ECONOMIC IMPACT OF ALTERNATIVE FOREST PRACTICE RULES TO PROTECT NORTHERN SPOTTED OWL SITES

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EXECUTIVE SUMMARY

1. INTRODUCTION

Commissioned by the Wildlife Committee of the Washington State Forest Practices Board, this study evaluates the economic impact of alternative forest practice rules designed to protect the equivalent of 234 northern spotted owl sites. The owl habitat is contained on private and state lands within 15 landscapes designated as important for owl protection by the Board's Scientific Advisory Group (SAG). The analysis involves the estimation of three effects:

1. The reduction in timber harvest for each rule.

2. The economic losses in the forest products industry (output, employment, and labor income) as well as the loss in state timber trust revenue due to reduced timber harvests.

3. The total economic impact of forest products industry and timber trust revenue losses on Washington state and four regions (Puget Sound, Olympic Peninsula, Lower Columbia, and Eastern Washington).

The rules vary significantly with regards to their impact on timber harvests and the economy. Some rules apply different strategies for different landscapes. For example, our interpretation of the New Rule proposed by the Wildlife Committee would reduce the annual timber harvest by an average of 299 million board feet during the ten years immediately following the adoption of the rule. This would lower employment in the Washington forest products industry (forestry, lumber and wood products, and pulp and paper products) by 2,900 jobs and would reduce the state timber trust revenue by $45.0 million (measured in 1992 dollars). The total impact of the Proposed New Rule, which takes into account the indirect economic effects of the rule, would amount to a loss of 10,400 jobs in the state (0.4 percent of total employment in 1992). Since this rule minimizes harvest restrictions on state and private forest lands in the Olympic Peninsula, it would have a negligible impact there, with a loss of 358 jobs on that region's economy.

In contrast, the DNR/WEC (Dept. of Natural Resources/Washington Environmental Council) Rule, which would preserve the largest amount of forest land, would lower the state's timber harvest by 690 million board feet per year, lead to a loss of 6,707 forest products jobs, reduce the timber trust revenue by $149 million, and cost the state a total of 25,324 jobs (0.9 percent of its total employment). The job losses in the forest products industry and supporting industries from the DNR/WEC Rule on the Olympic Peninsula and Lower Columbia regions would be significant, amounting to 2.9 percent and 2.6 percent of their total employment, respectively.

The 70-Acre Rule, which is the least restrictive rule, would have a relatively small economic impact on the state (a loss of 1,319 jobs) and the Olympic Peninsula (a loss or 200 jobs).

Sections 2-5 of the executive summary provide more detail on the analysis and findings of this study. While most of the report focuses on the expected impact during the next ten years, Section 6 discusses the long-term implications of the forest practice rules on timber management and harvests. Section 7 points out several caveats related to the study, including the potential for benefits not covered in the study. A complete set of findings as well as technical notes on the methodology are contained in the report entitled, "Economic Impact of Alternative Forest Practice Rules to Protect Northern Spotted Owl Sites."

2. ALTERNATIVE FOREST PRACTICE RULES

The Forest Practice Board is considering seven forest practice rules for private and state lands. The rules generally specify a minimum number of acres of habitat around each owl site that must be preserved. Timber on the remaining acres can be harvested. This study analyzes the economic impact of six of the seven rules (the SEPA Rule does not provide a predictable target for preserving habitat and was excluded from the analysis). The key criteria governing each rule are:

1. **70-Acre Rule:** This rule selects and preserves the most suitable 70 acres of habitat around each owl site. The characteristics of "suitable" habitat are defined in the SAG report. The 70 acres may include federal lands but only the harvest on the state and private portion of this land is considered in this analysis.

2. **500-Acre Rule:** This rule selects and preserves the most suitable 500 acres of habitat around each owl site in the same manner as the 70-Acre Rule.

3. **WFPA (Washington Forest Protection Assn.) Rule:** For 9 of the 15 identified landscapes the rule defaults to the 70-Acre Rule. For 3 landscapes, a "dispersal" strategy is proposed, which adds (on top of the initial 70 acres) forest land that is adequate for dispersal of owl populations but not necessarily "suitable" habitat. When the total acreage of dispersal and suitable habitat exceeds a specific target, the dispersal habitat can be substituted for suitable habitat in the harvest outside the 70 acre core, thereby reducing the cost of the harvest constraint so long as the targets are met. For the remaining three landscapes, a "pair maintenance" strategy is proposed. This calls for the retention of 40 percent foraging habitat within 1.8 mile circles.

4. **DNR/WEC Rule:** Based on the recommendations of the Scientific Advisory Group, this rule adopts specific habitat targets within owl circle boundaries for the 15 designated landscapes. The rule preserves all suitable habitat within 0.7 miles of the owl site and the best habitat outside this radius until specific targets are met. On the Olympic Peninsula, the target is 3,867 acres of suitable habitat within 2.7 miles of

the owl site. Somewhat smaller circles and targets are specified for other regions.

5. **Federal 4d Rule:** This rule preserves not less than 40 percent of the acres within identified circle boundaries if also suitable habitat, covering most of the important landscapes.

6. **SEPA (Class IV) Rule:** The SEPA rule establishes a permitting process (without a target) that in the extreme case could prohibit all harvesting within specific distances of owl sites. This rule could affect 14,657 acres on the Olympic Peninsula, 8,042 acres in the Western Cascades and 6.514 acres in the Eastern Cascades for each owl site.

7. **New Rule:** The Wildlife Committee of the Forest Practices Board proposed a new rule to the board on May 11, 1994. It establishes "dispersal" habitat targets for 5 of the 15 landscapes. The dispersal habitat definition in this rule appears to be more restrictive than in the WFPA Rule but was assumed to have the same intent.

   For another 5 landscapes, it establishes habitat "support" targets. The support rule is similar to the DNR/WEC Rule but has different acreage targets: 3,200 acres in the Western Cascades and 2,400 acres in the Eastern Cascades. For the remaining, 5 landscapes (2 in the Olympic Peninsula, 1 in Southwest Washington, and 2 in Northern Washington), the 70-Acre Rule is applied.

3. TIMBER HARVEST IMPACTS

Each forest practice rule would restrict Washington's timber harvest. Determining a rule's impact on timber harvests requires estimates of the number of acres preserved for each site and the quality and value of the timber impacted. Data to determine the acreage in habitat classes by private, state, and federal owners were obtained for 12 of the 15 important landscapes. Acreages classified by habitat type for each ownership group around each owl site were obtained for 6 of these important landscapes. Age classes by ownership around each owl site and, hence, more accurate timber value measurements were obtained for the other 6 areas. These sample data made it possible to estimate the volume, quality, and value of the timber that would be preserved under each rule for 80 percent of the known owl sites. In order to estimate the total impact on the state and regional timber harvests, the sample estimates were adjusted, scaled up for each landscape to represent all known owl sites.

A key assumption in this impact analysis is that all of the timber on the preserved acres is of sufficient age and quality for harvesting within the next ten years. In other words, if no forest practice rule to protect the owl was in place, the timber on the preserved land would be harvested within ten years.

Table 1:

First Ten-Year Timber Harvest Reduction

Millions of Board Feet per Ten Years—Non-Federal

	Puget Sound	Olympic Peninsula	Lower Columbia	Eastern Washington	Washington State
70-Acre Rule	127.2	133.0	73.4	43.8	377.4
500-Acre Rule	761.9	883.4	471.9	313.2	2,430.4
WFPA Rule	1,254.0	133.0	183.7	345.5	1,916.2
DNR/WEC Rule	1,135.2	3,457.4	1,271.3	1,040.2	6,904.1
Federal 4d Rule	732.2	3,192.6	167.6	583.2	4,675.6
New Proposed Rule	889.6	112.4	1,131.7	860.5	2,994.2

Estimates of the first ten-year timber harvest losses on private and state lands are given in Table 1.[1] The ten-year reductions in timber harvests range for 377.4 million board feet for the 70-Acre Rule to 6,904.1 million board feet for the DNR/WEC Rule. The impact of the New Proposed Rule amounts to 2,994.2 million board feet. The DNR/WEC Rule and the Federal 4d Rule impose substantial harvest restrictions on timber lands in the Olympic Peninsula region. In the case of the Federal 4d Rule, roughly two-thirds of the harvest loss would occur in that region.

4. FOREST PRODUCTS INDUSTRY IMPACTS

Forest Products Output, Employment, and Labor Income

The most immediate effect of the reduced timber harvest is a loss of output (production or sales), employment, and labor income in the forest products industry:

1. Lumber and wood products industry: Not all industries classified in lumber and wood products (e.g., mobile homes and prefabricated buildings) would be affected by a shortage of wood. Other industries would have to reduce output, employment, and labor income more or less in proportion to the reduction in timber supply.

2. Pulp and paper products industry: A wood shortage would not have an appreciable impact on the domestic market-oriented converted paper

[1] The four economic regions differ somewhat the regions cited in other reports on this subject. The four regions correspond to the five regions defined by the Washington State Department of Natural Resources, except that the two regions in Eastern Washington have been combined into one. The Puget Sound region includes Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom Counties. The Olympic Peninsula region includes Clallam, Grays Harbor, Jefferson, Lewis, Mason, Pacific, and Thurston Counties. The Lower Columbia region includes Clark, Cowlitz, Klickitat, Skamania, and Wahkiakum Counties. The remaining counties are in the Eastern Washington region.

industry. It would, however, affect other segments of the pulp and paper industry, especially the primary facilities (pulp mills and integrated pulp and paper mills), to the extent that they depend upon local sources of chips and pulp logs.

The impacts of each rule on Washington's timber harvest and the final sales (primarily exports) of the forest products industry are shown in Table 2. The annual losses are measured as a percent of their respective 1992 levels. The New Proposed Rule, for example, would lower the state's timber harvest by 299.4 million board feet per year (from Table 1) or about 6 percent of the 1992 harvest level. This would in turn reduce lumber and wood products final sales by an estimated $241.9 million (measured in 1992 dollars) or approximately 6 percent of final sales in 1992.[2] The relative impact on pulp and paper mills is estimated at one-half the impact on lumber and wood products, since one-half of the wood fiber (principally chips) used to make pulp and paper products comes from out-of-state sources (according to the mill survey conducted by the Washington State Department of Natural Resources) and would not be directly affected by a Washington State forest practices rule. The impact on other paper products (principally converted paper products) would be even smaller, amounting to only one percent of 1992 final sales.

Table 2:

Timber Harvest and Forest Products Final Sales Losses

Percent of 1992 Timber Harvest and Final Sales

	70-Acre Rule	500-Acre Rule	WFPA Rule	DNR/WEC Rule	Federal 4d Rule	New Proposed Rule
Timber harvest	0.8	4.8	3.8	13.8	9.3	6.0
Final sales [3]						
Logging	0.8	4.8	3.8	13.8	9.3	6.0
Sawmills	0.7	4.7	3.7	13.3	9.0	5.8
Plywood mills	0.8	4.8	3.8	13.8	9.3	6.0
Other wood products	0.8	5.2	4.1	14.9	10.1	6.4
Pulp mills	0.4	2.4	1.9	6.9	4.7	3.0
Paper mills	0.4	2.4	1.9	6.9	4.7	3.0
Other paper products	0.1	0.8	0.6	2.2	1.5	1.0

[2] Estimates of the impact of harvest changes on final sales are based on the 1992 Washington State forest products input-output table, which was developed for the recently completed forest products impact study, "The Forest Products Economic Impact Study: Current Conditions and Issues." In general, the impact estimates reported here are derived from the results of that study.

[3] Final sales refer to the sale of products in their final form and primarily include wood and paper products exported outside the state (e.g., log exported to Japan and lumber shipped to California.

The loss of final sales would have a ripple effect throughout the entire forest products industry. For example, a reduction in lumber exports (i.e., final sales from the sawmill industry) would lead to a loss of logging jobs. Taking into account the direct and indirect employment impact, the New Proposed Rule would result in a loss of 2,900 jobs (wage and salary employees and self-employed workers) in the forest products industry. As shown in Table 3, this would represent 4.5 percent of the industry's employment in 1992.[4] The DNR/WEC Rule, which would lower the state's timber harvest by an average of 690.4 million board feet per year (13.8 percent of 1992 harvest), would cost the state 6,707 forest products jobs or 10.4 percent of the industry's employment in 1992.

Table 3:

Forest Products Employment Losses*

	70-Acre Rule	500-Acre Rule	WFPA Rule	DNR/WEC Rule	Federal 4d Rule	New Proposed Rule
Forestry	34	224	174	639	432	269
Lumber & wood products	290	1,872	1,476	5,318	3,601	2,306
Pulp & paper products	41	264	208	750	508	325
Forest products employment	365	2,360	1,858	6,707	4,541	2,900
Percent of 1992 employment	0.6	3.7	2.9	10.4	7.1	4.5

* Includes direct and indirect losses in forest products employment (wages and salary employees and proprietors).

A rule's impact on forest products employment in a region depends upon the severity of the timber harvest restriction in the region as well as the number of forest products jobs supported by the regional timber supply. The Proposed New Rule, which imposes only the 70-Acre Rule on timber harvests in the Olympic Peninsula regions, would have a negligible impact on forest products employment in the region. In contrast, the DNR/WEC Rule would cost the Olympic Peninsula 2,271 forest products jobs or approximately one out of every seven jobs in the industry, according to 1992 employment statistics. In terms of the number of jobs, the DNR/WEC Rule would also have a significant impact on Puget Sound forest products employment (a loss of 2,064 jobs), but this would represent a much smaller fraction (about 8 percent) of total industry employment in the region.

[4] In 1992 there were 64,280 jobs in the Washington forest products industry (5,770 in forestry, 40,850 in lumber and wood products, and 17,660 in pulp and paper products).

Table 4:

Forest Products Industry Employment Losses by Region*

	70-Acre Rule	500-Acre Rule	WFPA Rule	DNR/WEC Rule	Federal 4d Rule	New Proposed Rule
Puget Sound	191	1,166	1,464	2,064	1,473	1,262
Olympic Peninsula	73	502	61	2,271	2,278	62
Lower Columbia	70	464	146	1,466	231	998
Eastern Washington	31	228	187	906	559	578
Washington State	365	2,360	1,858	6,707	4,541	2,900

* Includes direct and indirect losses in forest products employment (wages and salary employees and proprietors).

State Timber Trust Revenue

The second effect of reduced timber harvest would be a loss of revenue from commercial activities on state forest lands managed by the State Department of Natural Resources. These trust lands include federal grant lands, county lands deeded to the state, and other state lands. About 40 percent of the revenue is distributed to common schools for construction and 20 percent to counties for operations and capital expenditures. The remaining revenue is distributed into several other trust accounts or used to manage state forest lands.

Table 5:

State Timber Harvest Restrictions and Trust Revenue Impact

	Annual Timber Harvest Loss (mil. bd. ft.)	Annual Trust Revenue Loss (mil. $1992)
70-Acre Rule	15.7	6.0
500-Acre Rule	107.2	41.0
WFPA Rule	49.8	10.0
DNR/WEC Rule	388.2	149.0
Federal 4d Rule	285.6	99.0
New Proposed Rule	102.3	45.0

The share of timber harvest loss on state lands varies from as low as 26% for the WFPA Rule, 34% for the New Rule, 56% for the DNR/WEC Rule, and as high as 61% for the 4d Rule. While the state harvest restrictions contribute to losses in trust revenue, there will be some offset to that loss if the increased shortage in timber markets produces higher regional market prices. Based on experience with the Federal sales declines, short term price increases were estimated to be as high as $37/mbf for the DNR/WEC Rule. When applied to the remaining DNR harvest volume and assuming a harvest level of 700 mmbf with no rule, the price adjustments to trust revenues were as much as $8 million. The estimated trust revenue losses range from $6 million for the 70-Acre Rule to $149 million for the DNR/WEC Rule in $1992.

5. TOTAL ECONOMIC IMPACTS - FIRST 10 YEARS

The loss of forest products jobs and timber trust revenue constitutes the direct impact of the forest practice rules on the state and regional economies. The final step in the analysis is determining the impact of this loss on the rest of the economy, the so-called "multiplier effect." The analysis makes use of two models to estimate the total economic impact:

1. The economic impact on the state economy is estimated with the Washington Projections and Simulation Model (WPSM), an interindustry transactions model designed for forecasting and impact analysis.[5] Originally built at the University of Washington in 1977, the model has been used in more than 20 studies of the state economy (e.g., the impact of terminating the construction of two WPPSS nuclear power plant and the impact of the state convention center).

2 Economic base models are used to estimate the total economic impact by region. The economic base models are much simpler and therefore less precise in estimating impacts than the state interindustry model.

The state and regional economic impacts are summarized in Table 6. The total impact of the New Proposed Rule would amount to 10,400 jobs and $448 million of personal income (measured in 1992 dollars). In other words, the Washington economy would have 10,400 more people working under no rule than under the New Proposed Rule. Most of the jobs lost outside the forest products industry would be found in transportation, trade, services, and government, according to the simulations with the WPSM. The total losses would constitute about 0.4 percent of the state's employment and income in 1992. The reduction in state and local tax receipts is estimated to be $49.4 million. The New Proposed Rule would have its largest impact in the Lower Columbia region, which would stand to lose 1.9 percent of its employment. The DNR/WEC Rule would cost the state economy nearly one percent of its employment and income. This rule would have a substantial impact on the Olympic Peninsula and Lower Columbia regions and reduce state and local tax receipts by $120 million.

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[5] There is some debate over the size of economic multipliers. One test of the multipliers form the Washington Projection and Simulation Model (WPSM) is to compare them with multipliers from other models such as the IMPLAN, an input-output model commonly used in forest industry studies, or the Washington Economic Model (WEM), an econometric model maintained and operated by Washington State Office of the Forecast Council. WPSM, which has an explicit input-output framework, is designed to overcome many of the shortcomings of input-output models like IMPLAN. Being more comprehensive models of the state's economy than IMPLAN, both WPSM and WEM have higher multipliers than IMPLAN. WPSM's forest products employment multiplier is 3.5. IMPLAN appears to yield multipliers between 2.0 and 2.5 For further information regarding why multipliers vary among models, refer to the articles included in Appendix C of this report.

Table 6:

Total Economic Losses

	70-Acre Rule	500-Acre Rule	WFPA Rule	DNR/WEC Rule	Federal 4d Rule	New Proposed Rule
Washington Impact:						
Gross Product*	56.2	365.1	263.0	1,073.6	725.0	443.7
Employment	1,319	8,573	6,097	25,324	17,095	10,400
Personal Income*	57.2	373.2	248.6	1,126.6	759.1	448.5
Tax revenue* **	6.3	40.7	29.2	119.7	80.8	49.4
Percent of 1992 Total:						
Gross State Product*	0.0	0.3	0.2	0.9	0.6	0.4
Employment	0.0	0.3	0.2	0.9	0.6	0.4
Personal income*	0.1	0.3	0.2	1.0	0.7	0.4
Tax revenue*	0.0	0.3	0.2	0.9	0.6	0.4
Employment Impact by Region:						
Puget Sound	773	4,846	4,820	11,066	7,746	5,312
Olympic Peninsula	200	1,368	220	6,026	5,886	358
Lower Columbia	198	1,312	412	4,201	877	2,655
Eastern Washington	148	1,048	645	4,031	2,587	2,075
Percent of 1992 Employment:						
Puget Sound	0.0	0.3	0.3	0.6	0.4	0.3
Olympic Peninsula	0.1	0.7	0.1	2.9	2.8	0.2
Lower Columbia	0.1	0.8	0.3	2.6	0.6	1.7
Eastern Washington	0.0	0.2	0.1	0.6	0.4	0.3

* In millions 1992 dollars. ** Includes state and local tax revenues.

Because the state economy is expected to continue growing during the next few years, some observers have contended that the economy would actually suffer no job losses—that is, there would be no decline in total state employment. In a literal sense, this contention is correct. However, it is subject to two important qualifications. First, the economy would incur a job loss in the sense that the total employment level in Washington would be higher without the timber harvest restrictions than with them, as demonstrated by the model simulations. Second, in many of the rural timber communities where most of the job losses would occur, there is little or no economic growth from other industries to compensate for the timber downturn. As a consequence, these communities would experience absolute declines in total employment and personal income, increasing the economic disparity between rural and urban areas.

6. IMPLICATIONS FOR LONG-TERM TIMBER HARVESTS

Impact on Investment in Forest Management

The rules may also have a substantial long-term impact on the forest sector and the economy since they reduce the incentive to invest in forest management. The proposed rules that prevent the harvest of habitat also reduce the rate of return for

any management practices that create such habitat. Mid-rotation thinning to increase wood quality could increase the amount of young forest habitat. However, this would lead to greater harvest restrictions over that of an unthinned short rotation. Longer rotations designed to produce large diameter, high quality wood also produce acres with characteristics of young or mature habitat. The New Rule for owl "support" reduces the rate of return for thinning stands within owl circle targets by one-half. For most rules, the option of managing for a 50 year or shorter rotation, without thinning, is not penalized as severely as are thinning treatments.

Unlike all of the other rules, the dispersal rule concept does not penalize thinning treatments significantly. It encourages the creation of new habitat and allows the substitution of new habitat for old, thereby eliminating the penalty for creating more habitat. The dispersal rule penalizes 50-year rotations that are short of suitable habitat when they also contain dispersal habitat, reducing the rate of return for 50-year rotations by as much as 30%. The dispersal rules may, therefore, motivate thinning and longer rotations where the return is reduced only by retaining the core 70 acres of habitat. To the degree that the rule also promotes greater retention of downed logs and snags (definitions of the New Rule for "dispersal" landscapes appear to have this intent), the rule takes on many of the characteristics being identified for wildlife thinning treatments to produce better habitat (characteristics identified in the DNR Landscape Management Project).

Long-Term Economic Impact of No Investment in Mid-Rotation Thinning

Broadly adopting mid-rotation thinning is the next technology step upward in forest management and is expected to greatly increase both the value of the harvested resources and the secondary manufacturing from the higher quality wood produced. If 25% of all stands that reach the appropriate thinning age (at about age 25) are not thinned, the long-term economic activity loss will be a reduction in value of the timber harvest by up to 25%, corresponding to statewide economic activity losses of $1.5 billion to $2.5 billion annually. This would be a substantial lost economic opportunity from under-investment (as much as twice the annual impact from the DNR/WEC Rule over the first decade).

At the same time, if these acres are not thinned, there is the lost opportunity of increasing potentially suitable habitat at the rate of roughly 25,000 acres per year (ultimately .9 million acres of likely habitat) corresponding to 25% of the annual Westside harvest acres being thinned.

These long-term impacts are not as predictable as the first decade impacts. Just the risk of such rules being implemented in the future may be sufficient to demotivate the investment in mid-rotation thinning management strategies. The dispersal rule concept appears to provide increased motivation to thin stands, creating increased habitat over long-term rotations, but it may not prevent the adoption of even shorter rotations, which further reduce the economic activity level while precluding the creation of any new habitat on private land. It also has only been proposed for a few select landscapes and is not the major focus of the rules.

While the economic benefits of increased thinning and longer rotations are mostly three or more decades in the future, the increased volume of thinnings will reduce a large part of the chip and small-log shortage immediately. Thinning currently 30 year old stands with appropriate considerations for wildlife can in just a few years also produce new habitat. Changes in forest management will have these rather short-term economic and habitat impacts as well as longer-term impacts.

7. SOME CAVEATS

With regards to the accuracy of the estimates in this study, there are several caveats that should be kept in mind:

1. The estimates of timber harvest losses are based on our interpretations of the proposed forest practice rules, incomplete information on the acres of habitat, and the amount and quality of timber surrounding each owl site. Uncertainty on the amount of existing habitat implicit in the source data or as computed from age class data (and samples of habitat vs age class) appears to be large and endemic to habitat typing procedures and stand diversity. Our interpretation of the dispersal rule may understate the harvest constraint especially for the New Rule, which includes definitions that may be inconsistent with our interpretation of the intent. Further, estimates of the impact of a dispersal rule outside the owl circles, which could double the impact for the affected landscapes, were not made. In addition, it was not assumed that DNR could substantially offset the impact of harvest constraints in the first decade by moving forward planned harvests in later decades. Their reduction in recent harvest levels would seem to indicate they are not able to maintain a sustainable harvest or sales program under environmental constraints. If they are able to substitute harvest from future decades for constraints in the current decade, the estimates in this report will be overstated. DNR's share varies across cases such that a 50% reduction in their first decade harvest constraint represents a 28% overstatement for the DNR/WEC Rule and a 17% overstatement for the proposed New Rule. For all of these reasons the range of uncertainty may, therefore, be large.

2. While the computational procedure to determine the harvest impact of each rule may appear to be long, the steps are not difficult. The Appendix in Part I provides a description for each step of the procedure along with an assessment of the impact of the key assumptions on the accuracy of results. Examination of the impact of each rule for each important landscape and alternative forest management decisions provides considerable insight on the difficulty in developing rules that achieve their intent. While the major findings are included in this Executive Summary, the more detailed results may be helpful in characterizing important impacts of alternative rules.

3. The focus of the analysis is on the impact of a change between rules, not what happens prior, and how these rule changes add in a cumulative way to prior impacts or other rules. No attempt was made to determine which rule

lines up with the observed activity in any given year or how these rules might relate to any federal rule. Comparison of the rules to "no rule" refers to no state or federal rule, i.e. no constraint related to owl habitat.

4. The estimates of the impacts of timber harvest reductions on forest products employment are drawn from a study of the forest products industry's impact on the Washington economy in 1992 ("The Forest Products Economic Impact Study: Current Conditions and Issues"). Making use of the findings in this study in effect presumed that the number of industry jobs supported per million board feet of timber in 1992 will remain constant over the period of analysis. Changing technology or product mix could raise or lower this number over time. It should also be pointed out that mill closures caused by a log supply shortage will generally hit the oldest mills first. Since these mills tend to be the most labor intensive, estimates of the losses in forest products employment may be underestimated.

5. The total economic impacts are estimated with models of the state and regional economics. Like all models, they represent somewhat imperfect depictions of economic behavior and are subject to measurement error.

6. The economic impact is a one-time loss of jobs and income. The loss, however, would not occur immediately following the implementation of the rule. Simulations with the Washington Projection and Simulation Model indicate that it would take two to three years before the full impact is felt.

7. Preservation of habitat for spotted owls would create economic benefits that may in part offset the losses in the timber related jobs. Potential benefits include the value of protecting an eco-system, additional recreational opportunities, cleaner streams and enhanced salmon runs, and the harvesting of non-forest products (e.g., mushrooms). Some of the benefits are intangible and difficult to measure (e.g., the value of old growth forests), while others appear to be small (e.g., mushroom harvesting) or may be a long time in coming (e.g., restoration of commercial salmon runs). Moreover, it is unclear how these benefits might be affected in the long term as forest management changes in response to the adopted forest practice rule. Although it would be desirable to incorporate all potential economic benefits into a broad benefit-cost study of forest practice rules, it is beyond the scope of this study.

ADDENDUM:

SUMMARY OF REVIEW COMMENTS FOR THE STUDY ON THE ECONOMIC IMPACT OF ALTERNATIVE FOREST PRACTICE RULES TO PROTECT NORTHERN SPOTTED OWL SITES

The report was submitted to reviewers with specialties in regional economics and policy, forest resources management, forest resource economics, biology/habitat research, and natural resource economics. Some very pertinent question were raised by the reviewers. The text was modified in a few places in response to their comments and for clarification, but it is also appropriate to raise the issues identified by the reviewers in this summary since, as in most cases, there may not be a universally accepted solution to their concerns. While the reviewers provided many positive comments supporting many of the findings in the report, their role was primarily to identify weaknesses or questions that may need resolution. We have summarized their concerns below by stating the questions they raised and their perspective followed by our interpretation of how it may affect the validity of report.

1. What is the no rule base for comparing economic impacts? One reviewer noted that if there was no Forest Practices rule, the proposed federal "4d Rule" may be the relevant interpretation of a "no rule" alternative. And, since we estimated the impact of the 4d Rule, the impacts we tabulated relative to our interpretation of "no rule" are far too high since we should be using something like the 4d Rule as a base for economic impact comparisons.

Our contractual agreement was only to look at the relative impact between rules. It would be much more difficult to establish what rule has been in effect over the last several years or should be treated as a business-as-usual baseline. We do not know what the baseline rule or economic impact has been over the last several years or what default option might be appropriate with no state rule. Rather than to reference each case to the rule with the smallest impact, we stated the impact of each rule relative to no rule of any kind, state or federal. In part II under *Linkage to economic model* we tried to make it clear that "no rule" does not imply a level of activity that can be lined up with the economic activity of 1992 or any other year. We stated, "This analysis was restricted to determining the economic impact of rule changes relative to each other, not a forecast of future activity." We have increased the emphasis on this point in the executive summary based on reviewer concerns. If the "4d Rule" is the appropriate default to no state rule the estimated impacts for rules with less impact than the "4d Rule" would be over ridden by the "4d Rule".

2. Will the Department of Natural Resources reduce their sustainable harvest in such a way that they will be able to offset a substantial part of the decline in the first decade? One reviewer pointed out that DNR manages for sustainability and would be able to reduce the first decade harvest impact by accelerating their harvest plan for acres that would not otherwise have been planned for harvest during the first decade. This reduces the first decade impact by shifting part of it out to at least the second decade.

There is little evidence that DNR is consistently managing for a, sustainable harvest level as their harvest exceeded long-term sustainable targets for many years in a row but has also fallen far short of targets in recent years. The determinants of sustainable harvest planning can be complex. Since DNR has not taken economic advantage of the record high prices that have resulted from the federal sales decline over the last several years, it may have sufficient marketable inventory to accelerate the harvest of substitute acres to offset new supply constraints. It is not appropriate for this study to characterize why DNR did not participate in an increased supply response over the last few years; however, it still might do so in response to smaller supply reductions from the Forest Practices Act.

DNR's potential to offset harvest losses should not be confused with a private sector supply response. Prices are already substantially higher from the shortfall in federal sales. The impact of the proposed rules will have some local price affects, but they will be small relative to recent price movements. Any private sector supply response will not be significantly increased by the rule changes. There may be a modest price increase in the local area but as other supply regions respond, even these small changes may be eroded.

In effect, there is little if any potential supply response available from industry. There may be a further liquidation by non-industrial private owners resulting from increased fear of habitat takings; however, the existing motivation to liquidate is already high. To the degree that DNR can substitute supply, which is possible since they have emphasized carrying excess inventory above that which is justified by an economic response, our estimate for DNR's impact may, therefore, be too large. For those rules that have a substantial impact, it seems likely that the rule's impact on constraining marketable inventory will not be easily offset. If DNR is able to shift half of the impact to later decades, it could reduce the impacts shown in the report significantly. For the DNR/WEC Rule since 56% of the impact is on DNR the total harvest impact would be reduced by 28%. Since the DNR impact for the proposed New Rule is shown in the report as making up 34% of the total, the comparable impact reduction for this rule might be 17% or more.

The DNR harvest for 1993 was reported to be 45% below that of 1989, or about 35% below our understanding of the sustainable harvest level. The private sector's 1993 harvest was off 28% from 1989. The bottom line is that the private sector's economic response has not been able to produce an increasing supply response with increasing prices over the last several

years, and DNR did not offset its harvest reductions either. We are on reasonably safe ground to conclude that there will be no significant supply response from the private sector to the Forest Practices rule changes. Since DNR has not managed on an economic basis and holds excess marketable inventory, they still may be able to respond differently to new rules. We should have identified this as a significant uncertainty, and it has been added to the section dealing with uncertainties.

3. Are the estimates and measures of habitat accurate since they are subject to both complex estimating procedures and definitional uncertainty as to what is habitat? Several reviewers noted that the adequacy of some data and the complexity of estimating procedures make it difficult to say that the estimates are accurate.

There is no disagreement on this point, and it received considerable attention in the report. It is not very easy to identify a range of uncertainty for habitat estimates. Most of the error exists as uncertainty in the source data, and these errors are likely to have similar impacts across the rules so that the relative impact differences between the rules are less uncertain than the magnitude of impact.

4. Are the multipliers too high; does the multiplier definition make the multipliers appear high; are the impacts upon government and proprietors high—higher than for other sectors?

The size of a multiplier depends upon (1) the definition of the multiplier and (2) the specification of the model used to estimate the multiplier. With regards to the definition of the multiplier, the size of the multiplier depends upon the type of multiplier (output, employment, or income multiplier), whether or not it is a short-run or long-run multiplier, the size of the geographical region under consideration, what is considered the direct impact (i.e., what is included in the denominator of the multiplier), and, in the case of employment multipliers, whether or not the definition of employment includes self-employed workers along with wage and salary employees. With regards to model specification, the size of the multiplier depends primarily upon the degree of closure of the model (i.e., the extent to which the model captures indirect impacts). In general, these considerations make it difficult to compare multipliers from one study to another.

The multipliers from the Washington Projection and Simulation Model (WPSM), which was used in this analysis to estimate statewide impacts, tend to be larger than the multipliers from input-output models (e.g., the Washington Input-Output Model and IMPLAN, the model developed by the U.S. Forest Service) and similar in size to the multipliers from regional econometric models (e.g., the Washington Economic Model used by the Washington State Office of the Forecast Council). As noted in the paper (Part III, page 4), since input-output models fail to take into account the

indirect impacts on capital investment (e.g., housing construction), public expenditures (e.g., school operations), and changes in population, they tend to underestimate economic impacts (i.e., they tend to have low multipliers). Two technical papers in Part III, Appendix C, discuss the differences between WPSM and input-output models and the implications of these differences for multiplier estimates.

5. Is there double counting on the impact by allowing the lower state-wide economic activity level to lower the retail activities in the forest sector, which in turn reduces forest sector production even though it is not a supply constraint?

