East view over study area from near the far western corner of study area
5	Medium	FG/MG/BG	MG standard NFP harvests with BG fire-form and standard NFP harvests
6	Medium	FG/MG/BG	FB partial clearcut regeneration with MG/BG standard NFP harvests
7	Medium	FG/MG/BG	FG seed-tree clearcut regeneration with MG fire-form harvests
8	Medium	MG/BG	Standard NFP and fire-form harvests
9	Small	MG dominant	Just clearcut regeneration with no new NFP regeneration harvests
10	Small	FG/MG/BG	Just clearcut regeneration with no new NFP regeneration harvests
11	Small	FG/MG	FG clearcut regeneration with MG standard NFP harvests
12	Small	FG/MG	MG standard NFP harvest and clearcut regeneration
13	Small	FG/MG/BG	MG standard NFP harvests
14	Very Small	FG	FG aggregated 15 percent green-tree retention regeneration harvest
15	Very Small	FG/MG	FG dispersed 15 percent green-tree retention regeneration harvest

* FG = foreground, MG = middleground, BG = background, defined by VMS.

zones was not altered from that in the current-conditions photos.²³ Clearcuts and plantations found in the foreground and middleground of the current-conditions photos were aged by 20 years. In the middle-ground, this involved replacing them with older plantations' textures copied from similar slopes under similar lighting found in the photo library. In foreground clearcuts and plantations, whole portions of plantations about 20 years older were copied from other library photos.

Care was taken to achieve visual authenticity in simulating the harvests to depict vegetation changes

as they might actually occur under the NFP (Daniel 1992) in relation to their landscape context (Litton 1984). The primary guide in doing so was Iverson's (1985) concepts of visual magnitude, together with Sheppard's (1989) placement, scaling, and perspective techniques. Attention was paid in each harvest's simulation to tree and opening sizes and shapes in relation to perspective-aspect, slope, photo-sharpness, and scan-resolution. These harvests were

simulated to match the sharpness of the surrounding elements in the photo, the intensity of light there, and the degree of "green up" of the ground attributable to the time between projected harvest date and photo simulation date.²⁴

The simulations mimicked various prospective NFP-style harvests, and these styles varied within and between simulations, even for the same harvest in different views.²⁵ This was done to reflect the diversity and evolution of regeneration harvests that may occur under the NFP and in the study landscape. The NFP requires that at least 15 percent of the larger living trees found within each regeneration harvest unit remain standing. It further indicates that at least 70 percent of these trees be retained in clumps rather than dispersed across the harvest area (USDA and USDI 1994a, p. C-41). The NFP allows silviculturists to modify these prescriptions, such as retaining more trees or modifying retention pattern guidelines, in consultation with regional advisory teams. They may also make such modifications in ten-year plan revisions in response to local ecological needs and new research findings (USDA and USDI 1994a, pp. C-45, E-5; Franklin et al. 1997).

Many harvest simulations sought to portray standard NFP harvests with clumps of retention and dispersed retention.²⁶ Some just portrayed dispersed retention. Some had a bit more than 15 percent retention. Some sought to shape retained clumps and cut-over areas, and aggregations of several harvest units to collectively mimic fire patterns (Cissel et al. 1994; USDA Forest Service 1995a, pp. 90-91). Perforated and/or fire-pattern harvests were usually placed in the ridge-top, side-slope, and the visually sensitive middle-ground from the Clackamas National Wild and Scenic River, as indicated in the watershed analysis for the study landscape (USDA Forest Service 1995a).

The very-small-scale vistas in scenes 14 and 15 (Figure 13) were used to make simulations of different 15 percent green-tree retention patterns. Scene 14 was used to simulate an aggregated retention harvest

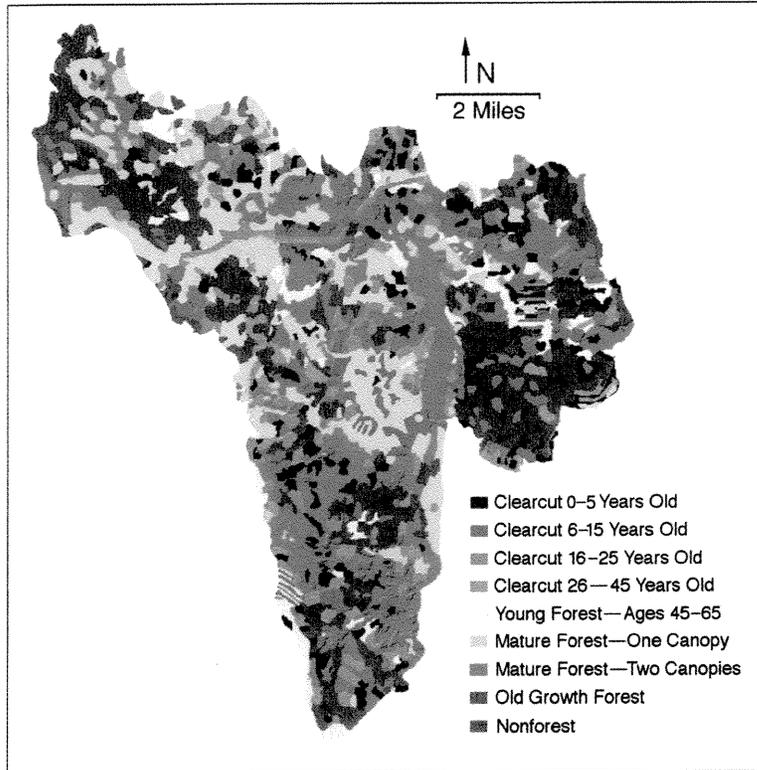


Figure 7. 1992 forest cover of the study landscape: Conditions during the spotted owl injunction halting all timber harvests.

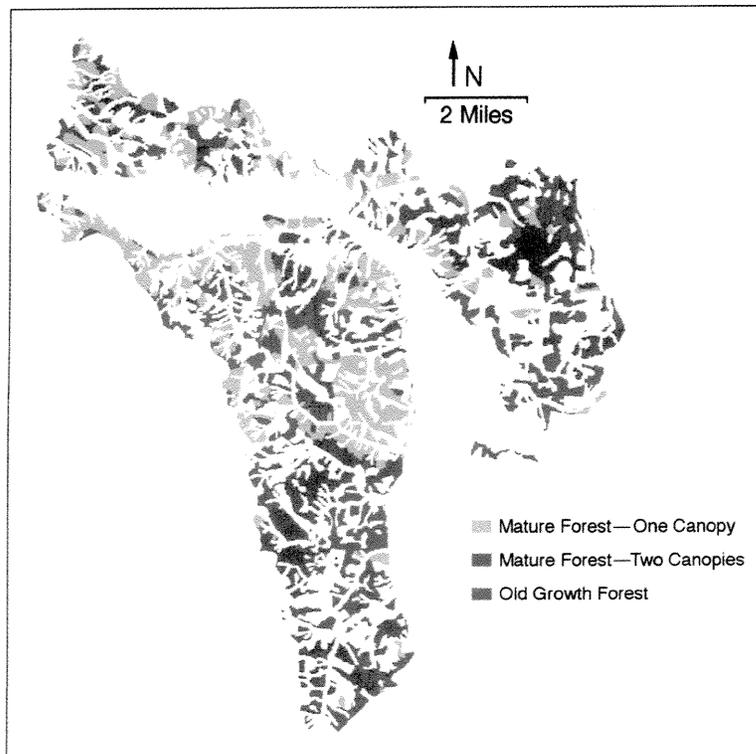
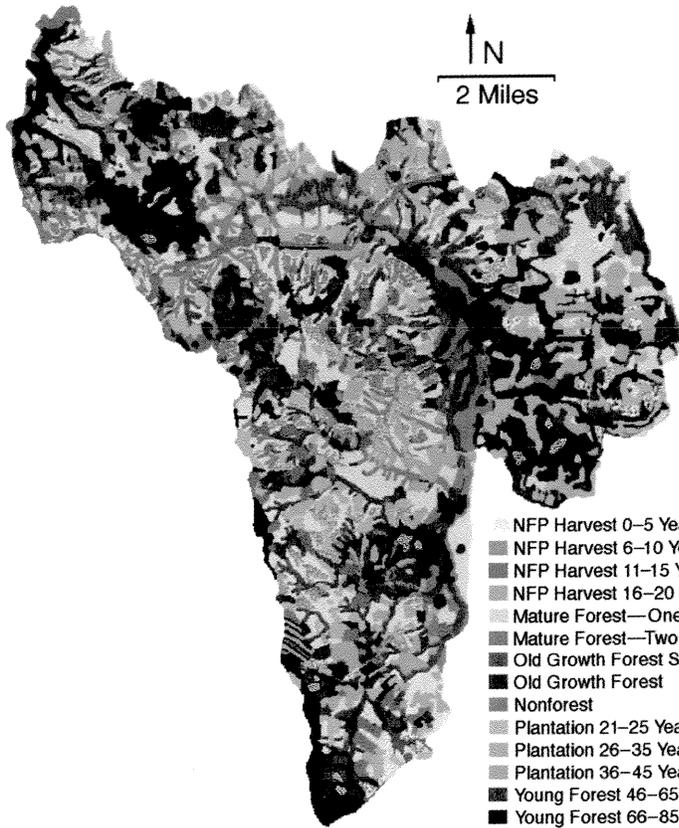
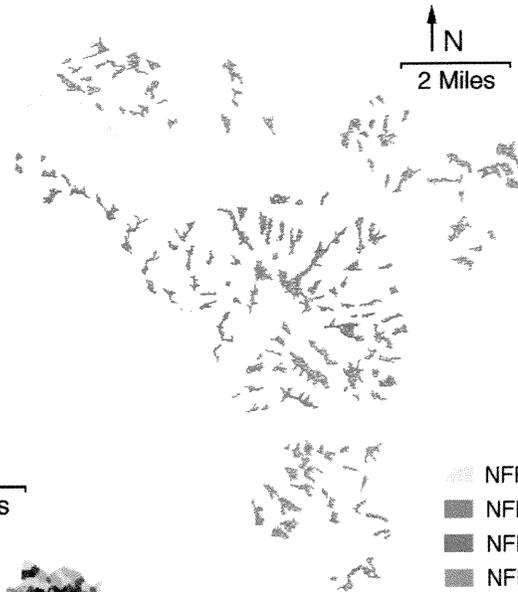
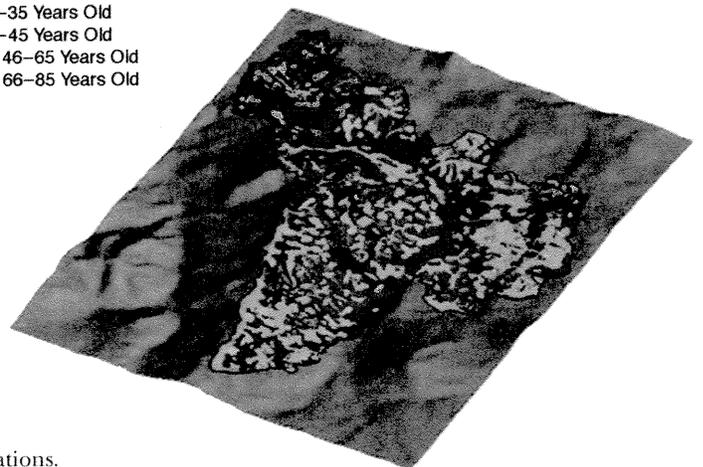


