roadless area-intensive management tradeoffs on western national forests

Roger D. Fight
K. Norman Johnson
Kent P. Connaughton
Robert W. Sassaman

revised october 1978

The Willamette National Forest programed harvest figures and the financial and employment figures developed from them were found to be incorrect for some of the alternatives in the original report dated July 1978. This revision is being published to correct those figures.

THE AUTHORS--Roger D. Fight is principal economist, 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. Kent P. Connaughton and Robert W. Sassaman are economists, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This report was requested by John McGuire, Chief, U.S. Forest Service. Five National Forest System Regions and four Forest Service Experiment Stations participated in the study. The principal contributor from each Region was: Northern Region, Robert Meuchel, Lolo National Forest, Missoula, Montana; Rocky Mountain Region, Howard (Bud) Hittenrauch, San Juan National Forest, Durango, Colorado; Intermountain Region, Robert Cottingham, Regional Office, Ogden, Utah; California Region, Klaus Barber, Regional Office, San Francisco, California; and Pacific Northwest Region, Alfred Burkhardt, Regional Office, Portland, Oregon. The principal contributor from each Experiment Station not authoring the report was: Intermountain Forest and Range Experiment Station, Enoch Bell, Missoula, Montana; Pacific Southwest Forest and Range Experiment Station, Robert Hrubes, Berkeley, California; and Rocky Mountain Forest and Range Experiment Station, Thomas Brown, Flagstaff, Arizona.

ROADLESS AREA-INTENSIVE MANAGEMENT TRADEOFFS ON WESTERN NATIONAL FORESTS

Roger D. Fight
K. Norman Johnson
Kent P. Connaughton
Robert W. Sassaman

1978

Western Resource Policy Economics Research
USDA Forest Service

TABLE OF CONTENTS

SUMMARY

Building roads in National Forest roadless areas to facilitate timber harvest and attainment of other multiple use objectives involves a substantial capital investment. It has been suggested that it would be better to reallocate those capital resources to timber management practices like reforestation, release, and thinning in the areas outside the roadless areas. Kutay suggests it might be possible to produce as much or more timber and keep the roadless areas for Wilderness or other uses.[1/]

The primary objective of this study was to test the hypothesis that as much timber could be harvested without harvesting from the roadless areas if the resources saved by not developing the roadless areas were used for more intensive timber management on the remaining land. Secondary objectives were to estimate the employment, financial, environmental, and multiple use implications if such an alternative were adopted. The intent was to perform the analysis with procedures that closely simulate how the alternatives would be implemented under current Forest Service policies and planning methods. 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. If some of these constraints were changed the results might be very different.

The seven Western National Forests included in the study and shown in figure 1 are: Bridger-Teton, Lolo, San Juan, Sierra, Siskiyou, Umatilla, and Willamette. Five of the seven Western Regions have at least one study Forest.

The acreage assumptions used in this analysis are shown in table 1. The acreage of roadless area for this study exceeds the acreage of RARE II roadless areas by a significant amount on four of the study Forests. This results primarily because the land base for this study was not reduced to reflect land allocations in recent land use decisions or Wilderness designations in the Endangered American Wilderness Act of 1978.

For each study Forest a direct test of the hypothesis was made by calculating two harvest levels: one with Forest planned levels of intensive timber management and with all roadless areas available for

---

1/ Kurt Kutay. Oregon economic impact assessment of proposed Wilderness legislation. April 1977.

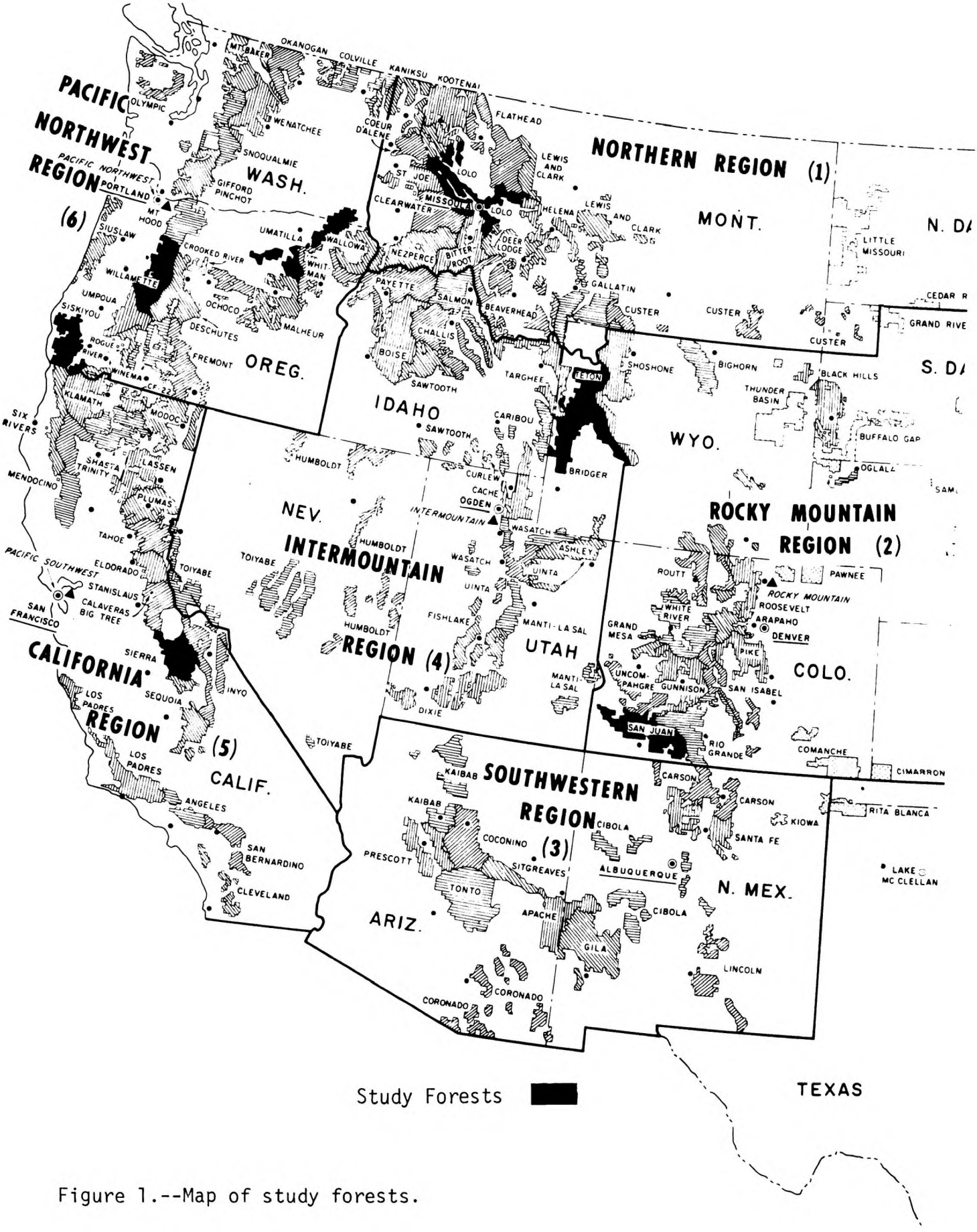


Figure 1.--Map of study forests.

timber harvest (the base alternative) and one with roadless areas withdrawn and road savings reallocated to further intensify timber management on the remaining land (the reallocation alternative). Forest planned levels of intensification are levels that the Forests 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. This report includes a discussion of the alternative harvest levels for each Forest.

On two of the six study Forests for which an alternative was prepared with half the roadless area withdrawn, more than half of the regulated commercial forest land of the roadless areas was removed with the first half withdrawn. On the other four of those six Forests, less than half of the regulated commercial forest land of the roadless areas was removed (table 1).

PRIMARY STUDY FINDING

THE HARVEST THAT COULD BE PROGRAMED IN THE FIRST DECADE WITH ALL THE ROADLESS AREA IN THE LAND BASE COULD NOT BE ACHIEVED ON ANY STUDY FOREST WITH ALL OF THE ROADLESS AREA WITHDRAWN THROUGH REALLOCATION OF COST SAVINGS TO MORE INTENSIVE TIMBER MANAGEMENT. WITH ONLY HALF OF THE ROADLESS AREA WITHDRAWN THE BASE PROGRAMED HARVEST COULD BE ACHIEVED THROUGH REALLOCATION ON ONLY ONE STUDY FOREST (table 2). With half or all of the roadless area withdrawn, funds for intensive management are generally not the principal constraint that limits the harvest that can be programed in the first decade. The protection of environmental and multiple use values often imposes a constraint on the extent and proximity of harvesting with half or all of the roadless areas withdrawn which restricts the level of harvest on the reduced land base. This constraint is becoming progressively more important as the limitations on logging roadless areas continue to concentrate the current harvest on this reduced base. Where funds for intensive management are not the principal constraint because environmental and multiple use constraints are overriding, increases in harvest from additional intensive management activities will be delayed to future decades. Sometimes funds for intensive management did not limit the harvest because there were no further intensive management activities identified. When there are no additional intensive management opportunities reallocating more funds for intensive management will not increase the harvest.

Table 1--*National Forest land areas*

(Thousand acres)

Item	Bridger-Teton	Lolo	San Juan	Sierra	Siskiyou	Umatilla	Willamette
National Forest System acres on forest	3,400	2,091	1,867	1,288	1,092	1,394	1,675
Regulated CFL acres on Forest[1/]	1,067	1,500	681	357	758	716	1,171
National Forest System acres in roadless areas	1,758	758	747	352	436	435	280
National Forest System acres in RARE II areas ("net acres")	1,750	682	743	351	340	413	174
Regulated CFL acres in roadless areas[1/]	724	430	243	50	275	158	195
Regulated CFL acres in first half of roadless area withdrawn[1/]	NA	204	99	36	122	91	85

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

Table 2--*Alternative harvests and recent harvest on study Forests*[1/]

Alternatives	Bridger-Teton	Lolo	San Juan	Sierra	Siskiyou	Umatilla	Willamette
	Volume (MMCF/year)						
Programed harvest:							
All roadless in the base[2/]	8.0	48.8	17.3	27.0	44.9	26.2	115.4
50-percent withdrawn, no reallocation	NA	42.3	16.0	23.7	39.1	23.9	109.9
50-percent withdrawn, with reallocation	NA	43.2	16.4	26.1	39.1	24.0	118.6
100-percent withdrawn, no reallocation	2.7	30.5	12.3	22.7	30.0	21.7	102.8
100-percent withdrawn, with reallocation	2.7	35.4	12.7	24.9	30.0	21.7	102.8
Potential yield:							
All roadless in the base[2/]	17.7	49.6	29.4	29.8	59.4	31.2	157.4
50-percent withdrawn	NA	43.2	25.1	26.1	51.9	27.3	146.3
100-percent withdrawn	5.9	35.4	17.8	24.9	39.8	24.3	134.1
Recent harvest	8	34	15	20	38	24	106

[1/] Programed harvests, as used in this study, and potential yields exclude material from unregulated areas and all dead material. Recent harvest is the average chargeable harvest for 1968-1977. It excludes harvests from unregulated areas and generally excludes salvaged dead material that is considered to be endemic mortality.

[2/] The base alternative not only assumes that all of the roadless areas are in the land base. It also assumes that there are no restrictions on entering the roadless areas. In addition the budget for intensive management is limited to the level assumed in the Forest's most recent planning effort.

NA = Not available.

OTHER HARVEST CONSEQUENCES

(I) THE RECENT HARVEST[2/] ON SIX OF THE SEVEN STUDY FORESTS IS BELOW THE LEVEL THAT COULD BE PROGRAMED WITH CURRENTLY PLANNED INVESTMENT LEVELS AND CURRENT MULTIPLE USE CONSTRAINTS WITH ALL OF THE ROADLESS AREAS IN THE BASE. WITH HALF OF THE ROADLESS AREA WITHDRAWN THAT RECENT LEVEL OF HARVEST COULD BE MAINTAINED OR EXCEEDED ON THOSE SIX STUDY FORESTS. AND WITH ALL OF THE ROADLESS AREA WITHDRAWN IT COULD BE MAINTAINED OR EXCEEDED ON TWO OF THE STUDY FORESTS (table 2). Recent harvests generally were less than could now be programed with all roadless areas in the base, for a variety of reasons including some of the following:

1. The recent harvest was based on a plan 10-15 years old; this study was based on newer inventories and planning assumptions.

