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RESEARCH SUMMARY

It has been suggested that the capital outlay associated with roading roadless areas for timber management be reallocated to intensive timber culture on areas already accessible in the National Forest System. As a part of a westwide effort, the Bridger-Teton and Lolo National Forest were studied to determine the consequences of such actions in terms of harvest, financial, employment, environmental and multiple-use effects.

Results indicate that when all roadless areas are removed from the timber harvest base and funds for intensive management are provided, the Lolo can make up one quarter of the 66 million board foot annual loss in timber harvest. Furthermore, the lowest level of harvest is above the past 5-year average sell; so actual harvest effects could be nil. The Bridger-Teton National Forest, however, can not make up any of its 25 million board foot annual loss.

Gross revenue, net revenue, costs, county payments, present net worth, and employment may decline on both forests when all or half of the roadless areas are withdrawn from the timber management base. On the Lolo, removal of all roadless areas would reduce the present net worth by $14.8 million and the employment by 980 man-years. Removal of the roadless areas on the Bridger-Teton National Forest would reduce present net worth and employment by $7 million and 400 man-years.

Some major environmental and multiple-use trade-offs will occur if the roadless areas are removed from the timber harvest base. On the Lolo National Forest, water quality, soil stability, and wildlife populations would benefit in the roadless areas. Forage production and wildlife populations would benefit in the accessible areas at the expense of forage production in the roadless areas. On the Bridger-Teton National Forest, water quality, fish, and wildlife populations away from roads would benefit at the expense of road-related dispersed recreation and mineral and energy development.

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INTRODUCTION

Increasing demands on our limited resource base have caused increasing conflicts over the management of public lands. One area of heated debate has been the question of whether to develop the roadless lands on national forests or place them in the wilderness system. One portion of the public points out our need for benefits such as wood products, motorized access, and developed recreation sites, which can only be achieved by development. Another portion of the public cites the increasing need for the decreasing areas available for undeveloped recreation, peace of mind, and research.

In 1977, Kurt Kutay, land use consultant, proposed an alternative in the Oregon economic impact assessment of proposed wilderness legislation that he claimed would benefit both publics and thus form a basis for consensus. He proposed that it might be possible to produce the timber required and also keep the roadless areas for wilderness or other use by shifting the funds that would be used to construct roads in the roadless areas to intensive timber management on the areas already roaded.

To test the feasibility of this proposal and to show its consequences, a study team of Forest Service economists and planning personnel was organized. This team selected seven western national forests in five regions for detailed study (fig. 1). For each forest, the test was made using existing Forest Service policies, procedures, and data. A summary of the results from that study has been published (Fight and others 1978).

The purpose of the present report is to detail study procedures and results for the two test forests in the Forest Service's Northern and Intermountain Regions. Specifically, this report covers the Lolo and Bridger-Teton National Forests. Originally, the Payette and the Nezperce National Forests were also included, but lack of adequate intensive management yield tables and time caused us to drop them. Some initial trials on the Nezperce showed a 56 percent reduction in programed harvest from removing all of the 428,000 commercial forest acres (173 000 ha) in roadless areas from the timber harvest base. Subsequent changes in constraints and acres have modified these results.

An overview of the two forests studied will be presented, overall methodology will be discussed, and physical, environmental, and economic effects will be presented.

DESCRIPTION OF THE SELECTED FORESTS

The Bridger-Teton and Lolo National Forests were selected for the study based on a number of criteria. First, timber data for the timber harvest scheduling model had to be available. This restricted the selection to only a few forests in both Regions. Second, the forest should have at least a moderate proportion of their commercial forest land in roadless areas. Finally, road costs, land productivity, and multiple-use constraints should be average for the Regions represented. The Lolo National Forest met these considerations and although the Bridger-Teton did meet most of the considerations it was chosen more for the fact that it represented an extreme case in terms of amount of forest land in the roadless category.

Figure 1.--Map of study forests.

Bridger-Teton National Forest

The Bridger-Teton National Forest is in the Rocky Mountains of northwestern Wyoming. Most of the forest is found in Teton, Sublette, and Lincoln Counties bordering Grand Teton and Yellowstone National Parks. As is shown in table 1, the Bridger-Teton contains about 1 million acres of regulated commercial forest land. This represents only 31 percent of the total forest acreage. Wilderness presently accounts for 28 percent of the forest. That acreage along with 1.75 million acres (708 000 ha) set aside from roadbuilding and development by the Forest Service's Roadless Area Review and Evaluation (RARE II) covers 79 percent of the forest.

Table 1.--*National forest land areas by use*

Item	Lolo acreage (1000's)	Bridger-Teton acreage (1000's)
	Acres (Hectares)	
Total national forest	2,091 (846)	3,400 (1 376)
National forest acres in wilderness	110 (44)	949 (384)
National forest acres in roadless areas	[1]758 (307)	1,750 (708)
Regulated commercial forest land (CFL)[2]	1,500 (607)	1,067 (432)
Regulated CFL in roadless areas	430 (174)	734 (297)

[1]Not equal to the 682,000 acres (276 000 ha) in RARE II on the Lolo because of changes that occurred after the data was gathered.

[2]That portion of the commercial forest land included in the land base for timber harvest calculations. The proposed timber management plan for the Bridger-Teton National Forest, which was completed after the study, reports 957,000 acres (387 000 ha) in regulated CFL.

Because of its location and size the Bridger-Teton National Forest receives considerable recreation and grazing use. However, the 7,576 MM bd.ft. regulated timber inventory has produced an average annual sell over the past 3 years of 31 MM bd.ft. The inventory is primarily composed of lodgepole and whitebark pines, Engleman spruce, subalpine fir, and Douglas-fir. The key game animals are elk, deer, antelope, moose, bighorn sheep, and grouse. Numerous trout species are extensively fished. In fact, this forest has the largest elk and moose populations of any national forest. Approximately 1.7 million visitor days of recreation are produced on the forest of which 19 percent are related directly to hunting and fishing. Range production accounts for 256,000 animal unit months annually.

A comparison with other forests in the Intermountain Region shown in table 2 indicates the Bridger-Teton's dominant position in a number of respects. Not only is it the largest forest, but also it has the largest wilderness area and the largest roadless area inventory in the Region. The largest wilderness is probably one reason why it ranks fourth in terms of recreation visitor days in spite of its remoteness from major population centers. Its proximity to Grand Teton and Yellowstone National Parks also affects recreation usage. Out of 16 forests, the Bridger-Teton ranks fifth in terms of timber production.

Table 2.--*Comparison of selected items for national forests in the Intermountain Region*

National forest	Net national forest acreage[1] (1000's)	Percent of net acres in wilderness and roadless areas	Timber sold 1977	Recreation visitor-days 1977 (1000's)	Authorized forage use 1977 (1000's)
	Acres (Hectares)	*Percent*	*MM bd.ft.*		*Aum's*[2]
Ashley	1,384 (560)	38	18	1,221	85
Boise	2,644 (1 070)	19	85	1,477	99
Bridger-Teton	3,400 (1 376)	79	35	1,690	256
Caribou	1,135 (459)	71	9	417	186
Challis	2,463 (997)	64	5	399	123
Dixie	1,884 (762)	18	27	1,458	113
Fishlake	1,424 (576)	41	3	1,164	153
Humboldt	2,528 (1 023)	63	Trace	483	324
Manti-Lasal	1,265 (512)	46	4	903	174
Payette	2,314 (936)	67	56	497	90
Salmon	1,770 (716)	56	38	400	51
Sawtooth	1,800 (728)	41	29	1,602	194
Targhee	1,642 (664)	61	82	1,720	162
Toiyabe	3,156 (1 277)	28	2	2,651	107
Uinta	813 (329)	57	3	1,532	124
Wasatch	1,419 (574)	49	7	5,031	85
TOTAL	31,042 (12 562)	50	402	23,515	2,327

[1]As of September 30, 1977.
[2]Animal unit months.

