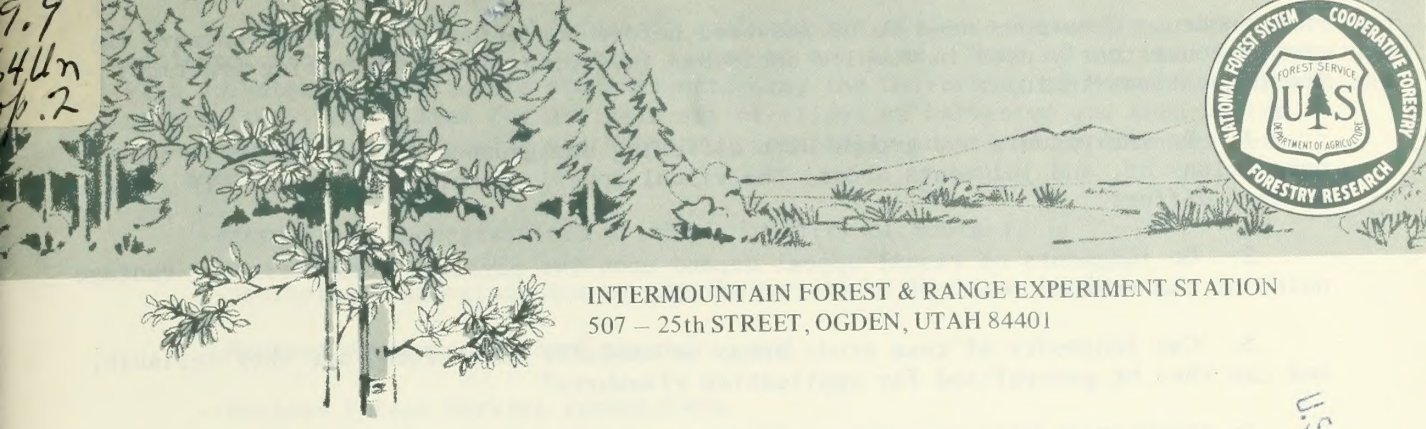

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ESTHETIC EVALUATION OF TIMBER HARVESTING IN THE NORTHERN ROCKIES--A PROGRESS REPORT[1]

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ABSTRACT

Panels of judges have been evaluating the esthetic dimension of harvested areas in the Northern Rockies. Studies conducted in Wyoming and Montana agree with intuition in that forest scenes are generally liked less as the evidence of man's activities increases.

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KEYWORDS: harvesting (silvicultural) systems, esthetics, visual impact

The appearance of forest areas that have been harvested is an important determinant of the timber harvesting systems that will be used on the National Forests in the future. At the present time, esthetics are considered in planning timber harvesting through formal agency guidelines and through the judgment of landscape architects in laying out harvesting units. Our modest research effort is intended to supplement these procedures. This report is intended both to present our findings to date and to let the reader know the nature of our work.

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[1]Most of this work has been carried out under a cooperative agreement between the University of Montana and the Intermountain Forest and Range Experiment Station. We acknowledge the contributions of Maureen F. Ullrich and Roy F. Touzeau of the University of Montana in collecting data and developing the methodology reported here.

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Numerous questions need to be answered before our efforts will yield answers that can be consistently used in complex decisions involving timber harvesting practices. These questions include:

1. Do individuals and groups with differing backgrounds differ widely in their perceptions of, and judgments about, the visual appeal of harvested areas? If so, how do they differ?

2. Do judgments of visual appeal depend upon the physical perspective or vantage point of the viewer?

3. Can judgments of case study areas be usefully quantified, are they reliable, and can they be generalized for application elsewhere?

In cooperation with researchers of the Rocky Mountain Forest and Range Experiment Station at Tucson and the University of Arizona, we are attempting to answer these questions. For the immediate future, our major efforts will lie essentially in adapting already-developed methodologies to the particular need of evaluating alternative harvesting systems in the rugged topography of western Montana.

