RESEARCH PAPER PNW-258
AUGUST 1979

Roadless Area–Intensive Management Trade-Offs on Pacific Northwest National Forests

By:
Robert M. Randall, Roger D. Fight,
Kent R Connaughton,
Robert W. Sassaman, and
K. Norman Johnson

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

ACKNOWLEDGMENT

This report is the result of a study requested by John McGuire, Chief, USDA Forest Service. This report presents results for the Pacific Northwest Region of the National Forest System. The data and staff from three National Forests--the Siskiyou, Umatilla, and Willamette National Forests--made this study possible. The principal contributor from the Pacific Northwest Regional Office in Portland, Oregon, was Alfred F. Burkhardt, Jr.

METRIC EQUIVALENTS

1,000 cubic feet = 28.3 cubic meters

1 cubic foot per acre = 0.070 cubic meter per hectare

1 inch = 2.54 centimeters

1 foot = 30.48 centimeters

1 mile = 1.61 kilometers

1 acre = 0.404 hectare

AUTHORS

ROBERT M. RANDALL, ROGER D. FIGHT, KENT P. CONNAUGHTON, and ROBERT W. SASSAMAN are economists, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

K. NORMAN JOHNSON is assistant professor, Department of Forestry and Outdoor Recreation, Utah State University, Logan, Utah.

ROADLESS AREA-INTENSIVE MANAGEMENT TRADE-OFFS ON PACIFIC NORTHWEST NATIONAL FORESTS

REFERENCE ABSTRACT

Randall, Robert M., Roger D. Fight, Kent P. Connaughton, Robert W. Sassaman, and K. Norman Johnson.
1979. Roadless area-intensive management trade-offs on Pacific Northwest National Forests. USDA For. Serv. Res. Pap. PNW-258, 69 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This study tested the hypothesis that timber harvest levels could be maintained on selected Pacific Northwest National Forests without harvesting from roadless areas, if resources saved by not developing the roadless areas were used for more intensive timber management on the remaining land. The study also examined the employment, financial, environmental, and multiple use implications if such a course of action were followed.

KEYWORDS: Wilderness management, land use, policy (forest), intensive management, economic evaluation.

RESEARCH SUMMARY
RESEARCH PAPER PNW-258
1979

Building roads to provide access to National Forest roadless areas for timber harvest and other multiple use objectives involves a substantial capital investment. It has been suggested that it might be possible to produce as much or more timber from a National Forest by reallocating that investment to timber management practices, such as reforestation, release, and thinning in the areas outside the roadless areas; this would leave roadless areas undeveloped and unmanaged.

The primary objective of this study was to test the hypothesis that as much timber could be harvested from a National Forest without harvesting from its roadless area as could be harvested with its roadless area in the timber base if the resources saved by not developing the roadless area were used for more intensive timber management on the area with roads. Secondary objectives were to estimate the employment, financial, environmental, and multiple use implications if such a policy were adopted. The intent was to do the analysis using approaches that closely simulate how such a policy would be implemented under current Forest Service regulations and planning approaches. Alternatives that change policies unrelated to the primary question were beyond the scope of the study. Thus, the analysis was done within the current policy constraints relating to timber flows, water quality, rare and endangered species, sustained yield, and other multiple use values.

Seven western National Forests were chosen for study. The results for three Pacific Northwest Region National Forests--the Siskiyou, Umatilla, and Willamette--are reported here.

For each study Forest the hypothesis was tested by calculating two harvest levels: one with Forest planned levels of intensive timber management and with the entire roadless area available for timber harvest (the base alternative) and one with the roadless area withdrawn and funds saved by not building roads available for further intensifying timber management on the remaining land (the reallocation alternative). Additional harvest levels were calculated to provide a more complete comparison of the results, and discussions of the alternative harvest levels for each Forest are included. The major conclusions of the timber harvest analyses are:

1. The harvest that could be programed in the first decade with the entire roadless area included in the timber base could not be achieved on any study Forest when the roadless area was withdrawn and the funds saved were reallocated to more intensive timber management. If only half the roadless area was withdrawn, however, the base programed harvest level could be achieved on one study Forest through reallocation of funds.

2. Potential yield was reduced on all Forests when half or all the roadless area was withdrawn.

3. The average annual chargeable harvest (recent harvest) on all study Forests is below the level that could be programed with current levels of investment and multiple use constraints with all the roadless area in the base. With half the roadless area withdrawn, the recent harvest could be maintained or exceeded on all study Forests with reallocation of funds; with all the roadless area withdrawn it could not be maintained or exceeded on any of the study Forests.

4. Reductions in potential yield on the study Forests were nearly proportional to reductions in regulated commercial Forest land acres.

The financial and employment effects of withdrawing roadless areas from timber harvest and reallocating funds to more intensive management of the remaining land are shown for the study Forests. The results were derived from several assumptions, including the expected trends in real stumpage prices and real costs when no changes in harvest occur on any National Forest except the one being analyzed.

The effects of the key alternatives on present net worth and receipts to counties are shown. These results show that on the Willamette and Siskiyou National Forests the reductions in financial values when roadless areas were withdrawn were quite large. On the Umatilla the changes in financial values were small.

The report includes a general discussion of the trade-offs in environmental conditions and nontimber benefits (benefits from nontimber goods and services produced by the Forest) when roadless areas are withdrawn and timber management is intensified on the remaining land. This discussion reveals that on the study Forests there are significant trade-offs associated with these alternatives.

Contents

Introduction

The administrative and legislative branches of Government are moving toward resolution of the questions of the aggregate amount and distribution of American wilderness. The National Forests are a key element in this decision because extensive roadless areas are still available which could be designated as wilderness. Many of these areas are also desirable for other uses; thus, conflicts have arisen among different classes of users over the ultimate disposition of these lands. In view of the complex trade-offs involved and of the need to identify and measure the consequences of some proposed solutions to the problem, a study team composed of USDA Forest Service economists and forest managers was organized to study, in depth, on a few selected western National Forests the proposal that investment funds be used to intensify forest management on roaded portions of National Forests, leaving roadless areas undeveloped. The results of this study are presented in a national report.[1] The purpose of this report is to detail results for the study of Forests in the Pacific Northwest Region (Oregon and Washington) and to present and explain in more detail the data and assumptions used in the national report. Reports detailing study results for other western regions are being prepared.

KEY QUESTION

It has been suggested that reallocating dollars from building roads in the roadless areas to more intensive management of the areas where a road network has already been established would be a better use of resources. Moreover, it has been suggested that reductions of timber harvest resulting from withdrawing roadless areas from the timber base can be made up from gains that result from intensified timber management practices, such as reforestation, release, and thinning in accessible areas.

The primary objective of this study was to test the hypothesis that as much timber could be harvested from National Forest areas without harvesting from the roadless areas as could be harvested with roadless areas in the timber base, if the resources saved by not developing a road system in the roadless areas were used for more intensive timber management on the lands with roads. Other objectives were to estimate the employment, financial, environmental, and multiple use implications if such a policy were adopted. Our analysis used approaches that

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[1] Fight, Roger D., K. Norman Johnson, Kent P. Connaughton, and Robert W. Sassaman. Roadless area-intensive management tradeoffs on western National Forests. West. Resour. Policy Econ. Res., USDA For. Serv. Revised October 1978.

closely simulated how the policy would be implemented under current Forest Service planning approaches. Policy changes unrelated to the primary question were beyond the scope of the study. Thus, the analysis was done within the current policy constraints relating to timber flows, water quality, rare and endangered species, sustained yield, and other multiple use values. If some of these constraints were changed the results might be very different.

SELECTION OF STUDY FORESTS

The Pacific Northwest Region is the leading timber producing region in the Nation. Within the region the National Forest System provides a substantial proportion of the total supply of timber. At local levels, National Forest timber harvests are often crucial to community welfare. Therefore, to many people the decision of whether to manage roadless areas for timber production and/or nontimber uses is of vital concern.

We did not have the time or resources to study more than a few Forests. Several criteria were used in selecting study Forests. Data for the allowable harvest model had to be available in suitable form. The Forest had to have a significant portion of its area in roadless status, and this had to comprise a significant part of the roadless area in the region. A significant part of the Forest's potential harvest had to be in its roadless area. The Forest had to be reasonably typical of the region in its roadbuilding costs and treatment of multiple use constraints.

Based on the above criteria, three National Forests were selected for study--the Siskiyou, Umatilla, and Willamette. The procedures used and alternatives studied are documented in the following sections.

The acreages used in this analysis are shown in table 1. Table 1 shows that the acreage of roadless area for this study exceeds the acreage of RARE II[2] roadless areas by a significant amount on all three study Forests. The reason is that, because the study was well underway, the land base for this study was not reduced to reflect land allocations resulting from recent land use decisions or wilderness designation in the Endangered American Wilderness Act of 1978 (U.S. Laws, Statutes, etc. Public Law 95-237, 1978).

For each study Forest the hypothesis was tested by calculating two harvest levels: one with Forest planned levels of intensive timber management and with all the Forest's roadless area available for timber harvest (the base alternative) and one with the roadless area withdrawn and funds saved by not building roads available for further intensifying timber management on the remaining land (the reallocation alternative).

Forest planned levels of intensification are levels that the Forest planners believe are likely to be funded. In some cases that is somewhat above the current funding level. Additional harvest levels were calculated to provide a more complete understanding of the results, including an alternative with half the roadless area withdrawn from timber harvest. The report includes a discussion of the alternative harvest levels for each Forest.

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[2] RARE II is an acronym for the second "Roadless Area Review and Evaluation" of land in the 187-million-acre National Forest System.

Table 1--National Forest land areas

Item	National Forest		
	Siskiyou	Umatilla	Willamette
		Thousand acres	
Total National Forest System land on the Forest	1,092	1,394	1,675
National Forest System land in the roadless area[1]	436	435	280
National Forest System land in RARE II areas[2] (net acres)	340	413	174
Regulated commercial forest land (CFL) on the Forest[3]	758	716	1,171
Regulated CFL in the roadless area[3]	275	158	195
Regulated CFL in first half of roadless area withdrawn[4]	122	91	85
National wilderness and wilderness study	109	177	265

[1]Total roadless area acreage used in this study.

[2]RARE II is an acronym for the second "Roadless Area Review and Evaluation" of land in the 187-million-acre National Forest System.

[3]Regulated commercial forest land is the land included in the determination of the harvest levels used in this study.

[4]This represents the CFL acres removed from the timber base when 50 percent of roadless areas are withdrawn from further development.

Description of the Study Forests

This section will characterize the study Forests and briefly describe the roadless area situation on each Forest.

SISKIYOU NATIONAL FOREST

Location

The Siskiyou National Forest is located in the extreme southwest corner of Oregon with a small extension into California. The Forest covers a major portion of the Siskiyou Mountain range which joins the Cascade Mountains on the east with the Coast Ranges on the northwest. Parts of Coos, Curry, and Josephine Counties in Oregon and Del Norte County in California lie within its boundaries.

Physical Characteristics

The Siskiyou Mountain area is a region of rugged topography with deeply dissected mountainous areas with no particular orientation of the valleys and ridges. Elevations range from near sea level to almost 6,000 feet. The climate on the west side of the Siskiyou Mountains is strongly influenced by the Pacific Ocean. Rainfall ranges from 80 to 90 inches along the coast to 120 inches at higher elevations. Precipitation mostly occurs during 9 months of the year; there is little rainfall during the summer. On the east side of the Siskiyous, the climate is characteristically hot and dry during the summer; precipitation for the year averages 30 inches.

The vegetation on the Siskiyou National Forest is part of a transition zone where Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) vegetative types found in the forests to the north become mixed with Douglas-fir and hardwoods commonly occurring in northern California. Variable soils and a diverse climate on the Siskiyou create many ecosystems where over 1,400 plant species may be found. Douglas-fir is the predominant species; almost 74 percent of the total forest timber volume is in Douglas-fir. Pines and hardwoods typically occupy many of the dry south slopes and areas on the east side of the Siskiyou Mountains. One of the most important factors on the Siskiyou has been repeated fires that have left approximately 75,000 acres of higher site and 46,000 acres of lower site lands occupied by low value hardwoods or brush. These areas have the potential of supporting commercial stands of conifers.

Resources

Forage resources are divided into grasslands and transitory range. Grasslands owe their existence to shallow-soil depths. Transitory ranges exist for a few years after fire or timber harvest. The estimated transitory range potential, based on full timber utilization (on a sustained yield basis) and grazing of slopes below 45 percent, is 4,000 animal unit months (AUM's). Present use of 2,350 AUM's does not include transitory range; thus, the total potential is 6,350 AUM's.

There are 25 developed recreation sites with a capacity of 1,620 persons at one time on the Forest. In 1975 total visitor days for recreational uses numbered 806,000. Use is categorized by use of facilities rather than activity. Use of general undeveloped areas was highest at 35 percent; roads for recreation, 25 percent; rivers and streams, 19 percent; campground and picnic sites, 14 percent; and others, 7 percent.

Timber inventory statistics for the Siskiyou show a volume of 15,866.6 million board feet or 3,293.3 million cubic feet. The regulated allowable cut was established at 190.9 million board feet per year in 1962. This was decreased to 188.3 million board feet in June of 1974. In addition to the regulated cut, 3.0 million board feet per year of unregulated commercial thinning volume was planned for sale when market conditions permitted.

Water on the Siskiyou National Forest drains primarily into the Rogue River Basin. The water originating within the Siskiyou is of high quality. The major water quality problems are high temperatures in the summer and high turbidity during spring runoff. Water quantity problems exist in some streams. Low summer flows contribute to excessive water temperatures. High winter flows may cause channel or bank erosion.

Many wildlife species are found on the Siskiyou. The Forest contains some 64 species of mammals, over 150 species of birds, and some 33 species of reptiles and amphibians. Fisheries are an important resource on the Siskiyou. The rivers of the Forest contain large runs of commercially important fish. Commercial salmon produced on the Siskiyou contributes heavily to retail markets nationwide.

The Roadless Situation

There are approximately 1,092,000 National Forest System acres on the Siskiyou National Forest as shown in table 1. There are 72,250 acres of other ownerships within the boundary; 6,426 acres in Research Natural Areas, Scenic Areas, etc., 76,200 acres in the Kalmiopsis Wilderness before passage of the Endangered American Wilderness Act (U.S. Laws, Statutes, etc. Public Law 95-237, 1978). Of the total National Forest System land, 69 percent was considered regulated commercial forest land for this study. The National Forest System acreage in the roadless area for this study was 435,537 acres (96,000 acres more than the RARE II inventory), of which 63 percent was considered to be regulated commercial forest land. Differences in roadless area acreages between our study and the RARE II inventory exist primarily because of wilderness designations in the Endangered American Wilderness Act of 1978 which was passed after our study was well underway. The average volume of chargeable harvest for the past decade was about 38 million cubic feet per year.

UMATILLA NATIONAL FOREST

Location

The Umatilla National Forest lies in the Blue Mountains range and is located in the northeastern corner of Oregon and in the extreme southeastern corner of Washington. Parts of Asotin, Columbia, Garfield, and Walla Walla Counties in Washington and of Baker, Grant, Morrow, Umatilla, Union, Wallowa, and Wheeler Counties in Oregon lie within the Forest's boundaries. Nearby communities with populations in excess of 1,000 persons are Walla Walla and Pomeroy in Washington and Pendleton, La Grande, and Heppner in Oregon.

Physical Characteristics

The Blue Mountains vary from undulating plateaus to steep, rugged mountains. Elevations on the Forest range from 1,900 to 7,936 feet. The climate of the Forest is temperate and semiarid, although wide variations in temperature and precipitation occur over the elevational ranges. Annual precipitation averages 20 inches at lower elevations and 55 inches at higher elevations.

