IDENTIFYING AND EVALUATING ENVIRONMENTAL IMPACTS ASSOCIATED WITH TIMBER HARVEST SCHEDULING POLICIES

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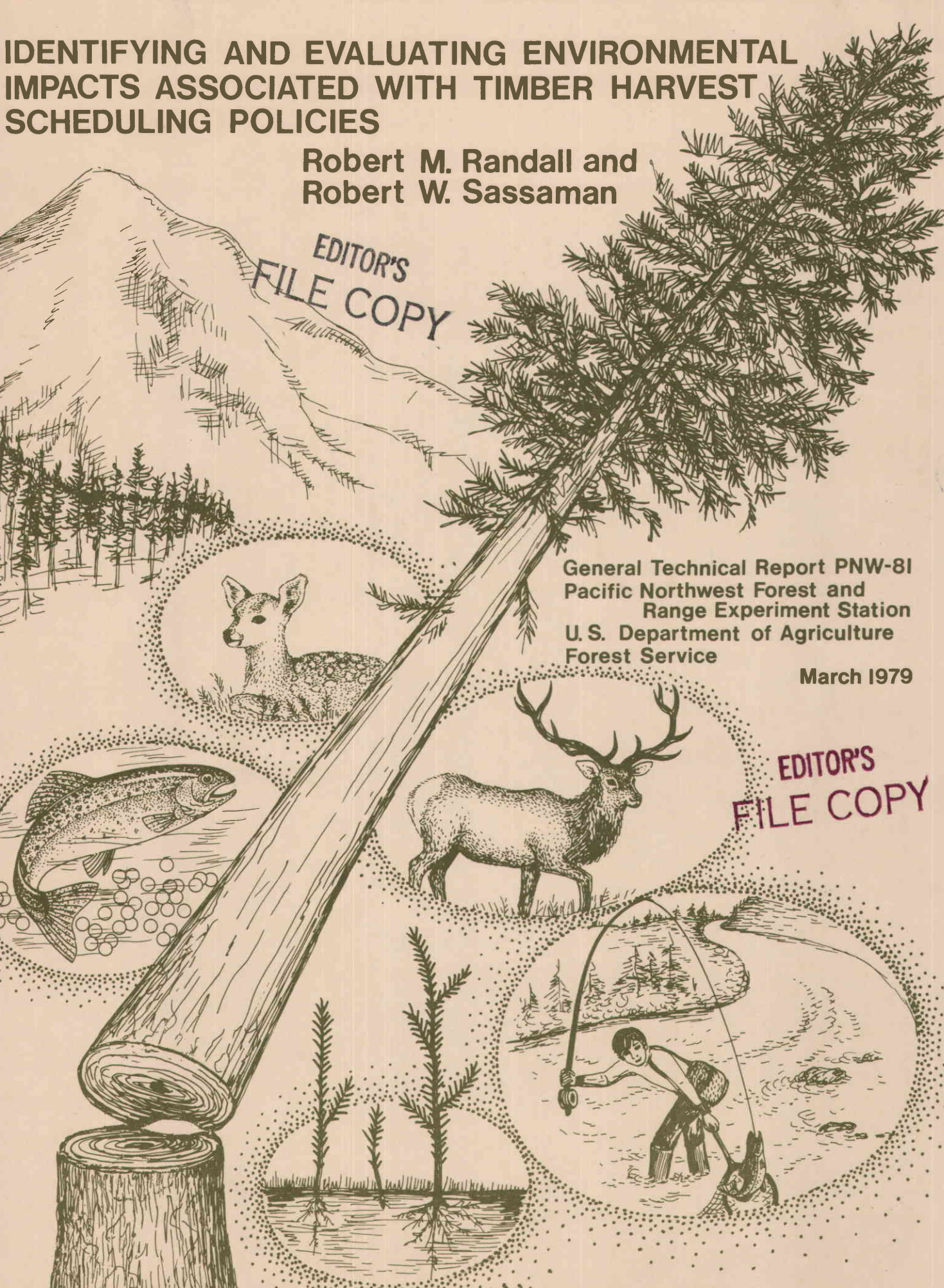

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ABSTRACT

Expected impacts on the ecosystem and nontimber benefits (that is, people's use of the resources--recreation, hunting, fishing, swimming, etc.) resulting from alternative timber harvest scheduling policies are identified and evaluated for the Mount Hood National Forest. Environmental criteria are established and used in evaluations of timber harvest and management data.

KEYWORDS: Logging operations analysis/design, amenity values (forest), ecosystems, environment, Oregon (Mount Hood National Forest).

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INTRODUCTION

Early in 1975, the Chief of the Forest Service initiated a study of the consequences that could be expected if the Forest Service were to depart from its harvest scheduling policy of nondeclining even flow. The study was accomplished in 18 months by a team of economists from the Pacific Northwest Forest and Range Experiment Station and representatives from other Experiment Stations and the academic community. The result was a report to the Chief, the "Timber Harvest Scheduling Issues Study."[1]

In brief, the study examined issues involving harvest scheduling alternatives, investment and utilization levels, and size of planning unit. Central to the study of harvest scheduling alternatives was an evaluation of social consequences expected if policy were to change; 13 consequences were identified and evaluated.

In this paper, we describe the procedures used to evaluate two of these consequences, impacts on the forest ecosystem and impacts on nontimber benefits. Nontimber benefits are derived from nontimber goods and services produced by the forest resources; for example, recreation, hunting, fishing, swimming, etc.

These two consequences were studied because any change in harvest scheduling or investment policy by an organization as large as the Forest Service results in impacts on the environment and the social uses of the nontimber resources. For example, changes in the rate of timber cutting, in silvicultural practices, and in the rate of road construction can be expected to produce impacts on the forest ecosystem with subsequent effects on resource supplies and uses. The purpose of these studies was to find out what impacts on the ecosystem and nontimber benefits might be expected and the magnitude of such impacts.