In this study, and the forest products industry impact study, we have taken steps to avoid double-counting impacts, especially on the forest products industry. In the present study, which estimates the impact of timber supply constraints on the forest products industry and the rest of the economy, the critical first step is estimating how much wood is required to produce a million dollars of final sales in each of the seven forest product industries (logging, sawmills, plywood mills, other wood products, pulp mills, paper mills, and other paper products). Final sales are the sales of forest products in their final form (e.g., logs for export, lumber for construction, kitchen cabinets, newsprint). The amount of wood required per million dollars of final sales is the volume of logs consumed to manufacture a million dollars of final product, whether the product is logs for export or paper for newsprint. There is a one-to-one correspondence between the final sales of forest products and the volume of logs consumed (or the timber harvest) in the sense that a 25% reduction in the availability of logs, for example, will lead to a 25% reduction in the final sales of the forest products industry (assuming no change in the mix of products). Conducting the analysis with respect to final sales, though sometimes confusing to the reader, avoids the problem of double-counting the economic impact on the forest products industry.

6. Why should the percentage of chip imports (roughly 50%) hold at the margin as supply is reduced?

While most of the chips have come from surplus supply in Oregon, the reduction of supply in Oregon, as a consequence of federal sales declines, is greater than that of other states. Washington mills may become more dependent on Washington chips. Chips have to some degree also been purchased from Canada and Idaho. Several mills have shut down as a consequence of chip shortages and other cost considerations. It is difficult to say exactly which mills will be most severely impacted and alter the import purchases. Therefore, we illustrated a possible range for the impact of imports by defining an alternative in which all needed chips were imported relative to a base case where the import share of chips did not increase.

7. Do the rules encourage or discourage the economic investment required to achieve biodiversity goals, including protection of owls? One reviewer noted that the alternative rules seem to have objectives different than promoting biodiversity and habitat in the long run. He summed up his review this way:

> "In summary, I believe your review makes the following valuable points:
>
> 1. clear statements of purpose are necessary to formulate and evaluate alternative rules;
>
> 2. existing alternatives probably do not serve well the array of unstated objectives of policymakers, regulators, land managers, and the general public;
>
> 3. existing alternatives may not even encompass the best single alternative for the spotted owl, with additional costs to loss of biodiversity; and
>
> 4. economic analyses tell us that there might exist other alternatives that would provide more of a win-win scenario for biodiversity—enhancing production of both economic and ecologic goods and services in the forests of Washington."

ECONOMIC IMPACT OF ALTERNATIVE FOREST PRACTICE RULES TO PROTECT OWL SITES

Provided by: **Bruce Lippke, Director**
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and

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By request of: **Wildlife Committee of the Forest Practices Board State of Washington**

APPROACH:

The economic impact of several alternative owl conservation rules on non-federal lands are evaluated. The impact on harvest and quality wood availability become the source data to evaluate the impact on wood product markets and their impact on economic activity. Part I will evaluate the harvest impacts; Part II will translate these impacts into market impacts and Part III will evaluate the 4 region and statewide economic impact.

Part I (Lippke):

(1) Analyze the impact of individual rules on harvest potential and habitat retention for representative situations.

(2) Integrate or scale impacts up to "important landscapes"—Special Emphasis Areas (SEAs)—and the state's four economic regions.

(3) Analyze long-term implications.

Part II (Lippke):

(4) Interpret how harvest reductions will impact product markets, including alternatives to test uncertainty.

Part III (Conway):

(5) Simulate the impact of these rules on statewide economic activity and its four subregions.

PART I:

ESTIMATING THE HARVEST IMPACTS

Uncertainty exists in the application of the rules, the data quality, the impact on land manager's decision making, the impact on markets, and the economic response. Some interpretation and sensitivity analysis will be provided in each of these analysis stages to characterize the impact of these uncertainties.

Procedure: Rules were first interpreted to allow for measuring their impact on the availability of timber quantity and quality within owl circles. The major thrust of each rule was selected as it was not practical to attempt to characterize each possible variation. While the Appendix for Part I provides supplementary detail on this approach to back up a more results-oriented discussion in the text, as a brief introduction, the procedure for analyzing the impact of individual rules for representative habitat settings is outlined here:

1. Data was gathered for 12 of 15 "important landscapes" identified in the report to the Forest Practices Board by the Scientific Advisory Group (SAG). Partial information was collected on the other landscapes. Either age-class GIS data or habitat-type GIS data across owners was located.

2. Sub-samples of habitat typing vs age class were developed to cross-correlate age with habitat where the habitat type was missing.

3. Procedures were developed to examine the impact for different owl circle sizes when data was not available for the circle size appropriate to the rule.

4. Board-foot yields were obtained to measure timber volume.

5. A function was developed to measure quality changes by determining the percentage of "#2 and better" and "special mill" logs as a function of age.

6. A separate timber-value function vs age class was also developed.

7. Analysis spread sheets were developed to compute the impact for each alternative rule on each landscape, detailing the impact of saving habitat across age and habitat classes, first, within .7 mile circles and second to the edge of circle boundaries where the habitat area target may vary for each rule and landscape.

8. Distribution corrections were developed for areas with a large number of owls, so that most of the analysis could be confined to an average owl circle for a landscape, rather than to analyze each owl circle.

9. The SAG report owl count in the 15 important landscapes was compared to the GIS data samples and adjustments made to the sample to correspond closely with the SAG owl count.

10. The adjusted data samples were identified by region so that they could be aggregated up into economic regions (as different than owl regions) and the state economy.

11. Acreage targets for each rule were identified for each landscape.

12. The Dispersal Rule and Pair Maintenance Rule required interpretation to provide acreage targets and to identify extended habitat definitions.

13. Impacts beyond the first decade and appropriate to the long-term steady state were developed along with impacts on long-term investment decisions.

14. Potentially significance sources for error were judgmentally analyzed, and where appropriate, the impact of alternative assumptions were estimated to demonstrate the range of uncertainty.

(1) ANALYZE THE IMPACT OF INDIVIDUAL RULES

Rule interpretation: While there was no intent to redefine the rules, different experts have responded to what the rules mean in different ways. For analysis purposes a specific repeatable procedure is required so that comparisons are meaningful and not reflections of random interpretational differences. Hopefully these interpretations characterize the key thrust of each alternative rule. While they are consistent from the standpoint of analysis, they may not always capture the full intent of the rule. The rules generally are keyed on preserving a target acreage of habitat. The target acres used in the analysis for each rule and landscape are tabulated in Appendix-11.

Rules Analyzed:

1. 70-Acre Rule: Find the best 70 acres closest to the owl site and constrain it from being harvested. Look within .7 miles first for A, B or C habitat in oldest growth first; then proceed to lower habitat, younger stands; and lastly, look outside of .7 miles (Type A is old-growth, Type B is mature, Type C is young growth forests, all are suitable habitat). This results in a fair share by ownership within these classifications. While one could envision the federal acres taking preference and becoming a larger share of the 70-Acre Rule application, the economic impact difference from the 70-Acre Base Rule or between rules would seem to be negligible and the data quality close to site centers not sufficient to make that a worthwhile focus of the analysis. Hence, the measurement procedure was designed for fair share within each circle-radius, habitat type, and age-class category rather than federal lands first for each category. Since the first 70 acres are common to all rules, by comparing the different rules to the 70-Acre Rule any over count that is common to all rules will be essentially eliminated.

2. 500-Acre Rule: Find the best 500 acres close to site. While the same procedure was used as in the 70-Acre Rule, the fair share principle across owners' lands would generally be required to find sufficient acres; hence, the federal-acres-first option is of less importance.

3. WFPA Rules: Either Dispersal or Pair Maintenance Rules apply within 1.8 mile circles on 6 specific SEAs, with the 70-Acre Rule default option elsewhere. {Details on the rule proposal appear in a memo to the Wildlife Committee (Yeager, 1994)}.

Dispersal Rule: Find best 70 acres first, plus make progress toward a dispersal habitat goal of not more than 1/2 mile spacing between 40 acre dispersal stands to the SEA boundary. The target ultimately may require 25% of the total acreage in dispersal or better stands. Sufficient progress toward the target was defined to be 15% in 10 years within the owl circles. If the rule is satisfied by minimum separation to the next dispersal site in only one direction rather than 4 directions, the 15% target should be a close estimate of the ultimate impact. Supplementary analysis was not completed to show the impact outside of owl

circles to the SEA boundary. While this impact will differ for each SEA, it was noted that the area outside of owl circles was generally equal to the area covered by circles. Exceptions include the Southwest where the area outside is much larger. A rough estimate of the impact of the Dispersal Rule on acres outside of owl circles would be equal to the impact inside the circles. This impact is less certain and has therefore been excluded from tabular results.

Dispersal habitat (type D) is not suitable habitat. Many stands as young as age 35 are potentially dispersal stands, at least if thinned. Many intensively managed stands might be too dense to qualify as dispersal prior to thinning. A portion of somewhat older stands are less dense and will qualify as dispersal. Alternative definitions for dispersal habitat can be important to the impact and intent of the rule.

Various owner options under the rule are not considered since they raise too many analysis alternatives and do not appear to be the central thrust of the rule, even though they may in some cases provide the ability to lower the cost to the owner.

Pair Maintenance Rule: Save suitable habitat (A, B, C) within .7 miles and provide 40% forage or better habitat (30% Eastside) if available within 1.8 mile circles. Excess habitat (outside the 70 acres) can be harvested with the most economic (oldest) being taken first, saving the forage habitat rather than the more marketable inventory that may be better habitat. The forage habitat definition is the same as "dispersal," plus the additional requirement of 3 wildlife trees per acre. It was assumed that half of type D will qualify as forage habitat (even though it is not suitable habitat). This forage definition is assumed to be less than suitable habitat (less than type C) and, hence, a new habitat class. Again, other options are not considered central to the intent of the rule.

Dispersal SEAs: Columbia Gorge, Mineral Link, Finney

Pair Maintenance SEAs: Mineral Block, I-90 West, I-90 East

4. DNR/WEC Rule: Specific habitat targets apply to 15 SEAs with the 70 acre default option elsewhere. The rule developed by the Department of Natural Resources in conjunction with the Washington Environmental Council is largely based on targets provided by the Scientific Advisory Group (SAG) in their report (Hanson, et al., 1993). Save all habitat within .7 mile, and save the best habitat up to specified targets within circle boundaries, allowing harvest of best timber within lowest-habitat class when in excess of targets. Habitat modification options are noted but do not offer a specific rule option and were not analyzed.

Circle boundaries and suitable habitat acreage targets:

Olympic: 2.7 miles, 3827 acres

Western Cascades: 2.0 miles, 3586 acres

Eastern Cascades: 1.8 miles, 3249 acres

5. Federal 4d Rule: Save suitable habitat up to specified acreage targets within circles (approximately 40% of the total acres becomes the target)

Olympic Province: 2.7 miles, 5708 acres

Western Cascades: 1.8 miles, 2663 acres

Eastern Cascades: 1.8 miles, 1906 acres

6. SEPA (Class IV) Rule: Any action within circle boundaries requires a ruling that could prevent any harvest within the circles (a worst case). While retaining 40% as habitat may be a regulatory implementation target, limitations on the availability of habitat make this not much different than the DNR/WEC Rule. If SEPA stops all harvest, not just the harvest of all suitable habitat, harvest reductions would be larger than shown. Analysis on this rule was terminated when the Wildlife Committee proposed a new rule for consideration (the SEPA Rule seemed the least important).

Olympic Peninsula: 2.7 miles, 14657 acres

Western Cascades: 2.0 miles, 8042 acres

Eastern Cascades: 1.8 miles 6514 acres

7. New-Com Rule: (New Rule proposed by the Wildlife Committee to the Board on May 11,1994): The newly proposed rule follows the DNR/WEC logic for some areas and shows the intent of following a dispersal logic on other areas. New or modified circle sizes and habitat targets are utilized. Since the definitions for dispersal habitat are different than the WFPA proposal, the impact shown for this rule must be considered just one variant of several possible interpretations. In particular, the definitions may preclude the existence of dispersal habitat that is not already suitable habitat. It was assumed that the intent was to allow a dispersal concept similar to the WFPA Dispersal Rule; hence, a similar concept was evaluated while using the newly specified circles sizes. The demographic support focus of the rule on the remaining areas was assumed to be similar in intent to the DNR/WEC Rule and not the WFPA Pair Maintenance Rule.

Targets/circle boundaries:

Westside: 2.0 mile circles, 500 acres within .7 miles+2700=3200 acres
Eastside: 2.0 mile circles, 500 acres within .7 miles+1900=2400 acres

Dispersal SEAs: Columbia Gorge, Easton, Mineral Link, Finney, Mineral Block, White Salmon

Demographic Support SEAs: I-90 West, I-90 East, Siouxon, Taneum

Timing of harvest loss from rule implementation: Each rule will prevent some number of acres from being harvested. Within 10 years time, stand structures will change enough to impact what is marketable and what is suitable for habitat. A reasonable economic assumption is that acres that can not be harvested due to rule implementation would otherwise have been liquidated for economic value within 10 years. This impact could easily be

larger in the first few years of the decade. Harvest losses identified from the rules are considered to be first-decade losses.

A steady-state impact of the rule under unchanged management assumptions can be generated by assuming that those acres that cannot be harvested are under long-term rotational yields. This will generally be smaller than the first decade impact as shorter rotations replace current, marketable inventory. This steady-state measure of impact eliminates the extra value of high quality inventory and the extra volume of mature inventory available only in the first decade, allowing more focus on the longer-term implication of the rules. It does not reflect the time value of money that should make this impact of less importance, and it does not reflect the impact of the rules on longer-term management behavior that may be much more important and will be considered separately.

At least in theory, the process of adjusting from pre-rule harvest rotations to post-rule rotations could be smoothed out by accelerating the harvest of younger stands to fill part of the lost harvest. While this may be possible under current market conditions with very high prices, that potential exists independent of the rules, and from an economic-management perspective there should generally be very little excess in marketable inventory to use to fill such a void. It is sub-optimal management to retain excess marketable inventory, and the rules are not the cause of making such an option available nor the motivation to exploit it since timber shortages already exist to motivate full use of such an option. Management efforts to adjust to a new long-term rotation target would also ultimately result in greater losses longer term if the full adjustment is not made quickly; hence, no attempt has been made to determine a reduced harvest impact for the first decade by harvesting younger stands to offset the constraints on older stands.

One reviewer pointed out that DNR manages for a sustainable harvest, not optimum economics. With a larger inventory of mature timber, they could more easily substitute acres that would not have been harvested until a later decade for acres that might be constrained by the location of owls. This would, of course, decrease the first decade harvest constraint on DNR harvest, relative to other owners. Since DNR's harvest has actually declined more than other non-federal owners since owl litigation began, contrary to a sustained harvest strategy, neither a sustained harvest rate nor an economic decision rationale may be appropriate to model DNR harvest plans. It is beyond the scope of this report to speculate on DNR's response; however, it has been identified as a major uncertainty with sensitivity estimates of alternative impacts provided. Thus, the impact tables assume DNR's constrained harvest would be fully reflected in the first decade.

Impact of Rules on various habitat and stand conditions: Given the above interpretation of the rules, it is instructive to look at the impact of these rules on several different kinds of stand structures with a broad range of habitats before characterizing the differences across the SEAs and regions. As it turns out, different rules will have a very different impact on stands with a large

amount of habitat vs those with little habitat. Today's stand structures on private acres are the result of approaching a short commercial rotation but still contain some pockets of stands with old-growth features. Further, the commercial rotations were initiated by economic competition that did not foster regulated rotations over a small spatial scale such that many acres in a watershed may be near the same rotation age. Dispersal of ownership and management styles then determines much of the variation in structure that currently exists.

The impact of the rules will vary as the amount of old growth or second growth management that affects stand conditions varies. Suitable habitat can result from natural disturbances or management operations. The DNR/WEC Rule seeks adequate habitat for acreage targets developed in the SAG report. That target can be achieved by preservation/natural disturbances over several hundred years or might also be provided by a 100-year rotation with commercial thinnings to create the target stand conditions. In order to reach the DNR/WEC target of 3586 acres, it will require the full 60-100 year-age structure and about half of the 50-60 year structure in suitable habitat for a 100 year rotation. This is about what could be done by a commercial thinning treatment on a 100-year rotation. A wildlife thinning treatment which gives a little more attention to retaining snags and downed logs would increase the amount of habitat even more than a normal commercial thinning. Without thinnings (natural or managed), even a 150-year rotation would likely have more acres failing the habitat criteria. Current landscapes with higher percentages of old second growth or even older stands will approach, but generally not reach, the desired habitat target.

At the other extreme, a 50-year commercial rotation will only produce a small portion of the 40-50 year old stands as young habitat and, then, probably only after a late pre-commercial thinning or a commercial thinning. Commercial thinning approaches but does not reach the habitat benefits of a thinning treatment designed for wildlife. Existing stands are largely a result of a short rotations but with small pockets of older stands and are still populated with owl sites. Many owl sites have only a small percentage of the acreage targets in suitable habitat.

Currently, landscapes on private lands generally have more suitable habitat than would exist if all land was on short rotations but substantially less habitat than would result on lands managed for long rotations. Each sub-landscape will contain some habitat, approaching the 100-year rotation example and some approaching the 50-year rotation example. Current conditions then make up a distribution of structures largely varying between these two extremes.

Generally, the percentage of a stand providing suitable habitat will increase with age, but that percentage will be very sensitive to management treatments and can be manipulated to create or destroy habitat. Thinnings and wildlife treatments or natural disturbances will generally speed up the creation of

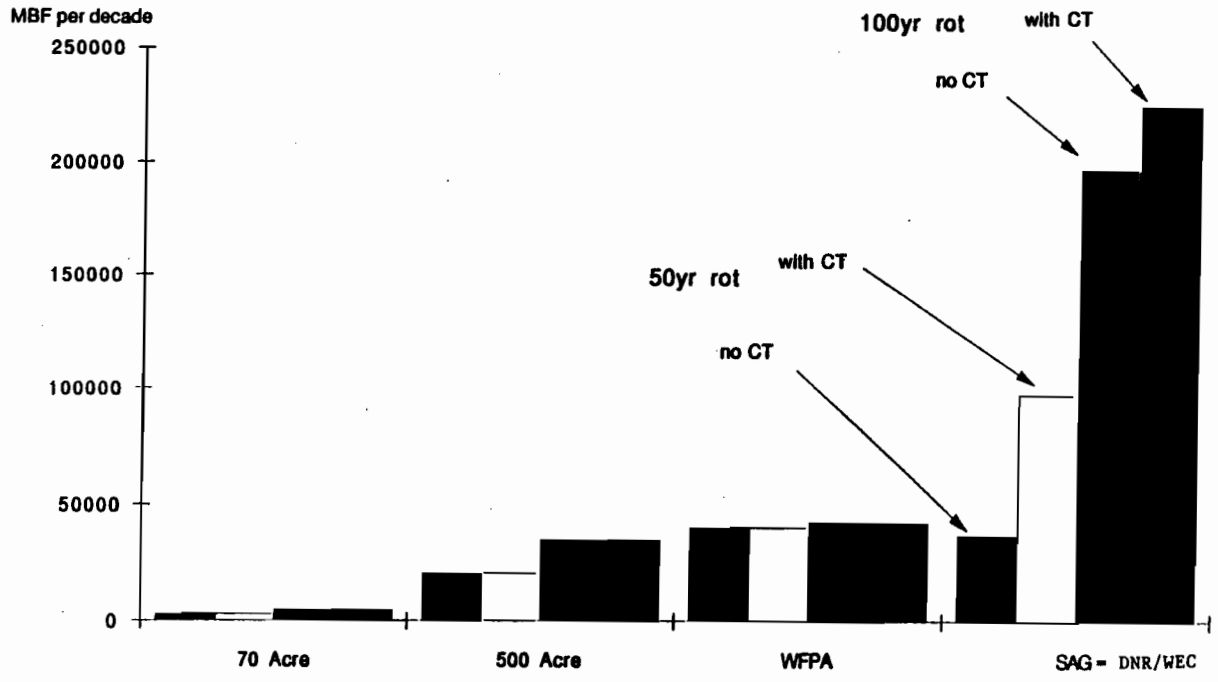
habitat in contrast to dense stocking and no management. Very short rotations may preclude the creation of any habitat.

For illustration purposes, the report assumes the amount of habitat created by age and management operations. Estimates of habitat vs age were obtained from acreage samples that have been categorized by habitat, and these estimates become an important assumption in estimating habitat.

Rule contrasts between 50-year and 100-year rotations: Using these two examples as upper and lower habitat extremes, the potential harvest loss for the first decade for these structures is shown in Figure 1 for each of four rules. The harvest loss is much greater for the 100-year rotation, because it creates more suitable habitat. The full target of acres in suitable habitat (3586 acres) are saved, consisting of large trees with a high board foot measure per acre. While there may be few sites on non-federal lands with as much habitat as this example, it shows approximately the upper limit impact potential of the rules, making it easier to understand the range of possibilities across variations in landscapes.

Figure 1:

Harvest Loss for Variation in Rotation-Age Management



Main causes for rule differences: As the figure shows, the DNR/WEC Rule shows a large variation in impacts for different management alternatives. It will also differ with the other rules which have different circle size and acreage targets. The DNR/WEC Rule is slightly more severe than the 4d Rule, because the acreage target is larger (not shown). The harvest loss will not be as large as the acreage difference since the remaining harvest under the DNR/WEC Rule will be on the younger stands while the older stands will be saved under each rule. The 4d Rule does not differ much from the DNR/WEC Rule except through these area differences. The DNR/WEC target is not reached with the 100-year rotation, largely because natural aging alone is not necessarily sufficient to produce habitat. A thinning treatment is shown to probably increase the habitat enough to reach the DNR/WEC acreage targets. The amount of habitat by structure and response to treatment becomes a key variable in such an impact assessment and will be evaluated from several perspectives. As the Figure 1 example shows, the DNR/WEC Rule has a larger impact on thinned stands which are generally managed over a longer rotation. This will become an important consideration for a longer-term impact analysis.

The WFPA Rule for dispersal habitat is able to harvest the oldest acres after the first 70 acres are protected, which lowers the cost, but still must maintain 15-40% of stands in dispersal or better habitat. This can be a severe constraint on the acres that can be harvested as will be seen in other examples, but for this example, where the rotation produces a uniform age distribution, it does not impose a large penalty. This sensitivity of the WFPA Rule to uneven age distributions will be demonstrated in greater detail below.

Impacts of the 500-Acre Rule and 70-Acre Rule largely reflect their acreage differences. The 50-year rotation produces less volume per acre at the time of harvest than the 100-year rotation.

For the 50-year rotation example there is very little habitat produced; hence, the harvest loss from high habitat protection targets may be small with little differentiation between the rules. Several landscape areas show no more habitat than the 50-year rotation example. However, the rule to protect dispersal habitat prevents harvesting some non-suitable dispersal habitat in order to retain up to 15% of the acres in dispersal or better habitat. If there is a shortage of suitable habitat even non-suitable dispersal habitat will be protected under a Dispersal Rule. This results in more acres being constrained from harvest when there is little habitat than would be constrained by rules constraining only suitable habitat. On the other extreme, if there is a large amount of habitat, the dispersal alternative allows substituting less valuable dispersal habitat for more valuable suitable habitat, greatly reducing the impact of the Dispersal Rule compared to rules constraining only suitable habitat. The observed impact of rules on sample landscapes therefore demonstrates these characteristics of the rules as well as the general availability of habitat on private lands.

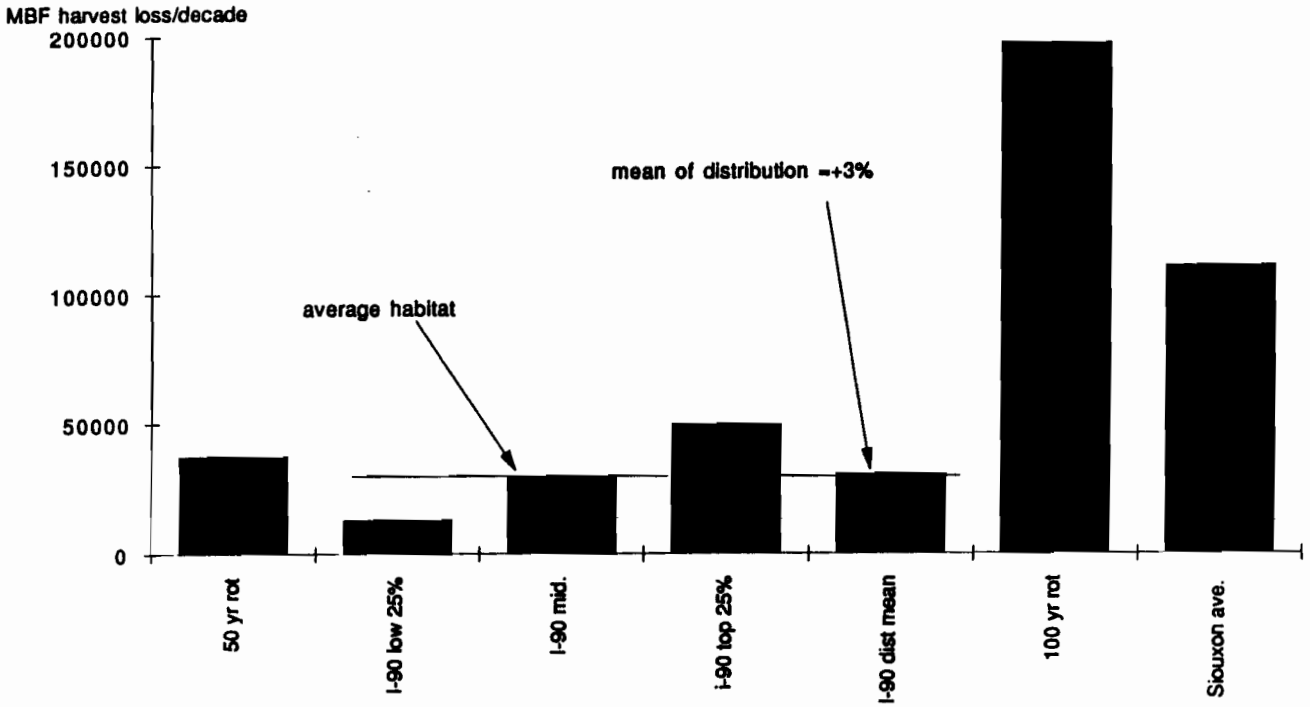
If the procedures used to determine how much of a specific structure is made up of suitable habitat are biased high or low, they may exaggerate these differences across the rules. Underestimating the habitat will understate the harvest impact and narrow the range of the differences observed across the rules (and vice versa). There is some evidence that habitat typing is not that repeatable or certain, with implications that will be considered in more detail when making cross-region comparisons.

Determining the average impact across a Special Emphasis Areas (SEA): Owl sites across an SEA such as I-90 West contain large variations in habitat. Some owl sites will approach old-growth structures like the 100-year rotation and some will approach the conditions of the 50-year rotation. The I-90 harvest impact for the DNR/WEC Rule is, therefore, shown in several components in Figure 2.

Figure 2:

Harvest Loss Variation within a Landscape

DNR/WEC Rule



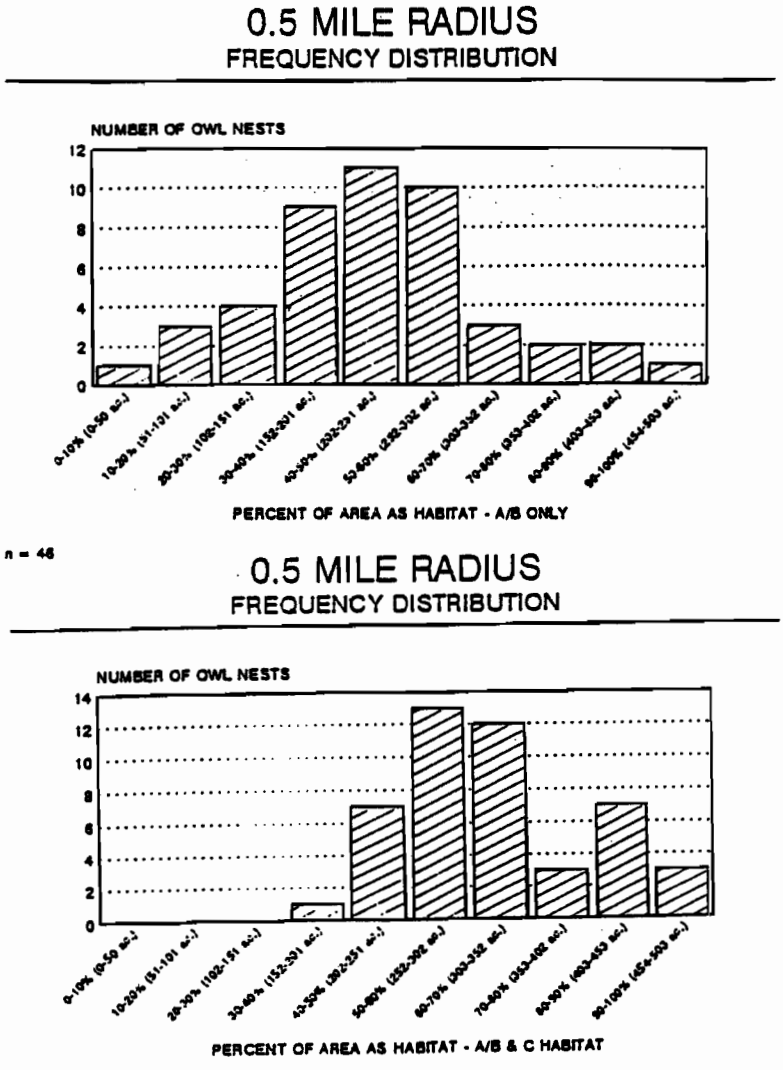
The six sites with the lowest habitat form the bottom quarter of the I-90 owl distribution (the lowest impact), and the six sites with the most habitat form the top quarter of the distribution (the largest impact). The impact for the top and bottom quarters are shown on each side of the impact for the average site. This average for the bottom 25% has less impact than for the 50-year rotation example. The average for the top 25%, while greater than the 50-year rotation example, is much less than the 100-year rotation example. That is, the I-90 owl circles have few, if any, sites with sufficient habitat to approach the DNR/WEC acreage target. The impact for the average conditions across all sites provides an estimate for the middle 50% of sites. As noted for the top and bottom quarters, the loss from the high habitat sites more than offsets the smaller loss from the low habitat sites. By weighting the top and bottom quarter by 25% each and the middle estimate by 50%, a distribution correction to the impact measured for an owl circle with average habitat can be determined. Noting that the sum of the impacts for the top 25% and bottom 25% is 6% greater than by analyzing the impact for the average structure, their 50% weight leads to the ultimate adjustment becoming 1/2 of +6%, or +3%, (which is barely visible in the example).

Distribution corrections for SEAs with high levels of habitat will be greater than for those with low levels of habitat. The largest impact would be expected when there are many sites with excess habitat such that there is a bunching of sites near the rule's target acreage. The distribution adjustment will also be sensitive to the location of federal timber. For the Olympic data with high levels of habitat, the distribution shape resulted in a +11% adjustment to the acreage impact for the average site, but the federal impact was the largest for these sites such that by removing the federal acres the full adjustment to the harvest became a -10%.

The adjustment may also be dependent upon the type of habitat. Figure 3 shows a number of owl sites with very little AB habitat, but none of these sites are without considerably more C habitat within a .5 mile circle. It takes very good spatial data to analyze the full impacts.

Figure 3:

Frequency of Owl Sites vs Habitat Type

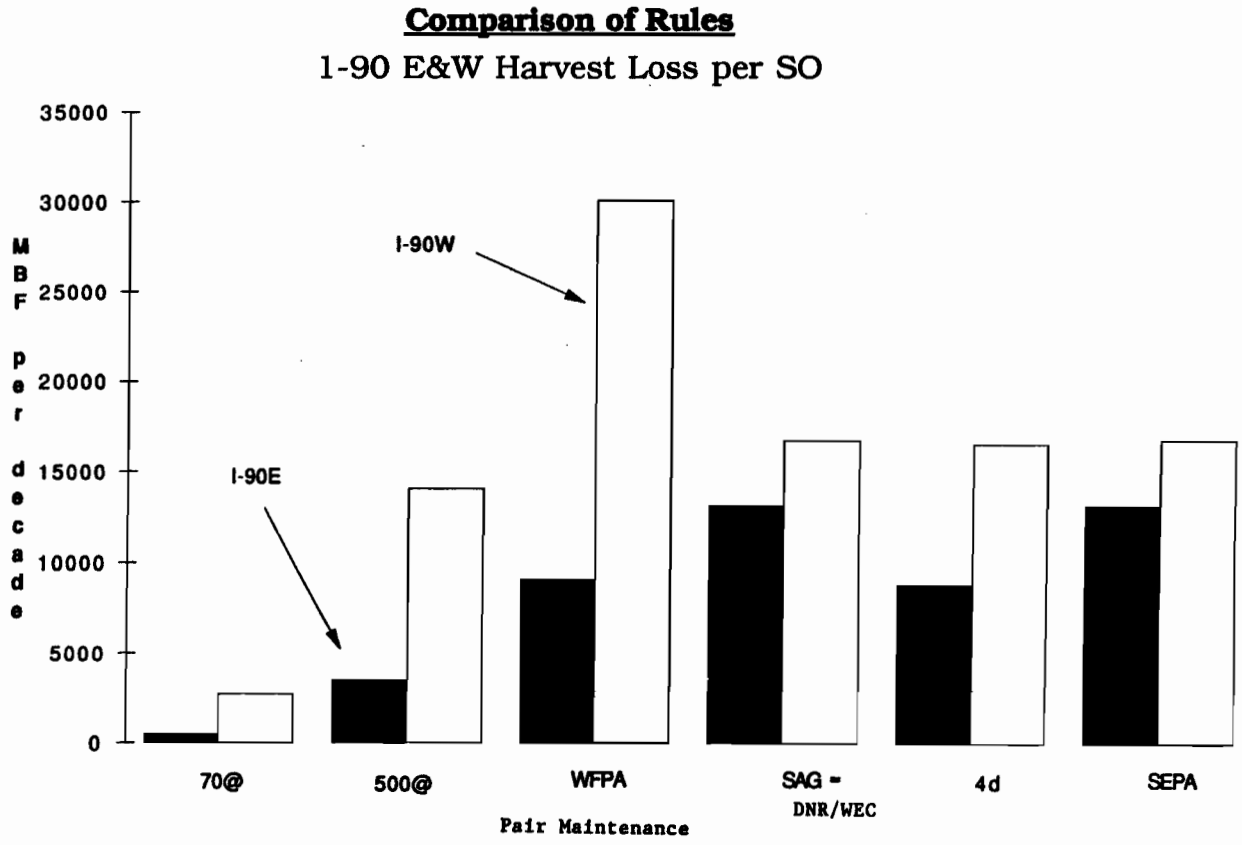


Rather than analyzing the rule impact on each site in a region which has many owls and adding them up, it is analytically efficient to measure the impact for a representative average site (average habitat in Figure 2 example) and correct that estimate for the impact of the distribution shape by weighting the impact to reflect the upper and lower tails of the distribution (mean of distribution shown in Figure 2). This correction can be made for the final analysis where it is considered important; although, it will not be shown for every rule as a matter of efficiency. The correction is generally very small for the large number of low habitat situations on private lands, but there are areas with high habitat levels such as Siouxon as shown in Figure 2. While a distribution correction for an SEA with as much habitat as Siouxon might be significant, Siouxon has few sites eliminating the need for such an analysis.