Four major vegetational zones have been identified for the Blue Mountains. The western juniper (*Juniperus occidentalis*) zone occurs on dry sites at lower elevations; annual precipitation is from 8 to 10 inches. The ponderosa pine (*Pinus ponderosa*) zone lies between 2,900 and 4,900 feet; annual precipitation is between 15 and 30 inches.

The grand fir (*Abies grandis*) zone, the most extensive zone in the Blue Mountains, occurs from 4,900 to 6,600 feet in elevation. The subalpine fir (*Abies lasiocarpa*) zone is the highest forested zone, occurring at 4,500 to 7,900 feet.

Resources

Grazing was an important use of the Umatilla National Forest, even before the Forest was established. There are 67 range areas allotted to 87 permittees. These allotments cover 907,073 acres. This includes most commercial forest lands. About 8,400 cattle and 13,000 sheep use these forest lands for 3 to 4-1/2 months each summer.

There are 36 developed campgrounds with 351 camping units and a capacity to camp 1,989 people at one time. In 1977 total visitor days for recreational uses numbered 1,376,000. Of this total, the fish-hunting category represented 29 percent of total use; camping, 26 percent; motorized travel, 22 percent; hiking and riding, 9 percent; and others uses, 14 percent.

Timber inventory statistics for the Umatilla National Forest show a volume of 10,896.6 million board feet or 2,904.9 million cubic feet. The volume by Forest type (the predominant species) consists of approximately 40 percent grand fir, 23 percent ponderosa pine, 15 percent Douglas-fir, 7 percent each lodgepole pine (*Pinus contorta*) and subalpine fir, and 8 percent other species. The Forest presently has an annual allowable timber harvest of 135.1 million board feet in the standard and special cut categories and 50.9 million board feet in the unregulated cut category.

The headwaters of the Umatilla, John Day, Grand Ronde, Walla Walla, and Lower Snake River basins originate on the Forest. The streams of the Forest provide 15 million gallons of water to almost 52,000 domestic users annually. Although Forest streams vary in flow and use, water quality is generally excellent.

The Umatilla is important in production of wildlife and fish. Portions of the Forest contain some of the most productive big game habitat in Washington and Oregon. The rivers of the Forest are significant anadromous fish streams. Approximately 350 vertebrate wildlife species can be found on the Forest.

The Roadless Situation

Table 1 shows total National Forest land on the Umatilla to be approximately 1,394,000 acres. Of this area, 716,000 acres (51 percent) are regulated commercial forest land. Of the total acreage, 612,000 acres (44 percent) were in wilderness, wilderness study, or roadless status prior to passage of the Endangered American Wilderness Act (U.S. Laws, Statutes, etc. Public Law 95-237, 1978). The roadless area represented 435,000 acres (31 percent) of the total acreage, of which 36 percent was considered regulated commercial forest land. This is about 22,000 acres more than the RARE II inventory. This difference exists primarily because the inventory for this study includes part of the land designated for wilderness in the Endangered American Wilderness Act of 1978. The average volume of chargeable harvest for the past decade was about 24 million cubic feet per year.

WILLAMETTE NATIONAL FOREST

Location

The Willamette National Forest is a predominantly Douglas-fir forest, located along the western slopes of Oregon's Cascade Range. Most of the Forest is in Marion, Linn, and Lane Counties, but small portions are in Clackamas, Douglas, and Jefferson Counties. The Forest is within a 1-1/2 hr drive from Portland and a 1-hour drive from Salem, Albany, Corvallis, Bend, and the Eugene-Springfield area.

Physical Characteristics

Physiographically the Forest is divided into two geological zones, the High Cascades and the Western Cascades. Elevation is from under 1,000 feet to over 10,000 feet. The High Cascades are a region of broad, undulating plateaus, with occasional volcanic peaks. Precipitation is mainly in the form of snow--from 30 to 100 inches annually. The area has been subject to glacial and volcanic activity that has shaped its character. The Western Cascades feature a landscape deeply dissected with steep slopes and many deep, V-shaped valleys. Precipitation is mainly in the form of rain, varying from 45 inches per year on the south end of the Forest to 120 inches on the north end. The Western Cascades is one of the most productive timber producing areas in the Nation. The climate is favorable to the growth of Douglas-fir, western hemlock, and western redcedar (*Thuja plicata*), as well as other species.

Resources

The Forest is the source of many products and services, including wood, water, wildlife, wilderness, and recreation.

A total of 254,744 acres have been set aside in wilderness status. In 1975, the Forest experienced 2,069,000 recreational visitor days of use. The four wildernesses on the Forest accounted for about 15 percent of the total visitor days.

There are 18,730 acres of surface water on the Forest. Five major reservoirs that provide flood control, power generation, and streamflow regulation contribute to the Forest's surface water. In addition, the Forest has over 300 lakes and 2,500 miles of rivers and streams.

The water resource also provides a wide variety of game fish, including a significant anadromous fishery.

Wildlife in the Willamette National Forest includes a large variety of big game and small game, as well as nongame species.

Timber inventory statistics for the Willamette National Forest (1976) show a volume of 43,486 million board feet (8,865 million cubic feet) on available commercial forest lands. The major timber species are Douglas-fir, about two-thirds of the total volume; western hemlock, about 14 percent; and smaller quantities of Pacific silver fir (*Abies amabilis*), mountain hemlock (*Tsuga mertensiana*), noble fir (*Abies procera*), western redcedar, and other species. The average annual level of harvest (sales) proposed for the next decade in the timber management plan will be 635.6 million board feet, which includes 30.9 million board feet of mortality salvage.

The Roadless Situation

Of the 1,675,000 acres on the Willamette National Forest, 255,000 acres (15.2 percent) of the area had already been classified as wilderness when this study was begun. In addition 10,221 acres had been designated for wilderness study for a total of approximately 265,000 acres in either actual wilderness or wilderness study status (table 1). The total roadless area acreage on which this study was based (as of June 1977) was 280,475 acres, of which 195,000 acres (70 percent) were classified as regulated commercial forest land (CFL). The total is 106,000 acres more than in the RARE II inventory. This difference exists primarily because we did not reduce the land base to reflect changes in land allocations in the 1977 land use plan, nor for wilderness designations in the Endangered American Wilderness Act (U.S. Laws, Statutes, etc. Public Law 95-237, 1978). The average volume of chargeable harvest for the past decade was about 106 million cubic feet per year.

Harvest Consequences of Roadless Area Withdrawals

In this section of the paper we discuss the methods and results of pursuing the main objective of this study; i.e., determining whether as much timber could be harvested from National Forest areas without harvesting from the roadless areas as could be harvested with roadless areas in the timber base, if the resources saved by not developing a road system in the roadless areas were used for more intensive timber management on the lands with roads. Subsequent sections will discuss results for the other objectives related to financial and environmental consequences.

In this section we first present the procedures and definitions used to reach the study results. Second, we define and discuss the major study alternatives. Next, we discuss the major findings, both in general and Forest by Forest. Finally, we examine possibilities for generalizing study results for use on other National Forests.

CALCULATING HARVEST CONSEQUENCES—APPROACHES AND ASSUMPTIONS

The major task of this study was to calculate the effect of roadless area withdrawals and reallocations of funds on the potential yield and programed harvest of each study Forest. We required timber management and inventory data and a timber harvest scheduling algorithm. The management and inventory data were provided by the timber management staff of each study Forest. The timber harvest scheduling computations were done by Johnson, using an optimal timber harvest scheduling algorithm, model II (Johnson and Scheurman 1977).

Land Base

Following RARE I (the first Roadless Area Review and Evaluation), the areas selected for wilderness study were placed in a deferred category and removed from the base on which timber harvests were calculated.

Existing timber management plans typically assume that all roadless areas except selected study areas will be available for timber harvest. We used these assumptions in calculating the base alternative.[3] After our study was begun, the Endangered American Wilderness Act of 1978 (U.S. Laws, Statutes, etc. Public Law 95-237, 1978) designated substantial parts of roadless areas as Wilderness on the study Forests. Although these areas have been removed from the RARE II inventory, they are assumed to be available for timber harvest in the base alternative used in this study. Because of these differences, the acres of roadless areas included in the base alternative do not correspond to the RARE II inventory. That does not seriously detract from the usefulness of our results, however, since one purpose of this study is to illustrate the trade-offs that may occur on many National Forests rather than to analyze a specific policy on a particular Forest.

Potential Yield

The potential yield for a National Forest is a ceiling on the volume of timber that may be sold from the Forest for the next 10 years. According to the Forest Service Manual, the potential yield:[4]

> is the maximum harvest that could be planned to achieve the optimum perpetual sustained-yield harvesting level attainable with intensive forestry on regulated areas considering the productivity of the land, conventional logging technology, standard cultural treatments, and inter-relationship with other resource uses and the environment.

Conventional logging technology and standard cultural treatments include all applicable developed and proven systems for intensive management, whether or not they are currently economical or in general use in the area. Excluded are the effects of intensive activities, such as fertilization and irrigation that currently remain speculative or with unquantified benefit over large portions of the country.

In practice, there is some range of interpretation of this definition. On some Forests, the potential yield is designed in full recognition of all current constraints and is a rate of harvest that could be immediately implemented--in some cases, it is being harvested now. On other Forests, the potential yield is a rate of harvest that might be achieved within a decade because the harvest constraints can be reasonably expected to be overcome during that time. On still other Forests, the potential yield rate of harvest is unlikely to be achieved within a decade because the harvest constraints are unlikely to be overcome.

Potential yield for each study Forest was calculated with (1) all the roadless area in the timber production base, (2) half the roadless area withdrawn from the base, and (3) all the roadless area withdrawn. Since potential yield is based on full funding for feasible intensive management practices, the potential always goes down when the land base is reduced, as when all or part of the roadless area is withdrawn

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[3] Our land base and roadless areas were as of June 1977.

[4] USDA Forest Service Manual, 2415.41, Potential yield. May 1972.

from the timber harvest base. Even with full funding, however, the potential yield level cannot always be immediately programed for harvest. When there are areas that can only be harvested after some technical, biological, or economic problems are resolved, the potential yield may not be immediately realized, even with full funding. It is a useful benchmark, however, because it represents a goal National Forest planners believe can be attained in the future. (For a more complete definition of potential yield, see Forest Service Manual 2415--footnote 4).

All harvest levels calculated in tests of the study hypothesis are only for live, green material from regulated areas. They exclude material from unregulated areas and all dead material.

Programed Harvest

Another set of calculations for each study Forest was the programed harvest with (1) the total roadless area in the timber production base, (2) half the roadless area withdrawn from the base, and (3) the total roadless areas withdrawn. The programed harvest for a Forest is that part of the potential yield scheduled for sale during a specific year. It is based on current stumpage prices, funding, silvicultural practices, and multiple use considerations. With half and all the roadless area withdrawn, we calculated a programed harvest both with and without reallocation of funds to intensive management.

Programed harvest levels were developed by calculating a nondeclining harvest level with assumptions used by the Forests in their most recent planning effort. The resulting harvest level and sequence was taken back to the Forest team of resource specialists to verify that it was a feasible schedule. In many cases the schedule was not feasible, and the team developed constraints to make it feasible. The harvest schedule was then recalculated with those constraints.

The programed harvest with half the roadless area withdrawn and no reallocation of funds was designed to permit intensive management activities to continue at a level not to exceed that in the base programed harvest. The alternative--half the roadless area withdrawn and reallocation of funds to intensive management--was calculated by permitting additional intensive management above the Forest planned level of management to the limit of funding represented by the savings available from not developing half the roadless area.

Reallocation of Funds

To estimate the amount of funds to be reallocated to intensive management, we used the costs of road construction, reconstruction, and maintenance necessary to fully develop the roadless area. These costs are described for each study Forest in appendix C and in table 2. The amount to be reallocated would be equal to the costs avoided by not developing the roadless area, less any increased costs incurred in the currently accessible area as a result of not developing the roadless area. For example, on the Willamette National Forest it would be necessary to build additional roads in currently accessible areas to connect with roads in other accessible areas that would have been linked if roads had been built in a roadless area.

Table 2--Initial stumpage prices and road data

Item	National Forest		
	Siskiyou	Umatilla	Willamette
Total miles constructed to complete road system in roadless areas	664	657	488
Total construction costs (dollars)	56,000,000	35,700,000	56,800,000
Cost per mile (dollars)	84,300	54,400	116,400
Construction (percent):			
1st decade	20	40	32
2d decade	30	25	35
3d decade	30	20	21
4th decade	20	15	12
Road miles per section in roadless areas:			
Regulated commercial forest land (acres)	1.5	2.7	1.6
Total National Forest (acres)	1.0	1.0	1.1
Reconstruction cost per mile (dollars)	19,300	7,200	28,000
Reconstruction cycle (years)	20	20	20
Maintenance costs (dollars per mile per year)	1,400	900	600
Stumpage price (dollars per 1,000 board feet):			
Accessible area	183	64	208
Roadless area[1]	158	53	204
Roadless area[2]	156	43	177

[1] Contains the half of the roadless area most likely to remain in the timber base.

[2] Contains the half of the roadless area most likely to remain roadless.

The cost saving consists of two components: (1) purchaser credits that would be generated from timber sale receipts in the roadless area and (2) road funds appropriated by Congress. If the roadless area is not developed, the purchaser credits are not generated. The cost saving then is not in the form of money that the Forest Service has available for reinvestment. This fact does not influence the study results, but it does mean that the reallocation alternatives could be implemented only if Congress decided to reinvest and appropriated additional money to be allocated to intensive management.

HARVEST ALTERNATIVES ON STUDY FORESTS

Five alternatives were examined for each study Forest. For each alternative there is a potential yield and a programed harvest. All figures presented exclude material from unregulated areas and all dead material. Because of this, our figures may differ from some published figures for the study Forests. Alternatives are summarized in table 3.

Table 3--Summary of alternatives used in analysis

Alternative	Proportion of roadless area available for timber management	Funds reallocated to more intensive timber management	Harvest calculations	
			Programed harvest	Potential yield[1]
Base	All	No	X	X
50 percent of roadless area withdrawn from timber harvest	Half	No	X	X } same
50 percent of roadless area withdrawn from timber harvest; funds reallocated to more intensive timber management	Half	Yes	X	X } same
100 percent of roadless area withdrawn from timber harvest	None	No	X	X } same
100 percent of roadless area withdrawn from timber harvest; funds reallocated to more intensive timber management	None	Yes	X	X } same

[1]Bracketed data were obtained with 1 computer run.

Base Alternative

The base alternative simulated a timber management plan in which roads would be built and timber harvested over all the roadless area. This alternative incorporated current plans for timber management, road construction, multiple use constraints, and funding levels. We wanted to know the programed harvest and the potential yield of this simulated plan. We were also interested in whether the volume actually sold recently was significantly different from the programed harvest.

It was essential to have a clear picture of the road system that would be needed to implement this simulated plan. We needed to know the road program that would be planned for the roadless area so as to determine the savings from not building those roads. We needed to know the road program that would be planned in the accessible area so as to determine the incremental costs associated with changes from the base program. We also needed information on the level of forest management practiced and on employment and nontimber impacts under the base alternative.