Figure 8. Available forests for harvest under the NFP within the study landscape. These are the “matrix” lands with mature enough forests for harvest in 1992, but include forests that may actually prove to be unavailable if found to be critical habitats.

► Figure 9. Simulated future NFP harvest pattern within the study landscape. This pattern is not an official or unofficial Forest Service plan or forecast. It is instead a generic, educated-guess scenario estimated by the researchers only for purposes of this study.



◀ Figure 10. Simulated 2013 forest cover of the study landscape under the NFP: A possible ecosystem management pattern that was used to generate the simulated photos of a potential future landscape.



► Figure 11. The virtual NFP landscape model. Virtual photographs were taken within this terrain model with the Figure 10 pattern draped upon it. These virtual photos then guided the photo simulations.

meeting NFP green-tree retention standards. This required an aggregated patch of retained trees, in this case straddling an ephemeral stream, with the remaining area containing a few dispersed retention trees. Scene 15 was used to simulate a dispersed retention harvest. This simulation was derived from imagery of a slope on which a dispersed, ten-percent retention harvest had recently been completed. The simulation involved adding back half as many retention trees.

Phase Two Methods—Evaluating Scenic Qualities.

Slide rating surveys. The before and after NFP versions of the 15 study scenes created a set of 30 images for analysis (Figure 13). These 30 study slides were placed randomly with 90 other slides of similar scenes into two trays. Different respondents saw different trays. This two-tray randomized strategy had the effect of preventing the same respondents from seeing both the before and after version of the same scene for 12 of the 15 study scene pairs. The use of two trays shown to different respondents and the additional slides served to contextualize the study scenes' perception and provide a baseline measurement procedure (Brown and Daniel 1990).

The other nonstudy slides into which the study slides were mixed depicted Cascade Mountain vistas of various scales showing landscapes from wilderness to heavily managed areas. This approach sought to elicit judgments that typically might be made on encountering such views during a trip through the mountains. This was preferred to the more intentional judgments that might be made if respondents' attention were focused just on the subject scenes with their more obvious comparative content.

A total of 608 respondents from 31 groups were surveyed. These were members of a variety of organizations in the Cascade region who rated the slides during meetings.²⁷ They rated slides privately, anonymously, and independently on individual rating forms, and filled in a questionnaire.²⁸ Each group rated one of the two slide

trays for scenic beauty. To help minimize bias effects, these groups were allocated so that ratings from ideologically similar groups were obtained for each slide set.²⁹

Respondents rated the slides for "scenic beauty" on a numeric scale from -5 to +5.³⁰ They were instructed that the scale ranged from "very ugly" to "very beautiful," with zero assigned to slides they found neither beautiful nor ugly or that they were undecided about (Ribe 1988). Respondents were asked to try to use the whole scale. The only information provided was that the scenes were from various national forest lands and collectively portrayed multiple uses and not just recreation areas. Respondents were told to view the slides as scenes they might encounter traveling through the Cascade Mountains "distant from

home" and "distant from their favorite place to visit." They were asked to try to rate the scenes without reference to their frames, the appearance of the sky, or the quality of the photograph.

Scene Analysis. All the scenic beauty ratings rendered for each scene were averaged (Schroeder 1984). The change in these average ratings was computed between the before and the after versions of the same scene (Figure 13). These 15 perceived changes in scenic beauty values, for the 15 scene pairs, served as the dependent variable for investigating the potential scenic effects of the simulated NFP.

To explain and interpret the observed changes in scenic beauty, two types of scenic content were measured. These are described in the sections below. The first involved

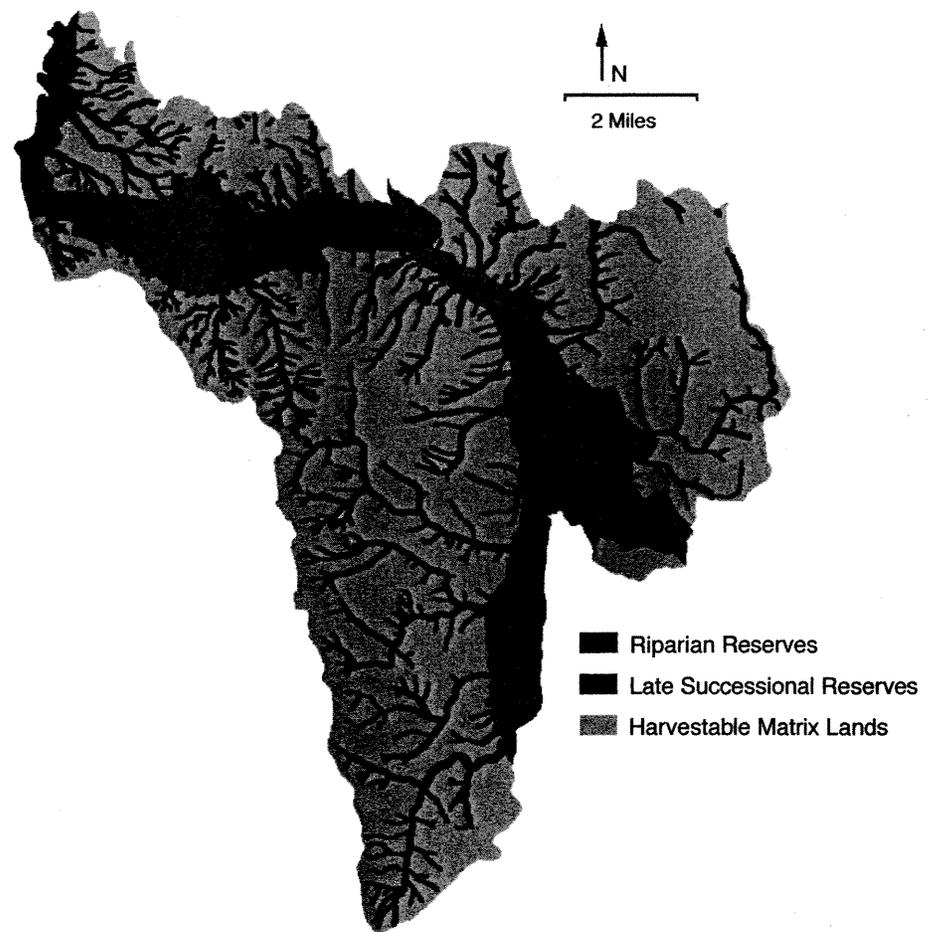


Figure 5. Northwest Forest Plan landscape designations for the study landscape. The riparian reserves show draft designations slightly different than the final ones.

measures derived from the Forest Service' visual resource management systems. The second measured the amount of harvests with strong color contrasts against the surrounding forest.

Visual Management System content. The percent of each individual scene, before or after the NFP, constituting an achieved (not a planned) visual quality objective or VQO, was measured (USDA Forest Service 1974). These were further classified by distance zone. The objective was to use changes in these measurements in each scene to explain the changes in perceived scenic beauty.