Lolo National Forest

The Lolo National Forest is located in west central Montana west of the Continental Divide. The major parts of the forest occur in Missoula and Mineral Counties with the city of Missoula being the closest major population center. As is shown in table 1, the forest contains about 1.5 million acres (607 000 ha) of commercial forest land regulated for timber harvest or about 72 percent of the forest acreage. One hundred ten thousand acres (44 517 ha) are presently dedicated to wilderness, while another 682,000 acres (276 000 ha) are included in RARE II as roadless. An additional 76,000 acres (31 000 ha) were classified as roadless that were removed from RARE II because of wilderness designation (Welcome Creek) and approved land management plans.

The Lolo has abundant resources that have considerable use. The 10 billion board feet of regulated timber inventory has produced an average annual sell of 90 million board feet over the last 5 years. Approximately 1.5 million visitor days of recreation are spent on the forest each year with hunting and fishing making up 17 percent of this use. The key game and fish species are elk, deer, bear, grouse, trout, and whitefish. The grizzly bear, peregrine falcon, and the Rocky Mountain wolf have been identified as rare or endangered species found on this forest. The Lolo also supplies 8,600 animal unit months of forage and water supplies for a number of towns, the city of Missoula, and local irrigation.

In relation to the 12 other forests in the Northern Region of the Forest Service (table 3), the Lolo National Forest is slightly above average in acreage, timber harvest, and road costs and much above average in recreation. It is the fifth largest forest and ranks fifth in terms of timber production. The Lolo ranks sixth for road costs and second in recreation visitor days. Its percent of area in wilderness and roadless areas, however, is below average, 38 percent, the fifth lowest forest.

Table 3.--*Comparison of selected items for national forests in the Northern Region*

National forest	Net national forest acreage[1] (1000's)	Percent of net acres in wilderness and roadless areas	1977 timber sold	1976 road costs	1978 recreation visitor-days (1000's)
	Acres (Hectares)		*MM bd.ft.*	*$/M bd.ft.*	
Beaverhead	2,120 (858)	35	12	-	413
Bitterroot	1,576 (638)	72	44	54	428
Clearwater	1,677 (679)	65	160	29	868
Custer	1,188 (481)	50	1	93	679
Deerlodge	1,195 (484)	37	16	85	737
Flathead	2,365 (957)	60	121	29	854
Gallatin	1,734 (702)	65	7	43	1,930
Helena	972 (393)	64	6	108	233
Idaho Panhandle	3,213 (1 300)	25	254	34	1,334
Kootenai	1,826 (739)	20	197	38	423
Lewis & Clark	1,835 (743)	78	7	29	815
Lolo	2,091 (846)	38	109	45	1,476
Nezperce	2,206 (893)	70	77	37	832
TOTAL	23,998 (9 712)	50	1,011	36	11,021

[1]As of September 30, 1977.

With these points in mind regarding the characteristics of the forests it might be attractive to extrapolate the results of this study to the respective Regions. Experience with other forests in other regions has not revealed any procedures for consistently generalizing the results. Each forest has unique constraints ranging from environmental restrictions to timber sale budgets that vary by harvest level. Therefore, though the conclusions reported here apply to the forests studied, they do not necessarily apply to other forests in their regions.

STUDY ALTERNATIVES

To determine the effects of roadless area withdrawals and the opportunities for intensive timber management, five alternatives were examined for each forest (table 4). For each alternative both the programed harvest and the potential yield for timber were calculated. Potential yield in this study represents the expected annual timber harvest from all regulated commercial forest lands under full funding for intensive timber management subject to some multiple-use constraints. Programed harvest is that part of the potential yield that is funded for harvest in any given year. In this study, unregulated harvest and mortality salvage were not included in the results that are reported.

Table 4.--*Summary of alternatives*

Alternative	Roadless areas available for timber management	Funds reallocated to more intensive timber management	Harvest calculations: Programed harvest	Harvest calculations: Potential Yield	
Base	All	No	X	X	
50 percent out	Half	No	X	X	same
50 percent out--reallocation	Half	Yes	X	X	same
100 percent out	No areas available	No	X	X	same
100 percent out--reallocation	No areas available	Yes	X	X	same

The Base Alternative

The base alternative is used as a basis for comparison with the other alternatives. It represents a timber management plan in which all specified roadless areas are roaded and harvested. This alternative incorporates current plans for timber management, road construction, multiple-use constraints, and budget levels.

The acreage used in the base alternative includes the standard, special, and marginal components of the regulated forest base for potential yield calculations. These components amounted to 1,500,000 and 1,067,000 acres (607 000 and 432 000 ha) on the Lolo and Bridger-Teton, respectively; however, for the programed harvest calculation on the Bridger-Teton, the acreage was reduced to 462,000 acres (187 000 ha).

This reduction represents removal of the marginal acres that could not be managed in the next decade because of environmental, economic, and access constraints. The acreage did not change on the Lolo for the programed harvest calculation.

For both forests, management of these acres consisted of stocking the nonstocked backlog, reforestation, stocking level control where appropriate, thinning, and final harvest. The final harvest was programed for clearcut, shelterwood, and selection harvests, whichever is appropriate to meet the silvicultural and multiple-use objectives of the forest. Such intensive management practices as using genetically improved stock, fertilizing, and irrigation were not considered because either the results were not well established or the practice was not economically feasible. On the Lolo National Forest, some thinning of existing stands was not planned because of an anticipated lack of funds. The Bridger-Teton management intensity was not restricted by the anticipated budget because environmental concerns were more constraining.

Road requirements for the roadless areas were carefully evaluated for each forest by the forest engineers. On the Bridger-Teton, 1,185 miles (1 907 km) of roads were planned, but on the Lolo 2,931 miles (4 716 km) of roads were planned. Both forests were also asked to say how many additional roads would be needed on the roaded areas if the roadless areas were removed from the harvest base. The forests reported that no additional roads were needed beyond those already required for harvest of the roaded areas.

Both multiple-use and environmental constraints were carefully considered on both forests. These constraints usually resulted in reductions in harvest through reduced yields per acre, restricted access, and general limits on acres to be harvested. In some cases, these constraints dictated the kind of harvest or silvicultural treatment permitted. For the Bridger-Teton, these constraints were more restrictive on the programed harvest than on the potential yield.

Budget levels were established for each forest based on the expected level of funding, which represented a projection of past funding levels. By definition, the budget served as a constraint on just the programed harvest. Even then, the budget limited management activities on only the Lolo National Forest. Adequate budgets exist in part because some of the funds for intensive management come from timber sale receipts rather than appropriations.

Since the base alternative was designed to reflect the new timber managemnt plans on the sample forests, we attempted to duplicate assumptions, data, and procedures actually used in the new plans. However, on the Lolo National Forest, the acreage base changed after our study began, thus reducing the actual programed harvest below the figures we show. Furthermore, the forest is involved in a forest planning process that may affect the final harvest figures in other ways yet to be determined.

On the Bridger-Teton, a problem arose because a markedly different scheduling model was used. The model the forest used, ARVOL, essentially schedules harvest of existing stands in a simulation fashion. The model we used scheduled the harvest of existing and future stands so as to maximize harvest in the first decade. Thus, the two answers do not coincide. In spite of these differences, we feel the study results fulfill our purposes because we are interested in illustrating concepts that may apply to forests in general rather than in analyzing a specific policy on a particular forest.

No Reallocation Alternative

The no reallocation alternative consists of removing all the roadless areas from the timber harvest base without intensifying timber management or relaxing other constraints. This alternative is designed to measure the effects of placing all roadless areas on the forest in wilderness or in some other classification that would eliminate timber harvest as an alternative. The difference in timber harvest between this alternative and the base alternative represents a realistic estimate of the amount of harvest attributable to the roadless area. The harvest level is generally different than that presented in RARE II because less precise procedures were used in RARE II.

The acreages on the Bridger-Teton and Lolo National Forests used in this alternative were 343,000 and 1,070,000 acres (139 000 and 433 000 ha), respectively, for potential yield. The programed harvest on the Bridger-Teton was based on 149,000 acres (60 000 ha), whereas the Lolo remained at 1,070,000 acres (433 000 ha). The intensity of timber management was assumed to be the same as for the base alternative. Thus, fewer dollars were generally required because fewer acres were managed. Also, road costs were reduced substantially because the roadless areas were not roaded. Where necessary, multiple-use and environmental constraints were modified to reflect the reduced land base.