2. Lack of markets reduced the volume of timber sold and harvested.

3. The timber sale budget limited the volume sold.

4. Roadless areas under formal study for Wilderness were removed by the Forest from the harvest base.

5. Locating cutting areas was difficult because of being restricted to the "accessible" portion of the Forest and having some of the proposed sale areas challenged by the public.

(II) POTENTIAL YIELD WAS REDUCED ON ALL FORESTS WHEN HALF OR ALL OF THE ROADLESS AREA WAS WITHDRAWN (table 2). These reductions were often quite 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

---

[2/] 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 from live green trees on regulated lands to local merchantability limits.

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.

(III) REDUCTIONS IN POTENTIAL YIELD ON THE STUDY FORESTS WERE VERY NEARLY PROPORTIONAL TO REDUCTIONS IN REGULATED COMMERCIAL FOREST LAND ACRES (table 3). This reduction as a percentage of the base potential yield ranges from 15 percent on the Willamette National Forest to 67 percent on the Bridger-Teton National Forest. THE REDUCTIONS IN PROGRAMED HARVEST VARY SOMEWHAT IN COMPARISON WITH THE REDUCTIONS IN REGULATED COMMERCIAL FOREST LAND. On the Bridger-Teton, Sierra, and Siskiyou the reductions in programed harvest were very nearly proportional to the reduction in commercial forest land. On the San Juan, Umatilla, and Willamette the reductions were substantially less than the reductions in commercial forest land. And on the Lolo the reduction was substantially more than the reduction in commercial forest land (table 3).

FINANCIAL CONSEQUENCES

The financial and employment effects of withdrawing roadless areas and reallocating funds to more intensive management of the remaining land are shown for most study Forests. The results included in the text were developed using expected trends in real stumpage prices when no changes in harvest occur on any National Forest except the one being analyzed. They also use expected trends in real costs. Two other sets of financial calculations are included in an appendix and summarized in the text to help in interpretation of the results.

Table 4 shows the effects of the key alternatives on present net worth and receipts to counties. ON TWO OF THE SIX FORESTS FOR WHICH A COMPLETE ANALYSIS IS AVAILABLE, THE WILLAMETTE AND THE SISKIYOU, THE CHANGES IN FINANCIAL VALUES WITH ROADLESS AREA WITHDRAWALS WERE QUITE LARGE. ON TWO MORE FORESTS, THE LOLO AND THE SIERRA, THE CHANGES IN FINANCIAL VALUES WERE MODERATE. ON THE REMAINING TWO FORESTS, THE SAN JUAN AND THE UMATILLA, THE CHANGES IN FINANCIAL VALUES WERE SMALL. THERE WERE TWO SITUATIONS WHERE PRESENT NET WORTH INCREASED WHEN ROADLESS AREAS WERE WITHDRAWN AND FUNDS REALLOCATED TO INTENSIFY TIMBER MANAGEMENT: THE WILLAMETTE WHEN HALF OF THE ROADLESS AREA WAS WITHDRAWN AND THE SAN JUAN WHEN HALF OR ALL OF THE ROADLESS AREA WAS WITHDRAWN. This information must be combined with a subjective evaluation of the nontimber consequences and unaccounted for costs in order to reach firm conclusions about the economic efficiency of the alternatives.

The changes in present net worth are sensitive to the price assumption used. When expected trends in real prices and costs were replaced with constant real prices and costs, present net worths increased when the roadless areas were withdrawn on the Sierra and Umatilla National Forests as well as on the San Juan and on the Willamette with half of

Table 3--*Comparison of reductions in regulated commercial forest land (CFL) acres and harvest volume when roadless areas are withdrawn*

	National Forest						
	Bridger-Teton	Lolo	San Juan	Sierra	Siskiyou	Umatilla	Willamette
Percent of regulated CFL acres in roadless areas	68	29	36	15	36	22	17
Percent of base potential yield from roadless areas	67	29	39	16	33	22	15
Percent of base programed harvest from roadless areas without reallocation	66	37	29	16	33	17	11

Table 4--*Change in present net worth, payments to counties, and employment between the base programed harvest and the reallocation alternatives*[1/][2/]

Forest and alternative	Change in PNW[3/] ($1,000,000)	Change in payments to counties[4/] ($1,000,000/yr)	Change in local employment related to change in timber harvest (person years/yr)
Bridger-Teton:			
50-percent withdrawn	NA	NA	NA
100-percent withdrawn	NA	-0.6	-399
Lolo:			
50-percent withdrawn	-17.1	-0.6	-421
100-percent withdrawn	-35.3	-1.5	-982
San Juan:			
50-percent withdrawn	+1.2	-0.1	-48
100-percent withdrawn	+7.6	-0.2	-233
Sierra:			
50-percent withdrawn	-0.7	-0.3	-81
100-percent withdrawn	-13.2	-0.5	-203
Siskiyou:			
50-percent withdrawn	-135.5	-2.0	-784
100-percent withdrawn	-331.7	-5.2	-2,013
Umatilla:			
50-percent withdrawn	-1.5	-0.3	-255
100-percent withdrawn	-1.9	-0.6	-530
Willamette:			
50-percent withdrawn	+163.7	+2.0	+502
100-percent withdrawn	-281.4	-4.0	-1,979

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

[2/] The recent harvest is less than the base programed harvest in most cases. In those cases part or all of these impacts represent reductions in opportunities for increases rather than reductions from actual levels.

[3/] Present net worth for ten decades with 5-percent interest rate.

[4/] Payments to counties are averages for the first four decades in 1978 constant dollars.

NA = Not available.

the roadless area withdrawn. And the reductions in present net worth on the remaining Forests were about half what they were with expected trends in real prices and costs (Appendix A). If roadless areas were withdrawn on all Forests simultaneously the harvest reductions might result in price increases that were large enough to cause present net worths to increase when roadless areas were withdrawn on all of the study Forest outside the Douglas-fir region. And changes in present net worths on the remaining Forests would be even less than with constant prices and costs (Appendix B).

EMPLOYMENT CONSEQUENCES

CHANGES IN EMPLOYMENT RELATED TO CHANGES IN TIMBER HARVEST ARE QUITE VARIABLE BETWEEN FORESTS (table 4). This results both because changes in harvest vary and because the amount of employment per million cubic feet of harvest vary.

ENVIRONMENTAL AND NONTIMBER CONSIDERATIONS

This report includes a general discussion of the tradeoffs in environmental conditions and nontimber benefits 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 multiple use tradeoffs of many kinds associated with these alternatives. Table 5 shows that major impacts are expected on at least one study Forest for 14 of the 16 environmental and nontimber criteria when the reallocation alternative is substituted for the base alternative.

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 National Forests in the West. However, this study does suggest that there is only limited ability to substitute management intensification for roadless area volume on other National Forests.

Identifying National Forests that are likely candidates for this substitution is made difficult by the changing 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, budget for management intensification is a primary constraint holding down the harvest. When all roadless areas are excluded from the Willamette's harvest calculation, however, regeneration harvest acres are the primary constraint holding down the harvest. Quantification of the degree to which management intensification on the "accessible" area can substitute for roadless area volume, and the harvest impact of removing roadless areas from the harvest calculations, will require harvest calculations for each Forest using a similar analytical framework.

Table 5--Summary of estimated impacts associated with withdrawing the roadless areas ... timber management on the remaining land ... study forests

Criteria	Impacts: Beneficial		Impacts: Neutral (No change from base)	Impacts: Adverse		Critical factors(s)
	Major	Minor		Minor	Major 1/	
1. Water quality	R	R	A	A	A	Sediment
2. Water quantity		A, R	A, R		R	Acres of regeneration harvest
3. Water flow		A, R	A, R	A, R		Peak flows
4. Soil stability	R	R	A	A	A	Disturbance on difficult sites
5. Soil productivity		R	A, R	A		Soil compaction and nutrients
6. Forage production (domestic)	A	A	A	R	R	Transitory range
7. Fish populations (anadromous)		R	A		A	Water quality, favorable habitat
8. Fish populations (residential)	R	R	A		A	Water quality. favorable habitat
9. Wildlife populations (game species)	A, R	A, R	A	A, R	R	Favorable habitat
10. Wildlife populations (threatened and endangered species)	R	A, R	A, R	A		Undisturbed natural habitat
11. Opportunities for developed recreation		A	A, R	R	A, R	Potential development sites
12. Opportunities for dispersed recreation related to roads		A	A	A, R	A, R	Extent of road system
13. Opportunities for dispersed recreation away from roads	R	R	A	A	A	Extent of roadless areas
14. Visual resources	R	R	A		A	Natural-appearing areas for viewing
15. Air quality		R	A, R	A	A	Extent of slash burning
16. Mineral and energy development		A	A, R	R	R	Access

R = At least one study forest with this impact on roadless areas.

A = At least one study forest with this impact on "accessible" areas.

1/ Major adverse impacts, while undesirable, are within limits considered acceptable under the current interpretation of multiple use objectives.

HARVEST CONSEQUENCES OF ROADLESS AREA WITHDRAWALS

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.

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 "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 interrelationship with other resource uses and the environment."[3/] 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 takes full recognition of all current constraints and is a rate of harvest that could be implemented immediately. 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 reasonably be 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 likely will not be overcome.

The programed harvest for a Forest is the part of the potential yield that is scheduled for sale during a specific year. It is based on current stumpage prices, expected funding, feasible silvicultural practices, and current multiple use considerations.

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

---

[3/] Forest Service Manual, 2415.41, May 1972.

back to the Forest team of resource specialists to verify that it was a feasible schedule. In many cases it was not feasible and the team developed constraints that would make it a feasible schedule. The harvest schedule was then recalculated with those constraints.

A key study alternative is the base alternative. 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 those selected study areas would be available for timber harvest. We followed that pattern in calculating the base alternative on the Pacific Northwest Region study Forests where new timber management plans were being prepared when we requested the data. Outside the Pacific Northwest Region the RARE I selected study areas had generally been put into the RARE II inventory when we requested the data and were included as available for timber harvest in the base alternative. The big differences between our roadless area acreage and the RARE II acreage are on the Lolo, Siskiyou, Umatilla, and Willamette National Forests where the Endangered American Wilderness Act of 1978 designated as Wilderness substantial amounts of roadless areas after the study was beyond the point where these changes could be accomodated. Therefore, while these areas have been removed from the RARE II inventory they are assumed to be available for timber harvest in the base alternative. That does not seriously detract from the usefulness of our results, however, since the purpose of this study was to illustrate the tradeoffs that may occur on Western National Forests rather than to analyze a specific policy on a particular Forest.

The programed harvest of the base alternative approximates the programed harvest of live green timber of an updated timber management plan where (1) we assume the Forest planned level of intensive management and silvicultural practices, current stumpage prices, and current multiple use considerations; (2) the regulated commercial forest land shown in table 1 is the land base for regulated timber production; and (3) there are no restrictions on harvesting timber in the roadless areas. 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 as an annual harvest over several decades that is consistent with the assumptions and constraints that apply initially.

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

The second and third alternatives calculated for each Forest were based on the assumption that half of the roadless area was withdrawn from the land base available for timber management.

To withdraw half of the roadless area, it was necessary to divide it into two halves and select that part which would be withdrawn given a policy to keep 50 percent of the roadless area without roads. This was done in cooperation with National Forest personnel familiar with the roadless areas. Factors that were considered in partitioning the area included the quality of the areas for Wilderness or other unroaded uses, Congressional, administrative and public interest in particular areas, manageability, and the direct and opportunity costs of permanent roadless designation. The total roadless area was divided on the basis of total National Forest acres, not commercial forest land acres. The first half withdrawn therefore might include more than half or less than half of the commercial forest land, standing inventory, or productive potential of the roadless areas.