The programed harvest of the base alternative approximates the programed harvest of live, green timber in an updated timber management plan where we assume the Forest planned level of intensive management and silvicultural practices, current multiple use considerations, and current stumpage prices. We also assume the regulated commercial forest land shown in table 1 is the land base for regulated timber production and that there are no restrictions on timber harvesting in the roadless area other than those normally associated with environmental and multiple use considerations. Although Forest Service managers normally think of programed harvest as pertaining to a specific year, we use a broader definition of the term. We use it to refer to an annual harvest over several decades that is consistent with the assumptions and constraints that initially apply.

The potential yield of the base alternative approximates the potential yield of an updated timber management plan with the land base as above. In most cases the silvicultural practices included are those that forest managers would include in a new plan for the Forest.

No Reallocation Alternative

The purpose of this alternative was to determine what would happen to future harvest on a Forest if the roadless area were removed from the timber base with no increase in intensive management. Under this alternative no increase in management intensity was permitted, and the multiple use adjustments were modified as necessary to reflect the reduced land base. As before, the desired result was a simulated programed harvest and potential yield.

Reallocation Alternative

The purpose of the reallocation alternative was to determine what would happen to harvests if we excluded the total roadless area from the timber base, but made available for timber management the resources that are saved by not developing the roadless area.

Except for the land base and the budget, this alternative had the same policy constraints as the previous alternatives. The new budget constraint for each decade was the implied level in the base alternative, plus the amount of money saved by not roading the roadless area.

Partial Roadless Area Alternatives

On each National Forest, the total roadless area is composed of a smaller subdivision of individually identified roadless areas. There is reason to believe that the harvest impact of these individual roadless areas varies widely, depending on the characteristics of the area. Because of these impacts that are probably variable, it would be useful to repeat the no reallocation and reallocation alternatives with a portion of the roadless area excluded. This would allow some interpolation of the results for policy alternatives that involved partial exclusion of roadless areas.

The approach for partial exclusion of roadless areas was to remove half the total roadless area from the timber management land base. The half to be removed was selected in cooperation with National Forest personnel familiar with the roadless area situation on each Forest.

Factors that were considered in determining removal included quality of areas for wilderness or other nontimber uses, public interest, congressional and administrative interest, manageability, and the direct and indirect costs of permanent roadless designation. In general, the allocation of areas selected to remain roadless and those to be removed from roadless status was done by individually identified units. Division of individual roadless areas was avoided where possible. The approximate 50-percent division was based on total National Forest acres in all roadless areas. There was no attempt to select the half on the basis of commerical forest land acreage, volume of standing timber inventory, or potential for production. Appendix G lists by name the roadless areas included in the study for each Forest and the roadless areas withdrawn from the timber base in the 50-percent alternative.

PRIMARY STUDY FINDING

The harvest that could be programed in the first decade with all the roadless area included in the timber base could not be achieved on any study Forest when all the roadless area was withdrawn and the funds saved were reallocated to more intensive timber management (table 4); if only half the roadless area was withdrawn, however, the base programed harvest level could be achieved on the Willamette National Forest through reallocation of funds.

When all the roadless area is withdrawn, funds for intensive management are not the principal constraint limiting the harvest that can be programed in the first decade. There are two reasons for this.

First, on the Siskiyou and Willamette National Forests the protection of environmental and multiple use values imposes a constraint on the extent of harvesting when all the roadless area is withdrawn which restricts the level of harvest to the reduced land base. This constraint is becoming progressively more important as the current ban on logging in roadless areas continues to limit the harvest to this reduced base. Where environment and multiple use are the principal contraints, increases in harvest from additional intensive management will be delayed to future decades.

Second, on the Umatilla National Forest, although funds for intensive management are available, a lack of unfunded management activities after all the roadless area is withdrawn does limit the harvest.

With half the roadless area withdrawn, environmental and multiple use constraints on harvest acreage still prevent an increase in the harvesting level on the Siskiyou National Forest. On the Umatilla and Willamette National Forests, however, the funding saved can be used to increase harvests. On the Umatilla this increase is slight because there are few opportunities. On the Willamette the increase is sufficient to more than make up for the decreased harvest resulting from withdrawal of half the roadless area.

Details on each study Forest are provided in a following section.

Table 4--Alternative harvests and recent harvest on study Forests[1]

Alternatives	National Forest		
	Siskiyou	Umatilla	Willamette
	Million cubic feet per year		
Programed harvest:			
All roadless areas in the timber base[2]	44.9	26.2	115.4
50 percent of roadless area withdrawn from timber base; no reallocation of funds	39.1	23.9	109.9
50 percent of roadless area withdrawn from timber base; reallocation of funds	39.1	24.0	118.6
100 percent of roadless area withdrawn from timber base; no reallocation of funds	30.0	21.7	102.8
100 percent of roadless area withdrawn from timber base; reallocation of funds	30.0	21.7	102.8
Potential yield:			
All roadless areas in the timber base[2]	59.4	31.2	157.4
50 percent of roadless area withdrawn from timber base	51.9	27.3	146.3
100 percent of roadless area withdrawn from timber base	39.8	24.3	134.1
Recent harvest	38	24	106

[1] Programed harvests and potential yields exclude material from unregulated areas and all dead material. Recent harvest is the average annual chargeable harvest for 1968-77; it excludes harvests from unregulated areas and generally excludes salvaged dead material considered to be endemic mortality.

[2] For the base alternative, we not only assume that all the roadless areas are in the timber base but also assume that there are no restrictions on entering the roadless areas.

OTHER HARVEST CONSEQUENCES

(1) The recent harvest[5] on all study Forests is below the level that could be programed with currently planned investment levels and current multiple use constraints with all the roadless area included in the base. With half the roadless area withdrawn, the recent level of harvest could be maintained or exceeded on all study Forests with reallocation of funds saved by not building roads on the withdrawn area and with all the roadless area withdrawn it could not be maintained or exceeded on the study Forests (table 4). Recent harvests generally were less than could now be programed with all the roadless

[5] Recent harvest is the average volume of chargeable harvest cut from the Forest for the past 10 years. This definition corresponds most closely with the harvest calculations which include only volumes to local merchantability limits from live green trees on regulated lands.

area in the base, for a variety of reasons. For example, on the Umatilla National Forest the recent harvest was based on a plan that was 10-15 years old; this study was based on new inventories and planning assumptions. Another example is on the Willamette National Forest where timber operators have been harvesting timber sales at a slower rate than they have been buying them, leading to a buildup in uncut, but sold, timber volume.

(2) Potential yield was reduced on all Forests when half or all the roadless area was withdrawn (table 4). These reductions were often large.

These comparisons relate to different questions. Comparing the base programed harvest with the programed harvest on the reduced land base is most relevant to the question of what do we give up in timber output in the near future if we withdraw the roadless areas and intensify timber management on the remaining land. Comparing the recent harvest with the programed harvest on the reduced land base is most relevant to the question of what is the impact on existing local economies if we withdraw the roadless areas and intensify timber management on the remaining land. Comparing the base potential yield with the potential yield on the reduced land base is most relevant to the question of what do we give up in timber output in the more distant future if we withdraw the roadless areas and intensify timber management on the remaining land.

(3) Reductions in potential yield on the study Forests were nearly proportional to reductions in regulated commercial forest land acres (table 5). This reduction as a percentage of the base potential yield is 15 percent on the Willamette National Forest, 22 percent on the Umatilla; and 33 percent on the Siskiyou. Because there are various kinds of constraints on programed harvest levels, the reductions in programed harvest vary somewhat more than potential yield in comparison with the reductions in regulated commercial forest land.

Table 5--Comparison of reductions (in percent) in regulated commercial forest land (CFL) acres and harvest volume when all the roadless area is withdrawn on study forests

Item	National Forest		
	Siskiyou	Umatilla	Willamette
Regulated CFL acres in the roadless area	36	22	17
Base potential yield from the roadless area	33	22	15
Base programed harvest from the roadless area without reallocation of funds	33	17	11

HARVEST RESULTS ON STUDY FORESTS

Willamette National Forest

Figure 1 illustrates that potential yield is reduced when half or all the roadless area is withdrawn by 7 and 15 percent, respectively. With respect to programed harvest, figure 1 illustrates that when 100 percent of the roadless area is withdrawn, none of the reduction can be offset. When 50 percent of the roadless area is withdrawn, however, the reduction in programed harvest can be more than offset by reallocating funds to more intensive management of the remaining land. This happens because the Willamette has a substantial amount of unfunded opportunities for cultural treatment. Some discussion of these results are in order.

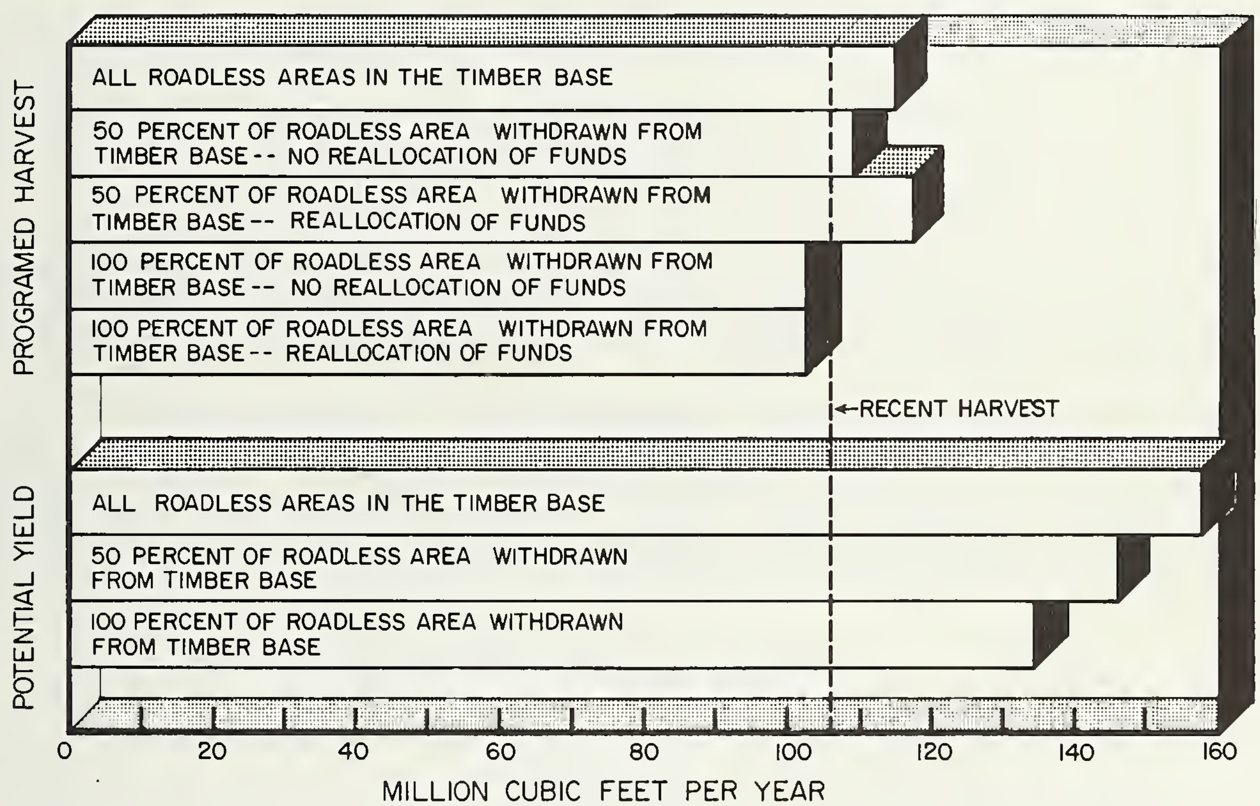

Figure 1.--Alternative harvest levels for the Willamette National Forest. Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 5.4 for programed harvests and 5.5 for potential yields.

It is important to realize that the primary constraint holding down the base programed harvest is lack of funds and manpower for investments in intensive management practices. If, however, this constraint were overcome, the next thing limiting the harvest would be a constraint on the number of acres of regeneration harvest imposed to protect non-timber resources, especially soil, water, fish, and wildlife resources. Recently, concentration of timber cutting in the accessible area, caused by the moratorium on harvesting in roadless areas has caused this constraint to assume greater importance. If all roadless areas are withdrawn from the timber base, a number of decades, perhaps five, would have to pass before assumed budgets again became a primary constraint on timber harvest.

Table 6 illustrates that with no constraints on the budget the first decade harvest is 130 million cubic feet per year with all roadless areas in the base, 119 million cubic feet per year with half the roadless area withdrawn, and 103 million cubic feet per year with all the roadless area withdrawn. The regeneration harvest constraint limits the harvest level in these cases.

Table 6 shows that, when budgets are constrained and 50 percent of the roadless area is withdrawn, the harvest is limited to 110 million cubic feet. This can be increased to 119 million cubic feet if funds for intensive management from not building roads in the roadless area are provided. Table 6 also shows that, when all the roadless area is withdrawn, the harvest is limited even with no budget constraint to 103 million cubic feet per year. In this case the budget is limited by environmental and multiple use restrictions that constrain regeneration harvest acreage.

After a number of decades have passed and the problems caused by concentrating cutting in the area with roads have been overcome, the harvest with reallocation of funds can be increased on the reduced land base. Table 6 shows that these levels, with half or all the roadless area withdrawn, might approach 126 million and 116 million cubic feet per year, respectively.

The potential yield shown (table 6) is a goal possibly attainable sometime in the future when marginal land problems have been solved and gains from genetic improvement have been incorporated into programed harvest calculations.

Previous analyses, such as Kutay's[6] have focused largely on these longrun effects of reallocation of road savings. We now know, however, that this approach cannot be expected to accurately estimate the immediate effects of withdrawing roadless areas in cases where the budget for intensive management will not be the principal constraint on harvest when the land base is reduced.

Siskiyou National Forest

Figure 2 shows that, when either 50 percent or 100 percent of the roadless area is withdrawn from the timber base, none of the reduction in programed harvest can be offset through reallocation of funds to more intensive management of the remaining land.[7] Concerns about the effects of timber harvest on other resources are similar to those found on the Willamette National Forest. On the Siskiyou, however, even the base programed harvest and the programed harvest with 50 percent of the roadless area withdrawn are constrained by the need to protect other resources. Therefore, reallocating the road savings to more intensive management of the remaining land will not increase the shortrun harvest because it is the regeneration harvest acreage constraint and not the budget that limits harvesting. On the Siskiyou as is the case on the Willamette, it can be anticipated that the harvest could increase somewhat in future decades (table 7).

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[6] Kurt Kutay. Oregon economic impact assessment of proposed wilderness legislation. April 1977.

[7] The base programed harvest exceeds the recent harvest primarily because the current planning effort assumes that funding for much of the intensive management opportunities will continue to be forthcoming. The recent harvest was based on the Hanzlik (1922) formula and did not recognize growth on future stands.

Table 6--Willamette National Forest programed harvests and potential yields for the study alternatives under various assumptions

Item	Base	50 percent of roadless area withdrawn from the timber base		100 percent of roadless area withdrawn from the timber base	
		No reallocation of funds	Reallocation of funds	No reallocation of funds	Reallocation of funds
		Million cubic feet per year[1]			
Maximum 1st decade programed harvest--no constraints on budgets	130	NA	119	NA	103
Maximum 1st decade programed harvest--budgets constrained	115	110	119	103	103
Programed harvest level that might be built up over next 50 years with budget constraint	115	110	126	103	116
Potential yield	157	NA	146	NA	134

NA = not applicable.

[1]Excludes dead and unregulated volume.

