AN EVALUATION OF VISUAL AND VERBAL BASED STANDARDS FOR LANDSCAPE ASSESSMENT

by

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(ABSTRACT)

Existing verbal standards accepted in visual resource management (U.S.D.A. Forest Service, 1975 and U.S.D.I., Bureau of Land Management, 1980) as a reference for evaluating the landscape have certain shortcomings. One hypothesis is that visual images of the landscape which are used as a basis or standard along with landscape descriptions for measuring different levels or categories of a landscape attribute (visual standards) will produce more consistent ratings than using verbal standards. The purpose of this thesis is to examine the use of visual standards as a predictive tool to improve landscape assessment. This study involved the development of visual standards and a comparative survey study. One group of survey respondents was asked to rate or evaluate selected landscape variables (complexity and vividness) for a set of 15 landscape scenes. Another group used more traditional verbal standards to evaluate the same variables for the same landscape scenes. The effects of visual standards was compared with the effect of verbal

standards on (1) assessing the landscape; (2) people's attitudes toward landscape ratings; and (3) people's attitudes toward the rating process. The findings indicate that using visual standards cannot produce more consistent results for rating landscape variables. Further research needs to be conducted for excluding the external variables which may affect the quality of visual standards. In fact, there is evidence to suggest that visual standards are perceived by the user as a more accurate reference. The findings also indicate that using visual standards result in a broader use of the rating scale particularly at the lower end of the scale and cause lower rating results for the tested scenes compared to verbal standards. Although using visual standards to access complexity and vividness cannot improve their predictive relationship to preference, the past research indicating a strong relationship between landscape complexity and visual quality may be influenced or biased by people's preference for the landscape. In terms of the use of image based visual standards in computer application, this limited research has been unable to find any clear advantages in terms or reliability or validity. However, visual standards do not appear to be any less reliable and valid than verbal standards.

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CHAPTER 1: INTRODUCTION

Different approaches for systematic evaluations of landscape and scenic beauty have been developed over the past thirty years. The most common method accepted by government agencies and researchers is the use of descriptions or verbal standards to assess scenic values. However, verbal standards, which are descriptions of the landscape related to landscape variables such as complexity and vividness, may evoke a range of images in different people's minds based on their personal interpretations and past experience. Furthermore, verbal standards cannot explain "concepts," "rules," and "principles" accepted in expert systems for landscape assessment. Therefore, the identification of new measurement systems to improve the existing verbal standards is needed.

Recently developed computer technology provides an opportunity for researchers to explore new methods for presenting landscape images for visual assessment. One new method worth studying is the use of standards based on visual images combined with descriptive explanation as a reference (visual standards) to explain each level of landscape variables such as complexity and vividness. The objective of this research is to identify the advantages of using this new method as a potential way to replace the existing verbal standards. The major concerns of this study are to test the effects of visual standards on: (1) assessing the landscape; (2) people's attitudes toward landscape ratings; and (3) people's attitudes toward the rating process. It is expected that using visual standards will not only efficiently support professionals in making accurate decisions, but also will help them communicate with the public in the process of landscape management.

This research involved the development of visual image based standards and a comparative survey. Visual image based standards is a set of landscape images with landscape descriptions corresponding to each level of the landscape variables being measured. Visual standards were digitized and placed in a computerized questionnaire. One group (N=15) of survey respondents were asked to use visual image based standards on the computer to evaluate selected landscape variables (complexity and vividness) for a set of 15 landscape scenes. Another group rated the same scenes or photographs by using verbal standards (written descriptions) of the landscape corresponding to different levels or categories of the variable being measured.

This thesis is divided into five chapters. They are: (1) introduction; (2) literature review; (3) research methodology; (4) analysis of results; and (5) conclusion and Implication. Literature related to this thesis and research problems existing in visual assessment are presented in the next chapter. Then in the research methodology chapter, methods used to develop visual standards and to administrate the survey design are described. Next, the significant results of this study are reported and assessed, and external variables which may affect the used of visual standards are analyzed. Finally, implications for both researchers and public land management agencies to improve visual image based standards are discussed.

CHAPTER 2: LITERATURE REVIEW

Landscape assessment and studies of scenic quality have received increased attention in the past thirty years. Different approaches have been used to assess scenic values of landscape by government agencies and professionals in landscape, forestry, transportation, and related fields. Regarding which approach is accepted by the professionals in the landscape assessment in order to predict scenic values, the approach must meet certain standards in landscape assessment. Miller (1984) pointed out that: (1) scenic preference measures and assessment methods must be reliable and valid; (2) landscape inventories utilized by an assessment or prediction system must reflect landscape conditions "causing" scenic beauty or preference fluctuation; and (3) models or methods must at least implicitly help to evaluate scenic quality impacts as a result of management manipulations.

Since the purpose of this chapter is not to provide a comprehensive summary of the literature of visual assessment, only literature relevant to the thesis is reported. There are three major objectives to this literature review. The first is to become familiar with the theoretical context of knowledge in the area of "landscape quality assessment" to support the research method of the thesis. The second is to become familiar with the results of previous research related to measures used in visual resource management. The third is to identify new ways to improve the rating procedures of visual assessment.

The literature review is composed of five parts: (1) historical overview, (2) systematic inventory approaches, (3) empirical approaches, (4) expert systems and (5) conclusion. The historical overview presents the general background of landscape quality assessment over time. The context of different research approaches used to evaluate the scenic value of the landscape will be discussed. The review of systematic inventory approaches focuses on identifying the strengths and weaknesses of measures used in existing visual assessment. The review of empirical approaches describes research that has been undertaken in order to assess the landscape quality based on the public's values. Next, the review of expert computer systems discusses the potential for applying computer techniques in landscape quality assessment. Finally, some thoughts generated from the literature review will be discussed in the conclusion.

2.1 HISTORICAL OVERVIEW

Before examining individual approaches for assessing landscape quality, understanding how these approaches have developed is important. This section introduces the historical background of landscape quality assessment and provides a framework for the following sections. The development of landscape quality assessment can be separated into three periods: (1) 1910-1960, (2) 1960-1980, and (3) 1980- to present. Each of these periods will be discussed below.

2.11 1910-1960

Before 1960, even before 1920, professionals, especially geographers, described the landscape features qualitatively. Frank Waugh in 1918 first articulated the conception of linear sequential experience of spaces in his pamphlet on landscape engineering in the National Forests. This approach later evolved into the scenic corridor concept used for roads and scenic rivers. During this period, landscape experts and professionals interpreted landscape values, even for large scale regions, based on their own observations. The landscape experts and professionals usually used the descriptive statements to provide their observations and illustrate their theories.

There are certain strengths of this qualitative descriptive approach. For example, it is simple and easy to use for small scale landscape designing and planning. However, its shortcomings are very obvious and difficult to overcome. First, it is subjective and can not avoid bias caused by individual personal preference and past experience. Second, it is not reliable enough to be applied across vastly different types of landscapes such as those public lands managed by the U.S. Forest Service. Finally and most critically, it is difficult to use the principles and theories established qualitatively as objective criteria for large scale landscape management, especially for national public lands. Therefore, with increasing public concerns for the natural landscape, a lot of approaches for analyzing landscape quality occurred between 1960 and 1980.

2.12 1960-1980

In the period between 1960 and 1980, numerous systematic approaches were developed to assess the visual quality of the landscape. These approaches developed by different researchers and government agencies, differ in scope, purpose, logic, and utility. They can be divided into two major categories:

1. systemic inventory approach to the management of visual resources by government agencies; and
2. empirical approaches for assessing landscape quality based on the general public's preference.

Much of the early innovation in methodologies for incorporating landscape values into project planning and analysis was accomplished by federal agencies such as the U.S. Forest Service, and the U.S. Bureau of Land Management. These agencies expected that using systematic approaches would lessen subjectivity and thereby enable different visual resource managers to produce more consistent results. A major detailed description of systemic inventory approaches that relate to this thesis will be introduced in section 2.2.

Some researchers (Daniel, 1976; Kaplans, 1975; and Zube, 1982;) believe that it is necessary to define landscape quality via observer-based measurements. They insist that the inventories or principles used in assessing the landscape quality should present the general public's preference. Psychophysical models and psychological methods are the two most popular empirical approaches to assess the opinions, attitudes, and perceptions of the general public and to probe complex management options or issues. The empirical studies related to this thesis will be described in section 2.3.

2.13 1980-to date

From 1980 to present, as computer techniques have developed very quickly, computer based visual simulation techniques and expert systems have been studied for supporting landscape assessment. Compared to the traditional approaches, an expert system has certain advantages. It can serve as a tool for integrating a large body of rules which can be used to develop assessments of landscape quality. Furthermore, such a system can provide coherent and logical explanations of the complex interactions of rules that comprise such assessments (Davis, 1986). Thus, expert systems have great potential in visual resource management. More details about exploring the new measures to support explanations of rules and principles used in expert systems will be discussed in section 2.4.

2.2 SYSTEMIC INVENTORY APPROACHES

Public attention to maintain and improve the aesthetic value of landscapes during the sixties and seventies spawned a major impetus for more systematic analyses and studies of landscape beauty. A substantial body of legislation (Federal Land Policy and Management Act, 1976; National Environmental Policy Act, 1969; and Countryside Act of Britain, 1969) was enacted during this period, both in the U.S.A. and Great Britain, that directed attention to the identification and management of scenic resources (Zube, 1982). The National Environmental Policy Act and the National Forest Management Act require that scenic beauty be managed on an equal basis with timber, water, forage, wildlife, and recreation. Therefore, visual quality of the landscape, as a natural resource, must be evaluated and managed by government agencies. Since this thesis is concerned with the measures used to evaluate visual quality, it is necessary for researchers to be familiar with measures used in visual resource management (VRM) systems by different government agencies. This section will be separated into two parts. One is about measures used for rating landscape inventories in VRM; and the other is about the fundamentals of establishing landscape inventories in different landscape assessment systems.

2.21 Measurements

The systematic inventory approach is widely used in managing public land. Government agencies have tended to use "systematic procedures"[1] to objectively quantify the landscape. The act of rating or quantifying the scenic quality of the landscape is a

[1]These "systematic procedures" of evaluating the landscape is defined as the Systematic Inventory Approach by R. Kaplan (1985).

component of most visual resource management (VRM) procedures. By using a step-by-step approach with explicitly descriptive criteria, different visual resource managers are expected to be able to produce the same results, when applied to the same landscape. This type of approach should also produce results that make sense when applied to different landscapes.

The systematic inventory approach relies heavily on descriptive measurements or verbal standards. Both the U.S. Forest Service (1974) and BLM (1980) utilize the descriptive measurements as a reference for describing the variety or diversity of the landscape. Compared to the qualitative landscape description used before the 1950's, these approaches are more objective and can be used to quantify the visual quality of the landscape. However, there is a shortcoming to using descriptive measures as a standard in visual resource management (VRM).

Descriptive standards used to rate landscape inventory in visual resource management are indirect and may not be accurate. For example, landform is accepted by the U.S. Forest Service as a domain for identifying variety class. The distinctive level of landform[2] in the Forest Service VMS is described as "Over 60 percent slopes which are dissected, uneven, sharp exposed ridges or large dominant features" (U.S. Forest Service, 1974, p13). In this case, without visual examples to support this description, people may have different images which come to mind according to their background and past experiences. For example, a person from the West may have an understanding of the adjectives used in this description, such as "dissected," "uneven," and "sharp exposed," different from a person from the East, because the landscape characteristics of the two

[2]There are three variety classes which identify the scenic quality of the natural landscape: Class A - Distinctive; Class B - Common; and Class C - Minimal.

regions are not the same. Since descriptive measurements (verbal standards) really involve interpretation in the minds of users, they are not accurate enough to support objective evaluation of the landscape.

Quantifying the landscape with subjective descriptive measures can not help professionals rate the landscape objectively and produce consistent results. Therefore, identifying new measures that can improve the existing verbal standards is an important problem that needs to be solved. Using a set of visual images (photographs or slides) as visual standards corresponding to each level of written description is one possible way of solving this problem which is examined by this thesis. There is the potential to significantly improve systematic inventory approaches if the visual standards prove to be valuable.

2.22 Landscape Character Type

Since this thesis attempts to identify new ways to improve verbal standards, the accepted methods of representing landscape inventories (landscape variables) need to be identified. To avoid problems arising from comparing visual quality between landscape from different regions with very different visual attributes, landscape inventories of both the U.S. Forest Service (1974) and the BLM (1980) are based on the Landscape Character type[3] which is based on physiographic regions. Landscape inventories based on landscape character type can only present the physical landscape, but do not adequately reflect a wide variety of vegetation. On the other hand, the "Biogeoclimatic Landscape

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[3]Landscape character type is established on physiographic regions as defined by Nevin M. Fenneman (1931). Physiographic region is defined as a regions of Appalachian Mountains, Great Plains, Cascade Mountains etc. It refers to an area of land that has common distinguishing visual characteristics of landform, rock formations, water forms, and vegetative patterns.

Classification System"[4] developed in British Columbia is based on regional climate and potential vegetation type. However, biogeoclimatic zones must be modified because they lack variance in visual character. A combination of biogeoclimatic zones and physiographic regions holds promise as a way of establishing meaningful regions within which visual resource management can occur (Miller, 1987). This thought is reasonable to be accepted for establishing landscape inventory in this study to keep the external validity of the new measure system.

2.3 EMPIRICAL APPROACHES

In addition to the visual resource management conducted by government agencies, there have been other methodological approaches to assessing landscape scenic quality. One direction that researchers have taken is to evaluate landscape scenic quality based on the general public's preference. Some researchers (Arthur et al., 1977) have questioned the validity of the assumptions that underlie descriptive models used in visual resource management. These researchers have suggested that an assessment approach based on the preferences of the general public is more meaningful and appropriate. This is because public lands should be managed with the public's best interests in mind.

Observer-based empirical research is one way of obtaining public opinions (Smardon et al., 1985). There are two main directions of the empirical approaches used: psychophysical modeling and psychological methods. Psychophysical modeling concentrates on the study of relationships between physical characteristics of an

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[4]The Biogeoclimatic Landscape Classification System has been developed by V. J. Krajina (1976) for British Columbia over the last 30 years.

environment and human perceptions/judgements of that landscape (Zube, 1982). Psychological methods focuses on understanding the interaction between people and environment, and it involves a search for human meaning associated with landscapes and landscape properties (Kaplan, 1985 and Zube, 1982). This rather intellectual view supports several theoretical approaches, ranging from psychobiological conceptualizations to emphasis on the effects of culture and personality (Berlyne, 1960 and 1971; Wohlwill, 1976; Clynes, 1969; Greenbie, 1975; and Appleton, 1975a).

Research studies by the Kaplans[5] and their students (Kaplan and Wendt, 1972; Kaplan and Kaplan, 1982; and Kaplan 1985) have demonstrated that various psychological constructs (such as "complexity," "mystery," "legibility" and "coherence") are important attributes or predictors of human landscape preferences. Complexity, as one of the important predictor variables studied, has been found to have a strong relationship to preference. Some research results indicate that high complexity in a natural landscape is reflected in higher preference (Kaplan, 1975; and T. Herzog 1984). Since complexity has been studied in assessing scenic value, it is one of the variables chosen for testing verbal and visual standards in this study.

Landscape attributes or predictor variables derived from psychological methods are valuable for application in visual assessment. It was found that little empirical evidence exists to support or discredit the scenic quality rating component of VRM

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[5]An important evolutionary psychological method has been developed based on Information Processing theory (R Kaplan, 1979, S.Kaplan, 1975 and 1979). The Kaplans have found that scene groupings or dimensions can be broken roughly into two types -- those having a "special content" in common such as water or certain types of land use, and those having a certain spatial configuration or organization in common (S. Kaplan, 1979a). In term of spatial configuration and organization, they have identified four perceptual elements that "provide means of assessing landscape quality that are empirically base while at the same time intuitively meaningful" (S. Kaplan, 1979b, P.241). These four perceptual elements are "coherence," "complexity," "legibility," and "mystery".

procedures (Gren,1979, Feimer et al.1979, Miller, 1984a). R. Kaplan (1975) suggests that in an attempt to develop methods that produce objective results between individuals, the methods that government agencies have evolved do not produce results consistent with public values. However, predictor variables developed from the psychological methods are difficult to apply in visual resource management, because the psychological constructs of these landscape attributes or predictor variables (such as complexity, coherence and mystery) are abstract and complicated. Furthermore, using VRM's descriptive measures to quantify qualitative landscape attributes is not easy. Although the Kaplans and other researchers have used visual examples, such as photographs and slides, to explain these abstract conceptions, there is still no ideal way to quantify and present these predictor variables. In order to apply predictor variables that can reflect the public values in visual resource management, new visual measures should be developed to present and explain the predictor variables instead of the existing verbal standards.

2.4 EXPERT SYSTEMS

Recent developments in computer technology, such as increased speed and storage capabilities, have significantly improved our ability to incorporate visual images into computer applications. Opportunities exists for exploration of the new visual measures studied in this thesis. There are two different aspects being discussed in this section: (1) expert systems and (2) visual simulations.

2.41 Expert Systems

Expert systems which have a potential for application in visual resource management can provide a basis for combining different approaches of landscape assessment. Thus, they provide a better way to evaluate and ultimately manage landscape resources by utilizing the strength of each approach and eliminating some of the negative qualities of each (Bishop and Hull, 1991). The most important contribution of expert systems is the capability of carrying out reasoning and explaining the knowledge of landscape assessment. This function of expert systems can help experts or professionals communicate with the public (Davis, 1986; McKinion and Lemmon, 1985). This capability of explaining why one scene is more visually satisfying than another is very important for any new landscape quality evaluation methodology.

To ensure the quality of expert systems for landscape assessment, measures used for expert systems should support explanation of rules, concepts, and principles clearly and objectively. This concern is one of the important urgent research issues that must be studied. Since the existing verbal standards involve individual judgments that may not accurate, they can not provide reliable support to explain comprehensive rules of expert systems. New measures being tested in this thesis should have the capacity to support an explanation of rules used in the expert systems.

2.42 Visual Simulation

Zube (1987) reviewed computer simulation techniques and felt that the potential for using computer graphics in landscape simulation was very high. Visual simulation techniques have been applied in the visual assessment of scenic corridors (such as powerlines and highways) successfully. Using visual simulation techniques to present photographs or slides for developing visual standards is a new method worth exploring. First, professionals can edit or change the original images of photographs or slides on the computer by using visual simulation techniques, so the visual images used to develop the visual standard can be improved by excluding external variables (i.e. light condition, graphic compositions) which can influence a person's preference for the landscape but are not part of the study. More importantly, visual images created by visual simulation techniques can be presented by using a computer questionnaire program, which has the option that people can look at different rating levels of visual standards as many times as they wish during the rating sessions of landscapes. With this computer administered, visual standards can be used to explain the rules or existing knowledge of visual assessment for expert systems. In addition, high resolution scanners and software packages, such as Photostyle, Photoshop, and Lumena, can be utilized to create visual images with better quality than before. As the visual images developed by simulation techniques have obvious advantages, the acceptance of modern computer technology becomes increasingly important to support the development of visual standards for improving visual assessment.

2.5 CONCLUSION

Measures used to present landscape inventories and predictor variables in landscape quality assessment need to be improved. Although slides and photographs have already been used to explain the written description of landscape inventory or predictor variables (the U.S. Forest Service, 1973; the BLM, 1980; and Kaplan and Kaplan, 1982), there are no visual images developed as measures corresponding to the different levels of landscape inventories and variables (i.e. complexity and vividness).

Recently developed computer techniques provide a chance for us to explore new measurement systems, such as visual standards, to improve the existing verbal standards used in visual assessment. Testing whether visual standards developed by the computer questionnaire program can really help people evaluate landscapes more consistently is therefore a meaningful exercise. Also, it is necessary to identify whether visual standards can better explain the rules or knowledge used in the expert systems of visual assessment than verbal standards. This thesis research will focus on testing these issues.

CHAPTER 3: RESEARCH METHODOLOGY

A comparative study was designed to test whether visual standards have advantages compared to existing verbal standards used in most visual assessment systems. The purpose of this chapter is to explain the methodology of this study and to provide information about visual standards. This chapter is divided into five sections: (1) hypothesis, (2) visual and verbal standards, (3) survey design, (4) statistic analysis; and (5) conclusion. The chapter begins with an explanation of the hypothesis on which the remainder of the thesis is based. This section is followed by a discussion of the methods for developing visual standards and verbal standards. Then, the survey design will be described. Next, statistical analysis used for testing the research hypothesis will be introduced. Finally, in the conclusion the methods used to control the external variables or elements which will influence the survey results will discussed.

3.1 HYPOTHESIS

The research hypothesis of this thesis focuses on evaluating and assessing the effects of using visual standards for evaluating the landscape. Three major effects that were tested as thesis questions are: 1) the effect of visual standards on information communicated; 2) the effect of visual standards on people's attitudes toward the information communicated; and 3) the effect of visual standards on people's attitudes toward the process of evaluating landscapes. The reasons for testing these effects will be described and explained below.

3.11 Effect on Assessing the Landscape

Visual standards have a potential application in visual resource management if they are significantly improved to present the landscape effectively and accurately. There are three research questions which test the effects of using visual standards on assessing the landscape. The first is to test whether using visual standards can better predict landscape preferences based on predictor variables, such as complexity and vividness. The second is to examine whether visual standards can be utilized to produce more consistent results for evaluating the landscape. The third is to determine whether using visual standards reflects a different rating scale; in other words, rating results of complexity or vividness by using visual standards are different from those of using verbal standards. The reasons for testing these three questions will be discussed as follows.

3.111 Predicting landscape preference

Verbal standards and descriptive explanations are the measures used to present and explain rating components of the landscape (i.e. complexity, variety, vividness) in most visual assessment systems. A number of empirical studies have been conducted which identify a positive relationship between people's preference and complexity (Kaplan, 1975; Herzog, 1984). Furthermore, the concept of complexity is similar both to "variety" used by U.S. Forest Service and to "diversity" used by BLM[6], and most rating procedures of visual assessment systems include ratings of "variety" and "diversity". Visual standards, which present a scene with a real image of the landscape, may be more reliable than verbal standards. Therefore, the research hypothesis is that using visual standards

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[6]It is a shortcoming that different government agencies and researchers accept similar landscape concepts by using different names. This causes confusion for new professionals.

can support acquisition of a stronger relationship between complexity and preference compared to verbal standards.

Testing if visual standards can support the predictive relationship between vividness and preference is also important. Vividness is more difficult to explain than complexity. The reason is that complexity is more closely related to physical attributes of the landscape (i.e. diversity of vegetation types, diversity in landform) but vividness is more of a visual attribute than the physical. Since this is the nature of vividness, visual standards are expected to be better at explaining the relationship between vividness and preference than the verbal standards.

Actually, to predict the relationships between preference and complexity and between preference and vividness is one of the reasons for choosing complexity and vividness as the test variables of this study. In addition, complexity and vividness are two of the variables used in the Explanation Visual Assessment System (EVA), an expert system developed by a research team at Virginia Tech. Testing whether the visual standards can present the variables used in expert systems is important, because expert systems are a recent technology advancement which holds promise in visual assessment.

3.112 Producing more consistent results

In order to make judgements objectively in visual assessment, professionals have to produce consistent results for a given landscape based on reliable and easily used standards. Most techniques and methods used in visual resource management rely on verbal standards. Using verbal standards to quantify the landscape, however, may not be accurate because verbal standards involve the interpretation of words into images in the mind of people. By providing visual images corresponding directly to each level of verbal description, visual standards may offer a clearer understanding of the rating components of the landscape (i.e. complexity and vividness). So the research hypothesis is that visual standards can be utilized to help professionals produce more consistent results.

3.113 Reflecting different rating scale

Without an accurate yard stick, there is no objective way to judge if visual standards are more objective and accurate than descriptive standards. However, testing is necessary to determine whether the rating scales for quantifying the landscape differ from each other. As rapidly developing digital technology has become available for transmitting and sharing visual information, applying visual images in landscape assessment has mushroomed. Therefore, identifying whether results of using visual standards are different from those of using verbal standards for the same landscape is important.

3.12 Attitudes toward Rating Landscape Variables

A measurement system may be a good predictor, but may not be successful if people do not believe that it is accurate or do not find it worthwhile to use. This subsection examines the confidence which influences people's attitudes toward visual or verbal standards. If people have more confidence in visual standards, that, in itself, could result in better visual assessment regardless of whether visual standards are a better predictor or not. Three domains were used to compare people's confidence level in using visual standards compared to verbal standards are: "helpful," "accurate," and "useful".

*helpful --- to test if the respondents believe that using visual standards can better help them rate complexity or vividness than verbal standards;

*accurate --- to examine the respondents' psychological feelings about accuracy of using visual standards compared to verbal standards for depicting each level of complexity or vividness; and

*useful --- to test if respondents believe that visual standards are a more useful measurement system compared to verbal standards in visual assessment.

3.13 Attitudes toward the Rating Process

A measurement system is not good enough for application to visual assessment, if it is cumbersome, inefficient, or boring. For example, although the Scenic Beauty Estimation (SBE) model (Daniel, 1976) is accurate, it is so mathematically complicated and difficult to understand that it can not be widely used. In this study, visual standards, which are developed based on a computer questionnaire program, are more complicated than the verbal standards. Therefore, it is necessary to test people's attitudes toward using visual standards and toward the process of rating landscape variables compared to verbal standards. Four measures used in this comparative study are: "easy," "valid," "interest," and "efficient".

*easy and efficient --- respondents' feeling on the ease of using the visual standards in distinguishing different levels of complexity/vividness

*valid --- the extent to which respondents believe the results from using the visual standards or verbal standards produced more valid results.

*interest --- the extent to which respondents feel the process of rating complexity/vividness was interesting.

3.2 VISUAL STANDARDS AND VERBAL STANDARDS

Both visual and verbal standards need to be established excluding the effects of external variables which may influence the reliability of this survey study. The purpose of this section is to explain the criteria and procedure for developing visual standards and verbal standards. In this section, the methods for developing the visual standards will be introduced first, then the verbal standards will be discussed.