Regional differences: Special emphasis areas such as Siouxon contain a larger percentage of habitat and, therefore, look more like the 100-year rotation than does the I-90 area. The DNR/WEC Rule impact for Siouxon is more than twice the impact per circle as shown in the I-90 area, as a consequence of Siouxon's older-age classes while assuming the same relationship between age and habitat type.

Impact of the WFPA Rule: It has been noted that the WFPA Rule reduces to the 70-Acre Rule for 9 of the 15 identified landscapes, a Dispersal Rule for 3 and a Pair Maintenance Rule for another 3. A comparison of the impact of the six rules on I-90 East and I-90 West for the average spotted owl circle shows a higher harvest impact of the WFPA Rule on I-90 West even though the habitat acreage percentages are higher for I-90 East, see Figure 4. A good part of the difference is explained by higher volumes per acre on the older-age distributions for I-90 West and the rest by the larger federal share in I-90 East.

Figure 4:



Pair Maintenance: The most striking comparison shown in the figure is the larger harvest loss shown for the WFPA Rule for I-90 West than harvest loss for the same area under the DNR/WEC Rule. The WFPA Pair Maintenance Rule for I-90 West calls for 40% forage or better habitat. Since the definition used for forage was considered more relaxed than for suitable habitat, more acres become at risk to reach the 40% rule. Dispersal habitat definitions can likely be reached by natural or managed thinnings to reduce the density prior

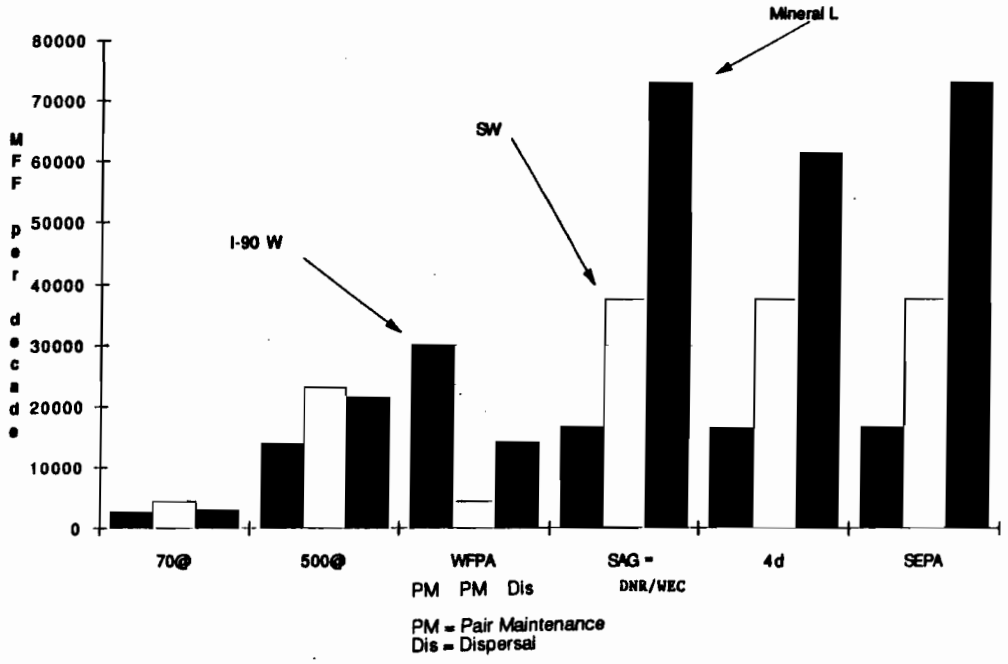
to age 40. If these stands have 3 wildlife trees per acre they are defined to be forage habitat. While no accurate assessment of this definition was attempted, the impact was illustrated with a portion of the non-suitable habitat over age 40 becoming dispersal habitat and half of that becoming forage habitat. The definition of such habitat and the ability to repeatedly type or accurately categorize the habitat will be critical to the impact assessment. The Pair Maintenance Rule impact will be largest relative to the DNR/WEC Rule on stands with little habitat as it becomes necessary to defer harvest on both the older stands and this new class of forage habitat. This is shown by the I-90 West example where the amount of habitat falls far short of DNR/WEC targets and, as a consequence, requires deferring harvest of the more readily available forage habitat. I-90 East has no comparable impact as there was no age class data to estimate the amount of forage habitat as different from suitable habitat.

Dispersal: A dispersal habitat definition and rule applies to 3 SEAs. Figure 5 illustrates the impact of the Dispersal Rule for Mineral Link (in comparison to the Pair Maintenance Rule for I-90 West) and to the DNR/WEC Rule. While the Dispersal Rule shows much less impact than the DNR/WEC Rule for Mineral Link, which has a large amount of habitat, it is still far greater than the 70-Acre Rule.

Figure 5:

Comparison of Rules

Harvest Loss per SO



The Dispersal Rule is not tightly defined and may be interpreted as requiring 25% habitat only in the long run in order to establish dispersal clusters on not less than 40 acres within 1/2 mile spacing. If stands are uniformly even aged, a 53-year rotation or longer can maintain 25% of the stands in age 40 or older. To classify as dispersal they may have to be pre-commercially thinned late or commercially thinned. The impact is difficult to estimate because stands are not of uniform age distribution and there will have to be delays in some harvest to ever create a uniform distribution or to ever reach the target. If the rule is interpreted to mean that no harvest penalties beyond 70 acres will be required, the dispersal target will never be reached.

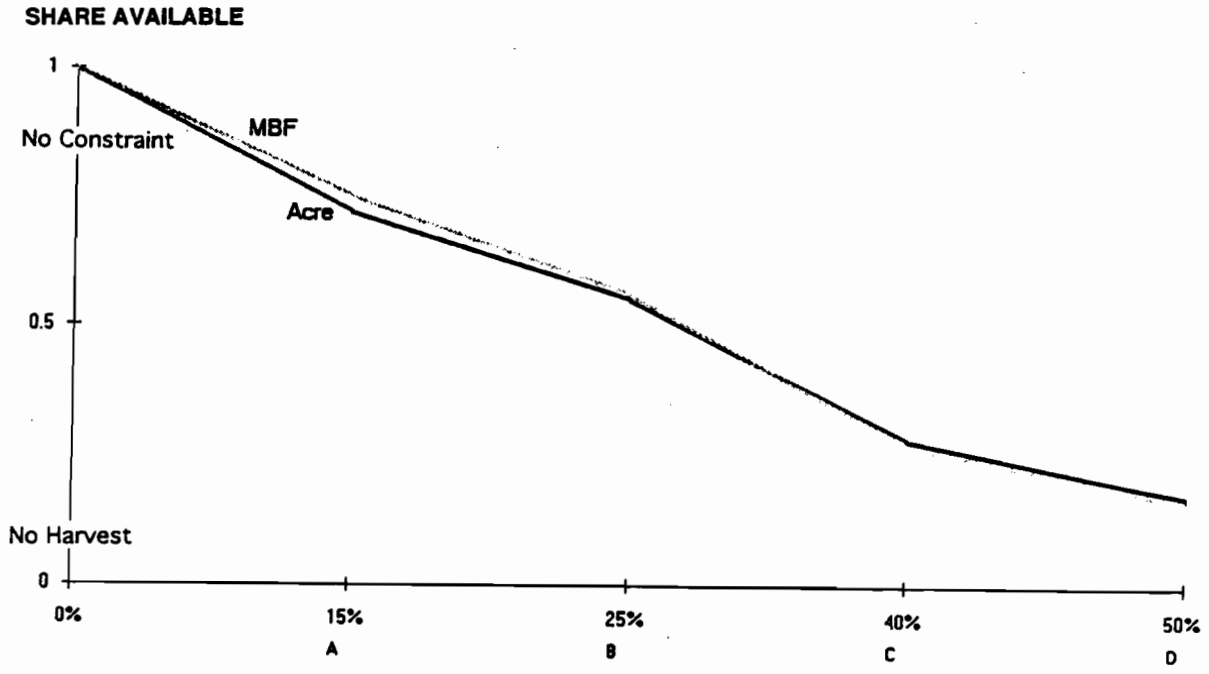
Many observers were astounded when land managers said the "50-11-40" Rule suggested by the ISC committee would reduce their harvestable acres by 75%. Retaining 50% in cover does not sound like it would curtail 75% of the harvest. The Dispersal Rule is equivalent to a 25-11-40 Rule, i.e. saving 25% under dispersal definitions. Figure 6 provides an analysis of the impact on a 113,000 acre sample (raw data provided by a private owner) varying the percentage that must be retained as cover.

Figure 6:

Harvest Impact of Cover Retention:

"X-11-40 Rule" Spatial Impacts

(Data for 113,300 acre sample characterized by quarter townships - 240 plots)



D: 50% corresponds to the 50-11-40 rule.
C: 40% corresponds to the 40% cover rule.
B: 25% corresponds to 40 acre dispersal clusters within one-half mile.
A: 15% corresponds to over 50% progress toward C in 10 years.

If there is no requirement to save anything for cover (0%), the full share of marketable timber is available for harvest. At 50% retention (point D), over 80% of that which is harvestable must be retained to meet the "50-11-40" Rule. The 40% point relates to typical 40% targets. The 25% point is comparable to the target of the Dispersal Rule. It takes more than a 25% harvest decline to reach 25% retention across the landscape. The 15% point was inserted as an attempt at making roughly half the contribution toward the 25% target in the first decade. An alternative interpretation to the 15% target is to require the 1/2 mile spacing between dispersal stands to only be required in 2 directions rather than 4 directions resulting in two minimum areas that must be retained within 1/2 mile, a 12.5% requirement.

For SEAs with very little suitable habitat, the harvest reduction under the WFPA Dispersal Rule with any realistic approach to the target over time will be greater than the harvest reduction under the DNR/WEC Rule. However, for situations with significant habitat, the cost may be much lower than that of the DNR/WEC Rule, because the dispersal habitat will substitute for higher-valued timber. Hence, the impact of the rule can range from the 70-Acre Rule to higher than the DNR/WEC Rule.

Indexing the impacts for comparisons: Impacts across several SEAs have been indexed as a ratio to the 70-Acre Rule in Table 1. Sub-table (a) provides the harvest loss data for 6 rules across 5 SEA's in millions of board ft. for the first decade. Sub-table (d) converts the losses to the average board foot loss per owl circle in thousands of board feet for the first decade. Sub-table (b) provides the target acres of habitat to be saved that is embedded in each rule for each area. Sub-table (e) indexes the harvest losses per owl circle to the 70-Acre Rule.

Table 1:

Harvest Loss Comparisons

			Harvest loss per rule first decade							Harvest loss per SO and index to base						
	SEA's	owls	70 Acre	500 Acre	WFPA	SAG*	4d	SEPA	SEA's	70 Acre	500 Acre	WFPA	SAG	4d	SEPA	
			mmbf	mmbf	mmbf	mmbf	mmbf	mmbf	non-Fed mbf/SOC	mbf/owl	mbf/owl	mbf/owl	mbf/owl	mbf/owl	mbf/owl	
(a)	I-90E	23	11	82	210	303	204	303	I-90E	496	3543	9117	13178	8861	13178	(d)
	I-90 W	25	69	352	752	419	414	419	I-90 W	2752	14088	30072	16768	16568	16768	
	SW	15	66	346	66	563	563	563	SW	4407	23093	4407	37507	37507	37507	
	Mineral Link	4	12	86	57	291	245	291	Mineral Link	3025	21550	14300	72800	61200	72800	
	Hoh	24	67	479	67	2165	2165	2165	Hoh	2792	19958	2792	90208	90208	90208	
	Target acres in rule		acres	acres	acres	acres	acres	acres	index to 70 acres	i.e. ratio to 70 acre base						
(b)	I-90E		70	500	1956	3249	1906	6514	I-90E	1	7	18	27	18	27	(e)
	I-90 W		70	500	2605	3586	2663	8042	I-90 W	1	5	11	6	6	6	
	SW		70	500	70	3586	2663	8042	SW	1	5	1	9	9	9	
	Mineral Link		70	500	977	3586	2663	8042	Mineral Link	1	7	5	24	20	24	
	Hoh		70	500	70	3827	5708	14657	Hoh	1	7	1	32	32	32	
	Index of target acres to 70 acre base								index to target acres	i.e. effectiveness ratio to reaching target						
(c)	I-90E		1	7	28	46	27	93	I-90E	1.00	1.00	0.66	0.57	0.66	0.29	(f)
	I-90 W		1	7	37	51	38	115	I-90 W	1.00	0.72	0.29	0.12	0.16	0.05	
	SW		1	7	1	51	38	115	SW	1.00	0.73	1.00	0.17	0.22	0.07	
	Mineral Link		1	7	14	51	38	115	Mineral Link	1.00	1.00	0.34	0.47	0.53	0.21	
	Hoh		1	7	1	55	82	209	Hoh	1.00	1.00	1.00	0.59	0.40	0.15	

*SAG = DNR/WEC

While the impacts of the DNR/WEC Rule are shown to be as much as 32 times the impact for the 70-Acre Rule where there is substantial habitat (DNR/WEC Rule for Hoh), for I-90 West it is as low as 6 times, because there is so little habitat within the I-90 West owl circles.

The ratio of harvest impacts to the primary acreage parameter in each rule for I-90 West shows that while the difference between the 500-Acre Rule and the 70-Acre Rule is almost totally an acreage difference (sub-table c), the impact of the other rules falls far short of the acreage impact, largely because there does not exist enough habitat on the sites to reach the target impact.

On private lands most owl sites have only a small fraction of the habitat target provided in the DNR/WEC or 4d rules. By comparing the harvest impact to the target acres that characterize each rule, (70, 500, DNR/WEC targets, 40% rules, etc.) an effectiveness ratio to the 70-Acre Rule can be characterized for each SEA (sub-table f). For the DNR/WEC Rule, the effectiveness ratio is as high as 50% for several regions with substantial habitat but as low as 12% for other regions. The question needs to be raised as to whether these differences are real or not. Is the owl relatively insensitive to the need for large acreage targets or is the data unreliable?

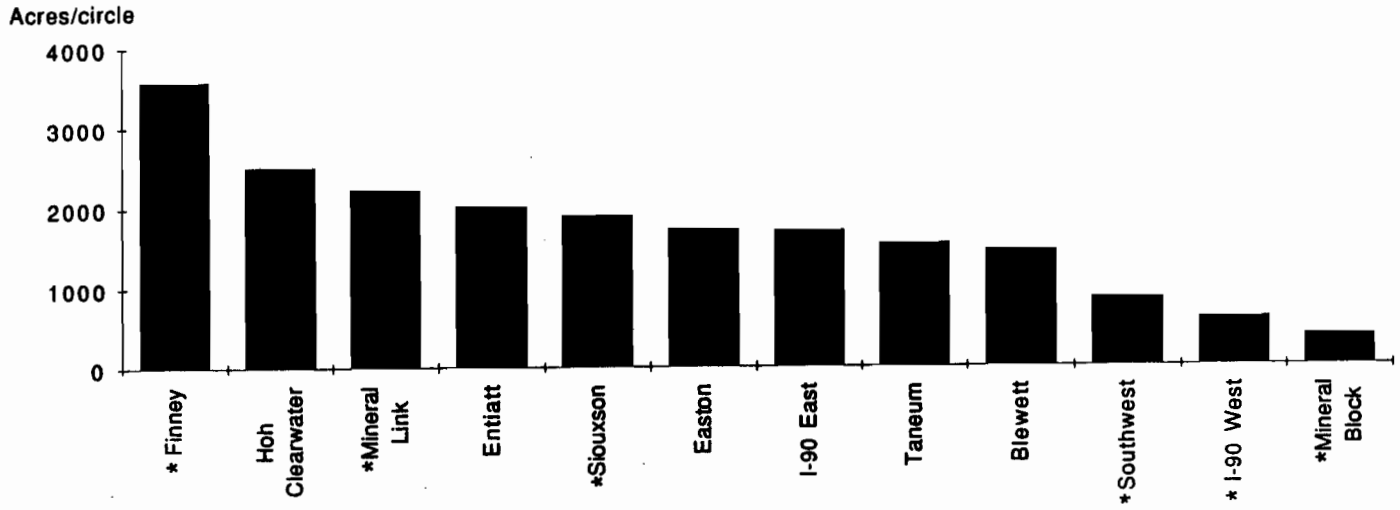
Habitat measurement uncertainty: The amount of habitat type has been arrived at by several methods. Where GIS age-distribution information was available, habitat types were cross correlated to age classes. These were available for several small samples. Owners also provided rules of thumb on how much of a given age class would be habitat. There is substantial variation in these estimates, which may reflect true differences in stands across the state or possibly uncertainty in habitat typing. Where GIS data was provided with habitat typing but without age class information (the habitat categories were determined by satellite imagery aerial photography and ground validation, usually by contractors to companies in the SEA,) it appears that a much higher percentage of habitat is present. For even-aged management, it probably requires nearly 100% of all stands above 40 years old to provide the levels of habitat characterized by some of the non-age dependent GIS habitat information. A greater percentage of selective-harvested stands may qualify as habitat, explaining some of their difference since most of the GIS habitat-type samples were from the Eastside.

The objective of this analysis was not to audit habitat typing procedures; hence, these differences are noted without attempts to resolve their source or determine whether they represent a real problem. Intuition might suggest that on those SEAs where age-class conversions to habitat were developed, the habitat is being underestimated. When developing the procedure, the first concern was that the process might overstate the habitat on the older-age groups. That includes I-90 West, SW, Mineral Block and Link, Siouxon, and Finney. Several of these regions actually have a very high percentages of habitat compared to the group average, which may refute the idea that there is any bias in the data. Figure 7 shows the amount of habitat on all of the SEAs, noting those regions that were based on age-class to habitat typing. Some of these regions have very little habitat and others have nearly as much as DNR/WEC targets.

Figure 7:

Variation in Habitat Acreage Across Landscapes

DNR/WEC Rule: Average Federal & Private Acres Constrained



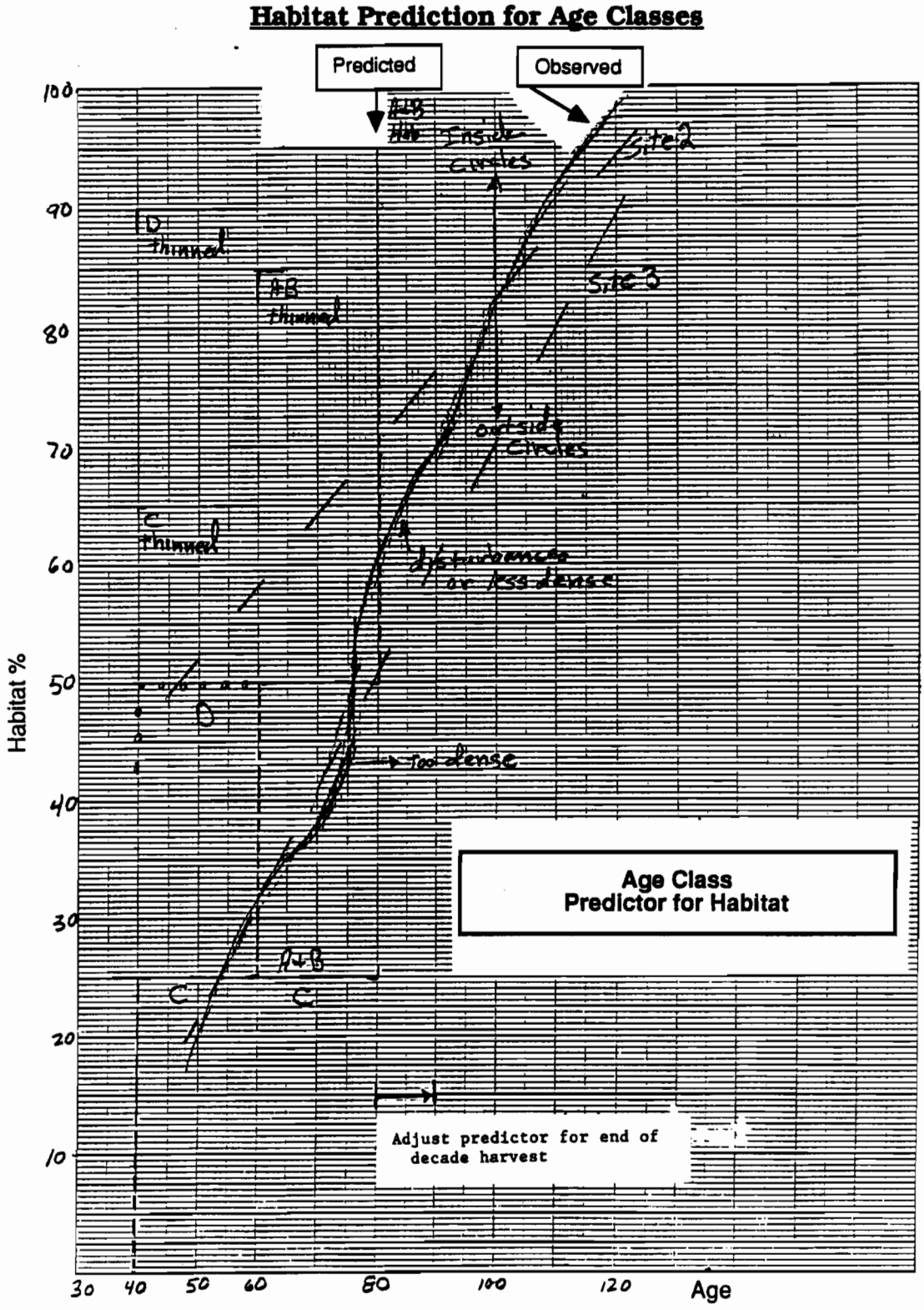
* age class habitat conversion

Footnote: It was determined that the 70-Acre Rule applied to Mineral Link under the 4d Rule after this chart was developed.

The benefits of using age-class data for economic analysis may not be obvious; but without it no accurate estimate can be made for changes in the volume per acre, or the value of the material removed, or the percentage of high-grade logs, all of which have a significant economic impact. It also made it possible to estimate the amount of dispersal habitat since that category was not available in the habitat typed sample data for six of the SEAs.

Figure 8 shows the percentage distribution of habitat type for each broad age-class that was used in the analysis, making specific adjustments where supplementary data was available.

Figure 8:



There are frequently stands over age 60 that are too dense to qualify as habitat (the rightward bulge in the curve). Existing stands over age 80 generally do not follow growth and yield tables but instead reflect either prior impacts of natural disturbances many years ago or the remaining stands that have not been harvested and, hence, have been picked over, resulting in lower yields. These conditions are likely to correlated with both openings and understory in the structure and, hence, desirable habitat, explaining the upward bulge in the curve. The observed curve was, therefore, not a straight line but showed low habitat percentages for the ages of typically dense stands and higher habitat percentages for older stands. The step curve shown on the figure as the predictor was used to predict habitat and convert age-class data to habitat. It rises to 25% after age 40, 50% after age 60 and 100% after age 80. In practice, the last years in a decade's harvest results in those trees having aged 10 additional years, effectively shifting the predictor curve to the right and closer to the observed curve.

When the 80 year and above age-class was collapsed to 60 and above as was required for some data samples, supplementary information suggested most of the age class was well above 80 for habitat typing. However, lower acreage productivity numbers were used. It was also estimated that 25% of the 40-60 year stock would fall below type C habitat but reflect type D or dispersal habitat.

Perhaps the most disconcerting sample overlap was the comparison of two GIS sources for I-90 West, one with age-class information and the other with habitat typing. The two samples appear to share 60% common owl sites, yet the non-age dependent habitat acre typing exceeded the age-class conversion to habitat acre result by more than 100%, far above that explainable by the sample differences. It would appear to have required 100% habitat of all ages over 40 to approach the percentage of habitat provided in the non-age class dependent GIS sample. Such a habitat increase would move the relative location of I-90 West from an SEA with one of the least amounts of habitat per circle to the middle of the sample of SEAs.

Another interesting observation was that if the I-90 West stands were redefined as having been commercially thinned, raising the predicted percentage of habitat, even that adjustment falls short of the non-age dependent GIS habitat sample.

While it is obvious that habitat typing will be very sensitive to stand conditions, it may also be subject to large errors in interpretation of maps, photos etc. At least in terms of the uncertainty in the estimates, the absolute magnitude of the overall impact would appear to be dominated by this uncertainty in the amount of habitat that actually exists vs the amount predicted. The amount of habitat that exists across SEAs for a given rule may be biased either high or low by procedures that are SEA dependent. The relative impact across rules for one SEA would appear to be less uncertain, although perhaps more severe at high habitat levels vs low levels.

Relative ranking of each SEA by non-federal harvest constraint: Figure 9 ranks each SEA for non-federal harvest constraints rather than acres. Lower timber productivity shifts the Eastside acres down relative to the Westside while also impacting those regions with a high federal share (see table 2). Even though the habitat samples for the Eastside show high levels of habitat, their impact is lower.

Figure 9:

Variation in Harvest Constraints Across Landscapes

DNR/WEC Rule: Non-Federal Volume Constrained

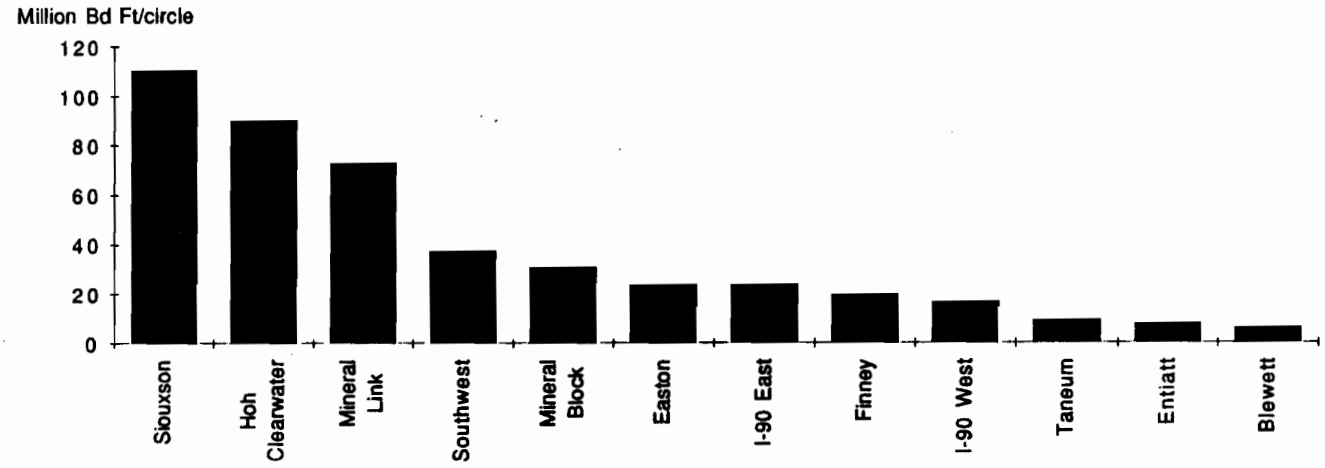


Table 2:

Federal share of harvest

(in data samples for 500-Acre Rule)

	90W	90E	Sioux	MB	ML	East	Blew	Tan	Ent	Finn	SW
Share %:	43	60	0	71	26	25	64	65	71	92	1

Thinned stands vs un-thinned stands: Several owners are thinning their stands and have noted that most of their stands will qualify as habitat. Thinning produces trees several inches larger, with greater spacing and a resurgence of understory. Thinning is expected to produce better habitat than natural stands 20 years older. The habitat predictor was adjusted accordingly. This predictor for thinned stands was not used on any SEA analysis as few managers have historically been commercially thinning stands but was used to demonstrate the impact on the 50-year and 100-year rotation examples. Increased thinning is believed to be the next technology step in forest management that will be broadly adopted and therefore may represent the future standard, an important consideration for the long term.

(2) FILLING IN SAMPLE VOIDS TO ESTIMATE THE FULL IMPACTS ON "IMPORTANT LANDSCAPES"

Adjusting "representative" sample site impacts to the region/state total: These representative rule impacts for the average owl site in each SEA can be adjusted up or down by the number of owl sites in each region to develop the total impact for several regions of the state and a state total. With corrections for owl-circle overlaps and removal of Forest Service acres that are not affected by the rules, these adjusted results then provide an estimator for the total impact of each rule.

For the 12 GIS samples, there are some USFS-site centers outside the SEA that have circles overlapping inside the SEA, thus the sample covers the impact of these circles. Circles that are totally outside of an SEA may still have an impact, such as the 500-Acre Rule, which is not bounded within SEAs. No adjustment for circles outside of the sample SEAs has been provided at this time since data characterizing the number of circles relative to different boundary definitions was not located. Adjustments to the samples were made to align the sample survey as close as practical to the SAG report of owls for each SEA (Appendix step 9 displays all adjustments). Table 3 shows a summary reconciliation of owls in the sample survey with those in the SAG report. While close correlation has been forced between owl circles inside the SEA's, the SAG report mentions more owls with overlaps into the areas than may have been captured in the sample survey. It was noted that it takes about 4 owl overlaps to equal 1 effective owl circle inside the landscape boundary and this rule was used to estimate how closely the sample matched the SAG report survey. Since the SAG report did not enumerate federal sites inside the boundaries and the samples did not identify site centers by owner, the categories in the table are not exactly comparable as indicated.

Table 3:

Owl Circle Reconciliation with SAG Report

Owl Circles on 15 Important Landscapes

	Non-fed Inside	Other & Overlapping	Total
SAG Report 15 Areas	179	138	317

	All owners inside	Other overlapping	Total
12 area GIS Survey	187	46	233
Survey Scaled to 15 Areas	232	58	290

The SAG report shows 317 owls either inside or overlapping the landscape boundaries. The adjusted sample survey characterizes all circles that are inside the SEA's but may fall short by 26 overlapping circles that presumably share some private acreage inside the SEA's.

The combination of the harvest losses and quality impacts become the determining factors impacting the range of products that will be produced as the key input to a state level economic impact analysis. Since the uncertainty in habitat typing appears to be large, distribution adjustments were not made to the SEA average-habitat condition. Since the adjustments were as dependent upon federal share as on the amount of habitat for a given rule it seemed likely that errors in one region would be largely offset by others. The relative impact of making a distribution adjustment for the scaling process seems low relative to the uncertainty in the habitat input and the effort required.

Table 4 (a two page table inserted, following this page) adds up the impact for the scaled survey to estimate the impact for 15 SEAs. The report shows total acres within circles, including federal acres; total harvest volume in million board feet that would be impacted, which excludes the federal volume and is assumed to be harvestable within the first decade; and values of that volume in millions of 1993 dollars. Regional and statewide totals are shown. Table 4a provides the results relating to the regions that are usually identified in the owl rules. Table 4b provides a different mapping of counties and SEAs into "economic regions" as the appropriate input into a regional economic analysis.

Summary of First Decade Harvest Impact: A brief summary of the impacts is provided by annualizing the decade impact (dividing by 10) and comparing it to the preliminary reported 1993 state harvest level of 4.3 billion board feet. That harvest would have a current market value of roughly $2.15 billion providing an index for comparison of the estimated value loss for each rule. The value loss runs higher because there is a much higher share of special mill and #2 and better logs in the constrained harvest than the average harvest. Comparisons to the 1992 harvest volumes is also provided since the economic model is benchmarked to the 1992 harvest and these become the relevant inputs to the economic activity analysis. The SEPA Rule analysis was not comparable in completeness and hence not included in these regional comparisons.