Table 7--Siskiyou National Forest programed harvests and potential yields for the study alternatives under various assumptions

Item	Base	50 percent of roadless area withdrawn from the timber base		100 percent of roadless area withdrawn from the timber base	
		No reallocation of funds	Reallocation of funds	No reallocation of funds	Reallocation of funds
			Million cubic feet per year[1]		
Maximum 1st decade programed harvest--no constraints on budgets	45	NA	39	NA	30
Maximum 1st decade programed harvest--budgets constrained	45	39	39	30	30
Programed harvest level that might be built up over next 50 years with budget constraint	54	42	46	34	36
Potential yield	59	NA	52	NA	40

NA = not applicable.

[1] Excludes dead and unregulated volume.

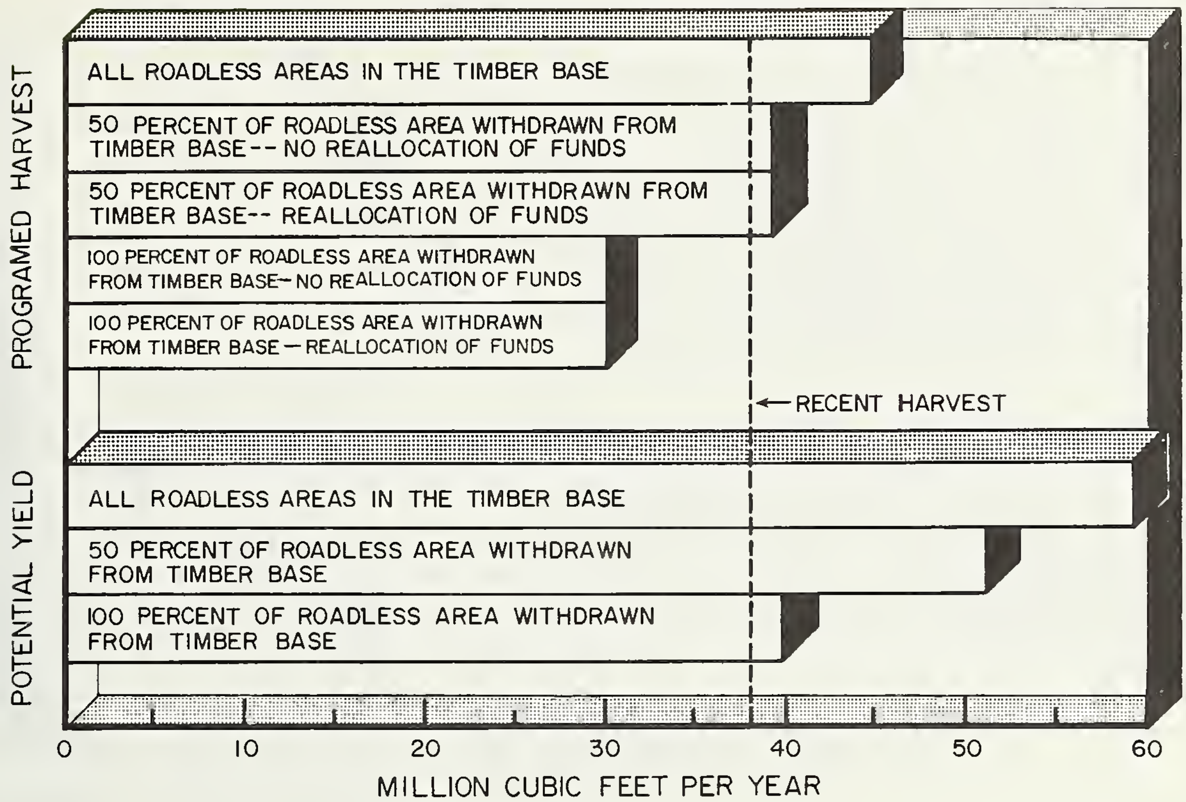

Figure 2.--Alternative harvest levels for the Siskiyou National Forest. Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 4.8.

Figure 2 also shows that the potential yield is reduced when half or all the roadless area is withdrawn (13 and 33 percent, respectively). Like the Willamette, however, the potential yield is a goal that is possibly attainable sometime in the future when marginal land problems have been resolved and genetic gains are included in programed harvest calculations.

Umatilla National Forest

Figure 3 shows that when roadless areas are withdrawn, there is virtually no opportunity to offset any of the reduction in programed harvest through reallocation of funds to more intensive management of the remaining land.[8] With all roadless areas in the base, funds for precommercial thinning slightly limit the harvest. When half the roadless area is withdrawn, the opportunities to precommercially thin are reduced to little more than the number of acres treated in the base programed harvest. This small amount of precommercial thinning results in a slight increase in programed harvest with reallocation. When all the roadless area is withdrawn, the opportunities to do precommercial thinning are reduced below the amount treated in the base programed harvest. Therefore, there are no opportunities for treatment and no response to reallocation.

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[8] The base programed harvest exceeds the recent harvest primarily because increased investments in precommercial thinning have resulted in higher investment assumptions than were used in the previous plan.

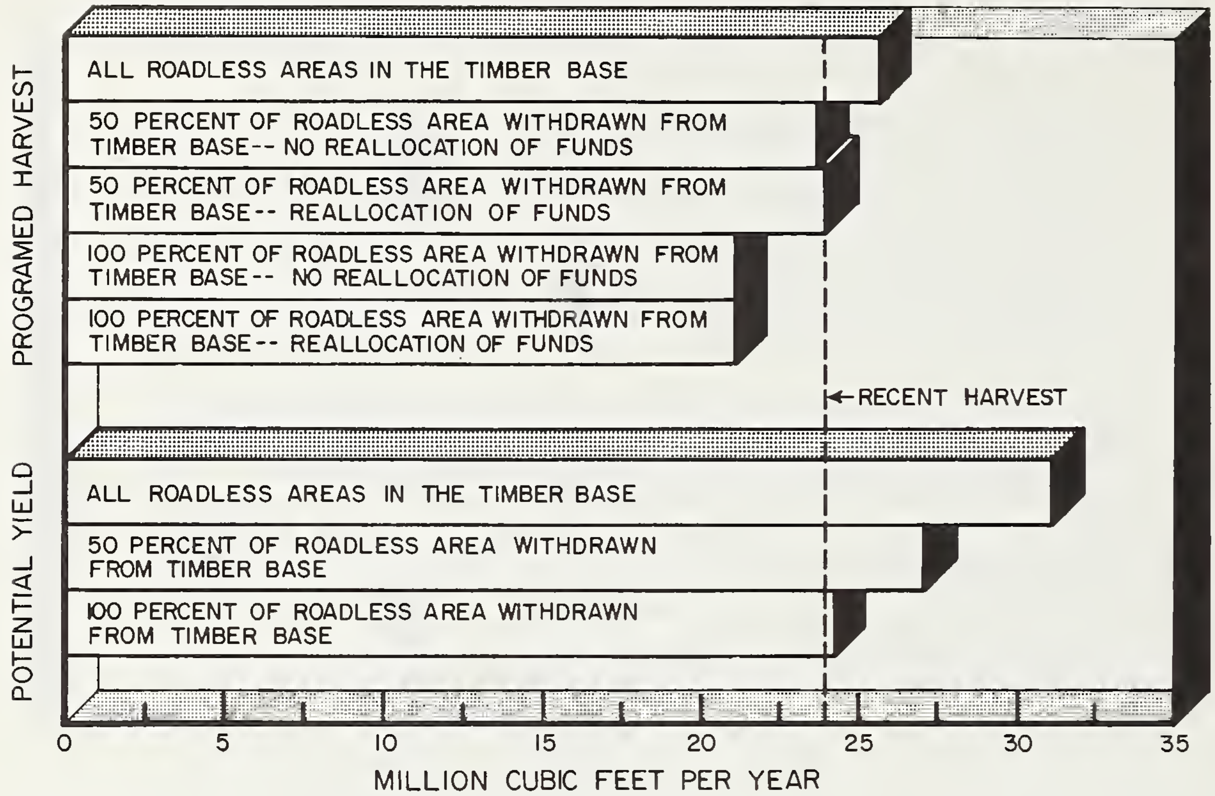

Figure 3.--Alternative harvest levels for the Umatilla National Forest. Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 6.4.

Figure 3 also shows that the potential yield was reduced from a base of 31 million cubic feet per year to 24 million, or 22 percent when 100 percent of the roadless area was withdrawn. Notice that potential yield when 100 percent of the roadless area was withdrawn is lower than the base programed harvest. With 50 percent of the roadless area withdrawn, potential yield is reduced 13 percent but still remains at a higher level than the base programed harvest.

GENERALIZING STUDY RESULTS TO OTHER NATIONAL FORESTS

The study Forests are not a scientific "sample." Therefore, no firm, quantitative conclusion can be drawn about other Pacific Northwest National Forests. This study, however, does suggest that there may be some ability to substitute management intensification for roadless area volume on other National Forests, especially if withdrawals include up to half rather than all the roadless area.

Identifying National Forests that are likely candidates for this substitution is made difficult by the nature of the constraints that hold down the harvest as the land base changes. For example, when all roadless areas are included in the Willamette's harvest calculation, the budget for management intensification is the primary constraint holding down harvest; however, when all roadless areas are excluded from the Willamette's harvest calculation, the number of acres allowed for regeneration harvest becomes the primary constraint holding down the harvest. This situation makes it extremely difficult or perhaps impossible to use the harvest results from the study Forests to predict the result of withdrawals of roadless areas on other National Forests. To predict the result of withdrawing roadless areas and intensifying timber management on the remaining land, we must be able to determine what the principal constraint on harvest would be with the reduced land base. In many cases that information can only be obtained by a careful consideration of some harvest calculations. For most Forests, calculations of that sort do not now exist. If one could determine that funds for intensive management would be the principal constraints with the reduced land base, it would still be necessary to have some harvest calculations to indicate the amount that the harvest could be increased through reallocation. The earned harvest from management activities on the full land base will not provide a reliable estimate because opportunities for applying management activities are normally reduced when roadless areas are withdrawn. Therefore, aside from the general conclusion that the opportunities to offset harvest reductions through investments in more intensive timber management appear to be limited, it does not appear possible to draw sound conclusions about other Forests without making harvest calculations for the alternatives as we have done.

Financial and Employment Consequences of Roadless Withdrawals

ASSUMPTIONS USED IN FINANCIAL ANALYSIS

Purpose of the Analysis

The purpose of our analysis is to explore the financial implications of some broad alternatives for allocation of roadless areas on the Siskiyou, Umatilla, and Willamette National Forests. One factor in particular, the 25 percent of gross revenues that National Forests are required to pay to counties, is a valuable financial indicator of the impact of roadless area allocations on local economies. Present net worth calculations are essential components of a national efficiency analysis. Finally, revenue and cost consequences are useful indicators of the effect of the alternatives on Forest budgets and Forest Service receipts to the United States Treasury.

We have no financial results for individual roadless areas on the Forests. We know, however, that within the broad averages used for each Forest individual roadless areas vary tremendously in timber inventories, amount of commercial forest land, productivity, and financial value.

Projecting Future Trends

Perhaps the most perplexing problem in quantifying the financial consequences of the harvest alternatives is how to account for the considerable uncertainty which exists regarding prices and costs in the future. To investigate the sensitivity of the financial results to alternative views of the future, we calculated the results with two interest rates, three assumptions about the course of stumpage prices, and two assumptions about future management costs. Real (deflated) prices, costs, and interest rates were used in the financial analysis. In terms of projecting future economic trends, "real" means that we make no attempt at projecting inflationary trends.

Our procedure for projecting future trends involves determining a current value for the item we are projecting and then estimating its future real increase, if any. The initial stumpage prices for each National Forest come from the trend in high bid prices from recent sales on the Forests. The changes in real prices come from an early version of the Resources Planning Act Timber Assessment Softwood Market Model.[9]

The average annual compound growth rate in real prices for the period 1978-2030 on Region 6 Forests is: West-side (Douglas-fir) region, 1.9 percent; east-side (ponderosa pine) region, 1.5 percent. The growth rate for prices is higher than average for the west side and east side until the year 2000, after which it slows considerably. After the year 2030, real stumpage prices are assumed to be constant.

Price Assumptions

Table 2 shows the values for initial stumpage prices and road items for each study Forest. Our assessment of stumpage prices starts with the high bid price for the accessible area. High bid is the value of stumpage as if the roads were in place. It is appropriate to use the high bid since we are accounting for road costs separately. The prices received for stumpage will be different in the roadless area from those in the accessible area because of differences in species mix, timber quality, and logging and hauling costs. These factors were accounted for when we developed separate prices on each Forest for each half of the roadless area and for the accessible area. The high bid prices for each area (table 2) were provided by each Forest and represent 1977 stumpage prices which were trended to average out recent fluctuations in stumpage markets.

In the financial analysis, we use three assumptions about the future course of stumpage prices.

The first assumption is that the stumpage price on each study Forest remains constant over time at the recent high bid levels reported by the Forests. The second and third assumptions are that real stumpage prices will rise until 2030; the difference between the second and third assumptions is in their treatment of Region 6 Forest Service harvest levels. With the second assumption no roadless areas would be withdrawn on other Region 6 National Forests and Forest Service harvest levels would follow trends assumed in the Resources Planning Act Timber Assessment Softwood Market Model (see footnote 9). The third price assumption for the Willamette and Siskiyou National Forests is the expected trend in prices if changes in harvest levels on all west-side Region 6 National Forests occur simultaneously and are proportional to the change on the Forest being analyzed. The third price assumption for the Umatilla is the expected trend in prices if there are simultaneous changes in harvest levels on all east-side Region 6 National Forests that are proportional to the changes on the Umatilla.

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[9] Adams, Darius M., and Richard W. Haynes. 1978. A preliminary description of the 1980 Timber Assessment Softwood Market Model. Report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

For the second and third assumptions, the stumpage price for each study Forest depends on three factors: (1) regional stumpage price, (2) the quantity of stumpage harvested on the Forest, and (3) the land base (roadless areas included or not) associated with harvest. Regional price effects are determined from demand relationships which take into consideration harvest changes on private lands.

In the absence of data on harvest changes on other Forests, we consider the second assumption most realistic, and results using that assumption are highlighted in the financial results section. Results for the third price assumption are included in appendix D. These results must be viewed as a rough approximation of the financial effects on each study Forest of withdrawing roadless areas simultaneously from the other National Forests because the actual harvest changes that would take place on other Forests would not likely be proportional to the change on the Forest being analyzed. Since we cannot estimate the Region 6 change in harvest from our limited number of study Forests, we use the assumption of proportional harvest changes to illustrate the effect of this alternative.

The actual prices used in present net worth calculations and other financial results are shown for each price assumption and for each study alternative in appendix A.

Interest Rates and Discounting

Gregersen (1975) points out the importance of not confusing market rates of interest (which incorporate expected inflation) with real rates of interest. Referring to investments in private forestry, Klemperer (1976) concludes that when inflationary effects are removed from interest rates, an after-tax rate of 5 to 6 percent is competitive.

Two interest rates, 5 and 10 percent, were used in present net worth (PNW) calculations; 5 to 10 percent represent a range in interest rates which is sufficiently wide to reveal the sensitivity of the financial results to the cost of capital. The 5- to 10-percent range also avoids the difficulties of attempting to identify a single "correct" interest rate for public investment evaluation.

Present net worths shown in the financial results section and in appendixes D and E are calculated for 10 decades by the following relationship:

$$PNW = \sum_{n=1}^{10} \frac{r_n \; [(1+i)^{10} - 1]}{i \; (1+i)^{10n}}$$

where,

PNW = present net worth,

r_n = average annual net revenue received in the n-th decade,

i = interest rate (0.05, 0.10),

n = decade (1, ..., 10).