The programed harvest with 50 percent withdrawn and no reallocation (alternative 2) permitted intensive management activities to continue at a level not to exceed that in the base programed harvest. The alternative with 50 percent withdrawn and reallocation (alternative 3) was calculated by permitting additional intensive management above the Forest planned level of management up to the limit of funding represented by the savings available from not developing half of the roadless area.

In order to estimate the amount of funds to be reallocated to intensive management, we estimated the costs of road construction, reconstruction, and maintenance to fully develop the roadless areas. The amount reallocated was equal to those costs which were avoided by not developing the roadless areas, less any increased costs incurred in the remaining area as a result of not developing the roadless areas. As an example of these latter costs, on one Forest it was necessary to build additional roads outside the roadless areas to tie together roads that would have been linked by going through a roadless area.

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

Since the potential yield on the study Forests assumes maximum feasible funding for intensive management, there is only one potential yield for the two alternatives with half of the roadless area withdrawn.

The fourth and fifth alternatives corresponded to the second and third alternatives with the exception that all of the roadless areas were withdrawn. The definitions of the five alternatives are summarized in table 6.

Table 6--*Summary of Alternatives.*

Alternative	Roadless areas available for timber management	Funds reallocated to more intensive timber management	Harvest calculations	
			Programed harvest	Potential yield
1. Base	All	No	x	x
2. 50 percent out	Half	No	x	x
3. 50 percent out--reallocation	Half	Yes	x	same x
4. 100 percent out	None	No	x	x
5. 100 percent out--reallocation	None	Yes	x	same x

HARVEST RESULTS ON STUDY FORESTS

Willamette National Forest

The Willamette National Forest is a predominantly Douglas-fir forest on the western slopes of the central Oregon Cascades. Elevation of the Forest is from under 1,000 to over 10,000 feet. The Forest contains about 1.7 million acres of National Forest System land of which 70 percent was considered regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 280,000 acres of which 70 percent was considered to be regulated commercial forest land. This is 106,000 acres more than the RARE II inventory. This difference exists primarily because we did not reduce the land base to reflect changes in land allocations in the recent land use plan, nor for Wilderness designations in the Endangered American Wilderness Act. The average volume of chargeable harvest for the past decade was about 106 million cubic feet per year.

Figure 2 shows that potential yield is reduced by 7 percent and 15 percent respectively when half or all of the roadless area is withdrawn.

Figure 2 also shows that when half of the roadless area is withdrawn, the reduction in programed harvest can be more than offset by reallocating funds to more intensive management of the remaining land. This results because the Willamette has a substantial amount of unfunded cultural treatment opportunities and the roadless areas removed contain a lower proportion of timberland available for harvest than the forest in general. When all of the roadless area is withdrawn, there is no opportunity to offset any of the reduction. Since this latter result is in contrast to the conclusion of Kutay,[4/] some discussion of this result is in order.

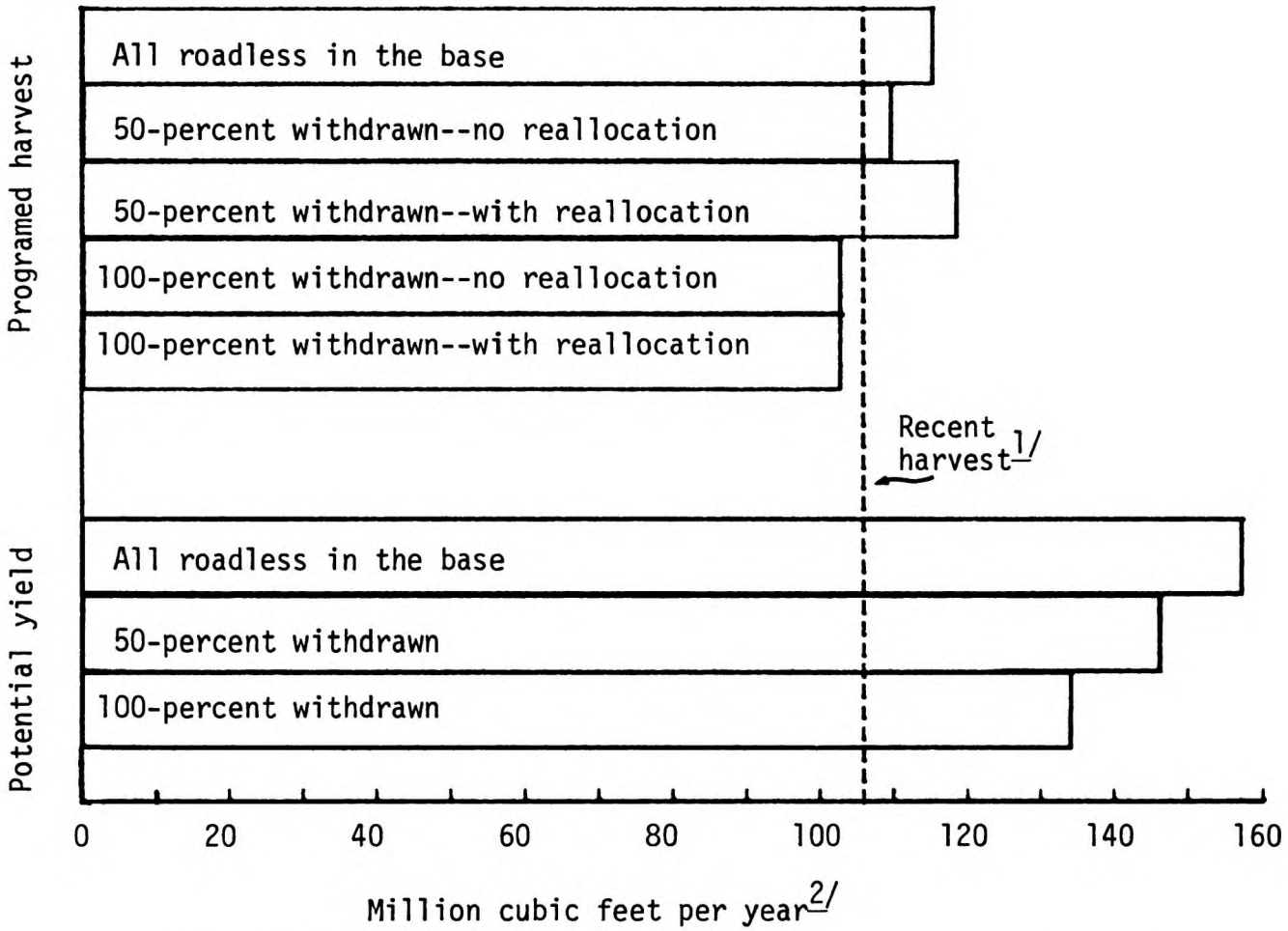
The primary constraint holding down the base programed harvest is lack of funds and manpower for investments in intensive management practices. If this constraint were overcome, the next constraint would be on the number of acres of regeneration harvest. This constraint is in response to concerns for protection of nontimber resources, especially soil, water, fish, and wildlife resources. Concentration of timber cutting in the "accessible" area, caused by lack of access to the roadless areas, plus a changing perspective on the environmental impact of timber harvesting, have caused this constraint to assume greater importance. A number of decades, perhaps five, must pass before assumed budgets again become the primary constraint on timber harvest, especially on the reduced land base that occurs when all roadless areas are withdrawn.

As line 1 of table 7 shows, the regeneration harvest acre constraint limits the first decade harvest to 130 million cubic feet per year with all roadless areas in the base, 119 million cubic feet per year with

---

[4/] See footnote 1.

Figure 2.--Alternative harvest levels
Willamette National Forest



1/ The primary reason that the recent harvest is below the base programed harvest is that for the past 3 years purchasers have chosen to harvest substantially less than the forest sold. The volume sold has been between 114 and 115 million cubic feet every year for more than 10 years.

2/ 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.

Table 7--*Detailed alternative harvests for the Willamette National Forest*

	Base	50-percent roadless withdrawn		100-percent roadless withdrawn	
		No reallocation	With reallocation	No reallocation	With reallocation
	- - - - - - - - - - - - Volume[1/] (Million cubic feet per year) - - - - - - - - - - - -				
Maximum first decade harvest - no constraints on budgets for intensive management or timber sales	130	NA	119	NA	103
Maximum first decade harvest - with budget constraint	115	110	119	103	103
Harvest that might be built up to over next 50 years with budget constraint	115	110	126	103	116
Potential yield	157	NA	[redacted] 146	NA	134

[1/] Excludes dead and unregulated volume.

NA = Not applicable

half of the roadless area withdrawn, and 103 million cubic feet per year with all of the roadless area withdrawn even with no limitation on budgets. Line 2 of table 7 shows that when half of the roadless area is withdrawn the harvest is limited by funds for intensive management to 110 million cubic feet which can be increased to 119 million cubic feet with additional funds for intensive management. Line 2 also shows that when all of the roadless area is withdrawn the harvest is limited by the regeneration harvest acre constraint and the budget for intensive management to 103 million cubic feet per year.

After a number of decades have passed, and the problems caused by concentrating cutting in the "accessible" area have been overcome, the harvest with reallocation can increase on the reduced land base. Line 3 shows that these levels might approach 126 and 116 million cubic feet per year, respectively, with half or all of the roadless area withdrawn.

The potential yield shown on line 4 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.

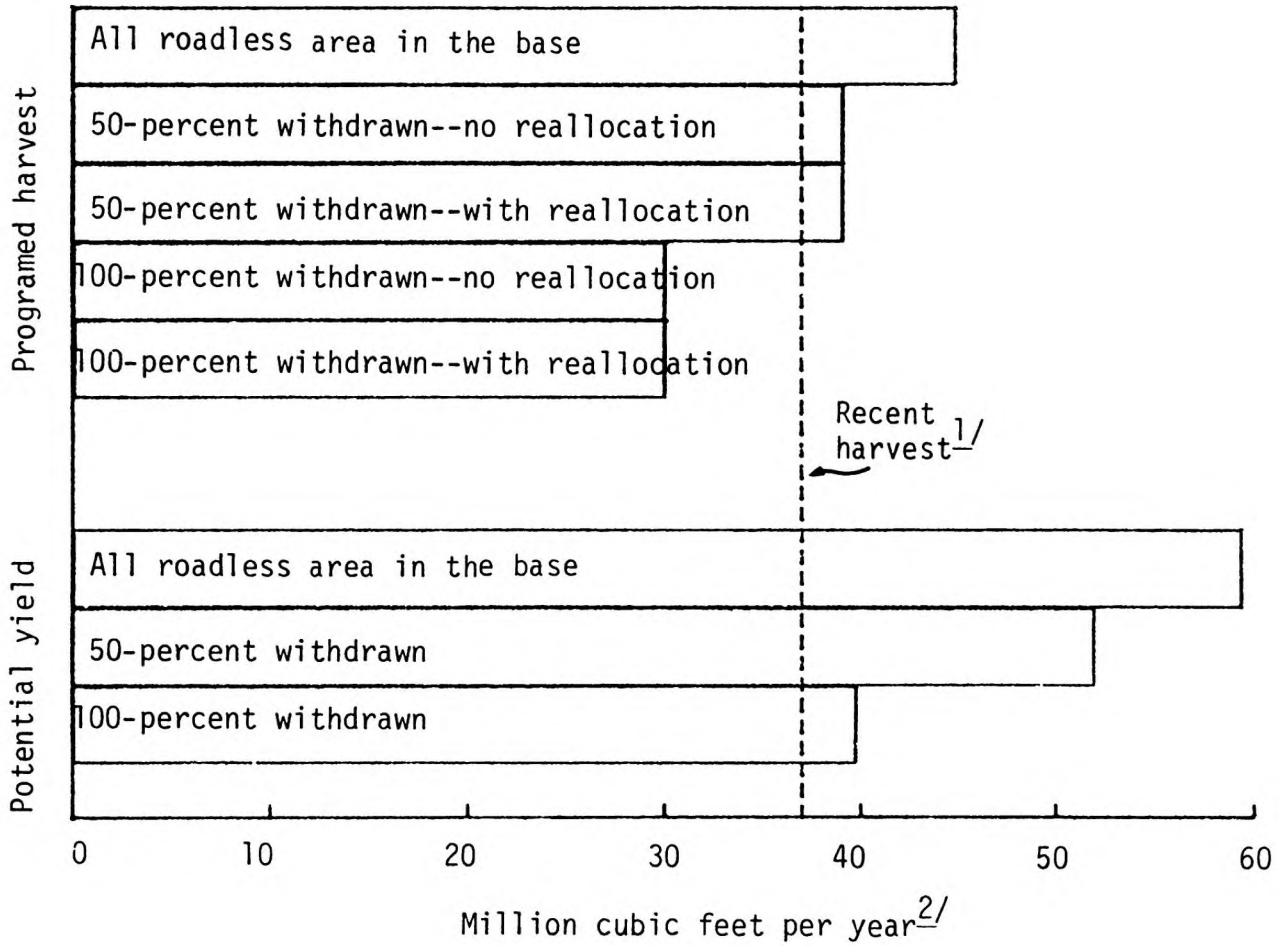
Previous analyses, such as Kutay's, have focused largely on these longrun effects of reallocation of road savings. We now know, however, that this approach cannot be expected to accurately estimate the immediate effects of removing roadless areas in cases where the budget for intensive management will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

Siskiyou National Forest

The Siskiyou National Forest in southwestern Oregon includes parts of the Siskiyou and coastal mountain ranges. The topography includes some of the steeper ground found in western Oregon. The Forest is predominantly Douglas-fir stands except for the Siskiyou Mountains portion which is a diverse mixture of many species. The elevation is from near sea level to almost 6,000 feet. The Forest contains about 1.1 million acres of National Forest System land of which 69 percent was considered regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 436,000 acres of which 63 percent was considered to be regulated commercial forest land. This is 94,000 acres more than the RARE II inventory. This difference exists primarily because we did not reduce the land base for wilderness designations in the Endangered American Wilderness Act. The average volume of chargeable harvest for the past decade was about 38 million cubic feet per year.