Table 5a:

SUMMARY

Impact of rules on State Harvest and Timber Revenue

(first decade impact - annual percentage)

	70@	500@	WFPA	DNR/WEC	4d	New-Com
% of 93 harvest	0.9	5.7	4.5	16.1	10.9	7.0
% of $2.15 Bil	1.2	7.1	5.5	18.9	12.0	9.4

Table 4a:

Summary Impact for Emphasis Areas and Owl Regions

				70 Acre Rule			500 Acre Rule			DNR/WEC			WFPA-D/M			Federal 4d			New rule	
					M-Million	Value:$400/mbf														
	Scale Facto	# of circle	Circle Acres	Non-fed Mbf	to 800 range	Circle Acres	Non-fed Mbf	alue (million	Circle Acres	Non-fed Mbf	/alue (millions	Circle Acres	Non-fed Mbf	/alue (millions	Circle Acres	Non-fed Mbf	/alue (millions	Circle Acres	Non-fed Mbf	/alue (million
West Cascades			Area--total owl circle acres all owners,				Harvest Volume--Millions (Mbf) non-fed harvest decline first decade,							Value-- millions of '93$ non-fed value loss first decade						
I-90 West	1.04	26	1,820	71.55	57.20	13,000	366.29	266.66	15,522	435.97	310.44	31,894	781.67	469.14	15,340	430.77	306.70	15,522	435.97	310.44
Mineral Block	1.00	30	2,100	36.70	31.00	15,000	274.70	189.00	11,376	216.30	155.70	17,850	327.10	215.90	11,376	216.30	155.70	11,370	216.19	155.62
Mineral Link	D:1.25	5	350	15.13	12.13	2,500	107.75	88.25	11,120	364.00	279.50	4,885	71.50	54.88	350	15.13	12.13	6,030	197.38	151.56
Slouxson	2.33	7	490	30.80	24.73	3,500	220.50	176.40	13,335	775.80	564.67	490	30.80	24.73	490	30.80	24.73	13,335	775.80	564.67
Finney	D:1.5	6	420	1.80	1.05	3,000	13.20	7.35	21,516	119.25	66.25	5,862	73.50	36.25	15,978	70.05	39.15	7,236	40.10	22.95
Gorge	D:0.14	10	700	21.35	17.04	5,000	132.76	98.00	9,847	256.26	186.29	9,770	131.80	82.30	6,886	115.70	71.10	9,850	258.33	186.35
Total SEA	1	84	5880	179	143	42000	1115	824	82716	2169	1585	70551	1417	885	50420	879	610	63343	1924	1392
Southwest																				
Southwest	0.86	12	840	52.88	42.32	6,000	277.10	155.70	10,320	450.00	232.20	840	52.88	42.32	840	52.88	42.32	840	36.63	18.90
Total SEA	1	12	840	53	42	6000	277	156	10320	450	232	840	53	42	840	53	42	840	37	19
East Cascades																				
I-90 East	1.52	35	2,450	17.35	10.35	17,500	124.02	74.41	59,804	461.24	276.80	42,417	319.10	191.50	41,346	310.13	186.11	63,610	490.59	294.42
Easton	1.00	5	350	5.20	3.10	2,500	37.50	22.50	8,640	119.20	71.50	350	5.20	3.10	29,084	93.40	56.00	9,430	130.10	78.04
Taneum	1.00	27	1,890	13.00	7.80	13,500	93.10	55.90	41,720	257.30	154.40	1,890	13.00	7.80	25,788	171.50	102.90	37,557	231.62	138.99
Blewett	1.00	14	980	4.20	2.50	7,000	30.20	18.10	20,356	87.90	52.79	980	4.20	2.50	980	4.20	2.50	980	4.23	2.54
Entiett	1.08	14	980	3.98	2.37	7,000	26.43	17.02	28,238	114.58	66.71	980	3.98	2.37	980	3.98	2.37	980	3.98	2.38
Salmon	0.06	8	560	3.68	2.20	4,000	26.38	15.83	13,369	87.60	52.56	513	3.52	2.10	513	3.52	2.10	13,056	85.55	51.33
Total SEA	1	103	7210	47	28	51500	340	204	172127	1128	677	47130	349	209	98691	587	352	125612	948	568
Olympic Peninsula																				
Hoh Clearwater	1.04	25	1,750	69.79	34.90	12,500	498.96	248.96	62,800	2,255.21	1,126.13	1,750	69.79	34.90	62,800	2,255.21	1126.13	1,750	62.84	31.44
N. Olympic	0	10	700	28	14	5000	200	100	25120	902	451	700	28	14	25120	902	451	700	25	13
Total SEA	1	35	2450	98	49	17500	699	349	87920	3157	1579	2450	98	49	87920	3157	1579	2450	88	44
Total all regions																				
Decade total		234	16360	377	263	117000	2430	1532	353084	6904	4053	120971	1916	1186	237871	4676	2583	192245	2994	2022
Annual Comparisons:																				
% of '93 Harvest @ 4.3 bil. bf & $2.15 bil.				0.88%	1.22%		5.65%	7.12%		16.06%	18.85%		4.46%	5.52%		10.87%	12.01%		6.96%	9.41%
% of '92 Harvest @ 5.02 bil. bf				0.75%			4.84%			13.75%			3.82%			9.31%			5.96%	

Table 4b:

Summary Impact for Economic Regions

Rule:				70 Acre Rule			500 Acre Rule			DNR/WEC			WFPA-D/M			Federal 4d			New rule		
					M-Million	Value:$400/mbf															
		Scale Factor	# of circles	Circle Acres	Non-fed Mbf	in 800 range	Circle Acres	Non-fed Mbf	Value (mil's)	Circle Acres	Non-fed Mbf	Value (mil's)	Circle Acres	Non-fed Mbf	Value (mil's)	Circle Acres	Non-fed Mbf	Value (mil's)	Circle Acres	Non-fed Mbf	Value (mil's)
Puget Sound				Area-total owl circle acres all owners,			Harvest Volume--Millions (Mbf) non-fed harvest decline first decade,									Value-- millions of '93$ non-fed value less first decade						
	I-90 West	1.04	26	1,820	71.55	57.20	13,000	366.29	266.66	15,522	435.97	310.44	31,694	781.87	469.14	15,340	430.77	306.70	15,522	435.97	310.44
	Mineral Block	1.00	30	2,100	38.70	31.00	15,000	274.70	189.90	11,376	216.30	155.70	17,850	327.10	215.90	11,376	216.30	155.70	11,370	216.19	155.62
	Mineral Link	D:1.25	5	350	15.13	12.13	2,500	107.75	86.25	11,120	364.00	279.50	4,885	71.50	54.88	350	15.13	12.13	6,030	197.38	151.56
	Finney	D:1.5	6	420	1.80	1.05	3,000	13.20	7.35	21,516	119.25	66.25	5,862	73.50	38.25	15,978	70.05	39.16	7,236	40.10	22.95
	Total SEA	1	67	4690	127	101	33500	762	549	59534	1136	814	60291	1254	778	43044	732	514	40158	890	641
Lower Columbia																					
	Blourson	2.33	7	490	30.80	24.73	3,500	220.50	176.40	13,335	775.60	564.67	490	30.80	24.73	490	30.80	24.73	13,335	775.60	564.67
	Southwest(33%)	0.80	12	840	52.88	42.32	6,000	277.10	155.70	10,320	450.00	232.20	840	52.88	42.32	840	52.88	42.32	840	36.63	18.90
	Gorge	D:0.14	10	700	21.35	17.04	5,000	132.76	98.90	9,847	258.26	186.29	9,770	131.80	82.30	6,886	115.70	71.10	9,850	258.33	186.35
	Salmon	0.08	8	560	3.68	2.20	4,000	26.38	15.83	13,369	87.60	52.56	560	3.68	2.20	560	3.68	2.20	13,056	85.55	51.33
	Total SEA	1	29	2030	73	58	14498	472	342	39988	1271	881	11100	184	123	8216	168	112	36521	1132	809
Eastside																					
	I-90 East	1.52	35	2,450	17.35	10.35	17,500	124.02	74.41	59,804	461.24	276.60	42,417	319.10	191.50	41,346	310.13	186.11	63,610	490.59	294.42
	Easton	1.00	5	350	5.20	3.10	2,500	37.50	22.50	8,640	119.20	71.50	350	5.20	3.10	5,816	93.40	56.00	9,430	130.10	78.04
	Taneum	1.00	27	1,890	13.00	7.80	13,500	93.10	55.90	41,720	287.30	154.40	1,890	13.00	7.80	25,786	171.50	102.90	37,557	231.62	138.99
	Blewett	1.00	14	980	4.20	2.50	7,000	30.20	18.10	20,356	87.90	52.70	980	4.20	2.50	980	4.20	2.50	980	4.23	2.54
	Entiatt	1.08	14	980	3.98	2.37	7,000	28.43	17.02	25,238	114.58	68.71	980	3.98	2.37	980	3.98	2.37	980	3.98	2.38
	Total SEA	1	95	6650	44	26	47500	313	188	158758	1040	624	46617	345	207	74910	583	350	112556	861	516
Olympics																					
	Southwest(67%)	0.80	12	840	52.88	42.32	6,000	277.10	155.70	10,320	450.00	232.20	840	52.88	42.32	840	52.88	42.32	840	36.63	18.90
	Hoh Clearwater	1.04	25	1,750	69.79	34.90	12,500	498.96	248.96	62,800	2,255.21	1,128.13	1,750	69.79	34.90	62,800	2,255.21	1128.13	1,750	62.84	31.44
	N. Olympic	0.40	10	700	27.92	13.96	5,000	199.58	99.58	25,120	902.08	451.25	700	27.92	13.96	25,120	902.08	451.25	700	25.14	12.57
	Total SEA	1	43	3010	133	77	21502	883	452	94803	3487	1734	3010	133	77	88480	3193	1808	3010	112	57
Total all regions																					
	Decade total		234	16380	377	263	117000	2430	1532	353084	6904	4053	121018	1916	1186	214650	4676	2583	192245	2994	2022
	Annual Comparisons:																				
	% of '93 Harvest @ 4.3 bil. bf & $2.15 bil.				0.88%	1.22%		5.65%	7.12%		16.06%	18.85%		4.46%	5.52%		10.87%	12.02%		6.96%	9.41%
	% of '92 Harvest @ 5.02 bil. bf				0.75%			4.84%			13.75%			3.82%			9.31%			5.96%	

Table 5b:

Harvest Impact by Region

			Impact of Six Alternative Rules by Region for 15 Special Emphasis Areas									
6 rules:	70acre		500acre		WFPA		* SAG		4d		NewCom	
	non-fed Mbf	value ($mil)	non-fed Mbf	value ($mil)	non-fed Mbf	value ($mil)	non-fed Mbf	value ($mil)	non-fed Mbf	value ($mil)	non-fed Mbf	value ($mil)
West Cascades	179	143	1,115	824	1417	886	2,169	1,566	979	610	1,924	1,392
Southwest	53	42	277	186	53	42	450	232	53	42	37	19
East Cascades	47	28	340	204	349	209	1128	677	587	352	946	568
Olympic	98	49	699	349	98	49	3,157	1,579	3,157	1,579	88	44
Total 15 areas	377	263	2,430	1,532	1,916	1,186	6,904	4,053	4,876	2,583	2,994	2,022
Annualized Comparisons												
1992 harvest % of 6.02 billion bd ft.	0.75%		4.84%		3.82%		13.75%		9.31%		5.96%	
1993 harvest % of 4.3 billion bd ft.	0.88%		5.65%		4.46%		16.06%		10.87%		6.96%	
% of current harvest value of $2.15 billion		1.22%		7.12%		5.52%		18.85%		12.01%		9.41%

*SAG = DNR/WEC

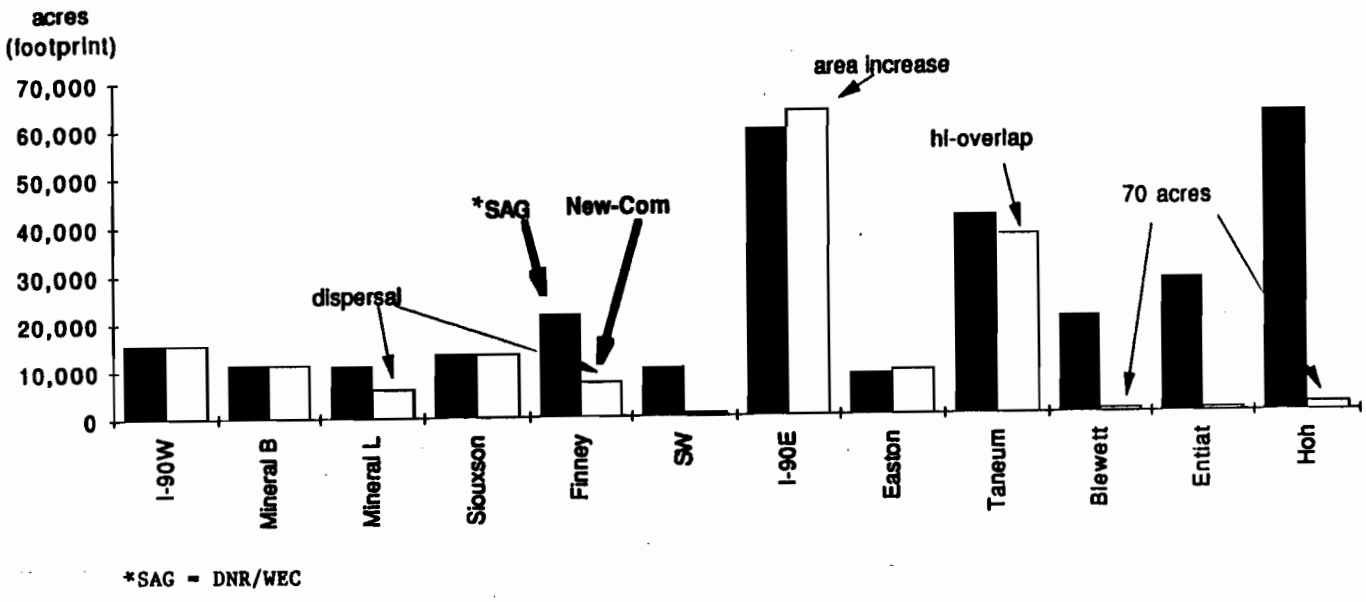
Supplementary Analysis of New-Com Rule: The earlier analysis preceded the definition of a new rule proposed by the Wildlife Committee on May 11 (a variant of the new rule is referred to above as the New-Com Rule). There are several aspects of the interpretation of this rule used in the analysis that may not conform to a legalistic interpretation or perhaps not even intent. The rule is largely modeled after the DNR/WEC Rule for those areas destined for demographic support of the owl. The circle size has been made larger for the Eastside but the area targets generally smaller. Figure 10 shows the comparison of the acres impacted by the New-Com Rule vs the DNR/WEC Rule across the 12 survey samples. Where the habitat levels are low and the circle size the same there is no difference as the target is never reached. For the Olympic area and several Eastside areas the rule reverts to the 70 acre requirement. For the remaining Eastside areas since the circle size is larger, there is a larger impact. Taneum has so many owls within overlapping circles, the formulas used to adjust the acres suggested that the overlap of circles increased more significantly than any new habitat incorporated in the circle hence it shows a negative change. While this may be an extraneous result outside the range of usefulness of the formulas developed, it may also be a proper conclusion and in any case has a negligible overall impact.

Figure 10:

Comparison of New Rule to DNR/WEC Rule—

Acres of Habitat

DNR/WEC vs New-Com Rule



*SAG = DNR/WEC

The Dispersal Rule impacts under the New Rule that apply to Mineral Link and Finney may be underestimated as the newly proposed definition for dispersal habitat on the Westside may exclude its existence. Stands harvested 30 years ago rarely if ever left green trees, snags or downed logs. If these conditions are not grandfathered out for stands harvested decades ago but available for thinning now, any stand that meets the dispersal definition otherwise will also likely meet the suitable habitat definition. The analysis shown assumes that the intent was for there to be dispersal stands (with reduced density and inadequate wildlife trees to be considered habitat) as was developed for the earlier WFPA Rule. The same estimates of dispersal acres available for the WFPA Rule were used to illustrate the impact of the New Rule even though the definitions appear to be different and more restrictive under the New Rule. These conditions become most important for long term management and will be reconsidered at that point.

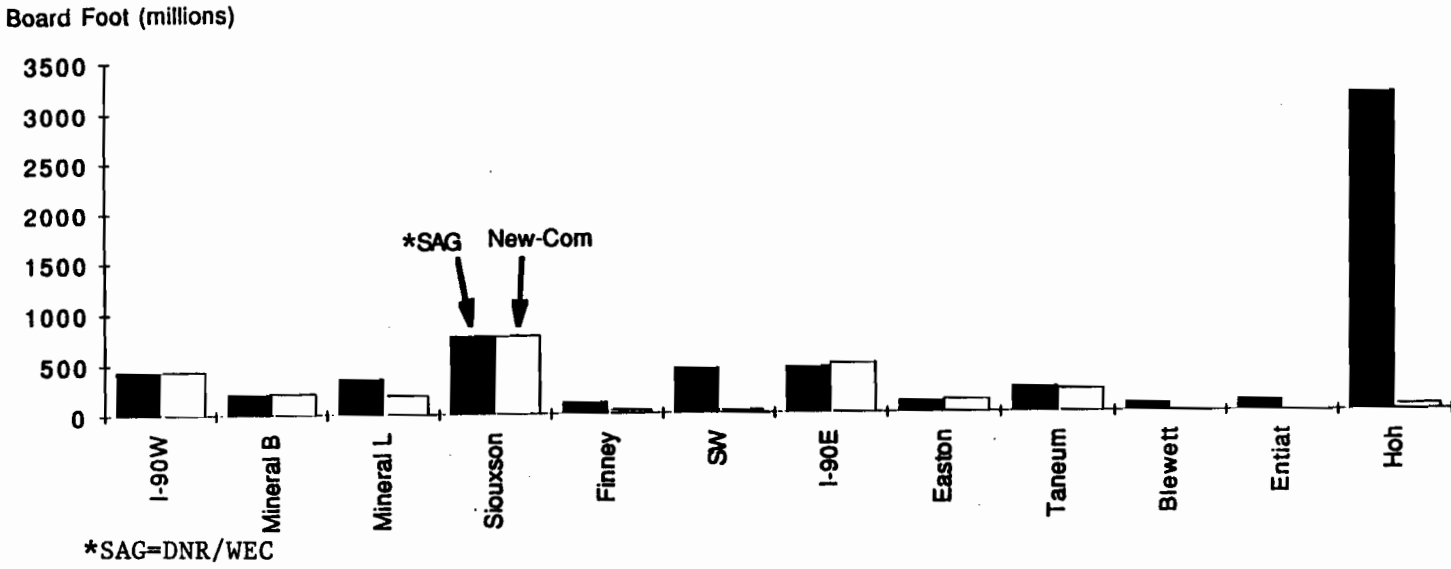
Figure 11 shows the same rule and area comparisons as figure 10 but for non-federal harvest volume that is assumed to be harvested in the first decade. Again, the Eastside impacts are greatly reduced as a consequence of lower board foot per acre in the inventory and increased federal acres. The Hoh/Clearwater stands out as the largest single change. Under the DNR/WEC Rule large circles with high habitat percentages and high yields resulted in large board foot constraints. While the New Rule reverts to 70 acres in the Hoh and several other areas, the average across all areas still exceeds the impact of the 500-Acre Rule. Again it should be noted that this may be but one interpretation of the intent of the New Rule as it relates to a dispersal strategy on several SEAs.

Figure 11:

Comparison of New Rule to DNR/WEC Rule:

Harvest Volume

DNR/WEC vs New-Com Rule: Non-Federal Volume



(3) ANALYZE LONG TERM IMPLICATIONS.

Steady state and long-term impacts: Long-term impacts can be divided into three different effects compared to the first decade analysis. First, the reduced board-foot yield associated with shorter rotations; second, the fact that the protection of old growth is not lost each of 5 decades over a rotation, but rather once in 5 decades (the current one); and third, the impact on investment decisions affecting future management.

1. Yield reductions in the steady state: The board-foot yield reduction in the steady state, after transitional adjustments are complete, was measured by inserting the approximate 55-year rotation board-foot-per-acre yield instead of the yield from the current inventory. That reduction can be large for the 70-Acre Rule that conserves choice timber today, which in the long term would be on acres under rotational management with a lower yield. Reductions in this impact for the 70-Acre Rule ranged from almost 50% less impact for some locations to 20% where type C habitat dominated. These estimates were derived for the SEAs with age class information. The long-term, steady-state cost is, therefore, generally lower under all rules. For the dispersal rules since dispersal habitat can be substituted for higher quality timber in suitable habitat, there may be no loss in yield except for the 70-Acre core. Reductions in cost for the 500-Acre Rule were somewhat smaller than for 70 acres as less choice timber is impacted, but the reduction in loss remained at nearly 30% for the DNR/WEC Rule where there was significant habitat involved.

2. Reduced frequency of loss occurrence in the steady state: The second impact can only be inferred for the very long run after a uniform age rotation is achieved. At that time, the owner would only be able to harvest one fifth of the acres that are being constrained in the first decade. The problem is finding a transition path to the long term that is not costly. Most targets require retention of about 40% of the acres in habitat which requires rotations at least 66 years long, thus imposing some long-term cost increase that would partially offset the reduction in loss associated with rotational yields. In any event, these adjustments will take a very long time. As shown in the Washington State Timber Supply study (Adams, et al., 1992), set asides of mature timber can have two impacts. If there is inadequate marketable timber in the inventory, as in the industry case, the reduction in harvest appears fully and immediately in the first decade or two and eventually, over 100 years, is reduced to the steady state impact. Where there is adequate marketable timber in the inventory, there may be alternative stands which may be brought to market earlier to spread out the impact over several decades. This was the case noted in the timber supply study for non-industrial private, but they have been liquidating their marketable inventory at a record rate over the last several years and may not be able to increase that rate further.

Collectively, these first two impacts reduce the cost impact for the long-term steady state by as much as 90% for the 70-Acre Rule, 86% for the DNR/WEC Rule, and 100% for the Dispersal Rule. But this long-term stability would have to be more than 5 decades in the future, which means the present value of the cost reduction is of little value to today's land managers.

3. Impact on forest management: What is of concern to today's land manager is how they should manage the forest for long-term profit. What investments should they make, if any? The region has continued to evolve toward higher levels of forest management as prices have increased. Restocking was not economical prior to the late 60's. Today stocking, site preparation, pre-commercial thinning, fertilization, seed and stock selection, and increasing amounts of commercial thinning are practiced, with some pruning a near-term potential.

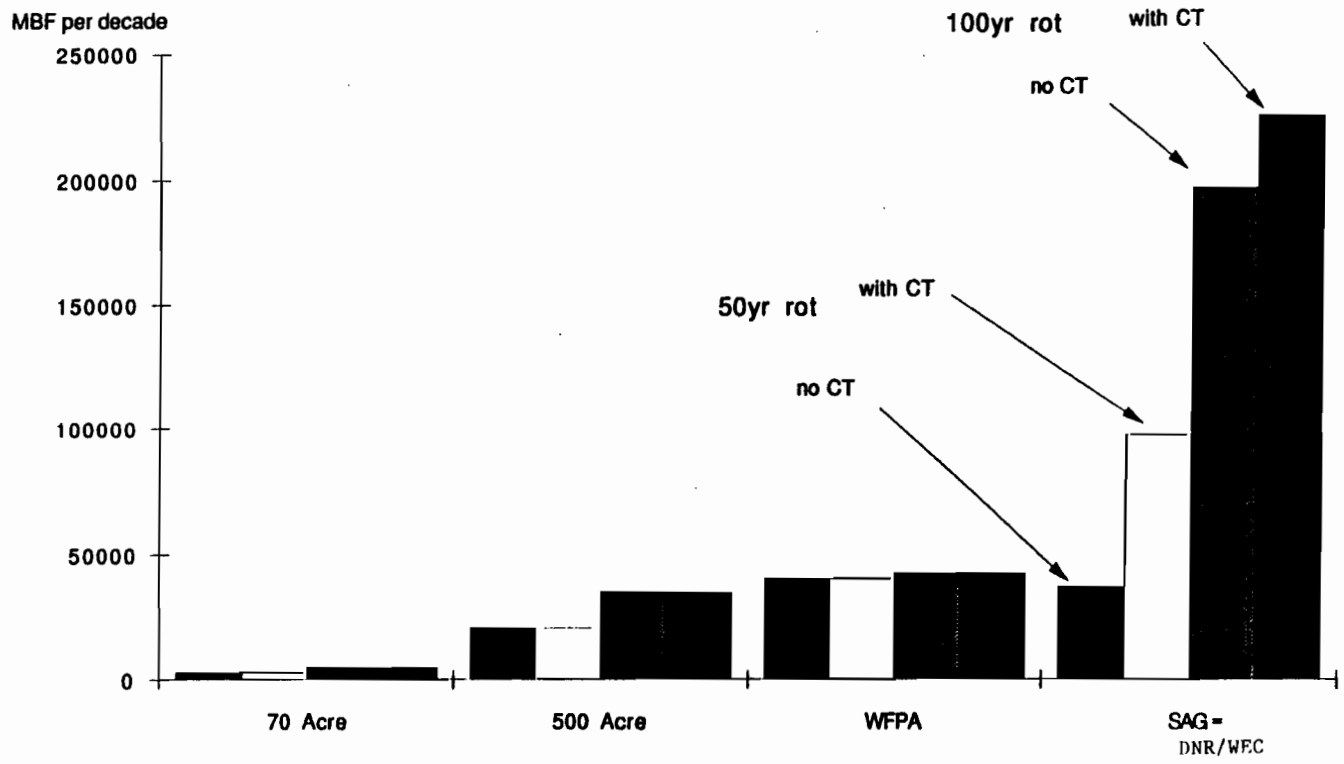
The forest sector's major future opportunity is to manage the forest for more outputs, which can include better habitat. As we noted in the commercial thinning examples, while thinning increases habitat substantially faster, it also increases the cost from the owl conservation rules and the risk of future asset losses. Commercial thinning has the potential to double the value of timber with a longer rotation and more than double the amount of habitat in many stands. Several of the alternative rules will motivate shorter rotations to avoid the cost imposed by the rules.

Noting Figure 12 (Figure 1 repeated), the DNR/WEC Rule (4d Rule or SEPA Rule) would appear to eliminate any motivation to thin stands or manage them for longer rotations, as it produces more habitat and more constraints to harvest. The management motivation becomes one of insuring that habitat is not created. Under the proposed rules, an owner that manages for

longer rotations will not be able to harvest in competition with an owner that harvests at the first available opportunity. Creating large amounts of potential habitat receives no benefit under the rules. Liquidating stands before they become habitat will be the economically preferred option. Degrading any stands, even when contributing to the creation of better habitat over time, is penalized. The rules do not promote the production of habitat, they prevent the reduction of existing habitat by landowners.

Figure 12:

Harvest Loss vs Age & Treatment



Estimating the potential loss from reduced management: The economic impact of not making management investments will likely become the major long-term cost of the rules. While the magnitude of that impact cannot be measured accurately, the scope of the opportunity can be characterized.

The top 50% of site classes are likely to have economic potential from thinning. The optimum rotation age for harvesting thinned stands is at least 10 years longer. That infers that for 5-7% rates of return, the value of the timber will be increased by 60-100% over current rotation counterparts. Managed stands would contain about 8 times more "special mill" logs and 60% more "#2 and better" logs, consistent with this value increase. This increased timber-value benefit is not available in the first decade but is available in the

second rotation. The first decade benefit does include the value of thinning overly dense young stands in the 25-35 year age class today, which increases dispersal habitat and soon after should also improve suitable foraging habitat, especially if it incorporates a low cost wildlife treatment to increase nests, perches, and understory protection. So the investment opportunity includes the increased value of the timber long term, the processing opportunities from this higher quality timber, and the shorter term supply of chips or small logs from the thinnings. These become the economic opportunities that may be lost by rules that de-motivate such investments.

While the increased habitat provided by these investments appears to be a long-term positive—producing many more acres of habitat than is currently being protected—the rules would seem to preclude such investments. The risk or threat of new rules may have negative impacts even without implementation. The case has been made to provide incentives to such investments rather than to discourage them. None of the rules provide that function (although the Dispersal Rule does provide less negative penalties for long term rotations than for a 50 year rotation).

The short-term bonus from long-term investments: Referring back to the commercial thinning examples (Figure 12), it appears that the DNR/WEC Rule (as well as the 4d and SEPA Rules) would penalize thinning, eliminating the option to manage lands for greater understory, tree size, and timber value, all at the same time. The Dispersal Rule, which was shown to produce substantial costs when there is little habitat, does not become a substantial penalty to thinning, at least on the regulated rotation, because it allows the substitution of new young habitat for older habitat. In that sense many more new acres of habitat can be produced than are being given up in old habitat. Since more intensive management can produce habitat much more quickly than natural forces, it would seem to be an important element in developing rules. The Washington State Landscape Management Project is about to release its Phase I report that may provide additional insight on how management can be altered to produce better habitat at lower cost (Carey and Elliott, 1994).

The economic-opportunity cost of the DNR/WEC, 4d, or SEPA Rules could be to prevent as much as 50% of the non-federal or private acres from being managed on longer rotations with commercial thinning treatments. Annual thinnings equal to the harvest acres would amount to 150 million board foot of small logs with perhaps 600 million per year potential for 5 years to make up for inadequate thinning over the last two decades. These logs would contribute from $60 million to $240 million to the forest-sector economy. Viewed as an offset to the chip shortage facing pulp mills and expected closures, the current shortage could be largely offset by accelerated thinnings at roughly twice the rate of the long-term regulated rate, which would not exhaust the backlog of overly dense stands in 10 years. These are crude estimates that could be refined but at least demonstrate the relative size of the impact.

The impact of increased timber values through management: The longer-term impact of increased management in thinning and perhaps some pruning can produce timber values estimated at twice the current values for short rotations for roughly half of the private harvest. It increases the share of "special mill" logs for high-valued processing by roughly 10 times, with a 60+% increase in "#2 and better" logs. This higher-grade material would contribute substantial opportunities for value-added processing. In dollar terms, this introduces $500 to $900 million of increased resource value, i.e. a 25-40% increase over the current base. Current estimates show the total forest sector producing roughly $10 billion of current output; hence, this impact poses a several billion dollar annual loss potential for the total economy from under-investment. Instead of mills closing down, there exists a long-term opportunity to increase output with higher quality resources through investment in forest management. At the same time, these investments would increase rather than reduce suitable habitat. If the thinning opportunity is lost for only 25% of the acres, a conservative estimate, it will preclude the creation of about .9 million acres of habitat. The lost economic activity would fall in the range of $1.5 to $2.5 billion per year, considerably larger than the impact of the DNR/WEC Rule in the first decade.

The long-term investment implications of the rule would appear to be substantial, both in terms of long-term gains and short-term benefits that flow from the investments, if made. While these investment impacts may appear to be surprising, they are one of the major focuses of the Washington State Landscape Management Project and other efforts to understand the potential role of landscape management.

Considering protection for the owl on a landscape basis rather than a single site basis may need to incorporate the forest management investment aspects that can improve the habitat over a period of time. It may, however, change the focus from protecting existing owl sites (and their immediate landscape) by specific rules to improving the habitat for owls and other species in general.

Relationship between New-Com Rule and Long-Term Management:

A major investigation under DNR's federally funded Landscape Management Project is to determine what incentives it might take to manage private lands to create more biodiversity and habitat (Carey and Elliott, 1994). Wildlife thinning treatments have been designed that do not differ radically from commercial thinning treatments although additional attention is directed to snags and cavities, and downed logs as an important part of the understory. The incremental cost of these wildlife treatments over commercial thinning is believed to be low until such time as the age of the stands become so old as to result in slower growth. But long before managing these stands becomes economically unfeasible, they have taken on many of the characteristics of old growth with larger diameters, more understory, adequate snags and downed logs for forage and multi-storied canopies for foraging. Recent research

(Carey, 1994) confirms that managed stands incorporating old growth legacies, thinning and other wildlife treatments can provide many of the characteristics desired by habitat that were generally thought available only in old-growth. Forest practices designed to retain current habitat may, instead of incentivizing such treatments, make them economically impractical.

To demonstrate the timber economic and habitat alternative created by commercial or wildlife thinning treatments, an example 50 year rotation with no commercial thinning is compared below to an example with a commercial thinning at age 30. In addition, a 70 year rotation is shown with commercial thinning at age 30. The habitat predictors are judgmental based on habitat definitions and the expected results from wildlife/commercial thinning treatments. To obtain high levels of suitable habitat, the commercial thinnings would necessarily have to be modified to be wildlife thinnings, with the required snags and downed material. The growth and yield assumptions used in this example are from the Landscape Management Project's wildlife thinning examples. Since the stands examined were for hemlock, it is likely that the returns to thinning would have been somewhat more favorable for Douglas fir stands.

The results suggest that wildlife thinning treatments hold the promise of creating the newly proposed target levels of suitable habitat under as little as 70 year rotations. But, the habitat retention rules generally make such practices unattractive while supporting short rotations which maintain little or no suitable habitat beyond what is present today. The exceptions include rules that encourage dispersal habitat which requires thinning as a step prior to a forest stand taking on suitable habitat characteristics. The Dispersal Rule tends to reduce the benefits of a 50 year rotation thereby encouraging thinning and longer rotations. It works to reduce the benefits of 50 year rotations because there is so little habitat at 50 years that existing dispersal habitat must be saved as well as suitable habitat. But for longer rotations, dispersal habitat can be substituted for older habitat reducing any penalty for thinning stands even though they will become suitable habitat. These two features are illustrated in Table 6. In the top section of the table {subtable (a)} predictions for the amount of habitat for a 50 year rotation with and without thinning and for a 70 year rotation are shown. While the amount of habitat may be somewhat site dependent, the increase of habitat with thinning and age, flows directly from habitat definitions. The illustration shows the amount of suitable habitat at 5% or even less on a 50 year rotation, 20% if thinned at age 30 but potentially 43% for 70 year rotations. And as much as 11% of these would be with diameters associated with fairly mature stands, characteristics not likely reached by natural growth in 150 years.