Cost Assumptions

The success of dealing with uncertainty through sensitivity analysis depends on thoughtful selection of alternative views of the future. Two assumptions about the future course of real costs were used in the financial analysis. The first assumption is that all costs will remain constant at their present levels. The second assumption is that the cost per acre for labor intensive practices will increase at the same rate as real per capita income in Oregon and Washington. Specifically, costs for regeneration, precommercial thinning, and timber sale preparation are assumed to increase at the same rate as the U.S. Water Resources Council (1974) projections of real per capita income in Oregon and Washington to the year 2020. The increase in real costs of these items is approximately 2.7 percent per year over the period 1980-2020. Costs are assumed constant after that.

All other cost items including road construction, reconstruction, and maintenance are assumed to remain constant in real terms; i.e., they will increase at the same rate as the general price level. The management and road costs for each Forest are found in appendix C. Road costs are also summarized in table 2.

The compound annual growth rate of real per capita income in Oregon and Washington for selected years between 1970 and 2020 is shown in appendix B. These growth rates are applied directly to the costs provided by each study Forest to obtain the future cost of the labor intensive practices.

ASSUMPTIONS AND PROCEDURES USED IN EMPLOYMENT ANALYSIS

We quantified the employment consequences of the harvest alternatives with the input-output (I-0) models developed as a part of the RARE II analysis. The RARE II I-0 model for each Forest is based on employment data from a multicounty area encompassing the Forest. These employment data are used to scale the national I-0 model to reflect the characteristics of the local economy.

Changes in harvest levels are directly and fully translated into changes in sales to final demand from the local wood products processing and timber supply sectors. No compensating adjustments in harvest flows from other local ownerships or nonlocal sources are recognized.

The consequences of the harvest alternatives on employment apply only to the local economies--economies for which the study Forests are an important source of forest-related goods and services. The reported impacts are not the only consequences of the harvest alternatives on employment, and another choice for the area of employment impact would lead to a different set of results. It is at the local level, however, that the effects of harvest changes and land allocation decisions take place and will be felt most heavily and the concern for impacts on employment is likely to be intense.

The employment results represent initial effects only. The difficulty of accurately assessing the future course of labor productivity and structural change within the local economy precludes a projection of the consequences for employment over several decades.

The results represent the sum of direct, indirect, and induced effects on employment resulting from the harvest changes on each Forest. The direct effect is the change in employment in the wood products manufacturing and timber supply sectors associated with changes in the sales of each sector to final demand. The indirect component consists of the changes in employment in all other sectors (with the exception of households) resulting from the changes in final demand sales of the wood products manufacturing and timber supply sectors. Not all the direct, indirect, and induced employment changes associated with changes in road construction are included in the employment results; however, correcting the results to reflect the omissions would likely add less than 10 percent to the employment impacts for each study Forest.

Increases in dispersed, nonmotorized recreation-related employment which would result from all the roadless areas remaining in a roadless status are likely to be small and, to varying degrees, offset by employment losses from decreases in dispersed, motorized recreation-related employment. No attempt is made to estimate the total effect on employment of changes in in-lieu tax payments to counties.

The magnitude of person-years of employment per million cubic feet of timber harvested differs from one Forest to another primarily because of differences in the structure of the economies located within the input-output areas. As indicated by the preceding discussion, the reported impacts on employment are probably conservative estimates of the local impacts of the harvest level-land base changes.

The actual level of timber-related employment in the local economy is based on the recent volume of chargeable harvest from the study Forest and other sources of timber. The employment consequences, which are directly proportional to the harvest changes, are quantified as deviations from the direct, indirect, and induced level of employment that is attributable to the base programed harvest. To the extent that the base programed harvest is greater than the recent volume of chargeable harvest, employment reductions stemming from harvest reductions represent decreases in opportunities to expand employment rather than decreases in the level of actual employment.

FINANCIAL CONSEQUENCES—SUMMARY OF FINDINGS

The financial and employment effects of removing roadless areas from the land available for timber management and reallocating the savings in road costs to more intensive management of the remaining land were derived for each study Forest. Using expected trends in real costs and real stumpage prices, we computed the results shown in the next section. The trend in real stumpage prices was based on the assumption that, with the exception of the National Forest for which the results were reported, there would be no harvest changes caused by roadless area withdrawals on any of the National Forests in the Pacific Northwest. Financial consequences calculated for two additional price and cost assumptions are shown in appendixes D and E and are discussed in the next section.

Table 8 shows the effects of the key alternatives on present net worth, receipts to counties, and local employment. On the Willamette and Siskiyou National Forests, the reductions in financial values were quite large when all the roadless areas were removed from the land base available for timber management. On the Umatilla, the changes were smaller. On the Willamette, when half the roadless area was withdrawn and funds were reallocated to intensify timber management on the area with roads, present net worth increased.

EMPLOYMENT CONSEQUENCES — SUMMARY OF FINDINGS

Changes in employment related to changes in timber harvest are variable between forests (table 8). This results both because changes in harvest vary and because the amount of employment per million cubic feet of harvest vary.

FINANCIAL AND EMPLOYMENT RESULTS ON STUDY FORESTS

The presentation of financial results in tables 9, 10, and 11 (also see appendixes D and E) shows the gross revenue and payments to counties for the base programed harvest. It shows the change in gross revenue, costs, net revenue, payments to counties, and present net worth[10] for reallocation alternatives compared with the base programed harvest. The change in costs associated with the reallocation alternatives has been estimated. The costs for roads in the accessible areas, administrative overhead, and many other costs associated with the base programed harvest have not been estimated. Therefore, we cannot show or

[10]When the Forest harvest changes are large enough to cause local price changes, present net worth is not the most relevant measure of the change in social welfare. Discounted net social benefit, or the discounted sum of consumers' and producers' surplus, is a more relevant criterion (McKean 1958, Prest and Turvey 1967). Net social benefit represents the difference between what society would be willing to forgo rather than go without the commodity (benefits) and the costs, exclusive of rents, which it must actually incur to produce the commodity. The distinction between discounted net social benefit and present net worth is crucial in the inelastic portion of the demand curve, since present net worth will increase when discounted net social benefit decreases, and vice versa. In the present case, however, demand relationships are elastic and the effects on prices at the National Forest level are so small that present net worth is a very close approximation to discounted net social benefit.

Table 8--Change in present net worth (PNW), payments to counties, and employment between the base programed harvest and the reallocation alternatives[1]

National Forest and alternative[2]	Change in PNW for 10 decades at 5-percent interest	Change in payments to counties[3]	Change in local employment related to change in timber harvest
	Million dollars	Million dollars per year	Person-years per year
Siskiyou:			
50 percent of roadless area withdrawn	-135.5	-2.0	-780
100 percent of roadless area withdrawn	-331.7	-5.2	-2,010
Umatilla:			
50 percent of roadless area withdrawn	-1.5	-.3	-251
100 percent of roadless area withdrawn	-1.9	-.6	-521
Willamette:			
50 percent of roadless area withdrawn	163.7	2.0	502
100 percent of roadless area withdrawn	-281.4	-4.0	-1,979

[1] Based on trends in real prices expected with no changes in harvest on other National Forests and expected trends in real costs.

[2] Alternatives show percent of the total roadless area withdrawn from a timber base that includes all roadless areas.

[3] Averages for the first 4 decades in 1978 constant dollars.

Table 9--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Willamette National Forest[1] [2]

Item	Base programed harvest	Change from base when 50 percent of roadless area is withdrawn	Change from base when 100 percent of roadless area is withdrawn
1. Harvest (million cubic feet per year)	115.4	3.2	-12.5
2. Gross revenue (million dollars per year)	232.2	8.1	-16.0
3. Cost of roads (million dollars per year)	NA	-1.0	-1.7
4. Cost of cultural treatments (million dollars per year)	NA	.7	-.1
5. Cost of selling timber (million dollars per year)	NA	.3	-.1
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	8.1	-14.1
7. Payments to counties (million dollars per year)	58.0	2.0	-4.0
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	163.7	-281.4
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	-45.2	-208.4
10. 1st decade average annual total employment (person-years)	18,215	502	-1,979

NA = not available.

[1] Trends in real stumpage prices expected, with no changes in harvest on other Douglas-fir region National Forests in the Pacific Northwest, and expected trends in real costs were used.

[2] Although the recent harvest on the Willamette National Forest is less than the base programed harvest, this was the result of short-term fluctuations in purchaser cutting patterns rather than changes in actual sales. Therefore, changes in revenues and employment shown represent changes from normal harvest levels.

Table 10--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Siskiyou National Forest[1] [2]

Item	Base programed harvest	Change from base when 50 percent of roadless area is withdrawn	Change from base when 100 percent of roadless area is withdrawn
1. Harvest (million cubic feet per year)	44.9	-5.8	-14.9
2. Gross revenue (million dollars per year)	67.9	-7.9	-20.7
3. Cost of roads (million dollars per year)	NA	-.7	-2.1
4. Cost of cultural treatments (million dollars per year)	NA	.2	-.7
5. Cost of selling timber (million dollars per year)	NA	-.4	-.9
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	-7.0	-17.0
7. Payments to counties (million dollars per year)	17.0	-2.0	-5.2
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	-135.5	-331.7
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	-59.8	-145.4
10. 1st decade average annual total employment (person-years)	6,067	-780	-2,010

NA = not available.

[1] Trends in real stumpage prices expected, with no changes in harvest on other Douglas-fir region National Forests in the Pacific Northwest, and expected trends in real cost were used.

[2] Because the base programed harvest exceeds the recent harvest by about 8 million cubic feet the reductions in revenues and employment with half the roadless area withdrawn represent losses in opportunities for increases rather than reductions from actual levels. About half the reductions in revenues and employment with all the roadless area withdrawn would be reductions from actual levels.

Table 11--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Umatilla National Forest[1] [2]

Item	Base programed harvest	Change from base when 50 percent of roadless area is withdrawn	Change from base when 100 percent of roadless area is withdrawn
1. Harvest (million cubic feet per year)	26.2	-2.2	-4.5
2. Gross revenue (million dollars per year)	17.1	-1.1	-2.3
3. Cost of roads (million dollars per year)	NA	-.6	-1.4
4. Cost of cultural treatments (million dollars per year)	NA	-.1	-.3
5. Cost of selling timber (million dollars per year)	NA	-.3	-.5
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	-.1	-.1
7. Payments to counties (million dollars per year)	4.3	-.3	-.6
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	-1.5	-1.9
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	.4	1.2
10. 1st decade average annual total employment (person-years)	3,067	-251	-521

NA = not available.

[1] Trends in real stumpage prices expected, with no changes in harvest on other ponderosa pine region National Forests in the Pacific Northwest, and expected trends in real cost were used.

[2] Because the recent harvest on the Umatilla National Forest is less than the base programed harvest, most of the reductions in revenues and employment with half the roadless area withdrawn represent losses in opportunities for increases rather than reductions from actual recent levels. The additional reductions when all the roadless area is withdrawn represent reductions from actual levels.

draw any conclusions about the net revenue or the present net worth of the base alternative. The first decade average annual total employment shown in tables 9, 10, and 11 for the base programed harvest represents the direct, indirect, and induced employment attributable to that volume of harvest. In all cases employment changes are directly proportional to the changes in programed harvest. More information concerning the employment consequences for the study Forests can be found in appendix F.

Financial results are included for three sets of price and cost assumptions. Results for individual Forest price and cost assumptions are shown in the text. This price assumption is the expected trend in prices for the Forest if the change in harvest on that Forest is the only change in harvest occurring on National Forests in the region. Under this assumption there are minor changes in prices caused by harvest reductions, but the changes in harvest are so small in comparison with the quantity of timber harvested in the region that the regional price of stumpage is unaffected. The cost assumption is the expected trend in real costs.

Results for the set of price and cost assumptions for the proportional change in harvest are presented in appendix D but are only summarized in the text. This price assumption is the expected trend in prices for the Forest if changes in harvest on all National Forests in the region occur simultaneously and are proportional to the change on the Forest being analyzed. This must be viewed as a rough approximation of the financial effects on this Forest of withdrawing roadless areas simultaneously from all National Forests in the region because the actual harvest change would likely not be proportional to the change on the Forest being analyzed. Since we cannot estimate the regional change in harvest from our limited number of study Forests, we use the assumption of proportional changes in harvest to illustrate the effect of this alternative. Under this price assumption, there may be substantial increases in prices caused by harvest reductions because the harvest change is large enough to affect the regional price of stumpage. The cost assumption is again the expected trend in real costs.

The third set of price and cost assumptions is constant real prices and constant real costs. These results show how the financial effects would differ if expected trends in real prices and real costs are not realized. These results are shown in appendix E.

Willamette National Forest

The financial results on the Willamette National Forest represent a Forest where the roadless area makes a sizable contribution to the timber program. Table 9 shows that changes in gross revenue, net revenue, and present net worth move in the same direction as changes in harvest.

The financial values increase when half the roadless area is withdrawn because the investment in additional intensive management increases the harvest more than the loss in land base reduces it. One cannot infer from that, however, that management of the roadless area would not be a financially attractive investment as well if there were sufficient funds to do the additional intensive management and build the necessary roads in the roadless area. This same general relationship also holds if we assume that future prices and costs will remain constant at their 1978 levels (appendix E).

If we assume that the harvests on all west-side National Forests in Region 6 change in proportion to the harvest changes on the Willamette, we would expect to observe substantial stumpage price decreases when half the roadless area is withdrawn and substantial increases when all the roadless area is withdrawn. The price decreases associated with the withdrawal of half the roadless area from the timber management base lead to increases in present net worth which are smaller than those that would be realized in the absence of proportional harvest changes on other Forests. Similarly, the price increases which accompany the withdrawal of all the roadless area leads to less of a reduction in present net worth than would be realized if there were no harvest changes on other Forests.

Employment, which is directly proportional to the first decade harvest, increases by 502 person-years when half the roadless area is withdrawn and decreases by 1,979 person-years when all the roadless area is withdrawn.

Siskiyou National Forest

The financial results on the Siskiyou National Forest also represent a Forest where the roadless area makes a sizable contribution to the financial value of the timber program. Table 10 shows that changes in gross revenue, net revenue, and present net worth all move in the same direction as changes in harvest. One should note, however, that the second half of roadless area withdrawn (to make 100 percent withdrawn) contains a substantial amount more of volume (and thus revenue) than the first half. With the first half withdrawn, volume drops 5.8 million cubic feet per year. Adding the second half to withdrawals reduces harvest another 9.1 million cubic feet to a total reduction of 14.9 million cubic feet. Although the magnitudes are reduced, these general relationships continue to hold if we assume constant costs and prices or if we assume price trends that result with proportional harvest changes on all National Forests in the region.

Umatilla National Forest

Table 11 shows that the changes in gross revenue, net revenue, and present net worth move in the same direction as changes in harvest. Comparing the results for the alternatives, 50 percent of the roadless area withdrawn and 100 percent withdrawn, shows that the reductions in financial values are approximately proportional to the reductions in harvest. The reductions in financial values, however, are much less than for the Siskiyou and Willamette National Forests. In fact, under the constant cost and price assumption and under the "proportional harvest change" price assumption, the net revenue and the present net worth are increased when 50 percent or all the roadless area is withdrawn. Results in table 11 show a decrease in present net worth when calculated with a 5-percent interest rate and an increase in present net worth when calculated with 10-percent interest rate.

CONCLUSIONS ABOUT THE FINANCIAL AND EMPLOYMENT CONSEQUENCES OF ROADLESS AREA WITHDRAWALS

When all the roadless areas are removed from the timber management base, average annual gross revenue, county payments, and net revenue decline on the study Forests under the assumption of expected trends in real costs and prices with no withdrawals of roadless areas on other Forests in the region. The employment changes for each Forest are directly proportional to the harvest reductions. The results for present net worth, county payments, and employment are summarized in table 8.