This measurement of VQOs was made by expert judges. These were the just-retired Regional Landscape Architect for Forest Service Region 6 containing the study landscape (who is also a co-developer of the VMS and SMS systems); the just-retired Forest

Landscape Architect for the Mount Hood National Forest (in which the study landscape is found); and his predecessor.³¹ These judges used prints of the scenes randomly mixed with those of 74 other scenes. They were not told the experimental design, nor which scenes were of interest in this study, nor which were simulated, or which represented post-NFP scenes. They were told which national forests the scenes were from and thereby the appropriate VMS "characteristic landscapes" that applied. The large number of photos may have helped prevent the judges from noticing the same scenes with different forest cover patterns as much, so as to discourage deliberately comparative judgments between such scene pairs.

The three judges independently marked up each photograph, dividing it into distance zones and vi-

sual quality objective (VQO) classes (Walters 1990) in a manner like that illustrated in Figure 12.³² Each VQO describes the extent to which portions of a landscape retain scenic integrity relative to the local, characteristic landscape undisturbed by management. The different photo mark-ups of each photograph from each of the three judges were then synthesized into one final version as follows.³³ Distance zone dividing lines were averaged unless two or three judges agreed, and then the agreed upon lines were used. For most of the photographs all three judges agreed and the corresponding VQO classification was assigned. When they did not agree, any classification where two of the judges agreed was assigned. In the few instances where all three judges disagreed, the middle VQO, in the order of degree of scenic modification, was assigned. Examples of final VMS mark-ups for one photo pair appear in Figure 12.

The final marked-up scenes, synthesizing the three experts' judgments, were digitized to measure the percent of each (exclusive of sky) in each distance zone-VQO combination (Figure 12). The maximum modification and unacceptable modification VQOs were combined because the three judges showed strong agreement regarding where either of these two VQOs applied but little agreement about which. The percent of scene change in each VQO and distance zone combination with the simulated NFP was then computed for each scene pair, as shown at the bottom of Figure 12. These scenic content change values then served as the independent variables.

High-contrast harvests content.

The second scenic content measurements sought to capture the extent to which each scene contained recent, obvious, harvested, forest openings. These measurements tested whether such simple content might determine scenic beauty perceptions as much or more than the more nuanced analysis of the landscape architects. It was hypothesized that the landscape architect judges may tend to over-emphasize harvest shapes rather than color contrasts in their VQO judgments, because in their work they had had the most control

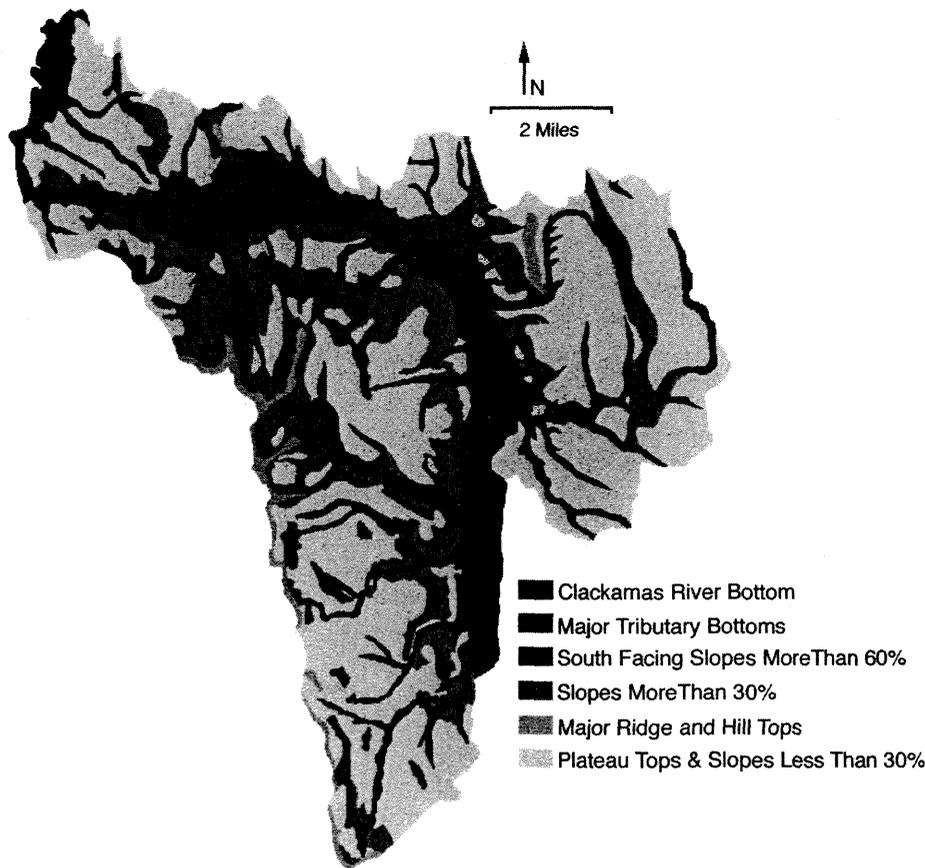


Figure 6. Landform analysis of study landscape. The categories reflect major determinants of fire behavior so that simulated NFP harvest patterns could begin to stitch together a more fire-like pattern of disturbances.

over harvest shapes. The percent of each scene in high color contrast (hereafter referred to as high contrast or fresh) harvested areas was measured by distance zone.³⁴ Each such high contrast harvest was further classified either as a clearcut, or as an NFP cut—if it at least met the 15 percent green-tree retention standard in any real or simulated pattern.

Phase Three Methods—Models to Explain Changes in Scenic Beauty

Both the dependent and independent variables were measurements of changes in the same scene due to the simulated NFP. Absolute beauty or VQO or high contrast harvest values measured for just one scene at a time were not analyzed in this study. The change in average perceived scenic beauty ratings served as the dependent variable across the 15 study scene pairs. The independent variables were the changes in the VQOs and high contrast harvest scene percentages across the 15 study scene pairs. These changes in scene content were used to try to explain the perceived scenic beauty changes found for the corresponding before-and-after scene pairs.

Single factors with changes strongly corresponding to changes in perceived beauty were sought first. The simple correlation of changes in each independent variable with changes in average scenic beauty ratings were found and tested for significance.

Combinations of factors that collectively corresponded to changes in perceived beauty were then sought. Linear regression models were used to investigate which changes in scene content together best explained changes in average perceived scenic beauty ratings. A best model was found using only VQO measurements, another using only high-contrast harvest measurements, and a third using any of these measurements.³⁵

The focus of these analyses was just on how the NFP might improve scenic beauty in pertinent vista views where pre-NFP policy produced low beauty. The statistical significance of the changes just in perceived scenic

beauty before and after the simulated NFP could have added to this investigation. This result would have been potentially misleading for two reasons and therefore was not tested. First, because the scene sample was not representative of the whole study landscape or of the larger regional landscape, this result might be misused to make claims about the general expected scenic consequences of

the NFP. Second, the NFP simulations used in the study were few and not representative of all the various ways the NFP may manifest itself in the landscape over time, due to the evolution of policy, planning, and management technologies, and is subject to the same potential misuse. Only results deriving specifically from the actual scenes and their content were appropriate.