An individual's visual perception of a harvested area depends in part upon his physical position relative to that area. We have divided our research efforts into determining

1. The impressions received when near or within a stand which has recently been harvested (that is, "near-view"), and

2. the impressions received when a stand is viewed from a distance, as from across a valley ("far view").

To date we have concentrated on obtaining quantitative and reproducible evaluations of the first, the near-view perspective, because a well-tested technique has been available (Daniel and Boster, in press). We are beginning preliminary work to validate the use of this technique or some substitute for evaluating far views; this may well be more significant in the Northern Rockies in light of the rugged topography.

TECHNIQUE USED

To date we have relied on the Scenic Beauty Estimation method (SBE) to define preferences for harvested areas; the mechanics of this technique, its validation and a wide range of applications have been thoroughly described by Daniel and Boster (in press). Essentially, the technique amounts to taking color slides or photographs of areas of interest and having groups of judges report on their degree of like/dislike for each. The process can be broken down into the following steps:

1. *Selecting areas to be evaluated.*--In the next section we report on evaluations of newly logged areas on the Teton National Forest in Wyoming and on the Bitterroot National Forest and Coram Experimental Forest (Flathead National Forest), both in Montana.

2. *Representing the areas as photographic slides.*--Because it is impractical to transport many viewers to sites that require evaluation, we have chosen to represent those sites through photographic slides. In our work, slides have been selected to represent the views that would be seen by an observer walking near or through the treated areas. Esthetic judgments seem to be unaffected by a rather wide variation in photographic quality, perhaps because of the radical differences between clearcut, partially cut, and uncut stands that we have compared. Presumably, photoquality would be more critical if we were attempting to measure more subtle differences, but this point has not yet been validated.

3. *Selecting panels of judges to evaluate the slides.*--Typically, evaluations are collected from a group of 25 or more judges at one time. Most of our work has been done with volunteer undergraduate students attending the University of Montana. Ullrich and others (1975) found that for a single set of slides of harvested and unharvested old-growth stands in Wyoming and Montana, essentially identical preferences were assigned by:

--psychology undergraduates at the University of Montana,

--psychology undergraduates at the University of Michigan at Flint,

--Montana elementary school teachers, and

--Montana Forest Service researchers.

Daniel and Boster (in press) conducted extensive studies with a wide variety of interested groups and found that, while numeric ratings vary somewhat by groups, average group evaluations ranked different landscapes in a consistent manner.

4. *Collecting judgments from the panels.*--The judges have been shown series of slides and asked to rate their preferences on a categorical scale from 0 to 9. There are a number of slides of each of several treatment areas. From all the photographic replications for a given area, one slide from each area is randomly selected to form a block; the order of presentation of the slides within each block is also randomized. Each block then consists of one picture of each area. Blocks are then shown until all of the photographic replications are used. This procedure usually requires a total of about 100 slides and 20 minutes of time.

5. *Reducing judgments to averages for selected areas on the ground.*--The judgments provide a set of numbers reflecting the panel members' perceptions of esthetic attractiveness. Daniel and Boster (in press) have pointed out that working with raw scores alone can be misleading if different panels use the 0-to-9 rating scale in different ways, especially if some tend to use the upper end and others the lower end of the scale. The authors have developed a method of mathematically transforming raw scores to avoid this problem. In addition, their transformed numbers meet all theoretical requirements for calculating means and variances and applying standard statistical tests of differences. Because, in our work to date, the results of working with such transformations are no different than the results obtained directly from the raw scores, no transformations are included in the present paper. (The transformed scores are available upon request.)

6. *Confirming that the average evaluations of treated areas from most- to least-preferred would be the same if made on the ground.*--To date we have not independently confirmed that this is true. Research carried out in the southwest and reported by Daniel and Boster (in press) strongly suggest the same esthetic judgments would be made based on slides as would be made by the same observers in the forest.