Table 6:

New Rule Potential Impact on Management and Habitat Production

	Impact of thinning on habitat – Impact of rules on thinning management					
	rotations with uniform age distribution					
	50 year rotations		50 yr rotation (thin by 30)		70 yr rotation (thin by 30)	
(a) Habitat	acres	%	acres	%	acres	%
B (mature)	0	0	0	0	862	11%
C (young forest)	402	5%	1608	20%	2586	32%
D (dispersal)	402	5%	1608	20%	1149	14%
candidate harvest acre	50 year rotations		50 yr rotation		70 yr rotation	
per decade	1608		1608		1150	
(b) No Rule Harvest	$497/mbf		$647/mbf		$851/mbf	$948/mbf
volume (mbf)	57888		33768		81586	
value ($)	28,799		21847		40095	58386
thin value	0		1780		4716	4716
Total harvest Rev.	28799		23627		44811	63102
ROI %	5%		4.60%		4.20%	4.70%
(c) New-Com harvest loss						
acres	402		1206		3200	
volume	14472		25326		49419	
value	7200		16386		32171	46849
Total harvest Rev.	21599		7241		12640	16253
ROI %	4.40%		2.10%		2.30%	2.70%
(d) Dispersal rule harvest	804		70		70	
volume	28944		1470		3752	
value	14400		731		2442	3557
Total harvest Rev.	14399		22896		29729	43293
ROI %	3.50%		4.50%		3.60%	4.10%
Management Decisions:					Habitat ABC acres after harvest	
If no rule: 50yr rotation					362	
If "demographic support" : 50yr rotation					362	
If Dispersal w density wo snags : thin at 30 harvest at 50 to 70					1494 to 3440	
Implications:						
Incentivizing thinning is key to long term habitat.						
Dis-incentives will avoid the creation of habitat.						
Commercial/Wildlife thinning treatments support target habitat.						

By comparing the economics of these three rotations {subtable (b)} under no owl rule, it can be seen that even with the value of thinnings, the 50 year rotation is the preferred economic alternative. If the 70 year old stands reach prime prices of $948/mbf they begin to approach the return of a 50 year rotation. But it should be noted that the harvest value of these stands is more than 100 % higher than for the 50 year rotations. That is the future growth potential for the industry—to produce higher quality wood for increased secondary processing.

By evaluating the impact of the newly proposed owl regulation (New-Com), {subtable (c)} assuming the land in the illustration is an owl circle which is highly probable based on the increased suitable habitat created, a different story emerges. The economics of each rotation is reduced, but far more seriously for the thinned stands than the unthinned stands. That is because

there is more habitat that will fall under the Forest Practice constraints if the stands are thinned. The management decision rule will therefore remain focused on short rotations to prevent the creation of incremental habitat. This is unfortunately the opposite of the goal to increase habitat and biodiversity which is the thrust of the Landscape Management Project.

If the New-Com Dispersal Rule is applied and includes the grandfathering in of existing 30 year old stands as dispersal once thinned with consideration for downed material {subtable (d)}, then the 50 year rotation economics is lowered by the need to save dispersal habitat. This habitat will soon become suitable habitat and both dispersal and new suitable habitat can be used to substitute for more mature habitat at harvest. Only the 70 acres around the site becomes protected in the rotation as there are an adequate number of acres of suitable habitat being generated new each year. While the economics of the thinned stands are reduced by the 70 acres around the owl site, this is a smaller economic penalty than the alternative rules. It makes the thinning alternative more attractive than a no-thin 50 year rotation. The optimum age for the rotation will generally fall at least 10 years beyond age 50 and perhaps as much as 20 if the market values for quality wood are high.

The proposed New-Com Dispersal Rule was assumed to have this intent but may not conform to this interpretation by definition. It does not require reduced stand densities on the Westside such that the acres may be too dense to be important for dispersal habitat. The requirement for green tree retention and downed logs in excess of what was provided by the management practices 30 years ago, and dominates the stands now available for thinning, may preclude them from dispersal management. In effect, there may be no dispersal stands by this definition that are not already suitable habitat.

Progress toward the creation of habitat is accelerated by thinning existing stands without as tough a green tree retention or snag requirement. These green tree and snag requirements serve an important purpose for new harvests and if less severe could contribute to making a commercial thinning closer to a wildlife treatment. Even though there is a lower chance of a 30 year stand becoming suitable habitat in the next few years than current harvests may become when they reach 30 years, the existing 30 year old stands can play an important role in establishing a renewed understory while reducing the dominance of overly dense young stands and providing dispersal if not suitable habitat. While it has been assumed in the analysis of the New Rule that the intent of the dispersal language was to create additional dispersal habitat with attractive wildlife quality, a precise reading of the definition may not support that interpretation.

The next section, Part II, will analyze how these first-decade and long-term impacts are likely to interact with the economic activity in the state and its four regions.

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Yeager, Mike. 1994. Alternative Spotted Owl Rule Proposals, memo to Forest Practices Board Wildlife Committee, March 9, 1994.

Wildlife Committee. 1994. Wildlife Committee Recommendation to the Forest Practices Board: Northern Spotted Owl Preferred Alternatives, for the May 11, 1994 FPB Meeting.

Other Assistance: Semi-proprietary data including GIS samples with habitat type or age class by ownership were obtained for 12 areas from many companies. The SAG report provided the basis for sampling and scaling and the interpretation of rules and habitat. Assistance by Joseph Buchanan and Leonard Young in understanding both the intent of the rules and the availability of data provided an important first step in developing the approach. Numerous other publications relating to forest practices and owl habitat were available. Guy Robertson assisted in the preparation of spread sheets characterizing each owl rule for each GIS sample and the analysis of the markets response to changed supply. Various stand tables were used to test the validity of reported yields and to determine the relationship between age, diameter, and "special mill" log output (Larsen and Wadsworth, 1982)

PART I:
APPENDIX

A description of key process steps with an analysis of the major uncertainties for each assumption. (This appendix is divided into fourteen parts corresponding to the analysis stages.)

Steps in brief:

1. Data was gathered from 12 of 15 SEAs, with partial information on the others. Either age-class GIS data or habitat-type GIS data across owners was located.

2. Sub-samples of habitat typing vs age class were developed to cross-correlate age with habitat where the habitat type was missing.

3. Procedures were developed to examine the impact for different owl circle sizes when data was not available for the circle size appropriate to the rule.

4. Board-foot yields were obtained to measure timber volume.

5. A function was developed to measure quality changes by determining the percentage of "#2 and better" and "special mill" logs as a function of age.

6. A separate timber-value function vs age class was also developed.

7. Analysis spread sheets were developed to compute the impact for each alternative rule on each landscape, detailing the impact of saving habitat across age and habitat classes, first, within .7 mile circles and second to the edge of circle boundaries where the habitat area target varies for each.

8. Distribution corrections were characterized for areas with a large number of owls, rather than to analyze each owl circle.

9. The SAG report owl count in the 15 important landscapes was compared to the GIS data samples and adjustments made to the sample to correspond with the SAG owl count.

10. The adjusted data samples were identified by region so that they could be aggregated up into economic regions (as different than owl regions) and the state economy.

11. Acreage targets for each rule were identified for each landscape.

12. The Dispersal Rule and Pair Maintenance Rule were interpreted to provide acreage targets and to identify extended habitat definitions.

13. Impacts appropriate to the first decade were separated from longer-term impacts. Impacts appropriate to the long-term steady state were developed along with impacts on long-term investment decisions.

14. Errors of significance were judgmentally analyzed and where appropriate, alternatives were developed to demonstrate the range of uncertainty.

Steps in more detail:

1. **Data Sources** - age class or habitat type data for 12 of 15 SEAs:

1a. Age class GIS data were obtained for 6 of the 15 important non-federal landscapes identified in the SAG report (Finney, I-90W, Mineral Block, Mineral Link, Southwest, Siouxon). A sample of this information is shown in table A.1, an attached spread sheet used for the analysis of owl rules. Item 3 and 6 identified on the spread sheet illustrate the age classes and ownership classes provided by the source data. Item 1 shows that the source data covers 1.8 mile circles around 22 owl sites (item 2). Item 7 shows that the total acres contained within the 22 overlapping circles is less than the total area for 22 non-overlapping 1.8 mile circles, the ratio being a footprint ratio of overlapping circles to total circle area (61% in the example). The age class data was converted to habitat types and age classes (item 8) by the habitat percentages assigned to each age class (item 4) which is described in step 2. The acres were converted to board foot inventory by conversions (item 5) which will be described in step 4. The average habitat per owl circle can be computed from the final habitat tabulation (item 9). Given habitat type by age class, ownership and board foot/acre, for each owl circle (or for the average of a number of circles) the impact of the owl rules were computed for the acreage targets appropriate to each rule as identified in step 11.

1b. Habitat type GIS data was obtained for the other 6 areas, without age class categories (I-90E, Easton, Blewett, Entiat, Taneum, Hoh/Clearwater). Table A.1 then collapses to the A, B, C, and non-habitat categories (item 4). Since a single habitat type may span many age groups and board foot densities per acre, wood quality and value of wood computations will be less precise than for the age class data. Only broad averages can be determined for assessing the impact on board foot volume and value measures.

Table: A.1:

DNR/WEC Rule with SAG Targets

(Age Class GIS Data)

I90W

① BASE

Circle size= 1.8 mi Steady State Mbf/acre = 36

# of Owl Circles= 25

② I90W * SAG Target 3586

Circle # 25

③ Age Class	④ Habitat Prob	Prob. Habitat	⑤ Mbf/acre	Footprint Totals Fed.	State	ACRES Ind.	Other	Unknown	Total	Circle Ttl.	Circle Averages Fed.	State	ACRES/SO Ind.	Other	Unknown	Total
>80				1,693.1	0.0	1,095.3	250.5	1,467.0	4,505.9		67.7	0.0	43.8	10.0	58.7	180.2
	100%	A or B	63											10.0	58.7	HAB 180.2
60-80				4,530.2	42.6	2,520.5								25.1	70.1	378.90
	25%	A or B	53											6.3	17.5	HAB 94.7
	25%	C	53											6.3	17.5	HAB 94.7
	50%	D	53											12.5	35.0	189.4
40-60				10,216.6	493.0	6,472.2								111.9	80.8	880.0
	25%	C	36											28.0	20.2	HAB 220.0
	50%	D	36											56.0	40.4	440.0
20-40				5,471.4	215.1	7,506.9	3,626.1	886.5	17,706.0		218.9	8.6	300.3	145.0	35.5	708.2
<20 etc.				7,749.7	411.3	27,239.1	7,121.7	3,284.9	45,806.7		310.0	16.5	1,089.6	284.9	131.4	1,832.3
											0.0	0.0	0.0	0.0	0.0	0.0
Total				29,661.0	1,162.0	44,834.0	14,423.0	9,411.0	⑦ 99,491.0	162,860.0	1,186.4	46.5	1,793.4	576.9	376.4	3,979.6

GIS Sample

(1) age by owner
(2) SO circles (each & total area)
(3) footprint of circles
(4) per SO averages are computed

* DNR/WEC Target

⑤ mbf/acre at harvest (oldest first)

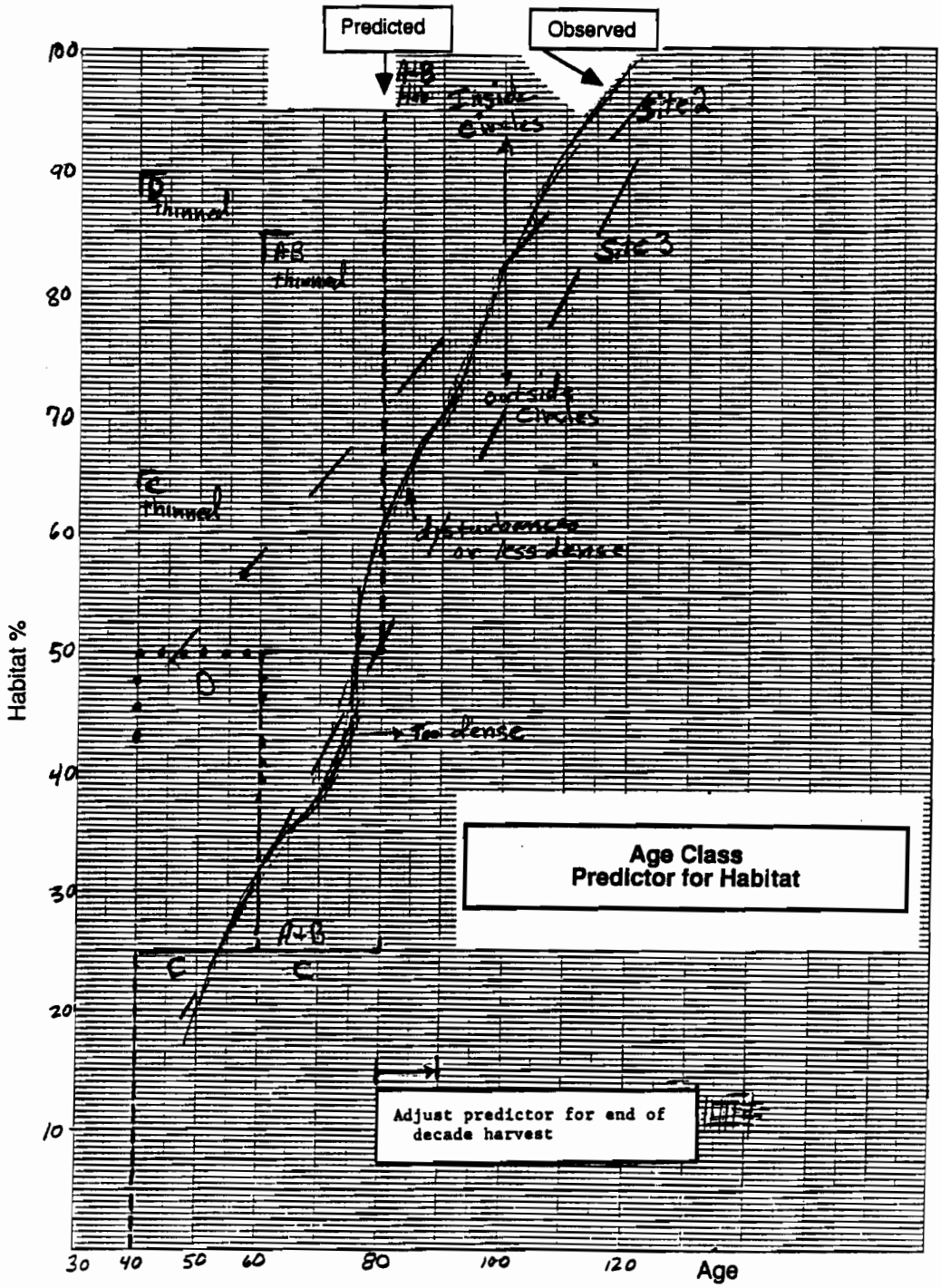
footprint = 61% of circle area

⑨ Hab 590

2. Habitat type source assumptions: Figure A.1 provides a graph summarizing several samples of habitat type vs age class (West of the Cascade crest and south of Olympia).

Figure A.1:

Habitat Prediction for Age Classes



The solid irregular line characterizes the observed habitat by age class. Starting at the top of the page with the observed line, and stands over 120 years, almost all acres were suitable habitat, type A or B. Above 100 years only about 75% was typed as habitat. Below 40 years there was no habitat and between 40 and 60 most acres were too dense for habitat (the rightward shift in the curve) but the amount of habitat begins to rise rapidly exceeding 30% by age 60. Since many of the stands were harvested by age 60 the character of stands from age 60 to 80 are more varied (being the last to be harvested and probably both patchy and less dense) therefor producing better habitat, (the upward shift in the curve). Conversations with owners suggested several believed a much greater percentage of stands over age 60 would be typed suitable habitat. They also suggested there will be large variations in what is suitable habitat depending upon the individual making the assessment given the large variation that exists in stand structures.

The amount of habitat found inside owl circles can be expected to be somewhat higher then that found outside owl circles, an upward bias to the observed habitat data for all acres. Higher site land, site 2, was observed to provide substantially more habitat especially for young stands in comparison to site 3 land (the two straight lines shown on the graph). These effects suggest a predictor of habitat within owl circles should be somewhat higher in habitat than the observed relation for all acres that is shown on the figure.

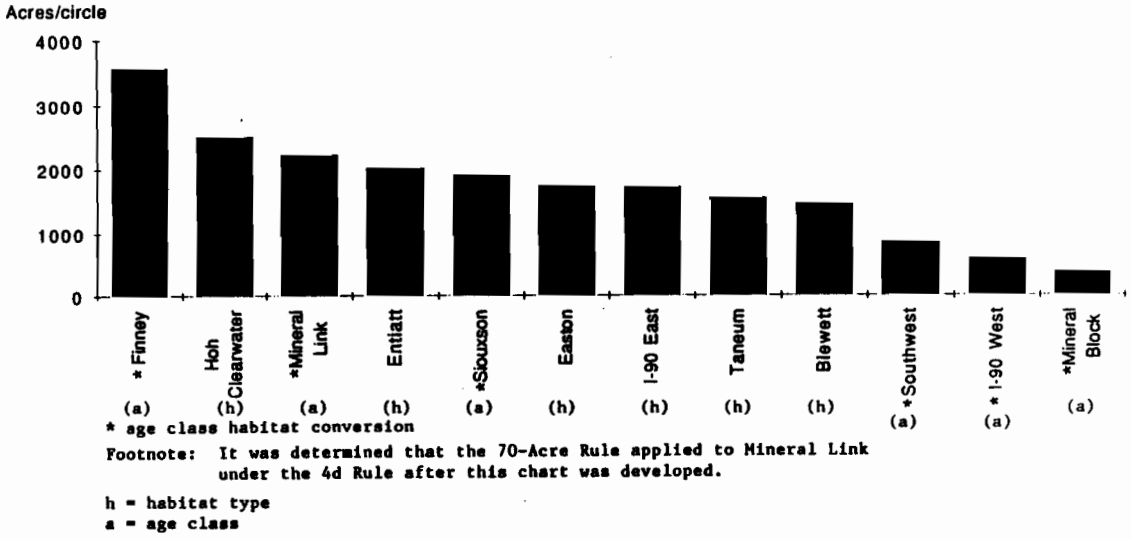
Since the acres normally harvested will be oldest first, the habitat predictor should emulate the habitat available at the top end of the 10 year interval. This predictor would therefore be shifted to the left about 10 years from the observed data which represents the average age of an interval. The predictor also can only change at the age breaks provided in the data. Specifically, the predictor assumes all timber over 80 years as 100% type A or B habitat. Between 60 and 80, 50% of the acres were assumed to be suitable habitat, half A or B (mature or older) and half C (young forest). Excess density and no understory eliminates most young stands from habitat. It was estimated that stands that had been thinned at about age 30 would be largely suitable habitat after age 60 (85% used for examples) but very few stands were thinned 30 years ago and none were assumed in computing the number of acres in suitable habitat. Between ages 40 and 60 relatively few acres would become suitable habitat, largely those that evolve without becoming overly dense as a consequence of site variations, disturbances or stocking problems. Samples showed as much as 25% habitat by age 55 and more for higher sites, hence 25% of all stands 40 to 60 were predicted to be suitable habitat with another 25% dispersal habitat. Again, if thinned, these stands would likely become suitable habitat much more quickly, estimated at 65% suitable habitat and another 25% dispersal after thinning.

The accuracy of such habitat predictors are questionable. With many acres of older age classes not considered habitat, there is a risk of underestimating the amount of habitat available. Figure A.2 shows that for the 6 regions where age class data was converted to habitat based on the above predictor, 3 contain considerably less habitat and 3 generally more habitat in comparison with GIS data provided with habitat type identified but lacking age classes.

Figure A.2:

Variation in Habitat Acreage Across Landscapes

DNR/WEC Rule: Average Federal & Private Acres Constrained



Many of the areas provided without age class data are Eastside where more uneven-aged management is practiced. Selective thinning practiced on the Eastside will generally produce better understory and multi-story conditions for habitat than the highly dense restocked stands on the Westside

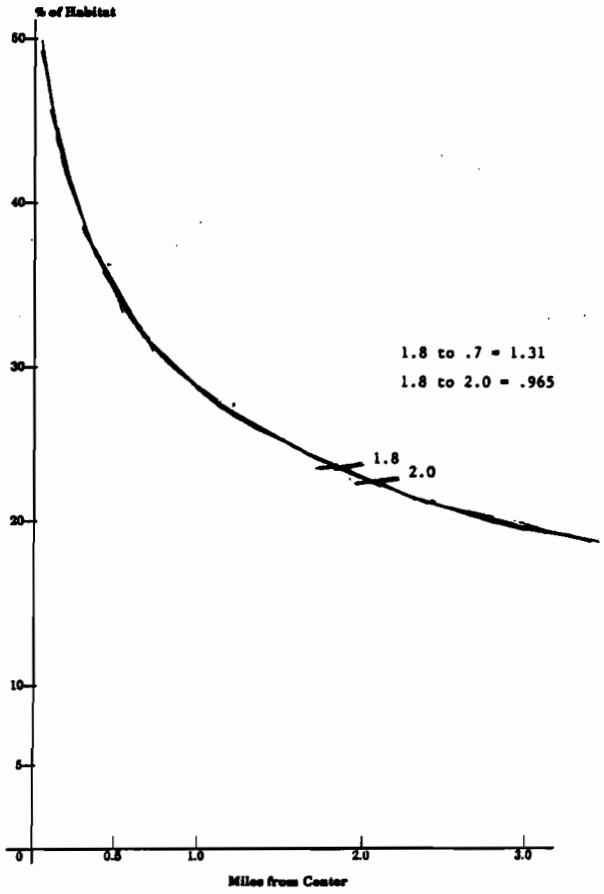
A partial overlap of age class GIS data converted to habitat by age with a separate sample of GIS habitat typed data was available for I-90 West. The habitat type sample included more than 100% more habitat than provided by the age class typing conversion. Assuming the samples were otherwise the same that would require almost all stands above age 40 to be suitable habitat. No resolution of whether habitat typing is accurate was attempted. There are many sources of possible variance. While the amount of habitat may be underestimated for the three regions with the lowest amount of habitat, that may also suggest more habitat on 3 regions with age class data that had a large amount of habitat. It does appear that there are large variations in the amount of habitat per SO. The procedure alone is unlikely to cause too little in one region and too much in another.

3. **Computations for different sized owl circles:** Since the GIS sources provided data for at least one owl circle radius but not all of the different circle sizes required for all rules, a procedure to scale the data for changes in circle size was developed. Acres for each owner were assumed to be proportional to changes in area as the circle is scaled up or down from that provided in the source data. The circle overlaps were also assumed to be proportional to area with zero overlap within .5 miles. The more significant adjustment was to note that the percentage of habitat increases closer to the owl site. For those samples where data was available over a large number of circle sizes this habitat correlation with distance from center was observed and used as an adjustment to the area calculations. As figure A.3 shows, the amount of habitat per unit area rises by about 30 % for a circle radius of .7 miles compared to 1.8 miles. The computed habitat for each circle size was then derived by adjusting the given data for circle area, changes in overlap, and changes in habitat (per figure A.3).

Figure A.3:

Habitat Density by Distance

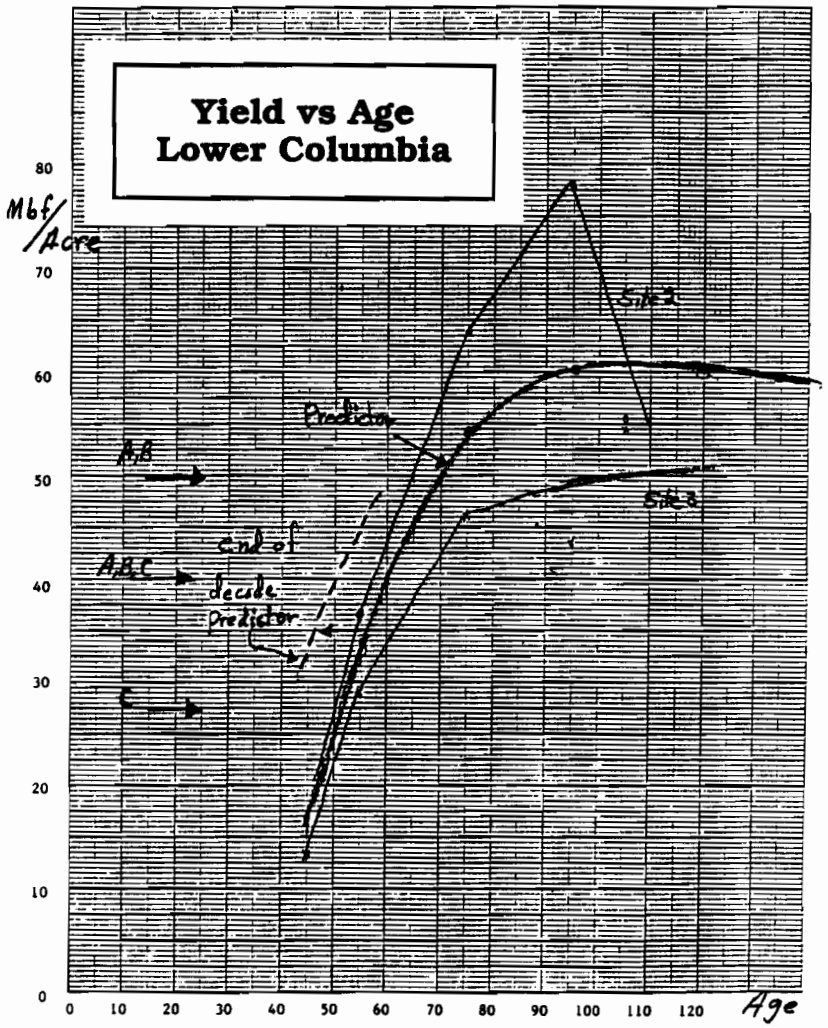
(Percent reduction in habitat vs miles from center for Hoh/Clearwater)



4. **Board foot densities at time of harvest:** Board foot density data was obtained for most samples. Figure A.4 provides a graph of the typical relationship between board foot per acre vs age class. Site differences are also noted on the graph. For ages less than 60 years, the board foot density data closely matches stand yield tables. For ages over 60 much of the acreage has already been cut, with the best acres more likely to be cut earlier, and those acres not cut more likely to fall below the density observed in stand management tables. Figure A.4 confirms that result.

Figure A.4:

Yield vs Age -- Lower Columbia



When type A, B, or C habitat data was provided, the relationship to density could be related to the density curve by the approximate age groups observed for each habitat type. Figure A.4 also illustrates the lower board foot densities shown for type C vs type A or B.

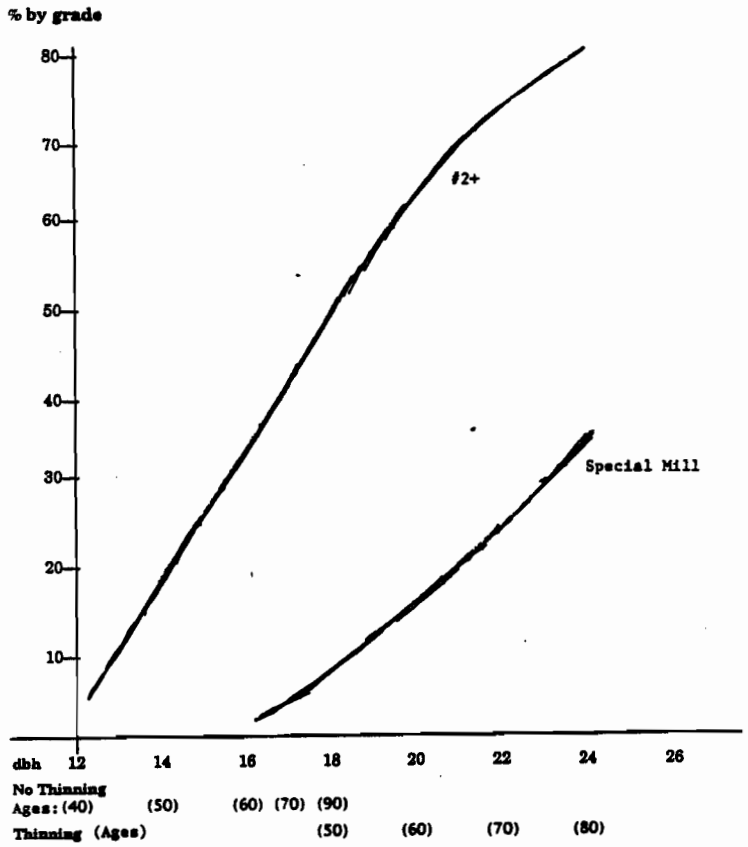
Board foot densities for Eastside landscapes were largely provided by landowners with the densities much lower than for the Westside, especially for uneven aged management harvests. General averages were roughly 36 thousand board foot per acre for 55 year harvests south of Olympia, 20% less for the northern landscapes and from 10-15 thousand board foot per acre for Eastside landscapes.

The measurement of board foot densities represent an average across an age class of 10 years. Since the harvest will generally be timed for the oldest first, the density used for decade computations reflects the density at the top end of a 10 year age class corresponding to cutting the oldest first while allowing the youngest to be harvested when it has aged another 10 years.

5. **Quality mix to produce #2 and better and special mill logs:** Since many of the acres being constrained from harvest are considerably older than the average acre being harvested, it was believed that the impact of the rules on high quality logs could be significantly higher than for lower quality logs. The percentage of Special mill logs and, separately, #2 and better logs was determined, relative to age class and diameter, from stand tables and mill recovery studies. These relationships are shown in figure A.5. (The number in ( ) is the age of the stand, corresponding to the average diameter.) For age class data, the percentage of Special mill and #2 and better logs were identified with the age classes so that the constrained volumes could be allocated to these quality classes. No similar computation could be derived when only habitat type GIS data was provided. The sub-sample of age class data showed that the percentage decline in special mill logs was likely to be much higher than the percentage decline in a typical harvest.

Figure A.5:

Log Mix by Mean Stand Diameter/Age Class



6. **Value index vs. age/diameter:** As a separate value measure, the value of stands vs age were indexed to derive a revenue impact that would reflect the quality of the logs vs age/diameter. Using current stumpage prices it was determined that 50 year old stands on the Westside (and south) would average $400/mbf but stands over 80 years would average $800/mbf. A price index range to age/diameter was developed and the price indexed for each available age class. Harvest values were therefore determined in addition to volume. This was only possible for age class source data; hence, some of the value difference with age was not available for landscapes without age-class data.

7. **An example spread sheet to determine the impact for a single rule and landscape:** Referring again to the table 1,2 and 3 computational spread sheets: GIS measures of the amount of habitat type for each owner (item 6) were converted to the average acres per owl circle, column numbers with item 9. These habitat acres were adjusted for the appropriate circle size (item 10) for each rule, such as .7 miles (item 11) and .7 to 2.0 miles (item 12) in the example. Target acres were also adjusted for habitat found in the first .7 miles with no overlap allowed and what would be required from .7 miles to the circle boundary after

adjustment for the overlap footprint ratio across owl circles (item 13). The total number of habitat acres were then derived for each rule (item 14) and the total board foot measure accumulated across each age and habitat type (item 15). The board foot measure from federal lands was removed (item 16) producing the total number of non-federal board foot harvest constraint for the first decade (item 17). Using the value index described above as a function of age (item 18), a value index was computed (item 19), from which revenue at current prices was derived by multiplying by $400/mbf. The percentage of special mill and #2 and better logs was derived as a function of age, (item 20) and the volume of high quality logs determined (item 21, Table A.3, page 3).

Table A.3 (pages 1, 2, & 3):

DNR/WEC Rule with SAG Targets

(Age Class GIS Data)

Found on the following three pages.