3.21 Visual Standards

This subsection describes the criteria and process of developing the visual standards. In order to ensure reliability of visual standards for presenting each level of complexity and vividness objectively, a calibration exercise was conducted to choose the final scenes used for developing visual standards. The purpose for conducting this calibration exercise is to develop a standard system for which there is no other stick available. Therefore, in essence what the researcher is attempting is to develop the visual standards based on expert judgements. To keep the expert judgement from being too idiosyncratic (i.e. just the researcher's own judgement), a group of advanced landscape architecture students (14 respondents) at Virginia Tech were chosen as an expert group to rate a set of scenes. The procedure used in administrating this calibration is described as follows.

In order to present the full range of visual standards, a diverse range of landscape with different levels of complexity or vividness were selected. The final scenes used for developing the visual standards were selected from two sets of 27 slides (i.e. one set for complexity and the other set for vividness) which were primarily chosen by eliminating the external variables that can influence the rating results. More details about excluding the external variables of the selected scenes will be discussed in section 3.3 of this chapter).

To minimize the possible bias resulting from the explanation, the presentation of vividness and complexity was limited to a reading of their definitions excluding the discussion of the related knowledge concerning these two variables. Respondents were allowed to ask questions if they felt confused about the concepts before taking the Survey. Two slides with an extremely high and an extremely low level of complexity or vividness were presented to the participants. There are two reasons for presenting these slides before the calibration. One is to illustrate or explain the concept of complexity and vividness, and the other one is to ensure that the participants will rate the slides based on a full range of complexity and vividness. The ratings of complexity and vividness were requested on a 1 to 5 ordinal scale. Participants were instructed to circle the number that most nearly represented their rating of complexity or vividness for each scene. A space was provided on the survey form after every fifth scene to aid the participants in visually keeping track of the scene number (Appendix A - Calibration Response Form). Although only 25 scenes were rated for complexity or vividness, 30 places were provided in order to avoid any "end effect" because participants might anticipate the end while rating the last few scenes. Each scene was presented for about 5 seconds. Raters could request that a scene be held on the screen longer by raising their hands.

The rating results of this calibration exercise were entered into the NCSS[7] statistical package in order to calculate descriptive statistics (Table 1). The rating results of both complexity and vividness for each scene were sorted into five groups (from 1=low

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[7]Number Crunchered Statistical System (NCSS) is a computer software package which can help researchers conduct statistical analysis.

Table 1. Descriptive Statistic Data for Visual Standards Calibration

Complexity					Vividness				
Scene Number	Mean	Mode	Standard Deviation	Level of Complexity	Scene Number	Mean	Mode	Standard Deviation	Level of Vividness
3	4	5	0.93		11	4	5	1.3	
8	4.07	5	0.94	H	16	4.14	5	1.03	H
13	3.57	5	1.22						
16	4.2	5	0.96	H	4	3.71	4	0.87	MH
23	4.14	5	1.03		8	3.64	4	0.84	
					10	4.07	4	0.99	H
1	3.38	4	0.82	MH	12	3.7	4	0.99	
4	3.35	4	0.84		15	4	4	0.87	MH
19	3.92	4	0.83		19	3.4	4	1.01	
20	3.78	4	0.79	MH	21	4.07	4	1.07	
22	3.92	4	1.14		24	3.2	4	0.97	
					25	3.8	4	0.99	
2	3.57	3	1.08						
7	3.07	3	0.91	M	1	2.92	3	1.14	
10	3.14	3	0.94	M	2	2.78	3	0.7	
11	3.14	3	0.96		5	2.14	3	0.86	
12	3.07	3	1.14		6	2.42	3	0.76	
14	2.71	3	1.13		7	2.71	3	0.91	
17	2.57	3	0.75		9	3	3	0.87	M
24	2.5	3	0.93		17	2.57	3	0.5	
25	3.07	3	0.73		20	2.57	3	0.93	M
					22	3.07	3	0.73	
9	1.92	2	0.82	ML	23	3.29	3	0.99	
15	2.6	2	0.92						
18	2.28	2	0.99		3	2.71	2	0.83	ML
21	2.21	2	0.8	ML	14	1.57	2	0.51	ML
					18	2.78	2	0.97	
5	1.57	1	0.64						
6	1.28	1	0.61	L	13	1.5	1	0.94	L

H = High
MH= Moderately high
M = Moderate
ML = Moderately low
L = Low

to 5=high) according to the mean and mode of each scene. From each group, two scenes with the smallest standard deviation were chosen for presenting each level of complexity and vividness. The result was 10 scenes for complexity and 10 scene for vividness which formed the visual standards (Appendix B - Scenes Selected for Developing Visual Standards).

On the whole, this calibration exercise established the visual standards based on the opinion of an expert group instead of the researcher's individual opinion. It is hoped that through this calibration the visual standards would be defined with less bias so that the selected scenes for presenting each level of complexity and vividness would be more accurate and objective.

3.22 Verbal Standards

This section discusses the verbal standards used in this comparative study. Verbal standards for complexity and vividness were developed based on the principles used in Visual Quality Components III: Visual Composition, in the Explanation Visual Assessment system (EVAS) (Appendix C - Verbal standards). Since expert systems have several advantages that have great potential for wide application in visual assessment, it is necessary to test which standards can better present the principles used in expert systems (as discussed in chapter 2). Classification for both variables was defined by using a five level scale: 1=low 2=moderately low, 3=moderate, 4=moderately high and 5=high. The reasons for choosing a five level scale will be discussed in section 3.6.

3.3 SURVEY DESIGN

A survey was conducted as part of study to collect data for comparing the usefulness of visual standards and verbal standards. The survey design is introduced in this section according to (1) scene selection; (2) survey participants; and (3) computer administration; (4) survey questionnaire; (5) survey design procedure.

3.31 Scene Selection

35 mm color slides were used as a surrogate for the actual landscape scenes. Some researchers (Shafer and Richards 1974; Zube et al. 1974; R.Kaplan 1977a; Daniel and Boster, 1976; Seaton and Collins 1972) have found photographs and slides of landscape scenes to be a good surrogate for the actual landscapes in evaluating landscape perceptions.

A large sample of approximately two thousand diverse landscape scenes was initially chosen from personal collections. In order to control external variables which might affect the ratings, this sample was reduced by eliminating scenes with specific elements , such as light, season, and sunset, which may sway the rating results (USDA Forest Service, 1973). Also, slides obviously containing people, wildlife, plants in bloom or dynamic cloud formations were excluded[8](Kaplan, R, 1975; and Buhyoff and Wellman, 1979). As different views, such as in-stand and panorama, represent the landscape with different visibility and details (Litton, 1968), only scenes with panoramic views were selected.

Since most land managed by the Forest Service and BLM belongs to the natural landscape, all the selected scenes were predominantly of natural landscapes without dominant man-made intrusions. Man-made elements in the landscape were, for the most

[8]External variables associated with sampling visual environment was discussed by R. Kaplan (1975).

part, minor such as fences or roads. This is important because man-made intrusions and culture elements are factors that can influence people's preferences and their judgements (Kaplan, 1985), but are not variables tested in this research.

A final set of 15 scenes[9] was chosen for testing both visual and verbal standards (Appendix D - The Tested Scenes of the Survey). These scenes were developed into 9 inch x 11 inch color photographs for conveniently conducting the survey. In order to assume a full range of potential complexity and vividness in the test scenes, a large set of the scenes was first broken into three categories (i.e. high/moderately high, moderate, moderate low/low) for both complexity and vividness by the author. An approximately equal number of scenes were selected for each category for both variables. Each scene was assigned a number for later use in the analysis of results.

A random number table was used to assign the scenes to a presentation order according to the following rules: first, no more than two consecutive scenes can represent the same level of complexity or vividness, used during scene selection; and second, no more than two consecutive scenes are represented with the same landscape character. Half the participants viewed the scenes in one order while for the other half the scenes were seen in the reverse of this order to avoid any "order effect" on rating.

3.32 Survey Participants

The 30 participants in this study were students in both the Department of Landscape Architecture (20 participants) and the Department of Forestry (10 participants) at Virginia Tech. A number of studies in landscape perception have used preselected

[9]Another two scenes selected as the pretest scenes for participants to be familiar with the visual standards.

groups such as classes of students (Buyhoff, 1983, Miller, 1984 and Herzog, 1984). While these groups are not truly random samples of the public, past studies would suggest that their preferences are not likely to be vastly different. Furthermore, these groups often represent a sub-group of the public, which will be the professionals to use the standards being studied in this thesis.

3.33 Computer Questionnaire

This subsection will discuss the use of computers to administrate the visual standards. Visual standards have to be easily carried and conveniently transmitted so that they can be effectively utilized to support new methods, such as expert systems in visual assessment. On the other hand, the quality of visual standards should be good enough to present adequate details of the landscape for depicting the concept of complexity and vividness.

Considering both quality of visual images and survey time, a special experimental study was conducted to identify the appropriate resolution for scanning slides. 1400 dpi resolution with 63% scaling was accepted for scanning the slides into the computer[10] (Appendix E - Experimental Study --- Quality of Visual Images). These visual images, corresponding to each level of complexity and vividness, were loaded on the screen by using a computer questionnaire program[11].

This computer questionnaire program can provide an option for respondents to

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[10]Using high resolution to scan slides will produce good quality images, but it would take a long time to load the image on the monitor. On the other hand, using low resolution to scan slides would not present the original images clearly and accurately.

[11]This computer questionnaire program was developed by using Quickbasic and TBASE tools.

select any images of visual standards which they want to look at. In this way, the participants could choose and compare different rating levels or visual images with the scenes being rated as many times as they wish during the rating process.

3.34 Survey Questionnaire

An important objective in designing the questionnaire was to minimize the amount of imposition on the time and privacy of the survey participants while obtaining the needed information. This was achieved by keeping the survey short and compact, and the question and response format as simple as possible. Thus, the entire survey required only three pages (Appendix F - Survey Response Form and Questionnaire). This was important because while people may not mind participating in the survey, they may become bored or agitated easily if they perceived the demands being made on them as unreasonable. Only questions deemed important to interpreting the results were included.

A five point scale, from low=1 to high=5, was used to rate complexity, vividness, and other domains related to people's attitudes. This ordinal scale is a relatively simple measure which has several advantages. First, it is easily understood by participants and requires minimal instructions. Second, it limits possible responses and thus minimizes problems with idiosyncratic use of the rating scale, yet it allows enough variation in response to identify relative ratings for the landscapes being viewed (Miller, 1984). A nine point, ordinal scale was used to rate each score for landscape preference, using 1=not like at all and 9=like very much. A different rating scale was used to reduce rating influence between preference, and complexity and vividness. The respondents were asked to use the full range of the rating scales.

3.35 Survey Process

The participants were randomly assigned into two groups. Controlling the external variables which may influence the survey is critical to keep reliability of the final survey results. In this survey, one group was asked to rate complexity, vividness, and preference of each scene by using visual standards (computer questionnaire program). The other group rated the same scenes by using the verbal standards.

The survey for the participants using the visual standards was conducted at a computer applications research lab of Department of Forestry and the computer lab of the Landscape Architecture Department at Virginia Tech. To avoid influence by other people who were working at lab, the computers used for the survey were placed at the end against the wall in both labs so that when the participants were facing the screen the background was a white wall. One participant at a time was asked to look at visual standards on the computer then place the rating of the tested scene on the survey forms. This method provided a chance for the participant to look at visual images which present different level of complexity or vividness as many times as he (she) wants without disturbance from other people. To avoid external variables (such as noise) that may influence the rating results, the survey for the participants using verbal standards was conducted in a quiet classroom because the verbal standards used in this survey were written descriptions of landscape scenes.

To avoid rating influence among complexity, vividness and preference, participants were asked to rate the same set of scenes three times separately, once for complexity, once for vividness, and another time for preference. There was no time limitation for participants to rate complexity and vividness. Participants were asked to mark the score of their preferences for each scene within 5 seconds. This limit was chosen to avoid time influence on the rating results because preferences are heightened with longer viewing time for natural landscapes (Kaplan 1982).

Questions about testing people's attitudes toward the ratings and the rating process were asked separately for complexity and vividness, because participants might have different feelings between rating complexity and vividness. Participants were asked to voluntarily write their opinions or suggestions about either using the visual standards or the verbal standards at the end of the survey. The participants' responses were anonymous.

3.4 STATISTICAL ANALYSIS

This section is to explain the statistical analysis used to test the research hypothesis of this thesis. In order to produce accurate results for identifying the effects of using the visual standards, correctly applying the appropriate statistical test corresponding to the rationale of each research hypothesis is important. The reasons for selecting statistical tests corresponding to each research hypothesis will be introduced as follows[12].

In order to test if the visual standards can be utilized to predict the preference better than the verbal standards, relationship between preference and the landscape variables being tested. Linear regression was used to examine the relationship between these variables. The means of preference, complexity and vividness ratings for each scene were calculated. The mean preference rating was used as dependent variable and the mean complexity or vividness rating served as independent variable.

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[12]Statistical references used in this study were Howell's Statistical Methods for Psychology (1991).

To determine whether the visual standards can be utilized to produce more consistent results in landscape assessment, heterogeneity of variance between the ratings based on using visual standards and verbal standards was examined. Two statistical methods were used. One method used the traditional parametric F-test, a ratio of the larger sample variance to the smaller. The other method used the frequency distributions of ratings for each scene. The expected frequency figure of each scene is leptokurtic for using visual standards and platykurtic for using descriptive standards. A leptokurtic curve indicates that most of the rating results are similar, while platykurtic represents rating results are different from each other (Figure 1).

To compare differences between the mean rating of using the visual standards and verbal standards, a one way ANOVA and a two sample independent t-test were used. Parametric t-tests were conducted to test people's attitudes toward information communicated and toward the process of evaluating the landscape.

All the statistical tests used in this study are parametric. Since the rating level of each variable of this study was designed from 1 to 5 (except preference from 1 to 9) at equal appearing interval scale, the data can be treated as continuous (Buyhoff, 1983). Since, in most empirical studies of landscape preference, $p<=0.05$ is the figure used to determine significant difference, $p<=0.05$ was set to determine the significant difference for all the tests in this study.

In short, in order to ensure the accuracy of the final assessment, the reliability and validity for obtaining the final results must be ensured. Therefore, we need to guarantee that the statistical analysis of the research questions followed the rationale and basic assumption of each statistical test. This is the principle or purpose guiding the statistical analysis of this study.

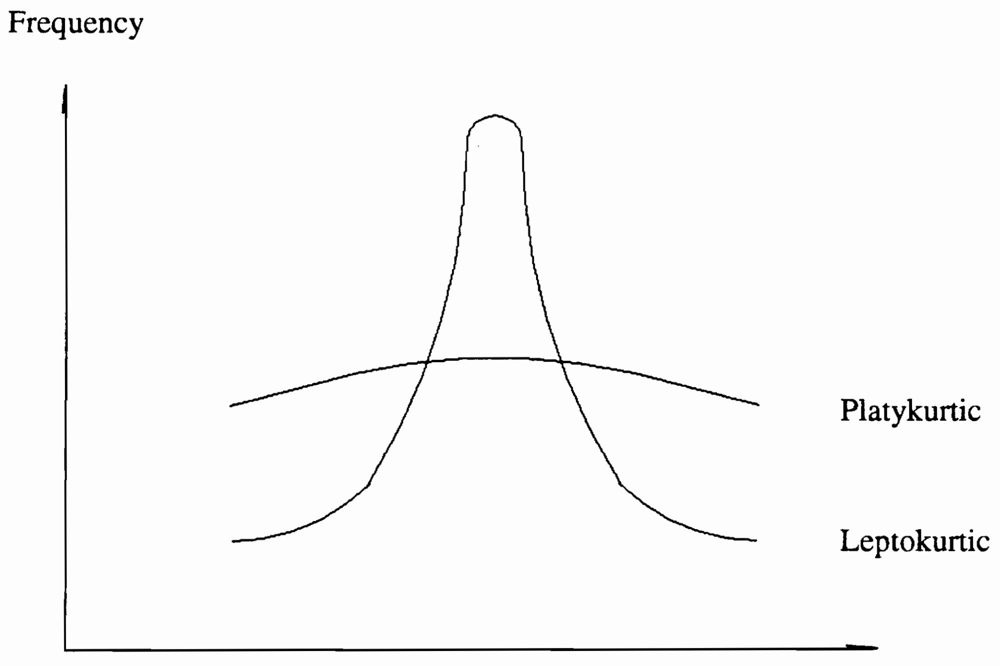

Figure 1. Platykurtic Curve and Leptokurtic Curve

3.5 CONCLUSION

In order to produce reliable results for testing the research hypothesis, several issues that would influence the reliability and validity of the survey were controlled. First, the scenes with the external variables which can influence the rating results were eliminated in the scene selection. Second, a calibration exercise was conducted to avoid the researcher's idiosyncracy for developing the visual standards. Third, an experimental study of resolution for scanning the slides into the computer was done to control the survey time and the quality of visual images for developing visual standards. Fourth, the external variables which influence the survey design were controlled.

CHAPTER 4: ANALYSIS OF RESULTS

The purpose of this chapter is to evaluate the reliability of visual standards as a definitional reference system. All the statistically significant results of the survey are reported and external variables that affect the use of visual standards are discussed.

This chapter is separated into five sections. The first three sections address the analysis of survey results for testing the usefulness of visual standards. The first section focuses on the effect of using visual standards on assessing the landscape. The second section discusses the effects of visual standards on people's attitudes toward rating landscape variables. The third section deals with the effects of visual standards on people's attitudes toward the process of rating landscape variables. The fourth section will address the participants' responses to rating complexity and vividness by using either visual standards or verbal standards. Finally, the major findings of this study will be summarized in the conclusion.

4.1 EFFECTS ON ASSESSING THE LANDSCAPE

The basic task to test whether visual standards are more reliable and accurate than existing verbal standards is to identify the effects of using visual standards on assessing the landscape. Analysis of survey results of this study are conducted to answer the three research questions related to using visual standards to assess the landscape (discussed in section 3.1 of chapter 3). This section is separated into three subsections to identify whether using visual standards can (1) predict preference better than verbal standards based on the tested variables, complexity and vividness; (2) produce more consistent results in assessing landscape variables; and (3) produce different ratings for landscape variables compared to verbal standards.

4.11 Predicting Preference

The primary task here is to assess whether using visual standards can better predict preference based on landscape variables. However, the results of this study indicated some unanticipated findings which are worth further investigation. The analysis of the relationship between landscape variables and preference is discussed below. The results of the regression analysis indicates that the relationship between preference and complexity is weaker when using the visual standard (r=0.27) as a measure than using the verbal standards (r=0.49) (Table 2, Figure 2). Other researchers have found a strong relationship between complexity and preference when using a descriptive explanation of complexity. The Kaplans (1972) found that complexity is a relatively good landscape preference predictor (r=0.69). Miller (1984a & b) found that diversity, which is similar to complexity, is a good predictor of landscape preference.

The relationship between vividness and preference when using visual standards (r=0.29) as a reference is much weaker than when using verbal standards (r=0.72) (Table 2, Figure 3). These results support the findings that there is a relatively strong relationship between vividness and preference when using verbal standards as measures.

There are two possible contradictory interpretations of the finding that using visual standards to assess complexity and vividness does not improve their predictive relationship to preference. One is that people form an initial conception in their minds when using the descriptive explanations, and that this conception, which serves as a reference, is simple and uniform. Thus, it may be to easier use verbal standards to assess variables such as complexity and vividness.

Table 2: Correlation Between Preference and Predictive Variables, Complexity and Vividness

	Visual Standards		Verbal Standards	
	Correlation Coefficient	Probability Level	Correlation Coefficient	Probability Level
Complexity	0.27	0.0471	0.49	0.0037
Vividness	0.29	0.0395	0.72	0.0001

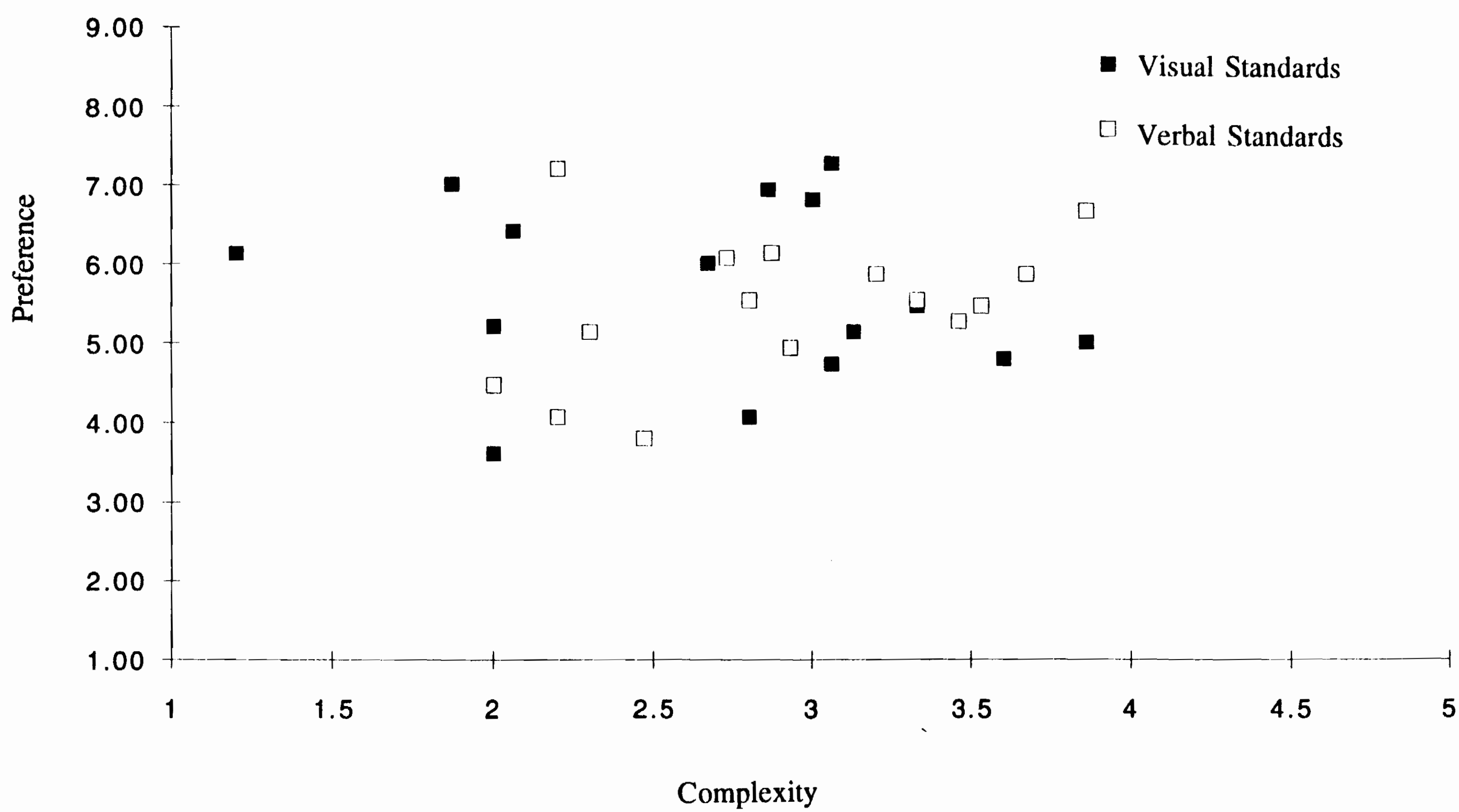

Figure 2. Scatter Plot of Mean Preference and Mean Complexity

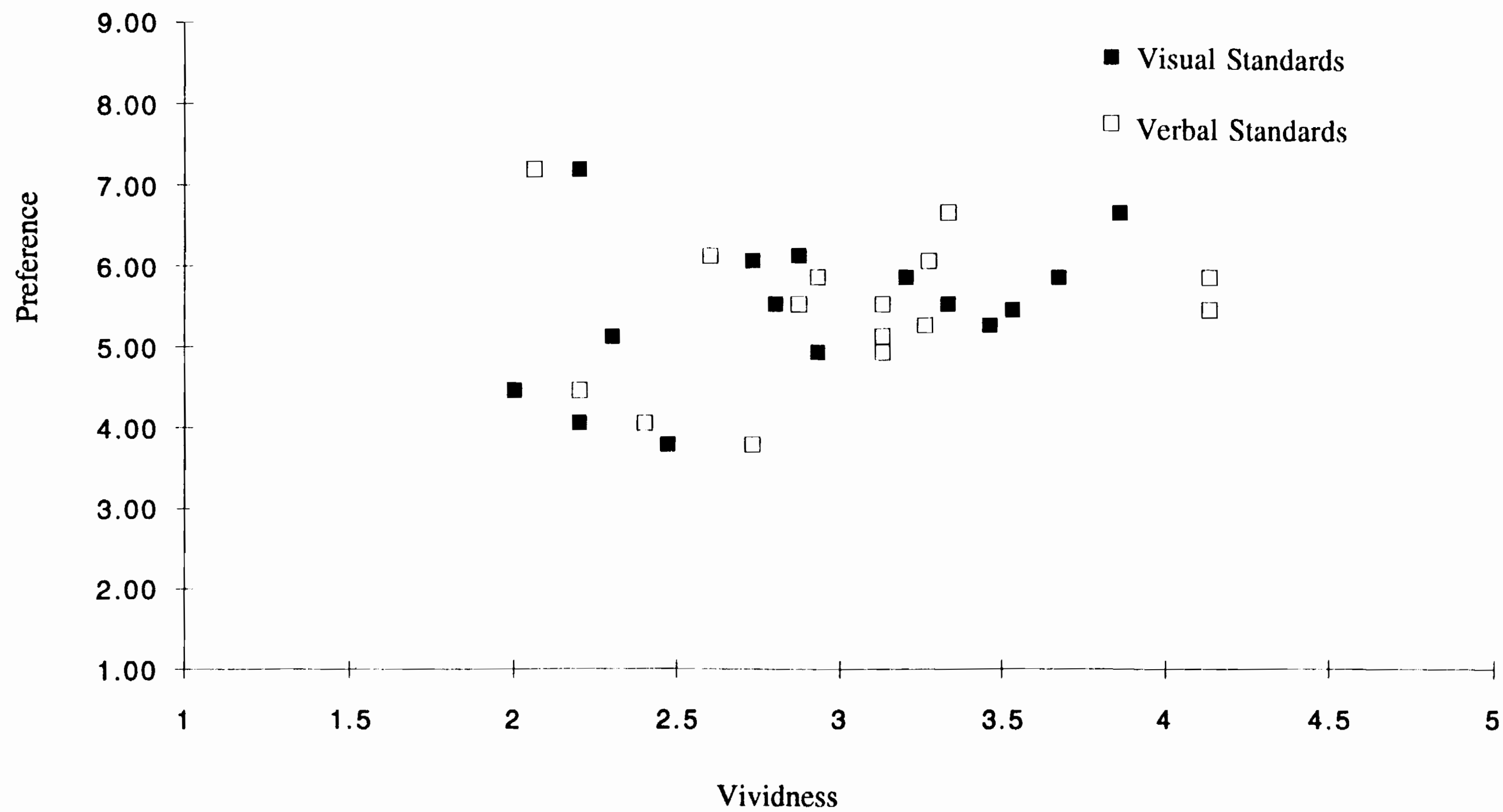

Figure 3. Scatter Plot of Mean Preference and Mean Vividness

Another interpretation may be that there is not as high a correlation between complexity and preference as past studies have indicated. The rating of complexity in previous studies may have been influenced by the rater's preferences for the scene. Perhaps people find the concepts of complexity and vividness difficult to understand. This may cause them to confound their rating of vividness based on their preference for the scene. The high correlation coefficient between vividness and preference ($r=.72$) supports this idea since vividness, probably a more difficult concept to understand than complexity, and is thus being more easily influenced by preference for the landscape. Therefore, visual standards may be providing a more reliable and valid assessment of complexity and vividness.