Reallocation Alternative

The purpose of the reallocation alternative was to show the effect on harvest and other outputs when roadless areas were excluded and the money saved by not developing roads was invested in intensive timber management on roaded areas instead. This alternative is identical to the previous alternative except that the budget for intensive timber management was increased by the amount of money that would have been spent roading the roadless areas on a decade-by-decade basis.

The amount of money available was determined by estimating the costs of road construction, reconstruction, and maintenance necessary to fully develop the roadless areas. The amount to be reallocated was equal to the costs avoided by not developing the roadless areas, less any increased costs incurred in the currently accessible areas as a result of not developing the roadless areas. No increased costs were projected for the two study forests.

The cost "saving" consisted of two components: (1) purchaser credits that would be generated from timber sale receipts in the roadless areas and (2) appropriated funds. If the roadless areas are not developed, purchaser credits are not available. This means that the reallocation alternatives could only be implemented if Congress appropriated additional money for intensive management.

Applying the cost savings to intensive management permitted increased thinning activity on the Lolo National Forest, but did not increase activities on the Bridger-Teton because the budget was not constraining there.

Partial Roadless Area Alternatives

To test the hypothesis that roadless areas do not contribute to the harvest in proportion to the amount of area involved, alternatives were identified in which only 50 percent of the roadless area was removed from the timber harvest base. Results were projected for both programed harvest and potential yield with and without reallocation of roading funds.

The selection of the half of the roadless area to be removed was based on: (1) the quality of the area for wilderness, (2) public concern for the area as wilderness, (3) congressional and administrative interest, (4) manageability, and (5) the direct and opportunity costs of permanent roadless designation. Because roadless areas were not subdivided, the 50 percent division was only approximated. Furthermore, this division was made on the basis of total forest lands in the roadless areas. The regulated commercial forest land in the first half of the roadless areas withdrawn represented 50 percent on the Bridger-Teton and 47 percent on the Lolo of the total commercial forest land in the roadless areas.

Because of some difficulties with the data, harvest computations representing the withdrawal of half of the roadless area were not made by computer for the Bridger-Teton National Forest. Instead, it was assumed that reducing the roadless area by half would halve the timber harvest attributable to the roadless area. Given the data available, this appears to have been a reasonable assumption.

HARVEST EFFECTS OF ROADLESS AREA WITHDRAWALS

When all of the roadless areas were removed from the timber harvest base and funds for intensive management were provided, the two forests studied here responded differently. The Lolo could make up 27 percent of the 66 MM bd.ft. loss through more intensive management. But the Bridger-Teton could not make up any of its 25 MM bd.ft. loss through more intensive management. These results, of course, depend upon the procedures and assumptions used in the study.

Procedures and Assumptions

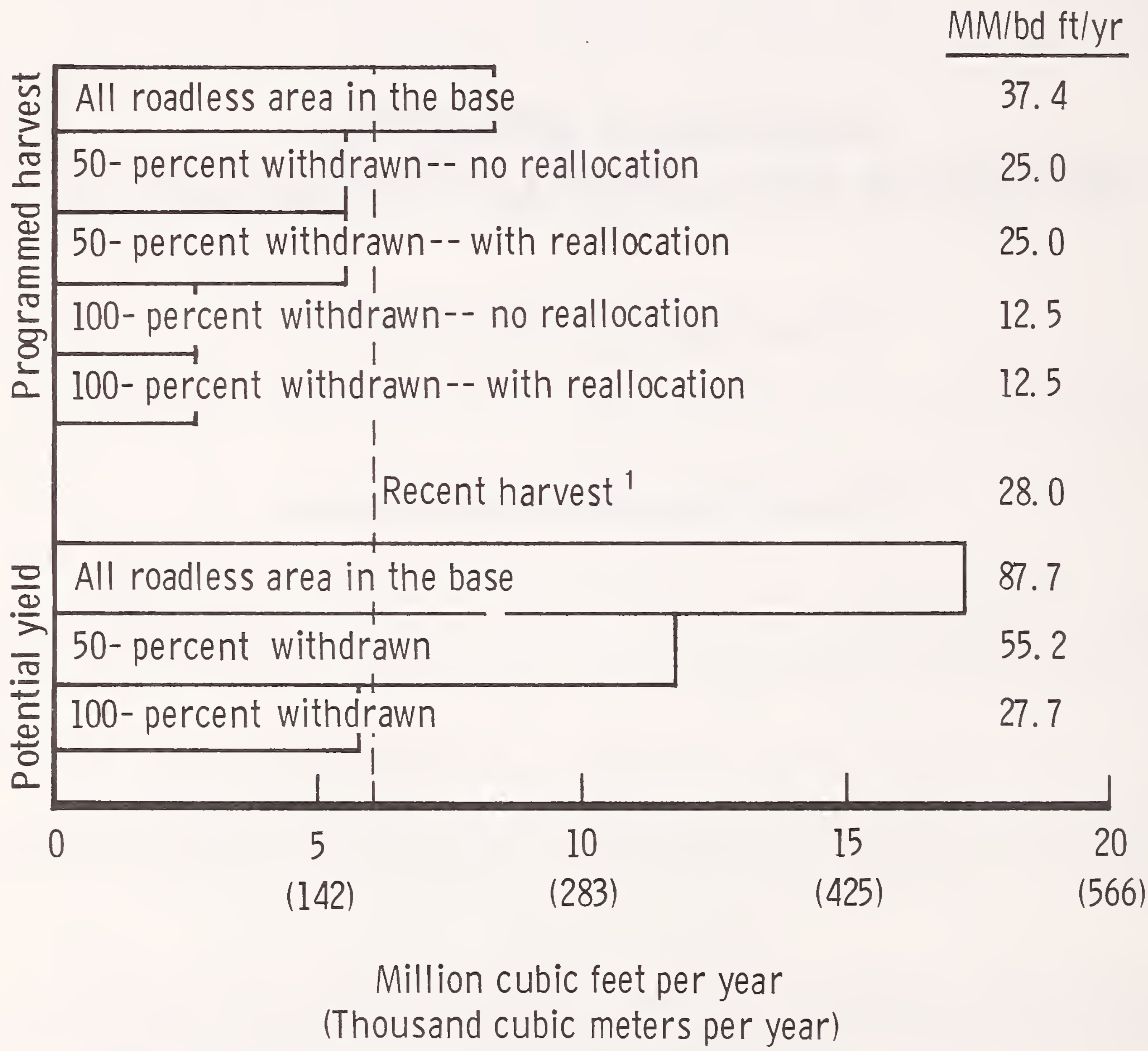
The results were arrived at by simulating the current Forest Service timber management planning process. This involved the use of a linear programing model to schedule the harvest of stands over time. The data for the model were provided by the forest being studied and generally conformed to data actually being used in the timber management planning process.

The linear programing model, called Model II by Johnson and Scheurman (1977), determined the programed harvest and potential yield. In each case, timber harvest was maximized in the first decade subject to nondeclining yield on a decadal basis over time. Other constraints included number of acres allowed for regeneration harvest, species mix in harvest, access to certain areas, adequate ending inventory, and budget level.

The forest's data used in the model consisted primarily of existing and managed stand yield tables organized by species type, habitat type, type of silvicultural treatments, and general age or size of existing stands. Also included were the acres associated with each type, the multiple-use and environmental constraint levels, and various harvest controls. (Details may be obtained from K. N. Johnson, Department of Forestry and Outdoor Recreation, Utah State University, Logan.) In all cases, the timber data considered live green regulated material only. Wood from unregulated areas and dead timber was excluded.