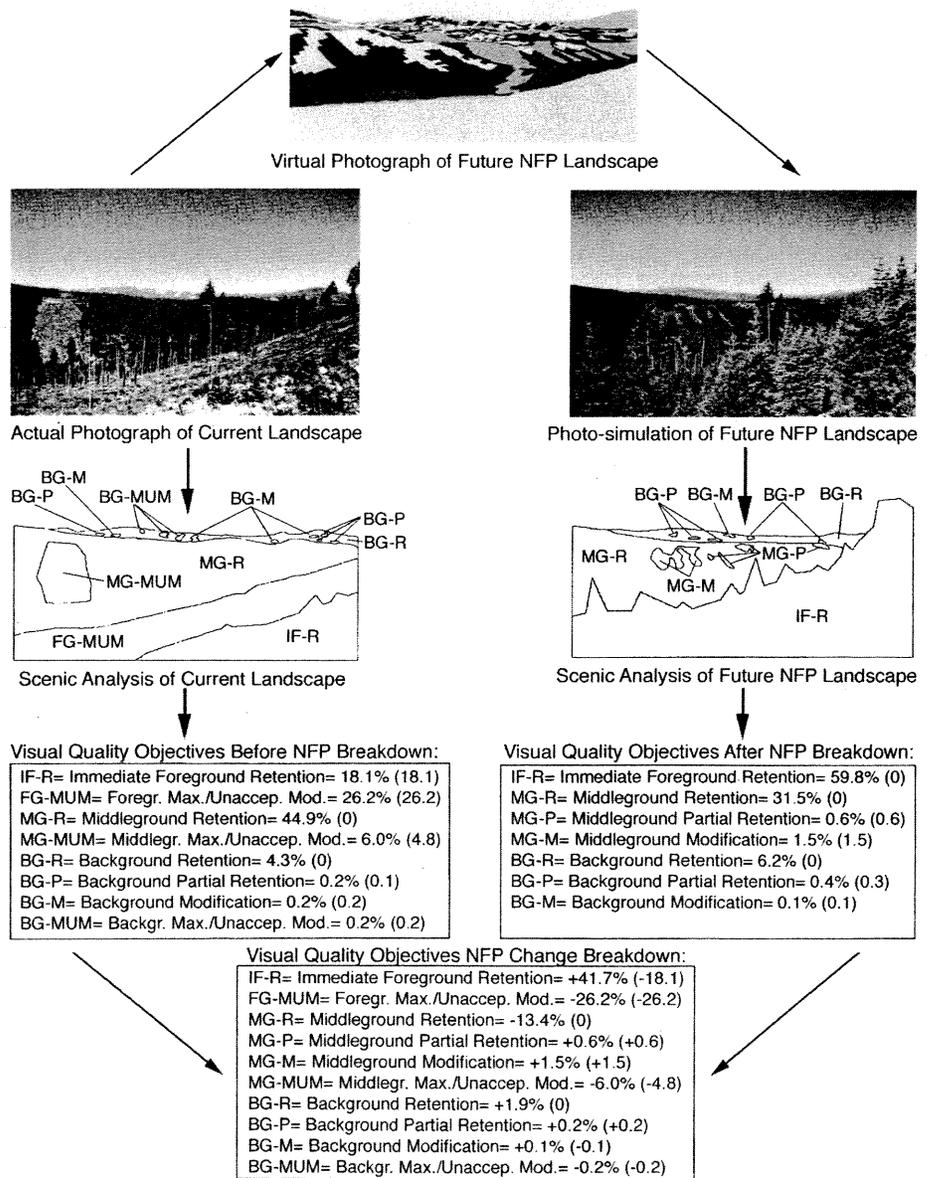
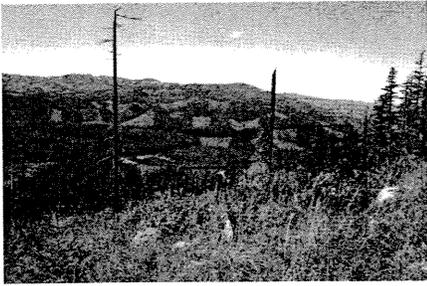
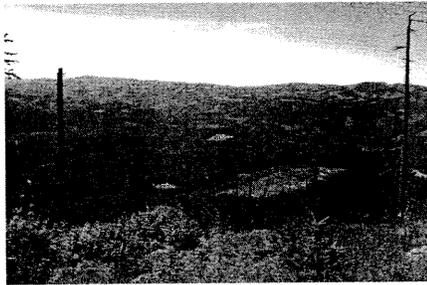


Figure 12. Illustration of the steps in generating photo-simulations of future scenes, and the Visual Management System analysis of consequent changes in the scenes' content. The parenthetical figures are for the subsets of high-contrast, fresh harvests in the scene.

Before NFP Scenes:



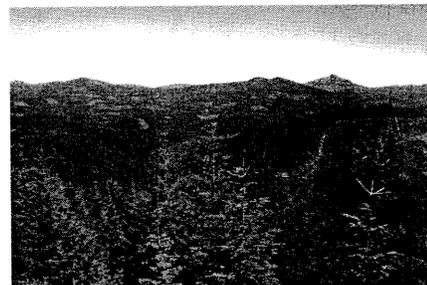
S.B. = -0.46



S.B. = -0.39



S.B. = -0.70



S.B. = 0.27



S.B. = 0.95

Scene 1

Scenic Beauty Change =
+0.26

Scene 2

Scenic Beauty Change =
+1.91

Scene 3

Scenic Beauty Change =
+1.65

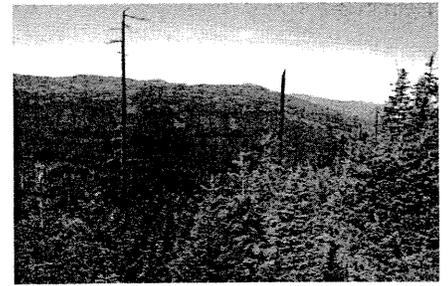
Scene 4

Scenic Beauty Change =
-0.53

Scene 5

Scenic Beauty Change =
-1.03

After NFP Scenes:



S.B. = -0.20



S.B. = 1.52



S.B. = 0.95



S.B. = -0.26



S.B. = -0.08

Figure 13. The before and after NFP versions of the study scenes with their corresponding average scenic beauty ratings, and changes in those ratings attributable to the simulated NFP. (See Table 1 for further description of the scenes.)

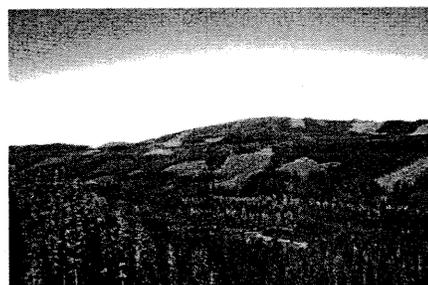
Before NFP Scenes:



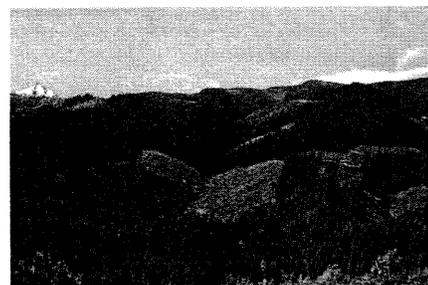
S.B. = 0.32



S.B. = -1.74



S.B. = 0.83



S.B. = -0.09



S.B. = -1.10

Scene 6
Scenic Beauty Change =
+0.57

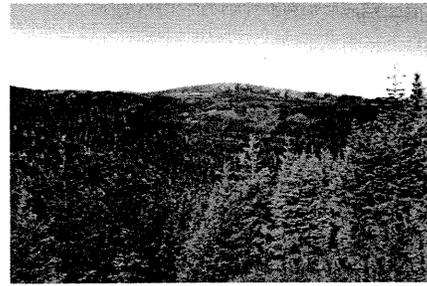
Scene 7
Scenic Beauty Change =
+2.39

Scene 8
Scenic Beauty Change =
+0.93

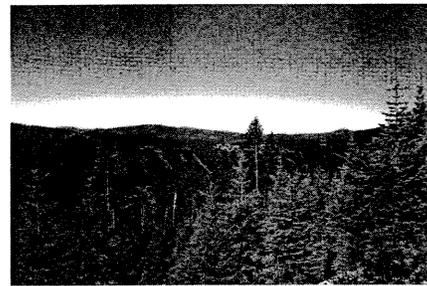
Scene 9
Scenic Beauty Change =
+0.48

Scene 10
Scenic Beauty Change =
+1.91

After NFP Scenes:



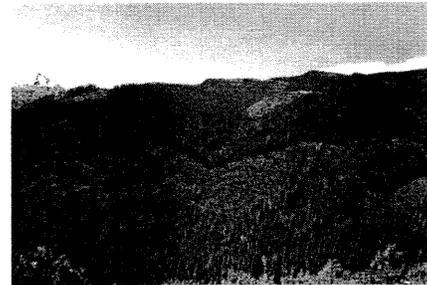
S.B. = -0.89



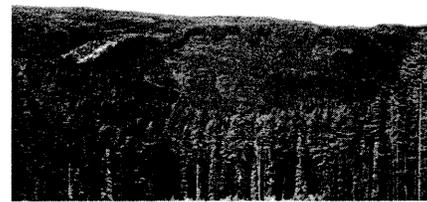
S.B. = 0.65



S.B. = 1.76



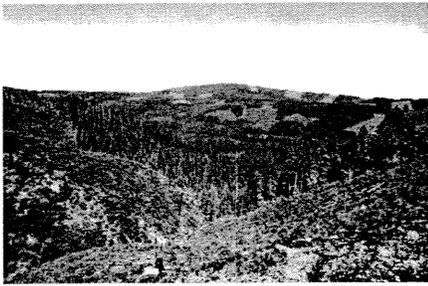
S.B. = 0.39



S.B. = 0.81

Figure 13 (continued).

Before NFP Scenes:



S.B. = 1.63



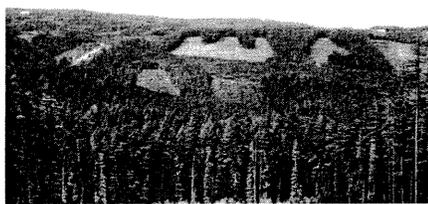
S.B. = 1.35



S.B. = 2.44

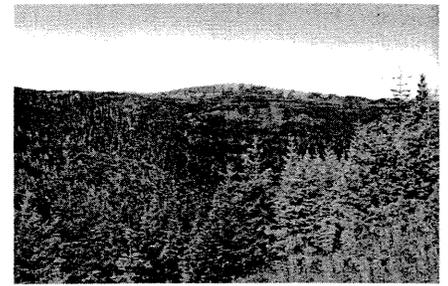


S.B. = 2.11



S.B. = 1.77

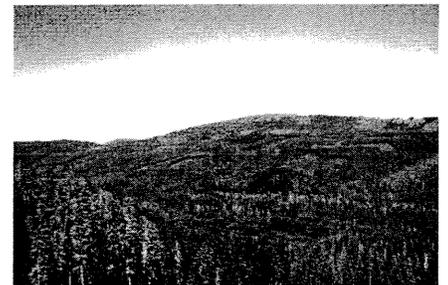
After NFP Scenes:



S.B. = -0.60



S.B. = 0.48



S.B. = 2.13



S.B. = 1.68



S.B. = -1.28

Scene 11
Scenic Beauty Change =
-1.03

Scene 12
Scenic Beauty Change =
-1.83

Scene 13
Scenic Beauty Change =
-0.31

Scene 14
Scenic Beauty Change =
-0.43

Scene 15
Scenic Beauty Change =
-3.05

Figure 13 (continued).