In this case, visual standards may not produce a stronger relationship between preference and complexity or between preference and vividness; however visual standards might support a better explanation of these landscape characteristics and preference. Additional research needs to be conducted to test this implication.

4.12 Producing More Consistent Results

Visual standards can be used as a new reference to improve visual resource management if using visual standards can produce more consistent rating results. The analysis of the rating results of landscape variables and the external variables which may affect ratings are discussed in this subsection.

For both complexity and vividness, the results of the F-test for each scene indicate that with one exception (scene 13) using the visual standards (presented in a computer questionnaire program) does not help people to obtain more consistent rating scores than using verbal standards (Table 3, 4). The comparison of the frequency distributions between using visual standards and verbal standards also indicates that there is no significant difference between the rating results of using visual standards and verbal standards (Appendix G - Frequency distribution of rating results for complexity and vividness).

It is hard to say anything conclusive at this stage, because the results may be affected by three external variables. First, the rating results of this study may be affected by the diversity of scenes used in the visual standards and in the survey. Scenes used in this test reflect a large variety of different landscape types[13]; the landscape character of some tested scenes is not consistent with that of visual standards. For example, the scene being rated may be of the Colorado Rocky Mountains while the scenes in the visual standards may come from the arid southwest or the Eastern United States. Crowe (1978) and the Forest Service (1973) believe visual resource management should be conducted based on a landscape character type or landscapes within a region. This is important because every landscape has its own character and patterns, its own scale and its own range of tone and color. This character is based on such factors as geology and climate and is developed through the history of land-use. Using visual standards to measure the landscape might produce more consistent results if visual standards were developed by utilizing scenes from the same region or same landscape "character type" as the landscape scenes being evaluated. Consistency in evaluating the landscape might be improved considerably if this were the case. This phenomenon merits additional research.

Second, people may require more time to learn how to use the visual standards.

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[13]The scenes selected for the Survey were chosen to cover as many landscape characteristics as possible in order to ensure the validity of the test. Therefore, landscape types, their geology, and their climate characteristics of the tested scenes were not exactly consistent with those of the visual standards.

Table 3. Complexity Ratings Using Visual Standards and Verbal Standards

	Mean			Standard Deviation			
	Visual Standards	Verbal Standards	Mean Difference	Visual Standards	Verbal Standards	Standard Deviation Difference	F-ratio
SCENE 1	2.81	2.31	+	0.94	1.21	-	0.8186
SCENE 2	2.01	2.21	-	1.19	0.86	+	0.1167
SCENE 3	3.61	3.33	+	0.82	0.97	-	0.7268
SCENE 4	2.67	2.47	+	1.11	0.83	+	0.2344
SCENE 5	2.06	2.81	-	1.03	0.77	+	0.2786
SCENE 6	3.01	3.67	-	0.75	0.72	+	0.6677
SCENE 7	3.33	3.46	-	0.97	1.06	-	0.6022
SCENE 8	3.13	2.73	+	1.18	0.79	+	0.0751
SCENE 9	2.01	2.87	-	0.75	0.74	+	0.6853
SCENE 10	3.86	3.53	+	0.83	0.74	+	0.3371
SCENE 11	2.86	3.21	-	0.67	0.83	-	0.2213
SCENE 12	3.06	3.86	-	1.22	0.92	+	0.1453
SCENE 13	1.21	2.21	-	0.41	0.86	-	**0.0495**
SCENE 14	1.87	2.01	-	0.63	0.75	-	0.1729
SCENE 15	3.06	2.93	+	1.27	0.88	+	0.0891
Non-parametric proportion test		p=0.4358				p=0.4358	

The difference between the mean ratings of using visual standards and verbal standards is significant at p<= 0.05.

Table 4. Vividness Ratings Using Visual Standards and Verbal Standards

	Mean			Standard Deviation			
	Visual Standards	Verbal Standards	Mean Difference	Visual Standards	Verbal Standards	Standard Deviation Difference	F-ratio
SCENE 1	2.73	3.13	-	0.96	1.12	-	0.7186
SCENE 2	1.93	2.06	-	1.09	1.33	-	0.7608
SCENE 3	2.81	3.13	-	0.77	0.99	-	0.8157
SCENE 4	2.81	2.73	+	1.08	1.03	+	0.4317
SCENE 5	2.81	2.87	-	0.86	0.99	-	0.6951
SCENE 6	4.01	4.13	-	1.06	0.83	+	0.2815
SCENE 7	2.87	3.26	-	1.18	1.43	-	0.5144
SCENE 8	3.06	3.27	-	0.88	1.09	-	0.7884
SCENE 9	2.61	2.61	=	0.63	1.35	-	0.9962
SCENE 10	4.06	4.13	-	0.88	0.51	+	0.0268
SCENE 11	3.01	2.93	+	0.92	0.71	+	0.8065
SCENE 12	3.27	3.33	-	1.03	0.89	+	0.3063
SCENE 13	1.61	2.41	-	1.12	1.06	+	0.4123
SCENE 14	1.61	2.21	-	0.83	0.94	-	0.6807
SCENE 15	2.13	3.13	-	0.74	0.92	-	0.7774
Non-parametric proportion test		p=0.0201				p=0.4358	

The difference between the mean ratings of using visual standards and verbal standards is significant at p<= 0.05.

If this is the case, there needs to be a learning period for the participants to understand and become familiar with visual standards prior to evaluating the landscape. As familiarity with using visual standards increases, the rating results may be different from those found in this study. If visual standards offer the potential for decreasing variance in rating complexity or vividness, it may happen after the learning period. Further research needs to be conducted to test whether increased familiarity with using visual standards could improve the consistency of assessing landscape variables.

Third, the format in which visual standards are presented to people may also influence the rating results. In this study, the format of the visual standards was designed to present only one visual image on the screen each time to avoid a longer time to retrieve the landscape images from memory to the screen. In this way people could not see all the visual standards at the same time. This format may have limited the ability of participants to make comparative judgements.

On the whole, to improve visual standards as a valid measurement system for producing consistent rating results, additional research needs to be conducted to exclude external variables which may affect using visual standards. Three factors needing further research are:

(1) to develop visual standards with the consistency landscape characteristic of the landscape to be evaluated;

(2) to identify if participants need a learning period for using visual standards before evaluating the landscape; and

(3) to examine the presentation format of visual standards.

4.13 Difference in the Rating Scale

It is important for government agencies to know that the measurement systems used in visual assessment are reliable and valid. Comparing the use of rating scales based on visual standards and verbal standards can provide further insight into the problems that exist for measuring landscape variables. The results for assessing the use of rating scale for visual standards and verbal standards will be discussed in this subsection.

Most of the visual standards mean ratings are somewhat lower than those from verbal standards (Table 3, 4, 5, and 6). The result of non-parametric one sample proportion test indicated that for vividness the ratings of participants using visual standards are significantly lower than those using visual standards (i.e. 12 out of 15 times the mean rating was lower for vividness using visual standards). Furthermore, the results of the ANOVA test indicate that the mean of the tested scenes with low level vividness for participants using visual standards (mean = 2.13) is significantly lower than those resulting from verbal standards (mean = 2.69). For complexity, however, there were no significant results found. There is a strong tendency that ratings using visual standards are lower than those using verbal standards. These results suggest that visual standards may result in a broader use of rating scale perhaps more indicative of the range of variability that is actually present, particularly at the lower end of the scale. Using verbal standards involves explanations created in people's minds, so the rating scale produced by using verbal standards is arbitrary. Unless there is an objective way to measure landscape variables, there is no way to determine whether the rating scale based on using visual standards is more objective or valid than using verbal standards. On the other

Table 5. Comparison of Mean Ratings for Complexity Using Visual Standards and Verbal Standards

	Mean Rating for Using Visual Standards	Mean Rating for Using Verbal Standards	F Value	Probability Level
Low/Moderately Low Level	2.02	2.51	2.17	0.152
Moderate Level	2.49	2.91	2.77	0.107
High/Moderately High Level	3.26	3.42	0.58	0.452

The difference between the mean response of visual standards and verbal standards is significant at $p <= 0.05$.

Table 6. Comparison for Mean Ratings for Vividness Using Visual Standards and Verbal Standards

	Mean Rating for Using Visual Standards	Mean Rating for Using Verbal Standards	F Value	Probability Level
Low/Moderately Low Level	2.13	2.69	10.26	**0.0028**
Moderate Level	3.04	3.18	0.82	0.3722
High/Moderately High Level	3.08	3.19	0.19	0.6643

The difference between the mean response of visual standards and verbal standards is significant at $p <= 0.05$.

hand, visual standards are established based on actual images of the landscapes; and they reflect a fuller range of complexity and vividness. Further research to establish a more objective measurement of complexity and vividness is needed.

4.2 PEOPLE'S ATTITUDES TOWARD THE RATINGS

Since a reliable and valid scale still may not work if people do not have confidence in their rating results, assessing people's attitudes toward the process of rating landscape is important. The results of people's attitude toward rating complexity and vividness will be reported below.

Those participants using visual standards to evaluate complexity had a significantly higher mean rating for accuracy than those using verbal standards (Table 7). It is important that people felt that the visual standards gave more accurate results. This finding of people's attitude toward rating complexity could reinforce the idea that past complexity ratings have been influenced by preference.

For vividness, no significant difference is shown between attitudes towards the ratings of the two groups by using "helpful," "accurate," and "useful" as measures (Table 8). One external variable that may affect people's attitude toward ratings is that the quality of computer visual images used in this test may not have provided enough detail of the landscape to rate vividness. Therefore, people may not have felt that using visual standards to rate landscape variables (complexity and vividness) is more accurate, helpful and useful. As vividness is a conception concerned with the contrast of landscape

Table 7. Attitude toward Rating Landscape Complexity

	Visual Standards		Verbal Standards		
	Mean	Standard Deviation	Mean	Standard Deviation	Probability Level
Accurate	3.26	0.59	2.73	1.03	**0.047**
Helpful	3.86	1.06	3.01	1.46	0.23
Useful	3.07	1.93	2.01	1.19	0.143

The difference between the mean ratings of using visual standards and verbal standards is significant at $p <= 0.05$.
The probability level is based on a two tail test.

Table 8. Attitude toward Rating Landscape Vividness

	Visual Standards		Verbal Standards		
	Mean	Standard Deviation	Mean	Standard Deviation	Probability Level
Accurate	3.06	0.88	3.33	0.62	0.192
Helpful	3.73	0.96	3.01	1.36	0.203
Useful	2.87	0.91	2.01	1.01	0.707

The difference between the mean ratings of using visual standards and verbal standards is significant at $p <= 0.05$.
The probability level is based on a two tail test.

elements, such as contrast between tree trunks and leaves, it is very important to ensure that the quality of the visual images reflects fine lines, texture and the color of the landscape clearly. Perhaps using higher resolution to scan visual images for developing visual standards might produce different results than those found in this study. If higher image quality of visual standards can better help participants rate complexity and vividness, then participants' attitudes toward using visual standards might be enhanced. Further research needs to be conducted to test this.

4.3 ATTITUDES TOWARD THE RATING PROCESS

A measurement system is still not good, regardless of accuracy and validity, if people feel that it is difficult or boring to use. This will influence whether it is accepted and used in the field. The purpose of this section is to assess people's attitude toward the rating process of landscape variables.

Respondents using visual standards and verbal standards felt similarly about the ease, validity, interest, and efficiency when they rated complexity and vividness of the landscape (see Table 9, 10). Although the rating results of interest for participants using visual standards are significantly different from those using verbal standards, the means for interest level of these two groups are almost similar. These findings indicate that there is no real difference between respondents' attitudes toward the process of evaluating the landscape for either visual standards or verbal standards.

Since the landscape type used in visual standards is not consistent with the

Table 9. Attitude toward the Process of Rating Landscape Complexity

	Visual standards		Verbal standards		
	Mean	Standard Deviation	Mean	Standard Deviation	Probability Level
Easy	3.06	0.81	3.13	0.83	0.871
Efficient	3.61	0.73	3.41	0.73	0.995
Valid	3.21	0.94	3.06	0.88	0.821
Interest	4.06	0.96	4.01	0.53	0.035

The difference between the mean ratings of using visual standards and verbal standards is significant at $p <= 0.05$.
The probability level is based on a two tail test.

Table 10. Attitude toward the Process of Rating Landscape Vividness

	Visual Standards		Verbal Standards		
	Mean	Standard Deviation	Mean	Standard Deviation	Probability Level
Easy	3.01	1.39	3.73	0.96	0.261
Efficient	3.26	1.03	3.67	0.82	0.391
Valid	3.01	0.93	3.47	0.74	0.421
Interest	4.06	0.73	3.81	0.86	0.457

The difference between the mean ratings of using visual standards and verbal standards is significant at $p <= 0.05$.
The probability level is based on a two tail test.

selected scenes, the participants may have had difficulty in rating landscape using visual standards (see section 4.12). Therefore, this influence may affect the respondents' feeling toward using visual standards.

Another external influence which might explain people's attitude toward the rating process is that the use of visual standards, which are relatively more comprehensive compared to descriptive standards, may require some training before people can use then with ease and comfort (see section 4.1). If participants have difficulty using the computer questionnaire program, they may feel the visual standards are easier to use after the learning period.

In short, the finding indicates that participants feel no difference between using visual standards and verbal standards in the process of rating landscape variables. This result implies that participants were able to accept using visual standards in the process of rating the landscape variables, such as complexity and vividness.

4.4 ANALYSIS OF PARTICIPANT'S RESPONSE

Volunteered free responses are worth study because participants expressed their opinion about using visual standards or verbal standards without any limitation. These responses may provide some insight about using visual standards to rate landscape variables.

60 percent (N=10, five non-respondents) of the respondents who used visual standards felt using these standards to rate the landscape was like a training session.

These participants also believed that using visual standards was very helpful in terms of clarifying the concepts of complexity and vividness. On the other hand, 54.54 percent (N=11, four non-responses) of the respondents using verbal standards complained about the difficulty of using verbal standards to rate the landscape, because the concepts of complexity and vividness were abstract.

These results imply that landscape variables which are accepted as the rating components of landscape assessment systems did not become familiar to many participants before they took the survey of this study. These results also demonstrate that visual standards can be further developed as a training tool to help people to become more familiar with the knowledge of visual assessment. In this case, even if visual standards are not used in the actual rating of landscapes, visual standards could possibly enhance reliability and validity of verbal standards. Therefmxe, one implication needs to be tested to see if visual standards can provide a valid and reliable representation of each level of landscape variables.

4.5 MAJOR FINDINGS AND CONCLUSION

In addition, reviewing the major research findings covered in this study will be helpful for further discussion of the implications of this thesis research in the next chapter. The major findings of this analysis are:

1. Using visual standards to assess complexity and vividness cannot improve their predictive relationship to preference compared to verbal standards. However,

visual standards might support a better explanation of the relationship between preference and landscape attributes such as complexity and vividness; and the past complexity ratings may have been influenced by the rater's preference for a given landscape.

2. Visual standards need further development by excluding the external influences to produce more consistent results in assessing landscape variables.

3. Using visual standards results in a broader use of rating scale particularly at the lower end of the scale and results in lower ratings compared to ratings using verbal standards.

4. People feel that using visual standards to rate complexity is more accurate than using the verbal standards. However, there were no rating differences for vividness using visual standards versus verbal standards.

5. There is no real difference between respondents' attitudes toward the process of evaluating the landscape, although visual standards are more complicated than verbal standards.

6. The concepts of complexity and vividness are still not quite familiar to students who will use visual or verbal standards in visual assessment.

In conclusion, this research has been unable to identify advantages in terms of the reliability and validity of visual standards compared to traditional verbal standards. On the other hand, there is no evidence to indicate that visual standards appear to be any less reliable and valid than verbal standards. Actually, using visual standards to rate complexity are perceived by the user as more accurate. Several research directions which could be explored to increase the reliability and validity of ratings will be discussed in the next chapter.

CHAPTER 5: CONCLUSIONS AND IMPLICATIONS

The purpose of this chapter is to address the implications of applying and improving visual standards in landscape quality assessment. Since the use of digital computer technology is increasing rapidly, using technology to share and to transmit information, including visual images, will become increasing important. In addition, recent technological advancements such as video capture and CD rom storage make it possible to use visual measurement systems to support the explanation of knowledge in landscape assessment. This thesis is an initial study of visual based standards used for measurement. Further study must be continued by government agencies and researchers. This chapter is divided into three sections: (1) implications for researchers; (2) implications for government agencies; and (3) conclusion.

5.1 IMPLICATIONS FOR RESEARCHERS

Visual standards need additional evaluation before they can be used in visual management systems. Several aspects of visual standards need further research and development and will be discussed below. The first is the human behavior aspect which affects the use of visual standards to rate landscape variables. The second is related to the reliability and accuracy of using visual standards as a reference. The third is to test if other variables (such as coherence, mystery and others) can be effectively presented and explained by using visual standards. The last is to study the quality of visual images for developing the visual standards.

5.11 Human Behavior Components

Visual standards will not be an effective measurement tool if professionals feel these standards are cumbersome or inefficient. Two aspects of human behavior that relate directly to the use of visual standards need to be studied. One is whether there is a learning period required to adequately use visual standards. The other is how visual standards can be presented so that people will not become bored or confused when using them to evaluate the landscape.

5.111 Testing the learning period

Since using visual standards is somewhat like using a tool, perhaps a learning period exists for people to become familiar with using visual standards properly. People may not produce more consistent results when rating the landscape with these tools before they have learned how to use them. Also, in the learning period, people may experience frustration and difficulty using visual standards.

An experimental test can be designed to examine whether a learning period exists for people to rate landscapes by using the visual standards. Research can be conducted to compare results of people after a training period to those who have not had a training session to determine if this improves producing a more consistent rating results when using visual standards. It can be proven that there is a learning period at the beginning for evaluating the landscape, if the rating variance of landscape variables (i.e. complexity and vividness) for people who use visual standards several times is less than those who have not yet used the visual standards.

If further research proves that visual standards could be utilized to produce more consistent results after a learning period, then the potential for developing the visual standards as a training tool to educate professionals or landscape architecture students will become meaningful. Therefore, further research is needed to examine whether a learning period exists at the beginning of using the visual standards.

5.112 The efficient method

Even if visual standards are reliable and valid, people will not use visual standards which are boring or confusing. Therefore, testing the effect of different methods for presentation of visual standards on ease of use is important. The implication of identifying the proper method for presenting visual standards will be described as follows.

In this study, only one image of a visual standard was able to be presented on the screen at a time, and the effects of presenting multi-images on a screen at the same time have not yet been studied. Research could be conducted to compare methods of presenting the visual standards. Logically it would seem better to have a chance to compare multiple images at the same time rather than referring back and forth between images. However, the scale of multi-images on the screen will be smaller. This may cause the blurring or loss of details and texture of the visual standard images. Blurring visual images affects the accuracy of visual standards. In addition, the time to retrieve multi-images will be longer than the time required to retrieve single images. Thus, people will have to wait longer. Since the method of presenting the visual standards influences the final rating results and people's attitudes toward the process of evaluation of the landscape, further research needs to be conducted to identify people's attitudes toward the process of presenting and using visual standards.

5.12 A More Objective Measurement System

Any measurement system used as a reference for rating the landscape should present the full range of landscapes accurately. Even if visual standards help professionals produce more consistent rating results than verbal standards, visual standards will still not contribute to a good reference system if they expand or compress different levels of landscape variables being rated (i.e. complexity and vividness).

Although the rating results for both complexity and vividness which resulted from using visual standards were found to be different from those using the verbal standards, there is no objective reference that can accurately quantify these landscape variables. Since there is no objective yard stick upon which to base measurement of landscape variables, we cannot determine whether visual standards or verbal standards are more reliable and accurate. Therefore, researchers need to develop objective measures to quantify the variables used in the visual assessment systems. Shafer (1969) used a grid system to objectively quantify certain variables. Buhyoff et al (1982) used digitation of landscape elements to predict scenic quality for pine beetle and western spruce. Although these types of quantitative methods are complicated and time consuming, they might provide an objective basis for determining the accuracy of other systems, such as visual standards or verbal standards. Therefore, quantitative research needs to be conducted to define the concepts of landscape variables such as complexity and vividness more accurately. Only with an objective measure, can it be determined whether there is a tendency to compress and shift the rating scale by using verbal standards compared to visual standards.

In short, research needs to be conducted to develop some type of "physically quantifiable measure" or a secondary measure based on physically quantifiable attributes of the landscape. Only in this way, can we test the reliability of using the visual standards.

5.13 Prediction of Other Landscape Variables

The visual standards developed in this thesis represent only two variables, complexity and vividness. There is a need to examine the use of visual standards to present other landscape variables, such as uniqueness and mystery. Perhaps visual standards can better explain a landscape variable that relates more to physical landscape attributes than one that relates to visual attributes. Therefore, additional research is needed to test the effects of using visual standards to predict other landscape variables, in order to identify the validity of using visual standards beyond the scope of research described in this thesis.

5.14 Resolution of Visual Images

Visual images can have different degrees of resolution. While higher resolution allows more realistic and detailed images it requires more storage space and a longer time to manipulate in the computer. Therefore, there is a need to determine what appropriate resolution is detailed enough to adequately convey landscape attributes being depicted by visual standards without requiring excessive storage space on computer.

Although a preliminary study was conducted as part of this thesis to identify the resolution for scanning the visual images in this thesis, no research has been systematically conducted to test the relationship between resolution and validity of visual images for representing landscape variables. Therefore, this is an area that needs further research.

5.2 IMPLICATIONS FOR GOVERNMENT AGENCIES

To systematically apply visual standards nation wide, there are two implications that government agencies need to address. They will be discussed below: first, is the implication relevant to the consistency of characteristic landscape type between visual standards and landscapes to be evaluated; the second is relevant to conveying information about visual standards in landscape quality assessment.

5.21 Consistency in Landscape Characteristic Types

Government agencies such as the Forest Service and BLM are in charge of managing public lands. Therefore, it is their responsibility to decide and develop visual standards based on the national viewpoint. In this study, the diversity of landscape character types used in the visual standards and in the test scenes of the survey may have reduced the reliability of visual standards. So one implication of this thesis that needs further exploration is to provide consistent landscape character types between visual standards and the landscape to be evaluated.

Most visual assessment systems are based on a similar landscape character type that limits the range of physical attributes of the landscapes being evaluated. In order to break the limitation of developing visual standards on physiographic regions (Holland, 1976), it is also appropriate to accept the strength of some natural landscape classification systems, such as biogeoclimatic regions (Krajina, 1976; Miller, 1987) as a basis for developing visual standards. In addition, visual standards should also be developed systematically or hierarchically for representing landscape attributes of different region scales. For example, in some cases, the major physiographic region and biogeoclimatic zones will be too broad or have to great a visual diversity of character to provide a logical frame of reference to classify visual features of the landscape. For such situations each major landscape type should be further broken into subtypes, and visual standards should be developed according to the landscape subtypes.

On the whole, recent technological advancements allow for more easily developed and used visual standards. Government agencies need to be responsible for further developing the visual standards based on a combination of physiographic zones and biogeoclimatic regions.

5.22 Dissemination of Information

If the visual standards prove valuable for application in landscape quality assessment, then there will be a need to provide training materials for professionals and students who will be using visual standards in the future. Government agencies should be responsible for developing training materials to teach people how to use visual standards in landscape assessment. On the other hand, even if visual standards do not replace the existing verbal standards, it is still necessary to develop visual standards as a training tool for explaining the concepts related to landscape visual assessment. Since it was found in this study that the concepts related to landscape variables such as complexity and vividness used in the landscape assessment were not familiar to many landscape architecture students, it is important to disseminate the concepts that related to landscape variables to the people who will be engaged in visual resource management. The importance of professionals understanding the theory behind landscape assessment or perception has been indicated by S. Kaplan (1975)[14].

Therefore, one implication for government agencies is to find a means of using visual standards to disseminate and explain the concepts of landscape variables in visual assessment. Multi-media systems (such as Authorware) offer the potential to use visual standards as an easily-carried and user friendly software package. There is a need of better ways of educating professionals on visual assessment concepts and methods.

5.3 CONCLUSION

The implication of applying and improving visual standards in landscape assessment will be summarized in this section. There are four implications of this thesis which need to be examined further by researchers before government agencies make the efforts to develop visual standards as a measurement tool for national use. They are:

1. to examine the human behavior components of using the visual standards;
2. to develop an objective measurement or yard stick for examining the accuracy of rating scales while using visual standards;
3. to test the effects of using visual standards for the purpose of presenting other landscape variables (such as uniqueness, coherence, and others), and
4. to identify the appropriate resolution of visual images for developing visual standards.

To apply the visual standards as a measurement tool or a training tool in landscape quality assessment, government agencies need to examine the following two implications:

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[14]S.Kaplan (1975) indicated: "...science is likely to continue to produce generalizations and frameworks while reality is likely to continue to be complicated and erratic. Thus, considerable skill will continue to be required in the application of scientific knowledge". pp.100-101

1. the establishment of visual standards based on landscape character types, and

2. the development of easily-carried and user friendly software packages for spreading the visual standards as a training tool for the education of professionals and students.