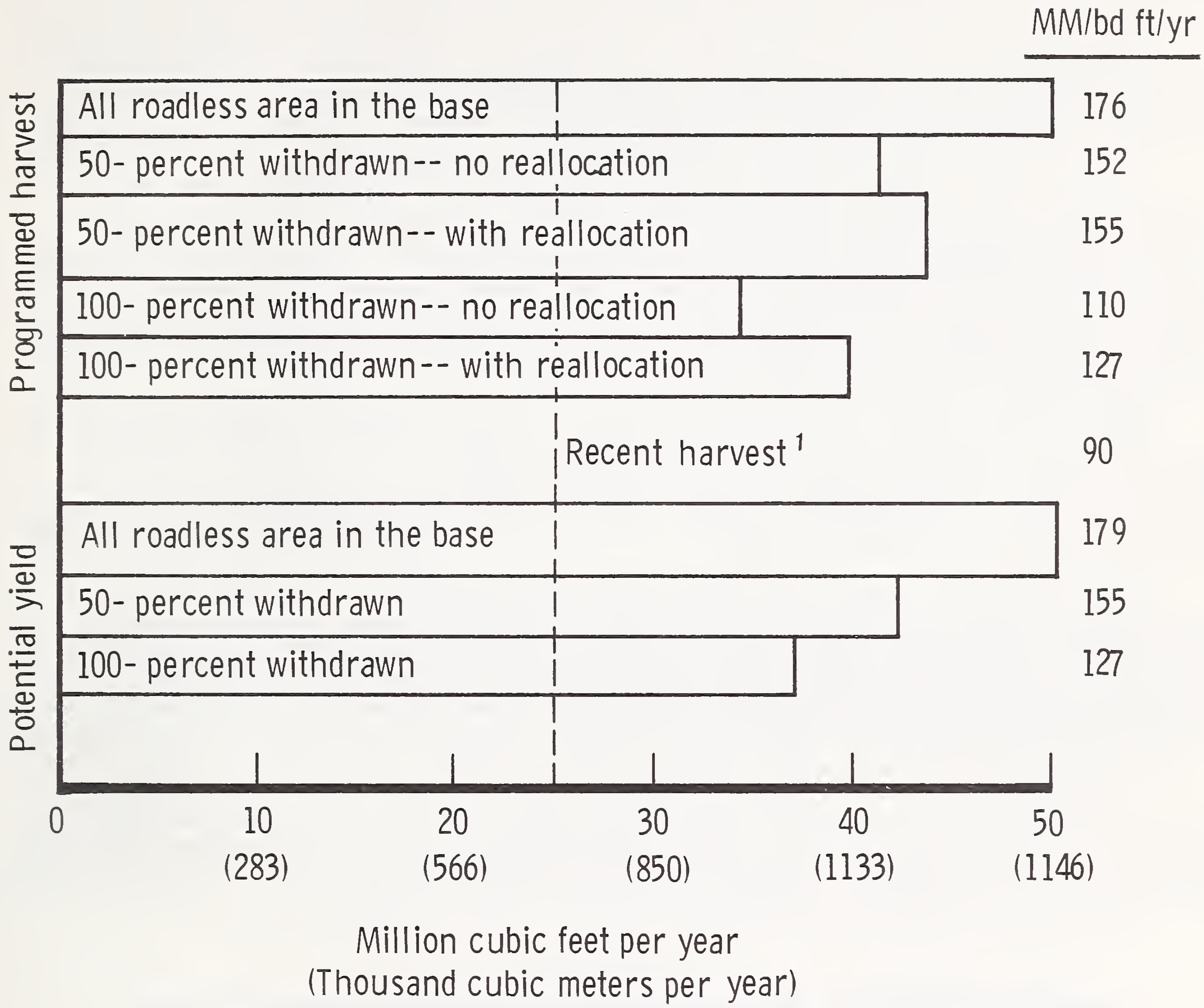
Timber Harvest Levels

Programed harvest levels for the Bridger-Teton and Lolo National Forests are shown in figures 2 and 3, respectively. On the Bridger-Teton, the recent harvest was 75 percent of the base alternative harvest level, but on the Lolo the recent harvest was only about one-half of the base level. This is because of losses to wilderness, wilderness study, and RARE II, which were not considered in the study, and the lack of full funding of the timber sales program.



[1] Average annual quantity sold during the past 5 years.

Figure 2.--Alternative harvest levels on the Bridger-Teton National Forest.



[1]The annual quantity sold the past 5 years is below the base program 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 sufficient funding for a complete timber sale program.

Figure 3.--Alternative harvest levels on the Lolo National Forest.

When all of the roadless areas were removed from the base, the programed harvest level dropped 67 and 38 percent, respectively, on the Bridger-Teton and Lolo. The Lolo could make up approximately one-quarter of this reduction, if roading funds were reallocated to intensive management. Even without the reallocation, the harvest level was above the recent sell. On the Bridger-Teton, there is no opportunity to offset any of the reduction in programed harvest through reallocation of funds to more intensive management of the remaining lands.

When one-half of the roadless area was removed the reduction of the programed harvest for the Bridger-Teton was directly proportional to the acres removed as explained earlier. However, on the Lolo removing one-half of the roadless areas reduced the programed harvest by only 14 percent or 24 MM bd.ft. Only 3 MM bd.ft. of this reduction could be made up by increased intensive management funding.

The potential yield on both forests is reduced in proportion to the acres removed. It is reduced 29 percent and 67 percent, respectively, on the Lolo and Bridger-Teton National Forests when all the roadless area is removed from the base. Those figures represent a reduction in commercial forest lands of 29 and 68 percent, respectively.

All the above results can be explained in terms of the constraints that are restrictive in the harvest scheduling model. On the Bridger-Teton with all roadless areas in the base, programed harvest is limited by the growth of the forest even though growth producing practices such as full stocking level control, prompt regeneration, removal of regeneration backlog, and thinning are assumed to be adequately funded. The difference between the base-programed harvest and the potential yield is produced by the harvest on marginal lands. Harvest there is limited by access, economics, technology, and possible environmental effects of harvesting.

When roadless areas on the Bridger-Teton are withdrawn from the base there are no opportunities to intensify timber management and the harvest is constrained by the number of acres of regeneration harvest allowed. Removing this constraint, which is designed to prevent environmental damage, would increase the programed harvest by more than 10 percent in the first decade.

The Lolo National Forest has similar limiting constraints. With half or all of the roadless areas in the timber harvest base, the harvest level is limited also by future yields of timber stands. When all the roadless areas are withdrawn, constraints on acres of regeneration and intermediate harvest become limiting. Constraints on intermediate harvests can be removed by additional funds to prepare low-volume sales of intermediate harvest on lands of low productivity.

In summary, losses of programed harvest on the Lolo National Forest caused by removal of roadless areas from the timber management base are more potential than real; however, losses will occur on the Bridger-Teton unless the uneconomic and environmentally sensitive marginal lands are brought into timber production. In both instances, the potential yield declines as acres are removed from the base.

FINANCIAL EMPLOYMENT EFFECTS

Financial Analysis Methods

The financial analysis quantifies the effect of the roadless area withdrawal alternatives on gross revenues, road costs, silvicultural costs, net revenues, in-lieu-tax payments to counties, and present net worth. The road cost data reflect the construction of roads to multiple-use standards. However, the financial analysis does not quantify all the land management benefits and costs associated with each alternative. For example, changes in the nontimber benefits of wilderness recreation and the associated nontimber opportunity costs of foregone recreation opportunities are not included in the financial analysis because we do not now have defensible estimates of their monetary values. Direct management costs for resources other than timber are not included in the analysis either. Therefore, one cannot draw conclusions as to the economic efficiency of the harvest alternatives without evaluating the nontimber consequences presented in the final section of this report, along with the financial consequences presented here.

Financial results are shown for two roadless area withdrawal alternatives (50-percent and 100-percent withdrawn). They do not apply to individual roadless areas, and no conclusions can be reached as to the economic efficiency implications of a particular land allocation decision for a particular roadless area.

One of the most difficult problems in quantifying the financial consequences of roadless area withdrawals is how to account for the uncertainty regarding future prices and costs. To investigate the sensitivity of the financial results to alternative futures, two interest rates, two stumpage price trends, and two assumptions about future management costs are used in the financial analysis. Real interest rates, real stumpage prices, and real costs are used throughout the analysis. "Real" means that we make no attempt to project inflationary trends and do not incorporate inflation into the analytical methodology.

COST AND ASSUMPTIONS

The study forests provided cost data for reforestation, precommercial thinning, release, and timber sale preparation and administration (table 5). These data reflect the variable costs of the project, including labor, materials, and contract preparation and administration. The costs in table 5 do not include any charges for general administration or the overhead costs of program administration. On the Lolo National Forest, there are additional charges, equal to 1-1/2 times the timber sale cost, to cover deficit intermediate harvests when the intensity of timber management is increased.