Specific objectives were to: (1) identify and estimate the magnitude of impacts on the forest ecosystem and on nontimber benefits caused by changes in Forest Service harvest scheduling policies and (2) evaluate the importance of these impacts in terms of criteria based on environmental standards and on social uses.

This paper describes the approach used to identify, estimate, and evaluate impacts and presents some of the results for analysts and land use planners who must assess environmental impacts and present them in a comprehensible form to decisionmakers.

Part 1 describes timber harvest scheduling alternatives and investment levels and the procedures used to identify, estimate, and evaluate impacts caused by these alternatives. Part 2 describes the criteria selected to evaluate each impact. Part 3 describes the results of the evaluation for one National Forest.

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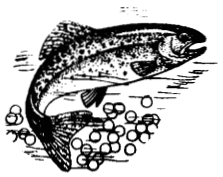
[1] U.S. Department of Agriculture, Forest Service. 1976. Timber harvest scheduling issues study. 292 p. Unpublished. Washington, D.C.



PART 1. ALTERNATIVES AND PROCEDURES

Alternative Harvest Schedules

Six harvest scheduling alternatives were evaluated; the procedures are outlined in this paper. The "Timber Harvest Scheduling Issues Study" (see footnote 1) had eight alternatives; however, the computer runs from two of these alternatives were not ready when specialists were convened to evaluate impacts and they are not included here since they were evaluated under different procedures. The six alternatives are described below:

A. *Nondeclining even flow* is the current Forest Service policy. It maximizes the first decade harvest, subject to no decline between decades. Harvest may rise but will not decline between decades.

B. *Conversion period even flow* was Forest Service policy prior to nondeclining even flow. It maximizes the first decade harvest subject to even flow for the first rotation only, followed by harvest at the resulting sustained-yield level. Harvest may neither rise nor decline during the first rotation. This policy may result in a drop in harvest level after the first rotation.

C. *Five-percent declining flow* maximizes the first decade harvest, subject to a maximum decline of 5 percent between decades. This alternative is likely to result in higher initial harvest levels.

D. *Ten-percent fluctuating flow*, as with alternative C, provides greater flexibility than strict even flow (alternatives A and B) does to vary the harvest to increase total yield. This alternative maximizes total harvest over the planning period (300 years), subject to a maximum fluctuation of $\pm$ 10 percent around the conversion period average.

E. *Area Control* attains a regulated forest more quickly than other alternatives do. Harvest is maximized over the first decade, subject to harvest cutting of an equal area each decade. Volume flows can be erratic from decade to decade.

F. *Price-controlling flow* is the scheduling of harvests so as to counter long-term upward trends in national wood product prices. The objective is to benefit consumers by harvesting old growth at a faster rate to dampen the trend of rising wood product prices.

Investment Assumptions

In the "Timber Harvest Scheduling Issues Study" assumptions were made about the silvilcultural practices that would be carried out in the future. Since these assumptions are speculative, two sets of assumptions were developed: a "low" level investment estimate about what might be done in the future and a "high" level investment estimate including a wider range of practices. These assumptions were evaluated for their impact on the forest ecosystem and on nontimber benefits.

Investment assumed	Investment level	
	Low	High
Planting "hard core" backlog areas	X	X
Planting harvest areas with:		
Regular stock	X	
Genetically improved stock		X
Stocking control		X
Commercial thinning	X	X

Study Procedures

Three kinds of data were needed to evaluate impacts: a description of the nature and estimate of the extent of management activities for each alternative and investment level; a description and estimate of magnitude of actual impacts on the ecosystem and nontimber benefits caused by management activities; and an evaluation of the importance, in social terms, of the impacts. This section describes the procedures used to obtain these data.

Description and Estimates of Management Activities

The Mount Hood and Ochoco National Forests were chosen as case studies for obtaining information about the nature and extent of management activities that would occur with each harvesting alternative. The information needed was provided by each Forest from Timber RAM (Resource Allocation Method) computer runs.[2] Only data for Mount Hood will be presented. Tables 1 and 2 summarize the pertinent management activities information provided by the Mount Hood National Forest. All data in tables 1 and 2 were a result of the Timber RAM program, except for road construction which was independently calculated. A similar format was used in analysis of impacts on the Ochoco National Forest.[3]

Table 1 shows figures for Mount Hood first at a low investment level; table 2, at a high investment level. The total area used in calculating the regulated harvest was 696,015 acres. This area does not include wilderness or other special areas devoted to nontimber uses.

Description and Estimation of Impacts on the Ecosystem and Nontimber Benefits

For information on impacts, specialists representing each resource area were either called together to comprise evaluation panels or were contacted individually.[4] The specialists were shown the data in tables 1 and 2. They were asked to describe the kinds of impacts and to estimate the levels of impacts on the ecosystem and nontimber benefits likely to occur as a result of changing from the current policy to one of the alternatives.

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[2] Navon, Daniel I. 1971. Timber RAM...a long-range planning method for commercial timber lands under multiple-use management. USDA For. Serv. Res. Pap. PSW-70, 22 p., illus. Pac. Southwest For. and Range Exp. Stn., Berkeley, Calif.

Timber RAM is a long-range planning method using linear programing for scheduling harvesting and reforestation on commercial forest lands under multiple-use management.

[3] Persons interested in the evaluation of impacts for the Ochoco National Forest should see background report 20, "Effects of harvesting alternatives on forest ecosystems" (36 p.), by Robert M. Randall, and background report 21, "Effects of harvest scheduling alternatives on nontimber benefits" (22 p.), by Robert W. Sassaman. These background reports are available from: Reprints, Graphic Information Systems, Inc., P.O. Box 23519, Portland, Oregon 97223; prices, postpaid to one address, are 15 cents per page for the first copy, 9 cents per page for additional copies.

[4] See appendix for list of panel participants.