Results

The average scenic beauty ratings for the study scenes and how they changed with the simulated NFP appear in Figure 13. These changes tended to be positive for the large- and medium-scale vistas, likely due to reductions in high-contrast new harvests, and negative in small- and very-small-scale vistas, likely due to near views of newly added harvests. More precise statistical results were needed to see which detailed changes in the various scene pairs were associated with changes in perceptions. These detailed results constitute an analysis of how scenic beauty perceptions relate to measured changes in the specific study scenes' content. They would be instructive as such even if the scenes did not derive from a simulation of the NFP.

Single Variable Effects. Table 2 shows how changes in each of the independent variables' correlated with scenic beauty changes, and reveals some notable results. Most of the high-contrast or fresh harvest change variables were significantly correlated (probability $F < 0.05$) with changes in beauty except in the immediate foreground where too few occurred in the scene sample. These high-contrast harvest measures tended often to be significantly correlated with beauty change whether the harvests were clearcuts, NFP harvests, or both.

A minority of the VMS-based measures of scene change significantly correlated to changes in beauty, and these were of only two types: retention/preservation, or maximum/unacceptable modification. Two of these were the most strongly correlated to changes in beauty: namely the percent of maximum/unacceptable modification VQO in whole scenes, or just in the middleground. Measures of changes in the percent of scenes in partial retention or modification VQOs, by themselves, were never significantly correlated with changes in scenic beauty.

None of the measures of scenic change in the immediate foreground showed a statistically significant relation to changes in scenic beauty (Table 2). This was likely because the scenes were photographed to be long

Table 2. Correlation of Changes in Scenic Content Measures with Scenic Beauty Changes

Scenic Content Measure*	r	r ²	F	Prob. F
Immediate Foreground Retention/Preservation	0.40	0.16	2.50	0.14
Immediate Foreground Partial Retention	-0.08	0.01	0.08	0.78
Immediate Foreground Modification	0.00	0.00	0.01	0.93
Immediate Foreground Maximum/Unacceptable Mod.	-0.32	0.11	1.54	0.24
Foreground Retention/Preservation	0.60	0.36	7.21	0.02
Foreground Partial Retention	-0.28	0.08	1.15	0.30
Foreground Modification	-0.28	0.08	1.10	0.31
Foreground Maximum/Unacceptable Modification	-0.60	0.36	7.28	0.02
Middleground Retention/Preservation	-0.31	0.10	1.38	0.26
Middleground Partial Retention	-0.22	0.05	0.67	0.43
Middleground Modification	0.32	0.10	1.45	0.25
Middleground Maximum/Unacceptable Modification	-0.75	0.56	16.27	0.00
Background Retention/Preservation	0.17	0.03	3.46	0.50
Background Partial Retention	0.35	0.12	1.77	0.21
Background Modification	0.16	0.03	0.34	0.57
Background Maximum/Unacceptable Modification	-0.40	0.16	2.56	0.13
Immediate Foreground Fresh Clearcuts	-0.35	0.12	1.84	0.20
Immediate Foreground Fresh NFP Regen. Cuts	0.00	0.00	0.00	1.00
Immediate Foreground All Fresh Cuts	-0.35	0.12	1.84	0.20
Foreground Fresh Clearcuts	-0.26	0.07	1.06	0.32
Foreground Fresh NFP Regeneration Cuts	-0.66	0.43	9.77	0.01
Foreground All Fresh Cuts	-0.58	0.34	6.63	0.02
Middleground Fresh Clearcuts	-0.67	0.45	10.64	0.01
Middleground Fresh NFP Regeneration Cuts	0.03	0.00	0.01	0.91
Middleground All Fresh Cuts	-0.59	0.35	7.12	0.02
Background Fresh Clearcuts	-0.57	0.32	6.17	0.03
Background Fresh NFP Regeneration Cuts	0.51	0.26	4.50	0.05
Background All Fresh Cuts	-0.26	0.07	1.01	0.33
Whole Scene Retention/Preservation	0.67	0.45	10.51	0.01
Whole Scene Partial Retention	-0.22	0.05	0.75	0.40
Whole Scene Modification	-0.01	0.00	0.01	0.98
Whole Scene Maximum/Unacceptable Modification	-0.81	0.66	19.91	0.00
Whole Scene Fresh Clearcuts	-0.46	0.21	4.74	0.05
Whole Scene NFP Regeneration Cuts	-0.64	0.41	9.06	0.01
Whole Scene All Fresh Cuts	-0.64	0.41	9.23	0.00

* All measures are changes in the percent of scenes, exclusive of sky, from each current conditions photo to its matching simulated NFP photo.

views and consequently had little if any immediate foreground. Where there was simulated growth of trees to replace clearcuts in the immediate foreground, this was moderately correlated with scenic beauty gains but not with statistical significance.

In the foreground, gains in retention/preservation VQO areas or losses in maximum/unacceptable modification VQO areas were significantly associated with gains in scenic beauty, while gains in all fresh harvests were significantly associated with losses in scenic beauty (Table 2).

The best explanations of increases in scenic beauty in the middleground were reductions in maximum/unacceptable modification VQO areas or reductions in fresh, high-contrast clearcut areas. In the background, only reductions in high-contrast clearcut areas were significantly associated with increases in scenic beauty (Table 2).

Regression Models. The combinations of variables in the models in Table 3 account for changes in scenic beauty more than single variables can. These models were developed to predict scenic beauty changes in the same scene and not to predict scenic beauty differences between different scenes. They employed the most explanatory combinations of independent variables possible without employing highly correlated variables.³⁶ The three models in Table 3 are equally significant and useful with interesting differences.

The most effective model using only VQOs in explaining gains in scenic beauty employed the reduction in maximum/unacceptable modification harvests in whole scenes as its most effective factor (Table 3). The next most effective measure in this model was gains in middleground modification, followed by gains in retention VQO area in the foreground.

The model employing only measures of fresh harvests shows that reductions in fresh clearcuts in the middleground explain the most gain in scenic beauty. This explanation of increases in beauty was followed by that from reductions in all fresh harvest types in the foreground, and then by reductions in fresh background clearcuts.

Table 3. Best Regression Models Explaining Scenic Beauty Changes. (Dependent Variable for All Three Models: Changes in Scenic Beauty due to simulated Northwest Forest Plan)

Model Using Only Scenery Management System Scene Measures:

Independent Variable	Estimated Coefficient	Standard Error	t	Prob. ^t
Whole Scene Maximum/Unacceptable Mod.	-0.06	0.01	-4.53	0.001
Middleground Modification	0.20	0.09	2.13	0.06
Foreground Retention/Preservation	0.03	0.02	1.34	0.20
Constant	-0.43	.34	-1.25	0.24
Regression Statistics: R ² = 0.78 Adjusted R ² = 0.73 F = 13.38 df = 11 p = .0005				

Model Using Only Fresh, High-contrast Harvest Scene Measures:

Independent Variable	Estimated Coefficient	Standard Error	t	Prob. ^t
Middleground Fresh Clearcuts	-0.27	0.09	-2.87	0.01
Foreground All Fresh Cuts	-0.02	0.01	-1.81	0.01
Background Fresh Clearcuts	-1.71	0.67	-2.55	0.03
Constant	-1.12	0.37	-3.03	0.01
Regression Statistics: R ² = 0.72 Adjusted R ² = 0.64 F = 9.25 df = 11 p = .002				

Model Using Any Scene Measures:

Independent Variable	Estimated Coefficient	Standard Error	t	Prob. ^t
Whole Scene Maximum/Unacceptable Mod.	-0.06	0.03	-1.79	0.11
Middleground Modification	0.20	0.08	2.31	0.05
Middleground Fresh Clearcuts	-0.14	0.02	-1.48	0.17
Background Fresh Clearcuts	-0.83	0.81	-1.03	0.33
Foreground All Fresh Cuts	-0.01	0.02	-0.43	0.68
Constant	-1.13	0.31	-3.67	0.005
Regression Statistics: R ² = 0.85 Adjusted R ² = 0.77 F = 10.20 df = 9 p = .002				

The best model employing any available measures of scenic changes is at the bottom of Table 3. It contained all the same variables as the two previous models except the measure of foreground retention/preservation VQO.

Conclusions

Where national forests are subject to more intensive timber harvesting, is it possible that a biocentric policy emphasis might pre-empt the need for explicit scenery management? Differences in respondents' ratings of scene pairs provide evidence that adoption of the biologically driven Northwest Forest Plan, with little attention to scenic design,

might produce more affectively acceptable scenery than a traditional clearcut-dominated landscape with low levels of VMS visual impact mitigation.