I-90W DNR/WEC

	I90W																
(1)	BASE																
	Circle size=	1.8 mi	Steady State Mbf/acre =	36													
	# of Owl Circles=	25			(2) I90W		* SAG Target	3586						(8)			
					Circle #	25	ACRES (6)								ACRES/SO		
(3)	Habitat Distribution Age Class	(4) Habitat Prob.	Prob. Habitat	(5) Mbf/acre	Footprint Totals Fed.	State	Ind.	Other	Unknown	Total	Circle Ttl.	Circle Averages Fed.	State	Ind.	Other	Unknown	Total
	>80				1,693.1	0.0	1,095.3	250.5	1,467.0	4,505.9		67.7	0.0	43.8	10.0	58.7	180.2
		100%	A or B	63											10.0	58.7	HAB 180.2
	60-80				4,530.2	42.6	2,520.5								25.1	70.1	378.90
		25%	A or B	53											6.3	17.5	HAB 94.7
		25%	C	53											6.3	17.5	HAB 94.7
		50%	D	53											12.5	35.0	189.4
	40-60				10,216.8	493.0	6,472.2								111.9	80.8	880.0
		25%	C	36											28.0	20.2	HAB 220.0
		50%	D	36											56.0	40.4	440.0
	20-40				5,471.4	215.1	7,506.9	3,626.1	886.5	17,706.0		218.9	8.6	300.3	145.0	35.5	708.2
	<20 etc.				7,749.7	411.3	27,239.1	7,121.7	3,284.9	45,806.7		310.0	16.5	1,089.6	284.9	131.4	1,832.3
										(7)		0.0	0.0	0.0	0.0	0.0	0.0
	Total				29,661.0	1,162.0	44,834.0	14,423.0	9,411.0	99,491.0	162,860.0	1,186.4	46.5	1,793.4	576.9	376.4	3,979.6

GIS Sample

(1) age by owner
(2) SO circles (each & total area)
(3) footprint of circles
(4) per SO averages are computed

* DNR/WEC Target

(5) mbf/acre at harvest (oldest first)

footprint = 61% of circle area

(9) Hab 590

I-90W DNR/WEC

* SAG Target	Overlap Factors (10)			.7 mi revised (11)	Revised Habitat (12)	Restricted Acres/circle (13) SEE NOTE BELOW			Mbf/Circle	Total Mbf (15)	% of footprint (16)	
	1.8 mi.	2.0 mi.	2.7 mi.	Hab.	Averages (1.8-2.0)	.7 mi.	To boundary	Total	(Short Term)	(Short Term)	Fed	Nonfed
3,586.0	61.09%	52%					1,765					
	(=footprint/tll. Circle)			58.5	124.0						37.58%	62.42%
				58.5	124.0	58.5	124.0	182.4	11,493.8	287,344.9	37.58%	62.42%
Footprint Ratio	1.8-.7 Mile Habitat Conversion			122.9	260.7						47.83%	52.17%
0.61	1.31			30.7	65.2	30.7	65.2	95.9	5,081.8	127,044.9	47.83%	52.17%
				30.7	65.2	30.7	65.2	95.9	5,081.8	127,044.9	47.83%	52.17%
	.7 mile size conversion											
	15%											
	1.8-2 Mi. Hab. Conversion			285.4	605.4						46.44%	53.56%
	96.3%			71.3	151.3	71.3	151.3	222.7	8,016.9	200,422.5	46.44%	53.56%
	(=1.31/1.36)											
	1.8 mi-2 mi. size conversion											
	1.235							(14)				
						191.2	405.7	596.9	29,674.3	741,857.2	29.81%	70.19%

* DNR/WEC Target

(13) New Target .7 to 2.0 mile

3586 old target
-182 within .7 mile
3404
x.519 non-dup. footprint
1765 new target .7 mile to 2.0 mile boundary

I-90W DNR/WEC

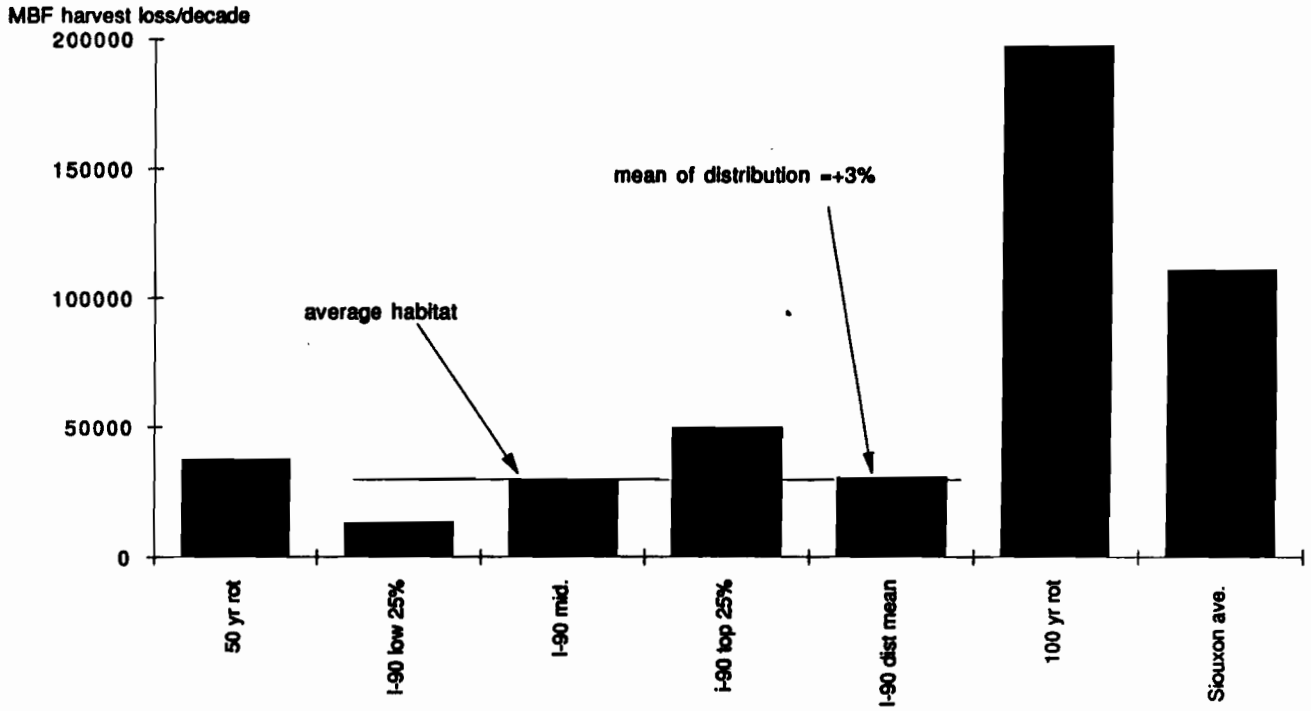
fed restrictions Mbf/footprint	Nonfed restrictions Mbf/Footprint	Value (total nonfed) Index		Total Staedy-State Mbf (non-fed)	Sawlog Breakout (short term) Ttl. Mbf (nonfed) % #2	% Special	Special	#2	<#2
		(18)				(20)			
107,970.3	179,374.5	2.01	360542.783	102,499.7	54%	11%	155,166.2	31,607.9	132,178.6
		$800/mbf							
60,759.6	66,285.3	1.4	92799.48729	45,024.0	48%	8%	60,981.6	9,909.5	66,063.4
60,759.6	66,285.3	1.4	92799.48729	45,024.0	48%	8%	60,981.6	9,909.5	66,063.4
		1.4			48%	8%	0.0	0.0	0.0
		$400/mbf							
93,074.4	107,348.1	1	200422.5284	107,348.1	35%	2%	70,147.9	4,008.5	130,274.6
		1			35%	2%	0.0	0.0	0.0
							(21)		
							#2+	Special Mill	
	(17)		(19)						
322,563.9	419,293.3		746584.286	299,895.9			347,277.2	55,435.4	394,580.0

8. **Difference between the impact for an average circle and the impact across the full distribution of owls:** Several test cases of the distributional error that might exist compared to measuring the rule on the average owl circle were examined. For I-90 West the impact of the DNR/WEC Rule on the 6 circles with the most habitat, the top 25% was computed separately, as was the impact on the bottom 6. Using a 25% weight for the top 6 and 25% weight for the bottom 6, and 50% weight for the center of the distribution, it was determined that the mean of the distribution was about 3% higher than the impact on the average owl circle (illustrated on Figure A.6). Such corrections could be made for each landscape with a large number of owls.

Figure A.6:

Harvest Loss Variation within a Landscape

DNR/WEC Rule



A similar correction for the Hoh/Clearwater landscape was determined to be about +11%, but the correlation of those circles with high habitat and federal acres was so high that after removal of the federal acres, the correction became -10%. No other landscapes would be expected to have such large corrections.

Since these errors seemed small relative to the likelihood of habitat type errors and not even of consistent sign, adjustments were not made to the impacts for average circles for each region prior to cumulating up the impact across all landscapes.

9. **Regional and State level estimates derived from the 12 sample landscapes:**

For many of the sample landscapes, the number of owl circles in the sample were very close to the number of circles identified in the SAG report as being on private lands. The SAG report identified the number of site centers inside the landscape boundary and a number of circles outside of the boundary that overlapped inside the boundary. Most GIS samples also included the partial circle impacts of owl sites outside the boundary but overlapping inside, net of sites inside the boundary that overlapped outside the boundary. It was noted that it takes about 4 circles outside and overlapping inside to equal one circle inside. The owl circles on GIS samples were compared to the SAG report measure of the number of circles inside the boundary plus 1/4 of the number of circles outside. If the computed SAG report number was 10% higher than the GIS sample the impact in the GIS sample was generally adjusted up by 10% to be comparable to the SAG report (and vice versa). No data was provided that would allow an assessment of the impacts for circles that do not overlap into the 15 identified special landscapes.

Exceptions to the above procedure were noted for Mineral block as the SAG report did not record sites on federal lands as being inside the landscape yet the GIS sample includes all sites. Since the total number of circles for Mineral Block by SAG were close to the total number of circles identified in the GIS sample, no adjustments to the sample were made.

Since no GIS data was available for the N. Olympic SEA the 6 SAG sites identified inside the boundary plus 18 outside were estimated to be (the same as 6 +1/4 of the 18 outside) 10 total, with the same average habitat as the Hoh/Clearwater sample. Similar estimates were made for White Salmon based on the average habitat for other Eastside landscapes and for the Columbia Gorge based on the average habitat for Lower Columbia landscapes.

The attached table shows the number of sites in the GIS samples and the adjustments that were made to correspond more closely to the SAG reported count of owl circles on private lands in the 15 special landscapes. Overall, the adjusted sample totals 232 circles compared to 231 for the SAG report when weighting the SAG circles outside the landscapes as having a 25% net impact except for Mineral Block which was given full weight. The total number of circles inside and outside the special landscapes reported in the SAG report was 317, but about 115 of them are believed to be outside the landscapes reducing the net effective circle impact by 86 circles for a 231 effective circle total.

Table A.4:

Adjustment of Sample Owl Sites to Owl Count in SAG Report

	SAG Report			GIS Sample		
	inside	outside	weighted total*	sample	adjusted	total
Hoh	19	27	25.7	24	+1	25
N. Olympic	6	18	10.5	N/A	+10	10
SW	12	1(?)	12.2	15	-3	12
N. Blewett	12	4	13.0	14	0	14
Entiat	14	2	14.5	13	+1	14
W. Salmon	7	4	8.0	N/A	+8	8
Finney	2	18	6.5	4	+2	6
C. Gorge	7	4	8.0	N/A	+8	8
Easton	3	5	4.25	5	0	5
Mineral Link	3	10	5.5	4	+1	5
I-90W	26	7	27.7	25	+1	26
I-90E	35	3	35.7	23	+12	35
Mineral Bk	4	23*	27.0*	30	0	30
Siouxon	6	5	7.25	3	+4	7
Taneum	23	7	24.7	27	0	27
TOTALS	179	138	***231***	187	+45	***232***
total		317				

*circles outside boundary weighted by 1/4 for effective number of circles except for Mineral Block with sites believed to be federal sites inside the landscape and hence given full weight.

10. Regional data is compiled by adding up the impact for each landscape:

Landscapes grouped into regions corresponding to owl protection strategies, Owl Regions, were necessarily reallocated to line up with the Economic Regions used in state economic models.

Table A.5:

Emphasis Areas in Owl Regions and Economic Regions

OWL REGIONS	ECONOMIC REGIONS
Olympic Peninsula	**Olympic**
Hoh/Clearwater	Hoh/Clearwater
N. Olympic	N. Olympic
	67% of SW
Southwest	**Lower Columbia**
SW	Siouxon
	33% of SW
	C. Gorge
	W. Salmon
West Cascades	**Puget Sound**
I-90 W	I-90 W
Mineral Block	Mineral Block
Mineral Link	Mineral Link
Finney	Finney
Siouxon	
C. Gorge	
East Cascades	**Eastside**
I-90E	I-90E
Easton	Easton
Taneum	Taneum
Blewett	Blewett
Entiat	Entiat
W. Salmon	

11. **Acreage targets under each rule:** The acreage targets are generally explicit with each rule but include different targets by region. The target believed to be appropriate to each rule and landscape are delineated below as used in the analysis.

Table A.6:

Target Habitat Area for Each Region and Rule

RULES:	70-Acre	500-Acre	WFPA			DNR/	4d	New
			Other	Dis	PM	WEC		
	70 all	500 all						
Olympic Peninsula						3827	5708	
Hoh/Clearwater			70					70
Southwest						3586	70	70
SW			70					
West Cascades						3586		
Mineral Block					2608		2663	1206+
Mineral Link				977+			70	1206+
Finney				977+			2663	1206+
Siouxon			70				70	3200
C. Gorge				977+			2663	1206+
East Cascades						3249		
I-90E					1956		1906	2400
Easton			70				1906	70
Taneum			70				1906	2400
Blewett			70				70	70
Entiat			70				70	70
W. Salmon			70				70	1206+

The habitat acreage targets for each rule are explicitly spelled out in the rule either directly or as a percentage formulae of the circle area, with the exception of the Dispersal Rule and Pair Maintenance Rule. Under the Dispersal Rule which applies to 3 landscapes under the WFPA Rule and 6 under the New Rule, both the number of habitat acres and the number of dispersal acres required interpretation. Under the WFPA Pair Maintenance which applies to 3 landscapes, the number of acres of habitat was specified however the definition of foraging habitat to meet the target appeared to include less than suitable habitat. A dispersal habitat predictor vs age class was developed in step 2.

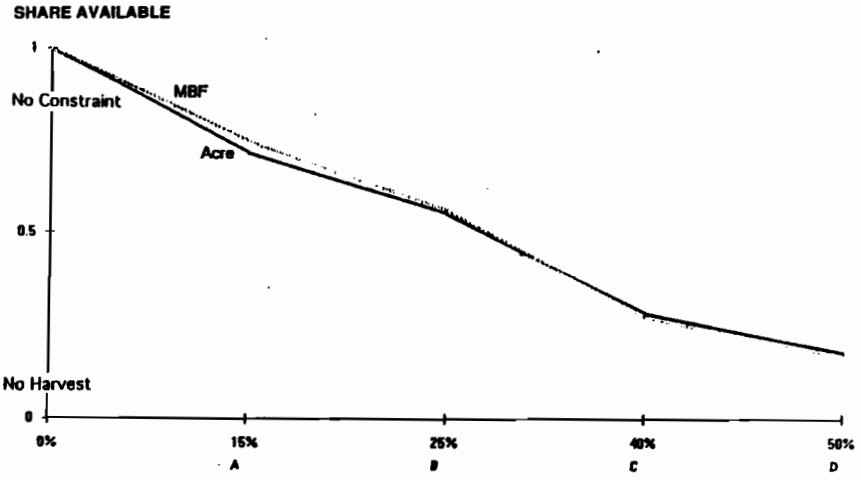
12. **Dispersal and Pair Maintenance Rule interpretation:** In order to meet the Dispersal Rule target of not less than 40 acre plots with not more than .5 miles separation, the target acres may be interpreted as 4 plots of 160 acres per square mile (25% of the acres maintained in dispersal or better), or if there is only 2 plots within the square mile (12.5% in dispersal or better). Since the spatial distribution of mature acres is far from uniform, it is known from earlier analysis on the impact of the 50-11-40 Rule that a larger portion of the mature acres will have to be constrained from harvest to meet targets with a spatial requirement. Figure A.7 provides an analysis of one typical area of 240 quarter townships and 113,300 acres. To maintain 25% in dispersal or better habitat with half mile spacing, 45% of the available habitat could not be cut. To maintain 12.5% in dispersal or better habitat, as much as 20% of the available habitat may be constrained. Since the WFPA Rule did not imply that the target had to be reached immediately, it was assumed that if 15% of the available dispersal or better habitat was retained it would allow progress toward the goal. While the wording on the New Rule is not the same as the impact of the WFPA Rule, the impact analysis assumed that the intent was similar and the same interpretation was used for it.

The amount of dispersal habitat available was discussed as a part of the habitat conversion analysis, Appendix Step 2. The WFPA Pair Maintenance area target is explicit but the definition of foraging habitat appears to include stands that are less than suitable habitat, estimated at 1/2 that determined to be dispersal habitat.

Figure A.7:

Harvest Impact of Cover Retention:
"X-11-40 Rule" Spatial Impacts

(Data for 113,300 acre sample characterized by quarter townships - 240 plots)



D: 50% corresponds to the 50-11-40 rule.
C: 40% corresponds to the 40% cover rule.
B: 25% corresponds to 40 acre dispersal clusters within one-half mile.
A: 15% corresponds to over 50% progress toward C in 10 years.

The Dispersal Rule calls for dispersal habitat outside of the owl circles to the landscape boundaries which could be two or more times the impact shown within circles.

13. **Impacts beyond the first decade and appropriate to the long-term steady state:** Long-term impacts, including probable impacts on long-term investment decisions, were developed in the report with no additional explanation needed and, hence, was not duplicated here.

14. **Estimates of errors that may significantly alter results:** The table below summarizes the sources of error that have been discussed for each procedural step in the appendix or in the report.

Table A.7:

Uncertainty of Data Quality or Assumptions

Risk of contributing to error:	**none**	**low**	**significant**
	<----+----------+---->		
GIS age class or habitat (by owner)	x		
Habitat-type in GIS		x-- ----x	
Age vs habitat			x
Distribution across landscapes		x	
MBF/acre	x		
Value/age		x	
Circle size transformations	x		
DNR sustainable management			x
Scaling up to full sample	x		
Market shares:			
other wood imports			x @
log exports		x	
pulp and paper imports			x @
Price adjustments		x	
Long term investment motivation		x-- ----	--x
Rule interpretation (using the correct variant?)			
WFPA (within circles)		x	
WFPA Dispersal (outside circles)			x
DNR/WEC	x		
4d (boundaries?)			x
New-Com (modified dispersal)			x
Owls outside important landscapes		x	

@ alternative sensitivity analysis provided

Risk of contributing to error:

The error sources identified as significant include:

* **Age vs habitat conversion:** The cross samples of habitat vs age may be too small leading to an underestimate of habitat for several landscapes which show low habitat percentages. While errors in the predictor of habitat from age class may be significant it would appear to have the potential to increase the habitat for more circles than it would decrease the habitat. It may be contributing to an understatement of the impact especially in the Puget Sound region which otherwise shows little habitat for many circles. Since any such error is not likely to change the rank order of impacts across rules, it did not seem essential to raise or lower the habitat conversion in a sensitivity analysis beyond the demonstrations of the impact across landscapes provided in the report.

* **DNR sustainable management impact:** Reviewers pointed out that DNR may be able to shift much of the first decade's harvest constraint impact to later decades. The assumption in this report was that there will be little if any economic substitution beyond the first decade. Since DNR may be able to employ sustainable management with its large mature inventory by substituting inventory that would otherwise have been planned for harvest in a later decade our estimate of the DNR impact may be overestimated. This suggests that DNR has not been optimizing economic returns by favoring sustainability targets.

  Since DNR's harvest rates are off in percentage terms even more than industry's over the last year, the market evidence to support this contention is lacking. DNR and the private sector appear to be constrained by inadequate marketable inventories to substitute for acres that are being impacted by owls.

  If DNR is able to substitute mature timber from a future decade's planned harvest to offset half of the impact in the current decade, our estimates may be 28% too high for the DNR/WEC Rule and 17% too high for the proposed New Rule. In any case, there is substantial uncertainty on the impact of these rules on DNR's harvest plans.

* **Other wood and paper imports markets assumption:** In the short term both the secondary manufacturing sector and the pulp and paper sector have the potential to import the quality sawnwood and chips they need. An alternative set of market assumptions was provided to illustrate the most optimistic adjustment that could be expected with full reliance on chip and sawnwood imports at no incremental cost.

  One reviewer noted that the other wood sectors includes some low quality wood usage such as pallets in addition to high quality

wood. Imports are less likely to offset the needs for pallets in contrast to imports of high quality wood for higher prices value-added products.

* **Long-term investment motivation assumption:** It is not possible to make a precise forecast on how long term investment will be impacted. The impacts illustrated in the report are judgmental interpretations on how many acres may be thinned or not, as a consequence of the rules. There is no doubt about the direction of impact of the rules but the number of acres that could be impacted is more problematic.

* **WFPA Dispersal (outside circles):** The impact of dispersal rules outside of owl circles was not computed. The impact shown to be inside owl circles would likely be as great or greater on the outside of the circle to the WAU or landscape boundary.

* **4d Rule boundaries:** While discrepancies were noted between several interpretations of the landscape and areas to be impacted under the 4d Rule, no effort was made to be certain there is a correct interpretation and it is the one included in the study. The summary table on target acres, Appendix step 11, characterizes the interpretation used in this study.

* **New-Com (modified dispersal):** The definitions within the New-Com Rule appear to compromise the attempt at creating dispersal habitat that is different than suitable habitat. The only variant analyzed assumed a similar definition to the interpretation provided for the WFPA Dispersal Rule. These interpretations may deviate from the intent.

* **Owls outside landscapes:** no data was made available to characterize owl circles other than those inside or overlapping into the 15 important landscapes identified in the SAG report.

Error sources judged to be lower in significance:

* **GIS age class or habitat (by owner):** GIS samples were provided by 10 companies. While the boundaries do not always correspond directly to the "important landscapes," the only significant errors would be in the habitat typing. This error source is not in the GIS source as such, but rather in the typing procedure from satellite or photograph or even on the ground interpretation. The contribution of the GIS source data to errors should be very low.

* **Distribution across landscapes:** The distributional corrections could have been made thereby reducing the potential for error to insignificance. But the effort seemed large given the size of the

correction (no more than 10% in worst cases with many corrections offsetting each other). So no correction was made.

* **MBF/acre:** Most estimates came from industry to match the GIS sample. The largest error derives from those landscapes not having age class data which results in a broad average being used rather than a more age dependent sample. Where the rule has a small impact, the volume will be underestimated as only the highest quality timber would be involved rather than average timber.

* **Value/age:** The value-per-age comparison has the right direction and range but confirming data from industry was only obtained in a few cases. Lower valued stands are $400/mbf with the very highest (oldest) at $800. Eastside is lower than Westside. Dominant hemlock regions were as expected lower than Douglas-fir regions. Again the major potential error is the broad average value that gets used in the absence of age class data.

* **Circle size transformations:** When the data is given at 1.8 miles the extrapolation error to 2.0 should be low and vice versa. Extrapolation to .7 miles generally contains the right amount of habitat but not necessarily by the correct owner if there is a substantial change in ownership. Who contributes the first 70 acres would not seem to be important when comparing across rules. Hence the errors contributed from the .7 mile extrapolation should be small.

* **Sample data completeness:** Since the sample data covers 80% of the owl circles in the SAG report, the sampling error should be small except for the three landscapes for which no GIS data was obtained.

* **Market shares—log exports:** There is a much lower risk of a high percentage error in log export assumption than for other wood since there is a large difference in price between domestic and exports, and it is not that easy to divert the logs without paying a substantial premium. The diversion of more export logs would not be at zero cost.

* **Price adjustments:** While there may be some uncertainty in that further shortages will not continue to produce the same degree of price increase as the first impacts caused by the federal sales declines, using the price response to volume already observed becomes conservative. It should, if anything, overestimate the price offset and understate the rule impact on the Trust revenue. The adjustment was relatively small, and any error should be smaller.

PART II:

HARVEST IMPACTS ON PRODUCT MARKETS

INTRODUCTION:

Market impacts from harvest and value reductions: The impact of each owl rule has been shown to have an impact on both harvest volume and the quality of the timber made available. The quality and volume impacts directly affect product markets. The impact on quality has a disproportionate impact on secondary manufacturing wood users who are more dependent on quality resources.

In addition, an estimate of the impact on timber revenue was developed. The revenue impacts are important for determining the impacts of spending timber profits within the economy. Timber revenues may also be impacted by price adjustments caused by the harvest decline as well as the volume impact of the harvest decline. Price impact adjustments are developed in order to provide a more accurate estimate of the change in revenue. Both the timber volume, quality, revenue and price impacts will be different over the long term, requiring a separate characterization of long term impacts.

There are several potential market adjustments that may, at least in the short term, reduce the economic impact. Substituting imported wood resources for reduced local supply may reduce the number of wood and paper processors that would otherwise be forced to curtail activity. These possibilities are developed as alternatives to the Base Case Assumptions.

Linkage to economic model: A harvest decline will in the absence of other adjustments reduce the output of every wood sector dependent upon that harvest by that same percentage. However, it is possible for imports or exports to change that impact, suggesting the need for alternative cases to examine a range of possibilities.

By pre-agreement, the focus of the analysis is on the change between rules, not what has happened prior and how these rule changes add in a cumulative way to prior impacts. The 1992 economic base year is used as a snapshot of the linkage between that year's harvest level and that year's economic activity. The base case here will then be a base set of assumptions on market changes induced by the different rules to compare with the 1992 economic activity. A change in harvest induced by rule changes will have an impact on the economic activity in proportion to its share of the activity observed in 1992.

No attempt has been made to determine which rule most closely lines up with the observed activity in 1992. The impact of "no rule" does not imply that the 1992 activity level would result. Some rule was in effect for much of 1992. Since private harvest levels declined by roughly 500 million board foot in 1993, even though market prices were attractive, there is certainly evidence of some constraints. While knowing how to line up the appropriate rule to 1992 would

be useful information to forecast economic activity levels in the future, that would require additional calibration efforts beyond the scope of the study. This analysis was restricted to determining the economic impact of rule changes relative to each other, not a forecast of future activity. Valid comparisons can only be made between the rules analyzed.

BASE CASE DEFINITIONS:

Assumptions in Base Case Analysis (The basic assumptions used to evaluate each rule):

(1) Pulp and Paper Sources: Since 50% of the chips serving State of Washington pulp and paper mills are imported, a reasonable base case definition would be to expect this relationship to continue. So the pulp and paper sector markets are shown in the base declining 1/2 as much as the other solid wood products sectors, based on their wood source dependence on imports (note: retail paper sales were not reduced, assuming any necessary product could be imported). That assumes neighboring states do not impose restrictive rules which would lower the imports, a rather weak assumption. It also assumes that if there are Washington mill shutdowns, they do not lead to reductions in imports, an even poorer assumption. From the standpoint of these two assumptions, the base assumption appears to be too optimistic, but as described in Alternative Case A, imports may be able to reduce these impacts for a short period of time as an offset; hence, the 1/2 dependence of pulp and paper on local resources seemed to be an appropriate base case.

(2) Log Export Diversion: Log exports may be impacted differently than product markets. An analysis of the relationship between log exports and Pacific Rim demand shows that 1/2 of the log export decline since 1988 corresponds to the economic slowdown in Japan and other Asian countries (see Appendix II-A). The remaining 25% decline in log exports since owl litigation began corresponds to the 25% reduction in harvest for the exporting region. As a consequence there has been a 1% decline in log exports for every 1% decline in harvest, plus or minus international market impacts. Log exports have so far experienced a fair share in decline with harvest reductions and this relationship is continued in the base case.

(3) "Other Wood" Sector Sources: Secondary manufacturers are most dependent upon high quality wood purchases, which are disproportionately impacted. Analysis of the reduction in #2 and better and special mill logs shows a substantial impact on the availability of quality logs. For the DNR/WEC Rule, the volume of special mill logs will decline by an additional 27%. The base assumption lowers the "Other Wood" sector by 27% more than other sectors, with the remaining sawmill sector increased by the volume not consumed by the "Other Wood" sector, so that the total wood consumption corresponds to the total harvest decline. Since secondary manufacturers may in the short run be able to compete using import substitutes, an Alternative B to this base case is provided as a sensitivity analysis maintaining the "Other Wood" sector output without any decline.

(4) Price Impacts on Revenues: Shortages may induce some local stumpage price increases, at least until international markets have had time to respond to the shortage. Both short and long term timber price impacts are developed below to characterize the impact of this feedback from reduced supply to higher prices. The short term impact is much larger as it precedes the full international supply response. Since the state economic model responds directly to volume impacts, the increase in prices has no direct impact on the forest sector outputs except for the impact on the way timber profits are used. The most direct impact is the expenditure of Trust Land receipts. The impact of 1.) the harvest decline on DNR revenue, and 2.) price increases, which partially offset the volume decline, are estimated. The revenue impact becomes a source for a reduction in trust fund spending or the impact of increased taxes to offset that reduction. These impacts are a direct consequence of the impacts from alternative rule changes, and are included in the Base Case.

(5) Timber Profit Impact: Timber receipts changes are estimated in 1992 dollars, and the State's Trust Fund portion of those receipts are then offset by tax increases, affecting personal income levels, which in turn impacts personal consumption.

Private sector timber receipts are not treated similarly. Private sector investments to support the required economic activity level of the forest sector are a direct part of the expenditures in the model. Any increase in timber receipts above that needed for investment is assumed to be a capital outflow, in contrast to state timber receipts, which will be spent within the state. Similarly, any private investment needs in excess of receipts would be considered an inflow of capital and not a constraint to expansion. If the regulatory climate promotes investment in other states rather than Washington, it will induce private capital outflow which could have a substantial negative economic impact. Within the economic model, it is the decline in output that is measured. When it is assumed that the forest sector's product output fails to grow as it has in the past, for instance due to harvest reductions, it may well infer capital outflow. The alternative of reduced forest management over the long term is another example, inferring changes to capital flows.

(6) Other Forest Sectors: All economic impacts are related to harvest changes, except the expenditures from timber receipts. The impact of the harvest change on each solidwood and pulp and paper sector is assumed to be proportional to the harvest decline, except as noted in (1) to (3) above.

ALTERNATIVE CASES:

Alternative Case A - chip imports: As an alternative to pulp or paper mills shutting down they may be able to import chips or pulp and remain competitive. While there will be some loss in competitiveness from importing chips, the possibility of importing chips from as far away as Chile has been investigated by the Port of Port Angeles. Over the long term it should be expected that paper production would take place closer to the raw material source but there may well be fewer mill closures in the next few years than indicated in the Base Case by utilizing increased chip imports. A sensitivity case assuming all of the chips that are needed can be imported is developed, recognizing that this represents an optimistic limit. There is some increase in cost associated with chip imports that will have a negative impact, but this impact is not known and would be difficult to determine quickly or model with sufficient accuracy to determine what percentage of chip import replacement might be reasonable.

Alternative Case B - sawnwood imports: While the import of sawnwood may be more costly than the import of chips, certainly a portion of the secondary manufacturing resource needs may be supported by increased imports of high quality sawnwood from Canada. A sensitivity case of importing all of the sawnwood needs for the "Other Wood" sector (millwork, doors, windows etc.) is shown, recognizing that this also represents an optimistic limit. Importing logs for the sawmill sector has so far not proven to be feasible, although fumigation or radiation procedures may eventually become acceptable. The reduction of log exports has already been estimated to be price sensitive in the base case. There is a loss in premiums associated with log exports that has been shown by many studies to result in lost economic activity by forcing the diversion of logs from export to domestic processing. This economic loss from the diversion of log exports is much greater than for chips or sawnwood, since the premiums received in processed product export markets is much smaller than for log exports.

Alternative Case C - increased thinnings: In conjunction with a program to increase forest management investment such as thinning stands to create more habitat and quality wood for secondary manufacturers, the impact of accelerated thinnings is considered a possible short term impact. In the first decade, increased thinnings would only benefit the pulp and paper facilities and the small log portion of the sawmill sector, not secondary manufacturing. This alternative serves to offset the pulp and paper resource shortages much like imports but may also support a different part of the solidwood sector, the "small log economy." The likelihood of this alternative is compromised by the impact of the rules on long term forest management as described in Part III.

Alternative Case D - the long-term impact of increased forest management with and without new rules: Timber and product prices have reached levels that should support increased commercial thinning. With recent high prices, there is a positive cash flow associated with the removal of thinnings. There may, however, not be an adequate rate of return for thinning. And, if Forest Practice

rules penalize the harvest of thinned stands relative to shorter rotation stands, there may be even less reason to increase forest management in the future. Ironically, thinned stands will produce increased owl habitat and other features desired for habitat. If the rules work to inhibit thinning, they reduce the long term creation of larger amounts of habitat as the cost for saving smaller amounts of current habitat. And at the same time, less thinning reduces considerably the value of future harvests, the quality of wood harvested, and therefore the growth potential of secondary processing.

This alternative demonstrates the economic impact of less investment in forest management via a lost opportunity to thin 25% of the Westside stands under rotation. That may overstate the opportunity over the next decade, but should be a conservative estimate of the longer term impact. An analysis of the impact of thinnings on habitat and how the rules impact the economics of thinning was provided in Part I.

DERIVATION OF PRICE IMPACTS:

Impact of price changes on the impact of Forest Practice rules for owl sites: While the volume impacts of these rules are generally small on a global scale and thus should not be expected to have a large impact on timber prices, which are over the long term set in global markets, in the short term local markets may be significantly impacted by supply changes. Estimates for short term supply impacts on price are available from a statistical analysis conducted across the DNR log export ban period and federal sales decline period (Fretwell, 1993). The CINTRAFOR global trade model provides estimates for the impact of regional timber prices from supply shifts over the longer term, after global markets have had time to adjust (Perez-Garcia 1991, Perez-Garcia 1993, Perez-Garcia, et al., 1994).

The price changes that are relevant to the rules will only be those changes induced by the rule changes. Since the largest volume decline was 690 million board feet per year (under the DNR/WEC Rule), price impacts are derived for a 100 million board foot impact and scaled to the level appropriate for each rule.

Short-term price impact: Fretwell showed the impact on DNR stumpage sales of a large number of attributes including grade, species, the impact of declining federal sales, and the impact of export restrictions. During the period 1989 first quarter to 1992 last quarter, stumpage prices were shown to have increased $217/mbf for unrestricted sales, an 80% increase, and $223/mbf for export restricted sales, a 110% increase. The decline in Forest Service sales was the largest contributor to the price increase, with prices rising $27.70/mbf for every 1 billion board foot loss in sales over two years. This cumulative loss form was determined to be a statistically better description of price changes than the loss in a single year. A 0.5 billion board foot harvest reduction per year would become 1 billion over the two year interval, generating a short term price increase of $27.70/mbf. For ease in conversion to the impacts corresponding to alternative rules, this corresponds to short

term price increases of $5.40/mbf for every 100 million board foot annual harvest reduction.