In conclusion, this research has attempted to find a more appropriate method for improving the existing verbal standards applied in landscape assessment. As this thesis is an initial study to test the usefulness of visual standards, not all external variables which may influence the rating results were eliminated. Furthermore, the statistical tests of this study were not very powerful in picking up differences in mean ratings because of the small sample size of this study. In order to improve visual standards as a reference for landscape assessment, both researchers and government agencies need to further explore improving the reliability and validity of visual standards.

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Appendixes

Appendix A: Calibration Response Form

Response Form --- Complexity & Vividness

1.Using the descriptive standards provided, please circle the number which most closely describes the appropriate level of vividness for each landscape.

(1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High)

Slide No.	Vividness	Slide No.	Vividness
1	1 2 3 4 5	16	1 2 3 4 5
2	1 2 3 4 5	17	1 2 3 4 5
3	1 2 3 4 5	18	1 2 3 4 5
4	1 2 3 4 5	19	1 2 3 4 5
5	1 2 3 4 5	20	1 2 3 4 5
6	1 2 3 4 5	21	1 2 3 4 5
7	1 2 3 4 5	22	1 2 3 4 5
8	1 2 3 4 5	23	1 2 3 4 5
9	1 2 3 4 5	24	1 2 3 4 5
10	1 2 3 4 5	25	1 2 3 4 5
11	1 2 3 4 5	26	1 2 3 4 5
12	1 2 3 4 5	27	1 2 3 4 5
13	1 2 3 4 5	28	1 2 3 4 5
14	1 2 3 4 5	29	1 2 3 4 5
15	1 2 3 4 5	30	1 2 3 4 5

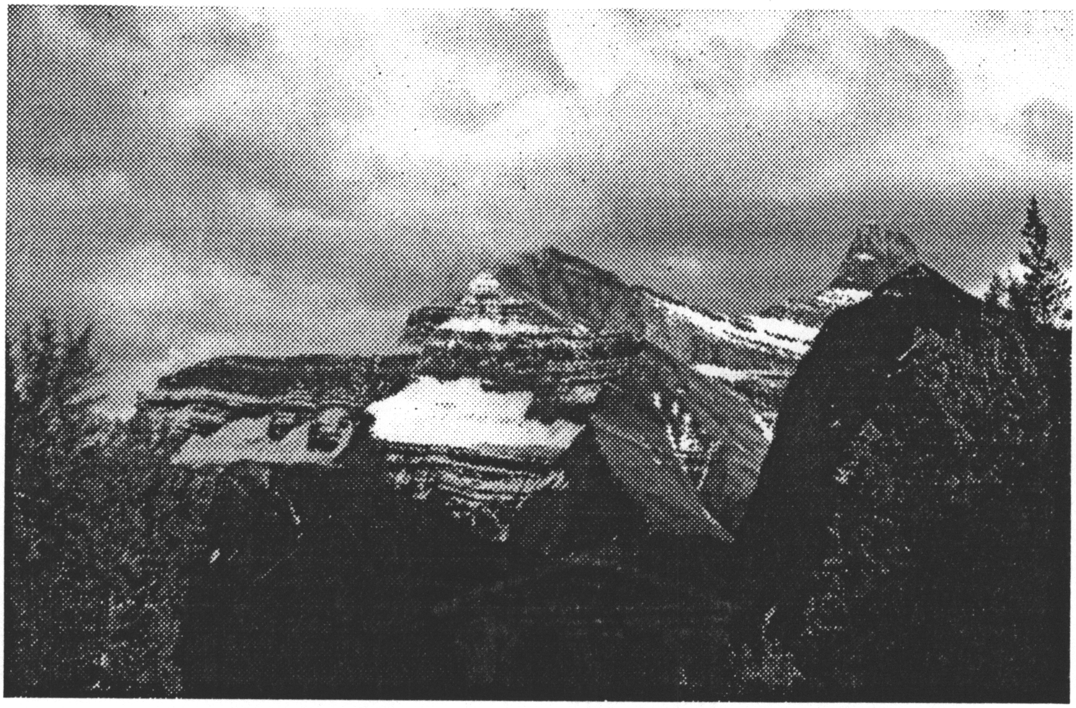
2. Using the descriptive standards provided, please circle the number which most closely describes the appropriate level of complexity for each landscape.

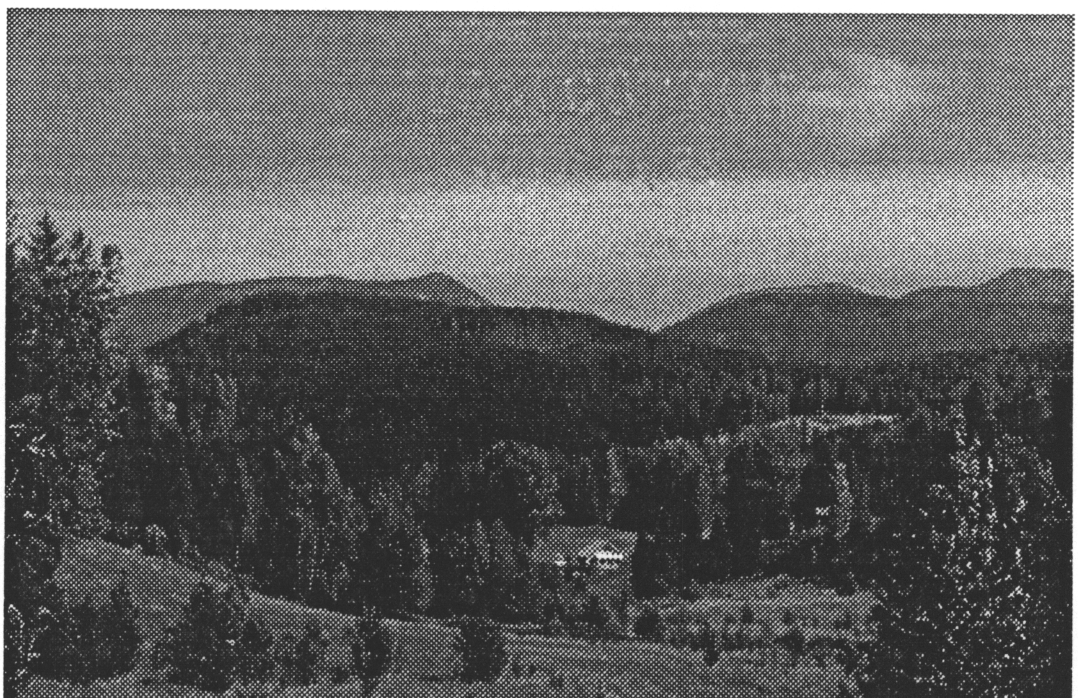
(1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High)

Slide No.	Complexity	Slide No.	Complexity
1	1 2 3 4 5	16	1 2 3 4 5
2	1 2 3 4 5	17	1 2 3 4 5
3	1 2 3 4 5	18	1 2 3 4 5
4	1 2 3 4 5	19	1 2 3 4 5
5	1 2 3 4 5	20	1 2 3 4 5
6	1 2 3 4 5	21	1 2 3 4 5
7	1 2 3 4 5	22	1 2 3 4 5
8	1 2 3 4 5	23	1 2 3 4 5
9	1 2 3 4 5	24	1 2 3 4 5
10	1 2 3 4 5	25	1 2 3 4 5
11	1 2 3 4 5	26	1 2 3 4 5
12	1 2 3 4 5	27	1 2 3 4 5
13	1 2 3 4 5	28	1 2 3 4 5
14	1 2 3 4 5	29	1 2 3 4 5
15	1 2 3 4 5	30	1 2 3 4 5

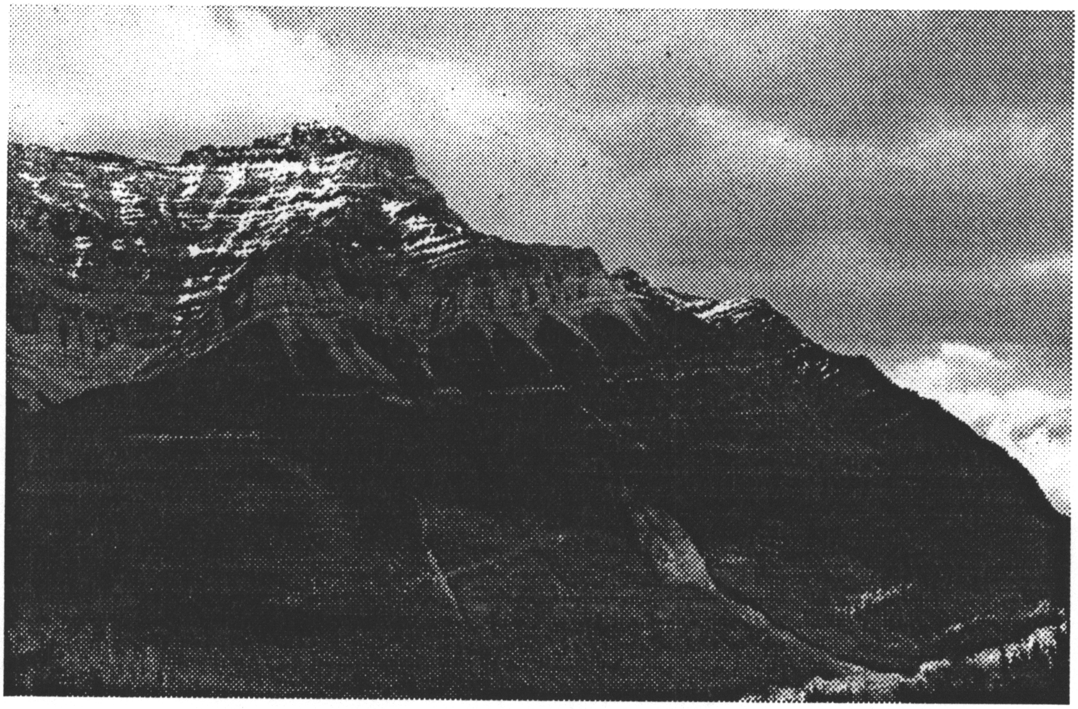
Appendix B: Scenes Selected for Developing Visual Standards

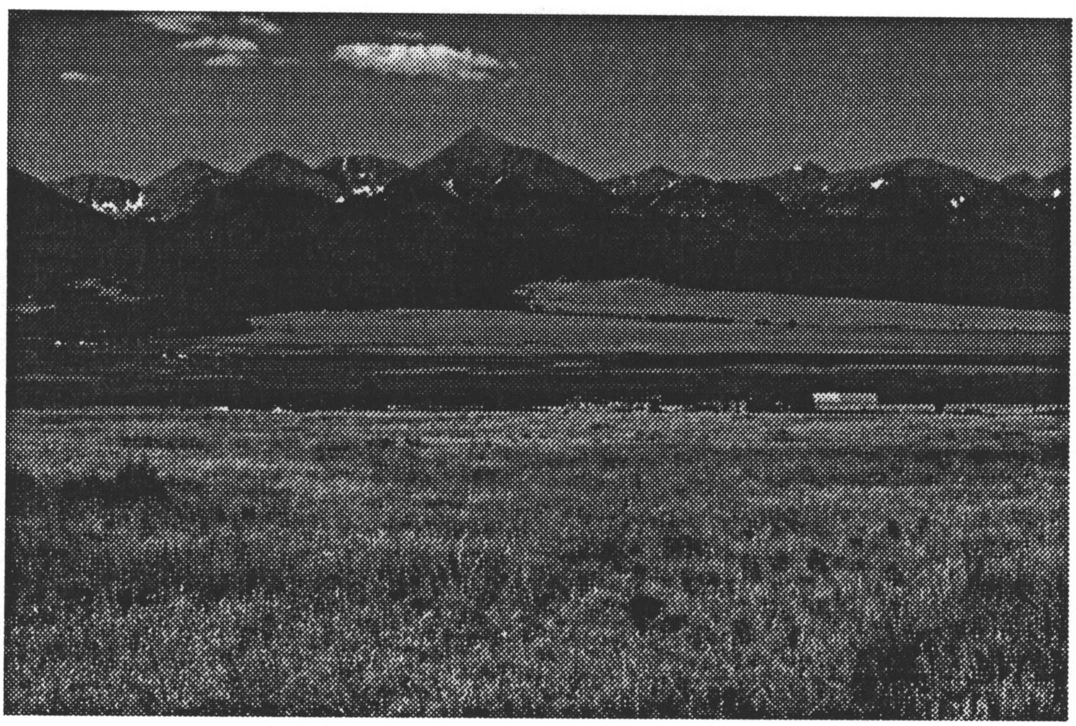
Complexity



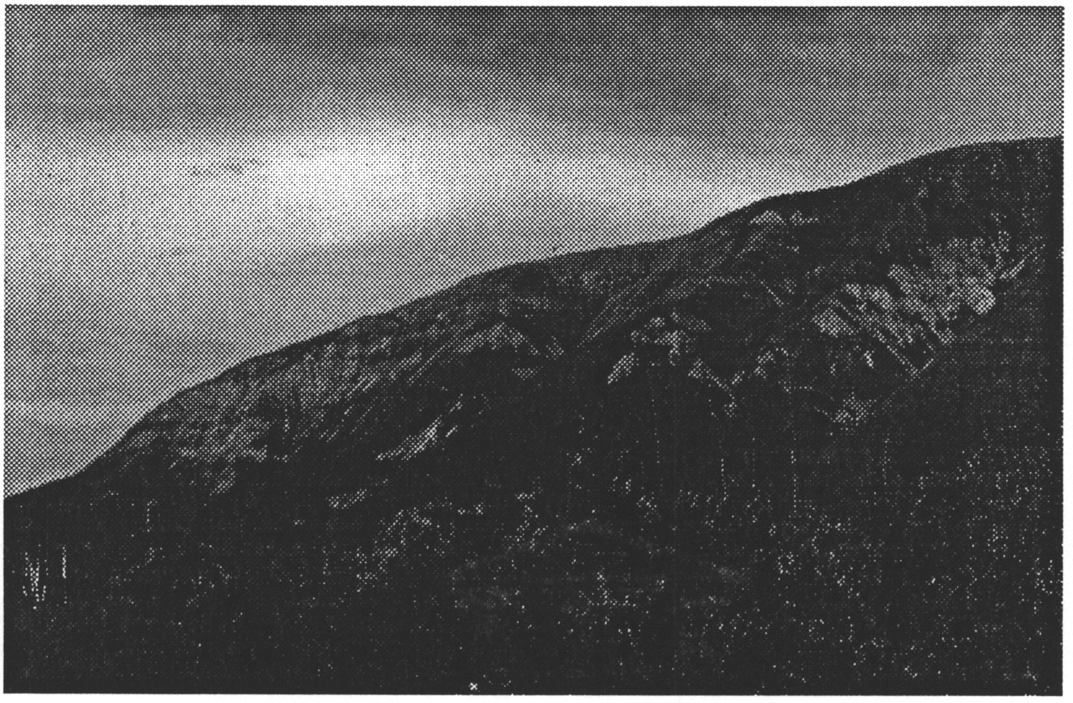


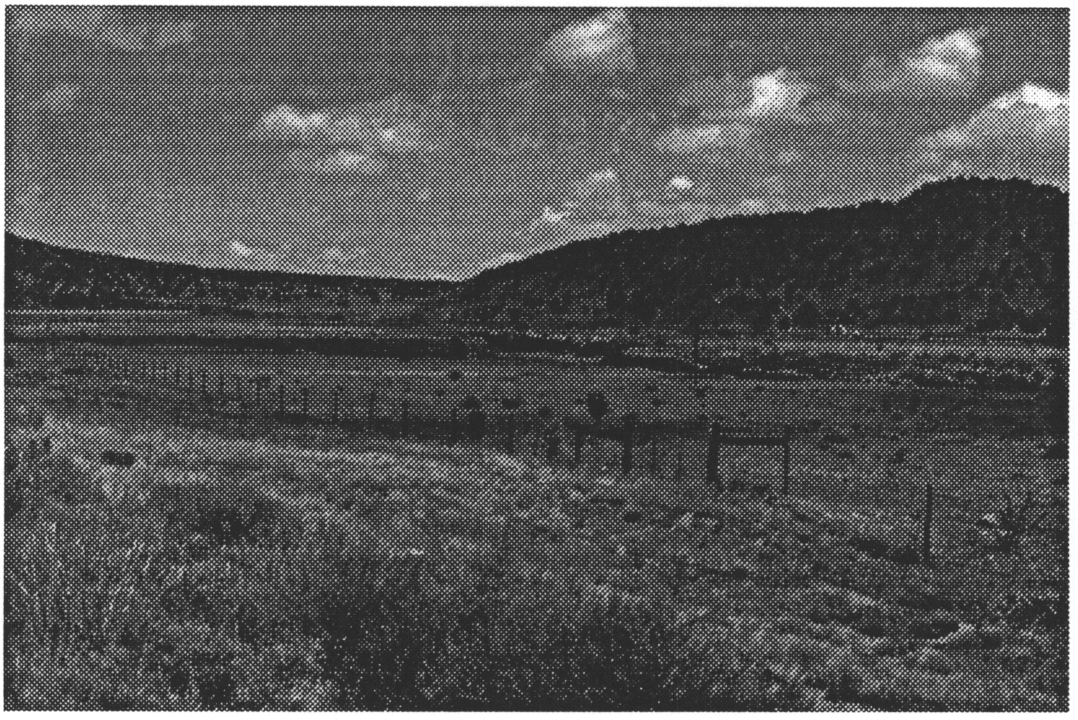
Visual Images for High Complexity



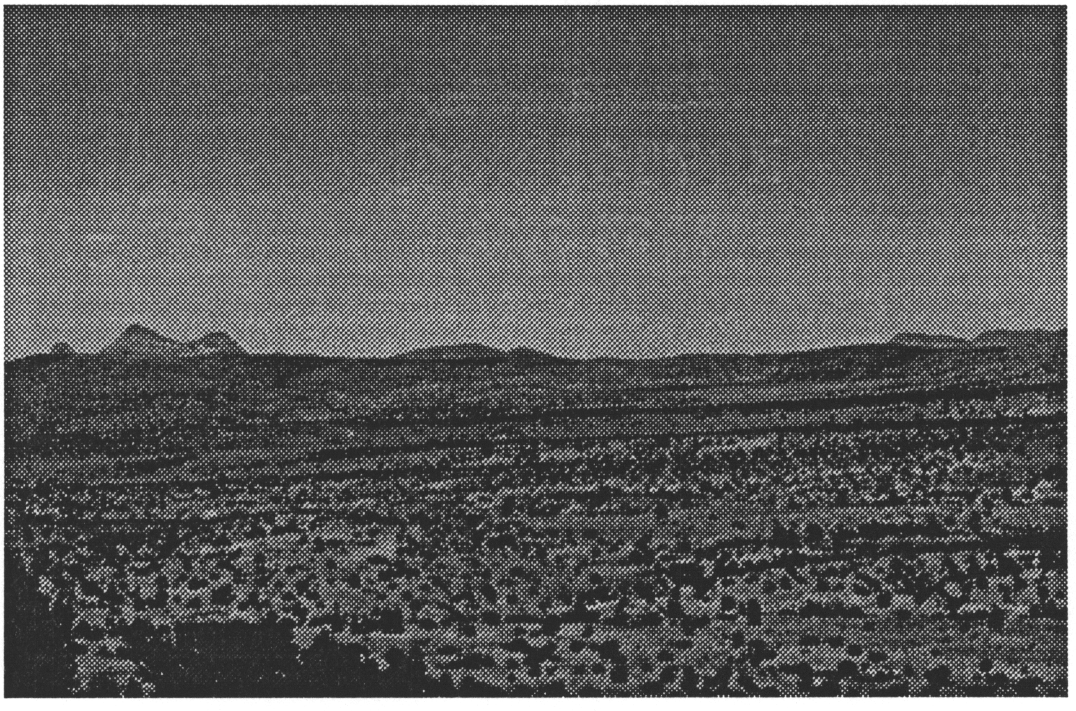


Visual Images for Moderately High Complexity





Visual Images for Moderate Complexity

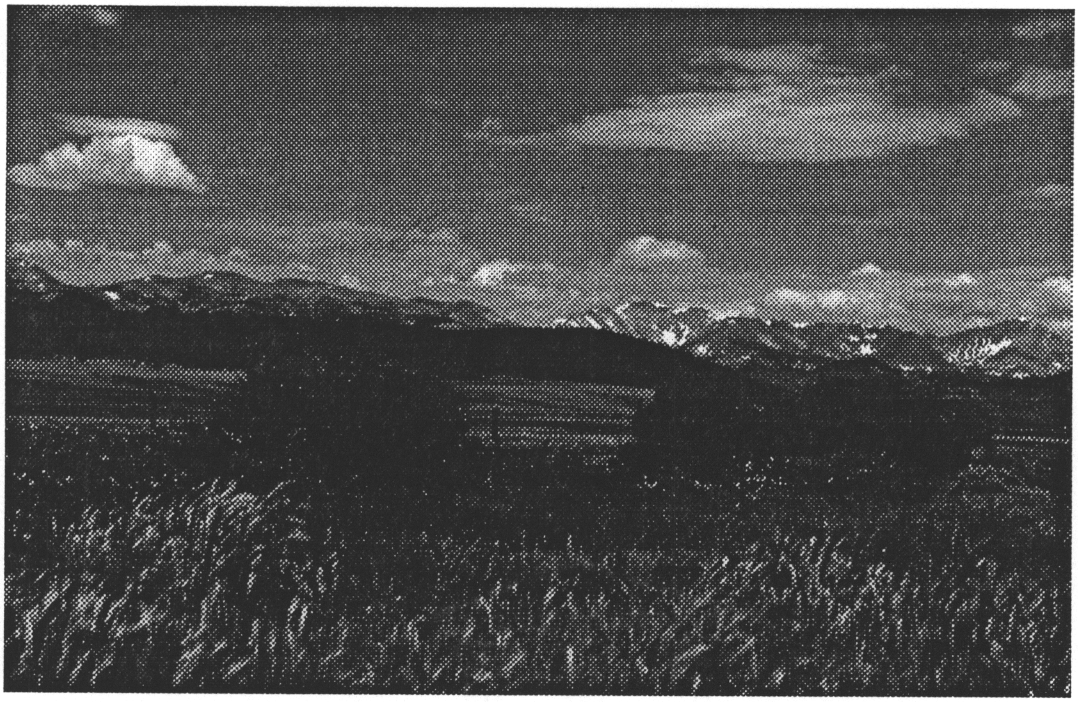


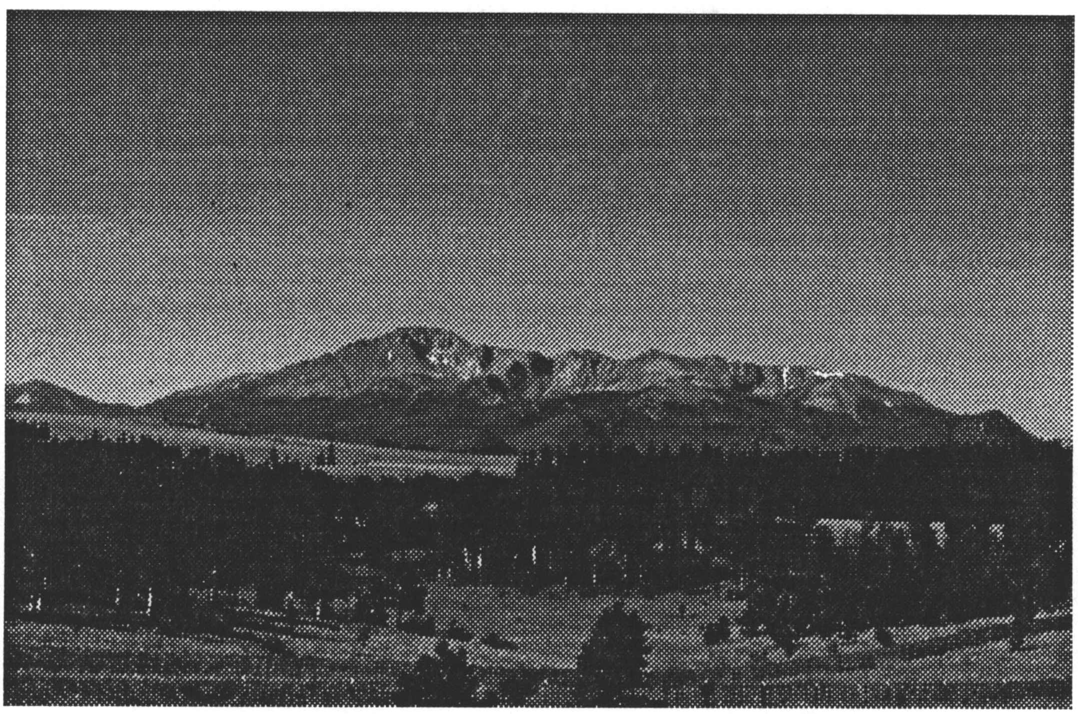
Visual Images for Moderately Low Complexity

Visual Images for Low Complexity

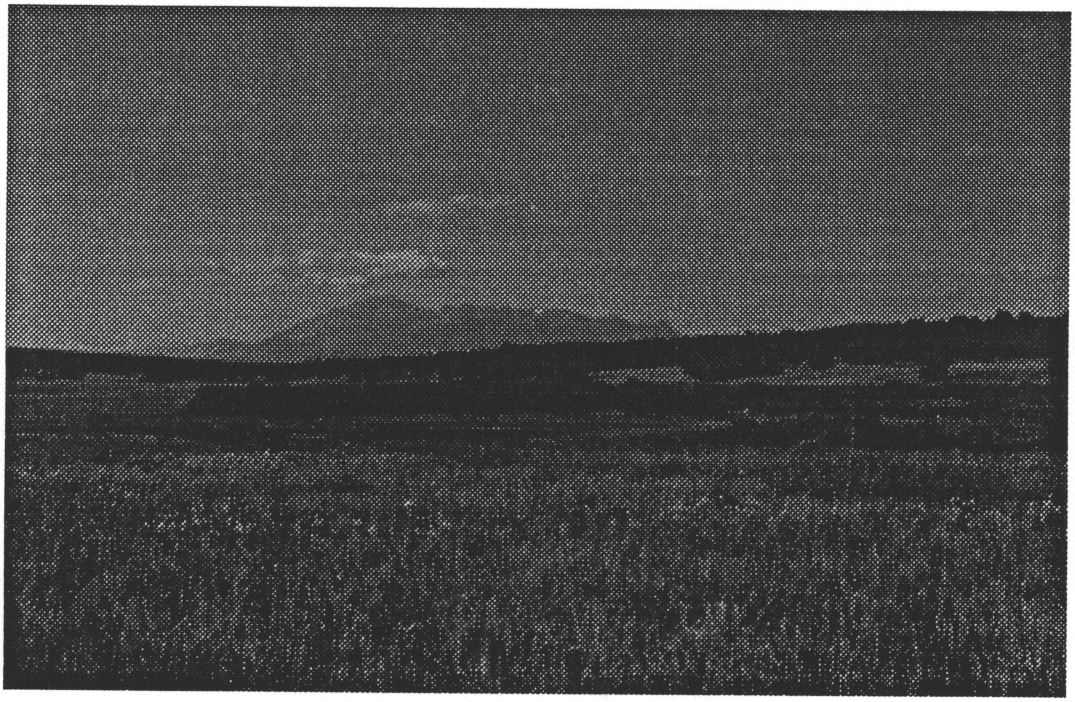
Scenes Selected for Developing Visual Standards