More detailed analytic results indicate that these simple changes in perceived beauty mask critical formal aspects of people's aesthetic responses to landscapes that still deserve the attention of ecosystem managers. Harvests with high color contrasts, even in the background, can still elicit adverse affective responses even if they are New Forestry regeneration harvests. Likewise, harvests in the foreground and middle-ground with unnatural, high-contrast color and form, so as to meet the unacceptable or maximum modification VQO, will also produce perceptions of low scenic beauty (Table 2). Changes in the natural landscape character of whole scenes remain, by themselves, significantly correlated with greater scenic beauty (Table 2), as is a foundation of VMS and SMS prescriptions, and this should remain a management concern.

The NFP promises to improve the affect of vista views in national forest landscapes where scenery has been adversely perceived. Nevertheless, visual resource management is still required to assure this outcome. For example, in the foreground, all recent harvests adversely affected scenic beauty changes irrespective of whether they were old-style clearcuts or NFP regeneration cuts with green-tree retention (Table 3). Of equal power in explaining reductions in scenic beauty was the extent of foreground harvests meeting the maximum or unacceptable modification VQO, or, in explaining gains in beauty, the extent of the retention VQO in the foreground (Table 2). Landscape architecture is still needed to mitigate the scenic impact of foreground harvests, even with green-tree retention.

The importance of visual resource management is clearly illustrated by one strong finding: The percent of whole scenes in unacceptable VQO or maximum modification VQO contrast harvests was the single most powerful factor in explaining reductions in scenic beauty. The

design of harvests matters in all distance zones to prevent unattractive harvests, even with green-tree retention.

The potential scenic advantages of the NFP and ecosystem management are manifest beyond the foreground. Increases in the modification VQO in the middle-ground were predictive of *gains* in scenic beauty, contrary to VMS theory (Table 3). This was likely because harvests meeting this moderate-contrast VQO increased with the simulated NFP along with scenic beauty. This increase had two components: First, pre-NFP clearcuts regenerated new forest cover and thereby changed from unacceptable/maximum modification VQOs into lower-contrast modification VQOs evidently benefiting scenic beauty. Second, new middle-ground NFP harvests were predominantly judged to meet the modification VQO, further adding to this measure and evidently not adversely affecting scenic beauty. This interpretation is supported by the complete lack of any correlation between middle-ground, high-contrast NFP harvests, and scenic beauty (Table 2), compared with the strong correlation there for clearcuts (Table 3).

These middle-ground results are likely a product of how middle-ground NFP harvests were simulated in this study. The researchers took seriously the intentions found in NFP planning studies to shape these harvests mimicking disturbance patterns and did so most, but not all, the time (Figure 13, Scene 12). If managers also mimic such patterns, with the aid of biologists and landscape architects, then improvements in scenic beauty will likely result from this new professional relationship. It is possible, however, that middle-ground NFP regeneration harvests could be designed to adversely affect scenic beauty. For example, they could appear, and perhaps functionally be, less natural, with straight edges and rectilinear green-tree retention patches. More research is

needed to determine how harvest patterns and shapes can be best accomplished to jointly meet aesthetic and ecological objectives.

The same set of potential positive New Forestry aesthetic effects evidently applies to the background, except more strongly. Ecosystem management should benefit scenery there without special design, for the reason that more natural, lower contrast, non-clearcut harvests should blend in to casual observation at such distances. The background-simulated NFP regeneration harvests were significantly and positively correlated with scenic beauty (Table 2). This is in contrast to background, fresh or high-contrast clearcuts that significantly reduced scenic beauty, just as they did in the middle-ground (Table 3).

Visual impact mitigation of ecosystem management harvests in foreground and middle-ground distance zones evidently need not be too finely applied. Changes in the area of scenes in partial retention and modification VQOs did not have significant and expected effects on perceived scenic beauty. The public reacts strongly only to high-contrast harvests (negatively), and to the retention of mature forest canopies (positively). Visual resource management under the NFP can best concentrate on these two less nuanced aspects of landscape form when designing green-tree retention harvests. This suggests an idealized scenario for this new policy landscape. If all NFP harvests were designed to meet modification or partial retention VQO standards everywhere, rather than lower VQOs—and if these were few enough to maximize closed forest canopy and green-tree retention was sufficient to prevent high color contrasts—then the landscape should produce few if any adverse affective responses.

Speculative Discussion

Public forest landscapes continue to change as a result of new policies to meet evolving public values and understandings of nature. Aesthetics has long been one key way that many people view the care of national forests, and visual resource

management has often responded by seeking to mitigate evidence of ecological impacts to a public conditioned to prefer natural scenery (Nassauer 1992). With the Northwest Forest Plan, long vistas of affected national forests are instead likely to become simply exhibits of what they are actually about. These broad landscapes could exhibit biologically driven forms, without need for as much scenic mitigation as in the past, and potentially with acceptable scenic beauty. Of course, only time, politics, and actual management choices will tell.

This potential convergence of management intentions and acceptable aesthetics could portend a period of policy stability, at least from the standpoint of public perceptions, provided visual resource management attends to persistent problems in small vistas. (Since this study was executed, many fewer harvests have occurred than the study anticipated and simulated.) Of course, other policy problems may arise because the NFP seems to privilege "ecological health" and biocentric values in its balancing of multiple-use forest outputs. Commercial, recreational, or other human needs may ascend in political power.

If aesthetic concerns are significantly and "naturally" taken care of under an ecosystem management paradigm, as this study suggests is possible, this would be important. The long-standing conflict of perceptions between the public and resource management professionals could be substantially reduced. This is one of the prime intentions of the ecosystem management paradigm (Bormann et al. 1994), where management is supposed to be based on socially defined goals and adaptive learning from the public as well as from natural systems.

Will the NFP reduce this conflict between the public and managers? This remains to be seen, but there is potential to integrate management of ecological systems with aesthetics, rather than have them compete or serve mainly to mitigate each other's impacts. This is one of the prime intentions of the Forest Service new Scenery Management

System (USDA 1995b). Past experience suggests this new system will succeed only if it does not exclude the kind of public perceptions investigated here. This exclusion is possible as managers seek their own ecologically beautiful solutions to problems with the help of local constituents with vested interests and potentially different aesthetic standards than the general public. There is a continued need for landscape architects to be involved in integrative planning and forest design to ensure that harvest patterns in the foreground and middleground can best meet public expectations.

The methods of this study illustrate how landscape visualization and research techniques can aid an understanding of the aesthetic implications of proposed changes in management (Chenoweth 1991). As forests develop policies for ecosystem management, such methods can help ensure that aesthetic and social acceptability issues receive due consideration among public groups and decision-makers (Chenoweth 1986). This can enable managers to protect traditional scenic values, and landscape architects can also be "advocates for the scenically challenged parts of nature" (Saito 1998). Less obviously visible attributes of ecosystems can also be a source of aesthetic pleasure (Kiester 1998) and these too need to be understood and communicated in management decisions (Gobster 1999).

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Notes

1. Clearcuts are also one type of regeneration harvest because they too are meant to regenerate a new forest.
2. Other issues, such as flood control, resolving resource use rights, and a steady timber supply, were certainly involved, especially at the local level (Dana and Fairfax 1980), but a major, national political impetus derived from the perceived ravaging of the landscape by mass clearcutting.
3. During this study, the Forest Service replaced the Visual Management System (USDA Forest Service 1974) with the Scenery Management System or SMS (USDA Forest Service 1995b), which is required by the National Environmental Policy Act as well as NFMA. The new SMS places added emphasis upon local residents' viewpoints and upon ecological dynamics and health. The scenery inventory and visual quality objectives portions of the new system are largely the same as the old, with new terminology for the same categories. Because this study only investigated scenic beauty perceptions of the general public, rather than of local residents, only the common, largely unchanged portions of these systems are relevant. It was therefore not necessary to make any changes to the research in light of the SMS. Either system's terminology could be employed. Because the VMS was the system the Mount Hood National Forest was using at the time of this study and because most of the landscape architects used as judges were more familiar with the VMS, the old VMS terminology is used to identify and measure visual resource management attributes.
4. Clearcuts are more common in regions where commercially preferred tree species are shade intolerant, requiring openings to become reestablished, as in the Cascade Mountains. They tend to be less common in national forests near big cities, which demand an emphasis on recreation, and/or in areas with few timber mills to demand high volumes of harvest.

5. The northern spotted owl scenario has indeed subsequently played out in similar fashion elsewhere. The same laws govern all national forests and precedents were set in the Northwest resulting in similar case law and alterations of management priorities and planning processes elsewhere. Examples include the Indiana Bat in the eastern Midwest, the Mexican spotted owl in Arizona and New Mexico, the "potential endangered threatened or sensitive" (PETS) species in the southeastern states, and most recently the California spotted owl in that state.

6. The NFP allocates public lands in categories sketched as follows (USDA and USDI 1994a; 1994b): "Matrix lands" (4.9 million acres) are available for timber harvests within which at least 15 percent of living trees must not be cut. "Late successional reserves" (7.1 million acres) are to be managed primarily for wildlife habitat restoration, including an eventual cessation of commercial harvests, but with thinning allowed in order to promote development of old-growth-like forest structures. "Adaptive management areas" (1.5 million acres) are designated for management innovation and experimentation initiated and planned by local citizens and managers. "Riparian reserves" (2.2 million acres) are stream buffers within all lands, varying in width by class of stream, where tree cutting is not allowed except as it may benefit water quality or riparian and in-stream habitats. Administratively and congressionally withdrawn areas (8.7 million acres), such as wilderness and forest types not at issue in the plan's development, make up other land designations.