On the Willamette and Siskiyou National Forests the reductions in financial values with all roadless areas withdrawn are quite large (table 8); on the Umatilla National Forest the changes are smaller. The total direct, indirect, and induced effects on employment when all roadless areas are withdrawn are losses of 530 person-years on the Umatilla National Forest, 1,979 on the Willamette, and 2,013 on the Siskiyou.

The financial results do not include a complete accounting of all the benefits and costs of the harvest alternatives. For example, nontimber benefits such as increased opportunities for wilderness recreation, and the nontimber opportunity costs, such as decreased opportunities for developed and roadside recreation are not included in the financial analysis because we do not now have defensible estimates of their monetary values. Changes in the direct management costs of producing the nontimber benefits and differences in forest protection costs are also not accounted for. Therefore, the financial results must be interpreted with care, and considerable attention must be directed to a subjective valuation of the nontimber consequences before one can draw firm conclusions as to the economic desirability of a particular alternative.

The financial analysis quantifies the major changes in the benefits and costs of the timber program. The results are useful measures of the impacts of the alternatives on local community employment, Forest Service payments to counties, Forest Service receipts that go to the U.S. Treasury, and Forest Service timber management budgets under alternative assumptions about the future course of prices and costs. The results are a necessary component of an efficiency analysis, but, as the above discussion suggests, firm conclusions about the efficiency implications of the alternatives require simultaneous scrutiny of the consequences on nontimber resources.

Changes in Environmental Conditions and Nontimber Benefits

BACKGROUND

This section of the report demonstrates that the roadless area issue involves many kinds of trade-offs concerning environmental conditions and nontimber benefits. The trade-offs examined are those attributable to withdrawing roadless areas from the timber base and reallocating road funds to intensify timber management on remaining areas. We focused our analysis of impacts on nontimber resources on a comparison of the alternative, 100 percent of the roadless area withdrawn with reallocation of funds, with the base alternative.

Impacts were estimated for five decades into the future for each nontimber benefit criterion. Major, minor, and neutral impacts were recognized according to their timing (decades one, two through four, and five plus), nature (adverse or beneficial), and, in the case of major adverse impacts, the costs of mitigation.

Major impacts were identified as those that exceeded the "threshold of concern," which is defined as the amount of impact that would generate one or more of these effects: (1) Create a public expression of concern or interest, (2) change long-term traditional use patterns, and (3) require funds substantially in excess of usual planning and budgeting levels to mitigate impacts to an acceptable level. Major adverse impacts, although undesirable, were within limits considered acceptable under current interpretation of multiple-use objectives.

We identified impacts by meeting with resource specialists from the various disciplines on each study Forest. We provided data on road schedules, schedules of intermediate and regeneration harvests, and acres of management activities. The specialists evaluated the differences in these data between the base alternative and the reallocation alternative in terms of nontimber benefits and ecosystem criteria. Forest data were divided into a roadless portion and an accessible portion, which were evaluated separately. The evaluations of these impacts are shown in table 12. Of 16 environmental and nontimber benefit criteria, table 12 indicates the ones on which the effect is likely to be major or minor on at least one study Forest when the roadless area is withdrawn from the timber base and management intensified on the remaining land.

PRESENT SITUATION

Before discussing the impacts of withdrawing roadless areas and reallocating funds to more intensive management, we will briefly discuss the impacts of the base alternative compared with the current situation.

Since 1972 all RARE I roadless areas and some more recently identified RARE II areas have been closed to timber harvesting except where they have been allocated to such use through a completed land use plan. As a consequence, on many National Forests most roadless areas are still unavailable for timber harvest even though they are included in the commercial forest land base, on which allowable harvests are calculated. As a result, since 1972, road construction and timber harvesting have been concentrated outside the roadless areas. Adverse environmental impacts are beginning to develop and are in danger of exceeding acceptable levels on many National Forests. As the interdisciplinary teams have pointed out, there will be both beneficial and adverse impacts of going from the present condition to the base programed harvest. It is not our purpose, however, to evaluate these effects. We focus entirely on the changes expected to take place between the base programed harvest and reallocation alternative.

COMPARISON OF ALTERNATIVES

Table 12 summarizes the impacts expected if the base alternative is replaced by the reallocation alternative on the study Forests. If the reallocation alternative were adopted, the roadless area would remain roadless and the accessible area would be intensively managed in a manner consistent with timber flow, multiple use, and environmental policies. Impacts represent changes from the base alternative.

Table 12--Summary of estimated impacts associated with withdrawing the roadless area from the timber base and intensifying timber management on the remaining land on three Pacific Northwest National Forests

Criterion	Beneficial impacts		Neutral (no change from base)	Adverse impacts		Critical factors
	Major	Minor		Minor	Major[1]	
Water quality		R	A	A, R	A	Sediment
Water quantity		A, R	R, A			Acres of regeneration harvest
Waterflow		A, R	R, A	R, A		Peak flows
Soil stability		R	A	A	A	Disturbance on difficult sites
Soil productivity		R	A	A		Soil compaction and nutrients
Forage production (domestic)		A	A	R	R	Transitory range
Fish populations (anadromous)		R	A		A	Water quality, favorable habitat
Fish populations (residential)		R	A		A	Water quality, favorable habitat
Wildlife populations (game species)		R, A		A, R		Favorable habitat
Wildlife populations (threatened and endangered)	R	R	A	A		Undisturbed natural habitat
Opportunities for developed recreation		A	A	R	R	Potential development sites
Opportunities for dispersed recreation related to roads		A	A	R, A	R	Extent of road system
Opportunities for dispersed recreation away from roads	R	R	A	A		Extent of roadless areas
Visual resources	R	R	A		A	Natural appearing areas
Air quality		R	A	A	A	Extent of slash burning
Mineral and energy development		A	R, A		R	Access

[1] Major adverse impacts, although undesirable, are within limits considered acceptable under current interpretation of multiple use objectives.

R = at least one study Forest with this impact on the roadless area.

A = at least one study Forest with this impact on the accessible area.

Table 12 helps illustrate the trade-offs between the various criteria and between the roadless area and the accessible area within each criterion.

Our experience in this study has confirmed findings that were evident in the "Timber Harvest Scheduling Issues Study."[11] Specifically, impacts on nontimber resources are site specific; they may be variable within a Forest; and they often exhibit great variability between Forest and regions. For these reasons, we did not try to extrapolate regional impacts from the study Forests.

In the following section, the criterion impacts are identified and briefly discussed, and the results of the analysis of the impacts are presented for each Forest.

CRITERIA

Water Quality

Slope failure associated with timber harvests and roadbuilding activities--including the selection of sites, design, construction methods, and maintenance levels of roads--are critical factors affecting the present water quality levels in managed forest watersheds. Sediment introduced to forest streams determines, to a large extent, the impact on water quality.

Water Quantity and Timing of Flow

Impacts on water quantity and timing of flow are considered together here. In areas with abundant water, such as the Douglas-fir region of the Pacific Northwest, impacts on total water quantity are less important than impacts related to peak flows. On Forests adjacent to semiarid areas, quantity may be more important. In both the water-abundant and the semiarid areas, specialists expressed concern about peak flows reaching critical levels.

Soil Stability

Erosion and mass soil movement are the major soil stability problems. Both can affect water quality; in addition, mass movements can also be a threat to life and property. The risk of soil stability problems is increased by road construction and timber harvesting operations. The risk is also influenced by steepness of terrain and soil characteristics.

Soil Productivity

Soil productivity problems resulting from timber harvesting and roadbuilding activities take the form of compaction and nutrient loss. How residues are handled is usually considered the critical factor affecting nutrient levels. The frequency of timber harvests on a given site and the type of machinery used are critical factors affecting soil compaction. Careful selection of harvesting systems is one means of minimizing compaction problems.

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[11] U.S. Department of Agriculture. 1976. Timber harvest scheduling issues study. 292 p. USDA For. Serv., Washington, D.C.

Forage Production

On western National Forests, domestic forage production usually is associated with transitory, forested ranges that are utilized during the summer grazing season. A close relationship exists between the amount of forage used and the location and terrain of the harvested acres. The terrain must be negotiable by domestic livestock and located in the proximity of existing active grazing allotments.

Anadromous and Residential Cold Water Fish Populations

Fish populations are directly related to habitat conditions, of which water quality is a critical factor. Hence, impacts on fish populations generally relate closely to impacts on water quality.

Wildlife Populations

The level of given wildlife populations is strongly influenced by the presence or absence of certain wildlife habitat types. Road construction and timber harvest activities impact habitat types by altering the number, size, age, arrangement, and species composition of timber stands that comprise a Forest.

Opportunities For Developed Recreation

Opportunities for developed recreation usually involve a relatively high density form of recreation centered around a developed site, such as a campground, boat launch, marina, etc. Frequently, the developed facility is located at or near a natural land feature, such as a lake, stream, waterfall, or scenic vista that provides an attractive setting. Manmade improvements may vary from primitive to relatively elaborate.

Opportunities for Dispersed Recreation Related to Roads

Opportunities for dispersed recreation related to roads are scattered, individual activities, usually not associated with developed areas.

Opportunities for Dispersed Recreation Away From Roads

Opportunities for dispersed recreation away from roads are backpacking, horseback riding, and various types of off-road vehicle experiences. Many of these activities involve a more primitive form of camping than is normally associated with developed or road-related dispersed recreation.

Visual Resources

In this paper the term "visual resources" refers to opportunities for viewing natural- appearing forest landscapes from a distance. Generally, a direct relationship exists between visual resources and the acres disturbed at any time. Impacts tend to be adverse in the short run following timber harvests , but they can be minimized through proper shaping of the harvest units to the natural characteristics of the land.

Air Quality

Smoke from burning slash is the principal source of air pollutants associated with timber management activities. The impact on air quality is, however, a short-term, seasonal problem that smoke management plans have largely overcome on many Forests. In the long run, increased utilization of residue and conversion of overmature forests to younger, less defective stands will reduce the need for burning slash.

Mineral and Energy Development Opportunities

At present, opportunities to efficiently develop mineral and energy resources are directly enhanced by the presence of a road system. On most forests, no other form of access is currently feasible for utilizing mineral and energy resources.

SISKIYOU NATIONAL FOREST RESULTS

If the reallocation alternative were adopted in place of the base alternative, no roads would be built and no road-related timber harvests would occur in the roadless area. In such an event, specialists on the Siskiyou National Forest anticipated one major adverse impact and three major beneficial nontimber and environmental impacts in the roadless area and three major adverse impacts and no major beneficial impact in the accessible area. The specialists also expected 11 minor beneficial impacts, 12 minor adverse impacts, and 2 neutral impacts in the roadless area and the accessible area. All these impacts are shown in table 13.

The major beneficial impacts of the reallocation alternative are on populations of threatened and endangered species, opportunities for dispersed recreation away from roads, and visual resources. These beneficial impacts result because the roadless area will not be developed for timber production.

The major adverse impacts involve anadromous and residential cold water fish populations, visual resources, and mineral and energy development. The impacts on fish populations are associated with habitat degradation anticipated in the accessible area when the roadless area remains roadless and timber harvests continue to be concentrated in the accessible area. The adverse impact on visual resources is associated with the expected reduction of natural-appearing forest landscapes in the accessible area. The adverse impact on opportunities for developing mineral and energy resources in the roadless area concerns access problems associated with the lack of an available road system.

In summary, if the reallocation alternative were adopted in place of the base alternative, specialists on the Siskiyou National Forest would anticipate major nontimber and environmental trade-offs in addition to the loss of timber harvests. Major beneficial impacts on wildlife (threatened and endangered species), dispersed recreation, and visual resources in the roadless area would be expected at the expense of major (adverse) impacts on fish populations and visual resources in the accessible area and on opportunities to develop mineral and energy resources in the roadless area.

Table 13--Summary of estimated impacts associated with withdrawing the roadless area and intensifying timber management on the remaining land on the Siskiyou National Forest

Criterion	Impacts[1]				
	Beneficial		Neutral (no change from base)	Adverse	
	Major	Minor		Minor	Major[2]
Water quality		R		A	
Water quantity			A, R		
Waterflow				A, R	
Soil stability		R		A	
Soil productivity		R		A	
Forage production (domestic)		A		R	
Fish populations (anadromous)		R			A
Fish populations (residential)		R			A
Wildlife populations (game species)		A, R			
Wildlife populations (threatened and endangered species)	R			A	
Opportunities for developed recreation		A		R	
Opportunities for dispersed recreation related to roads				A, R	
Opportunities for dispersed recreation away from roads	R			A	
Visual resources	R				A
Air quality		R		A	
Mineral and energy development		A			R

[1]R = roadless area; A = accessible area.

[2]Major adverse impacts, although undesirable, are within limits considered acceptable under current interpretation of multiple use objectives.

UMATILLA NATIONAL FOREST RESULTS

If the reallocation alternative were adopted in place of the base alternative, no roads would be built and no road-related timber harvests would occur in the roadless area. In such an event, specialists on the Umatilla National Forest anticipated two major beneficial impacts and three major adverse impacts in the roadless area as shown in table 14. No major impacts were expected in the accessible area; 8 minor beneficial impacts were expected in the roadless area and 19 neutral impacts in both areas.

The major beneficial impacts are on visual resources and opportunities for dispersed recreation away from roads. Impacts on visual resources and opportunities for dispersed recreation away from roads are associated with the proportion of the total area disturbed in the roadless area.

Table 14--Summary of estimated impacts associated with withdrawing the roadless area and intensifying timber management on the remaining land on the Umatilla National Forest

Criterion	Impacts[1]				
	Beneficial		Neutral (no change from base)	Adverse	
	Major	Minor		Minor	Major[2]
Water quality		R	A		
Water quantity			A, R		
Waterflow			A, R		
Soil stability		R	A		
Soil productivity		R	A		
Forage production (domestic)			A		R
Fish populations (anadromous)		R	A		
Fish populations (residential)		R	A		
Wildlife populations (game species)		R	A		
Wildlife populations (threatened and endangered species)		R	A		
Opportunities for developed recreation			A		R
Opportunities for dispersed recreation related to roads			A		R
Opportunities for dispersed recreation away from roads	R		A		
Visual resources	R		A		
Air quality		R	A		
Mineral and energy development			A, R		

[1]R = roadless area; A = accessible area.

[2]Major adverse impacts, although undesirable, are within limits considered acceptable under current interpretation of multiple use objectives.

The major adverse impacts involve domestic forage production, opportunities for developed recreation, and opportunities for dispersed recreation related to roads. The impacts on forage production are associated with the opportunity forgone to increase forage production in the roadless area. Likewise, the impacts on opportunities for dispersed recreation related to roads and developed recreation are linked to the opportunities to build roads and develop attractive recreation sites in the roadless area.

Useful information about trade-offs may be obtained from table 14. Three of the five major impacts concern opportunities for recreation; one was considered beneficial and two were considered adverse by the specialists. A fourth major impact involves visual resources, and the fifth major impact involves domestic forage production. In addition, all five major impacts are associated with the roadless area and are directly affected by the policy of not building roads in the roadless area. Hence, the major trade-offs associated with the Umatilla National Forest involve different forms of recreation opportunities in the roadless area. Visual resources and dispersed recreation away from roads are significantly enhanced in the roadless area at the expense (trade-off) of decreasing opportunities for developed recreation, dispersed recreation with roads, and domestic forage production. There are no major nontimber and environmental trade-offs between the roadless area and the accessible area on this Forest. All impacts related to the accessible area are neutral.