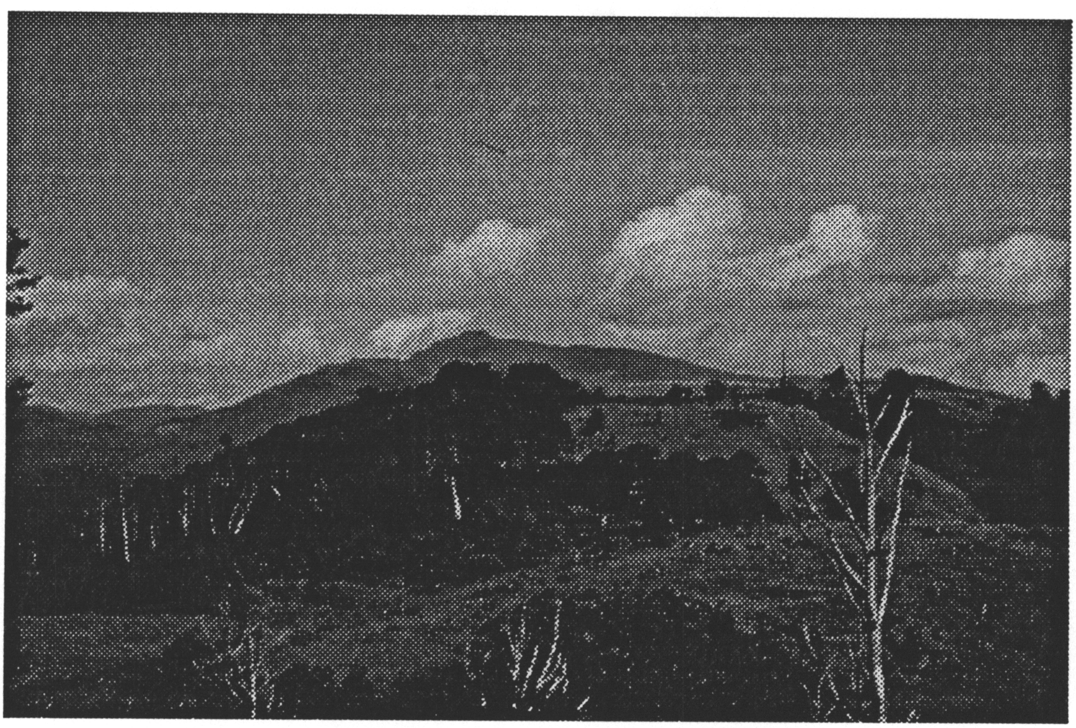
Vividness



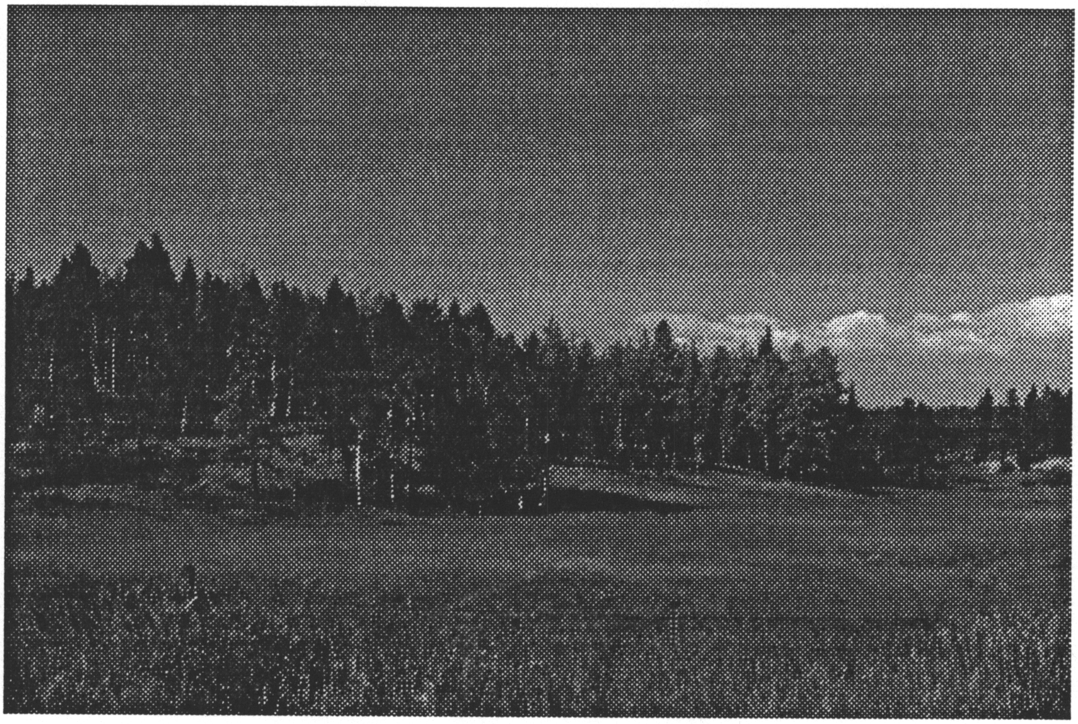


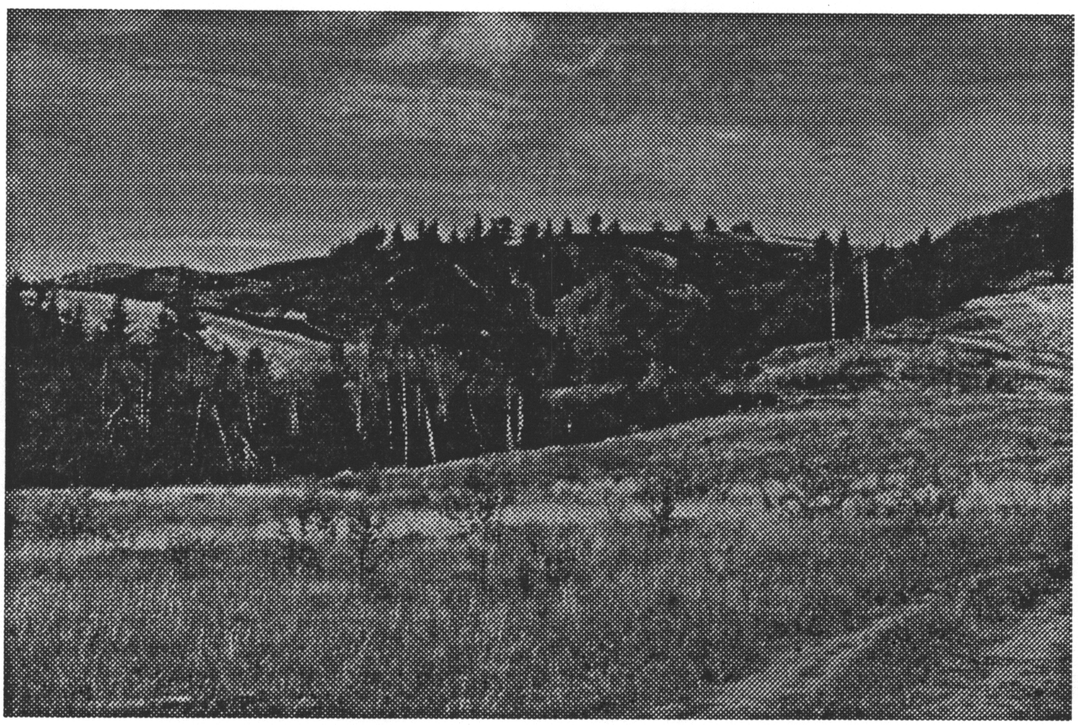
Visual Images for High Vividness



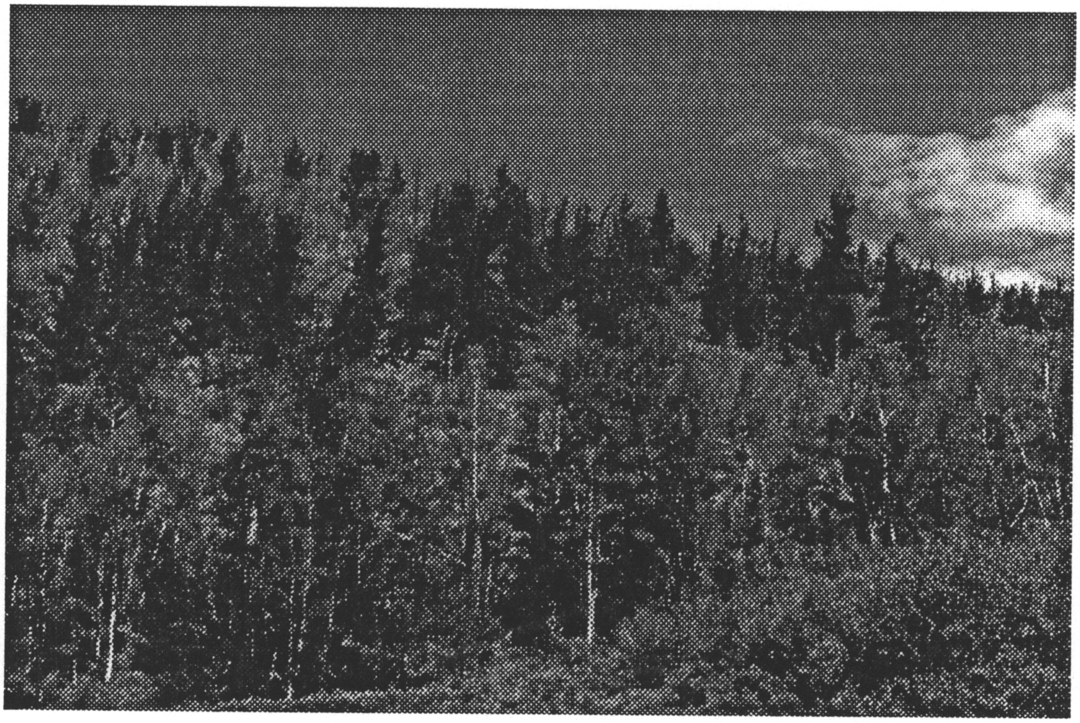


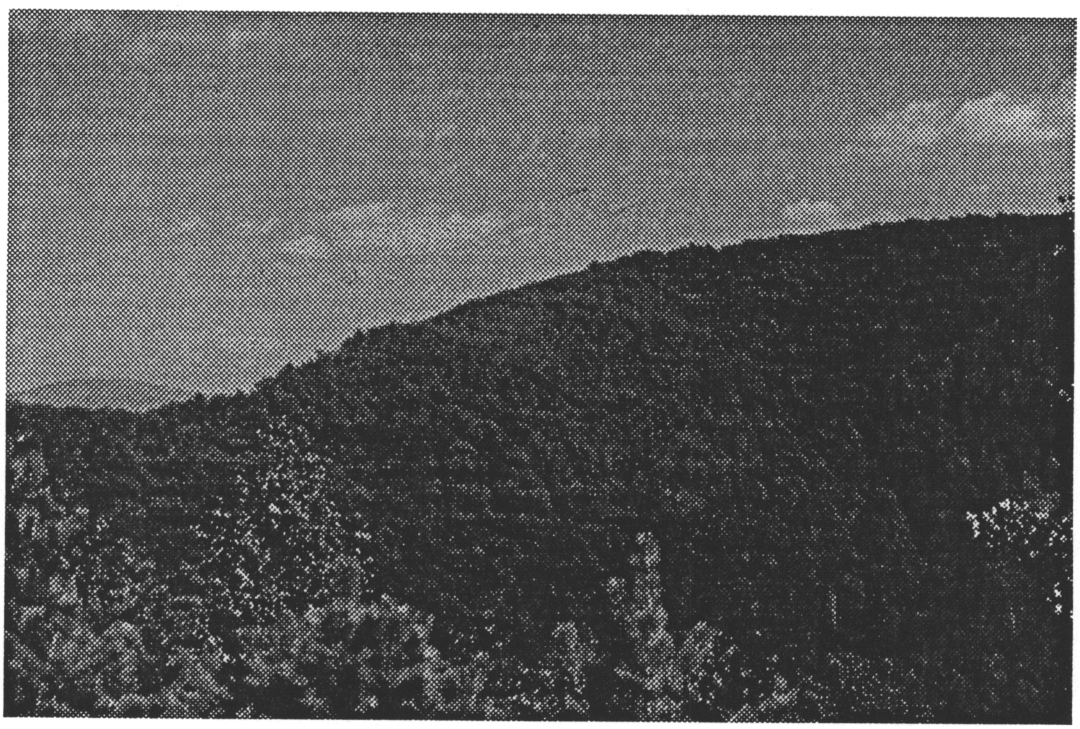
Visual Images for Moderately High Vividness





Visual Images for Moderate Vividness





Visual Images for Moderately Low Vividness

Visual Images for Low Vividness

Appendix C: Verbal Standards

Criteria of Complexity

Visual complexity is the quantity or number of different visual elements in the landscape, or the degree of variation in the lines, forms, colors and textures which comprise the visual landscape. It is a measure of how intricate or rich the landscape is visually.

High visual complexity is large quantity of different visual elements in the landscape, such as landforms, vegetation patterns and etc., or the high degree of variation in the lines, forms, colors and textures which comprise the visual landscape.

Moderately high complexity is the moderately large quantity or number of different visual elements in the landscape, such as landforms, vegetation patterns and etc., or the moderately high degree of variation in the lines, forms, colors and textures which comprise the visual landscape.

Moderately visual complexity is the moderate large quantity or number of different visual elements in the landscape, such as landforms, vegetation patterns and etc., or the moderate degree of variation in the lines, forms, colors and textures which comprise the visual landscape.

Moderately low visual complexity is relatively small quantity or number of different visual elements in the landscape, such as landforms and vegetation patterns, or the moderately low degree of variation in the lines, forms, colors, and textures which comprise the visual landscape.

Low visual complexity is the small quantity or number of different visual elements in the landscape, such as landforms and vegetation patterns, or the low degree of variation in the lines, forms, colors and textures which comprise the visual landscape.

Criteria of Vividness

Vividness is the extent to which individual landscape features and/or patterns within the landscape are visually distinct and readily visible. Landscapes that are more vivid are more distinctive and more memorable. The memorability, intensity, or dramatic content of the landscape experience, derived form contrasting landscape components as they combine in striking and distinctive visual patterns.

High vividness is the extent to which individual landscape features and/or patterns within the landscape, such as landforms, vegetation patterns and etc., are highly striking and very visually distinct.

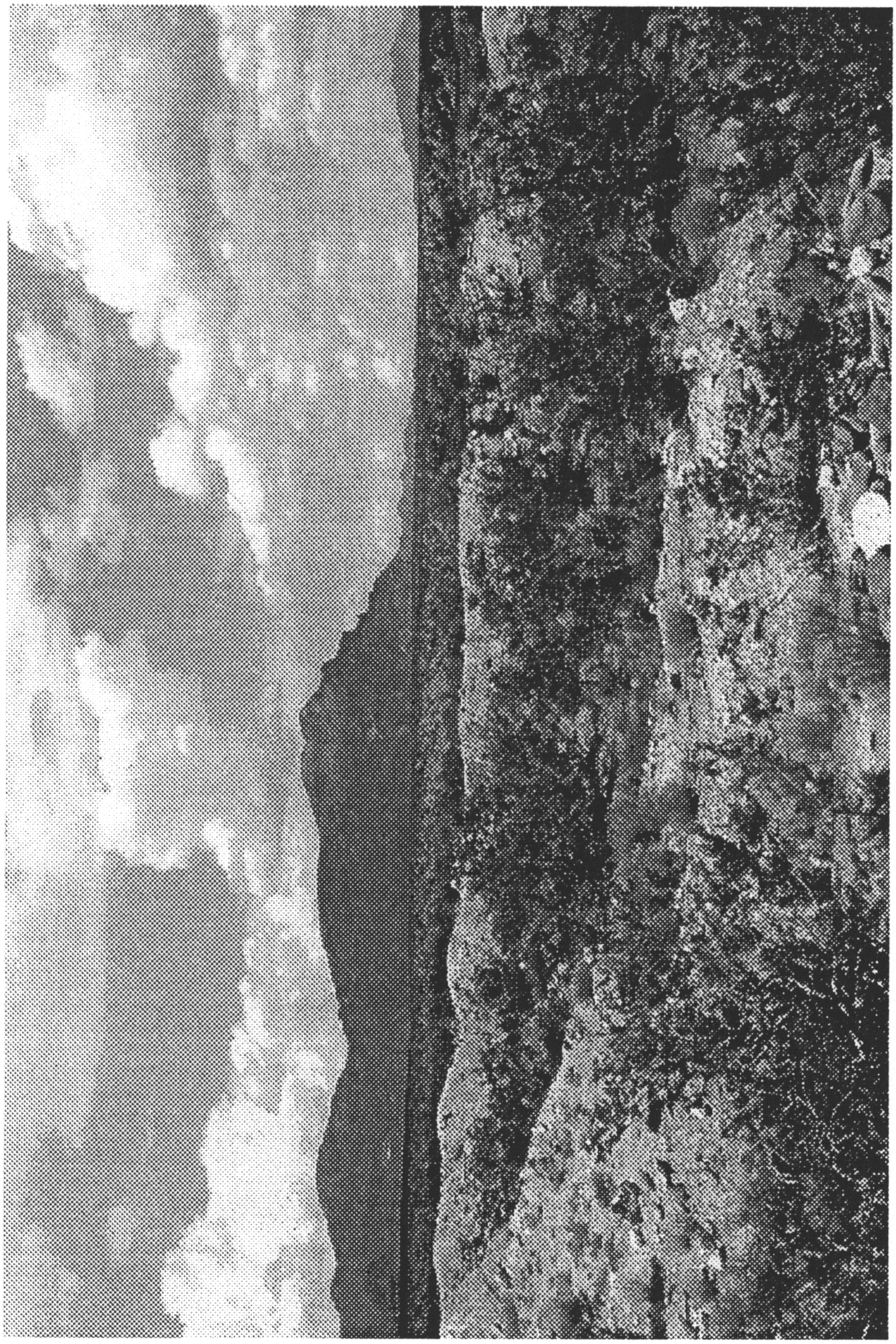
Moderately high vividness is the extent to which individual landscape features and/or patterns within the landscape, such as landforms, vegetation patterns and etc., are visually interesting but are not very striking.

Moderate vividness is the extent to which individual landscape features and/or patterns within the landscape, such as landforms, vegetation patterns and etc., have visually distinct pattern but are not very striking.

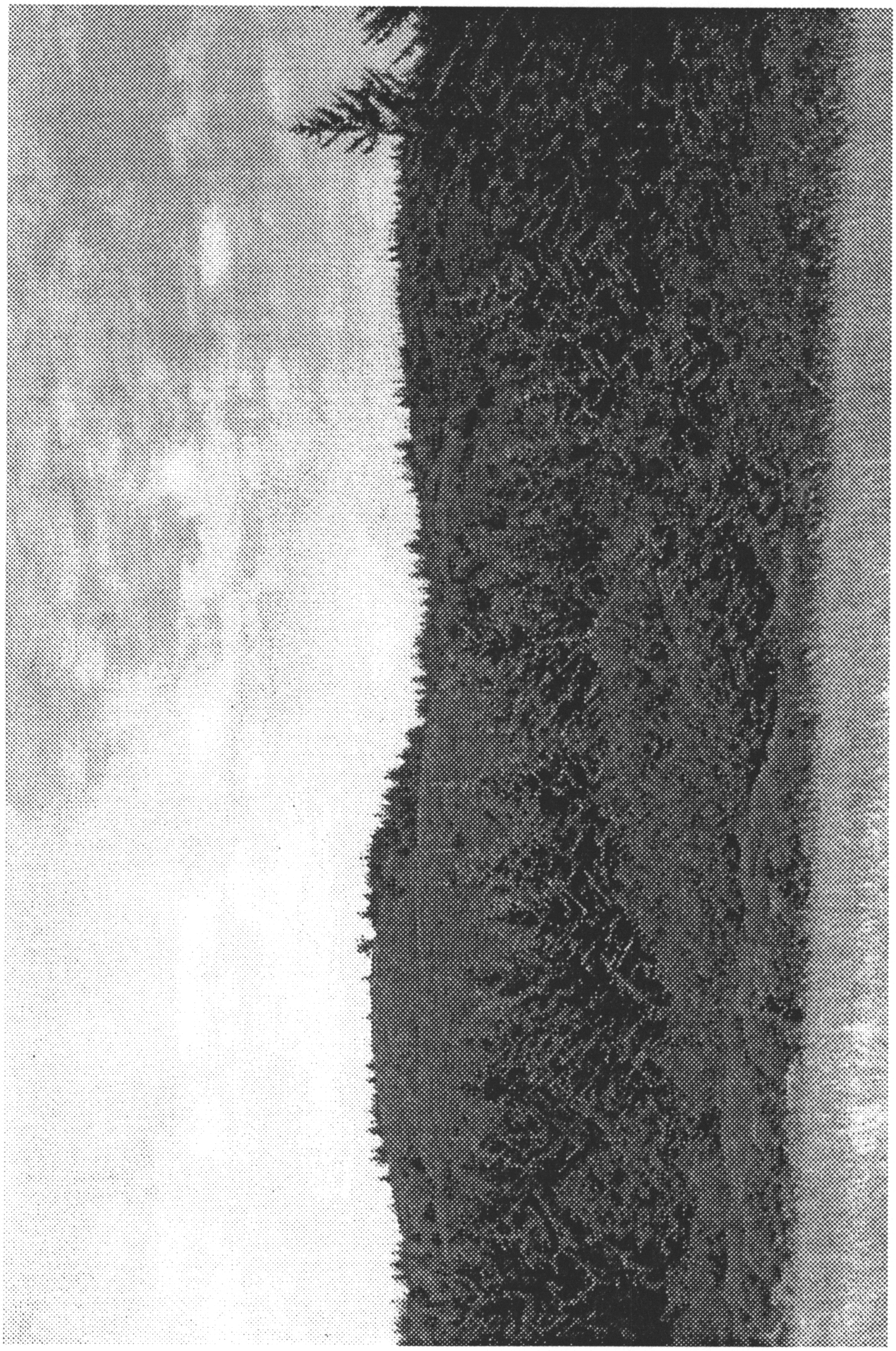
Moderately low vividness is the extent to which individual landscape features and/or patterns within the landscape, such as landforms, vegetation patterns and etc., are existing but are not easily noticed and not striking.

Low vividness is the extent to which individual landscape features and/or patterns within the landscape, such as landforms and vegetation patterns, do not exist. The landscape appears visually homogenous.