Table 1--Average acres per decade by management activity and average miles of road constructed per decade for 6 policy alternatives in the Douglas-fir zone of the Mount Hood National Forest,[1] low investment level

	Policy alternative	Clear-cutting	Shelter-wood cutting	Commercial thinning	Road construction
					Miles
		SHORTRUN IMPACT			
		Acres (in thousands) treated			
		(Average of 1st 3 decades)			
A	Nondeclining even flow	43.9	14.7	43.7	243
B	Conversion period even flow	44.2	14.7	43.7	243
C	5-percent declining flow	54.4	18.1	43.7	281
D	10-percent fluctuating flow	48.9	16.3	43.7	261
E	Area control	41.4	13.8	42.5	[2]
F	Price controlling flow	101.4	33.8	43.7	456
		LONGRUN IMPACT (10 DECADES)			
		Acres (in thousands) treated			
		(Conversion period average per decade)			
A	Nondeclining even flow	41.8	13.9	127.0	151
B	Conversion period even flow	41.8	13.9	127.0	151
C	5-percent declining flow	42.2	14.0	133.5	151
D	10-percent fluctuating flow	42.3	14.1	130.5	151
E	Area control	41.4	13.8	95.6	[2]
F	Price controlling flow	46.4	15.5	144.7	151

[1] Total managed area, 696,015 acres.

[2] Data not available.

Impact estimates were subjectively developed. Panelists estimated impacts on the basis of the acres harvested and treated per decade and the miles of road constructed. They felt that acres entered and miles of road constructed were better indexes of impacts than was volume harvested per decade. Because information linking the acres designated for harvest by the RAM model and the actual location of these acres on the ground was lacking, panelists had to make broad estimates of the impacts on the ecosystem and nontimber benefits.

Evaluation of Impacts

To evaluate impacts on the ecosystem, panelists were asked to judge whether an expected change in policy would produce

Table 2--Average acres per decade by management activity and average miles of road constructed per decade for 6 policy alternatives in the Douglas-fir zone of the Mount Hood National Forest,[1] high investment level

	Policy alternatives	Clear-cutting	Shelter-wood cutting	Commercial thinning	Precom-mercial thinning	Road con-struction
						Miles
			SHORTRUN IMPACT			
			Acres (in thousands) treated			
			(Average of 1st 3 decades)			
A	Nondeclining even flow	69.5	23.1	57.2	50.7	377
B	Conversion period even flow	69.4	23.2	57.4	51.1	377
C	5-percent declining flow	79.8	26.5	57.2	65.2	415
D	10-percent fluctuating flow	73.7	24.6	57.1	52.0	392
E	Area control	52.8	17.6	64.3	56.7	[2]
F	Price controlling flow	106.7	35.6	57.1	62.5	515
			LONGRUN IMPACT (13 DECADES)			
			Acres (in thousands) treated			
			(Conversion period average per decade)			
A	Nondeclining even flow	56.8	18.9	178.3	59.2	196
B	Conversion period	56.0	18.7	169.0	68.3	196
C	5-percent declining flow	63.2	21.1	184.2	59.2	196
D	10-percent fluctuating flow	60.8	20.3	181.8	55.1	196
E	Area control	52.8	17.6	179.0	62.2	[2]
F	Price controlling flow	64.6	21.6	192.1	57.3	196

[1] Total managed area, 696,015 acres

[2] Data not available.

an adverse or beneficial impact as measured against various environmental standards. They were also asked to judge whether the impact would be of minor or major social concern. When an impact on the ecosystem was of major concern, the changes produced could be expected to require additional costs to restore the ecosystem element to its original condition, change use patterns, violate legal requirements, or draw the attention and concern of interest groups or the general public. An impact of minor concern was a change in the ecosystem that might be noticed by the trained eye but would not likely produce any of the four results listed above. Impacts were beneficial when a policy change produced impacts that moved in the direction of meeting environmental standards or surpassing them. Impacts were adverse when policy changes produced impacts that moved away from environmental standards. Panelists used the nondeclining

even flow alternative at a low investment level as the base for evaluating impacts.

To record the impacts of alternative harvest schedules on the various ecosystem criteria, we used a plus sign (+) for beneficial impacts and a minus sign (-) for adverse impacts. "N.C." indicated no change, 1 indicated a minor impact, and 2 indicated a major impact (table 3).

The study of impacts on nontimber benefits was carried out in conjunction with the ecosystem study to avoid duplication of effort. Panelists identified and estimated the impacts of timber harvest alternatives in terms of supply or use levels of nontimber benefits.

The evaluation system for impacts on nontimber benefits was different from that for the ecosystem. For example, plus and minus signs indicated increases or decreases in supply or use levels of the various nontimber benefits. The number 1 indicated impacts did not exceed a "threshold of concern" (TOC); 2 indicated impacts exceeded a TOC.

Threshold of concern is associated with a benchmark level of social concern that, if exceeded, will draw the attention and/or concern of interest groups or the general public, cause a noticeable change (positive or negative) in use patterns, or have an effect on the costs of maintaining the ecosystem. The important point with this concept is that small changes may be unnoticed or may be observed with some degree of indifference, but at some point in the range of social impacts, people take notice. They often become motivated to either take advantage of an impact, as in the case of increased opportunities for dispersed recreation, or take action to reverse the trend of impacts if they are negative.

As with the evaluation of impacts on the ecosystem, the present timber harvest schedule with low investment was used as a base for comparison with the other alternatives (table 4). The impacts recorded in the tables are changes from the base level. It is important to recognize that the base level is in no sense an ideal. The base is merely used for comparison. There may be adverse effects associated with the base level.

In evaluating impacts at the high investment level, panelists wanted to know what to assume about the proportion of the increased funding that would be allocated to environmental protection and the production of nontimber benefits. Panelists were told to assume that "high investment" refers only to investments for timber production. Expenditures, however, to mitigate adverse environmental impacts associated with timber management would be continued and increased, but only in *proportion* to increased timber harvest levels. Therefore, increased investment in timber management does not reflect an increased emphasis on protection of nontimber resources nor does it mean the production of nontimber benefits will be increased.