Figure 3 shows that when roadless areas are withdrawn, there is no opportunity to offset any of the reduction in programed harvest through reallocation of funds to more intensive management of the remaining land. Concerns about the effects of timber harvest on other resources are similar to those on the Willamette National Forest. On the Siskiyou however, the base programed harvest and the programed harvest with half

Figure 3.--Alternative harvest levels
Siskiyou National Forest



1/ 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 a Hanzlik formula calculation that did not recognize growth on future stands.

2/ Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 4.8.

or all of the roadless area withdrawn is limited by the regeneration harvest acreage constraint to protect other resources rather than the budget. Therefore, reallocating the road savings to more intensive management of the remaining land will not increase the shortrun harvest. Like the Willamette, it can be anticipated that the harvest could increase somewhat in future decades (table 8).

Figure 3 also shows that the potential yield is reduced 13 and 33 percent, respectively, when half or all of the roadless area is withdrawn. Like the Willamette, however, the potential yield is a level that is possibly attainable sometime in the future.

Bridger-Teton National Forest

The Bridger-Teton National Forest is in western Wyoming in the high central Rocky Mountains. The predominant tree species are lodgepole pine, Englemann spruce, subalpine fir, and Douglas-fir. Although elevations range from 5,600 to 13,800 feet, the productive forest land is generally found from 7,000 to 9,500 feet. The Forest contains about 3.4 million acres of National Forest System land of which 31 percent was considered to be regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 1,758,000 acres, of which 41 percent was considered to be regulated commercial forest land. The average volume of chargeable harvest for the past decade was about 8 million cubic feet per year.

Figure 4 shows that there is no opportunity to offset any of the reduction in programed harvest through reallocation of funds to more intensive management of the remaining land.

With all roadless areas in the base the programed harvest is limited by the growth of the forest. Precommercial thinning is assumed to be fully funded. The difference between the base programed harvest and the base potential yield is the extent of harvest of marginal land. With roadless areas withdrawn there are no opportunities to intensify timber management, and the harvest is limited by the number of acres of regeneration harvest allowed.

Figure 4 also shows that the potential yield is reduced 67 percent when all of the roadless area is withdrawn.

Lolo National Forest

The Lolo National Forest is a mixed conifer forest located in west central Montana west of the Continental Divide. Elevation of the Forest is from under 3,000 to over 9,000 feet. The Forest contains about 2.1 million acres of National Forest System land of which 72 percent was considered regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was

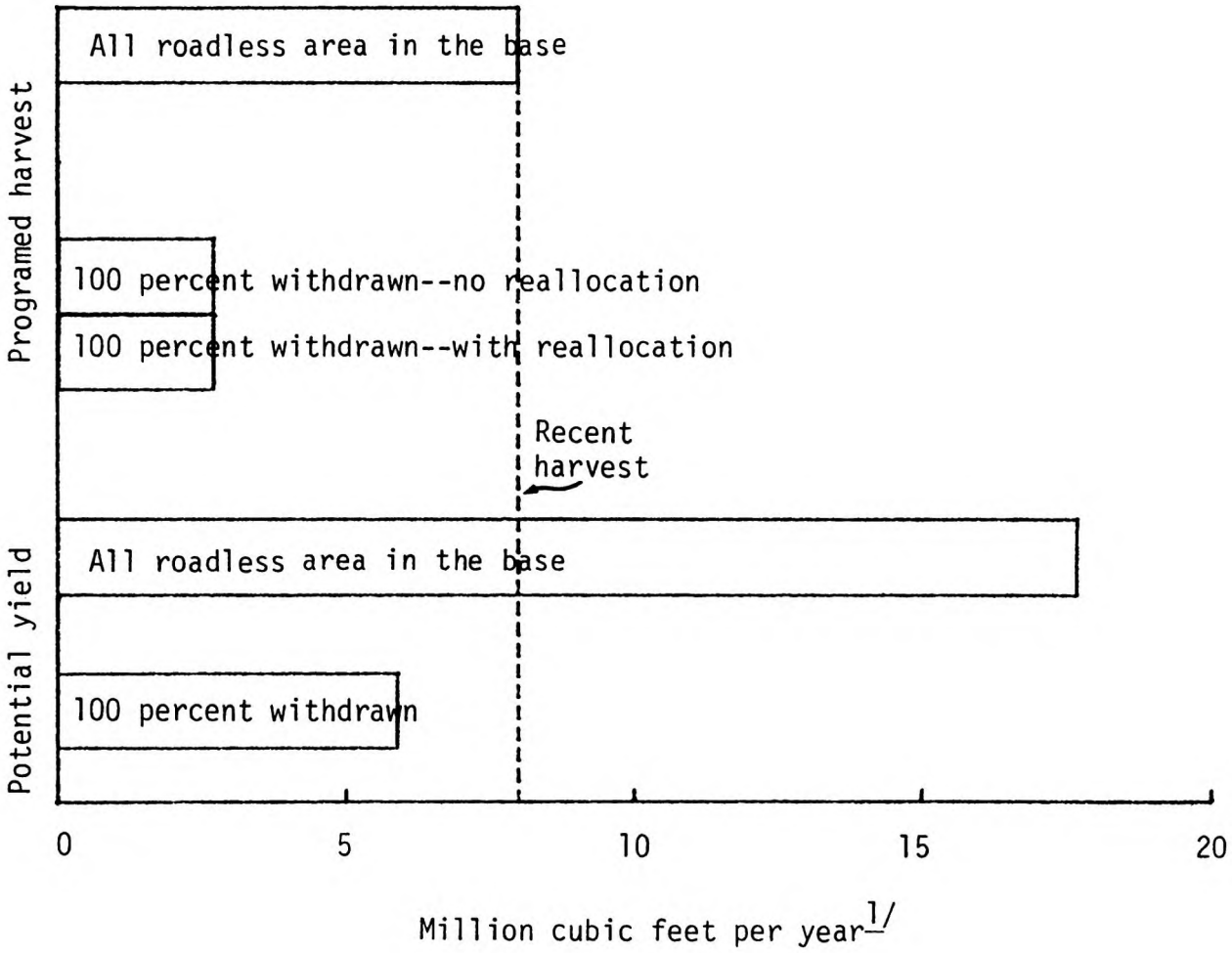
Table 8--*Detailed alternative harvests for the Siskiyou National Forest*

	Base	50-percent roadless withdrawn		100-percent roadless withdrawn	
		No reallocation	With reallocation	No reallocation	With reallocation
	- - - - - - - - - - - - Volume[1/] (Million cubic feet per year) - - - - - - - - - - - -				
Maximum first decade harvest - no constraints on budgets for intensive management or timber sales	45	NA	39	NA	30
Maximum first decade harvest - with budget constraint	45	39	39	30	30
Harvest that might be built up to over next 50 years with budget constraint	54	42	46	34	36
Potential yield	59	NA	52	NA	40

[1/] Excludes dead and unregulated volume.

NA = Not applicable

Figure 4.--Alternative harvest levels
Bridger-Teton National Forest



1/ Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 4.7.

about 758,000 acres of which 57 percent was considered to be regulated commercial forest land. This is 76,000 acres more than the RARE II inventory. This difference exists primarily because we did not reduce the land base to reflect changes in land allocations in recent land use plans, nor did we correct for Wilderness designations in the Endangered American Wilderness Act. The average volume of chargeable harvest for the past decade was about 34 million cubic feet per year.

Figure 5 shows that when half of the roadless area is withdrawn, a small amount of the reduction in programed harvest can be offset through reallocation. When all of the roadless area is withdrawn, the absolute amount of harvest reduction that can be offset through reallocation is greater than when half of the roadless area is withdrawn. Even so, only about one-fourth of the reduction can be offset through reallocation.

With half or all of the roadless areas in the timber base, the harvest level is limited by growth on future stands. When all of the roadless areas are withdrawn, constraints on acres of regeneration harvest and acres of intermediate harvest become binding. The constraint on intermediate harvest can be removed by additional funds to prepare low volume sales of intermediate harvests on less productive lands.

Figure 5 also shows that the potential yield is reduced 13 and 29 percent, respectively, when half or all of the roadless area is withdrawn.