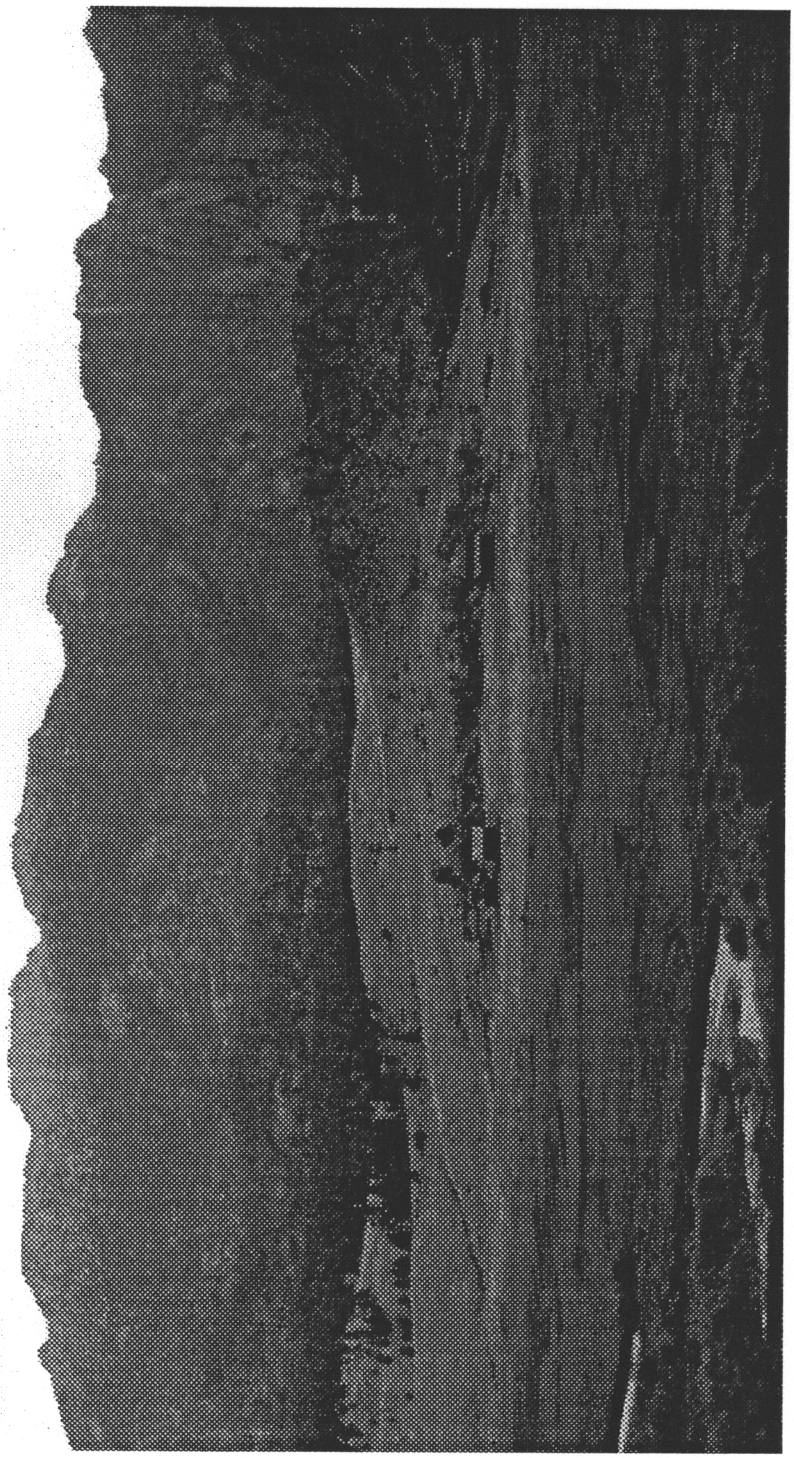
Appendix D: The Tested Scenes of the Survey



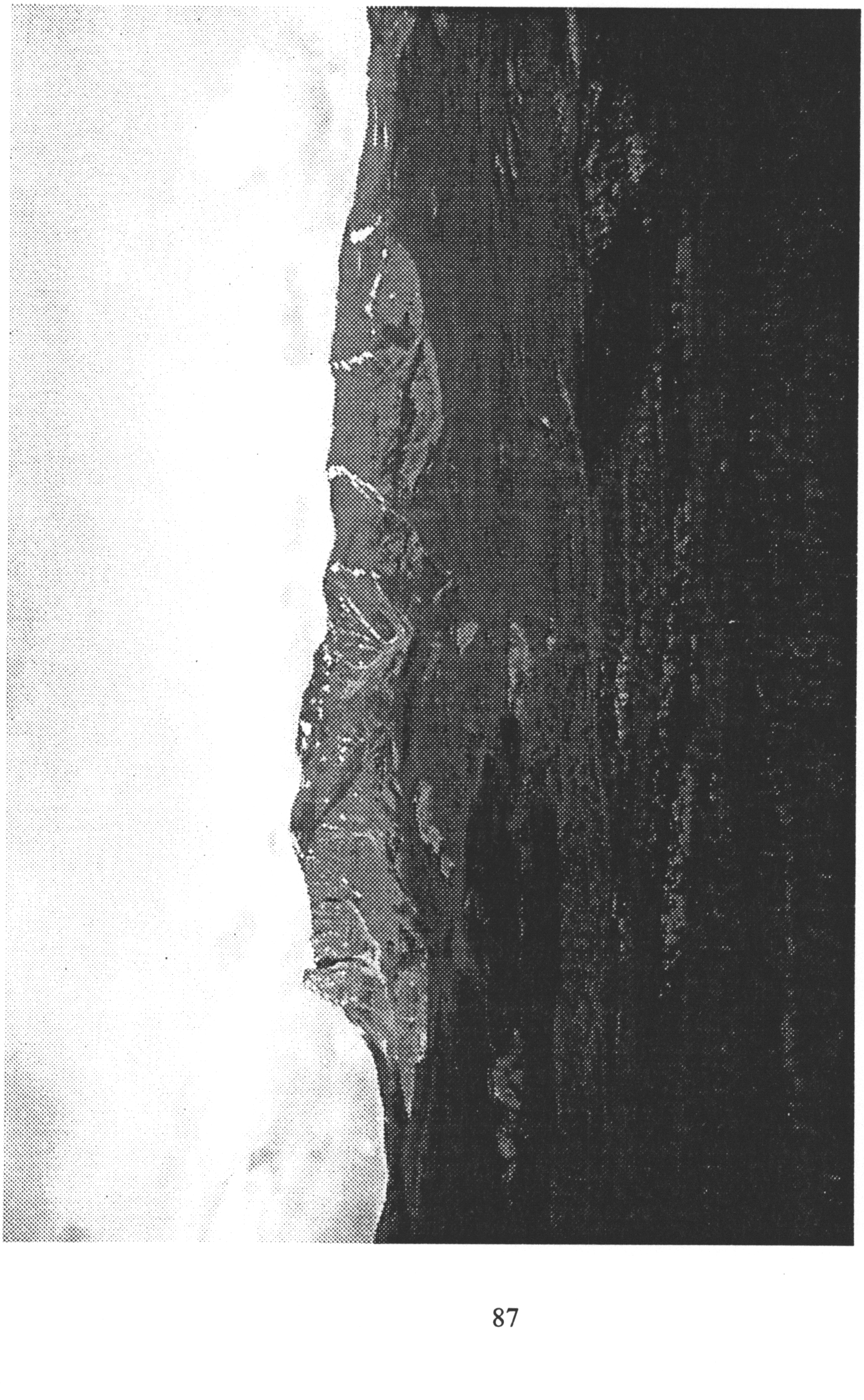
Scene 1



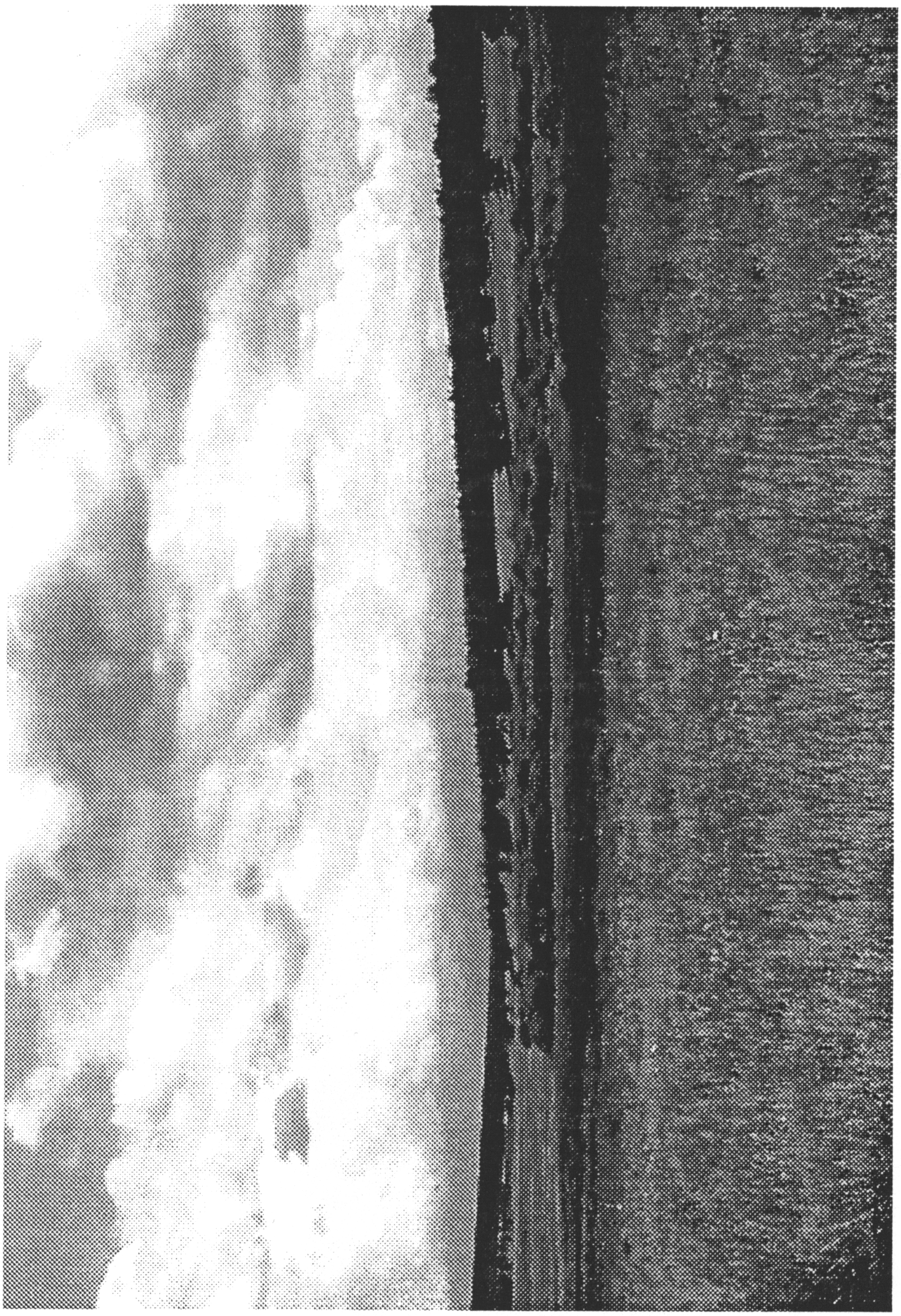
Scene 2



Scene 3



Scene 4



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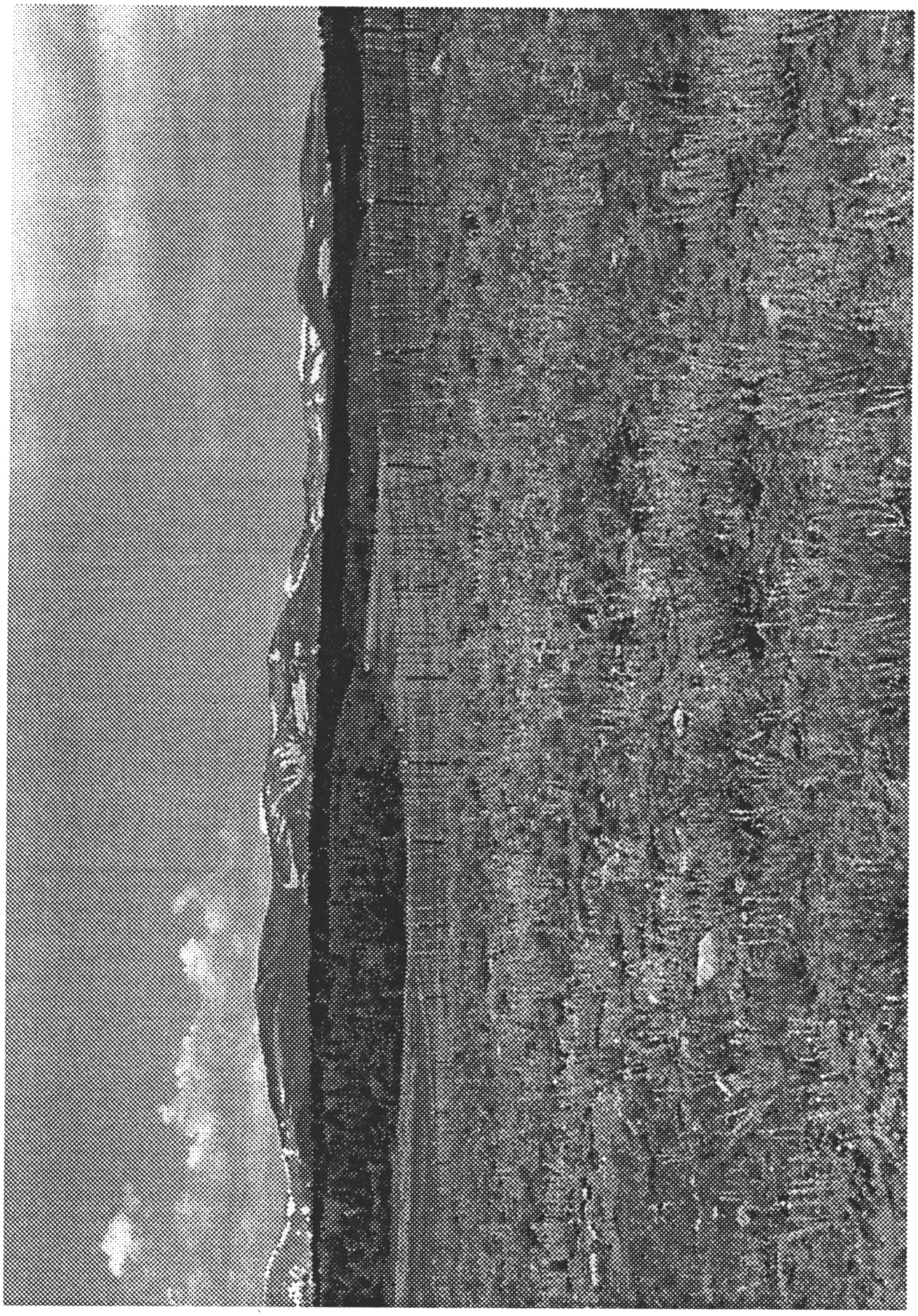
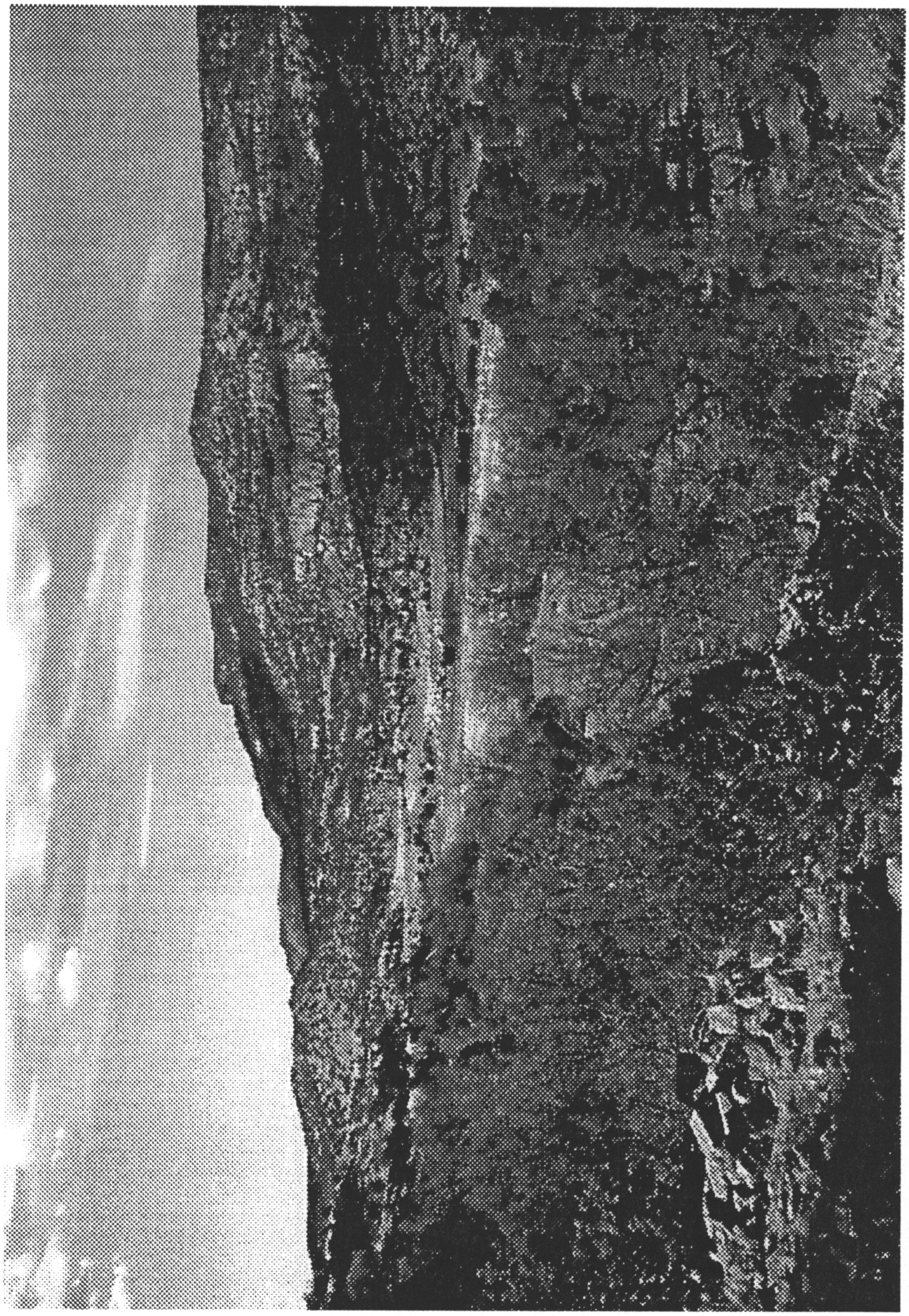
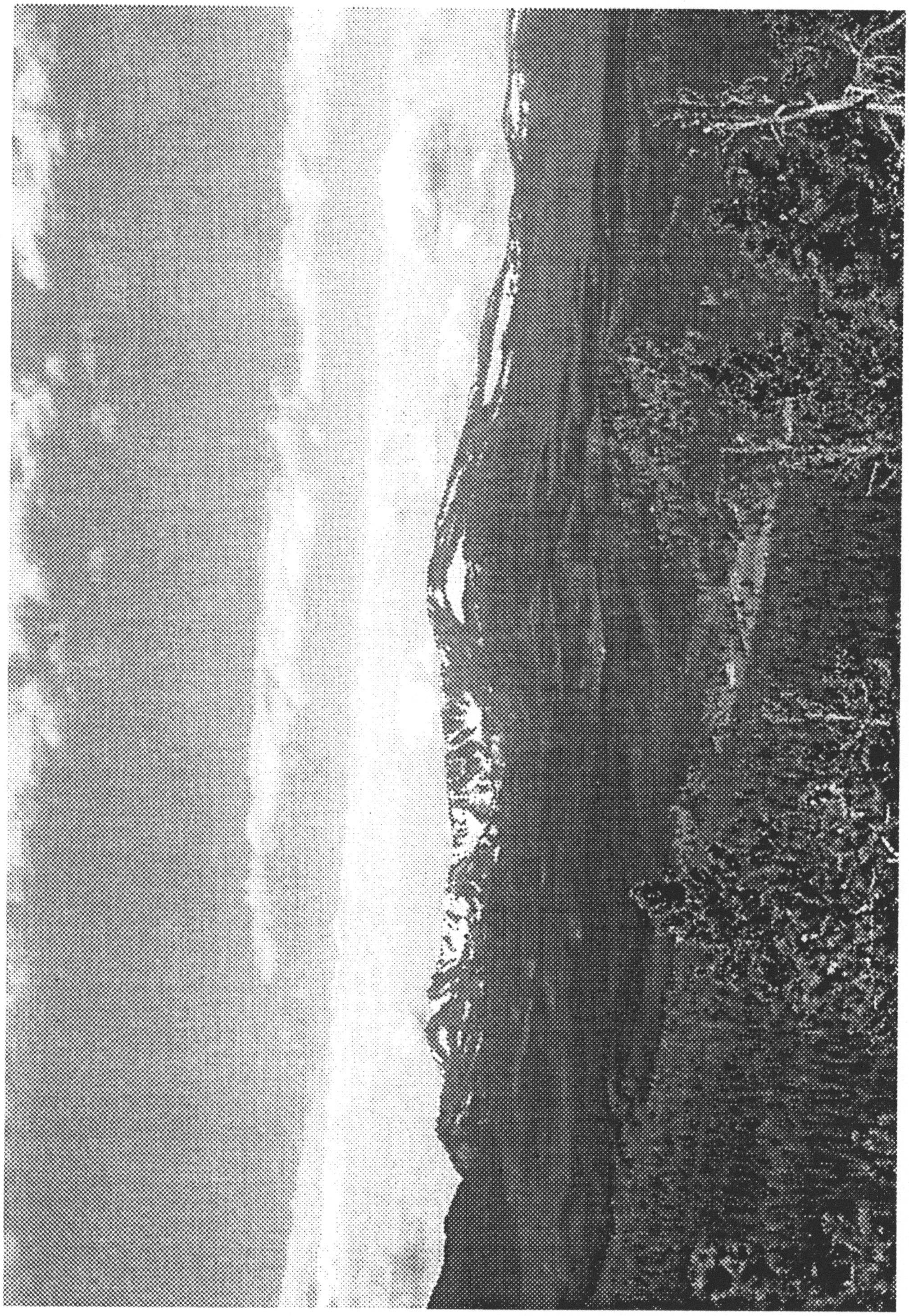