Table 3--Relative impacts of timber harvest scheduling alternatives on various ecosystem criteria for the Douglas-fir zone of the Mount Hood National Forest compared with nondeclining even flow at the low investment level 1/

Harvest scheduling alternative and investment level	Water quality		Water quantity		Waterflow		Soil stability		Soil productivity		Wildlife habitat diversity		Fish habitat diversity	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
A Nondeclining even flow:														
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High	-2	-2	+1	+1	-1	-1	-2	-2	-1	-1	-1	-1	-2	-2
B Conversion period even flow:														
Low	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
High	-2	-2	+1	+1	-1	-1	-2	-2	-1	-1	-1	-1	-2	-2
C 5-percent declining flow:														
Low	-1	N.C.	N.C.	N.C.	N.C.	N.C.	-1	N.C.	-1	N.C.	-1	N.C.	-1	N.C.
High	-2	-2	+1	+1	-1	-1	-2	-2	-1	-1	-1	-1	-2	-2
D 10-percent fluctuating flow:														
Low	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
High	-2	-2	+1	+1	-1	-1	-2	-2	-1	-1	-1	-1	-2	-2
E Area control:														
Low	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
High	-1	-2	+1	+1	-1	-1	-1	-2	-1	-1	-1	-1	-1	-2
F Price controlling flow:														
Low	-2	N.C.	+1	N.C.	-1	N.C.	-2	N.C.	-1	N.C.	-1	-1	-2	N.C.
High	-2	-2	+1	+1	-1	-1	-2	-2	-1	-1	-1	-1	-2	-2

1/ N.C. = no change; 1 = minor impact; 2 = major impact; + = beneficial impact; - = adverse impact; 0 = base alternative.

Table 4--Relative impacts of timber harvest scheduling zone of the Mount Hood National Forest compared

Harvest scheduling alternative and investment level	Cold water fish populations		Domestic forage production		Opportunities for developed recreation		Opportunities for dispersed recreation		Natural-appearing forest landscape	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
A Nondeclining even flow:										
Low	0	0	0	0	0	0	0	0	0	0
High	-2	-2	N.C.	N.C.	N.C.	+1	+2	+2	-2	-2
B Conversion period even flow:										
Low	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
High	-2	-2	N.C.	N.C.	N.C.	+1	+2	+2	-2	-2
C 5-percent declining flow:										
Low	-2	N.C.	N.C.	N.C.	N.C.	N.C.	+2	N.C.	-2	N.C.
High	-2	-2	N.C.	N.C.	N.C.	+1	+2	+2	-2	-2
D 10-percent fluctuating flow:										
Low	-1	N.C.	N.C.	N.C.	N.C.	N.C.	+1	N.C.	-1	N.C.
High	-2	-2	N.C.	N.C.	N.C.	+1	+2	+2	-2	-2
E Area control:										
Low	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.	N.C.
High	-2	-2	N.C.	N.C.	N.C.	+1	+2	+2	-2	-2
F Price controlling flow:										
Low	-2	N.C.	+1	N.C.	N.C.	N.C.	+2	N.C.	-2	N.C.
High	-2	-2	+1	N.C.	N.C.	+1	+2	+2	-2	-2

[1/] N.C. = no change; 1 = minor impact; 2 = major impact; 0 = base alternative;

alternatives on various nontimber benefits for the Douglas-fir with nondeclining even flow at the low investment level[1/]

Industrial and municipal water		Irrigation water		Recreational use of water		Deer and elk populations		Wildlife for viewing by the					
								Discriminating observer		General observer		Casual observer	
Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
0 -2	0 -2	0 +1	0 +1	0 -2	0 -2	0 +2	0 -2	0 -2	0 -2	0 +2	0 +1	0 +2	0 -2
N.C. -2	N.C. -2	N.C. +1	N.C. +1	N.C. -2	N.C. -2	N.C. +2	N.C. -2	N.C. -2	N.C. -2	N.C. +2	N.C. +1	N.C. +2	N.C. -2
-1 -2	N.C. -2	N.C. +1	N.C. +1	-1 -2	N.C. -2	+1 +2	N.C. -2	-1 -2	N.C. -2	+1 +2	N.C. +2	+1 +2	N.C. -2
N.C. -2	N.C. -2	N.C. +1	N.C. +1	N.C. -2	N.C. -2	+1 +2	N.C. -2	N.C. -2	N.C. -2	N.C. +2	N.C. +2	+1 +2	N.C. -2
N.C. -1	N.C. -1	N.C. N.C.	N.C. N.C.	N.C. -1	N.C. -1	N.C. +1	N.C. -2	N.C. -1	N.C. -1	N.C. +1	N.C. +1	N.C. +1	N.C. -2
-2 -2	N.C. -2	+1 +1	N.C. +1	-2 -2	N.C. -2	+2 +2	N.C. -2	-2 -2	N.C. -2	+2 +2	N.C. +2	+2 +2	N.C. -2

+ = beneficial impact; - = adverse impact.

PART 2. CONSEQUENCES AND CRITERIA

Ecosystems

Discussion of the Consequences

The condition of the forest ecosystem is of considerable interest to segments of the public. Many people value the ecosystem for its own sake and are interested in and sometimes opposed to any changes that take place. Other people are not opposed to modifications of the forest ecosystem but are concerned about the effects that harvesting and management activity might have on both the shortrun and longrun flow of benefits and on forest productivity.

The public also recognizes that harvesting and management activities can have impacts on other areas too. An example of this is the smoke from slash burning that adds to pollution problems of urban and rural areas outside the National Forest.

To determine how the ecosystem would be affected by management activity, we divided it into subsystems. A subsystem was selected for study if it was the source of a socially valued output of the forest and if the harvest scheduling alternatives and investment levels would be expected to affect this subsystem.