Table 5.--*Silvicultural and timber sale preparation and administration costs for the Bridger-Teton and Lolo National Forests*[1]

Item	Bridger-Teton National Forest		Lolo National Forest	
	$/acre ($/hectare)	*$/M bd.ft.*	*$/acre ($/hectare)*	*$/M bd.ft.*
Reforestation[2]	160.00 (395.00)		250.00 (618.00)	
Release	65.00 (161.00)		57.00 (141.00)	
Precommercial thinning	65.00 (151.00)		57.00 (141.00)	
Timber sale preparation and administration		5.27		7.00

[1]Costs include contract preparation, contract costs, materials and labor, and contract administration. Costs exclude general administration and program management charges.

[2]Reforestation costs include site preparation and planting and apply to both harvested acres and nonstocked backlog.

Table 6 shows the road construction and road cost data provided by the forests. The road construction cost is the total cost that would be incurred to construct a road system in the roadless area. The road system is necessary to support the base programed harvest. Reconstruction and maintenance costs were also included in the financial calculations. For the harvest alternatives with one-half and all of the roadless area excluded from timber management, road construction, reconstruction, and maintenance costs were reduced to reflect the road system for the reduced land base plus any additional roading costs incurred in the currently accessible areas as a result of the reduced land base. All road costs reflect road construction to multiple-use standards rather than the minimum standards for timber sale purposes.

Table 6.--*Road construction and road cost data*

Item	Bridger-Teton National Forest	Lolo National Forest
Total miles constructed to complete road system in roadless areas (kilometers)	1,185 (1 907)	2,931 (4 716)
Total construction costs ($1000's)	31,955	75,000
Cost-dollars per mile ($/kilometer)	26,966 (16 757)	25,588 (15 903)
Construction percent by decade[1]		
First decade	20	20
Second decade	20	20
Third decade	20	18
Fourth decade	20	15
Road miles per section (kilometers/1 000 hectares), in roadless areas		
Regulated commercial forest land acres (Bridger-Teton based on 734,000 acres [297 000 hectares])	1.0 (6.4)	4.4 (27.1)
Total National Forest acres (Bridger-Teton based on 1,750,000 acres [708 000 hectares])	.4 (2.7)	2.5 (15.4)
Reconstruction cost-dollars per mile ($/kilometers)	9,400 (5 800)	1,800 (1 100)
Reconstruction cycle in years	--	30
Maintenance costs-dollars per mile per year ($/kilometer/year)	365 (227)	141 (88)

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

The success of dealing with uncertainty through sensitivity analysis depends on the thoughtful selection of alternative views of the future. Two assumptions about the future course of real costs (costs without inflation) were used in the financial analysis. The first assumption was that future real costs for all conditions would remain at the same levels as shown in tables 5 and 6.

The second cost assumption was that the cost per acre for those practices which use a relatively large quantity of labor would increase at the same rate as projected real per capita income in the Rocky Mountain States, Idaho, Utah, Nevada, Wyoming, Montana, Colorado, and South Dakota. (This assumption is based on empirical evidence gathered by Connaughton.) All other cost items were assumed to remain constant in real terms. Specifically, costs for reforestation, precommercial thinning, and timber sale preparation and administration were assumed to increase at the same rate as the U.S. Water Resources (1974) projections of real per capita income in the Rockies to the year 2020. The increase in real costs of these items is approximately 2.6 percent per year (compounded) over the period 1980 to 2020. Costs were assumed constant after that. The compound annual growth rate of real per capita income in the Rocky Mountain States for selected years between 1970 and 2220 is shown in appendix A.

STUMPAGE PRICE DATA AND ASSUMPTIONS

The prices received for stumpage may be different in the roadless areas from those on the currently accessible areas because of differences in species mix, timber quality, and logging and hauling costs. These factors were accounted for when we developed separate prices on each forest for each half of the roadless area and for the accessible area. The high bid prices for each area were provided by the forests and are shown in table 7. The high bid represents the price of stumpage as if the road system were in place. The prices shown in table 7 represent 1977 stumpage prices that were trended to average out recent fluctuations in stumpage markets.

Two assumptions were made about the future course of stumpage prices. The first was that future stumpage prices would be constant at the same level as the 1977 high bid prices reported by the forests (table 7). The second price assumption was that real stumpage prices would be increasing over time from their 1977 levels.

Table 7.--*High bid stumpage prices for the Bridger-Teton and Lolo National Forest, 1977*

Area	Bridger-Teton National Forest: Lodgepole pine type	Englemann spruce-subalpine fir type	Douglas-fir type	Lolo National Forest
	- - - - - - - - - - - -	*$/M bd.ft.*	- - - - - - - - - - - -	
Accessible	58.76	69.69	64.99	73.00
Roadless area 2[1]	57.51	68.44	63.74	73.00
Roadless area 3[2]	55.50	66.44	61.74	73.00

[1]Roadless area 2 includes the half of the roadless areas most likely to remain in the timber base.
[2]Roadless area 3 includes the half of the roadless areas most likely to remain roadless.

The increases in real stumpage price for the second price assumption came from an early version of the Resources Planning Act Timber Assessment Softwood Market Model.[1] Prices on both study forests were projected to increase at an average annual compound rate of 1.5 percent from 1978 to 2030. We assumed that prices would remain constant after 2030. The stumpage price projections used in the financial calculations for each forest are reported in appendix B, tables 16, 17, 18, and 19.

In the absence of data on harvest changes caused by roadless withdrawals on other forests, we consider the increasing price assumption to be the more realistic. Results calculated with increasing prices are highlighted in the financial results section. We know, however, that roadless withdrawals on other national forests have the potential of affecting total Forest Service harvest levels in the Rocky Mountain States. Reductions in total Forest Service harvest caused by roadless area withdrawals would likely lead to future stumpage prices that would be relatively higher than those in this analysis, despite the price responsive behavior of private stumpage owners and the price responsive flows of products in the manufactured wood products markets. Higher future prices would lead to larger changes in gross revenue, net revenue, county payments, and present net worth than those reported in the financial results section.

Results calculated with constant prices are briefly referred to in the financial results section and are reported in detail in appendix C, tables 20 and 21.

DISCOUNT RATES AND DISCOUNTING

Two discount rates, 5 and 10 percent, were used in present net worth calculations. Five and 10 percent represent a range in rates that is wide enough to reveal the sensitivity of the financial results to the cost of capital. The 5 to 10 percent range also avoids the difficulties of attempting to identify a single "correct" discount rate for public investment evaluation. The range includes the 5 to 6 percent after-tax real rate that Klemperer (1976) concludes is competitive for private forestry.

Present net worths shown in the financial results section and in appendix C, tables 20 and 21, were calculated for 10 decades with the following relationship:

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

where

PNW = present net worth,
r_n = average annual net revenue received in the nth decade,
i = discount rate ($i = 0.05, 0.10$),
n = decade ($n = 1, \ldots, 10$).

[1]Adams, Darius M., and Richard W. Hayes. 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, Oreg.

Employment Analysis Methods

Estimates of the changes in employment resulting from various harvest levels were derived from local input-output tables. These were developed as part of the RARE II analysis for most study forests including the Lolo. The data shown in table 8 for Missoula, Mineral and Sanders Counties were used to scale down the national input-output table to the local level for the Lolo National Forest. Analysis using this local table indicated a change in total employment of 20 man-years for each million board feet processed by the forest products industry in these counties.

The data for measuring the employment impacts resulting from changes in Bridger-Teton harvest differed from data used elsewhere. The two input-output regions developed for western Wyoming in RARE II did not adequately represent the forest's log flows. the two input-output regions developed for western Wyoming in RARE II did not adequately represent the forest's log flows since only one included county was a log destination while three excluded counties were log destinations. Consequently, an export base model was developed using covered employment in Fremont and Lincoln Counties in Wyoming and Fremont and Madison Counties in Idaho (table 9). The multiplier derived from this analysis was combined with the employment consumption ratio of a nearby county to produce a total employment effect of 16 employees per million board feet processed.

The results for both forests 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 final demand sales of each sector. 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.

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 consequence of the harvest alternatives, and the choice of a greater 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 are felt most heavily and where employment concerns are likely to be greatest.