We have applied this general technique in the three areas described in the next section. For convenience of presentation and ease in reading, we have adopted the convention that all raw data scores are presented as if judges had used a 0-to-9 categorical scale from "dislike" to "like." In fact, in some instances the judges were instructed that 0 represented "like" and 9 represented "dislike." (The literature of psychological testing suggests judges would be only slightly influenced by scale reversals in ranking treatments.) We have used this convention in our most recent work and intend to use it in the future.

We have evaluated logging practices in three different areas:[3]

Area	*Principal Comparison*
Teton National Forest northwestern Wyoming	Alternative treatments of logging residues in old-growth lodgepole pine
Bitterroot National Forest western, Montana	Logging by horses, crawler-tractor skidders and wheeled skidders in old-growth lodgepole pine
Coram Experimental Forest (Flathead National Forest), northwestern Montana	Clearcutting and shelterwood cutting in old-growth fir-larch

TETON STUDY

In 1971, a study was begun to evaluate a system of harvesting mature lodgepole pine in which virtually all the logging residue--branches, tops, and dead and cull material--was yarded and chipped at the logging site (reported in detail in Benson 1974). The study area is located in Wyoming near the Union Pass area of the Teton National Forest.

Four units of approximately 20 acres each were harvested by clearcutting. Two of the units were logged following conventional practices for that part of Wyoming. Saw logs to a 6-inch top were removed; the remaining material was left for burning on the site. The other two units had "near-complete" removal of slash; in addition to taking out the merchantable saw logs, virtually all the remaining material was yarded and chipped. On the near-complete units, a feller-buncher and rubber-tired grapple skidder were used in connection with an in-the-woods chipper.

Esthetic evaluations of six different logging and residue treatments were made by a panel of students. They rated a series of slides taken to represent the views of an observer hiking or driving alongside the treated areas on a 0-to-9 scale; summary statistics are presented in table 1. The median ratings show that half the judges rated the treatment higher and half lower than the value shown.

From these data, the judges most preferred scenes of unharvested areas and least preferred scenes of a recent clearcut where logging residues had recently been piled and burned. Clearcut areas where vegetative regrowth had started to mask the partially burned residues or where the residues had been converted to chips that were then spread throughout the harvested area were judged intermediate in esthetic value. The panel's judgments agreed closely with independent evaluations made of the area by a Forest Service landscape architect.

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[3]Detailed physical descriptions of all study areas have been reported in the internal report, "Forest residues utilization research and development program: progress report I," March 1975, 126 p. USDA For. Serv., Intermt. For. and Range Exp. Stn., Ogden, Utah.

Table 1.--*Evaluations of harvested and unharvested old-growth lodgepole pine stands on the Teton National Forest*

Treatment	Median rating
Edge between meadow and unharvested old-growth stand	8.00
Unharvested old-growth stand	5.85
5 years after clearcutting with residues piled and burned	4.25
1 year after clearcutting with chips spread over area	3.90
1 year after clearcutting with near-complete removal of residues	3.65
1 year after clearcutting with residues piled and burned	2.15

BITTERROOT STUDY

In 1974, a number of small units averaging about 1-1/2 acres were clearcut in small-diameter, old-growth lodgepole pine on the Bitterroot National Forest to determine the productivity of several logging systems including rubber-tired skidding, crawler-tractor skidding, horse skidding, and a combination of horse and rubber-tired skidding. Photographs were taken before and after harvesting to determine whether near-view esthetic values varied by the skidding method used.

Because of the small size of the clearcut areas, the photographic slides were taken from the periphery of each cutting unit, oriented inward. These slides were then evaluated by 29 students (summary results are presented in table 2).

Higher scores indicate those skidding methods that were relatively liked. Although the uncut stands were all preferred to any of the stands after harvest, no statistically significant differences (regardless of the level of probability) were found among the areas either before or after harvesting.