The subsystems were: (1) water, (2) soils, (3) fish and wildlife, (4) air, and (5) vegetation.

Each subsystem is vital in the production of multiple goods and services from the forest. They are all affected one way or another by forest management activities.

Selection of the Criteria

The criteria and objectives listed below were developed from a review of literature related to laws pertaining to National Forest management and from discussions with specialists. The criteria are presented as nine formal statements to "maintain," "regulate," or "protect," etc. Each criterion embodies social objectives as well as a statement of commonly used measurement indexes. Readers interested in a further discussion of the legal or social background from which the objectives and criteria are derived should refer to background report No. 20 by Randall (see footnote 3, page 3). The objectives and criteria were to:

1. Maintain or enhance water quality--measured by sediment concentrations and water temperature.
2. Maintain or enhance water quantity--measured by acre-feet of waterflow from a given stream over a given period.
3. Regulate waterflow--measured by cubic feet of waterflow from a given stream over a given period.
4. Maintain or enhance soil stability--measured by inches per year of sheet erosion or cubic yards per square mile of mass wasting.
5. Maintain or enhance soil productivity--measured by compaction, in terms of percent reduction in macropore space, and by fertility, in terms of changes in available nutrients and moisture-holding capacity.
6. Protect and enhance threatened and endangered fish and wildlife species--measured in terms of populations per given species.
7. Maintain enough habitat diversity to accomodate the various fish and wildlife species living in a specified area--measured by acres of habitat type.

8. Maintain or enhance air quality--measured by particulate matter at a particular location over a given period.

9. Maintain vegetative cover that will provide options for the various multiple benefits society derives from the forest--measurable vegetative indicators might include species composition of trees and understory plants, stand age and density, successional stage of forest, and proportion of openings to solid tree cover.

Nontimber Benefits

Discussion of the Consequences

In our evaluation of potential impacts on nontimber benefits resulting from alternative timber harvest scheduling policies, we had to recognize that although forest products such as timber and forage are marketed for monetary returns, other products such as recreation, fish, and wildlife are not. Our evaluation, therefore, would have to rely on physical measures of benefits rather than financial measures.

Faced with the responsibility of evaluating alternatives in such a context, we needed to establish relationships between management activities and nontimber benefits. We devised a method to utilize the intuitive judgment and experience of nontimber resource specialists in identifying the levels of physical output associated with given levels of harvesting and in evaluating their importance.

A key step in our evaluation of impacts on nontimber benefits was the selection of criteria.

In selecting criteria, we identified the impacts we wished to measure with the help of specialists in appropriate disciplines. Our intent was to define criteria in terms that related to socially valued output. The nontimber resource specialists indicated that forest managers would be better equipped to judge potential impacts if they could relate them to a benchmark level of social concern. From this idea we developed the TOC concept described in part 1.

Selection of Criteria

Criteria were selected to measure expected levels of opportunities relative to current levels. We selected them to be used with data from any forest in the West; we recognized, however, that data from one forest are not necessarily applicable to other forests. Data should be analyzed on a forest-by-forest basis and applied only to subregions or groups of forests characterized by similar species composition and climate.

The categories used were: No change ("NC"), not exceeding threshold of concern ("1"), and exceeding threshold of concern ("2").

Criteria for nontimber benefits follow:

Anadromous and resident cold water fish populations.--This criterion is of concern to sportsmen and environmentalists. The level of fish populations is closely related to water quality conditions. If not carefully planned and executed, the construction and maintenance of roads, residue treatment, and timber harvesting operations can all have major adverse impacts on water quality and thus, fish habitat.

Domestic forage production.--Forested ranges represent a large forage resource in National Forests of the Pacific Northwest. Presently, most grazing occurs on forested ranges rather than in natural forest openings or

harvested areas. In 1975, about 90 percent of the domestic forage production in Region 6 occurred in the so-called ponderosa pine subregion, where forested ranges serve as summer ranges. The seasonal nature of these ranges enhances their importance, since a lack of summer grazing is often a limiting factor in cattle operations. Without adequate summer range grazing permits, many ranches cannot maintain the herds they are capable of supporting the rest of the year. In the Douglas-fir region, there are some possibilities that domestic livestock grazing may increase if harvesting of timber is accelerated in the future, but such impacts are largely uncertain as the increased harvests may occur in areas unsuitable for grazing.

Opportunities for dispersed recreation.--These opportunities are closely related to the miles of forest roads open to recreationists. In turn, the number of miles of usable road is affected by road maintenance (historically, recreation management has not been funded to do this) and the management philosophy toward dispersed recreation (scattered, individual outdoor recreation activities normally not identified with developed facilities) as a legitimate use of National Forests. The attitude and approach to dispersed recreation varies widely among forest administrators. Some encourage it, others do not. Statistics indicate it is the fastest growing form of recreation on most National Forests.

Opportunities for developed recreation.--Developed recreation facilities are usually located near major roads and attractions, such as lakes and streams. These opportunities are less affected by an expanding timber management road system than are opportunities for dispersed recreation.

Opportunities for viewing natural-appearing forest landscapes.--This criterion is closely linked to the type and extent of forest management activities. Extensive use of clearcutting is generally not conducive to a natural look; however, if clearcuts are limited in size and carefully placed, much can be done to soften their impact. Other silvicultural techniques, such as shelterwood cutting and thinning, leave trees standing after operations are through and thus give a more natural appearance, especially when viewed from a distance.

Water uses--industrial, municipal, recreational, and irrigation.--All these common uses of water are affected by the quality (mainly sediment content) and the quantity (mainly timing of flow) of available water. Water quality in watersheds is affected by the location and amount of site disturbance associated with forest management activities. Waterflow is closely related to the size of the area devoid of vegetation at any given time.