Long-term price impact: After international markets have had time to react there may be no price increase at all. That potential is certainly true for the PNW, where prices for west coast timber are largely determined by consumption in the Pacific Rim, where the PNW has no protection from competitors. If products were consumed in local markets there would be some protection from imports as a consequence of the higher transportation costs incurred by the competing imports. As a major exporting region there is no such protection. The CINTRAFOR global trade model does show, however, that the general shortage of timber in Pacific Rim Markets will require regional timber price increases to respond to any supply reduction in the PNW as global prices rise somewhat. That increase is lower than the short term impact because most of the supply response to higher prices will not be by local PNW suppliers but rather by the US South, Canada, and overseas suppliers plus substitution by non-wood products. The CINTRAFOR global trade model shows a PNW regional price increase of $2.45/mbf for a 100 million board foot annual harvest reduction in owl region supply over the longer term.

Impact of short-term price increase on the state economic model: Most of the inputs to the economic model are derived from harvest volumes and not price and hence are not affected by the impact of a price increase from a supply shift. Timber profits are the sole exception. DNR timber sales have therefore been adjusted for the impact of the volume changes on equilibrium prices. The $5.40/mbf price increase for a 100 million board feet volume reduction therefore produces the volume adjustment for DNR trust revenues impacts. The no-rule base harvest volume for DNR was assumed to be 700 million board feet/year, which may be optimistic, but therefore makes the price adjustment computation larger, a most favorable or conservative assumption.

The impact of each rule on DNR revenue, volume, and the price adjustment is shown in the attached table. The unadjusted trust revenue and the price adjusted trust revenue are shown in 1992 dollars as the input for the economic impact assessment.

Table 1:

See **State Revenue Impact . . .** table on the following page.

State Revenue Impacts: with price adjusted Trust Revenue

	State share	State Value	State Value	State Value	State Value	State Value	State Value		State Volume	State Volume	State Volume	State Volume	State Volume	State Volume
Rule:		new	DNR/WEC	WFPA	500	4d	70		new	DNR/WEC	WFPA	500	4d	70
		($ mils)	($ mils)	($ mils)	($ mils)	($ mils)	Mbf		Mbf	Mbf	Mbf	Mbf	Mbf	Mbf
Puget Sound	($ millions) per decade of state harvest revenue decline								(M-millions) of board foot state harvest decline per decade					
I-90 West	0.023	7	7	11	6	7	1		10	10	18	8	10	2
Mineral Block	0.316	49	49	68	60	49	10		68	68	103	87	68	12
Mineral Link	0.218	33	61	12	19	3	3		43	79	16	23	3	3
Finney	0.501	11	34	19	4	20	1		20	60	37	7	35	1
Total SEA		101	151	110	88	79	14		141	217	174	125	117	18
Lower Columbia														
Siouxson	0.934	527	527	23	165	23	23		724	724	29	206	29	29
Southwest(33%)	0.438	8	102	19	68	19	19		16	197	8	121	23	23
Gorge	0.1	19	19	8	10	7	2		26	26	13	13	12	2
Salmon	0.1	5	5	0	2	0	0		9	9	11	3	0	0
Total SEA		554	585	38	199	37	31		764	825	56	262	48	39
Eastside														
I-90 East	0.006	2	2	1	0	1	0		3	3	2	1	2	0
Easton	0.219	17	16	1	5	12	1		26	26	53	8	20	1
Taneum	0.001	0	0	0	0	0	0		0	0	1	0	0	0
Blewett	0.083	0	4	0	2	0	0		0	7	1	3	0	0
Entiatt	0.172	0	12	0	3	0	0		1	20	1	5	1	1
Total SEA		20	34	2	10	14	1		33	56	57	16	24	2
Olympics														
Southwest(67%)	0.438	8	102	19	68	19	19		16	197	8	121	23	23
Hoh Clearwater	0.84	26	948	29	209	948	29		53	1894	59	419	1894	59
N. Olympic	0.84	11	379	12	84	379	12		21	758	147	168	758	23
Total SEA		42	1395	53	338	1339	53		85	2784	211	668	2668	98
Total		717	2165	204	635	1468	100		1023	3882	498	1072	2856	157
								DNR Share	0.34	0.56	0.26	0.44	0.61	0.42
									Base Harvest	700	mil bd ft/yr			
				Annualized price adjustment to DNR revenue (millions of '93$)					9.66	11.63	6.73	7.78	10.46	1.39
			Annual price adjusted Trust Revenue (millions of '92$)						45	149	10	41	99	6
Base DNR Harvest	700	mil bd ft/yr												
					Annual Trust Revenue no adj (millions of '92$)				52	157	15	46	107	7

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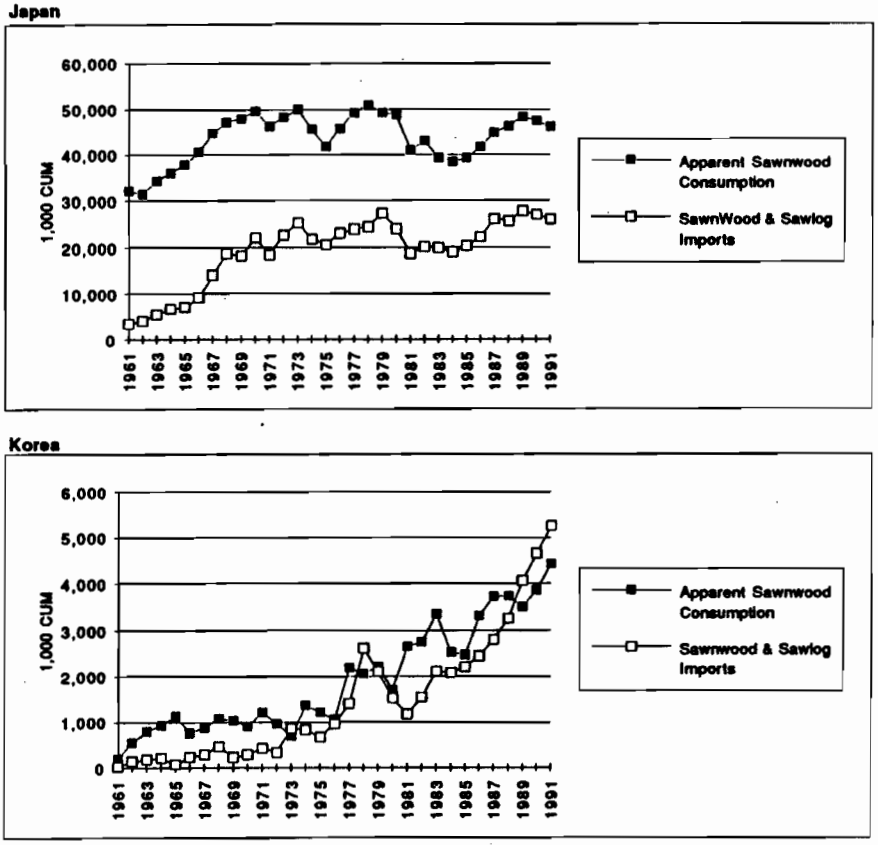
PART II
APPENDIX

Log Export Market Impact: Figure 1 shows the historic relationship between Japan's imports and their total consumption. While there is a slight trend increase in imports, the relationship shows for every million cubic meters of change in domestic consumption there is a corresponding change in their imports. A similar relationship exists with Korea although the total volume is much smaller.

Figure A.1:

Softwood Consumptions and Imports

(Given in Roundwood Equivalents)



Japan's domestic consumption declined almost 4 million cubic meters from it's peak in 1989, but then recovered to a 2 million cubic meter decline by 1993. Imports of US wood products remained down by 4.2 million cubic meters in 1993. As shown in the next table, the US share of imports declined from 52 to 38%, but should not have fallen below 45% based on the historic cycle. In effect, half of the US reduction in log exports can be attributed to the Asian business cycle, the other half to the unusual high prices and availability problems in the US market.

Table A.1:

Apparent Japanese Softwood Consumption (1977-1992)

(1,000 CUM RndWd Equivalent; 1.4 conversion multiplier used for lumber conversion)

	Domestic	USA	Total Imports	Ttl App Cons	US Imp Share
1977	20,464	11,522	21,925	42,389	53%
1978	20,228	11,679	22,595	42,823	52%
1979	21,219	14,421	24,454	45,673	59%
1980	21,427	12,311	21,739	43,166	57%
1981	20,145	8,913	16,768	36,913	53%
1982	20,860	10,015	18,752	39,612	53%
1983	20,648	9,581	20,501	41,149	47%
1984	20,418	8,912	19,685	40,103	45%
1985	20,558	9,644	20,799	41,357	46%
1986	20,224	10,704	22,353	42,577	48%
1987	20,292	12,718	26,055	46,347	49%
1988	20,287	12,640	25,688	45,975	49%
1989	20,078	14,603	27,861	47,939	52%
1990	19,549	13,686	26,999	46,548	51%
1991	19,549	12,290	25,979	45,528	47%
1992	18,900	11,403	25,461	44,361	45%
1993	19,000	10,414	27,154	46,154	38%

Since PNW log exports are off 50% by 1993 about 25% of that decline is related to the supply availability problem and the other 25% to the Asian business cycle. Since the supply region is off about 25% in harvest, the log exports decline of 25% related to availability shows a 1:1 relationship between log exports and the supply shortfall.

We have therefore assumed a 1% decline in log exports for every 1% decline in regional supply from any harvest constraints.

PART III:
IMPACT OF RULES ON THE WASHINGTON STATE ECONOMY AND FOUR SUBREGIONS

TECHNICAL NOTES ON THE ECONOMIC IMPACT ANALYSIS

1. INTRODUCTION

This study evaluates the economic impact of six alternative forest practice rules designed to protect northern spotted owl sites on private and state lands in Washington State. The analysis involves the estimation of three effects:

1. The reduction in timber harvest for each rule.
2. The economic losses in the forest products industry (output, employment, and labor income) as well as the loss in state timber trust revenue due to reduced timber harvests.
3. The total economic impact of forest products industry and timber trust revenue losses on the state and four regions (Puget Sound, Olympic Peninsula, Lower Columbia, and Eastern Washington).

The purpose of these technical notes is to describe in detail the last two steps, the economic impact analysis. The actual analysis of each rule is contained in a spreadsheet consisting of 16 tables. At the bottom of the spreadsheet, two additional tables and a set of "case assumptions" summarize the economic impact of the rule on the state and the four regions. Appendix A shows the complete spreadsheet for the most recently proposed New Rule by the Forest Practices Board's Wildlife Committee. Appendix B presents the case assumptions and summary impact tables for all of the six rules. Appendix C contains two articles on regional economic models and their use in impact (multiplier) analysis. These articles provide more specific information on the Washington Projection and Simulation Model, the principal model used in this study. Appendix D contains a copy of the report entitled "The Forest Products Economic Impact Study: Current Conditions and Issues," which provides much of the base information used in the impact analysis of forest practice rules. In particular, it develops the economic impact over the state of Washington resulting from the 1992 timber harvest.

The main body of the report begins with a brief description of the impact analysis procedure. This is followed by a discussion of the models used in the impact analysis. Specific technical notes on the study's methodology are given in the final section of this report.

2. GENERAL APPROACH

The simplest way to describe the impact estimating procedure is by listing the tables in the aforementioned spreadsheet:

Washington State Impact

1. Case Assumptions
2. Washington State Forest Products Impact, 1992
3. Washington State Forest Products Impact
4. Washington State Timber Trust Revenue Impact ($100 Million)
5. Washington State Timber Trust Revenue Impact
6. Washington State Total Impact

Regional Impacts

7. Case Assumptions
8. Washington Employment, Income, and Population by Region, 1992
9. Forest Products Total Employment and Labor Income by Region, 1992
10. Washington Employment, Income, and Population by Region as Percent of State, 1992
11. Regional Economic Base Model
12. Forest Products Employment and Labor Income Impact by Region
13. Initial Estimate of Forest Products Economic Impact by Region
14. Estimate of Unallocated Forest Products Economic Impact by Region
15. Total Forest Products Economic Impact by Region
16. Forest Products Economic Impact as Percent of Total Region

Summary Impact Tables

Case Assumptions

1. Washington State Economic Impact
2. Economic Impact by Region

The first six tables calculate the impact of the given forest practice rule on the Washington economy (see Appendix A). The case assumptions include the estimate of the change in timber harvest and the resulting effects of that on the final sales of seven forest products industries and on the trust revenues from the sale of timber off of state lands. These assumptions come from the analysis conducted in Parts I and II of this report.

In the parlance of regional impact analysis, the change in final sales, employment, and labor income in the forest products industry as well as the change in timber trust revenue represent the "direct impact" of the forest practice rule. Given the direct economic impact, tables 2, 3, 4, and 5 estimate the "total impact" of the rule on the state economy. In this case, the total impact is derived from the findings of a recent study of the forest products industry's impact on the Washington economy in 1992 ("The Forest Products Economic Impact Study: Current Conditions and Issues," provided as Part III, Appendix D). The sixth table summarizes the rule's impact on the state economy. The impact is measured with respect to Gross State Product, employment, personal income, population, and state and state and local tax receipt. The expected changes in these variables are shown as a percent of their respective levels in 1992.

The next ten tables calculate the economic impact by region. Table 7 shows the impact of the change in timber harvests on forest products employment in each of the four regions. These estimates, which constitute the case assumptions in the regional impact analysis, are based on the magnitude of the timber harvest loss and the number of forest products jobs in the region dependent upon the local timber supply. Tables 8, 9, and 10 show 1992 estimates on employment, income, and population in the four regions. These estimates are used to develop economic base models for the four regions, which in turn provide the means of allocating the state economic impact among the regions. The parameters of the economic base models are reported in Table 11. The regional impact analysis is carried out in Tables 12, 13, and 14, and the results are shown in Tables 15 and 16.

The results of the impact analysis are repeated at the bottom of the spreadsheet in a list of case assumptions and two summary tables. The first table shows the state economic impact, while the second shows the state impact by region.

3. ECONOMIC MODELS AND IMPACT ANALYSIS

Input-Output Models

The input-output model, as represented by the table of output (production or sales), employment, and income multipliers, is the analytical method most commonly used to measure regional economic impacts. Five survey-based input-output models for Washington State have been constructed, the most recent one being for 1987 (Chase, Bourque, and Conway, 1993).

An input-output model shows how industries and households in the economy are interrelated. When one industry expands or declines, the model estimates the production, employment, and income changes in other industries affected directly or indirectly by the demands of that industry. For example, a reduction in lumber production reduces the demand for business services. The decline in business services leads to lower levels of

employment and income in that industry, which in turn means less household income in Washington and lower demands for consumer goods, among other things.

Although the Washington input-output model attempts to capture the interactions among industries and households in the state, it still represents a somewhat simplified depiction of regional economic behavior. The model is subject to four restrictions that affect the precision of the impact estimates: (1) static depiction of impacts; (2) constant input-output coefficients; (3) a simple specification of the interactions among production, income, and personal consumption; and (4) neglect of the effects of induced private investment, state and local government spending, and migration. In estimating impacts, the fourth restriction is the most significant. Because the input-output model does not take into account investment, public expenditures, and population changes, it tends to yield systematic and sizable under-estimates of the magnitude of economic impacts. For a more complete account of the properties of the Washington input-output model in the context of an impact study, refer to Chapter 5 in The 1972 Washington Input-Output Study (Bourque and Conway, 1977).

Washington Projection and Simulation Model

The Washington Projection and Simulation Model (Bourque, Conway, and Howard, 1977, and Conway, 1990) is a regional interindustry econometric model. WPSM IV, whose structure is described here, is the third re-estimation of a model originally developed at the University of Washington seventeen years ago.

As shown in Table 1, WPSM generates economic projections on an annual basis, the forecasting horizon extending up to 25 years. The system of equations is formulated to predict the behavior of 151 endogenous variables. The model consists of 123 behavioral equations, 28 accounting identities, and 68 exogenous variables, the last of which primarily express economic conditions in the United States. WPSM identifies 26 Washington industries--two of which, lumber and wood products and pulp and paper products, are further disaggregated into seven industries for purposes of this analysis--and three public sectors. For each industry, there are projections of output, employment, and labor income. Among the other economic and demographic variables predicted by the model are Gross State Product, personal consumption expenditures, investment, state and local government spending, labor force, the unemployment rate, personal income, population by age and sex, and the Seattle consumer price index.

Table 1:

Features of Washington Projection and Simulation Model IV

Projection Horizon

1-25 years

Model Size

151	endogenous variables
68	exogenous variables
123	behavioral equations
28	identities

Industry Detail

26 industries, each having projections of
output
employment (including proprietors)
labor income (wages, salaries, and proprietors' income)

Other Selected Endogenous Variables

Gross State Product
personal consumption expenditures
housing construction
nonresidential investment
state and local government expenditures
exports (including federal government expenditures)
imports
labor force
unemployment rate
personal income
per capita income
net migration
population by age and sex
consumer price index
price of single-family house

With a more comprehensive formulation of the structure of the state economy, WPSM is designed to overcome many of the shortcomings of regional input-output models. Its specification differs from that of traditional input-output frameworks in a number of important respects:

1. Estimation with cross-sectional and time-series data using linear and nonlinear equations.
2. Dynamic characterization of economic behavior, yielding estimates of short-run and long-run multipliers.
3. Depiction of induced private investment and state and local government expenditures.

4. Complex specification of the interrelationships among production, income, and consumption.
5. Projection of input-output coefficients.
6. Inclusion of a demographic submodel.
7. Use of selected price variables.
8. Integration with a national econometric model, permitting the development of long-range forecasts.

Primarily because of the depiction of induced investment, state and local government spending, and population change, WPSM shows higher impacts than does the input-output model. This is one reason why the estimate of the number of jobs related to the forest products industry is greater in this study than in some previous investigations (see comments below on the employment multiplier).

Impact Estimation Procedure

This study draws upon the simulation capabilities of the Washington Projection and Simulation Model to measure the direct and indirect impact of the forest products industry on the Washington economy. The impact estimation procedure is in general a straightforward exercise. Employing WPSM, the behavior of the economy is first simulated with forest products output (and thus its employment and labor income) to produce a baseline projection over a period of time. The simulation is then repeated but without forest products output to yield a conditional projection of the economy. The difference between the two projections is a measure of the forest products industry's total (direct and indirect) impact on the state economy. Since WPSM is a comprehensive model, the impact can be expressed in terms of employment and income by industry, population, personal income, personal consumption expenditures, state and local government spending, and fixed investment, among other economic and demographic variables.

Because the impact analysis is conducted for seven forest product industries not specifically defined in WPSM, one important modification to the usual simulation procedure is required. Since WPSM defines the lumber and wood products industry (SIC 24) but not the logging industry (SIC 241), for example, it is necessary to take into account the differences between the two industries--in terms of their interindustry purchases, use of employment, and wage levels--in simulating the economic impact of the logging industry. Although logging is part of lumber and wood products, simulating changes in the broader industry would not estimate the desired logging impact. It is therefore necessary to alter the model in accordance with the observed differences. Through the use of so-called ADD-FACTORS, one needs to alter the lumber and wood products employment-output ratio specified in WPSM, for example, to give an employment-output ratio that is equal to that for logging. Similar adjustments to the lumber and wood products simulation are required to take into account differences in wage

rates (income-employment ratios) and in-state expenditures for goods and services (in-state expenditures-output ratios). In effect, the ADD-FACTOR adjustments are tantamount to introducing a new industry, in this case logging, into the simulation model. This procedure is repeated for the six other forest products industries to complete the impact analysis.

Employment Multiplier

Employment multipliers are standardized measurements of economic impacts for purposes of comparison. The employment multiplier is commonly defined as the ratio of the total employment impact to the direct employment impact. As an example, consider the impact of the final sales (primarily exports) of sawmills (see page 20 of "The Forest Products Economic Impact Study: Current Conditions and Issues"). In 1992, final sales of $1,420.8 million directly supported 9,880 jobs in sawmills and indirectly supported another 39,160 jobs in the rest of the Washington economy, according to a simulation with WPSM. The sawmill employment multiplier is therefore 4.96 (=[9,880+39,160]/9,880). In this case, the employment multiplier can be interpreted to mean that, on average, each sawmill job directly and indirectly supported 4.96 jobs (including the original sawmill job) in the state economy.

Alternatively, the employment multiplier can be defined as the ratio of the total employment supported by the industry to the number of jobs in the industry (see page 16 in the previously cited report). According to this definition, the forest products industry employment multiplier is 3.64 (=213,080/58,510). When comparing multipliers from different studies, it is important to take into account the various definitions of multipliers.

As noted previously, because the interindustry econometric model gives a more comprehensive depiction of regional economic behavior, the employment multipliers derived from the Washington Projection and Simulation Model tend to be substantially higher than those obtained from input-output models. For example, the sawmill employment multiplier from the 1987 Washington input-output model is 4.17.

WPSM's multipliers are similar to those derived from the Washington Economic Model (WEM), an econometric model maintained and operated by the Washington State Office of the Forecast Council. The WEM multiplier for the forest products industry is 3.56, virtually the same as WPSM's multiplier of 3.64 (for an analysis using WEM, see "The Economic Impact of Timber Harvest Reductions in Washington State").

Regional Impacts

Estimating the regional impacts of the forest products industry is basically a four-step procedure:

1. Estimate the direct employment and labor income impacts for each of the forest products industries by region.
2. Using economic base models of each region, estimate the forest products industries' indirect employment and labor income impacts.
3. Allocate any residual indirect employment and income impacts to each region in proportion to its share of total state employment.
4. Based on estimates of total employment and total labor income, estimate the population and personal income impacts by region.

Four regions are defined for this analysis: Puget Sound; Olympic Peninsula; Lower Columbia; and Eastern Washington. These regions correspond to the Department of Natural Resource's five forest sheds, with the two forest sheds east of the Cascade Mountains combined into one region. The direct employment and income impacts are based on regional employment and payroll data from the Washington State Employment Security Department. The economic base models for each region identify fifteen employment categories, including nine major industrial groups: resources; wood products; paper products; other manufacturing; construction; transportation and utilities (including communications); trade; services (including finance, insurance, and real estate); and government.

The economic base model is specified in terms of income. Thus, following standard procedures in building economic base models, a single income multiplier is estimated for each region. This multiplier, combined with the estimate of the forest products industry's direct labor income impact, leads to an estimate of the region's total income impact. Employment-income ratios--that is, the number of jobs in trade, for example, supported per dollar of income in each region--are then used to estimate the indirect employment impacts.

The third step of regional impact estimating procedure is required because the economic base models do not allocate to the four regions all of the indirect employment and income impact estimated at the state level by WPSM. The reason for this is that regions within Washington trade goods and services among themselves, a phenomenon not depicted by economic base models. The most notable of these trade flows are the sale of specialized financial and business services from the Puget Sound region and the sale of state government services from the Olympic Peninsula region (which includes Olympia) to the rest of the state.

It should be pointed out that the simple models used to estimate the regional impacts are less precise than WPSM, which is used to estimate the state impact. Nevertheless, the findings of the analysis represent a reasonable characterization of the regional distribution of the state economic impact.

4. TECHNICAL NOTES

Following are more specific technical notes describing the impact estimating procedure. The analysis of the impact of the New Proposed Rule is used to illustrate the procedure. The notes refer to the 16 tables in the spreadsheet that carry out the analysis. As noted above, the first six tables pertain to the state impact analysis. The other ten tables pertain to the regional impact analysis. Appendix A contains the 16 tables for the analysis of the New Proposed Rule that is described here:

1. **Case Assumptions.** The analysis of the state economic impact begins with two key assumptions: (1) the effect of the forest practice rule on the state's timber harvest on private and state lands; and (2) the effect of the rule on the trust revenue of timber removed from state lands managed by the Washington State Department of Natural Resources. In the case of the New Proposed Rule, it was estimated in Part I of this study that the timber harvest on private and state land would be reduced by 299.4 million board feet per year. The reduction on state land would lower the timber trust revenue by $45.0 million per year. This revenue loss takes into consideration the fact that a reduced timber supply would raise timber stumpage prices. Thus, the revenue loss is not directly proportional to the reduction in timber harvest on state land.

   A third key assumption in the analysis is the reaction of the forest products industry to a reduced supply of timber. In a simple world, in which every establishment was strictly dependent upon local timber supplies, we would expect that the output of the industry would have to drop in proportion to the reduction in timber supply. Thus, a five percent reduction in timber supply would lead to a five percent reduction in the output of the industry. In reality, how a particular segment of the industry would react to a timber shortage would depend upon several factors, including the quality of wood that it uses and its ability to procure material inputs from sources outside the state.

   It is assumed that logging and plywood mills would have to reduce their final sales in proportion to the reduction in timber supply. Using information for 1992, this means that a 299.4 million reduction in timber harvest, which is 5.97 percent of the 1992 timber harvest, would reduce final sales of logging and plywood mills by 5.97 percent.

   Note that final sales refer to the sales of products in final form. Final products are primarily products that are exported out of state (e.g., logs exported to Japan or lumber exported to California). In impact analysis, a distinction is made between final products and intermediate products. Intermediate products refer to products

that are sold to other forest products industries in the state for further processing. Intermediate products include logs sold to Washington sawmills or pulp sold to Washington paper mills. Impact analyses typically begin with an assessment of the direct impact of an event—whether it is a forest practice rule change or a loss of market share by Boeing--on the final sales of the industry under study.

The impact of the 5.97 percent reduction in timber harvest would be somewhat larger on the final sales of "other wood products." This high value added segment of the industry tends to use high quality wood. Since the rules tend to preserve older forests with higher quality wood, it is calculated that the reduction in timber harvest would lead to a 6.44 percent reduction in final sales of other wood products. The impact would have been even higher except for the fact that we excluded two components of the other wood products industry from the analysis (mobile homes and prefabricated buildings), which serve local market demands that are not likely to respond directly to supply constraints.

Similarly, the sawmill sector is somewhat less affected by the rule since sawmills tend to use a smaller proportion of higher quality wood. In the case of the New Proposed Rule, it is assumed that the final sales of sawmills would be reduced by 5.79 percent.

The impact on pulp and paper products is much smaller for two reasons: (1) one half of the wood fiber (primarily chips) used by Washington pulp and paper mills comes from out of state; and (2) the market-oriented converted paper products industries would be little affected by a shortage of local wood fiber. Thus, it is assumed that the Proposed New Rule would lead to a 2.98 percent reduction (one half of the relative harvest loss) in the final sales of pulp and paper mills and only a 0.95 reduction in the final sales of other paper products.

2. **Washington State Forest Products Impact, 1992.** Since there was little time allotted for the economic impact analysis (a little over two weeks), the analysis was expedited by using the results of a recently completed study of the forest products industry's impact on the state economy ("The Forest Products Economic Impact Study: Current Conditions and Issues," see Part III, Appendix D). In this study, the economic impact of the final sales for each of seven forest products industries was estimated. The results of this analysis are shown in Table 2. For example, in 1992, the final sales of sawmills amounted to $1,420.9 million and directly supported 9,885 jobs (wage and salary employees and self-employed workers) who earned $375.2 million in labor income (wages and salaries and proprietors' income). The total impact of sawmills final sales amounted to $2,172.4 million of Gross State Products, 49,040 jobs, and $1,957.5 million of

personal income. Note that some of the jobs indirectly supported include jobs in the forest products industries (e.g., logging jobs that are providing the logs used as intermediate inputs to lumber production). These impacts were estimated with the Washington Projection and Simulation Model. This model and its use in impact analysis were described in Section 3.

There are two implications of using the 1992 study as the basis for the forest practice rules analysis. First, it is presumed that the technology that existed in 1992 (principally, the employment supported in forest products per million board feet of timber) remains constant over the period of analysis. We have not been specific about when we expect the full impact of the adopted forest practice rule to be felt, but it will probably occur three or four years down the road. And technological change tends to alter impacts over time, although slowly. However, it is unclear that using 1992 technology leads to an underestimate or an overestimate of the direct forest products employment impact. Technological advancement generally means that fewer workers are required to process a given amount of timber. On the other hand, the impact of timber restrictions are likely to hit the oldest and most labor intensive mills hardest, which could have a reverse impact.

The second implication of using the 1992 study is that the impacts are expressed in 1992 dollars.

3. **Washington State Forest Products Impact.** Table 3 shows the economic impact of the forest practice rule on the forest products industry and the rest of the state economy. As noted, the estimated impacts are derived from Table 2. Specifically, each column of Table 3 is a strict ratio of the corresponding column in Table 2. The ratio is simply the percent that final sales are reduced in each industry because of the rule. Thus, for example, the sawmills column in Table 3 is simply 5.79 percent of the column in Table 2, since the Proposed New Rule is expected to reduce final sales in sawmills by 5.79 percent (relative to its level in 1992).

4. **Washington State Timber Trust Revenue Impact ($100 Million).** The 1992 impact study also estimated the impact of the loss of timber trust revenue on the state economy. There are two potential ways that this impact could play itself out. First, since the revenue is used to fund school construction and local government operations, there could be a reduction in school construction and government operations because of the shortfall. Second, taxes paid by Washington residents could increase to make up the revenue shortfall. Both ways would result in job losses in the state. In the second case, the job losses would come from reduced disposable income as residents pay higher taxes. The impact of both ways has been estimated and the total impact on the economy--the employment and personal income losses-

-is about the same. For purposes of this study, we assume that the impact occurs by way of the second route (i.e., higher taxes).

Table 4 shows the impact on the state economy of a hike in state and local taxes amounting to $100 million. Again, the figures are expressed in 1992 dollars.

5. **Washington State Timber Trust Revenue Impact.** Table 5 shows the impact of the $45.0 million loss in trust revenue on the state economy because of the Proposed New Rule. This impact is derived from the results in Table 4. It is simply 45 percent of the $100 million impact.

6. **Washington State Total Impact.** Table 6 combines the impacts in Tables 3 and 5 to obtain an estimate the total economic impact of the rule on the state. In the case of the Proposed New Rule, the combined loss would amount to 10,400 jobs and $448.5 million of personal income. The income loss includes the "effective loss of income" because of the $45.0 million increase in taxes.

   This impact should be interpreted as the impact on the economy relative to no rule. In other words, the impact is the additional jobs and dollars of income that the economy would have in each year if there were no forest practice rule in place, including no default to a federal rule.

7. **Regional Assumptions.** The regional impact analysis begins with a calculation of the total forest products employment loss by region due to the forest practice rule. The total number of jobs lost in the forest products industry in the state (including the jobs lost in forestry, which is not one of the original seven forest products industries) comes from the state impact analysis (Table 6). The state jobs losses are distributed among the four regions in accordance with the forest practice rule's impact on the timber harvest in the region and the number of forest products jobs in the region that is dependent upon the local timber supply. Specifically, it is assumed, for example, that if a region experiences a ten percent loss in timber harvest, its logging jobs will be reduced by ten percent. After making initial estimates of job losses in each forest products industry for all regions, the losses are summed across all regions and compared with the state total job loss in that industry, which comes from the state impact analysis (Table 6). The regional estimates of jobs losses are then scaled so that they add up to this state total.

   The results of these calculations are shown in Table 7. Since the Proposed New Rule excludes the Olympic Peninsula region from additional timber harvest restrictions, the forest products job losses are minimal.

8. **Washington Employment, Income, and Population by Region, 1992.** Table 8 shows employment, personal income, and population in each of the four regions for 1992. These numbers are used to estimate the four economic base models. The sources of these estimates are the U.S. Bureau of Economic Analysis and the Washington State Employment Security Department.

   The four economic regions differ somewhat from the regions cited in other reports on this subject. The four regions correspond to the five forest regions defined by the Washington State Department of Natural Resources, except that the two regions in eastern Washington have been combined into one. The Puget Sound region includes Island, King, Kitsap, Pierce, San Juan, Skagit, Snohomish, and Whatcom counties. The Olympic Peninsula region includes Clallam, Grays Harbor, Jefferson, Lewis, Mason, Pacific, and Thurston counties. The Lower Columbia region includes Clark, Cowlitz, Klickitat, Skamania, and Wahkiakum counties. The remaining counties are in the Eastern Washington region.

9. **Forest Products Total Employment and Labor Income by Region, 1992.** Table 9 gives estimates of forest products employment and labor income by region in 1992. These estimates are also based on information from the U.S. Bureau of Economic Analysis and the Washington State Employment Security Department.

10. **Washington Employment, Income, and Population by Region as Percent of State, 1992.** This table is used in the second part of the regional impact analysis, namely estimating the unallocated portion of the state impact.

11. **Regional Economic Base Model.** The regional economic base model has been described in Section 3. Table 11 shows the various multipliers and factors that are used to estimate the total economic impact on a region of a given loss in forest products labor income.

    Compared to WPSM, the economic base models are simple tools of analysis. As a result, they tend to have larger measurement errors associated with them. Nevertheless, they are a reasonable way of allocating the state impact among the four regions.

12. **Forest Products Employment and Labor Income Impact by Region.** Table 12 shows the estimated forest products employment and labor income losses by region associated with the forest practice rule. The employment losses come from Table 7, while the labor income losses are derived from Table 9.

13. **Initial Estimate of Forest Products Economic Impact by Region.** The economic base models are used to make initial estimates of the

rule's impacts on the four regions. The forest products labor income loss in a region (Table 12) is multiplied by the income multiplier for that region (Table 11) to obtain an estimate of the total personal income loss in the region because of the rule. The total personal income loss and the employment factors in the region's economic base model are used to calculate the employment losses in each of the major non-basic sectors (e.g., trade). In economic base models, it is assumed that all employment in a non-basic sector is supported by local income. In a similar manner, the economic base model estimates the regional population impact. These results are reported in Table 13.