It is important to recognize the dangers of trying to extrapolate the results from this small experiment to generalizations about the esthetic dimension of the examined skidding systems. For example, the woody material left on the ground after logging averaged nearly 1,000 cubic feet per acre, quantities which might well have led to different esthetic evaluations than if only a few pieces had remained. Further,

Table 2.--*Evaluations of four different skidding methods used in the Bitterroot National Forest*

Skidding method	Mean rating	
	Before harvest	After harvest
Combination horse and rubber-tired skidder	3.82	1.60
Crawler-tractor skidder	3.69	1.98
Rubber-tired skidder	3.53	1.91
Horse skidder	3.43	1.67

the evaluations probably were influenced by the small size of the clearcut areas, which averaged about 1-1/2 acres each, and by every photograph having a background of uncut forest. We can only state with assurance that our particular study did not detect differences among the appearances of the small areas that were harvested.

CORAM STUDY

In 1974, old-growth stands in the Douglas-fir and western larch forest type in northwestern Montana were harvested under several different silvicultural prescriptions to test the ecologic, economic, and esthetic consequences. Two stands each were harvested by clearcutting, group selection cutting, and shelterwood cutting techniques. Each stand was divided further into subtreatments by the manner in which the logging residues and understory were to be treated before, during, and after harvesting.

PREHARVEST AND POSTHARVEST EVALUATIONS

To determine the extent of preharvest differences in the stands, a series of near-view pictures were taken in June 1974 of areas to be shelterwood-cut and clearcut. (The group selection areas were omitted.)

In the subtreatments designated as "weed and bundle" areas (where trees to a 1-inch diameter were removed), all 5-inch and smaller trees had been cut and tied in bundles which were lying on the ground (and which were later removed from those areas during overstory harvest). Generally, these areas contained small, freshly cut stumps as well as the ends of the bundled trees; in addition, the forest canopies were more open than in the other subtreatments.

Two physical constraints dictated the method of obtaining the photographic slides. Because the subtreatments consisted of long, narrow areas on the ground, all photographs were oriented along the long axis to avoid confounding judgments with backgrounds of different areas. Because we had little idea of how the steep topography would influence esthetic judgments, half of the photographs were oriented uphill and half downhill.

The photographs were shown to a panel of 29 students. The mean scores are presented in table 3. Based on Tukey's HSD test (Winer 1971), when evaluations were appropriately pooled the following differences were found to be statistically significant at the 0.05 probability level:

--the to-be-clearcut unit was preferred to either of the future shelterwood units;

--the areas with undisturbed understories were preferred to those containing bundles of small trees; and

--photographs looking uphill were preferred to those looking downhill.

A general analysis of variance (assuming fixed effects) revealed significant interaction between treatments and photographic replications, that is, there were some slides from generally liked areas that were disliked and there were slides from generally disliked areas that were liked. We hypothesized that if a particular slide happened to present an unattractive object in the foreground of a generally liked area that slide would be relatively disliked. Because we want to establish overall ratings of like-dislike for each of the treatment conditions, we have ignored the statistically significant interaction among individual slides.

Table 3.--*Preharvest esthetic evaluation of Coram areas destined to be shelterwood-cut and clearcut*

Harvest method	Understory[2]	Camera orientation	Mean[1] rating
Shelterwood	Undisturbed (11-4)	Uphill	6.22
		Downhill	5.49
	Weed-and-bundle (11-3)	Uphill	5.27
		Downhill	5.39
Shelterwood	Undisturbed (21-4)	Uphill	6.20
		Downhill	5.60
	Weed-and-bundle (21-3)	Uphill	6.01
		Downhill	4.38
Clearcut	Undisturbed (23-4)	Uphill	7.22
		Downhill	6.41
	Weed-and-bundle (23-3)	Uphill	6.56
		Downhill	6.32

[1]A difference of 0.72 between any two numbers in this table is statistically significant at the 0.05 level. Smaller differences between pooled judgments, as reported in the text, are significant.