Deer and elk populations.--Populations of deer and elk are closely linked to the condition of their habitat. Adequate summer and winter range with sufficient conifers to provide cover are needed to maintain herd size. The ever-expanding road system which accompanies timber harvests has an impact on deer and elk by reducing cover and increasing human access. With loss of cover and increased access opportunities for hunters and the general public, bucks may be harvested in numbers too great to maintain breeding levels, and just the presence of greater numbers of people may become a harrassment that lowers the general vigor of the herd.

Opportunities for viewing wildlife.--Viewers of wildlife are frequently classified as casual, general, or discriminating observers. The casual observer looks for deer, elk, or bear. The general observer spends considerable time in the forest trying to view a wide variety of species. The discriminating observer is after a glimpse of rare and unusual species. These observers will spend considerable time, effort, and expense to pursue their hobby. Forest management activities including road construction, affect wildlife populations by altering their habitat and increasing human harrassment.

Thresholds of Concern

The panels of resource specialists suggested that the following changes in levels of impact may represent the TOC for nontimber benefits in the Pacific Northwest: anadromous and resident cold water fish populations, 10 percent; domestic forage production, 20 percent; opportunities for developed and dispersed recreation, 15 percent; opportunities for viewing natural-appearing forest landscapes, 15 percent; industrial, municipal, irrigation and instreamflow uses of water--any change that exceeds present objectives for a prolonged period of time; deer and elk populations, 10-15 percent (or anytime the buck ratio drops below 15 percent); wildlife populations for the casual viewer, 10-20 percent; wildlife populations for the discriminating viewer--10-20 percent and 25-50 percent for the general viewer.

PART 3. EVALUATION OF IMPACTS ON ONE NATIONAL FOREST[5]

Tables 3 and 4 show the impacts on the ecosystem and on nontimber benefits resulting from six harvest scheduling alternatives and two investment levels for the Mount Hood National Forest in the Douglas-fir subregion.

The starting point or base for evaluation was the current Forest Service policy of nondeclining even flow (alternative A); in addition, we assumed a low level of investment. Panelists were quick to warn that current policies might lead to some undesirable effects if they were carried out for the long run; that is, there was room for improvement in present management practice. We asked panelists to use current policy and its trends, whether beneficial or adverse, as the base against which to evaluate other activities and investment levels. Thus, alternative A at the low level of investment in tables 3 and 4 appears as a row of zeros.

The following discussion is divided on the basis of impacts on the ecosystem and nontimber benefits. The purpose of the discussion is to describe the cause and nature of impacts and, in the case of adverse impacts, to suggest solutions.

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[5] For discussion of impacts on both Mount Hood and Ochoco National Forests see the background reports by Randall and Sassaman mentioned in footnote 3, page 3.

Impacts on the Ecosystem

Water Quality

The major concern about water quality is the possibility of sediment entering streams. This likelihood increases as logging and particularly roadbuilding increase. Aside from any accelerated rate of harvesting, the panelists felt that the Forest Service could be headed for water quality problems under its present program. The problems may come in failure to meet water quality standards that are being formulated by various State agencies and the Environmental Protection Agency. A major uncertainty is how these regulations may affect silvicultural activities.

When we examine alternative harvest schedules, as shown in table 3, we see that water quality impacts depend in large part on the level of investment chosen. At low levels we will have little or no change except for alternative F where cutting is periodically high. At high investment levels, impacts become more serious.

In the short run, we can expect major adverse impacts with the accelerated harvesting and road construction associated with high investment levels. An exception is alternative E where activities do not accelerate until after the third decade. Adverse impacts are expected to take the form of reduced recreational opportunities, spoiled fish habitats, and violations of environmental laws and regulations.

In the long run, as the road system is completed, adverse impacts will be less, although the panelists thought that the high levels of final harvesting and thinning could still be a source of water quality problems.

The panelists suggested that adverse water quality impacts might be mitigated by improved harvest planning and by specialized equipment and harvesting systems. Of course, such measures will involve higher costs.

Water Quantity

Water yields are known to be influenced by forest management practices. The panelists agreed that clearcutting was the major practice that would influence water yield. The panelists felt, however, that even substantial increases in cutting would have at most a minimal effect on regional water supplies. Some localities might experience noticeable increases in yield, but the data are not sufficiently precise to identify these areas nor the magnitude of increase.

In water quantity, the harvest scheduling alternative chosen by the Forest Service does not seem to make much difference.

Waterflow

The major concern over waterflows is storm runoff and its potential for damage to life and property through flooding. There is also concern for erosion of stream channels by unusually high water levels.

The panelists indicated that there was potential for localized onforest flooding that could result in damage to bridges, culverts, roads, and campgrounds. Even at current levels of management localized flood damages occur. Table 3 shows that for most alternatives at the low investment level, damages would not likely increase; but at the high investment level, we could expect more flood-induced damages in some localities.

Although local damage might occur, the potential for off-forest flooding was considered minimal even at the higher activity levels associated with the high investment assumption.

Soil Stability

The major concern for soil stability is that erosion has adverse impacts on water quality and that landslides can damage property and at times are a threat to life. The problems with soil stability are especially aggravated by roadbuilding and, to a lesser degree, by harvesting--particularly on steep, unstable slopes. Erosion occurs even under natural conditions. As man intrudes, erosion can accelerate. The question is, how much will it accelerate?

As seen from table 3, major adverse impacts are correlated with the high level of investment and with the heavy periodic cutting patterns of alternative F at the low investment level. The panelists predicted longrun major problems with soil movements, mainly because of the combination of extensive road systems with heavy rainfall.

Soil Productivity

Soil productivity is a longrun concern of forest managers and of society. Some panelists expressed concern over current practices and their effects on productivity. Factors mentioned as having important impacts on productivity were drains on the nutrient budget of the soil and compaction. Reduction of residue was noted as an important management activity affecting nutrient levels, and use of harvesting machinery was seen as a major factor influencing soil compaction.