WILLAMETTE NATIONAL FOREST RESULTS

If the reallocation alternative is adopted in place of the base alternative, specialists on the Willamette National Forest anticipate one major beneficial nontimber or environmental impact and eight major adverse impacts. Six would involve the accessible area and two the roadless area. Sixteen minor beneficial impacts and seven minor adverse impacts would also be expected. All are shown in table 15.

Table 15--Summary of estimated impacts associated with withdrawing the roadless area and intensifying timber management on the remaining land on the Willamette National Forest

Criterion	Impacts[1]				
	Beneficial		Neutral (no change from base)	Adverse	
	Major	Minor		Minor	Major[2]
Water quality		R			A
Water quantity		A, R			
Waterflow		A, R			
Soil stability		R			A
Soil productivity		R		A	
Forage production (domestic)		A		R	
Fish populations (anadromous)		R			A
Fish populations (residential)		R			A
Wildlife populations (game species)				A, R	
Wildlife populations (threatened and endangered species)		R		A	
Opportunities for developed recreation		A			R
Opportunities for dispersed recreation related to roads		A		R	
Opportunities for dispersed recreation away from roads	R			A	
Visual resources		R			A
Air quality		R			A
Mineral and energy development		A			R

[1]R = roadless area; A = accessible area.

[2]Major adverse impacts, although undesirable, are within limits considered acceptable under current interpretation of multiple use objectives.

The six major adverse impacts associated with accessible area affect water quality, soil stability, anadromous and cold water residential fish populations, visual resources, and air quality. Four of these impacts are closely related to soil erosion and sediment problems. Impacts on soil stability are directly tied to erosion and mass soil movement. Water quality impacts are caused by sediment from erosion. Fish populations, both anadromous and cold water residential, are directly affected by habitat degradation which is associated with water quality, etc. Hence, these four impacts are interrelated and are expected as a result of the increased timber harvesting associated with the reallocation alternative in the accessible area.

Continued concentration of timber harvests in the presently accessible area will cause a further reduction in the supply of natural-appearing forest landscapes and thereby contribute to major adverse impacts on visual resources. Slash will accumulate with the concentrated harvests in the accessible area. Fire management policies will require burning of slash to reduce fire hazard, an action that will have an adverse effect on air quality for a short time each year.

The two major adverse impacts associated with the roadless area involve opportunities for developed recreation and development of mineral and energy resources. The adverse impact on developed recreation opportunities is a result of the forgone opportunity to develop attractive recreation sites in the roadless area when the reallocation alternative is adopted. Likewise, major adverse impacts on opportunities for mineral and energy development are anticipated mainly because of the lack of a road system in the roadless area.

In conclusion, our analysis of environmental conditions on the study Forests suggests that not only do withdrawals seem to shift the adverse and beneficial impacts of timber harvesting from roadless areas to accessible areas, they often intensify them.

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Appendix A

REAL STUMPAGE PRICE (DOLLARS PER THOUSAND BOARD FEET)
ASSUMPTIONS USED FOR STUDY FORESTS

Table 16--Real stumpage price assumptions for the Siskiyou National Forest

Decade	Price assumption 1[1] (constant prices)			Price assumption 2[3] (increasing prices)			Price assumption 3[4] (increasing prices)		
	Base	50 percent withdrawn[2]	100 percent withdrawn	Base	50 percent withdrawn[2]	100 percent withdrawn[2]	Base	50 percent withdrawn[2]	100 percent withdrawn[2]
				Dollars per thousand board feet					
1	173.52	176.71	183.00	227.42	231.47	239.13	227.42	254.36	298.12
2	173.52	176.71	183.00	300.67	304.73	312.41	300.67	328.89	374.68
3	173.52	176.71	183.00	347.25	351.49	359.44	347.25	380.41	433.99
4	173.52	176.71	183.00	385.62	390.05	398.29	385.62	423.72	485.08
5	173.52	176.71	183.00	420.68	425.32	433.88	420.68	464.34	534.49
6	173.52	176.71	183.00	447.62	452.36	461.10	447.62	494.14	568.79
7	173.52	176.71	183.00	447.62	452.36	461.10	447.62	494.14	568.79
8	173.52	176.71	183.00	447.62	452.36	461.10	447.62	494.14	568.79
9	173.52	176.71	183.00	447.62	452.36	461.10	447.62	494.14	568.79
10	173.52	176.71	183.00	447.62	452.36	461.10	447.62	494.14	568.79

[1] High bid values reported by the Forest.

[2] Percent of total roadless acreage removed from the timber management land base.

[3] RPA Timber Assessment softwood market model projection with regional Forest Service harvest unaffected by roadless withdrawals (Adams, Darius M., and Richard W. Haynes. 1978. A preliminary description of the 1980 timber assessment softwood market model. Report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.)

[4] RPA Timber Assessment softwood market model projection with regional Forest Service harvest changed by the same proportion as the proportional change between the harvest levels of the base and each alternative.

Table 17--Real stumpage price assumptions for the Umatilla National Forest

Decade	Price assumption[1] (constant prices)			Price assumption 2[3] (increasing prices)					Price assumption 3[4] (increasing prices)				
	Base	50 percent withdrawn,[2]	100 percent withdrawn	Base	50 percent withdrawn,[2] no reallocation	50 percent withdrawn,[2] with reallocation	100 percent withdrawn[2] no reallocation	100 percent withdrawn,[2] with reallocation	Base	50 percent withdrawn,[2] no reallocation	50 percent withdrawn,[2] with reallocation	100 percent withdrawn,[2] no reallocation	100 percent withdrawn,[2] with reallocation
							Dollars per thousand board feet						
1	60.34	62.15	63.90	78.03	80.21	80.18	82.31	82.31	78.03	82.70	82.58	87.58	87.28
2	60.34	62.15	63.90	103.02	105.20	105.19	107.31	107.30	103.02	107.22	107.43	112.02	111.99
3	60.34	62.15	63.90	108.75	110.93	110.91	113.04	113.03	108.75	113.95	113.80	119.10	119.05
4	60.34	62.15	63.90	114.65	116.83	116.80	118.93	121.93	114.65	120.31	120.15	125.93	125.88
5	60.34	62.15	63.90	120.62	122.80	122.78	124.91	124.90	120.62	126.45	126.48	132.24	132.19
6	60.34	62.15	63.90	127.44	129.62	129.60	131.72	131.72	127.44	133.19	133.03	140.91	138.86
7	60.34	62.15	63.90	127.44	129.62	129.60	131.72	131.72	127.44	133.19	133.03	140.91	138.86
8	60.34	62.15	63.90	127.44	129.62	129.60	131.72	131.72	127.44	133.19	133.03	140.91	138.86
9	60.34	62.15	63.90	127.44	129.62	129.60	131.72	131.72	127.44	133.19	133.03	140.91	138.86
10	60.34	62.15	63.90	127.44	129.62	129.60	131.72	131.72	127.44	133.19	133.03	140.91	138.86

[1] High bid values reported by the Forest.

[2] Percent of total roadless acreage removed from the timber management base.

[3] RPA Timber Assessment softwood market model projection with regional Forest Service harvest unaffected by roadless withdrawals (Adams, Darius M., and Richard W. Haynes. 1978. A preliminary description of the 1980 timber assessment softwood market model. Report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.).

[4] RPA Timber Assessment softwood market model projection with regional Forest Service harvest changed by the same proportion as the proportional change between the harvest levels of the base and each alternative.

Table 18--Real stumpage price assumptions for the Willamette National Forest

Decade	Price assumption 1[1] (constant prices)			Price assumption 2[3] (increasing prices)			Price assumption 3[4] (increasing prices)		
	Base	50 percent withdrawn[2]	100 percent withdrawn[2]	Base	50 percent withdrawn[2]	100 percent withdrawn[2]	Base	50 percent withdrawn[2]	100 percent withdrawn[2]
	Dollars per thousand board feet								
1	204.38	207.61	208.00	267.87	270.56	273.62	267.87	264.79	296.41
2	204.38	207.61	208.00	358.15	356.83	359.92	358.15	350.74	383.98
3	204.38	207.61	208.00	409.02	411.58	414.14	409.02	404.06	430.89
4	204.38	207.61	208.00	454.22	456.66	459.60	454.22	447.92	470.11
5	204.38	207.61	208.00	495.52	495.85	498.96	495.52	464.08	497.09
6	204.38	207.61	208.00	527.37	527.37	530.68	527.25	493.36	528.68
7	204.38	207.61	208.00	527.25	527.37	530.68	527.25	493.36	528.68
8	204.36	207.61	208.00	527.25	527.37	530.68	527.25	493.36	528.68
9	204.36	207.61	208.00	527.25	527.37	530.68	527.25	493.36	528.68
10	204.36	207.61	208.00	527.25	527.37	530.68	527.25	493.36	528.68

[1] High bid values reported by the Forest.

[2] Percent of total roadless acreage removed from the timber management land base.

[3] RPA Timber Assessment softwood market model projection with regional Forest Service harvest unaffected by roadless withdrawals (Adams, Darius M., and Richard W. Haynes. 1978. A preliminary description of the 1980 timber assessment softwood market model. Report on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.)

[4] RPA Timber Assessment softwood market model projection with regional Forest Service harvest changed by the same proportion as the proportional change between the harvest levels of the base and each alternative.

Appendix B

Table 19--Annual real per capita income growth rate, Oregon and Washington

Year	1971	1980	1985	1990	2000	2020
			Percent			
1970	1.297	3.202	3.018	2.934	2.900	2.739
1971	--	3.416	3.142	3.021	2.956	2.768
1980	--	--	2.651	2.667	2.750	2.623
1985	--	--	--	2.682	2.783	2.619
1990	--	--	--	--	2.833	2.609
2000	--	--	--	--	--	2.497

Appendix C

DOCUMENTATION OF ROAD COSTS AND ASSUMPTIONS AND SILVICULTURAL COSTS FOR EACH STUDY FOREST

ROAD COSTS AND ASSUMPTIONS

Some of the road costs are also presented in table 2; however, a more thorough documentation of the assumptions behind road costs for each Forest follows.

Siskiyou National Forest

Table 20 shows the road miles and costs expected for development of the roadless area on the Siskiyou National Forest. The table shows that development of the half of the roadless area most likely to remain in the timber base would require substantially more roads than would development of the other roadless half. This difference reflects varying requirements for logging systems found on the two areas. Below are described the different logging systems used as well as other important assumptions behind the numbers shown in table 20.

Table 20--Road miles and costs if the roadless area remains in the timber base and roads are constructed on the roadless area of the Siskiyou National Forest

Road miles and costs	Area 2[1]	Area 3[2]	Total
Road construction (miles)	417.0	247.0	664.0
Construction, including engineering (million dollars)	34.9	21.1	56.0
1 reconstruction of the total system, including engineering (million dollars)	8.0	4.8	12.8
Maintenance of total system for 1 decade (million dollars)	5.8	3.5	9.3

[1] Area 2 contains the half of the roadless area remaining in the timber base in the partial withdrawal alternative.

[2] Area 3 contains the half of the roadless area that would be removed in the partial withdrawal alternative.

Construction

The road network needed for development of the roadless area would take 40 years to complete. In the first decade, only 20 percent of the development is expected to take place because of time needed for area reconnaissance and preparation of development plans; 30 percent of the development is expected to take place in each of the second and third decades; and the final 20 percent in the fourth decade. The density of roads in a given area will vary by the log yarding system used. Total construction and reconstruction costs take into account that part of the road system will be of all-weather standard and part will be of seasonal standard.

A necessary component of developing total construction costs were the road miles to square mile ratios (existing road areas average about 2.6 miles/square mile). These ratios were applied in each roadless area to calculate miles of road needed for development.

Logging system	All-weather roads	Seasonal roads	Total
	(Road miles/square mile)		
Highlead and short span skyline	2.0	2.0	4.0
Long span skyline	1.3	.7	2.0
Helicopter	.6	.4	1.0

If the total roadless area were removed from the timber harvest base, it might be necessary to build additional roads in the currently accessible area to connect some ends of the existing road system for administrative purposes; 35 miles of additional roads may be needed to accomplish these ends.

If half the roadless area is removed from the timber harvest base, about 25 miles of additional roads may be needed.

Reconstruction

It is assumed that each mile of road is reconstructed within 20 years after original construction. It is further assumed that road standards will remain the same when reconstruction takes place. Average reconstruction costs for all standards are assumed to be approximately $19,300 per mile, including engineering costs (at 1978 prices). Applying this average to one reconstruction of the entire road system necessary to develop the roadless area results in a total reconstruction cost of $12,800,000.

If the roadless area is not developed, savings will be offset somewhat by reconstruction of the 25 and 35 additional road miles required in the currently accessible area if 50 percent and 100 percent, respectively, of the roadless area is removed from the timber base.

Maintenance

In the first four decades, each mile of road constructed in the development of the roadless area will require an average of 20 years of maintenance; roads built in the 1st year will be maintained for 40 years, and roads built in the last year will be maintained for 1 year.

If the total roadless area is removed from the timber harvest base, maintenance impacts on the area with roads include the 35 additional miles of road.

If only half the roadless area is removed from the timber base, maintenance impacts on the area with roads include maintenance of the 25 additional miles of road built.

Umatilla National Forest

Table 21 shows road miles and costs expected for development of the roadless area on the Umatilla National Forest. A total of 657 miles of new road construction would be required to develop the roadless area; of this, 360 miles would be built in that part of the roadless area considered most likely to remain in the base if 50 percent of the roadless area were withdrawn, and 297 miles would be built in that part of the roadless area considered most likely to be withdrawn from the base.

Table 21--Road miles and costs if the roadless area remains in the timber base and roads are constructed on the roadless area of the Umatilla National Forest

Road miles and costs	Area 2[1]	Area 3[2]	Total
Road construction (miles)	360.0	297.0	657.0
Construction, including engineering (million dollars)	18.8	16.9	35.7
1 reconstruction of the total system, including engineering (million dollars)	2.5	2.2	4.7
Maintenance of total system for 1 decade (million dollars)	3.2	2.7	5.9

[1]Area 2 contains the half of the roadless area remaining in the timber base in the partial withdrawal alternative.

[2]Area 3 contains the half of the roadless area that would be removed in the partial withdrawal alternative.

Construction

The road network needed for development of the roadless area is expected to be built in the next 40 years. Costs of construction vary widely by road standards and land characteristics, but for the purposes of this study, an average cost of $54,400 per mile is used for the entire road network planned for the roadless area. This average cost includes engineering costs as well as the actual construction costs.

The capital investment schedule for road construction and the cost per decade follow:

Decade	Roads constructed	Construction cost
	(Percent)	(Dollars)
1	40	14,298,000
2	25	8,936,000
3	20	7,149,000
4	15	5,362,000
	100	35,745,000

Table 21 shows how the total cost is divided between the two roadless area halves used in the partial withdrawal alternative.

Reconstruction

Road reconstruction was assumed to take place in the 20th year after initial construction. Reconstruction costs of nonpaved roads were assumed to 10 percent of the initial construction cost.