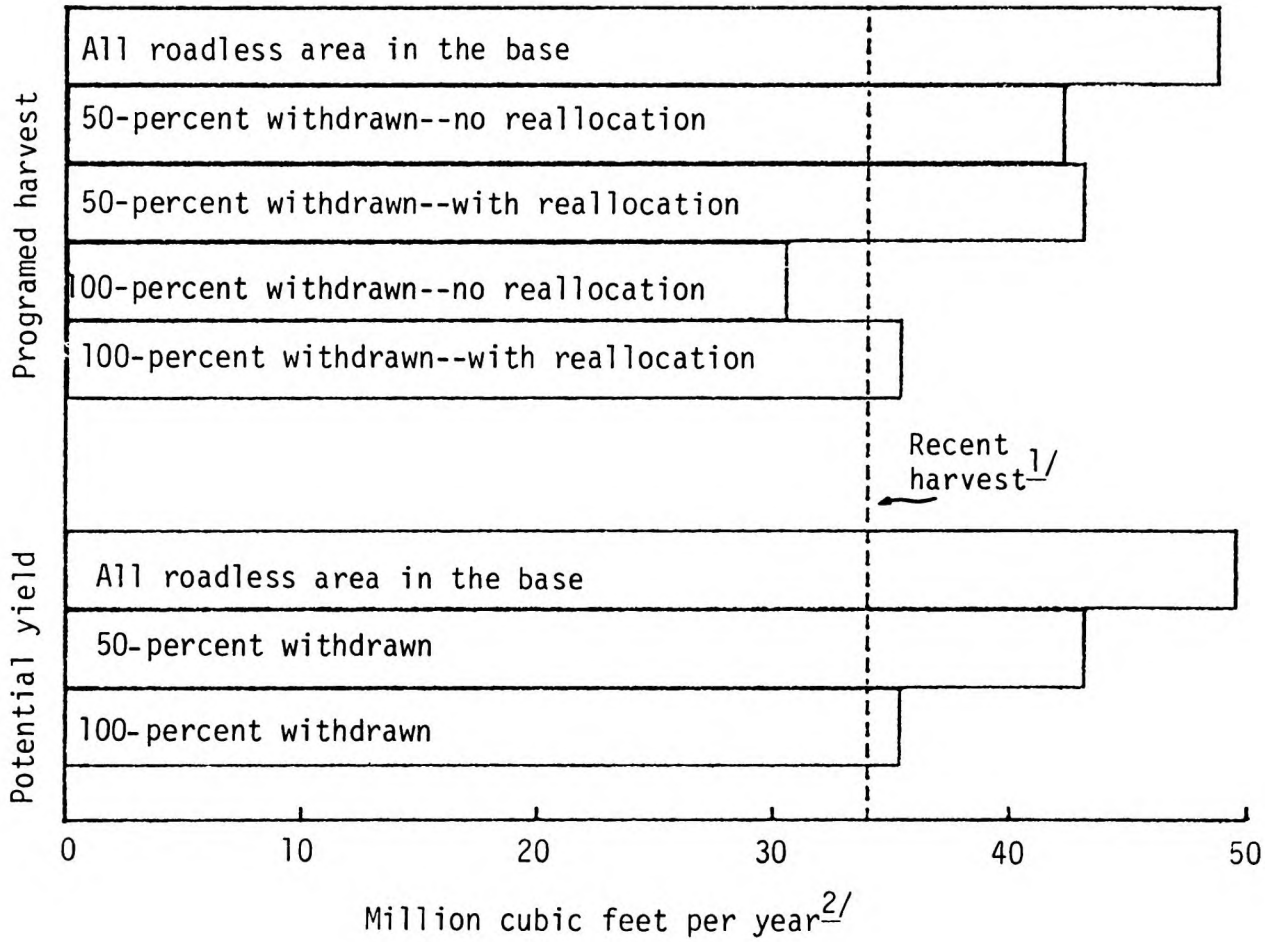
San Juan National Forest

The San Juan National Forest is located in the four corners area of southwest Colorado. Elevations range from 6,500 to over 14,000 feet in the San Juan Mountain Range along the Continental Divide. Ponderosa pine is the primary commercial timber type occupying the lower elevations. Mixed conifer and spruce-fir types occupy the mid and upper elevations, respectively.

The Forest contains about 1.9 million acres of National Forest System land of which 36 percent was considered to be regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 747,000 acres of which 32 percent was considered to be regulated commercial forest land. The average volume of chargeable harvest for the past decade was about 15 million cubic feet per year.

Figure 6 shows that 0.4 million cubic feet of the reduction in programed harvest from roadless withdrawals can be offset through reallocating funds to more intensive management of the remaining land. This is 30 percent of the reduction when half of the roadless area is withdrawn and 8 percent of the reduction when all of the roadless area is withdrawn. This increase comes from controlling understory brush in ponderosa pine stands. The remaining difference between programed harvest and potential yield relates to harvesting on marginal lands.

Figure 5.--Alternative harvest levels
Lolo National Forest

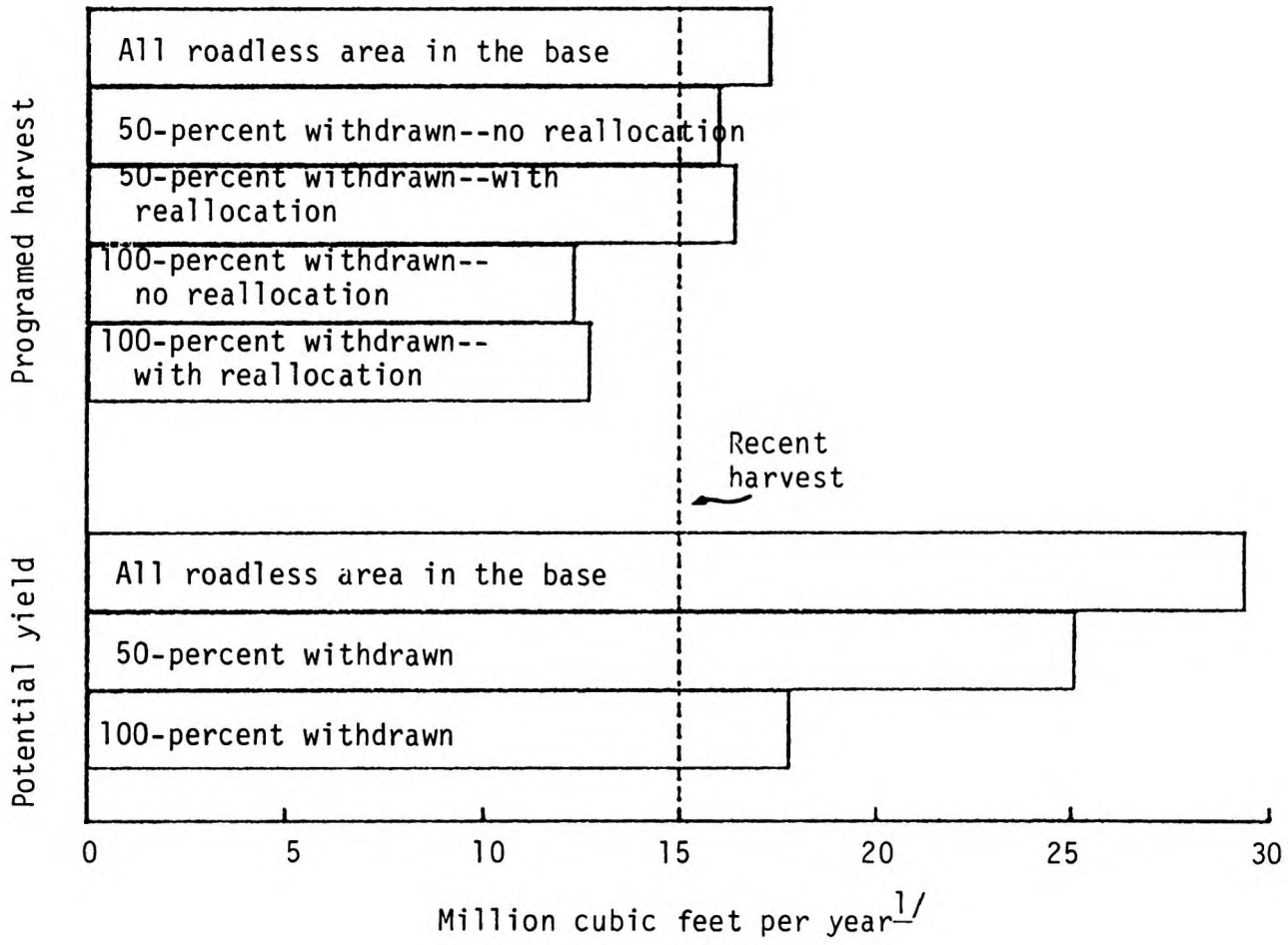


1/ The recent harvest is below the base programed harvest primarily for the following reasons: (1) There have been losses of planned harvests through additions to wilderness, wilderness study, and RARE II. (2) There has not been full funding of the timber sale program.

2/ Harvest levels can be converted to board feet, local scale, using the board-foot/cubic-foot ratio of 3.6.

Figure 6.--Alternative harvest levels

San Juan National Forest



1/ Harvest levels can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio of 4.3.

Figure 6 also shows that the potential yield is reduced 15 percent and 39 percent, respectively, when half or all of the roadless area is withdrawn.

Sierra National Forest

The Sierra National Forest lies on the west side of the Sierra Nevada Mountains in California between the crest and the foothills adjacent to the south side of Yosemite National Park. Mixed conifers are the major timber type. Other types include ponderosa pine, red fir, and subalpine types. Most of the productive forest land lies in a range of elevation from 4,000 to 6,000 feet. The Forest contains about 1.3 million acres of National Forest System land of which 28 percent was considered to be regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 352,000 acres of which 14 percent was considered to be regulated commercial forest land. The average volume of chargeable harvest for the past decade was about 20 million cubic feet per year.

Figure 7 shows that about 2.3 million cubic feet of the reduction in programed harvest from roadless withdrawals can be offset through reallocating funds to more intensive management of the remaining land. This is 73 percent of the reduction when half of the roadless area is withdrawn and 51 percent of the reduction when all of the roadless area is withdrawn. The source of the gains from reallocation is in planting genetically improved trees. This practice was not included in the base programed harvest. It was added to all three potential yield calculations even though it is normally not included in either programed harvest or potential yield on California National Forests.

Figure 7 also shows that the potential yield is reduced by 12 percent and 16 percent, respectively, when half or all of the roadless area is withdrawn.

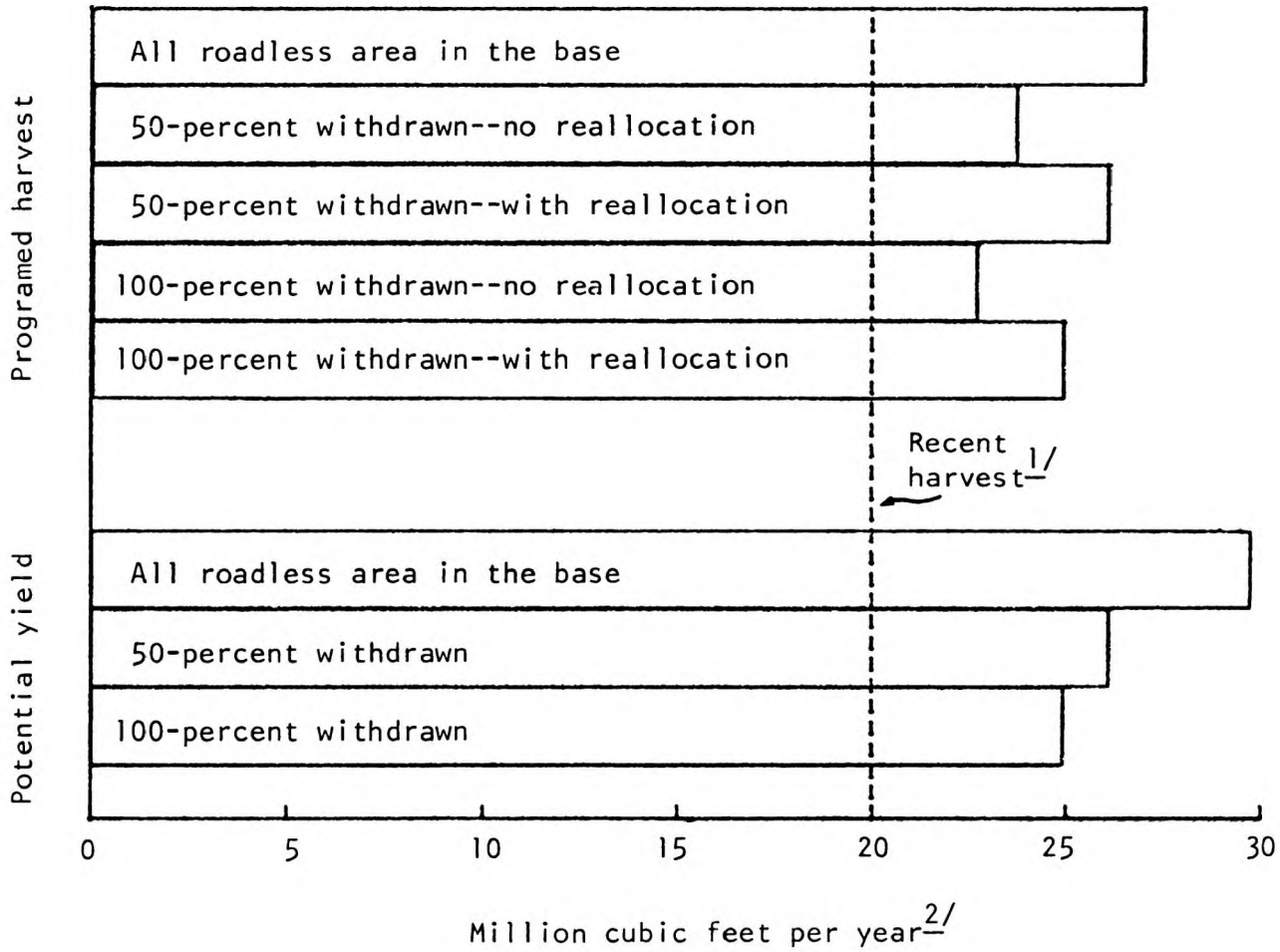
The reductions in programed harvest and potential yield from withdrawing the first half of the roadless areas is substantially more than the reductions from withdrawing the second half. This occurs because most of the regulated commercial forest land is included in the first half to be withdrawn.