Low investment levels were not expected to result in any significant longrun change in current productivity trends. Shortrun reductions in productivity would be possible with alternatives C and F because of their higher cutting rates. These reductions would be minor, however. High investment levels were not seen as producing any major impacts although there might be minor losses in productivity.

Diversity of Wildlife and Fish Habitat

Wildlife.--We found that the impact evaluation used in table 3 was of limited usefulness in evaluating the impacts on diversity of wildlife habitat and on the status of threatened and endangered species; cutting can be accelerated and management investments intensified without closing habitat options if management is willing to maintain a variety of habitat types. We do not know whether the Forest Service's management of wilderness areas, foreground and middleground retention zones, streamside leave strips, and other environmental measures provides the habitat diversity necessary to prevent closing out options. If we assume that diversity is adequate, however, differences still exist between alternative harvest schedules.

In general, at low investment levels, accelerated cutting will create a larger number of habitat types and edge effects; however, the accelerated building of roads will increase man's harrassment of wildlife populations. At high levels of investment, we create a forest, a large portion of which is narrowly diversified. In terms of wildlife objectives, this narrowed diversity over large areas would not be desirable even if certain areas were reserved for specific wildlife habitats.

Fish.--Habitat diversity for Forest Service fisheries management essentially means protecting and enhancing habitat conditions conducive to stable or growing populations of warm water fish, cold water anadromous and resident

fish, and threatened and endangered fish species.

Panelists felt that present fish habitat management practices were insufficient to prevent gradual deterioration of habitat conditions. The major problem is stream sedimentation. There was a feeling that if current regulations and the best practices were vigorously carried out; adverse effects would be avoided under current policies. The reasons given for weaknesses in fisheries program were lack of funding and manpower to enforce regulations and less than enthusiastic cooperation from many operators.

Table 3 shows that at low levels of investment, the only major adverse impacts expected would be in the shortrun at the high cutting levels of alternative F. At high levels of investment, the panelists expected difficulties in maintaining the quality of fish habitat. With an extensive road system and a high level of harvesting activity, to keep sediment out of streams would be difficult, even with rigorous enforcement of regulations.

Threatened and Endangered Fish and Wildlife Species

Wildlife.--The comments about diversity of wildlife habitat apply here. A trend toward intensified management can increase diversity to some degree; carried too far, it will begin to close out options.

Two categories of threatened and endangered species must be considered--those established at the national level and those established at the State level. On the Mount Hood National Forest there were 5 threatened and endangered species classified by Federal law and 10 classified by State law at the time of the study. In the panelists' view, none of these species were in imminent danger of extinction on the Forest; however, there was concern over the possible future impact of conversion to intensified management.

Fish.--The panelists did not expect accelerating the harvest or intensifying management to be a major threat to the continued existence of any fish species found on the Mount Hood National Forest.

Air Quality[6]

Unlike controls over other impacts on the ecosystem, managers have direct control (except for wildfires) over the source of smoke production. They make the decisions of whether or not to burn, the methods to use, and the timing. Once these decisions are made, the impact of resulting smoke depends on the location of the fire, its duration, the concentration of pollutants in the smoke, and weather conditions.

Smoke produced by slash fires can add to pollution levels of both rural and urban areas, possibly causing pollution levels to exceed national standards for particulate matter in the air (the major air pollutant contributed by slash burning). National standards are based on annual and 24-hour averages. Slash burning is not significant enough to cause violation of annual averages, but it certainly could cause levels in localities to exceed 24-hour averages.

In the short run, if we accelerate cutting or intensify management, we can expect a corresponding increase in the risks

[6] Owen Cramer, meteorologist, Pacific Northwest Forest and Range Experiment Station, was the primary contributor to this section.

of aggravating air pollution by slash burning. The extent to which this will happen depends on a combination of managerial skill, condition and amount of slash, weather, and pollution levels over populated areas.

In the long run, as management gradually becomes based on young-growth forests, we can expect residues and the air pollution problem to decrease. One negative element, however, is the increased risk of wildfire that may be associated with slash from precommercial thinning. This hazard will build as we move toward more intensive management.

Vegetative Character

Much of what was said in the section on diversity of wildlife habitat applies here. As we move toward intensified management of timber, we tend to undiversify the forest. Species composition is deliberately limited to one conifer or a few selected conifers. Successional stages at the beginning and end of a stand's life are eliminated. Openings in the stand are replanted to conifers. Although these actions may favor timber production and may not noticeably detract from water or recreation use, they can adversely affect certain grazing and wildlife uses.

Impacts on Nontimber Benefits

Anadromous and Resident Cold Water Fish Populations

Fish populations are directly affected by water quality. Sediment, a common indicator of water quality, is a byproduct of timber harvest practices, including road construction. Fish and watershed management specialists felt, however, that the degree of managerial emphasis (staffing and funding) placed on road maintenance and the enforcement of contract stipulations governing logging practices has an important bearing on water quality. In fact, the panelists felt that even a continuation of the present timber harvest policy would decrease fish populations in both the short run (three decades) and the long run (conversion period) unless funding were increased to mitigate adverse impacts. Table 4 shows major adverse impacts for any sizable increase in harvesting activity; however, with adequate funding and management, many of these impacts might be offset.

Domestic Forage Production

No significant impact on domestic forage production is expected in the Douglas-fir subregion of Region 6 under the present timber harvest scheduling policy or with any of the alternatives. Increases in forage production may occur because of alteration of species composition, but they are expected to be small and not to significantly affect use patterns.

Opportunities for Developed and Dispersed Recreation

None of the scheduling alternatives was expected to have a significant impact on opportunities for developed recreation. As the road system expands to accommodate increased harvests and investments in timber management, however, opportunities for dispersed recreation should increase significantly as shown in table 4.

Opportunities for Viewing Natural-Appearing Forest Landscapes

This criterion concerns the prevalence of forest areas with little apparent evidence of manmade manipulation of the landscape.