[2]Numbers in parentheses are treatment and subtreatment designations.

After harvest was completed in the fall of 1974, photographs were taken of clearcut and shelterwood cut areas (a mixup led to not completely replicating the pretreatment areas). A group of 32 students[4] then evaluated a mixed group of precut and postcut slides; the results are presented in table 4. Using the same statistical testing procedures as before, we concluded that:

--both shelterwood areas before harvest were preferred to either the shelterwood or clearcut area after harvest; and

--the harvested shelterwood area was preferred to the harvested clearcut area.

Although uphill photographs were again favored over downhill photographs, the difference is not statistically significant (the understory in three subareas had been slashed when postharvest photographs were taken; the understory in one other subarea had been inadvertently torn up during harvesting).

[4]The judgments of two student panels, of 18 and 14 members, were pooled because no statistically significant differences could be found between the group scores, and the experimental conditions were judged by the experimenters to be similar. The data underlying (preharvest) table 3 and (preharvest-postharvest) table 4 were not pooled because the panel evaluations were conducted in the fall and spring, times having substantially different implications for student participation.

Table 4.--*Preharvest and postharvest esthetic evaluation of shelterwood cut and clearcut areas at Coram*

Harvest method	Understory	Camera orientation	Mean rating[1]	
			Preharvest	Postharvest
Shelterwood	Weed-and-bundle (11-3)	Uphill	5.26	--
		Downhill	5.46	--
	Undisturbed (11-4)	Uphill	5.75	--
		Downhill	5.13	--
Shelterwood	Weed-and-bundle (21-3)	Uphill	6.40	4.33
		Downhill	4.70	3.83
	Undisturbed (21-4)	Uphill	6.06	4.60
		Downhill	5.73	5.11
	Slashed (21-1)	Uphill	--	3.24
		Downhill	--	3.54
	Slashed (21-2)	Uphill	--	3.99
		Downhill	--	3.48
Clearcut	Weed-and-bundle (13-3)	Uphill	--	--
		Downhill	--	1.89
	Unprotected (13-4)	Uphill	--	3.85
		Downhill	--	1.75
	Slashed (13-1)	Uphill	--	2.04
		Downhill	--	1.79

[1]A difference of 1.12 between any two numbers in this table is statistically significant at the 0.05 level. Smaller differences between pooled judgments, as reported in the text, are significant.

OTHER CORAM STUDIES

Several other exploratory tests have been run on the Coram Experimental Forest as preliminary steps in developing techniques for assessing the esthetic values of leave strips between forest roads and harvested areas, of forest roads themselves, and of distant views of harvested areas. These tests were based on adaptations of the previously discussed near-view methodology.

Leave strip analysis.--A study was undertaken to determine the effects of leave strips between the observer and the cutting units after harvesting. Photographs were taken defining five subjectively determined treatment conditions: no leave strip, light leave strip, and heavy leave strip next to a clearcut block (block 13), and presence or absence of a leave strip next to a shelterwood block (block 21). Ratings of these slides were obtained from 28 students; mean ratings are presented in table 5.

For the clearcut block, the greater the amount of leave strip the greater the preference. This was not true for the shelterwood block, probably because a large number of the slides with the leave strip contained views of a road in the foreground,

Table 5.--*Evaluations of leave strips adjacent to clearcut and shelterwood cut areas*

Treatment	Leave strip	Mean rating
Clearcut Block 13	Heavy leave strip	4.46
	Light leave strip	2.98
	No leave strip	1.19
Shelterwood Block 21	Leave strip present	3.92
	No leave strip	4.33

while those without the leave strip did not. The subsequent comparisons were correlated almost perfectly with the presence or absence of the road in the photographs: we hypothesize the presence of the road led to lowered ratings.