Umatilla National Forest

The Umatilla National Forest is in northeast Oregon and extreme southeast Washington. The Forest is composed predominantly of stands that are mixtures of true firs, Douglas-fir, and pines. There are also some ponderosa pine and lodgepole pine stands. The average elevation of the Forest is about 4,000 to 4,500 feet. The Forest contains about 1.4 million acres of National Forest System land of which 51 percent was

Figure 7.--Alternative harvest levels

Sierra National Forest



1/ The recent harvest is less than the base programed harvest primarily because of inadequate financing of the timber sale program.

2/ Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 6.3.

considered to be regulated commercial forest land for purposes of this study. The National Forest System acreage in roadless areas for this study was about 435,000 acres of which 36 percent was considered to be regulated commercial forest land. This is 22,000 acres more than the RARE II inventory. This difference exists primarily because the inventory for this study includes the part of the land designated for Wilderness in the Endangered American Wilderness Act that was outside the Wenaha-Tucannon Backcountry. The average volume of chargeable harvest for the past decade was about 24 million cubic feet per year.

Figure 8 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. With all roadless areas in the base, funds for precommercial thinning slightly limit the harvest. When half of the roadless area is withdrawn, the opportunities to do precommercial thinning are reduced to just a bit more than the number of acres treated in the base programed harvest. This small amount of precommercial thinning results in a small increase in programed harvest with reallocation. When all of 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 treatment opportunities and no response to reallocation.

Figure 8 also shows that the potential yield is reduced by 13 and 22 percent, respectively, when half or all of the roadless area is withdrawn.

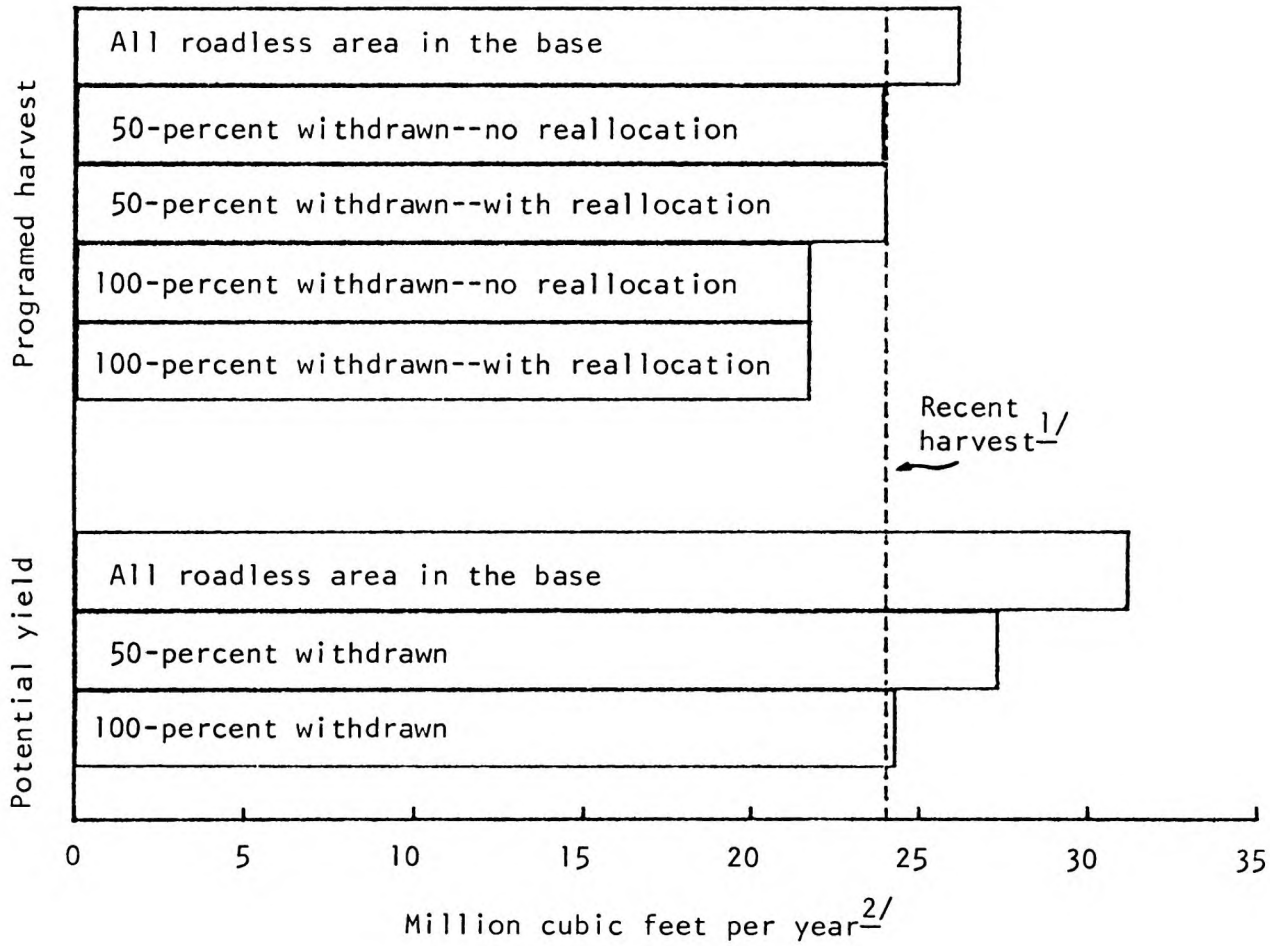
CONCLUSIONS ABOUT HARVEST CONSEQUENCES OF ROADLESS AREA WITHDRAWALS

The harvest results discussed here and summarized in table 2 do not substantiate the hypothesis that as much timber could be harvested without harvesting from the roadless areas, if the resources saved by not developing the roadless areas were used for more intensive timber management on the remaining land. On the other hand these results also show that the recent volume harvested on six of the seven study Forests is below the base programed harvest. With half of the roadless area withdrawn the recent level of harvest could be maintained or exceeded on those six study Forests. And with all of the roadless area withdrawn it could be maintained or exceeded on two of the study Forests.

The study Forests are not a scientific "sample." Therefore, no firm quantitative conclusion can be drawn about other National Forests in the West. However, this study does suggest that there is only limited ability to substitute management intensification for roadless area volume on other National Forests.

Figure 8.--Alternative harvest levels

Umatilla National Forest



1/ The base programed harvest exceeds the recent harvest primarily because increased investments in precommercial thinning have resulted in higher investment assumptions than were recognized in the previous plan.

2/ Harvests can be converted to board feet, local scale, by using the board-foot/cubic-foot ratio 6.4.

Identifying National Forests that are likely candidates for this substitution is made difficult by the changing 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, budget for management intensification is a primary constraint holding down the harvest. When all roadless areas are excluded from the Willamette's harvest calculation, however, regeneration harvest acres become a primary constraint holding down the harvest. Quantification of the degree to which management intensification on the "accessible" area can substitute for roadless area volume, and the harvest impact of removing roadless areas from the harvest calculation, will require harvest calculations for each Forest using a similar analytical framework.

FINANCIAL AND EMPLOYMENT CONSEQUENCES OF ROADLESS AREA WITHDRAWALS

ASSUMPTIONS USED IN FINANCIAL ANALYSIS

In order to interpret the financial results correctly, one must understand that they do not include a complete accounting of all benefits and costs associated with the alternatives. Although we do attempt to account for all significant consequences at least verbally, it is not technically possible to put all costs and benefits into monetary terms. For example, our estimates of road and timber management activities account for many costs, but the only benefits included in the financial analysis are receipts from the sale of stumpage. We take account of costs for roads designed for multipurpose benefits and for silvicultural activities designed with multiple use objectives in mind. In some cases these costs are substantially higher than they would be if the roads and activities were designed to provide only for timber management needs. The 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, at this time, have defensible estimates of their monetary values. The direct management costs of producing the nontimber benefits and differences in forest protection costs are also not accounted for. The nontimber benefits and the nontimber opportunity costs of these alternatives are an important component of the consequences and in some cases undoubtedly are more significant than the financial consequences. One, therefore, cannot draw conclusions about the economic feasibility or the economic efficiency of the alternatives by considering only the financial analysis. The financial consequences must be considered in conjunction with a subjective assessment of the value of the nontimber consequences in order to draw conclusions about the economic feasibility or economic efficiency of the alternatives. The effects on environmental conditions and nontimber benefits are described in a separate section of the report.

One must also understand that there is no single financial calculation that can be proven to be the "right" one. All financial analyses involve projections of future prices and costs. They also require a specified interest rate for which there is no generally accepted correct one. It is therefore prudent to look at the results under some alternative sets of assumptions in order to understand the sensitivity of the results to some of the variables about which there is uncertainty. One can therefore neither prove that an alternative is efficient nor that it is inefficient. What one can do is say that under a particular set of assumptions, believed to be reasonable, certain results would occur.

The purpose of our analysis is to look at the implications of some broad roadless area allocation alternatives. Accordingly, we are working

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

In all cases the financial analyses use real costs, real prices, and real interest rates. In terms of projecting future economic trends, "real" means that we make no attempt at projecting inflationary trends. We still expect increases in real stumpage prices and real costs for labor intensive timber management activities because these are expected to increase relative to the general price level.

Our procedure for projecting future trends involves determining a current value for the measure 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.[5/] The average real price increase per year for each region for the period 1978-2030--without any price impacts related to roadless area withdrawals --is as follows: coastal Douglas-fir region of Oregon and Washington, 1.9 percent per year; eastern Oregon and Washington, 1.5 percent per year; and California, 2.1 percent per year. After the year 2030, real stumpage prices are assumed to be constant. The price trend for eastern Oregon and Washington is also used for Forests throughout the remainder of the West.

Real costs for activities that are labor intensive are assumed to increase at the same rate as real per capita income. These are regeneration, precommercial thinning, and timber sale costs. These rates of increase come from U.S. Water Resources Council (1974) projections. The increase in the real costs of these items is approximately 2.7 percent per year over the period 1980-2020.

All other cost items are assumed to remain constant in real terms, i.e., they will increase at the same rate as the general price level.

The prices received for stumpage may be different for the roadless area than for other areas because of differences in species mix and timber quality and because of differences in logging and hauling costs.

[5/] Adams, Darius M., and Richard W. Haynes. 1978. A preliminary description of the 1980 Timber Assessment Softwood Market Model. Internal report on file at the Pac. Northwest For. and Range Exp. Stn., Portland, OR.

These factors were taken into account in developing separate prices on each Forest for each half of the roadless area and for the accessible area.

Payments to counties are assumed to be 25 percent of the estimated gross revenue.

All reported financial results involving discounting of values were computed using a real rate of interest of 5 percent. 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 return of 5 to 6 percent is competitive.

Table 9 shows the values for initial stumpage prices and road items that were used on each study Forest. These data were supplied by the Forests and reflect then expectations about future trends. They are based on existing forest plans and extrapolation of past trends.

Financial results are included for three sets of price and cost assumptions. Results for the "individual Forest" set of 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 price assumption there are minor price changes caused by harvest reductions because the harvest changes are so small in comparison to the regional quantity of timber harvested that the regional price of stumpage is unaffected. The cost assumption is the expected trend in real costs.

Constant real prices and constant real costs are the second set of price and cost assumptions. These results show how the financial effects would differ if expected trends in real prices and real costs are not realized (Appendix A).