Average reconstruction costs for all standards of roads, paved as well as nonpaved, was $7,209 per mile, including engineering cost. Applying this average to one reconstruction of the entire road system needed to develop the roadless area results in a total reconstruction cost of $4,736,000. Costs per decade for the reconstruction are:

Decade	Cost
	(Dollars)
1	0
2	0
3	1,894,000
4	1,184,000
5+	1,658,000

Maintenance

Maintenance costs are annual costs based on hauling timber. Once the road system is in place, it will cost $591,300 per year to maintain it. Table 21 shows the decadal cost of maintenance. Costs for the first four decades, when the road system is not entirely in place, are:

Decade	Cost
	(Dollars)
1	1,306,000
2	3,192,000
3	4,513,000
4	5,537,000

Willamette National Forest

Table 22 shows road miles and costs expected for development of the roadless area on the Willamette National Forest. A total of 488 miles of road construction will be required to develop the roadless area access system. If only half the roadless area is developed, 277 miles of new road construction will be necessary.

Construction

The road network for the roadless area is expected to be developed in the next 40 years. Costs of construction vary by road standards, topography, soil conditions, and other factors. The average cost per mile for the total 488-mile system is $116,434.

Table 22--Road miles and costs if the roadless area remains in the timber base and roads are constructed on the roadless area of the Willamette National Forest

Road miles and costs	Area 2[1]	Area 3[2]	Total
Road construction (miles)	277.0	211.0	488.0
Construction, including engineering (million dollars)	32.4	24.4	56.8
1 reconstruction of the total system, including engineering (million dollars)	7.8	5.9	13.7
Maintenance of total system for 1 decade (million dollars)	1.7	1.3	3.0

[1]Area 2 contains the half of the roadless area remaining in the timber base in the partial withdrawal alternative.

[2]Area 3 contains the half of the roadless area that would be removed in the partial withdrawal alternative.

The capital investment schedule for road construction and the cost per decade for total development follow:

Decade	Roads constructed	Cost
	(Percent)	(Dollars)
1	32	20,410,000
2	35	18,810,000
3	21	11,220,000
4	12	6,380,000
		56,820,000

Table 22 shows how the $56,820,000 construction costs are divided between the roadless area halves.

If roads are built in the roadless area, this will also produce changes in the rate of road construction and thus in the timing of costs in already accessible area. Analysis of these changes showed that although the timing would change, costs over the four decade period would not change significantly if the roadless area remains undeveloped.

Reconstruction

Road reconstruction was assumed to progress at an annual rate of 5 percent of the total miles of roads. These costs are zero in the first decade, then gradually increase until the entire road system is built, at which time they level off. Reconstruction costs were assumed to be $28,000 per mile. Reconstruction costs of roads constructed in the roadless area for the first four decades totaled $10,100,000. Costs per decade for the first reconstruction are:

Decade	Cost
	(Dollars)
1	0
2	1,209,000
3	3,514,000
4	5,377,000
5+	3,564,000

The costs of reconstruction in the roadless area is partly offset by $4,770,000 saved over four decades by a lower rate of reconstruction in the presently accessible area.

Maintenance

Road maintenance is assumed to take place annually over the entire road system. The total average annual maintenance cost was estimated at $600 per mile and was based on the sum of nontraffic generated maintenance costs of $150 per mile and traffic generated maintenance costs of $450 per mile. For the roadless area, the total annual maintenance charge would be the accumulated miles of road completed times $600. If the road system is developed for the total roadless area, it will cost $3 million per decade to maintain.

Total costs for four decades for nontraffic generated maintenance in the roadless area will be $1,763,000. This will be offset by savings of $602,000 in the accessible area. The four-decade costs for traffic generated maintenance are the difference between maintenance costs for the roadless area and for the accessible area--$2,668,000.

Logging and hauling cost differences between the roadless area and the currently accessible area need to be considered in addition to road costs. Differences in types of harvesting systems needed on the two areas indicate that stump to truck costs will be greater on the roadless area. Hauling costs will also be greater on the roadless area because of the greater distance from mills. These cost differences are reflected in the stumpage price differentials between the roadless area and the currently accessible area (table 2).

Table 23--Silvicultural costs[1] for the study Forests

Item	National Forest		
	Siskiyou	Umatilla	Willamette
Reforestation cost per nonstocked acre (dollars/acre)	200.00	160.00	312.00
Reforestation cost per cutover acre (dollars/acre)	170.00	160.00	204.00
Restocking cost per acre, brushfield conversion (dollars/acre)	526.00	--	--
Precommercial thinning (dollars/acre)	127.00	75.00	87.00
Release (dollars/acre)	60.00	12.50	12.50
Timber sale cost (dollars/thousand cubic feet)	31.10	53.75	16.82

[1]Costs are average; all acres are assumed to be in the base.

Appendix D

SUMMARY AND DETAILED FINANCIAL CONSEQUENCES FOR STUDY FORESTS WHEN PROPORTIONAL CHANGES IN HARVEST ON OTHER NATIONAL FORESTS ARE ASSUMED

Table 24--Change in present net worth and payments to counties between the base programed harvest and the reallocation alternatives[1]

Forest and alternative	Change in PNW[2]	Change in payments to counties[3]
	Million dollars	Million dollars per year
Siskiyou National Forest:		
50 percent of roadless area withdrawn	-33.1	-0.7
100 percent of roadless area withdrawn	-129.2	-2.7
Umatilla National Forest:		
50 percent of roadless area withdrawn	6.7	-.2
100 percent of roadless area withdrawn	12.7	-.4
Willamette National Forest:		
50 percent of roadless area withdrawn	74.1	.9
100 percent of roadless area withdrawn	-39.4	-1.0

[1] Trends in real prices expected with proportional changes in harvests on other National Forests and expected trends in real costs were used.

[2] Present net worth for 10 decades at 5-percent interest rate.

[3] Payments to counties are averages for the first 4 decades.

Table 25--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Siskiyou National Forest[1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	44.9	-5.8	-14.9
2. Gross revenue (million dollars per year)	67.9	-2.8	-10.6
3. Cost of roads (million dollars per year)	NA	-.7	-2.1
4. Cost of cultural treatments (million dollars per year)	NA	.2	-.7
5. Cost of selling timber (million dollars per year)	NA	-.4	-.9
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	-1.9	-6.9
7. Payments to counties (million dollars per year)	17.0	-.7	-2.7
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	-33.1	-129.2
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	-13.8	-54.4

NA = not available.

[1] Trends in real stumpage prices expected with proportional changes in harvest on other Douglas-fir region National Forests in the Pacific Northwest and expected trends in real costs were used.

Table 26--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Umatilla National Forest[1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	26.2	-2.2	-4.5
2. Gross revenue (million dollars per year)	17.1	-.7	-8.2
3. Cost of roads (million dollars per year)	NA	-.6	-1.3
4. Cost of cultural treatments (million dollars per year)	NA	-.1	-.3
5. Cost of selling timber (million dollars per year)	NA	-.3	-.5
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	.3	.6
7. Payments to counties (million dollars per year)	4.3	-.2	-.4
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	6.7	12.7
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	4.2	8.2

NA = not available.

[1] Trends in real stumpage prices expected with proportional changes in harvest on other ponderosa pine region National Forests in the Pacific Northwest and expected trends in real costs were used.

Table 27--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Willamette National Forest[1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	115.4	3.2	-12.5
2. Gross revenue (million dollars per year)	232.2	3.6	-4.1
3. Cost of roads (million dollars per year)	NA	-1.0	-1.7
4. Cost of cultural treatments (million dollars per year)	NA	.7	-.1
5. Cost of selling timber (million dollars per year)	NA	.3	-.1
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	3.6	-2.2
7. Payments to counties (million dollars per year)	58.1	.9	-1.0
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	74.1	-39.4
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	35.5	-19.4

NA = not available.

[1] Trends in real stumpage prices expected with proportional changes in harvest on other Douglas-fir region National Forests in the Pacific Northwest and expected trends in real costs were used.

Appendix E

SUMMARY AND DETAILED FINANCIAL CONSEQUENCES FOR STUDY FORESTS WHEN CONSTANT REAL PRICES AND CONSTANT REAL COSTS ARE ASSUMED

Table 28--Change in present net worth and payments to counties between the base programed harvest and the reallocation alternatives[1]

Forest and alternative	Change in PNW[2]	Change in payments to counties[3]
	Million dollars	Million dollars per year
Siskiyou National Forest:		
50 percent of roadless area withdrawn	-69.5	-1.0
100 percent of roadless area withdrawn	-164.7	-2.7
Umatilla National Forest:		
50 percent of roadless area withdrawn	5.4	-.1
100 percent of roadless area withdrawn	11.0	-.3
Willamette National Forest:		
50 percent of roadless area withdrawn	122.0	1.4
100 percent of roadless area withdrawn	-155.8	-2.2

[1] Constant real prices and constant real costs were used.

[2] Present net worth for 10 decades with 5-percent interest rate.

[3] Payments to counties are averages for the first 4 decades.

Table 29--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Siskiyou National Forest[1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	44.9	-5.8	-14.9
2. Gross revenue (million dollars per year)	37.4	-4.2	-11.0
3. Cost of roads (million dollars per year)	NA	-.7	-2.1
4. Cost of cultural treatments (million dollars per year)	NA	.1	-.4
5. Cost of selling timber (million dollars per year)	NA	-.2	-.5
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	-3.4	-8.0
7. Payments to counties (million dollars per year)	9.3	-1.0	-2.7
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	-69.5	-164.7
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	-36.4	-86.0

NA = not available.

[1]Constant real stumpage prices and real costs were used.

Table 30--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Umatilla National Forest [1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	26.2	-2.2	-4.5
2. Gross revenue (million dollars per year)	10.2	-.6	-1.3
3. Cost of roads (million dollars per year)	NA	-.6	-1.3
4. Cost of cultural treatments (million dollars per year)	NA	-.1	-.2
5. Cost of selling timber (million dollars per year)	NA	-.2	-.3
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	.3	.5
7. Payments to counties (million dollars per year)	2.6	-.1	-.3
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	5.4	11.0
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	3.2	6.7

NA = not available.

[1] Constant real stumpage prices and real costs were used.

Table 31--Four-decade average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management, Willamette National Forest[1]

Item	Base programed harvest	Change when 50 percent of the roadless area is withdrawn	Change when 100 percent of the roadless area is withdrawn
1. Harvest (million cubic feet per year)	115.4	3.2	-12.5
2. Gross revenue (million dollars per year)	127.8	5.6	-8.9
3. Cost of roads (million dollars per year)	NA	-1.0	-1.7
4. Cost of cultural treatments (million dollars per year)	NA	.6	-.1
5. Cost of selling timber (million dollars per year)	NA	.2	-.1
6. Net revenue--item 2 minus items 3, 4, and 5 (million dollars per year)	NA	6.8	-7.0
7. Payments to counties (million dollars per year)	32.0	1.4	-2.2
8. Present net worth for 10 decades at 5 percent (million dollars)	NA	122.0	-155.8
9. Present net worth for 10 decades at 10 percent (million dollars)	NA	61.1	-93.9

NA = not available.

[1] Constant real stumpage prices and real costs were used.

Appendix F

EMPLOYMENT CONSEQUENCES FOR THE SISKIYOU, UMATILLA, AND WILLAMETTE NATIONAL FORESTS, JULY 28, 1978

Siskiyou National Forest[1]

Harvest alternative	Deviations from actual employment	Deviations from opportunities to increase employment	Total
50 percent of roadless area withdrawn from timber base--no reallocation of funds	0	-780	-780
50 percent of roadless area withdrawn from timber base--reallocation of funds	0	-780	-780
100 percent of roadless area withdrawn from timber base--no reallocation of funds	-944	-1,066	-2,010
100 percent of roadless area withdrawn from timber base--reallocation of funds	-944	-1,066	-2,010

[1]Base programed harvest level of employment is 6,067 attributable to a base harvest level of 215.466 million board feet per year; actual employment level is 5,001 attributable to a recent harvest (average annual chargeable harvest for 1968-77) of 177.6 million board feet per year.

Umatilla National Forest[1]

Harvest alternative	Deviations from actual employment	Deviations from opportunities to increase employment	Total
50 percent of roadless area withdrawn from timber base--no reallocation of funds	-4	-257	-261
50 percent of roadless area withdrawn from timber base--reallocation of funds	0	-251	-251
100 percent of roadless area withdrawn from timber base--no reallocation of funds	-268	-257	-525
100 percent of roadless area withdrawn from timber base--reallocation of funds	-264	-257	-521

[1]Base programed harvest level of employment is 3,016 attributable to a base harvest level of 169.229 million board feet per year; actual employment level is 2,758 attributable to a recent harvest (average annual chargeable harvest for 1968-77) of 154.8 million board feet per year.

Willamette National Forest[1]

Harvest alternative	Deviations from actual employment	Deviations from opportunities to increase employment	Total
50 percent of roadless area withdrawn from timber base--no real allocation of funds	0	-834	-834
50 percent of roadless area withdrawn from timber base--reallocation of funds	0	502	502
100 percent of roadless area withdrawn from timber base--no reallocation of funds	-1,058	-921	-1,979
100 percent of roadless area withdrawn from timber base--reallocation of funds	-1,058	-921	-1,979

[1]Base programed harvest level of employment is 18,215 attributable to a base harvest level of 625.439 million board feet per year; actual employment level is 16,732 attributable to a recent harvest (average annual chargeable harvest for 1968-77) of 574.52 million board feet per year.

Appendix G

ROADLESS AREAS IN THIS STUDY, BY FOREST

ROADLESS AREAS, SISKIYOU NATIONAL FOREST

The 50-percent roadless area alternative contained some roadless areas that subsequently came under the Endangered American Wilderness Act (U.S. Laws, Statutes, etc. Public Law 95-237, 1978) and parts of other roadless areas that remain in RARE II. A map showing these areas is on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

NAMES OF ROADLESS AREAS, UMATILLA NATIONAL FOREST

Hellhole	Jumpoff Joe
Owsley	Battle Creek
Horseshoe Ridge	Kelly
Lookingglass	Texas Butte
Mt. Emily	Walla Walla River[1]
Big Sinks	North Fork Umatilla[1]
South Fork	Grande Ronde[1]
Tower	North Fork John Day[1]
	Greenhorn Mountain[1]

[1]In the 50-percent alternative, these areas are withdrawn from the timber base and remain roadless.

NAMES OF ROADLESS AREAS, WILLAMETTE NATIONAL FOREST

Little North Santiam[1]	Browder[1]
Elkhorn	Smith Reservoir
Middle Santiam	McLennen Mountain
Pyramids	Walker Creek[1]
Moose Lake	French Pete[1]
Rooster Rock	Rebel Creek[1]
Echo Mountain[1]	Chucksney Mountain[1]
Gordon Meadows	Maiden Peak[2]
Jumpoff Joe	Packard Creek
	Timpanogas[1]

[1]In the 50-percent alternative these areas are withdrawn from the timber base and remain roadless.

[2]Only the Waldo Lake Recreation Area portion of the Maiden Peak roadless area remains roadless (46,077 acres) in the 50-percent alternative.

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Within this overall mission, the Station conducts and stimulates research to facilitate and to accelerate progress toward the following goals:

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Mailing address: Pacific Northwest Forest and Range Experiment Station
809 N.E. 6th Ave.
Portland, Oregon 97232

Randall, Robert M., Roger D. Fight, Kent P. Connaughton, Robert W. Sassaman, and K. Norman Johnson.
1979. Roadless area-intensive management trade-offs on Pacific Northwest National Forests. USDA For. Serv. Res. Pap. PNW-258, 69 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This study tested the hypothesis that timber harvest levels could be maintained on selected Pacific Northwest National Forests without harvesting from roadless areas, if resources saved by not developing the roadless areas were used for more intensive timber management on the remaining land. The study also examined the employment, financial, environmental, and multiple use implications if such a course of action were followed.

KEYWORDS: Wilderness management, land use, policy (forest), intensive management, economic evaluation.

GPO 989-174

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