The employment results should also be considered in light of the scope within which they were developed. First, changes in harvest levels were directly 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 non-Forest Service ownerships or nonlocal sources were recognized. Second, the employment results in short-term 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. Third, we believe increases in dispersed, nonmotorized recreation-related employment that would result from all of the roadless areas remaining in a roadless status are likely to be 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. Finally 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.

Table 8.--*Original data for 14-sector input-output model for the Lolo National Forest*[1]

Sector	Final demand ($1000's)	Total gross output ($1000's)	Labor	Income ($1000's)	Value added ($1000's)
			Man-years		
Livestock agriculture	4,068	10,336	1,023	2,452	2,590
Other agriculture	4,664	8,012	497	2,466	3,656
Mining	1,205	1,807	56	89	705
Construction	48,636	54,880	1,948	17,693	24,217
Forest products industry	124,384	164,404	4,270	33,589	
All other manufacturing	48,749	69,525	946	9,295	26,419
Transportation, communication and utilities	48,666	72,611	2,614	26,546	47,051
Wholesale trade	16,236	27,585	1,611	15,081	18,338
Auto dealers - gas stations	12,730	13,686	1,158	7,764	10,460
Eating and drinking places	24,146	24,913	2,108	10,468	19,003
Other detail trade	35,855	39,446	2,540	19,762	30,088
Finance, insurance, real estate	23,130	32,813	1,181	10,228	22,565
Lodging	10,631	10,734	648	2,816	5,375
Other services	40,007	65,556	6,280	29,789	38,588
Private sectors total	443,107	596,308	26,880	188,039	309,518
Government and miscellaneous			6,436	62,248	93,372
Total	443,107	596,308	33,316	250,287	402,890

[1]Includes Missoula, Mineral, and Sanders Counties.

Table 9.--*Covered employment*[1] *for Counties influenced by Bridger-Teton timber harvest, 1976 (U.S. Bureau of Census 1977)*

County	Total number employees	Number basic[2] employees	Wood products industry employees
Wyoming			
Lincoln	2,159	1,017	125[3]
Fremont	7,629	2,516	117
Idaho			
Fremont	1,366	395	100[3]
Madison	3,352	459	70[3]
Totals	14,506	4,387	412

[1]Includes those covered under Federal Insurance Contributions Act except government, self-employed, farm, domestic, and railroad employees.

[2]Includes employees in agriculture, mining, and manufacturing.

[3]Estimates used to avoid disclosure.

Financial and Employment Consequences on Study Forests

Two sets of financial results were calculated using different price and cost assumptions. Results assuming increasing real costs and prices are shown in the text. Those assuming constant real costs and prices are shown in appendix C, tables 20 and 21.

BRIDGER-TETON NATIONAL FOREST

Gross revenue, silvicultural costs, road costs, timber sale costs, net revenue, county payments, present net worth and employment all decline when the roadless areas are withdrawn from the timber management base (table 10). Although the absolute harvest level on the Bridger-Teton is not as great as on the Lolo, the roadless areas on the Bridger-Teton contribute a substantial portion of the volume to the timber program. Since the changes in financial and employment impacts are highly correlated with these harvest changes, the financial and employment consequences depend heavily on whether or not the roadless areas are available for timber harvesting. Present net worth will probably increase when roadless areas are withdrawn, if the marginal lands added to produce the potential yield were programed for harvest in the base alternative. This is because these lands are generally uneconomic to harvest with the present technology, costs, and markets for timber.

When constant real costs and constant real prices (appendix C) are used in the financial analysis the results are similar to those reported for the increasing cost/price assumption. However, the reductions in present net worth are much less than those reductions observed with increasing prices and costs. These results are obtained because present net worth calculations give less weight to future decades--decades in which stumpage prices are considerably higher than they are now. With constant prices and costs, the reductions in present net worth are less when all of the roadless areas are withdrawn than when only one-half of the roadless areas are withdrawn. This result occurs because the lower prices do not generate enough revenue to offset the savings in road costs, which are higher for the second half of the roadless area than for the first half.

Wood products dependent employment is reduced by 200 and 400 person years for the one-half roadless and the all roadless areas out alternatives, respectively. This is probably a high estimate of the total employment effect.

LOLO NATIONAL FOREST

Table 11 shows that gross revenue, net revenue, present net worth, and costs move in the same direction as harvest changes on the Lolo National Forest. A comparison of the results for the 50 percent withdrawn and the 100 percent withdrawn alternatives shows that the reductions in the financial values are approximately proportional to reductions in harvest. Payments to counties may not be affected by harvest levels on this forest, because alternative payments may be elected by the counties.

Wood products-dependent employment is reduced by 420 person years when half of the roadless areas are withdrawn and by 980 when all of the roadless areas are withdrawn from timber harvesting. Since the present harvest is less than the reduced level, these reductions in employment represent lost potential rather than actual employment.

Table 10.--*Forty-year-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management*[1]*, Bridger-Teton National Forest*

Item	Base programed harvest	Change from base when 50 percent roadless withdrawn	Change from base when 100 percent roadless withdrawn
Harvest (MM bd.ft./yr)	37.4	-12.4	-24.9
Gross revenue ($1 million/yr)	3.7	-1.2	-2.4
Cost of roads ($1 million/yr)	NA	- .4	- .9
Cost of cultural treatments ($1 million/yr)	NA	- .3	- .6
Cost of selling timber ($1 million/yr)	NA	- .1	- .2
Net revenue (Item 2-items 3, 4, and 5) ($1 million/yr)	NA	- .4	- .7
Payments to counties[2] ($1 million/yr)	0.9	- .3	- .6
Present net worth for 10 decades at 5 percent ($1 million)	NA	-8.1	-15.8
Present net worth for 10 decades at 10 percent ($1 million)	NA	-4.0	-7.8
First decade average[3] annual total employment (man-years)	600	-200	-400

NA = not available

[1]Trends in real costs and real stumpage prices expected with no harvest changes due to roadless area withdrawals on other national forests in Regions 1, 2, 3, and 4 were used.

[2]Based on 25 percent of gross receipts. Actual value may be greater and not vary between alternative withdrawals.

[3]Because recent harvest is 25 percent less than the base programed harvest, 150 man-years are potential employment and the rest is actual.

Table 11.--*Forty-year-average financial and employment effects of withdrawing roadless areas and reallocating funds to intensive management*[1], *Lolo National Forest*

Item	Base programed harvest	Change from base when 50 percent roadless withdrawn	Change from base when 100 percent roadless withdrawn
Harvest (MM bd.ft./yr)	176.0	-21.0	-49.0
Gross revenue ($1 million/yr)	21.5	-2.5	-5.9
Cost of roads ($1 million/yr)	NA	- .7	-1.5
Cost of cultural treatments ($1 million/yr)	NA	- .9	-2.0
Cost of selling timber ($1 million/yr)	NA	- .3	- .6
Net revenue (Item 2-items 3, 4, and 5) ($1 million/yr)	NA	- .6	-1.8
Payments to counties ($1 million/yr)[2]	5.4	- .6	-1.5
Present net worth for 10 decades at 5 percent ($1 million)	NA	-17.1	-35.3
Present net worth for 10 decades at 10 percent ($1 million)	NA	-7.1	-14.8
First decade average[3] annual total employment (man-years)	3,510	-420	-980

NA = not available

[1]Trends in real costs and real stumpage prices expected with no harvest changes caused by roadless area withdrawals on other national forests in Regions 1, 2, 3, and 4, were used.

[2]Based on 25 percent of gross receipts. Actual value may be greater and vary less between alternative withdrawals.

[3]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 represent losses in opportunities for increases rather than reductions from actual recent levels.

Conclusions About the Financial and Employment Consequences of Roadless Withdrawals

Gross revenue, net revenue, costs, present net worth, and employment decline on both forests when all or half of the roadless areas are withdrawn from the timber management base. The roadless areas on the Lolo make a financial contribution to the timber program that is larger in absolute value than the contribution made by the roadless areas on the Bridger-Teton. However, in relative terms, the roadless areas on the Bridger-Teton make a larger contribution to the financial value of the timber program than do such areas on the Lolo.

The employment changes on both forests are directly proportional to the harvest changes. With all roadless areas withdrawn, the employment losses are 980 and 400 person years on the Lolo and Bridger-Teton, respectively.