Results for the "proportional harvest change" set of price and cost assumptions are included in Appendix B. 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 not likely 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 harvest changes in order to illustrate the effect of this alternative. Under this price assumption,

Table 9--*Initial stumpage prices and road data*

Item	Bridger-Teton	Lolo	San Juan[1/]	Sierra	Siskiyou	Umatilla	Willamette
Total miles constructed to complete road system in roadless areas	NA	2,931	1,522	196	664	657	488
Total construction costs (in $1,000)	NA	75,000	56,000	21,400	56,000	35,700	56,800
Cost per mile (dollars)	NA	26,000	37,000	109,000	84,300	54,400	116,400
Construction percent by decade[2/]							
First	NA	20	100	60	20	40	32
Second	NA	20	0	25	30	25	35
Third	NA	18	0	10	30	20	21
Fourth	NA	15	0	5	20	15	12
Road miles per section in roadless area							
Regulated CFL acres	NA	4.4	4.0	2.5	1.5	2.7	1.6
Total National Forest acres	NA	2.5	1.3	0.4	1.0	1.0	1.1
Reconstruction cost per mile (dollars)	NA	1,800	None	25,000	19,300	7,200	28,000
Reconstruction cycle in years	NA	30	None	60	20	20	20
Maintenance costs per mile per year (dollars)	NA	141	295	450	1,400	900	600
Stumpage price (dollars per MBF)[3/]							
Accessible areas	64	73	31	92	183	64	208
Roadless areas	59	73	26	64	157	48	192

[1/] The road miles and total construction cost shown for the San Juan are for the potential yield which includes harvesting from marginal lands that are not included in the base programed harvest. The estimated miles constructed in the roadless areas and the total cost for the base programed harvest are 578 miles and $21.2 million.

[2/] The percentages do not sum to 100 where the road system is not expected to be completed within four decades.

[3/] Stumpage prices were developed with the assumption that purchasers are reimbursed for specified road costs and that reforestation will be done by the Forest Service rather than the purchaser. The price shown, therefore, includes expected purchaser credits and funds to be set aside for reforestation.

NA = Not available.

there may be substantial price increases caused by harvest reductions because the harvest change is large enough to affect the Regional price of stumpage. Regional price effects are determined from demand relationships which take into consideration compensating price responsive harvest changes on private lands. The cost assumption is again the expected trend in real costs.

ASSUMPTIONS AND PROCEDURES USED IN EMPLOYMENT ANALYSIS

For all Forests except the Sierra and the Bridger-Teton, the employment consequences are quantified using the input-output (I-O) tables developed as a part of the RARE II analysis. The RARE II I-O table for each Forest is based on employment data from an encompassing multicounty area. These employment data are used to scale the national I-O 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 employment consequences of the harvest alternatives 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 employment consequences of the harvest alternatives, and another choice for the employment impact region would lead to a different set of employment results. However, it is at the local level where the effects of harvest changes and land allocation decisions take place and will be felt most heavily, and where the concern for employment impacts 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 employment consequences over several decades.

The results represent the sum of direct, indirect, and induced employment effects resulting from the harvest changes on each Forest. The direct employment 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. The induced employment effect is that change resulting from the spending actions of local households. Not all of 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 omission would likely add less than 10 percent to the employment impacts for each of the study Forests except the San Juan National Forest. The large size of the first decade road construction program and the small size of the harvest changes on the San Juan indicate that the road-related employment impact might be equal to the reported size of the harvest-related impact.

Increases in dispersed, nonmotorized recreation-related employment which would result from all of 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 employment effect of changes in 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 employment impacts are probably conservative estimates of the local employment 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 employment level 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 actual level of employment.

FINANCIAL AND EMPLOYMENT RESULTS ON STUDY FORESTS

The presentation of financial results 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[6/] for reallocation alternatives as compared to the base programed harvest. The changes in costs associated with the reallocation alternatives have been estimated. The costs for roads in the "accessible" area, administrative overhead, and many other costs associated with the base programed harvest have not been estimated. Therefore, we cannot show nor draw any conclusions about the net revenue nor the present net worth of the base alternative. The first decade average annual total employment shown for the base programed harvest represents the direct, indirect, and induced employment attributable to that volume of harvest. Employment changes are in all cases directly proportional to the changes in programed harvest.

Willamette National Forest

The financial results on the Willamette National Forest are typical of a Forest where the roadless areas make a sizeable 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. The fact that financial values increase when half of the roadless area is withdrawn is principally due to the fact that harvest would increase. This results because the investment in additional intensive management would increase the programed harvest more than the loss in land base would reduce it. One cannot infer from that, however, that accessing roadless areas would not be a financially attractive investment as well if there were sufficient funds to do the intensive management and access the roadless areas too. This same relationship occurs if we assume constant costs and constant prices, but

---

[6/] When forest quantity 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 Consumer's and Producer's 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 forego 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 price effects at the National Forest level are so small that present net worth is a very close approximation to discounted net social benefit.

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

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	115.4	3.2	-12.5
2. Gross revenue ($1,000,000/yr)	232.2	8.1	-16.0
3. Cost of roads, ($1,000,000/yr)	NA	-1.0	-1.7
4. Cost of cultural treatments ($1,000,000/yr)	NA	0.7	-0.1
5. Cost of selling timber ($1,000,000/yr)	NA	0.3	-0.1
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	8.1	-14.1
7. Payments to counties ($1,000,000/yr)	58.0	2.0	-4.0
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	163.7	-281.4
9. First decades average annual total employment (person years)	18,215	502	-1,979

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

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

NA = Not available.

the changes in present net worth are smaller. If we assume that the harvest on all National Forests in the Region were to change in proportion to changes on the Willamette we would expect substantial price changes. This would result in a further substantial reduction in the changes in present net worth.

Siskiyou National Forest

The financial results on the Siskiyou National Forest are also typical of a Forest where the roadless areas make a sizeable contribution to the financial value of the timber program. Table 11 shows that changes in gross revenue, net revenue, and present net worth all move in the same direction as changes in harvest. Comparing the results for the 50-percent-withdrawn and the 100-percent-withdrawn alternatives shows that the reductions in financial values are substantially more for the withdrawal of the second half of the roadless area than they are for the withdrawal of the first half. This is principally due to the fact that the reduction in harvest follows that pattern. 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.

Bridger-Teton National Forest

The financial results for the Bridger-Teton National Forest are incomplete because reliable road cost estimates were not available when this report was written. Table 12 shows that gross revenue and payments to counties decline when all of the roadless areas are withdrawn. These financial values also decline when roadless areas are withdrawn under the alternative price assumptions.

The RARE II input-output model for this Forest does not adequately characterize the markets for stumpage from this Forest. The employment estimates reported were therefore derived using an employment-wood consumption ratio for a nearby area and applying a base-export multiplier for the surrounding four-county area.

Lolo National Forest

Table 13 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 50-percent-withdrawn and the 100-percent-withdrawn alternative shows that the reductions in financial values are approximately proportional to reductions in harvest. The reductions in financial values are much less than for the study Forests in the Coastal Douglas-fir region. This general relationship holds if we assume constant costs and constant prices. If we assume that the harvest on all National Forests in the Region change in proportion to changes on the Lolo, the

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

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	44.9	-5.8	-14.9
2. Gross revenue ($1,000,000/yr)	67.9	-7.9	-20.7
3. Cost of roads, ($1,000,000/yr)	NA	-0.7	-2.1
4. Cost of cultural treatments ($1,000,000/yr)	NA	0.2	-0.7
5. Cost of selling timber ($1,000,000/yr)	NA	-0.4	-0.9
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	-7.0	-17.0
7. Payments to counties ($1,000,000/yr)	17.0	-2.0	-5.2
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	-135.5	-331.7
9. First decades average annual total employment (person years)	6,067	-784	-2,013

1/ Using trends in real prices expected with no changes in harvest on other National Forests. Using expected trends in real costs.

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

NA = Not available.

Table 12--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management,* 1/ 2/ *Bridger-Teton National Forest*

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	8.0	NA	-5.3
2. Gross revenue ($1,000,000/yr)	3.7	NA	-2.4
3. Cost of roads, ($1,000,000/yr)	NA	NA	NA
4. Cost of cultural treatments ($1,000,000/yr)	NA	NA	NA
5. Cost of selling timber ($1,000,000/yr)	NA	NA	NA
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	NA	NA
7. Payments to counties ($1,000,000/yr)	0.9	NA	-0.6
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	NA	NA
9. First decades average annual total employment (person years)	599	NA	-399

1/ Using trends in real prices expected with no changes in harvest on other National Forests. Using expected trends in real costs.

2/ Because the base programed harvest is equal to the recent harvest, reductions in revenues and employment represent reductions from actual recent levels.

NA = Not available.

Table 13--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management,* [1/] [2/] *Lolo National Forest*

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	48.8	-5.6	-13.4
2. Gross revenue ($1,000,000/yr)	21.5	-2.5	-5.9
3. Cost of roads, ($1,000,000/yr)	NA	-0.7	-1.5
4. Cost of cultural treatments ($1,000,000/yr)	NA	-0.9	-2.0
5. Cost of selling timber ($1,000,000/yr)	NA	-0.3	-0.6
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	-0.6	-1.8
7. Payments to counties ($1,000,000/yr)	5.4	-0.6	-1.5
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	-17.1	-35.3
9. First decades average annual total employment (person years)	3,514	-421	-982

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

[2/] Because the recent harvest on the Lolo National Forest is near the programed harvest with all of the roadless area withdrawn, reduction in revenues and employment generally represent losses in opportunities for increases rather than reductions from actual recent levels.

NA = Not available.

increase in prices is sufficient to cause net revenue and present net worth to increase when roadless areas are withdrawn.

San Juan National Forest

Table 14 shows that while gross revenues are reduced, net revenues are unchanged and present net worths are increased when roadless areas are withdrawn. It appears odd that present net worth should increase when net revenue remains constant. This results because all of the road construction cost savings from not roading the roadless areas occur in the first decade. In present net worth calculations, first decade effects receive greater weight than effects in subsequent decades. With constant costs and constant prices the results are similar except that present net worths increase more when roadless areas are withdrawn. We do not have a financial analysis for the "proportional harvest change" price assumption because the version of the Resources Planning Act Timber Assessment Softwood Market Model we used did not yield plausible price effects for this region with changes in National Forest volumes sold. It is quite likely, however, that with an adequate representation of price effects, present net worth would increase when roadless areas are withdrawn.

Sierra National Forest

The Sierra is a National Forest where the financial contribution of the roadless areas is moderate. Table 15 shows that financial values are reduced when roadless areas are withdrawn. Under the constant cost and price assumption and the "proportional harvest change" price assumption present net worths go up while gross revenues and net revenues go down. This results for two reasons. One reason is that different timber species have different prices and their order of harvest is somewhat arbitrary in the harvest calculations. Therefore the order of harvest tends to jump around between alternatives and cause some erratic changes in revenues. The road cost savings also occur primarily in the first two decades.

The employment effects for the Sierra were estimated with an input-output model that was developed specifically to estimate the effects of changes on the Sierra National Forest. We believe that this model is more applicable than the RARE II model.

Umatilla National Forest

Table 16 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 50-percent-withdrawn and the 100-percent-withdrawn alternatives shows that the reductions in financial values are approximately proportional to the reductions in harvest. The reductions

Table 14--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management,* [1/] [2/] *San Juan National Forest*

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	17.3	-0.9	-4.6
2. Gross revenue ($1,000,000/yr)	3.5	-0.2	-0.8
3. Cost of roads, ($1,000,000/yr)	NA	-0.2	-0.7
4. Cost of cultural treatments ($1,000,000/yr)	NA	0.1	0.2
5. Cost of selling timber ($1,000,000/yr)	NA	-0.1	-0.3
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	--	--
7. Payments to counties ($1,000,000/yr)	0.9	--	-0.2
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	1.2	7.6
9. First decades average annual total employment (person years)	868	-48	-233

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

[2/] Because the recent harvest on the San Juan National Forest is less than the programed harvest with half of the roadless area withdrawn, the reductions in revenues and employment with half of the roadless area withdrawn represent losses in opportunities for increases rather than reductions from actual recent levels. With all of the roadless area withdrawn, about half of the reductions in revenues and employment would represent reductions from actual levels.

NA = Not available.

Table 15--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management,* [1/] [2/] *Sierra National Forest*

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	27.0	-0.9	-2.1
2. Gross revenue ($1,000,000/yr)	34.2	-1.2	-1.9
3. Cost of roads, ($1,000,000/yr)	NA	-0.3	-0.7
4. Cost of cultural treatments ($1,000,000/yr)	NA	-0.1	0.2
5. Cost of selling timber ($1,000,000/yr)	NA	-0.1	-0.1
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	-0.7	-1.4
7. Payments to counties ($1,000,000/yr)	8.5	-0.3	-0.5
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	-0.7	-13.2
9. First decades average annual total employment (person years)	2,438	-81	-203

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

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

NA = Not available.