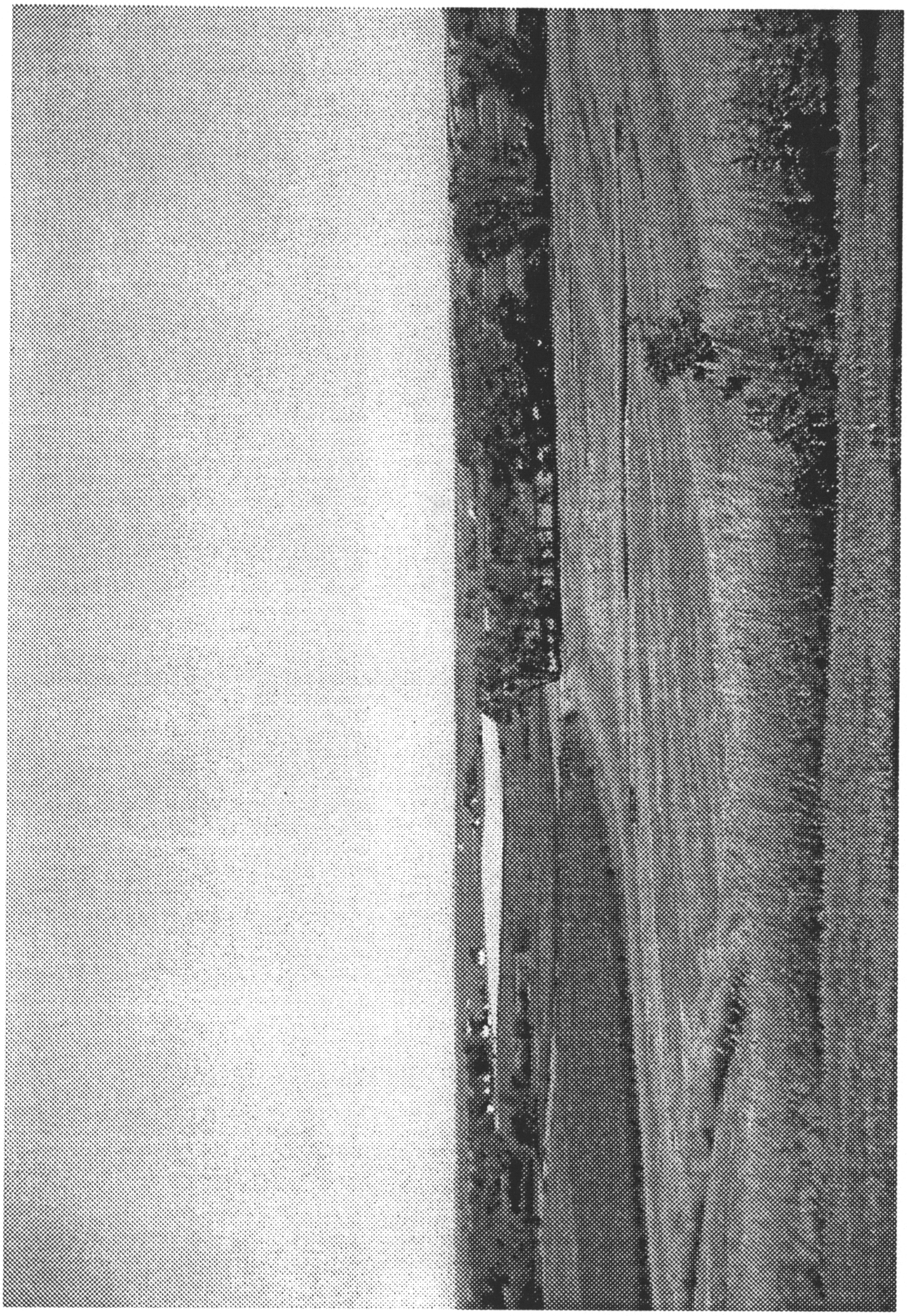
Scene 6



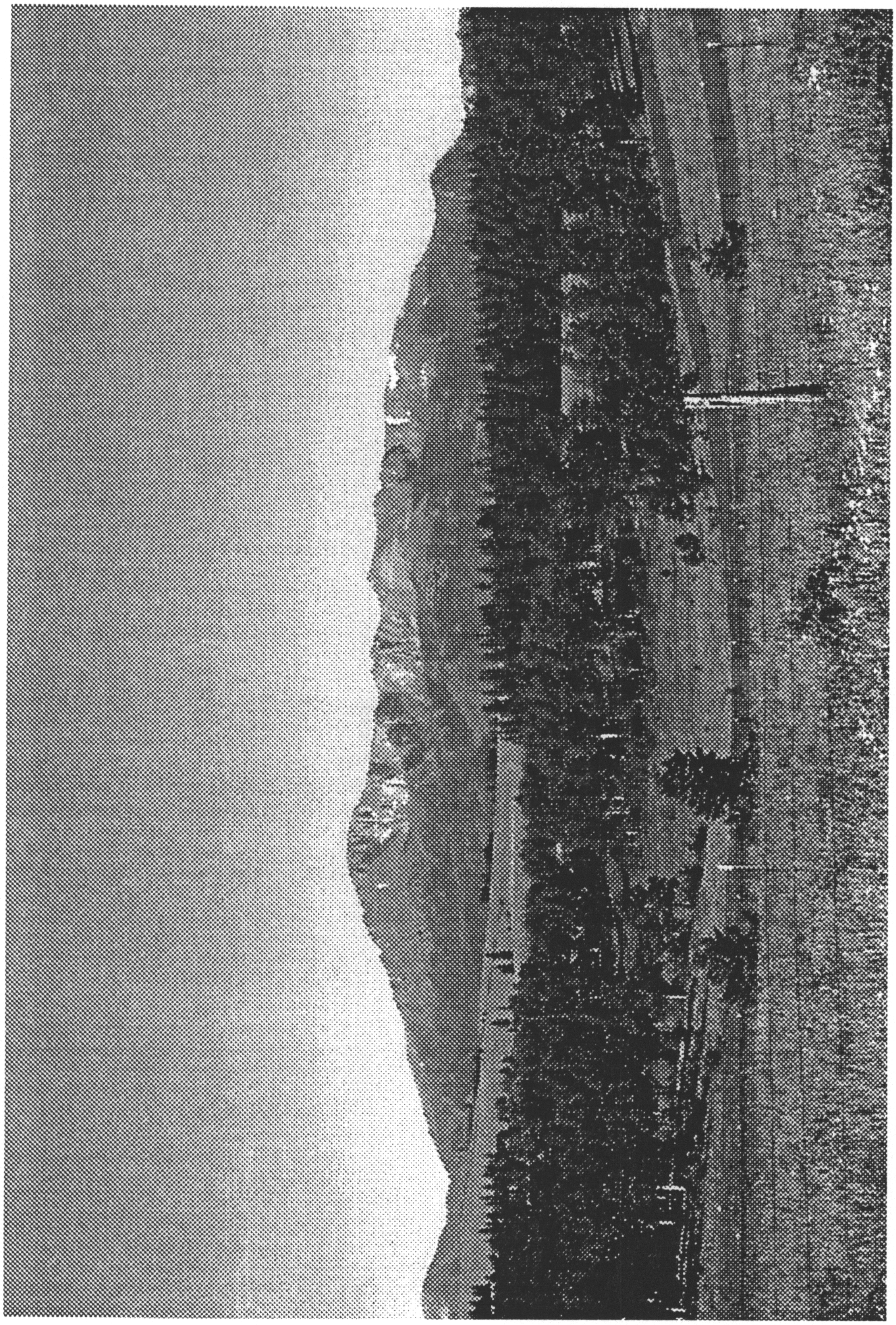
Scene 7



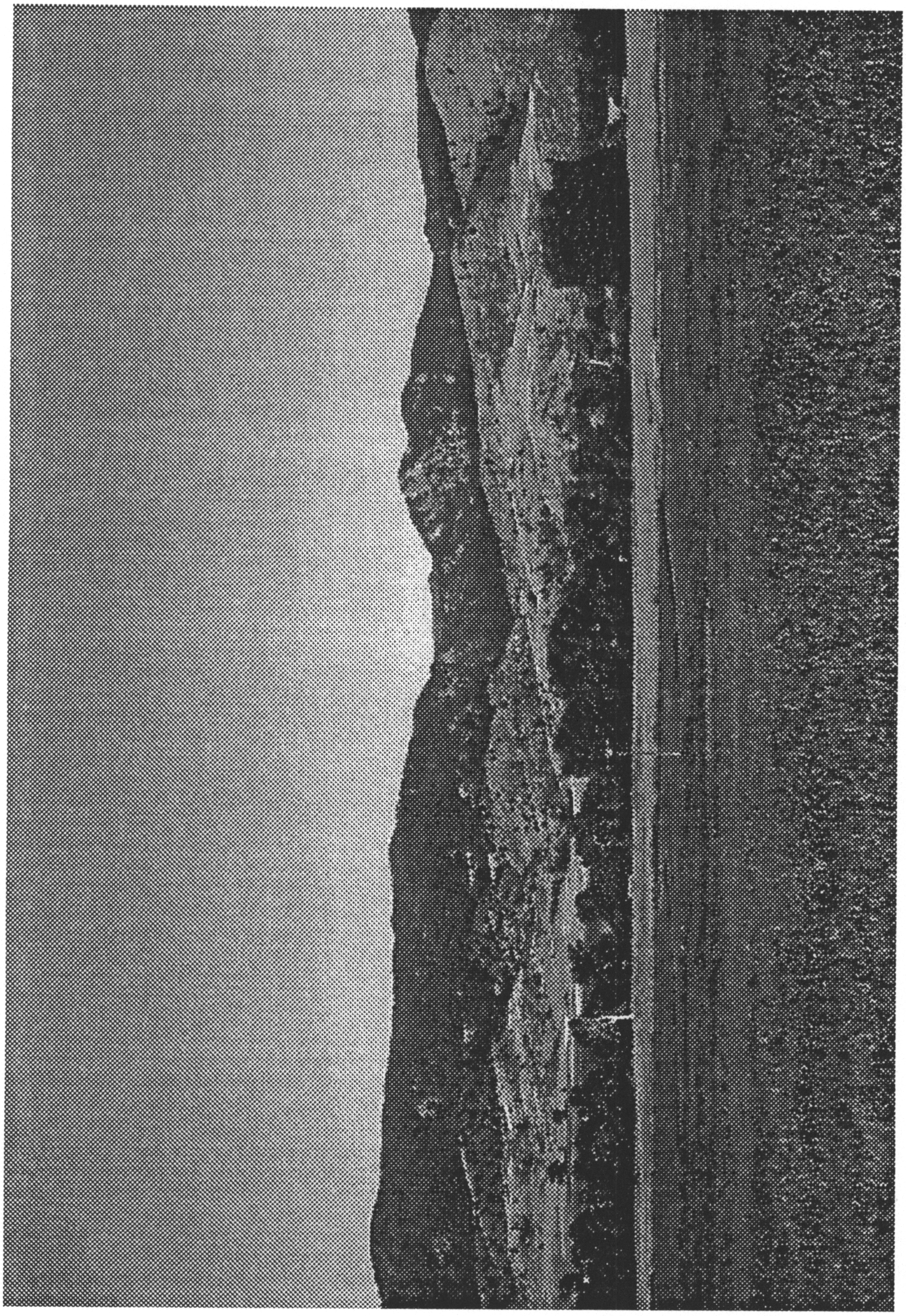
Scene 8



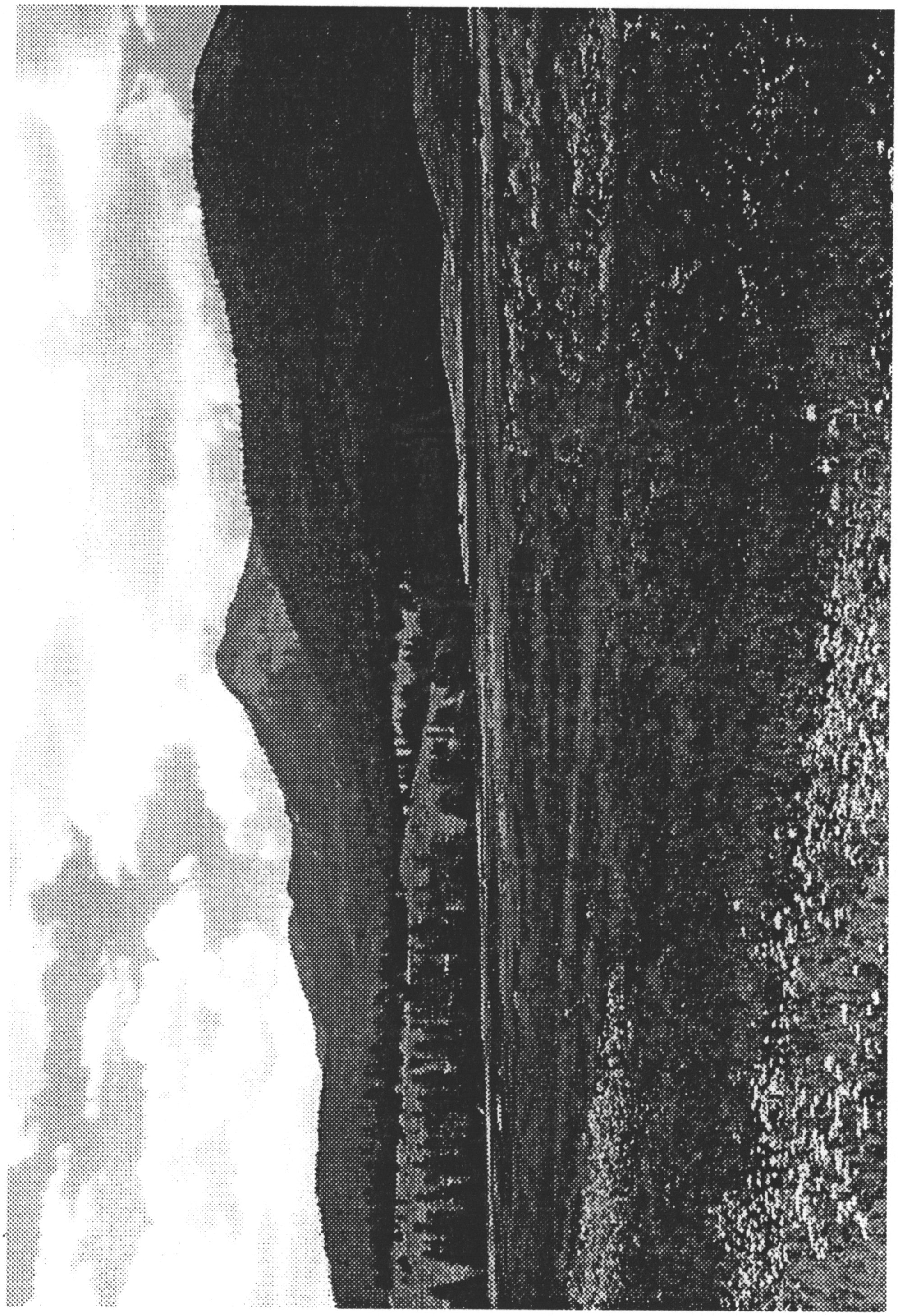
Scene 9



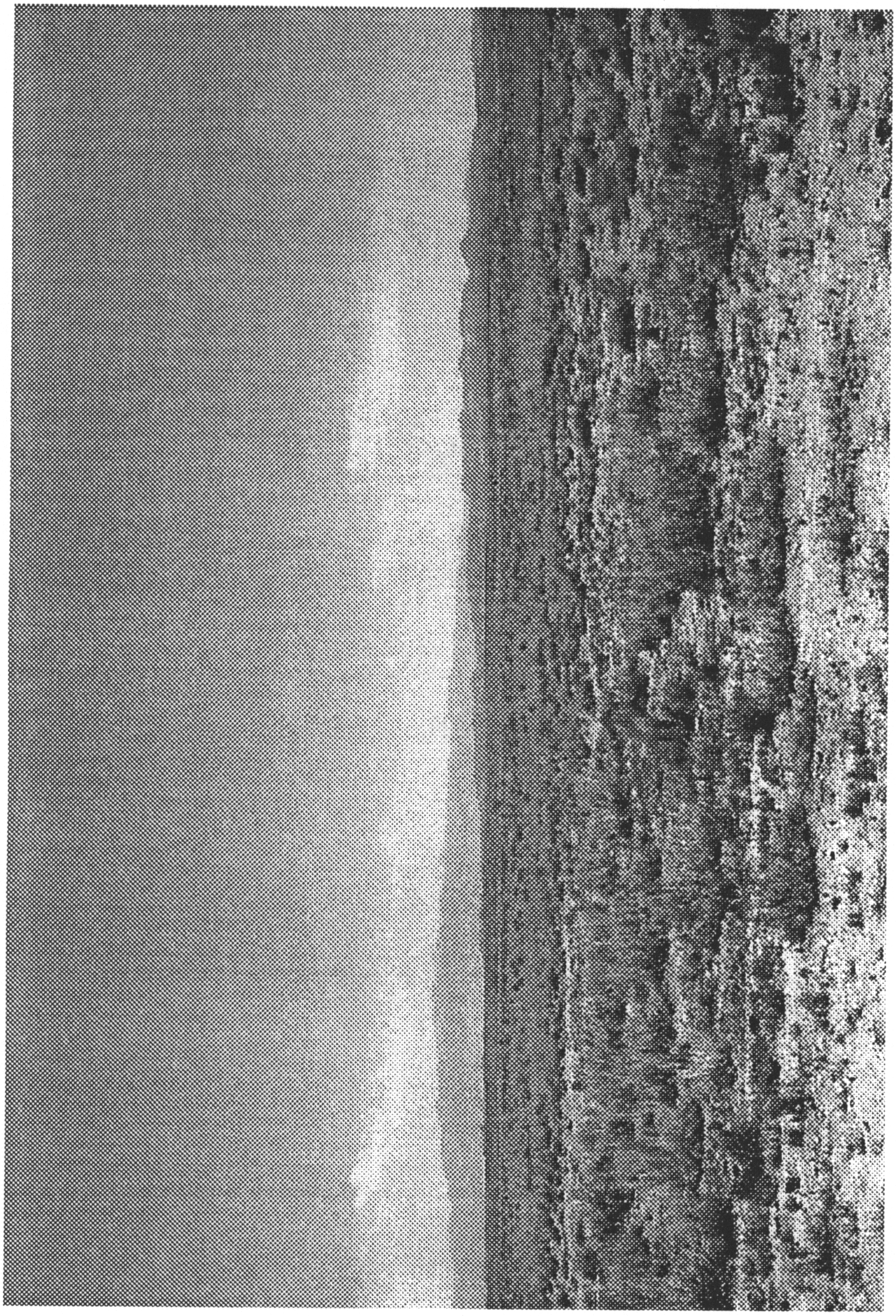
Scene 10



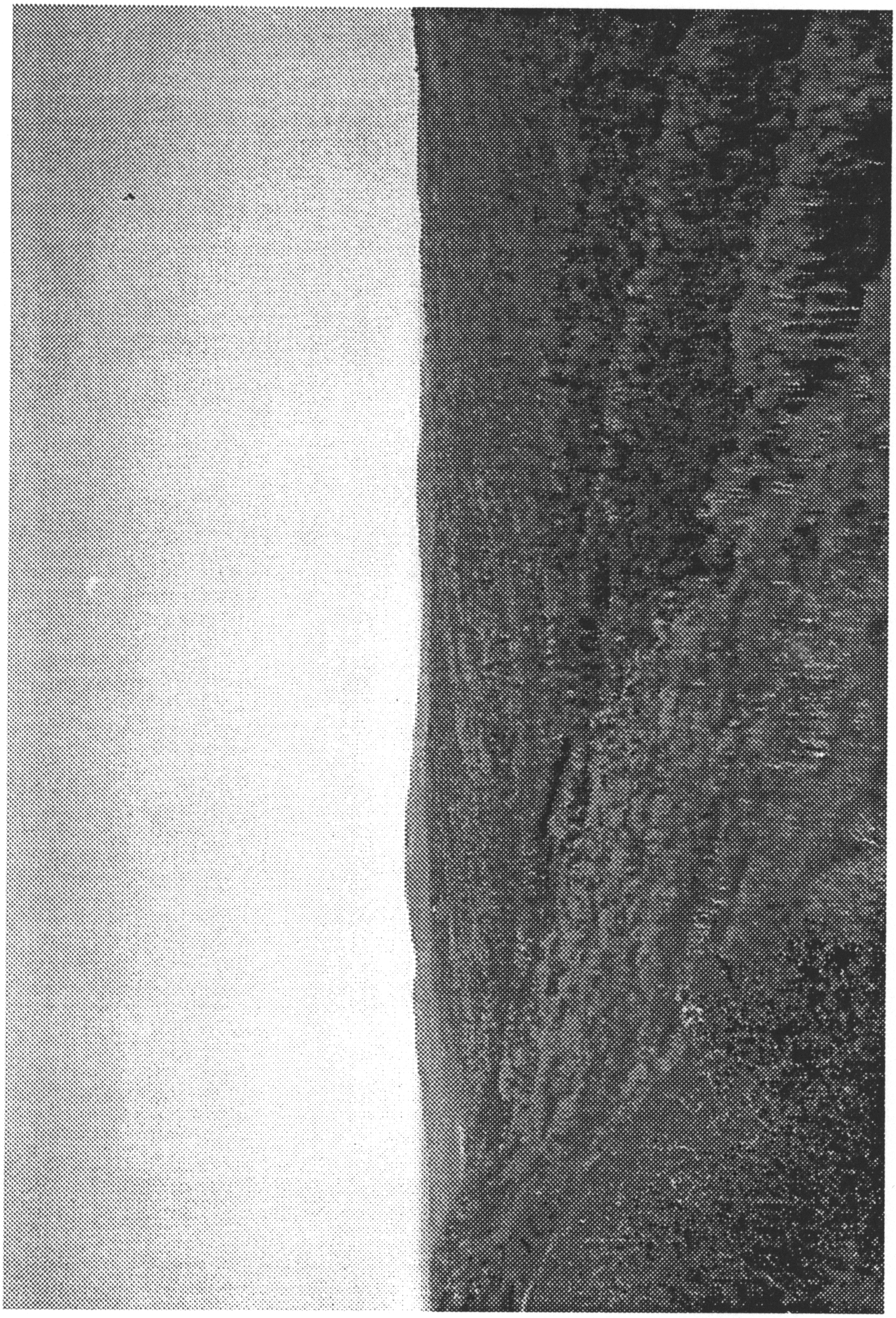
Scene 11



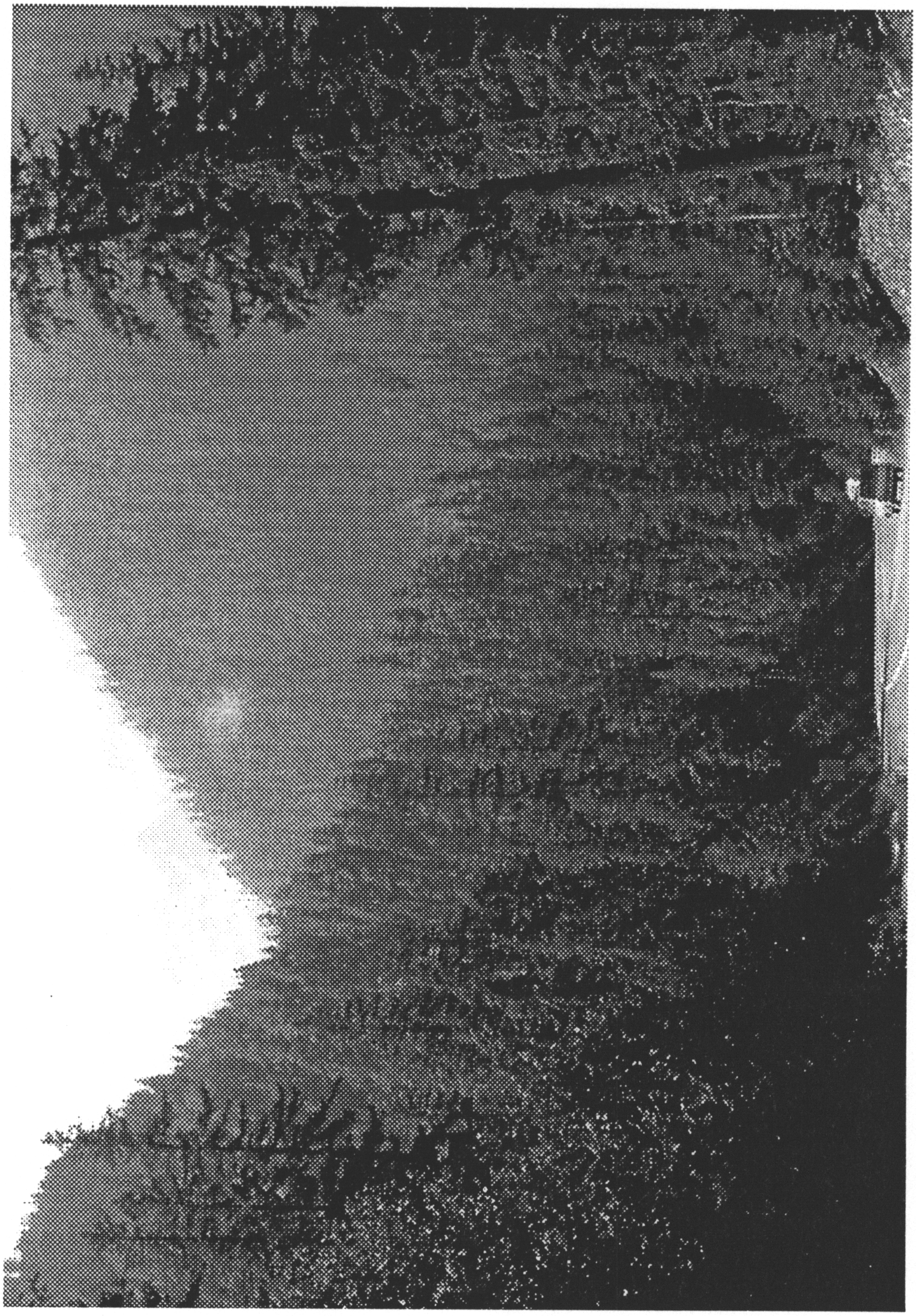
Scene 12



Scene 13



Scene 14



Scene 15

Appendix E: Experimental Study --- Quality of Visual Images

Resolution	Scaling	Loading Time	File size	Quality of Visual Images
800	60%	5 Seconds	789K	Landscape elements, such as line, point, and texture lose details. Color contrast is not clear enough.
1400	65%	15 Seconds	3, 233K	Landscape elements, such as line, point, texture can be presented clearly, while color contrast is somewhat not as sharp as the original slides.
1850	100%	5.6 Minute	11,056K	Landscape elements, such as line, point, color texture can be presented accurately as the original slides.

Appendix F: Survey Response Form and Questionnaire

Response Form and Questionnaire --- Using Verbal Standards

1. Using the packet of photographs and the verbal description provided, please circle the number that most closely describes the appropriate level of complexity for each landscape.

1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High

Photograph No.	Complexity
1	1 2 3 4 5
2	1 2 3 4 5
3	1 2 3 4 5
4	1 2 3 4 5
5	1 2 3 4 5
6	1 2 3 4 5
7	1 2 3 4 5
8	1 2 3 4 5
9	1 2 3 4 5
10	1 2 3 4 5
11	1 2 3 4 5
12	1 2 3 4 5
13	1 2 3 4 5
14	1 2 3 4 5
15	1 2 3 4 5
16	1 2 3 4 5
17	1 2 3 4 5

2. Please circle the number that best describes how you feel about your landscape complexity rating:

Not easy	1	2	3	4	5	Very easy
Not accurate	1	2	3	4	5	Very accurate
Not efficient	1	2	3	4	5	Very efficient
Not valid	1	2	3	4	5	very valid
Boring	1	2	3	4	5	Interesting

3. Do you believe the use of verbal description would be helpful in assessing the visual complexity of a landscape?

Not helpful 1 2 3 4 5 Very helpful

4. If you used verbal description more frequently do you believe it would be

More useful 1 2 3 4 5 Less useful

5. Using the packet of photographs and the verbal description provided, please circle the number which most closely describes the appropriate level of vividness for each landscape.

1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High

Photograph No.	Vividness
1	1 2 3 4 5
2	1 2 3 4 5
3	1 2 3 4 5
4	1 2 3 4 5
5	1 2 3 4 5
6	1 2 3 4 5
7	1 2 3 4 5
8	1 2 3 4 5
9	1 2 3 4 5
10	1 2 3 4 5
11	1 2 3 4 5
12	1 2 3 4 5
13	1 2 3 4 5
14	1 2 3 4 5
15	1 2 3 4 5
16	1 2 3 4 5
17	1 2 3 4 5

6. Please circle the number which best describes how you feel about your landscape vividness rating:

Not easy	1	2	3	4	5	Very easy
Not accurate	1	2	3	4	5	Very accurate
Not efficient	1	2	3	4	5	Very efficient
Not valid	1	2	3	4	5	very valid
Boring	1	2	3	4	5	Interesting

7. Do you believe the use of verbal description would be helpful in assessing the visual vividness of a landscape?

Not helpful	1	2	3	4	5	Very helpful

8. If you used verbal description more frequently do you believe it would be

More useful	1	2	3	4	5	Less useful

9. Please circle the level that indicates how much you like the landscape of each scene.

Not like at all 1 2 3 4 5 6 7 8 9 Like very much

Photograph No.	Preference
1	1 2 3 4 5 6 7 8 9
2	1 2 3 4 5 6 7 8 9
3	1 2 3 4 5 6 7 8 9
4	1 2 3 4 5 6 7 8 9
5	1 2 3 4 5 6 7 8 9
6	1 2 3 4 5 6 7 8 9
7	1 2 3 4 5 6 7 8 9
8	1 2 3 4 5 6 7 8 9
9	1 2 3 4 5 6 7 8 9
10	1 2 3 4 5 6 7 8 9
11	1 2 3 4 5 6 7 8 9
12	1 2 3 4 5 6 7 8 9
13	1 2 3 4 5 6 7 8 9
14	1 2 3 4 5 6 7 8 9
15	1 2 3 4 5 6 7 8 9
16	1 2 3 4 5 6 7 8 9
17	1 2 3 4 5 6 7 8 9

10. What is your professional major?

11. How familiar are you with the visual resource management (VRM)?

Not familiar 1 2 3 4 5 Very familiar

12. What is your age? ---<20 ---20-25 --- 26-30 --- 31-40 --->40

13. Which kind of landscape area do you live in most of your time or you most familiar with?

a. ---rural ---urban ---suburban

b. ---forested ---open ---arid ---coastal

c. ---mountains ---flat land

14. If you like, please write down your opinions about this survey.

Survey Form and Questionnaire --- Using Visual Standards

1. Using the packet of photographs and the visual images provided, please circle the number that most closely describes the appropriate level of complexity for each landscape.
1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High

Photograph No.	Complexity
1	1 2 3 4 5
2	1 2 3 4 5
3	1 2 3 4 5
4	1 2 3 4 5
5	1 2 3 4 5
6	1 2 3 4 5
7	1 2 3 4 5
8	1 2 3 4 5
9	1 2 3 4 5
10	1 2 3 4 5
11	1 2 3 4 5
12	1 2 3 4 5
13	1 2 3 4 5
14	1 2 3 4 5
15	1 2 3 4 5
16	1 2 3 4 5
17	1 2 3 4 5

2. Please circle the number that best describes how you feel about your landscape complexity rating:

Not easy	1	2	3	4	5	Very easy
Not accurate	1	2	3	4	5	Very accurate
Not efficient	1	2	3	4	5	Very efficient
Not valid	1	2	3	4	5	very valid
Boring	1	2	3	4	5	Interesting

3. Do you believe the use of visual images would be helpful in assessing the visual complexity of a landscape?

Not helpful	1	2	3	4	5	Very helpful

4. If you used visual images more frequently do you believe it would be

More useful	1	2	3	4	5	Less useful

5. Using the packet of photographs and the visual images provided, please circle the number which most closely describes the appropriate level of vividness for each landscape.