7. The actual implementation of the NFP to date has resulted in lesser than expected harvest volumes (Haynes 1998) due to the limiting effects of the requirement that to-be-harvested areas be "surveyed and managed" for sensitive species, fewer compensatory harvests of old-growth forests than planned, and other legal and budgetary factors. These unknown possibilities were assumed away for this study, so as to simulate the plan's then-expected impact on the landscape. The initially expected harvest volumes constitute a middle basis—between prior policy and an effective shutdown of harvesting—for examining how the NFP's alternative harvest patterns might affect scenic beauty. Different actual manifestations of the NFP on the landscape over time might then be referenced against those used in this study.

8. The formulation of the NFP did not completely ignore the social dimensions of the controversy. This was done to the extent required by law. Social values and perceptions are integral to the chosen "ecosystem management" approach to solving the controversy (Bengston 1994). The social consequences of ecosystem management have been debated (Lee et al. 1990; Stankey and Clark 1992) and considered in the formulation of the NFP (USDA et al. 1993, Chapter 7) and its environmental impact statement (USDA and USDI 1994b); and the perception of the landscapes it might produce has received attention (Brunson and Shelby 1992; Gobster 1994; Ribe 1999). Methods for understanding the production of socially and aesthetically acceptable

landscapes via ecosystem management are also being explored (Brunson 1993; Gobster 1996; Kiester 1998).

9. The study area does include a corridor historically protected for scenic and biological values (Clackamas National Wild and Scenic River, now also a late successional reserve) in rough proportion to that now similarly protected in the larger region effected by the NFP via late successional reserves. The VMS remains in force, and has and does protect foreground and to a lesser extent middleground views from that river. None of the simulated landscape changes in this study affected those scenically protected distance zones differently than VMS standards. The study scenes focused mainly on the remaining larger landscape that sustains low VQOs.

10. This time interval was chosen to allow clearcuts to regenerate into forest cover so the new NFP pattern of harvests will begin to dominantly affect scenic beauty. The chosen interval was not so long as to exceed the normal political cycle of national forest management styles (Bonnicksen 1990) and thereby exceed the optimistic life of the NFP.

11. This study assumes that aesthetic tastes in relation to environmental attitudes will remain substantially unchanged over twenty years. There is no other readily tractable option. This assumption is problematic because, for example, the public may, over time, become accustomed to intensively managed landscapes and find more beauty in them (Palmer 1997; Northrop 1956). Other authors suggest aesthetic tastes are quite stable in this short a time frame (Hays 1987; Huth 1972). This uncertainty should be recognized in interpreting this study.

12. The validity of the visual resource management systems (VMS and SMS) employed by the Forest Service is not well established by empirical evidence. These methods are strongly established as the standard of professional practice for forested landscapes throughout the U.S. and elsewhere. They therefore have high face validity for this study's topic, and are the most practical, readily available, and widely understandable tools for use in executing and disseminating this research.

13. This map is not included among the figures in order to help protect these habitats.

14. The projected harvest rates for simulation were estimated at the GIS projection stage of the study during 1994 and 1995. The acreage of harvests to be simulated in the study landscape was estimated by steps. The steps sought to estimate the acreage of harvest in future five-year intervals that might be representative under the NFP in landscapes like the study landscape, while seeking to anticipate roughly how much harvesting might actually occur there as well. The basis for these estimates was the acreage of forest harvested within the study landscape during the 1980s, as measured from the 1992 vegetation GIS map's plantations fewer than 12 years old. (Few harvests oc-

curred during 1990 and 1991 due to spotted owl related moratoria and injunctions.)

The first estimate was by reference to the harvest volume (board feet) expectations of the NFP (USDI and USDA 1994b pp. 3&4-265). This projection indicated that volumes of timber removed in Oregon National Forests per decade under the NFP would be about 20 percent that of the 1980-1989 period. The land base available for these harvests is reduced to about 40 percent of that prior to the NFP after withdrawal of late successional reserves and riparian buffers, indicating that half the acreage harvested in the 1980s will be required within the NFP's matrix lands to meet expected volumes. The study landscape contains roughly the right proportion of riparian reserves and about one-third of the late successional reserves to be representative of the western Cascade Mountains of Oregon (USDA et al. 1993 pp. III-44). Consequently, the acreage harvested within the study area will be greater than 20 percent of 1980s levels due to its greater proportional inclusion of matrix lands available for harvest. This adjustment for a shortage of late successional reserves in the study landscape brought the proportion of 1980s harvested acreage to simulate forward up to 25 percent.

Further refinements were necessary to account for changes in the nature of future harvests under the NFP. The acreage proportion found above had to be increased by 15 percent to compensate for the NFP's 15 percent green-tree retention requirements within harvest units, as opposed to the prevailing clearcuts of the 1980s, thus bringing the total to 29 percent of 1980s levels. (This 15 percent retention requirement is a minimum, but it was assumed to be the norm for simulation purposes in light of past Forest Service tendencies to predominantly use standard limits most conducive to maximizing harvest volumes. It is also indicated in USDA Forest Service (1995b) as the norm for the study landscape.)

This 1980s acreage proportion had to be increased again by 15 percent. This adjustment was performed in order to account for estimated lesser volumes per acre harvested from second-growth forests compared to the estimated mix of second-growth and old-growth forests harvested from the Mount Hood National Forest and western Cascade Mountains from 1980 to 1989 (USDA et al. 1993 pp. IV-64; Beuter et al. 1976 pp. 28, 75; MacLean et al. 1992, Table 59; Staebler 1955).

This second 15 percent adjustment seemed a bit low given the shift away from old-growth harvests throughout the NFP region. It was accepted because it affects the area of final harvests to be simulated and does not consider the added volume from thinning expected under the NFP. It was further justified by the fact that substantial late seral forests will be harvested from the study landscape (USDA Forest Service 1995a, p. 40). This brought the final estimated proportion of 1980s acres harvested going forward under the NFP to one third. This final calculation yielded an estimated area to simulate in regeneration harvests of 2,290 acres per decade, or 1,145 per five-year interval. The official watershed analysis forecast roughly 1,000 acres of regeneration harvests per five years over a slightly larger area (USDA Forest Service 1995a,

p. 52). The similarity of these values was encouraging. The higher value was used for the forest cover simulation in order to be more representative of NFP impacts on matrix lands throughout the western Cascades rather than of the study area.

As the harvests were simulated, a tally of their volume was kept as a check against the expectations of the NFP. The acres and age of each harvest yielded a volume estimate averaged from tables found in MacLean et al. (1992) and Staebler (1955). These values were reduced by 15 percent to account for green-tree retention in future harvests. Estimating a 1980s volume from the same study landscape for comparison began with the volume reported for the whole Mount Hood National Forest (USDA Forest Service 1980–1989; Sessions et al. 1991, pp. 82, 184). Then, the proportion of that typically coming from the Clackamas Ranger District (as communicated by the district staff) was calculated. This was then reduced by the fraction of that district encompassing the study landscape. The resulting 1980s estimated volume cut value proved just a bit more than four times the simulated harvest volume estimate. The simulated harvest fell slightly below the 25 percent of 1980s volume target based only on NFP expectations derived above. It was accepted because it did not include the volume yielded from thinnings not simulated. It was also close to the harvest volumes projected for the study area by the watershed analysis (USDA Forest Service 1995a, p. 52).

15. These were landscape design efforts aimed at continuing management and harvests. The emphasis was on restoring forest composition, structures, and patch patterns to be more like those that occurred in this landscape under the pre-settlement disturbance regimes to which native wildlife are adapted (Montgomery et al. 1995; Cissel et al. 1994; Diaz and Apostol 1992). This approach emphasizes fitting new landscape patterns to landforms, microclimates, existing habitat patterns, hydrologic functioning, slope failure hazards, and landscape ecological flows, while reducing forest fragmentation. Road closures, controlling cumulative environmental impacts, recreation, and protecting critical habitats were also considered, along with meeting NFP guidelines.

16. No attempt was made to predict actual harvest locations and types for the study landscape. These will be determined over time by interdisciplinary management teams based upon studies of wildlife requirements and the outcome of biological surveys (USDA Forest Service 1995a). Standards indicated in the watershed analysis for the study landscape (USDA Forest Service 1995a) influenced the pattern of simulated regeneration harvests in the following ways: Even aged forests at least 60 years old were harvested. Harvests were aggregated with each other and with existing young plantations into larger patch sizes. Harvests were aggregated away from bands of connectivity placed across the landscape where relatively more mature, closed-canopy forest now exists. Smaller, late-seral forest patches were harvested if they were outside these bands, as indicated in the watershed analysis, which forecasts that 50 percent of old-growth

forests in matrix lands will be harvested over 30 years (USDA Forest Service 1995a, p. 55). A few harvests were simulated within the edges of spotted owl activity center protection circles as permitted as a low priority option by the NFP and indicated in the watershed analysis (USDA Forest Service 1995a).

17. The study focused only on long-distance views, and only these were photographed. The 35mm photos were recorded on maps by location, altitude, photo-vector bearing, and lens focal length. The use of digital terrain-model cameras to matching virtual photographs to these actual photographs made it unnecessary to record camera inclination because all but one variable was sufficient.