CHANGES IN ENVIRONMENTAL CONDITIONS AND NONTIMBER BENEFITS

Background

This section of the report demonstrates that the roadless area issue involves many kinds of trade-offs concerning environmental conditions and nontimber benefits. The trade-offs examined are those attributable to withdrawing roadless areas from the timber base and reallocating road funds to intensify timber management on remaining areas. We focus our analysis of nontimber impacts on a comparison of the alternative, 100 Percent Roadless Area Out--Reallocation (of roading funds), with the base alternative.

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

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

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 harvest, and acres of management activities. The specialists reviewed the differences in these data between the base alternative and the reallocation alternative. Then, they interpreted these differences in terms of their effects on nontimber benefits and ecosystem criteria. For this report, forest data were divided into a roadless portion and an accessible portion. Each was evaluated seperately.

Present Situation

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

Since 1972, all RARE I roadless areas and some more recently identified RARE II areas have been closed to timber harvesting, except where they have been allocated to such use through a completed land management plan. Consequently, 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, road construction and timber harvesting have been concentrated outside the roadless areas since 1972. 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 in 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 to the choice between the two.

Comparison of Alternatives and Criteria

The impacts presented here represent changes from the base alternative. Generally trade-offs exist between the various criteria and between the roadless and accessible areas within each criterion. Impacts related to roadless areas are generally those on the base alternative that are avoided by the adoption of the reallocation alternative.

Our experience in this study has confirmed findings that were evident in the Timber Harvest Scheduling Issues Study (USDA 1976). Specifically, impacts on nontimber resources are site specific; they may be variable within a forest; and they often exhibit great variability between forest and regions. For these reasons, we did not try to extrapolate regional impacts from the study forest.

In the following discussion, the criteria impacts are identified and briefly discussed and the results of the analysis of the impacts are presented for each forest.

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.

WATER QUANTITY AND TIMING OF FLOW

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

SOIL STABILITY

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

SOIL PRODUCTIVITY

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

FORAGE PRODUCTION

On western national forests, forage production often occurs on 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 harvested acres. The terrain must be negotiable by domestic livestock and located in the proximity of existing active grazing allotments.

RESIDENTIAL COLD WATER FISH POPULATIONS

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

WILDLIFE POPULATIONS

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

OPPORTUNITIES FOR DEVELOPED RECREATION

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

OPPORTUNITIES FOR DISPERSED RECREATION RELATED TO ROADS

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

OPPORTUNITIES FOR DISPERSED RECREATION AWAY FROM ROADS

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

VISUAL RESOURCES

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

AIR QUALITY

Smoke from burning slash is the principal source of air pollutants associated with timber management activities. The impact on air quality is, however, a 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.

MINERAL AND ENERGY DEVELOPMENT OPPORTUNITIES

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

Bridger-Teton National Forest Results

If the reallocation alternative were adopted in place of the base alternative on the Bridger-Teton National Forest, no roads would be built and no road-related timber harvest would occur in the roadless areas of the forest. Specialists would anticipate two major adverse and five major beneficial nontimber or environmental impacts. All of the major impacts would be associated with roadless areas. Also expected by the specialists are 7 minor adverse, 4 minor beneficial, and 12 neutral nontimber or environmental impacts. All of these impacts are listed in table 12.

Table 12.--*Summary of estimated impacts associated with withdrawing the roadless areas and intensifying timber management on the remaining land in the Bridger-Teton National Forest*[1]

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

[1]R = Roadless areas, A = Accessible areas.

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

The major beneficial impacts of the reallocation alternative involve water quality, fish and wildlife populations, and dispersed recreation away from roads. The beneficial impacts on fish populations relate to the opportunity to avoid habitat degradation in the roadless areas. For wildlife populations of game, primarily elk, moose, and bighorn sheep and threatened and endangered species, primarily grizzly bear, gray wolf, and bald eagle, the major anticipated beneficial impacts result from the opportunity to avoid intensive road-related timber management in the roadless areas. Finally, for dispersed recreation opportunities away from roads, the beneficial impacts result from the opportunity to avoid reducing the roadless areas.

The major adverse impacts involve dispersed recreation opportunities related to road, mineral, and energy development. The adverse impact on road-related dispersed recreation results from opportunities foregone to increase the accessible area. The adverse impact on mineral and energy development relates to the opportunity foregone to gain access to the roadless areas.

In summary, when the reallocation alternative is adopted in place of the base alternative, specialists on the Bridger-Teton National Forest would anticipate major nontimber trade-offs in addition to the loss of timber harvests listed in figure 2. Water quality, fish, wildlife, and dispersed recreation away from roads would be expected to benefit at the expense of dispersed recreation related to roads and of mineral and energy development.

Lolo National Forest Results

If the reallocation alternative were adopted in place of the base alternative on the Lolo National Forest, no roads would be built and no road-related timber harvests would take place in the roadless areas of the forest. Specialists would anticipate one major adverse and five major beneficial nontimber or environmental impacts. Four of these six major impacts would be associated with the roadless areas and two with the accessible areas. Also expected by the specialists are three minor adverse impacts, six minor beneficial impacts and 15 neutral nontimber or environmental impacts. All impacts are listed in table 13.

The major beneficial impacts of the reallocation alternative involved water quality, soil stability, forage, and wildlife populations of game species. The beneficial impacts on water quality and soil stability result from the opportunity to avoid sedimentation, erosion, and mass soil movement in the roadless areas. With forage, the beneficial impacts are associated with the opportunity to increase forage production in the accessible areas. For wildlife populations of game species, the beneficial impacts result from opportunities to avoid a reduction of desirable habitat, mainly cover in the roadless areas, and to increase browse and cover in the accessible areas.

The major adverse impact, forage production in roadless areas, results from the opportunity foregone to increase forage production in the roadless areas when they are withdrawn from the commercial forest land base.

In summary, adoption of the reallocation alternative in place of the base alternative would cause specialists on the Lolo National Forest to anticipate major nontimber and environmental trade-offs in addition to the loss of timber harvest. Water quality, soil stability, and wildlife populations would benefit in the roadless areas and forage production and wildlife populations would benefit in the accessible areas at the expense of forage production in the same areas.

Table 13.--*Summary of estimated impacts associated with withdrawing the roadless areas and intensifying timber management on the remaining land in the Lolo National Forest*[1]

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

[1]R = Roadless areas, A = Accesible areas.

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

CONCLUSIONS

A summary of some consequences of intensifying timber management as roadless areas are withdrawn from timber production is presented in table 14. In general, there is little opportunity to offset potential timber harvest reductions through intensive management as roadless areas are removed. Consequently, present net worth, payments to counties, and employment may be reduced along with forage production, dispersed recreation related to roads, and mineral and energy development. On the other hand, fish and game populations, water quality, soil stability, and opportunities for dispersed recreation experiences away from roads may be improved. Although it is tempting to extrapolate these consequences to other forests in the regions studied, great care must be exercised because the variability between forests is so great.

Table 14.--*Consequences of changing from the base alternative to 100 percent removal of roadless areas with reallocations of roading funds to intensive management by forest*

Criteria	Bridger-Teton National Forest	Lolo National Forest
Programed harvest (MM bd.ft.)	-25	-49
Potential Yield (MM bd.ft.)	-55	-52
Roads (miles, kilometers)	-1185, 1907	-2931, 4716
Present net worth at 5 percent ($1 million)	-15.8	-35.3
Employment (man-years)	-400	-980
Water quality	Major beneficial (R)[1]	Major beneficial (R)
Forage production	Minor adverse (R)	Major beneficial (A)[2] and adverse (R)
Fish population	Major beneficial (R)	Minor beneficial (R)
Big game population	Major beneficial (R)	Major beneficial (A,R)
Threatened and endangered species	Major beneficial (R)	Minor beneficial (R)
Dispersed recreation related to roads	Major adverse (R)	Minor adverse (R)
Dispersed recreation away from roads	Major beneficial (R)	Minor beneficial (R)
Mineral and energy development	Major adverse (R)	Minor adverse (R)

[1]R = roadless areas.
[2]A = accessible areas.