The panel of forest recreation specialists indicated a direct connection between this criterion and the total number of acres disturbed per decade. They felt that increased cutting levels or investment levels would seriously decrease opportunities for viewing natural-appearing forest landscapes in both the short run and the long run.

Industrial, Municipal, Irrigational, and Recreational Uses of Water

Industrial and municipal uses of water are directly affected by water quality. At the high investment level, all timber harvest alternatives, except area regulation, would create impacts that exceed the threshold of concern for industrial and municipal water in both the short run and the long run.

Impacts on irrigation water are related to quantity. None of the timber harvest alternatives create a significant impact on irrigation water.

In Region 6, recreational use of water relates directly to water quality and, to a much lesser extent, water quantity. Impacts recorded in table 4 indicate that at the high investment level all the timber harvest alternatives, except area control, create impacts that exceed the TOC.

Deer and Elk Populations

At the low investment level, panelists indicated that there would be a tendency for deer and elk populations to increase under alternatives that accelerated cutting rates. This would only be a shortrun effect. At a high investment level, with its larger timber harvest, panelists expected significant increases in populations in the short run because of an expected increase in browse. In the long run, however, populations would decline because of reduced cover and increased harassment.

Wildlife Populations for Viewing

Table 4 shows impacts differentiated by three categories of viewers. It is evident that increases in harvesting also produce increases in viewing opportunities for the general observer. These increases are especially evident at the high investment level and also as a shortrun effect for the high cutting rate alternatives at the low investment level.

Casual observers are expected to experience greater opportunities for viewing in the short run; but in the long run, opportunities are expected to significantly decline, especially at the high investment level. This effect is closely related to the longrun decline of deer and elk populations at the high investment level.

Discriminating observers will experience diminished viewing opportunities. As cutting is accelerated and the forest more intensively managed, habitat for many species of wildlife will be reduced, severely modified, or eliminated.

EVALUATION OF THE APPROACH

Because of severe time constraints, information needed for this study had to be collected quickly. An early obstacle was a paucity of documented information which might link impacts on the ecosystem and nontimber benefits to possible changes in the Forest Service's harvesting policy. We overcame this obstacle by consulting resource specialists who were asked to identify impacts and then to estimate both the magnitudes of impacts and the likely responses of various interest groups. Tables 3 and 4 show the results.

The critical part of the study involved developing criteria against which impacts could be compared. Impacts on the ecosystem were formulated in terms of goals, e.g., "maintain or enhance...," that society has expressed through various laws and regulations as desirable environmental conditions. Criteria for nontimber benefits were formulated in terms of use levels. For these criteria, the concept of threshold of concern was used to identify changes in use levels that were socially significant.

A major drawback in our attempts to assess the magnitude of impacts was that the timber resource information used in generating timber harvest schedules was too broadly defined to be useful in identifying harvests that might occur in specific areas that are sensitive from an environmental or nontimber benefit point of view. Because of this, resource specialists could only estimate the magnitude of impacts for the Forest as a whole, which resulted in very imprecise statements; i.e., "minor" and "major" impacts.

Another major drawback was uncertainty concerning what the Forest Service would do with increased investment funds. What proportion of these funds would be used to mitigate adverse impacts of increase timber production? For purposes of evaluation, we assumed that increased funding for protection of nontimber benefits would be proportional to increases in funds for intensified management. Many of the resource specialists commented that if funding could be increase more than proportionally, many of the major adverse impacts could be reduced or eliminated.

In retrospect, we now feel that resource managers should have been included on the panels to help evaluate the importance of impacts. Although the resource specialists did an adequate job in determining major and minor impacts, a decisionmaker's perspective would have helped us to better understand how impacts are perceived and acted on by decisionmakers.

In conclusions, although the study had its problems and its results are imprecise concerning the connections between proposed actions and their resulting impacts, we believe the results strongly indicate the problems and trends that can be expected if harvest schedules or investment levels are changed. Moreover, the approach used in this study, though hurried and with little data, did result in highlighting problem areas which managers can use to better assess the consequences of alternative actions.

APPENDIX

Panel Participants

Panels of U.S. Forest Service and State resource specialists included the following:

Watershed Panel
- Bob Meurisse, Leader, Soils Group, R-6
- Gerry Swank, Leader, Watershed Management Group, R-6
- Art Tiedemann, Project Leader, Wenatchee Lab
- Dave Helvey, PNW, Wenatchee Lab
- Glen Klock, PNW, Wenatchee Lab
- Dennis Harr, PNW, Corvallis Lab

Range Panel
- Fred Hall, Ecologist, R-6
- Rick Ross, Land Use Planning Team, Mt. Hood National Forest
- Jon Skovlin, Range Scientist, PNW, La Grande Lab
- Lou Spink, Regional Range Vegetation Improvement Specialist, R-6
- Ray Zolanardo, Umpqua National Forest

Fish Management Panel
- Gene Deschamps, Washington State Department of Fisheries
- Fred Everest, Siskiyou National Forest
- Bill Meehan, Fisheries Biologist, PNW, Corvallis Lab
- Monty Montgomery, Oregon State Department of Fish and Wildlife

Wildlife Management Panel
- Bernie Carter, Ochoco National Forest
- Garry Garrison, Washington State Department of Game
- Kirk Horn, Wildlife Biologist, Mt. Hood National Forest
- Carlos Pinto, Okanogan National Forest
- Gene Silovsky, Siuslaw National Forest
- Jack Thomas, Project Leader, PNW, La Grande Lab

Recreation Panel
- Don Warman, Recreation Management, R-6
- Roger Stamie, Umpqua National Forest
- Phil Gillman, Ochoco National Forest
- John Hendee, Project Leader, PNW, Seattle

METRIC EQUIVALENTS

1,000 acres = 404.69 hectares
1 mile = 1 609.344 meters

GPO 988-310

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