18. The Visual Management System includes procedures for identifying the inherent visual quality of the landscape and the visibility and importance of views of that landscape in order to determine objectives for managing visual quality. Using VMS terminology, Variety Classes (distinctive, common, minimal) are used in combination with Distance Zones (foreground, middleground, background) and Sensitivity Levels (high, average, low) to determine Visual Quality Objectives (preservation, retention, partial retention, modification, maximum modification or marginally acceptable, unacceptable modification, and rehabilitation). Specific definitions and procedures are found in USDA Forest Service (1974) and the corresponding revised versions of the same elements for the Scenery Management System are found in USDA Forest Service (1995b).

19. The selection of photographs for simulation was aided by the virtual NFP landscape model with the photograph map registered to it. Photographs that seemed likely to incorporate a variety of future land cover conditions were identified. The pre-simulation, current-conditions photographs were then inspected to see if they actually included the expected and desired distance zones and terrain areas. This process was repeated until the best possible set was found. (The selected photos were digitized at a resolution of 2048 × 3072 pixels.) The selective sampling strategy could not directly capture the frequency or experiential magnitude of changes to the landscape that a person traveling through it would see. This would have required a sample size exceeding the simulation resources available for this study, which is interpreted accordingly.

20. The scale categories of photographs were determined by the planimetric size, measured only within the case study landscape boundaries, of the seen area found within the photos. Large-scale photos' seen areas exceeded five square miles. Medium-scale photos were between two and five square miles. Small-scale photos were between one-quarter and two square miles, and very-small-scale photos less than one-quarter square mile.

21. The altitude GIS layer for the study area was converted into a 256 step gray-scale image. This was converted to dxf format and im-

ported into Strata Studio Pro software as a terrain model of the study area. This method was chosen instead of a wireframe terrain model to enable draping of higher resolution raster vegetation data, and because Studio Pro software allows virtual cameras to be placed anywhere in the model to match photographs of current conditions (Armstrong 1996). The resolution of this model was increased, then smoothed, to produce a terrain simulation realistic enough for these virtual photos without excessive memory requirements. Better software for doing these tasks has since been published.

22. Strata Studio Pro allowed placement of a virtual camera in the virtual NFP landscape model to match the real camera in the real landscape by placement, direction, inclination, and focal length. Sometimes, attempts to fine tune these placements to better match the real photo view caused the virtual camera to move below the surface of the virtual NFP landscape model, yielding a nonsense image. In these cases the best possible match was recorded. This proved to be a drawback of this virtual picture-taking strategy. It was likely due to the inadequate resolution of the 256-step terrain model used. The method of Lange (1994) achieves similar virtual photos, perhaps avoiding this drawback, and new software available since this study was executed may also do so.

23. This was judged to be the most visually authentic strategy for simulating these forests. Their appearance will change relatively little at a long-distance-view scale, and leaving the forest canopies alone in the photos would produce more authentic-looking simulations than using a forest change simulation algorithm such as that advocated by Orland (1994) to change the texture of forested slopes.

24. A variety of techniques were used to simulate the harvests. The dominant method was to copy a harvest from another or the same photo as a floating selection. This selection was then adjusted for its light direction and quality, shadows, brightness, slope perspective, detail resolution and sharpness, color hue and balance, and scale until it matched those of the photo where it was to be placed. After placement according to the virtual photo layer guide, the edges were blended, usually through smudging and detail copying. The retention clumps and/or dispersion of trees required in NFP regeneration harvests were then added by the same methods, except when such a harvest—with retention—from the photo library could be copied into the simulation. Finally, the overall simulated image was touched up for consistency of lighting, shadows, and other attributes. Each simulation took between 16 and 28 hours to produce. (None of the 1,120 respondents who rated these scenes for this or another companion study indicated that they had detected that some of the photos were simulations.)

25. The principal author is involved in another study of various NFP-style harvests, thereby gaining experience in how these appear. Experience observing various NFP-style harvests in the field and in photographs, such as those in Kohm and Franklin (1997), indicated two key features: First, different retention patterns' visual textures look similar in the background

from one to two miles away, and much like traditional clearcuts beyond that distance. Second, when they are placed within a mature forest on a gradual slope oriented toward or sideways to the observer, such harvests are detectable only as openings in the canopy-top texture. In such cases, the retained trees inside the harvest unit are either undetectable or simply break up the appearance of the opening in the canopy. These observations were employed in the simulations.

26. The NFP also has guidelines for woody debris and snag creation or retention in harvests. Field inspections of example harvests with these elements found that their presence did not appreciably affect their appearance in long-distance views beyond 100 meters. Consequently, these provisions of the NFP did not affect the simulation of the long-distance views in this study. None of the study simulations included NFP regeneration harvests in the immediate foreground.

27. Groups were recruited to include a diversity of people with interests in preservation versus commodity production on public lands (Chandler and Lee 1994). They were also recruited to include rural, suburban, and urban respondents representing a corresponding diversity of attitudes (Tremblay and Dunlap 1978). To a lesser extent, diversity was sought in incomes, ages, educational attainments, relationship to the forest product industry, and recreational preferences. The groups included natural-resource-related organizations such as logging and property rights advocates, environmental groups, civic clubs, social clubs, professional organizations, outdoor recreation groups, higher-education classes, business clubs, corporate offices, granges, and neighborhood associations.

28. The questions that followed the slide rating session asked about respondents' outdoor recreation preferences (Clark and Stankey 1979), attitudes toward forest land management and the spotted owl controversy (Oregon Business Council 1993; Chandler and Lee 1994; Steel et al. 1994), and demographic attributes.

29. At first, slide trays were assigned to groups at random until each had been rated by at least 200 respondents. From that point, groups were assigned intentionally to make the two sets of respondents "similar" to each other to reduce the chance that any one would have a chance over-representation of respondents with some key bias. Groups were judged to be similar if each contained at least one fourth residents of rural areas and cities with populations less than 20,000, and if each contained roughly equal numbers of respondents tending to favor forest production versus forest protection.

To similarly balance the ideology of the two sets of respondents, a running tally was kept of responses to two questions about the northern spotted owl controversy. These were questions about whether the spotted owl should be saved even at a high economic cost; and whether the spotted owl should be saved only without infringing on private property rights. This intentional assignment of groups continued until at least 600 respondents were sampled. Seventeen groups (320 respondents)

rated one tray and 14 groups (288 respondents) rated the other.

30. Survey sessions were conducted in a manner now well established by numerous studies for group surveys of scenic beauty perceptions. The instructions were read out loud, simple logistical questions answered, numbered slides projected to the group for seven seconds each and each was rated privately by each respondent. Quiet time was then provided to answer the questionnaire.

31. These judges were respectively Warren Bacon, Dean Apostol and Richard Shaffer, to whom special thanks are due. All three had extensive experience applying the VMS and training others to do so.

32. The judges were instructed not to distinguish between preservation and retention VQOs, since these are indistinguishable by simply looking at photos. This distinction often rests on the legal or forest plan status of a land area that the judges did not know. They were instructed to leave these two classes unmarked and only to circumscribe the areas of the photos meeting lesser VQOs as seen from the vantage point of the photograph. They were not asked to judge variety classes or sensitivity levels, as these were invariant within the same-scene pairs analyzed in this study and not relevant to the study design.

33. The reliability of VMS judgments of VQOs and distance zones has not been established. These were used in spite of this shortcoming due to their face validity as the most widely established measurements used for understanding long-distance forest scenery, and as those used to manage the case study landscape and others like it.

The reliability of the experts' VQO judgments proved quite high. All three judges' VQOs agreed 87 percent of the time, including "retention" VQO identifications, and 64 percent of the time excluding these easy retention VQO judgments. Two experts agreed 84 percent of the time excluding retention VQO judgments. All three experts disagreed two percent of the time including retention judgments and five percent of the time excluding retention judgments, and never disagreed by more than the least possible range of VQO levels.

The reliability of distance zone measurements was quite poor. The three experts disagreed in the exact placement of these boundaries more often than they agreed, although they were often not far apart. Their distance zone boundary placements were averaged in the hope that this would produce placements close to where the judgments of more judges would reliably converge.

These results are consistent with Palmer's (2000) findings. Three judges—the number used in this study—were sufficient to achieve reliable (0.9 level) measurements of naturalism, as in VQO judgments. Scale-related measurements somewhat similar to distance zone identification required seven to 24 judges to achieve the same reliability.

34. This was done reliably by use of digital versions of the scenes. Each known harvested area or simulated harvest identified as partial retention or worse by the judges was selected in Adobe Photoshop along with an equal area of the neighboring forest. If the average standard deviation across all four channels in the image histogram dialogue box exceeded 15, then the harvest area was counted as high-contrast.

35. Combinations of variables were tried, seeking to maximize the F statistic, minimize the standard error of estimate, and maximize explanation of variance (Adjusted R²). To be included in a best model, a predictor had to have a statistically significant coefficient at $p = .10$ level, or contribute at least 2 percent to R², and not introduce a serious multicollinearity error. It also had to noticeably decrease the error sum of squares of the model, given the loss of degrees of freedom from adding it to the model.

36. Some independent variables pairs one would intuitively expect to be strongly correlated were not because they are measures of change across scene pairs and not measures of amounts within single scenes.

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