Near-view road study.--Photographs were taken of four different road sections by first shooting along the road and then pivoting the camera 45° between shots until a circle was completed. Evaluations indicated the most preferred road segment was a section of an old road with established vegetation. As more bare earth and rock and less vegetation were included in the slides, ratings decreased. This conclusion held both for individual slides taken at one point and for groups of slides taken on different road segments.

Far-view study.--To this point, all reported work was based on photographs taken in or at the edge of treated areas. However, distant views predominate in the mountainous regions of northwestern Montana. This study was an exploratory attempt to determine how to best evaluate the esthetic values of such views of the Coram logging treatments.

Photographs were taken from the ground and from a helicopter using a 35-mm camera (with a normal lens). From this pool of slides a sample of 39 was shown to a panel of 16 students. These slides were selected as follows:

1. Show at least three different perspectives of each unit both before and after cutting. (Some photographs were made from the air because it was not possible to get enough different perspectives from the ground.)

2. Show only a single treatment, excluding other cutting units and irrelevant scenic backgrounds and foreground foliage.

3. Use only slides of high photographic quality.

All three criteria were to some extent violated, most notably in our inability to exclude areas outside the logged area.

While the perception of a harvested area is influenced by the kind of forest and prominent land features surrounding the area, our interest was centered on evaluating particular harvesting systems. To define the area to be evaluated, supplementary line drawings were made of each photograph showing prominent terrain features; the area of interest was enclosed in a bold, dotted box. The judges were instructed to rate only that portion of the slide that corresponded to the area within the enclosure and to ignore the surrounding land. To provide a reference point, slides taken before harvest as well as after harvest were included. The mean ratings are given in table 6.

Table 6.--*Evaluations of far views of Coram harvesting areas by panels of students and professional foresters (number of slides in parentheses)*

Harvest area	Mean rating			
	Preharvest		Postharvest	
	Students	Professionals	Students	Professionals
Shelterwood Block 11	6.91 (8)	7.21	4.52 (3)	7.20
Shelterwood Block 21	6.55 (8)	7.26	3.82 (3)	6.72
Group selection Block 12	7.34 (3)	7.35	--	--
Group selection Block 22	--	--	2.81 (5)	5.24
Clearcut Block 13	--	--	.81 (4)	4.33
Clearcut Block 23	--	--	1.00 (5)	4.14

Two groups of judges independently evaluated the slides: university undergraduates and a group of foresters attending a professional meeting. While both groups assigned relatively high ratings to the preharvest slides, the professional foresters assigned substantially higher ratings to the postharvest slides than did the students. We hypothesize this was primarily due to the professionals having undergone a 3-hour introduction to many aspects of the experimental work at Coram just prior to their acting as judges. We do not know whether their general technical expertise influenced their evaluation.

The mean scores indicate an esthetic preference for the shelterwood cuttings and a relative dislike for the clearcuts, with the group selections being intermediate. We conducted no statistical testing, however, because of the small number of slides and because of the unknown extent to which the several uncontrolled influences noted above may have altered the ratings.

SUMMARY AND CONTINUING RESEARCH

The results reported in this paper have been obtained from several case-study areas. Because most of the comparisons made between cut and uncut stands represent radically different conditions of the forest, our test results generally agree with our intuition: as the amount of downed wood or the evidence of man's activities increases, forest scenes are liked less by most observers. As we explore more subtle differences among scenes, it is likely that the testing procedure will lead to less "obvious" conclusions.

We are beginning a study to determine the manner in which esthetic judgments change as vegetation changes after timber harvesting. The study will include periodic evaluations of the harvested areas on the Coram Experimental Forest and on the Teton National Forest.

Within any particular scenic view, we are trying to define the functional relationship between like-dislike evaluations and specific features of those views. The current experimental technique utilizes choices among simultaneously projected pairs and triads of pictures.

Finally, distant-view evaluation techniques are being developed. Given the rugged topography in the Northern Rockies, we feel such techniques will be the most useful of all in providing information for the further development of generalized land management guidelines.

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