Table 16--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management,* 1/ 2/ *Umatilla National Forest*

Item	Base programed harvest	Change from base when 50-percent roadless withdrawn	Change from base when 100-percent roadless withdrawn
1. Harvest (MMCF/yr)	26.2	-2.2	-4.5
2. Gross revenue ($1,000,000/yr)	17.1	-1.1	-2.3
3. Cost of roads, ($1,000,000/yr)	NA	-0.6	-1.4
4. Cost of cultural treatments ($1,000,000/yr)	NA	-0.1	-0.3
5. Cost of selling timber ($1,000,000/yr)	NA	-0.3	-0.5
6. Net revenue (Item 2-Items 3, 4, and 5) ($1,000,000/yr)	NA	-0.1	-0.1
7. Payments to counties ($1,000,000/yr)	4.3	-0.3	-0.6
8. Present net worth for ten decades at 5 percent ($1,000,000)	NA	-1.5	-1.9
9. First decades average annual total employment (person years)	3,067	-255	-530

1/ Using trends in real prices expected with no changes in harvest on other National Forests. Using expected trends in real costs.

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 of the roadless area withdrawn represent losses in opportunities for increases rather than reductions from actual recent levels. The additional reductions when the second half of the roadless area is withdrawn represent reductions from actual levels.

NA = Not available.

in financial values, however, are much less than for the study Forests in the coastal Douglas-fir region. 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 the roadless areas are withdrawn.

CONCLUSIONS ABOUT THE FINANCIAL AND EMPLOYMENT CONSEQUENCES OF ROADLESS WITHDRAWALS

Average annual gross revenue, county payments, and net revenue decline on all Forests except the San Juan under the assumption of expected trends in real costs and prices with no roadless withdrawals on other Forests in the Region, when all of the roadless areas are removed from the timber management base. Present net worth also declines on all Forests except the San Juan, where sizeable road costs savings in the first decade account for the increases in present net worth when roadless areas are withdrawn. The same relationships occur when half of the roadless area is withdrawn except on the Willamette where financial values increase because the harvest with reallocation would exceed the base programed harvest. The employment changes for each Forest are directly proportional to the harvest reductions. The results for present net worth and county payments are summarized in table 4.

On the Willamette and Siskiyou National Forests, the changes in financial values with all roadless areas withdrawn are quite large; on the Lolo and Sierra National Forests the changes are moderate; on the Umatilla and San Juan National Forests the changes are small. The total direct, indirect, and induced effect on employment when all of roadless areas are withdrawn ranges from a loss of 203 person-years on the Sierra to 2,013 on the Siskiyou National Forest.

CHANGES IN ENVIRONMENTAL CONDITIONS AND NONTIMBER BENEFITS

BACKGROUND

The tradeoffs examined are those attributable to withdrawing roadless areas from the timber base and reallocating roading funds to intensify timber management on remaining areas. We obtained those impacts by meeting with resource specialists from the various disciplines on each study Forest. We provided road schedules, schedules of intermediate and regeneration harvests, and lists 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. For the purpose of this evaluation, forest data were divided into a roadless portion and an "accessible" portion which were evaluated separately.

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 the 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 because these are the impacts that are relevant if the choices are restricted to the base and reallocation alternatives.

COMPARISON OF ALTERNATIVES

Table 5 summarizes the estimated impacts that are generated when the base is replaced by the reallocation alternative on the study Forests. When the base is replaced by the reallocation alternative, roadless areas remain roadless and "accessible" areas are intensively managed in a manner consistent with timber flow, multiple use, and environmental policies. Impacts represent changes from the base alternative. General tradeoffs between the various criteria and between the roadless and

"accessible" areas within each criterion are illustrated. Impacts related to roadless areas are generally those on the base alternative which are avoided by the adoption of the reallocation alternative. Major impacts are identified as those that exceed the "threshold of concern" which is defined as the amount of impact that would generate one or more of the following effects:

(1) Create a public expression of concern or interest.
(2) Change long-term traditional use patterns.
(3) Require funds, substantially in excess of usual planning and budgeting levels, to mitigate impacts to an acceptable level.

Major adverse impacts, while undesirable, are within limits considered acceptable under the current interpretation of multiple-use objectives.

The discussions that follow identify the critical factors and highlight the major impacts.

Water Quality

Slope failure associated with timber harvests and roadbuilding activities, including the selection of road sites, design, construction methods, and maintenance levels, 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.

If the reallocation alternative were adopted in place of the base alternative, the now roadless areas would remain unroaded and specialists on at least one study Forest would anticipate major beneficial impacts related to the opportunity to avoid sedimentation in the roadless area. Major adverse impacts on water quality related to sedimentation would be expected in the "accessible" areas of at least one study Forest.

Water Quantity and Timing of Flow

Impacts on water quantity and timing of flow are considered together in this section. In areas with abundant water, such as the coastal 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, impacts related to quantity may be more important. In both water-abundant and semiarid areas, however, there is concern with peak flows reaching critical levels.

If the reallocation alternative were adopted in place of the base alternative, the specialists on at least one study Forest would anticipate a major adverse impact related to the opportunities foregone to

increase water flow from the roadless areas. There were no Forests on which specialists would anticipate major impacts relating to timing of flow.

Soil Stability

Erosion and mass soil movement are the major soil stability problems. Both can affect water quality; in addition, mass movements also can 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.

If the reallocation alternative were adopted, specialists on at least one study Forest would anticipate major beneficial impacts related to the opportunity to avoid increases in erosion and mass soil movement in the roadless areas. Major adverse impacts on soil stability would be expected in the "accessible" areas on at least one study Forest.

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.

There were no study Forests on which major impacts were anticipated with the adoption of the reallocation alternative.

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.

Major adverse and major beneficial impacts would be anticipated if the reallocation alternative were adopted. Specialists on at least one study Forest would anticipate major beneficial impacts associated with the opportunity to increase forage production in the "accessible" area. Specialists on at least one study Forest would anticipate major adverse impacts associated with the opportunity foregone to increase forage production in roadless areas.

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.

If the reallocation alternative were adopted, the specialists on at least one study Forest would anticipate major adverse impacts on anadromous fish populations associated with habitat degradation in the "accessible" areas. The same type of impact would be anticipated on residential fish populations on at least one study Forest. On at least one Forest major beneficial impacts on residential fish populations would be anticipated with the opportunity to avoid habitat degradation in the roadless areas.

Wildlife Populations

The levels of given wildlife populations are 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. As a result, we may have more desirable habitat for some wildlife species and at the same time, less desirable habitat for other wildlife species.

If the reallocation alternative were adopted, the following major impacts on principal game species would be anticipated on at least one study Forest: (1) major beneficial impact associated with the opportunity to avoid disturbance of game populations in roadless areas; (2) major beneficial impact associated with additional opportunities to increase desirable habitat in the "accessible" areas; and (3) major adverse impact associated with the opportunity foregone to increase desirable habitat in roadless areas. In addition, major beneficial impacts would be anticipated from the opportunity to avoid disturbance of threatened and endangered species in the roadless areas.

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. Improvements may vary from primitive to relatively elaborate.

Major adverse impacts would be anticipated in both the "accessible" and roadless areas with the adoption of the reallocation alternative. The adverse impacts in the roadless areas are related to opportunities

foregone to develop sites. The adverse impacts in the "accessible" area are associated with increased logging traffic, noise pollution, etc.

Opportunities for Dispersed Recreation Related to Roads

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

Major adverse impacts would be anticipated in both the "accessible" and roadless areas with the adoption of the reallocation alternative. The adverse impacts in the roadless areas are related to opportunities foregone to increase the land area accessible from roads. The adverse impacts in the "accessible" areas are associated with increased logging traffic, noise pollution, etc.

Opportunities for Dispersed Recreation Away from Roads

Opportunities for dispersed recreation away from roads are activities that are normally associated with roadless areas. Included in this category 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.

If the reallocation alternative were adopted, there would be anticipated major beneficial impacts on roadless areas on at least one study Forest. The beneficial impact would be associated with the opportunity to avoid reductions in roadless area.

Visual Resources

In this report 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.

If the reallocation alternative were adopted, there would be anticipated major beneficial impacts on roadless areas on at least one study Forest and major adverse impacts on "accessible" areas on at least one study Forest. The beneficial impact would be associated with the opportunity to avoid an increase in the amount of area disturbed in the roadless areas. The adverse impacts would be associated with additional disturbance of the "accessible" areas.

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 and conversion of overmature forests to younger, less defective stands will reduce the need for burning slash.

If the reallocation alternative were adopted, major adverse impacts would be anticipated in the "accessible" areas of at least one study Forest.

Mineral and Energy Development Opportunities

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.

If the reallocation alternative were adopted, major adverse impacts would be anticipated on at least one study Forest. This adverse impact would be associated with the increased cost of utilizing mineral and energy resources in the roadless area because of limited access.

CONCLUSIONS ABOUT CHANGES IN ENVIRONMENTAL CONDITIONS AND NONTIMBER BENEFITS

This analysis shows that Forest resource specialists anticipate significant tradeoffs of many kinds associated with changing from the base programed harvest to the reallocation alternative. Many multiple use values are expected to be affected when roadless areas are withdrawn and timber management is intensified on the remaining land.

LITERATURE CITED

Gregersen, H. M.
1975. Effect of inflation on evaluation of forestry investments. J. For. 73(9):570-572.

Klemperer, W. David.
1976. Economic analysis applied to forestry: does it short-change future generations? J. For. 74(9):609-611.

McKean, Roland N.
1958. Efficiency in government through systems analysis. John Wiley, Inc. New York. 336 p.

Prest, A. R., and R. Turvey.
1967. Cost-benefit analysis: a survey. Survey of Econ. Theory, Am. Econ. Assoc. Vol. III., p. 155-207.

U. S. Water Resources Council.
1974. OBERS Projections. Vol. 4:States. Washington, D.C.

Appendix A--*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/] ($1,000,000)	Change in payments to counties[3/] ($1,000,000/yr)
Bridger-Teton:		
50-percent withdrawn	NA	NA
100-percent withdrawn	NA	-0.4
Lolo:		
50-percent withdrawn	-5.2	-0.4
100-percent withdrawn	-10.7	-0.9
San Juan:		
50-percent withdrawn	+1.8	0.0
100-percent withdrawn	+10.3	-0.1
Sierra:		
50-percent withdrawn	+5.8	-0.1
100-percent withdrawn	+4.1	-0.2
Siskiyou:		
50-percent withdrawn	-69.5	-1.0
100-percent withdrawn	-164.7	-2.7
Umatilla:		
50-percent withdrawn	+5.4	-0.1
100-percent withdrawn	+11.0	-0.3
Willamette:		
50-percent withdrawn	+122.0	+1.4
100-percent withdrawn	-155.8	-2.2

[1/] Using constant real prices and constant real costs.

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

[3/] Payments to counties are averages for the first four decades in 1978 constant dollars.

NA = Not available.

Appendix B--*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/] ($1,000,000)	Change in payments to counties[3/] ($1,000,000/yr)
Bridger-Teton:		
50-percent withdrawn	NA	NA
100-percent withdrawn	NA	-1.2
Lolo:		
50-percent withdrawn	+13.6	-0.3
100-percent withdrawn	+24.8	-0.7
Sierra:		
50-percent withdrawn	+13.6	-0.1
100-percent withdrawn	+20.1	0.0
Siskiyou:		
50-percent withdrawn	-33.1	-0.7
100-percent withdrawn	-129.2	-2.7
Umatilla:		
50-percent withdrawn	+6.7	-0.2
100-percent withdrawn	+12.7	-0.4
Willamette:		
50-percent withdrawn	+74.1	+0.9
100-percent withdrawn	-39.4	-1.0

[1/] Using trends in real prices expected with proportional changes in harvest on other National Forests. Using expected trends in real costs.

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

[3/] Payments to counties are averages for the first four decades in 1978 constant dollars.

NA = Not available.