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APPENDIXES

APPENDIX A

Annual Compound Growth Rate of Real Per Capita Income in the Rockies, 1978-2020

Table 15.--*The annual compound growth rate (percent) of real per capita income in the Rockies*[1], *1978-2020*

Year	1983	1993	2003	2013	2020
1978	3.19	2.78	2.71	2.68	2.59
1983	--	2.58	2.59	2.60	2.51
1993	--	--	2.60	2.61	2.49
2003	--	--	--	2.62	2.42
2013	--	--	--	--	2.14

Source: U.S. Water Resources Council, 1974.

[1]The Rockies include Idaho, Utah, Nevada, Montana, Wyoming, Colorado, and South Dakota.

APPENDIX B

Real Stumpage Price Assumptions Used for Study Forests

Table 16.--*Real stumpage price in 1978 dollars Lolo National Forest*

Decade	Constant in all areas[1]	Increasing in all areas[2]
	- - - - *Dollars per thousand board feet* - - - -	
First	73.15	94.59
Second	73.15	124.89
Third	73.15	131.83
Fourth	73.15	138.98
Fifth	73.15	146.22
Sixth	73.15	154.49
Seventh	73.15	154.49
Eighth	73.15	154.49
Ninth	73.15	154.49
Tenth	73.15	154.49

[1]High bid price reported by the forest.

[2]Resources Planning Act Timber Assessment Softwood Market Model projections from 1978 high bid price levels.

Table 17.--*Real stumpage price in 1978 dollars Bridger-Teton National Forest--lodgepole pine timber type*

Decade	Constant prices[1 3]			Increasing prices[2 3]		
	All roadless areas in	50 percent roadless areas out	All roadless areas out	All roadless areas in	50 percent roadless areas out	All roadless areas out
	Dollars per thousand board feet					
First	47.59	48.28	48.76	74.16	75.24	75.99
Second	47.59	48.28	48.76	95.59	96.99	97.94
Third	47.59	48.28	48.76	98.71	100.16	101.15
Fourth	47.59	48.28	48.76	102.98	104.49	105.52
Fifth	47.59	48.28	48.76	108.35	109.94	111.03
Sixth	47.59	48.28	48.76	115.11	116.79	117.95
Seventh	47.59	48.28	48.76	115.11	116.79	117.95
Eighth	47.59	48.28	48.76	115.11	116.79	117.95
Ninth	47.59	48.48	48.76	115.11	116.79	117.95
Tenth	47.59	48.28	48.76	115.11	116.79	117.95

[1]High bid price reported by the forest.
[2]Resources Planning Act Timber Assessment Softwood Market Model projections from 1978 high bid price levels.
[3]Prices vary by land base because of differences in logging and hauling costs and in timber quality.

Table 18.--*Real stumpage price in 1978 dollars Bridger-Teton National Forest--Englemann spruce-subalpine fir type*

Decade	Constant prices[1] [3]			Increasing prices[2] [3]		
	All roadless areas in	50 percent roadless areas out	All roadless areas out	All roadless areas in	50 percent roadless areas out	All roadless areas out
	Dollars per thousand board feet					
First	56.88	57.47	57.83	88.64	89.57	90.12
Second	56.88	57.47	57.83	114.26	115.45	116.16
Third	56.88	57.47	57.83	118.00	119.23	119.96
Fourth	56.88	57.47	57.83	123.10	124.39	125.15
Fifth	56.88	57.47	57.83	129.52	130.87	131.68
Sixth	56.88	57.47	57.83	137.59	139.03	139.89
Seventh	56.88	57.47	57.83	137.59	139.03	139.89
Eighth	56.88	57.47	57.83	137.59	139.03	139.89
Ninth	56.88	57.47	57.83	137.59	139.03	139.89
Tenth	56.88	57.47	57.83	137.59	139.03	139.89

[1]High bid price reported by the forest.
[2]Resources Planning Act Timber Assessment Softwood Market Model projections from 1978 high bid price levels.
[3]Prices vary by land base because of differences in logging and hauling costs and in timber quality.

Table 19.--*Real stumpage price in 1978 dollars Bridger-Teton National Forest--Douglas-fir type*

Decade	Constant prices[1] [3]			Increasing prices[2] [3]		
	All roadless areas in	50 percent roadless areas out	All roadless areas out	All roadless areas in	50 percent roadless areas out	All roadless areas out
	Dollars per thousand board feet					
First	52.99	53.57	53.93	82.85	83.49	84.04
Second	52.99	53.57	53.93	106.45	107.62	108.33
Third	52.99	53.57	53.93	109.93	111.14	111.87
Fourth	52.99	53.57	53.93	114.68	115.95	116.71
Fifth	52.99	53.57	53.93	120.66	121.99	122.80
Sixth	52.99	53.57	53.93	128.18	129.60	130.45
Seventh	52.99	53.57	53.93	128.18	129.60	130.45
Eighth	52.99	53.57	53.93	128.18	129.60	130.45
Ninth	52.99	53.57	53.93	128.18	129.60	130.45
Tenth	52.99	53.57	53.93	128.18	129.60	130.45

[1]High bid price reported by the forest.
[2]Resources Planning Act Timber Assessment Softwood Market Model projections from 1978 high bid price levels.
[3]Prices vary by land base because of differences in logging and hauling costs and in timber quality.

APPENDIX C

Detailed Financial Consequences for Study Forests Under the Constant Cost-Constant Stumpage Price Assumption

Table 20.--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management*[1], *Bridger-Teton National Forest*

Item	Base programed harvest	Change from base when 50 percent roadless withdrawn	Change from base when 100 percent roadless withdrawn
Harvest (MM bd.ft./yr)	37.4	-12.4	-24.9
Gross revenue ($1 million/yr)	1.9	- .6	-1.2
Cost of roads ($1 million/yr)	NA	- .4	- .9
Cost of cultural treatments ($1 million/yr)	NA	- .1	- .3
Cost of selling timber ($1 million/yr)	NA	- .1	- .1
Net revenue (Item 2-items 3, 4, and 5) ($1 million/yr)	NA	--	+ .1
Payments to counties ($1 million/yr)	.5	- .2	- .3
Present net worth for 10 decades at 5 percent ($1 million)	NA	- .4	- .2
Present net worth for 10 decades at 10 percent ($1 million)	NA	- .2	- .1

NA = not available.
[1]Constant real stumpage prices and real costs were used.

Table 21.--*Four-decade-average financial effects and employment effects of withdrawing roadless areas and reallocating funds to intensive management*[1]*, Lolo National Forest*

Item	Base programed harvest	Change from base when 50 percent roadless withdrawn	Change from base when 100 percent roadless withdrawn
Harvest (MM bd.ft./yr)	176	-21	-49
Gross revenue ($1 million/yr)	12.9	-1.5	-3.5
Cost of roads ($1 million/yr)	NA	- .7	-1.5
Cost of cultural treatments ($1 million/yr)	NA	- .5	-1.2
Cost of selling timber ($1 million/yr)	NA	- .1	- .3
Net revenue (Item 2-items 3, 4, and 5) ($1 million/yr)	NA	- .2	- .5
Payments to counties ($1 million/yr)	3.2	- .4	- .9
Present net worth for 10 decades at 5 percent ($1 million)	NA	-5.2	-10.7
Present net worth for 10 decades at 10 percent ($1 million)	NA	-2.0	-4.1

NA = not available.
[1]Constant real stumpage prices and real costs were used.

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Enoch F. Bell, K. Norman Johnson, Kent P. Connaughton, and Robert Sassaman.
1979. Roadless area - intensive management trade-offs on the Bridger-Teton and Lolo National Forests. USDA For. Serv. Gen. Tech. Rep. INT-72, 38 p. Intermt For. and Range Exp. Stn., Ogden, Utah 84401.

This study on two national forests of ways to offset losses in timber harvesting resulting from removal of roadless areas from the timber management base revealed few opportunities to do so. Removal of roadless areas also resulted in decreases in present net worth, in employment, in opportunities for mineral development, in dispersed recreation related to roads, and in forage production in the roadless areas. When the roadless areas were reserved from timber harvest, major improvements on both forests were projected in water quality, in soil stability, in fish and wildlife populations, and in dispersed recreation opportunities away from roads.

Enoch F. Bell, K. Norman Johnson, Kent P. Connaughton, and Robert Sassaman.
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The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

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