1=Low 2=Moderately low 3=Moderate 4=Moderately high 5=High

Photograph No.	Vividness
1	1 2 3 4 5
2	1 2 3 4 5
3	1 2 3 4 5
4	1 2 3 4 5
5	1 2 3 4 5
6	1 2 3 4 5
7	1 2 3 4 5
8	1 2 3 4 5
9	1 2 3 4 5
10	1 2 3 4 5
11	1 2 3 4 5
12	1 2 3 4 5
13	1 2 3 4 5
14	1 2 3 4 5
15	1 2 3 4 5
16	1 2 3 4 5
17	1 2 3 4 5

6. Please circle the number which best describes how you feel about your landscape vividness rating:

Not easy	1	2	3	4	5	Very easy
Not accurate	1	2	3	4	5	Very accurate
Not efficient	1	2	3	4	5	Very efficient
Not valid	1	2	3	4	5	very valid
Boring	1	2	3	4	5	Interesting

7. Do you believe the use of visual images would be helpful in assessing the visual vividness of a landscape?

Not helpful	1	2	3	4	5	Very helpful

8. If you used visual images more frequently do you believe it would be

More useful	1	2	3	4	5	Less useful

9. Please circle the level that indicates how much you like the landscape of each scene.
Not like at all 1 2 3 4 5 6 7 8 9 Like very much

Photograph No.	Preference
1	1 2 3 4 5 6 7 8 9
2	1 2 3 4 5 6 7 8 9
3	1 2 3 4 5 6 7 8 9
4	1 2 3 4 5 6 7 8 9
5	1 2 3 4 5 6 7 8 9
6	1 2 3 4 5 6 7 8 9
7	1 2 3 4 5 6 7 8 9
8	1 2 3 4 5 6 7 8 9
9	1 2 3 4 5 6 7 8 9
10	1 2 3 4 5 6 7 8 9
11	1 2 3 4 5 6 7 8 9
12	1 2 3 4 5 6 7 8 9
13	1 2 3 4 5 6 7 8 9
14	1 2 3 4 5 6 7 8 9
15	1 2 3 4 5 6 7 8 9
16	1 2 3 4 5 6 7 8 9
17	1 2 3 4 5 6 7 8 9

10. What is your professional major?

11. How familiar are you with the visual resource management (VRM)?

Not familiar 1 2 3 4 5 Very familiar

12. What is your age? ---<20 ---20-25 --- 26-30 --- 31-40 --->40

13. Which kind of landscape area do you live in most of your time or you most familiar with?
a. ---rural ---urban ---suburban

b. ---forested ---open ---arid ---coastal

c. ---mountains ---flat land

14. If you like, please write down your opinions about this survey.

Appendix G: Frequency Distribution of Rating Results for Complexity and Vividness

Frequency Distribution of Rating Results for Complexity

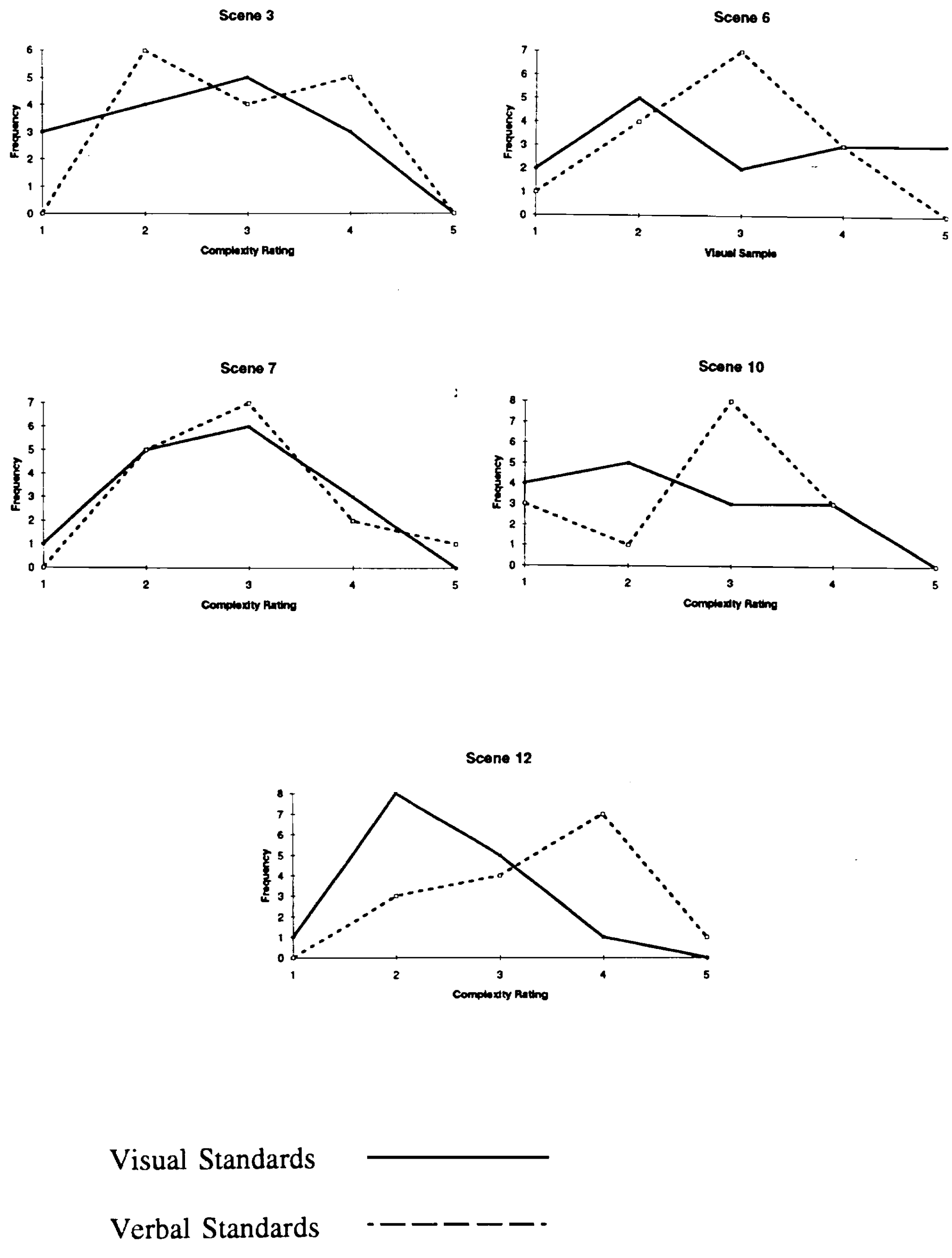


Figure 4. Frequency Distribution for Scenes with Moderately High and High Complexity

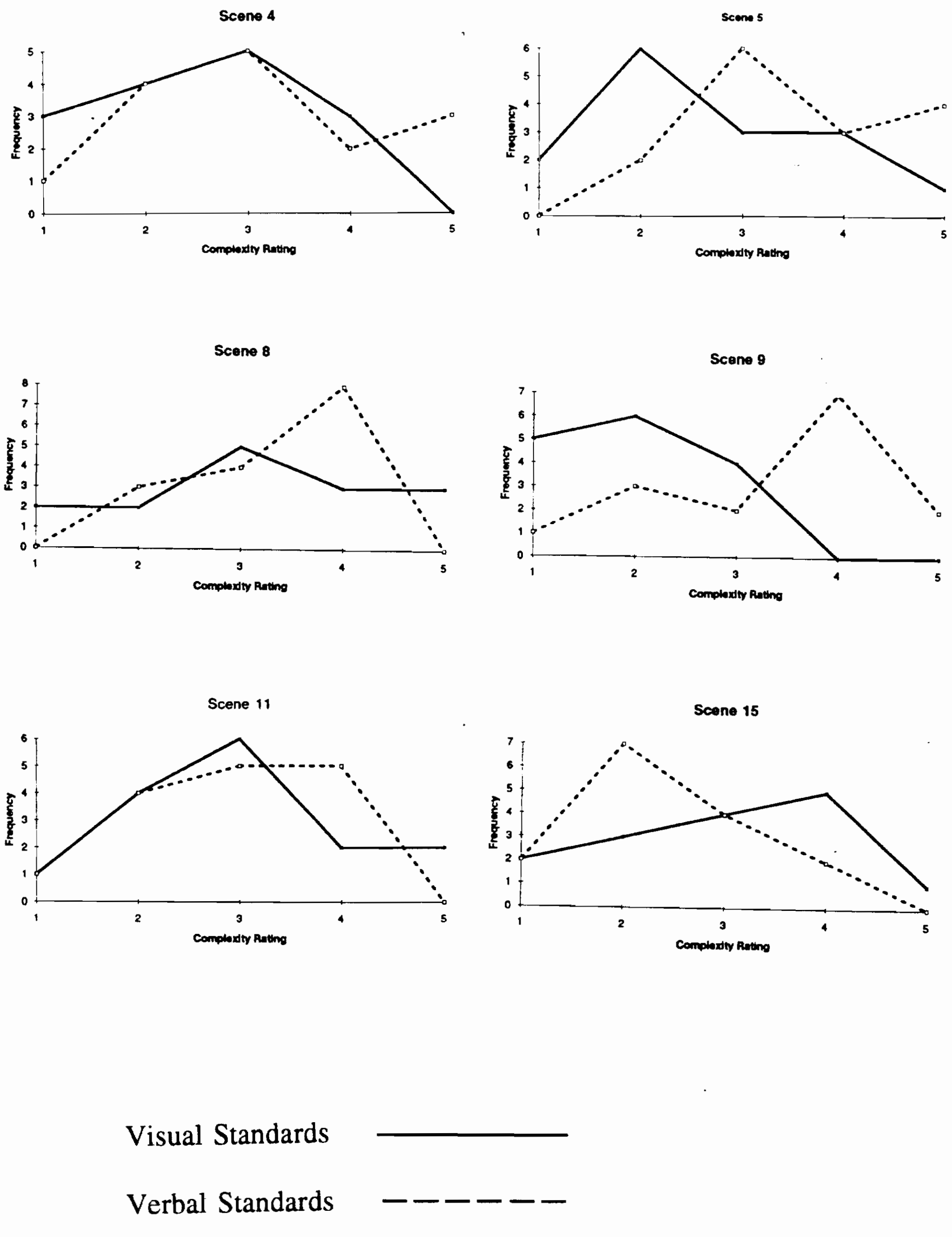


Figure 5. Frequency Distribution for Scenes with Moderate Complexity

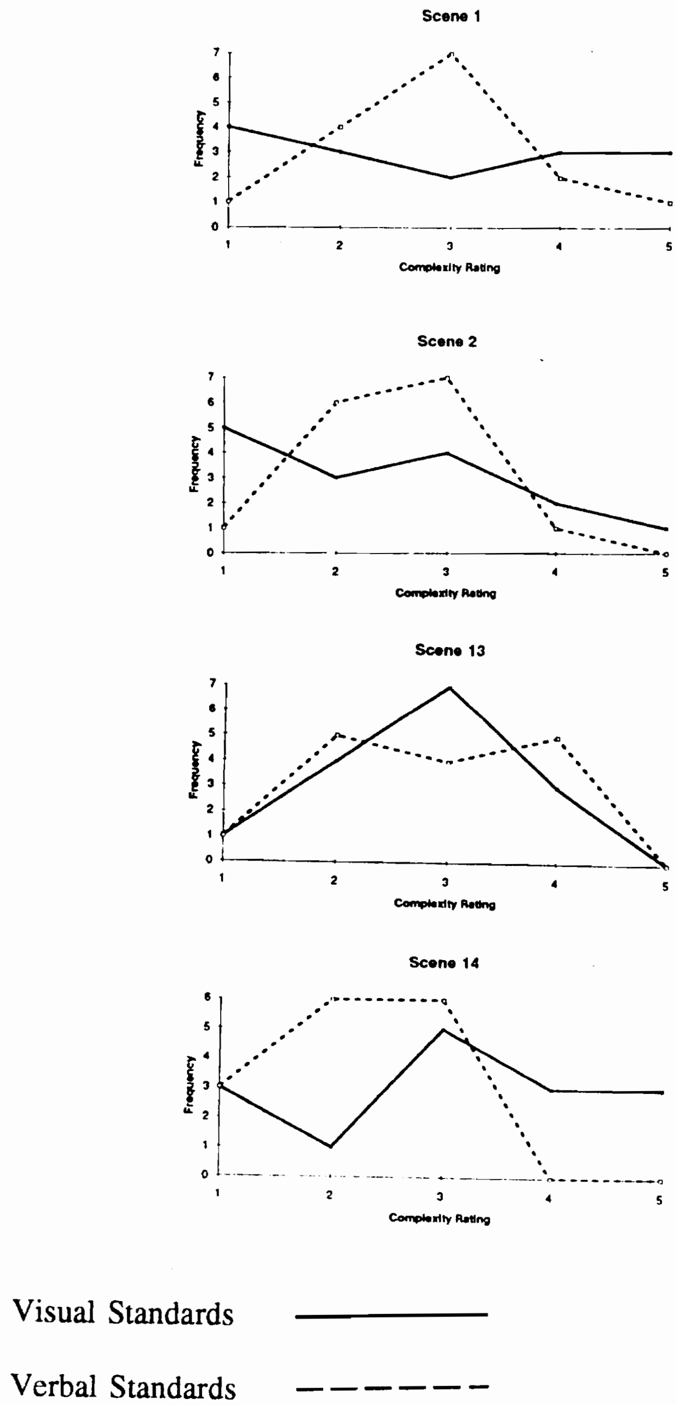


Figure 6. Frequency Distribution for Scenes with Moderately Low and Low Complexity

Frequency Distribution of Rating Results for Vividness

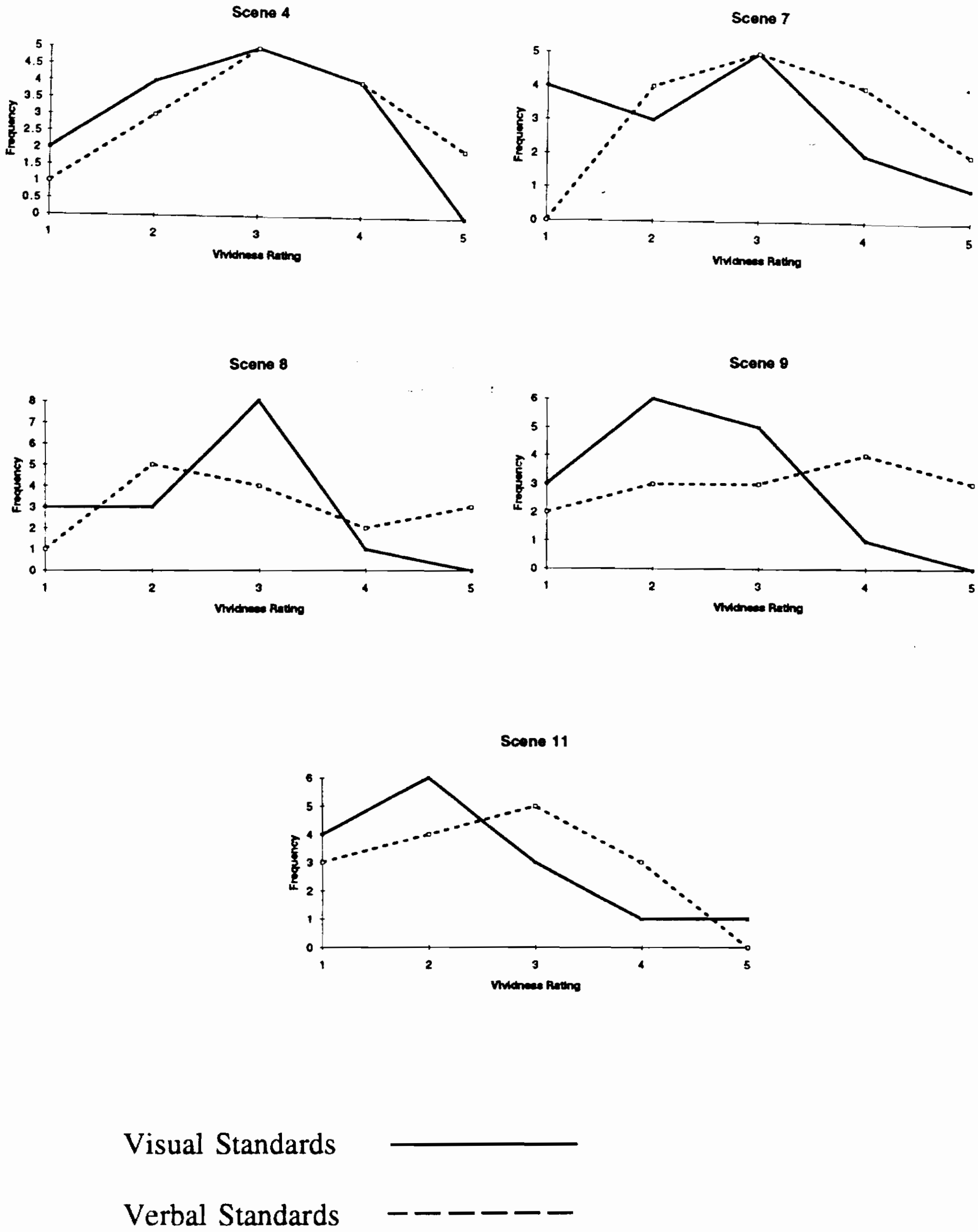
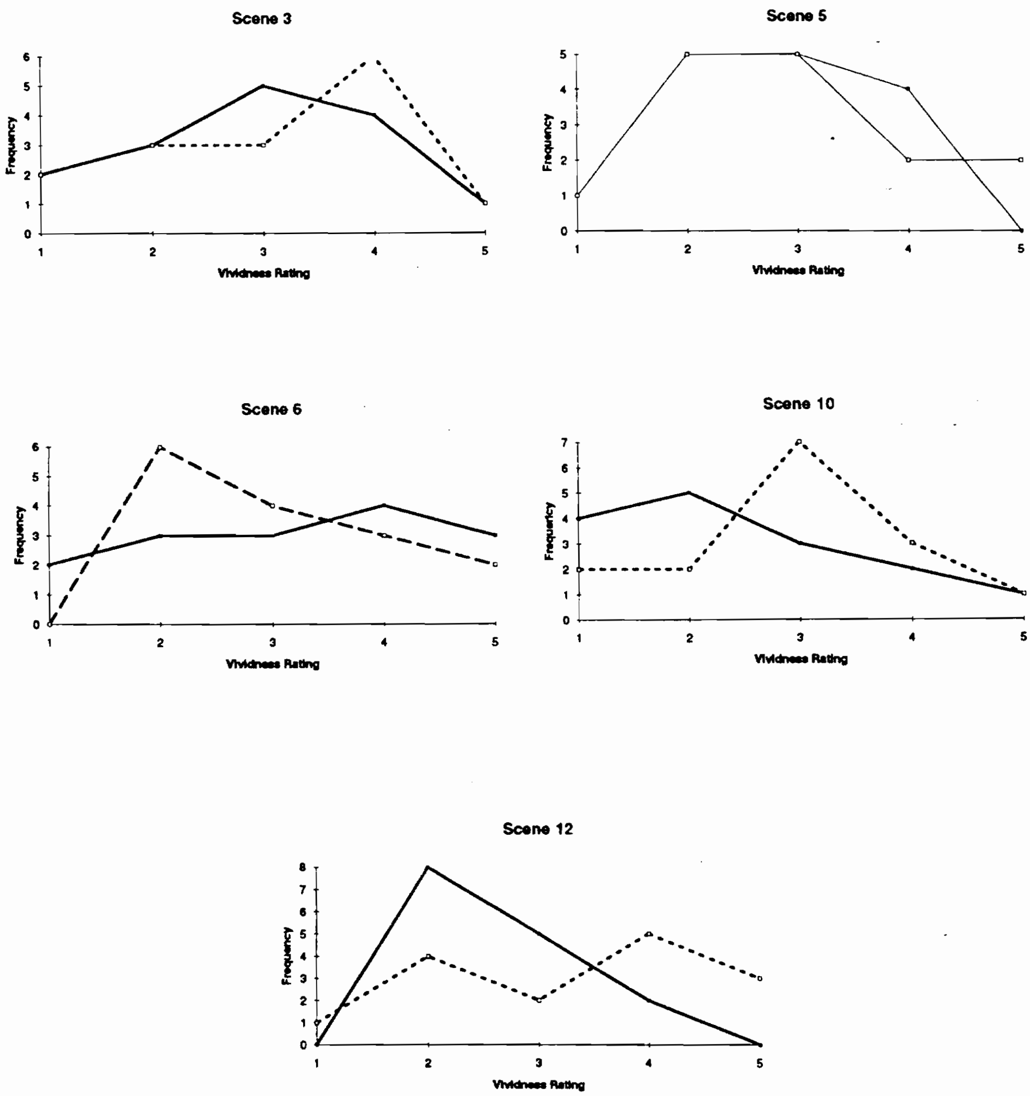


Figure 7. Frequency Distribution for Scenes with Moderately High and High Vividness



Visual Standards ————————

Verbal Standards — — — — — —

Figure 8. Frequency Distribution for Scenes with Moderate Vividness

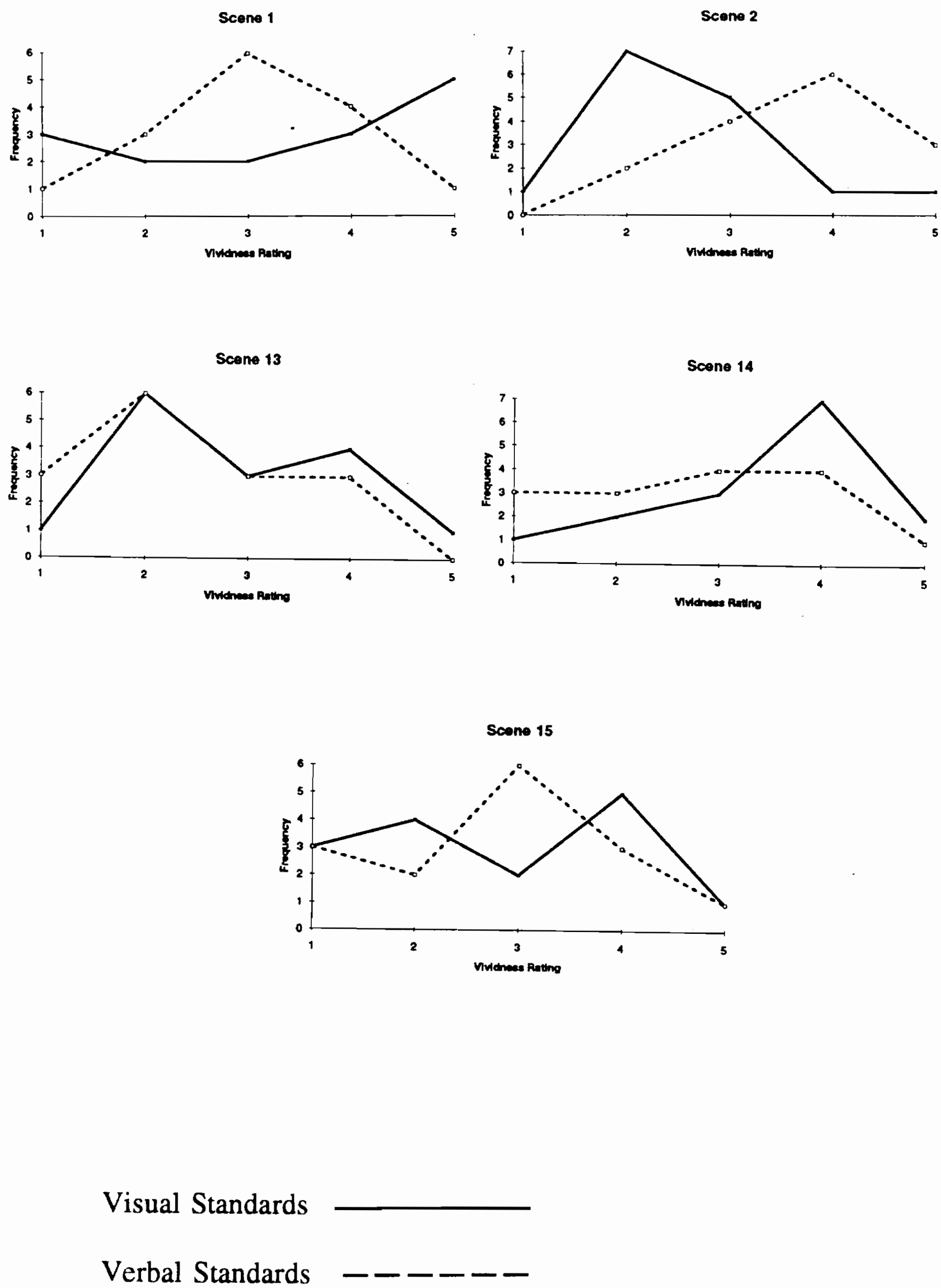


Figure 9. Frequency Distribution for Scenes with Moderately Low and Low Vividness

VITA

Song Zhang

Education

* Master of Landscape Architecture (professional degree). Virginia Polytechnic Institute and State University, Blacksburg, May 1994.
  Thesis: "An evaluation of visual and verbal based standards for landscape assessment".

* Master of Architecture (finished all courses), Qinghua University, Beijing, China, 1989-1991.
  Major in Chinese Classical Architecture and Garden.

* Bachelor of Architecture (5-year engineering degree), Qinghua University, Beijing, China, July 1989.

Professional Experience

* <u>Research Assistant</u>, Landscape Architecture Department, Virginia Tech, 1991-present
  Participated in the project "Visual imaging technology for an artificial intelligence based landscape assessment system " for USDA, North Central Forest Experiment Station. Focus on testing the reliability and validity of visual and verbal based standards for landscape assessment by using computer visual simulation techniques.

* <u>Research Assistant</u>, College of Architecture, Qinghua University, 1989-1991
  Participated in project design for "Dan Bie Valley Garden" which was constructed in spring 1991 in Hokkaido, Japan. Responsible for the main layout design of "Dan Bie Valley Garden"

* <u>Architecture Intern</u>, (the major project for Bachelor of Engineering Degree), 1988-1989
  Participated in the "Architecture Department Building Design" for Qinghua University (from preliminary design to construction drawings) in Beijing. This comprehensive building is currently under construction.

  Main designer for the preliminary design of "Haidian Book Market

Street Design and Planning" in Beijing. This street has already been constructed since 1991.

Teaching Experience

* Teaching Assistant, Landscape Architecture Department, Virginia Tech. 1992-1993

  Assisted with teaching of Basic Landscape Technology and Intermediate Landscape Technology courses

* Teaching Assistant, College of Architecture, Qinghua University, 1989-1990.

  Assisted with teaching Classical Chinese Architecture Survey course.

Honors:

* Member of the Honor society of PHI KAPPA PHI
* Member of the Honor society of SIGMA LAMBDA ALPHA
* Instructional Scholarship Awards conferred by Landscape Architecture Department, Virginia Tech.