14. **Estimate of Unallocated Forest Products Economic Impact by Region.** As noted in the discussion of the economic base model in Section 3, not all of the state impact is allocated to the regions with the initial impact estimates from the economic base models. The unallocated employment of an industry is distributed to the regions in accordance with each region's share of total state employment in that industry (Table 10). In those few cases where the economic base models over-allocate employment for an industry (e.g., construction), the initial estimates of employment by region are scaled down so that they sum to the total state employment impact for that industry.

15. **Total Forest Products Economic Impact by Region.** The total regional impact, which is shown in Table 15, is found by adding Tables 13 and 14. Note that at this point the regional impacts sum up to the state impact.

16. **Forest Products Economic Impact as Percent of Total Region.** The regional impacts (Table 15) are expressed as a percent of each region's total employment, personal income, and population in Table 16.

5. ALTERNATIVE ASSUMPTIONS

The economic impacts of the Forest Practice Rule estimated in this report are based on specific market assumptions regarding how the industry would cope with reduced supply. Part II developed a range of alternative market assumptions indicating potential range of uncertainty for the estimated impacts.

Alternative Case A - Paper Sector resource imports: If the paper sectors could import fiber resources with no economic cost, the result would be almost as favorable as eliminating the paper loss contribution to the total impact as characterized in the Total Paper sector in Appendix A, Table 6. For the New Rule example, the paper sector impact is 20% of the impact on gross state output, 18% of the impact on employment, 17% of the impact on personal income, and 19% of the impact on state and local tax receipts. This option to

import resources will not be without cost, hence this alternative is at best only a temporary option while also being unduly optimistic. It will be more practical when world markets are weak, as they have been for the last several years, than when world markets are strong, which eliminates surplus resources that can be imported at low incremental cost. In the long term we should not expect any higher share of import chips than has developed over the historical period. That would result in a greater impact than the Base Case, since it has been assumed that the Washington state chip sources decline without a loss in chip imports, largely from Oregon. Washington mills will lose some of their competitiveness with a lower local source of chips and may therefore lose some of their purchased imports with the closure of each Washington mill resulting in a larger impact in the long term than the base case.

Alternative Case B - Other Wood Sector resource imports: If the secondary manufacturing sector could import quality sawnwood resources to replace those lost by harvest reductions with no economic cost, the result would be almost as favorable as eliminating the other wood loss contribution to the total impact as characterized in the other Wood sector in Appendix A, Table 3. For the New Rule example, the other wood sector impact is 20% of the impact on gross state output, 22% of the impact on employment, 19% of the impact on personal income, and 21% of the impact on state and local tax receipts. This option to import resources will not be without cost, hence this alternative, like the paper alternative, is at best only a temporary option. Like the paper sector, it will be more practical when world markets are weak, as they have been for the last several years, than when world markets are strong, which eliminates surplus resources that can be imported at low incremental cost.

Alternative C - Increased thinnings: The increased shortage of wood has made thinning stands over 25 years old more economic. While the timber resources exist to greatly increase thinnings and reduce the impact of the chip and small log shortage, there are several factors working against this impact being significant. The impact of the rules provides another incremental shortage on top of the wood shortage already created by the decline in federal timber sales. If a large increase in thinnings is underway as a consequence of the large decline in federal timber sales, there would at most be only a small additional impact resulting from the further harvest reductions under the rules.

An even greater concern for the future will be whether the rules will eliminate any motivation to thin stands for the long term. It appears more likely that the rules will decrease thinnings than increase thinnings. While the alternative of increased thinnings to reduce the economic impact exists and could be as large as that suggested by Alternative A, the impact of the rules will if anything reduce the availability of chips from thinnings.

Alternative C does not appear to be likely as a consequence of the currently proposed rules but still reflects an option that could be triggered by policy changes and could be comparable in size to alternative A.

Alternative D - The long-term scenarios of increased forest management and the impact of new rules: As described in the Part I discussion of long term impacts, increased forest management, particularly in the form of increased thinnings, is expected over time. That would raise the economic level of the forest sector in the state, or at least offset some of the recent declines. The quality and value of wood is increased much more than the volume. Therefore, many of these increases will appear in secondary manufacturing and will induce a different regional distribution of impacts than currently exists. Some of the increase in value added will be at existing primary processing facilities but some will likely be closer to the cities and export container facilities. The expected increase in state output relative to 1992 (not adjusted for further declines from federal harvests or state and private regulations) should approach 25% in conjunction with increased thinnings as was described in the analysis of the long term forest management impacts in Part I. The impact would be considerably larger in that part of the Sawmill sector adding value to lumber products and in the Other Wood sector which characterizes the highest level of secondary manufacturing plus the increase in management operations in the forest sector. Together these should add $1.5 to $2.0 billion of economic activity to the economy. To the degree that the rules discourage this increase in forest management, the long term economic loss to the economy would be as large.

While the linkage between the rules and future forest management is not as direct as the first decade impacts the long term impact appears to be larger than the short term impact. Even the 500 acre rule imposes a substantial cost to thinning operations and may effectively eliminate the use of longer rotations.

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PART III
APPENDIX A

IMPACT ESTIMATING PROCEDURE

THE FIRST SIX TABLES CALCULATE THE WASHINGTON STATE IMPACT

TABLE 1. CASE ASSUMPTIONS

CASE: PROPOSED NEW RULE

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	299.4
PERCENT OF 1992 TIMBER HARVEST	5.97
PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:	
LOGGING	5.97
SAWMILLS	5.79
PLYWOOD	5.97
OTHER WOOD	6.44
PULP MILLS	2.98
PAPER MILLS	2.98
PAPERBOARD MILLS	0.95
TIMBER TRUST REVENUE CHANGE	45.00

TABLE 2. WASHINGTON STATE FOREST PRODUCTS IMPACT, 1992

	LOGGING	SAWMILLS	PLYWOOD	OTHER WOOD	TOTAL WOOD	PULP MILLS	PAPER MILLS	PAPERBOARD MILLS	TOTAL PAPER	TOTAL FOREST PRODUCTS
DIRECT IMPACT (FINAL SALES)										
OUTPUT (MILS. $92)	1213.29	1420.86	293.41	1083.58	4011.14	279.24	2061.03	1680.06	4020.33	8031.47
EMPLOYMENT	5909	9685	1729	10098	27621	1005	5913	6309	13227	40848
LABOR INCOME (MILS. $92)	208.30	375.16	55.89	267.67	907.03	51.72	306.05	260.55	618.31	1525.35
TOTAL IMPACT										
GROSS STATE PRODUCT (MILS. $92)	1130.05	2172.40	369.61	1398.46	5070.52	315.19	1985.24	2056.54	4356.97	9427.49
OUTPUT (MILS. $92)	2462.15	4098.60	809.59	2612.32	9982.65	693.39	4582.40	4166.43	9442.22	19424.87
RESOURCES	505.72	283.66	36.90	49.40	875.68	15.67	97.36	71.80	184.83	1060.51
MANUFACTURING	1333.36	2507.62	528.90	1751.48	6121.36	448.17	3046.49	2764.92	6259.58	12380.95
NONMANUFACTURING	623.06	1307.31	243.79	811.44	2985.60	229.56	1438.55	1329.70	2997.81	5983.41
EMPLOYMENT	25964	49040	8825	34769	118598	6612	43040	44825	94476	213074
PROPRIETORS	4782	6719	1210	4067	16778	881	5941	5943	12765	29543
WAGE AND SALARY EMPLOYEES	21183	42321	7615	30701	101820	5731	37099	38881	81711	183531
RESOURCES	1941	1198	167	298	3604	77	512	411	1000	4605
MANUFACTURING	6009	14675	2740	13333	36758	1766	10348	12846	24960	61717
WOOD PRODUCTS	5210	13255	2383	12375	33223	404	2360	1463	4226	37449
PAPER PRODUCTS	14	41	9	47	111	1117	6311	10103	17531	17642
OTHER MANUFACTURING	785	1380	348	911	3424	245	1677	1280	3202	6626
NONMANUFACTURING	10220	20582	3692	13160	47655	3059	20951	20138	44148	91803
CONSTRUCTION	271	345	59	173	848	73	483	457	1013	1861
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	600	1583	311	879	3374	288	1819	1509	3616	6989
TRADE	3711	7977	1481	5245	18414	1211	8329	8069	17610	36024
FINANCE, INSURANCE, AND REAL ESTATE	799	1705	302	1084	3890	236	1535	1509	3280	7170
SERVICES	4839	8972	1539	5779	21129	1250	8784	8595	18629	39758
GOVERNMENT	3012	5866	1016	3910	13804	829	5288	5486	11603	25407
PERSONAL INCOME (MILS. $92)	1007.33	1957.47	339.47	1310.94	4615.20	277.75	1764.06	1832.78	3874.59	8489.79
LABOR INCOME	726.37	1396.70	237.59	898.79	3259.45	202.60	1275.92	1321.95	2800.47	6059.92
OTHER PERSONAL INCOME	280.95	560.77	101.88	412.15	1355.75	75.15	488.14	510.83	1074.12	2429.87
POPULATION	45820	91057	16408	65910	219194	12334	79741	83386	175460	394655
STATE AND LOCAL TAX REVENUE (MILS. $92)	123.30	239.59	41.55	160.46	564.90	34.00	215.92	224.33	474.25	1039.15

SOURCE: SIMULATION WITH WASHINGTON PROJECTION AND SIMULATION MODEL

TABLE 3. WASHINGTON STATE FOREST PRODUCTS IMPACT

	LOGGING	SAWMILLS	PLYWOOD	OTHER WOOD	TOTAL WOOD	PULP MILLS	PAPER MILLS	PAPERBOARD MILLS	TOTAL PAPER	TOTAL FOREST PRODUCTS
DIRECT IMPACT (FINAL SALES)										
OUTPUT (MILS. $92)	72.40	82.24	17.51	69.80	241.94	8.33	61.49	16.04	85.86	327.80
EMPLOYMENT	353	572	103	650	1678	30	176	60	267	1945
LABOR INCOME (MILS. $92)	12.43	21.71	3.34	17.24	54.72	1.54	9.13	2.49	13.16	67.88
TOTAL IMPACT										
GROSS STATE PRODUCT (MILS. $92)	67.43	125.74	22.05	90.08	305.30	9.40	59.23	19.63	88.27	393.56
OUTPUT (MILS. $92)	146.91	237.22	48.31	168.27	600.71	20.69	136.71	39.78	197.18	797.88
RESOURCES	30.18	16.42	2.20	3.18	51.98	0.47	2.90	0.69	4.06	56.04
MANUFACTURING	79.56	145.14	31.56	112.82	369.07	13.37	90.89	26.40	130.66	499.73
NONMANUFACTURING	37.18	75.67	14.55	52.27	179.66	6.85	42.92	12.69	62.46	242.12
EMPLOYMENT	1549	2838	527	2240	7154	197	1284	428	1909	9063
PROPRIETORS	285	389	72	262	1008	26	177	57	260	1269
WAGE AND SALARY EMPLOYEES	1264	2450	454	1978	6145	171	1107	371	1649	7794
RESOURCES	116	69	10	19	214	2	15	4	22	236
MANUFACTURING	359	849	163	859	2230	53	309	123	484	2714
WOOD PRODUCTS	311	767	142	797	2017	12	70	14	96	2114
PAPER PRODUCTS	1	2	1	3	7	33	188	96	318	325
OTHER MANUFACTURING	47	80	21	59	206	7	50	12	70	276
NONMANUFACTURING	610	1191	220	848	2869	91	625	192	909	3778
CONSTRUCTION	16	20	4	11	51	2	14	4	21	72
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	36	92	19	57	203	9	54	14	77	280
TRADE	221	462	88	338	1109	36	249	77	362	1471
FINANCE, INSURANCE, AND REAL ESTATE	48	99	18	70	234	7	46	14	67	301
SERVICES	289	519	92	372	1272	37	262	82	381	1654
GOVERNMENT	180	340	61	252	832	25	158	52	235	1067
PERSONAL INCOME (MILS. $92)	60.11 89%	113.30	20.26	84.44	278.10	8.29	52.63	17.50	78.41	356.51 90.5%
LABOR INCOME	43.34 64.3%	80.84	14.18	57.89	196.25	6.04	38.07	12.62	56.73	252.98
OTHER PERSONAL INCOME	16.76	32.46	6.08	26.55	81.85	2.24	14.56	4.88	21.68	103.53
POPULATION	2734	5270	979	4245	13229	368	2379	796	3543	16772
STATE AND LOCAL TAX REVENUE (MILS. $92)	7.36	13.87	2.48	10.34	34.04	1.01	6.44	2.14	9.60	43.64
	11%	11.0		11.5				10.9	10.9	

TABLE 4. WASHINGTON STATE TIMBER TRUST REVENUE IMPACT ($100.00 MILLION DOLLARS)

DIRECT IMPACT	
TIMBER TRUST REVENUE (MILS. $92)	100.00
TOTAL IMPACT	
GROSS STATE PRODUCT (MILS. $92)	111.45
OUTPUT (MILS. $92)	121.87
RESOURCES	2.58
MANUFACTURING	15.49
NONMANUFACTURING	103.80
EMPLOYMENT	2970
PROPRIETORS	530
WAGE AND SALARY EMPLOYEES	2440
RESOURCES	10
MANUFACTURING	110
WOOD PRODUCTS	0
PAPER PRODUCTS	0
OTHER MANUFACTURING	110
NONMANUFACTURING	1710
CONSTRUCTION	50
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	80
TRADE	630
FINANCE, INSURANCE, AND REAL ESTATE	140
SERVICES	810
GOVERNMENT	610
PERSONAL INCOME (MILS. $92)	204.39
LABOR INCOME	71.71
OTHER PERSONAL INCOME	132.68
POPULATION	5220
STATE AND LOCAL TAX REVENUE (MILS. $92)	12.78

NOTE: PERSONAL INCOME IMPACT INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE.

SOURCE: SIMULATION WITH WASHINGTON PROJECTION AND SIMULATION MODEL

SOURCE: SIMULATION WITH WASHINGTON PROJECTION AND SIMULATION MODEL

TABLE 5. WASHINGTON STATE TIMBER TRUST REVENUE IMPACT

DIRECT IMPACT	
TIMBER TRUST REVENUE (MILS. $92)	45.00
TOTAL IMPACT	
GROSS STATE PRODUCT (MILS. $92)	50.15
OUTPUT (MILS. $92)	54.84
RESOURCES	1.16
MANUFACTURING	6.97
NONMANUFACTURING	46.71
EMPLOYMENT	1337
PROPRIETORS	239
WAGE AND SALARY EMPLOYEES	1098
RESOURCES	5
MANUFACTURING	50
WOOD PRODUCTS	0
PAPER PRODUCTS	0
OTHER MANUFACTURING	50
NONMANUFACTURING	770
CONSTRUCTION	23
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	36
TRADE	284
FINANCE, INSURANCE, AND REAL ESTATE	63
SERVICES	365
GOVERNMENT	275
PERSONAL INCOME (MILS. $92)	91.98
LABOR INCOME	32.27
OTHER PERSONAL INCOME	59.71
POPULATION	2349
STATE AND LOCAL TAX REVENUE (MILS. $92)	5.75

TABLE 6. WASHINGTON STATE TOTAL IMPACT

PROPOSED NEW RULE

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)				
OUTPUT (MILS. $92)	241.94	85.86		327.80
EMPLOYMENT	1678	267		1945
LABOR INCOME (MILS. $92)	54.72	13.16		67.88
TIMBER TRUST REVENUE (MILS. $92)			45.00	45.00
TOTAL IMPACT				
GROSS STATE PRODUCT (MILS. $92)	305.30	88.27	50.15	443.72
OUTPUT (MILS. $92)	600.71	197.18	54.84	852.73
RESOURCES	51.98	4.06	1.16	57.20
MANUFACTURING	369.07	130.66	6.97	506.70
NONMANUFACTURING	179.66	62.46	46.71	288.83
EMPLOYMENT	7154	1909	1337	10400
PROPRIETORS	1008	260	239	1507
WAGE AND SALARY EMPLOYEES	6145	1649	1098	8892
RESOURCES	214	22	5	240
MANUFACTURING	2230	484	50	2764
WOOD PRODUCTS	2017	96	0	2114
PAPER PRODUCTS	7	318	0	325
OTHER MANUFACTURING	206	70	50	325
NONMANUFACTURING	2869	909	770	4547
CONSTRUCTION	51	21	23	94
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	203	77	36	316
TRADE	1109	362	284	1755
FINANCE, INSURANCE, AND REAL ESTATE	234	67	63	364
SERVICES	1272	381	365	2018
GOVERNMENT	832	235	275	1341
PERSONAL INCOME (MILS. $92)	278.10	78.41	91.96	448.49
LABOR INCOME	196.25	56.73	32.27	285.25
OTHER PERSONAL INCOME	81.85	21.68	59.71	163.24
POPULATION	13229	3543	2349	19121
STATE AND LOCAL TAX REVENUE (MILS. $92)	34.04	9.60	5.75	49.39

NOTE: PERSONAL INCOME IMPACT INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE.

THE NEXT TEN TABLES CALCULATE THE REGIONAL IMPACTS

TABLE 7. CASE ASSUMPTIONS

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	1262	62	998	578	2900
FORESTRY	107	17	115	30	269
WOOD PRODUCTS	1075	42	666	523	2306
PAPER PRODUCTS	80	3	217	25	325

TABLE 8. WASHINGTON EMPLOYMENT, INCOME, AND POPULATION BY REGION, 1992

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	1893400	207942	159002	628822	2889166
WAGE AND SALARY WOOD PRODUCTS	16172	9173	5370	6739	37454
WAGE AND SALARY PAPER PRODUCTS	6182	2463	7058	1936	17639
WAGE AND SALARY STATE AND LOCAL GOVERNMENT	196393	48304	19543	80587	344827
PERSONAL INCOME (THOUS. $92)	73378394	7962452	6784054	20176228	108301128
POPULATION	3196902	445951	372579	1118248	5135680

TABLE 9. FOREST PRODUCTS TOTAL EMPLOYMENT AND LABOR INCOME BY REGION, 1992

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	25219	15690	13741	9630	64280
FORESTRY	1392	3219	818	341	5770
WOOD PRODUCTS	17638	10005	5857	7350	40850
PAPER PRODUCTS	6189	2466	7066	1939	17660
LABOR INCOME (MILS. $92)	949.8	512.9	557.8	313.9	2334.4
FORESTRY	55.7	60.1	14.2	10.9	140.9
WOOD PRODUCTS	630.9	338.8	183.8	217.7	1371.2
PAPER PRODUCTS	263.2	114.0	359.8	85.3	822.3

TABLE 10. WASHINGTON EMPLOYMENT, INCOME, AND POPULATION BY REGION AS PERCENT OF STATE, 1992

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	65.5	7.2	5.5	21.8	100.0
PROPRIETORS	59.2	9.5	5.9	25.4	100.0
WAGE AND SALARY EMPLOYEES	66.7	6.8	5.6	20.9	100.0
RESOURCES	28.5	8.6	4.2	58.7	100.0
MANUFACTURING	68.0	6.3	8.5	17.2	100.0
WOOD PRODUCTS	43.2	24.5	14.3	18.0	100.0
PAPER PRODUCTS	35.0	14.0	40.0	11.0	100.0
OTHER MANUFACTURING	74.2	2.5	5.4	17.9	100.0
NONMANUFACTURING	68.9	5.8	5.1	20.2	100.0
CONSTRUCTION	69.9	6.1	6.5	17.5	100.0
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	71.9	5.7	5.2	17.2	100.0
TRADE	67.3	6.1	5.1	21.5	100.0
FINANCE, INSURANCE, AND REAL ESTATE	73.0	4.8	4.8	17.4	100.0
SERVICES	68.6	5.8	4.9	20.7	100.0
GOVERNMENT	64.5	10.2	4.9	20.4	100.0
STATE AND LOCAL	57.0	14.0	5.7	23.4	100.0
FEDERAL	78.3	3.4	3.4	14.9	100.0
PERSONAL INCOME	67.8	7.4	6.3	18.6	100.0
LABOR INCOME	69.7	6.1	5.3	18.9	100.0
TRANSFER PAYMENTS	60.1	10.3	6.7	22.9	100.0
OTHER INCOME	59.6	10.8	10.2	19.4	100.0
PER CAPITA INCOME	108.8	84.7	86.3	85.6	100.0
POPULATION	62.3	8.7	7.3	21.8	100.0

TABLE 11. REGIONAL ECONOMIC BASE MODEL

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON
INCOME MULTIPLIER	2.7207	2.2048	2.4804	2.4535
NON-BASIC EMPLOYMENT PER MILLION DOLLARS OF PERSONAL INCOME				
CONSTRUCTION	1.1427	0.8879	1.1328	0.9616
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	1.2110	0.8573	0.9313	0.9705
TRADE	5.4197	4.3367	4.3878	5.8448
FINANCE, INSURANCE, AND REAL ESTATE	1.3950	0.8152	0.9897	1.1016
SERVICES	5.5679	4.1565	4.2349	5.6816
STATE AND LOCAL GOVERNMENT	2.7507	2.9371	2.9489	3.9921
PROPRIETORS-WAGE AND SALARY EMPLOYEES RATIO	0.17043	0.26690	0.20431	0.23296
LABOR INCOME-PERSONAL INCOME RATIO	0.74823	0.59513	0.61795	0.67563
POPULATION-EMPLOYMENT RATIO	1.69869	2.20944	2.32534	1.94478

TABLE 12. FOREST PRODUCTS EMPLOYMENT AND LABOR INCOME IMPACT

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	1262	62	998	578	2900
FORESTRY	107	17	115	30	269
WOOD PRODUCTS	1075	42	666	523	2306
PAPER PRODUCTS	80	3	217	25	325
LABOR INCOME (MILS. $92)	46.1	1.9	33.9	17.5	99.5
FORESTRY	4.3	0.3	2.0	1.0	7.6
WOOD PRODUCTS	38.5	1.4	20.9	15.5	76.3
PAPER PRODUCTS	3.4	0.1	11.0	1.1	15.7
EFFECTIVE INCOME LOSS (MILS. $92)	30.5	3.3	2.8	8.4	45.0

TABLE 13. INITIAL ESTIMATE OF FOREST PRODUCTS ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON	TOTAL STATE IMPACT	UNALLOCATED
EMPLOYMENT	4566	206	2668	1836	9275	10400	1124
PROPRIETORS	665	43	453	347	1508	1507	-1
WAGE AND SALARY EMPLOYEES	3901	163	2215	1489	7767	8892	1125
RESOURCES	107	17	115	30	269	240	-29
MANUFACTURING	1066	42	827	505	2439	2764	325
WOOD PRODUCTS	986	39	611	480	2114	2114	-1
PAPER PRODUCTS	80	3	217	25	325	325	0
OTHER MANUFACTURING	0	0	0	0	0	325	325
NONMANUFACTURING	2299	82	1016	749	4146	4547	401
CONSTRUCTION	178	7	99	49	333	94	-239
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	189	6	81	50	326	316	-10
TRADE	846	32	382	301	1560	1755	194
FINANCE, INSURANCE, AND REAL ESTATE	218	6	86	57	366	364	-2
SERVICES	869	31	369	292	1560	2018	458
GOVERNMENT	429	22	257	205	913	1341	428
STATE AND LOCAL	429	22	257	205	913	1341	428
FEDERAL	0	0	0	0	0	0	0
PERSONAL INCOME (MILS. $92)	156.0	7.4	87.0	51.4	301.9	448.5	146.6
LABOR INCOME	93.9	2.5	52.0	29.1	177.5	285.3	107.7
OTHER INCOME	62.1	5.0	35.0	22.4	124.4	163.2	38.8
POPULATION	7755	456	6203	3570	17984	19121	1137

TABLE 14. ESTIMATE OF UNALLOCATED FOREST PRODUCTS ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	746	152	-13	239	1124
PROPRIETORS	-0	-0	-0	-0	-1
WAGE AND SALARY EMPLOYEES	746	152	-13	239	1125
RESOURCES	-11	-2	-12	-3	-29
MANUFACTURING	241	8	18	58	325
WOOD PRODUCTS	-0	-0	-0	-0	-1
PAPER PRODUCTS	0	0	0	0	0
OTHER MANUFACTURING	241	8	18	58	325
NONMANUFACTURING	308	33	-39	99	401
CONSTRUCTION	-128	-5	-71	-35	-239
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	-7	-1	-1	-2	-10
TRADE	131	12	10	42	194
FINANCE, INSURANCE, AND REAL ESTATE	-1	-0	-0	-0	-2
SERVICES	314	27	22	95	458
GOVERNMENT	209	113	21	86	428
STATE AND LOCAL	209	113	21	86	428
FEDERAL	0	0	0	0	0
PERSONAL INCOME (MILS. $92)	74.9	5.1	37.4	29.2	146.6
LABOR INCOME	55.0	3.7	27.5	21.5	107.7
OTHER INCOME	19.8	1.3	9.9	7.7	38.8
POPULATION	707	187	-17	260	1137

TABLE 15. TOTAL FOREST PRODUCTS ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	5312	358	2655	2075	10400
PROPRIETORS	865	43	452	347	1507
WAGE AND SALARY EMPLOYEES	4647	315	2202	1728	8892
RESOURCES	96	15	103	27	240
MANUFACTURING	1307	50	845	563	2764
WOOD PRODUCTS	985	38	610	479	2114
PAPER PRODUCTS	80	3	217	25	325
OTHER MANUFACTURING	241	8	18	58	325
NONMANUFACTURING	2607	115	977	848	4547
CONSTRUCTION	50	2	28	14	94
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	181	6	81	48	316
TRADE	976	44	392	342	1755
FINANCE, INSURANCE, AND REAL ESTATE	216	6	86	56	364
SERVICES	1183	58	391	387	2018
GOVERNMENT	638	135	277	291	1341
STATE AND LOCAL	638	135	277	291	1341
FEDERAL	0	0	0	0	0
PERSONAL INCOME (MILS. $92)	230.9	12.5	124.4	80.7	448.5
LABOR INCOME	149.0	6.2	79.5	50.6	285.3
OTHER PERSONAL INCOME	81.9	6.3	44.9	30.1	163.2
POPULATION	8462	643	6186	3830	19121

TABLE 16. FOREST PRODUCTS ECONOMIC IMPACT AS PERCENT OF TOTAL REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON
EMPLOYMENT	0.3	0.2	1.7	0.3	0.4
PERSONAL INCOME	0.3	0.2	1.8	0.4	0.4
POPULATION	0.3	0.1	1.7	0.3	0.4

← Puget Sound others
metro. rural.
1/2 1/2.

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	299.4
PERCENT OF 1992 TIMBER HARVEST	6.0

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	6.0
SAWMILLS	5.8
PLYWOOD	6.0
OTHER WOOD	6.4
PULP MILLS	3.0
PAPER MILLS	3.0
OTHER PAPER	1.0

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	45.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	107	17	115	30	269
WOOD PRODUCTS EMPLOYMENT*	1075	42	666	523	2306
PAPER PRODUCTS EMPLOYMENT*	80	3	217	25	325
PERSONAL INCOME (MILS. $92)**	30.5	3.3	2.8	8.4	45.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	241.9	85.9	—	327.8	—
EMPLOYMENT	1678	267	—	1945	—
LABOR INCOME (MILS. $92)	54.7	13.2	—	67.9	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	45.0	45.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	305.3	88.3	50.2	443.7	0.4
OUTPUT (MILS. $92)	600.7	197.2	54.8	852.7	0.5
RESOURCES	52.0	4.1	1.2	57.2	0.9
MANUFACTURING	369.1	130.7	7.0	506.7	0.7
NONMANUFACTURING	179.7	62.5	46.7	288.8	0.3
EMPLOYMENT	7154	1909	1337	10400	0.4
PROPRIETORS	1008	260	239	1507	0.3
WAGE AND SALARY EMPLOYEES	6145	1649	1098	8892	0.4
RESOURCES	214	22	5	240	0.5
MANUFACTURING	2230	484	50	2764	0.8
WOOD PRODUCTS	2017	96	0	2114	5.6
PAPER PRODUCTS	7	318	0	325	1.8
OTHER MANUFACTURING	206	70	50	325	0.1
NONMANUFACTURING	2869	909	770	4547	0.3
CONSTRUCTION	51	21	23	94	0.1
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	203	77	36	316	0.3
TRADE	1109	362	284	1755	0.3
FINANCE, INSURANCE, AND REAL ESTATE	234	67	63	364	0.3
SERVICES	1272	381	365	2018	0.3
GOVERNMENT	832	235	275	1341	0.3
PERSONAL INCOME (MILS. $92)*	278.1	78.4	92.0	448.5	0.4
LABOR INCOME	196.3	56.7	32.3	285.3	0.4
OTHER PERSONAL INCOME*	81.8	21.7	59.7	163.2	0.5
POPULATION	13229	3543	2349	19121	0.4
STATE AND LOCAL TAX REVENUE (MILS. $92)	34.0	9.6	5.7	49.4	0.4

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	5312	358	2655	2075	10400
PROPRIETORS	665	43	452	347	1507
WAGE AND SALARY EMPLOYEES	4647	315	2202	1728	8892
RESOURCES	96	15	103	27	240
MANUFACTURING	1307	50	845	563	2764
WOOD PRODUCTS	985	38	610	479	2114
PAPER PRODUCTS	80	3	217	25	325
OTHER MANUFACTURING	241	8	18	58	325
NONMANUFACTURING	2607	115	977	848	4547
CONSTRUCTION	50	2	28	14	94
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	181	6	81	48	316
TRADE	976	44	392	342	1755
FINANCE, INSURANCE, AND REAL ESTATE	216	6	86	56	364
SERVICES	1183	58	391	387	2018
GOVERNMENT	638	135	277	291	1341
PERSONAL INCOME (MILS. $92)*	230.9	12.5	124.4	80.7	448.5
LABOR INCOME	149.0	6.2	79.5	50.6	285.3
OTHER PERSONAL INCOME*	81.9	6.3	44.9	30.1	163.2
POPULATION	8462	643	6186	3830	19121
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.3	0.2	1.7	0.3	0.4
PERSONAL INCOME*	0.3	0.2	1.8	0.4	0.4
POPULATION	0.3	0.1	1.7	0.3	0.4

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

PART III
APPENDIX B

DETAILED ECONOMIC IMPACTS

SUMMARY OF ECONOMIC IMPACTS (LOSSES RELATIVE TO NO RULE)

	70-ACRE RULE	500-ACRE RULE	WFPA RULE	DNR RULE	4D RULE	PROPOSED NEW RULE
WASHINGTON TIMBER HARVEST CHANGE (MILS. BD. FT.)	37.7	243.0	191.6	690.4	467.6	299.4
PERCENT OF 1992 TIMBER HARVEST	0.8	4.8	3.8	13.8	9.3	6.0
TIMBER TRUST REVENUE CHANGE (MILS. $92)	6.0	41.0	10.0	149.0	99.0	45.0
WASHINGTON FOREST PRODUCTS EMPLOYMENT CHANGE	365	2360	1858	6707	4541	2900
FORESTRY	34	224	174	639	432	269
WOOD PRODUCTS	290	1872	1476	5318	3601	2306
PAPER PRODUCTS	41	264	208	750	508	325
TOTAL IMPACT ON WASHINGTON STATE ECONOMY						
GROSS STATE PRODUCT (MILS. $92)	56.2	365.1	263.0	1073.6	725.0	443.7
EMPLOYMENT	1319	8573	6097	25324	17095	10400
PERSONAL INCOME (MILS. $92)	57.2	373.2	248.6	1126.6	759.1	448.5
STATE AND LOCAL TAX REVENUE (MILS. $92)	6.3	40.7	29.2	119.7	80.8	49.4
PERCENT OF 1992 TOTAL						
GROSS STATE PRODUCT	0.0	0.3	0.2	0.9	0.6	0.4
EMPLOYMENT	0.0	0.3	0.2	0.9	0.6	0.4
PERSONAL INCOME	0.1	0.3	0.2	1.0	0.7	0.4
STATE AND LOCAL TAX REVENUE	0.0	0.3	0.2	0.9	0.6	0.4
TIMBER HARVEST CHANGE BY REGION (MILS. BD. FT.)						
PUGET SOUND	12.7	76.2	125.4	113.6	73.2	89.0
OLYMPIC PENINSULA	13.3	88.3	13.3	345.7	319.3	11.2
LOWER COLUMBIA	7.3	47.2	18.4	127.1	16.8	113.2
EASTERN WASHINGTON	4.4	31.3	34.5	104.0	58.3	86.1
PERCENT OF 1992 TIMBER HARVEST						
PUGET SOUND	1.1	6.7	11.1	10.0	6.5	7.9
OLYMPIC PENINSULA	0.6	4.1	0.6	16.2	14.9	0.5
LOWER COLUMBIA	0.9	6.0	2.3	16.0	2.1	14.3
EASTERN WASHINGTON	0.5	3.3	3.6	10.9	6.1	9.1
TOTAL EMPLOYMENT IMPACT BY REGION						
PUGET SOUND	774	4846	4820	11066	7746	5312
OLYMPIC PENINSULA	200	1368	220	6026	5886	358
LOWER COLUMBIA	198	1312	412	4201	877	2655
EASTERN WASHINGTON	148	1048	645	4031	2587	2075
PERCENT OF 1992 TOTAL EMPLOYMENT						
PUGET SOUND	0.0	0.3	0.3	0.6	0.4	0.3
OLYMPIC PENINSULA	0.1	0.7	0.1	2.9	2.8	0.2
LOWER COLUMBIA	0.1	0.8	0.3	2.6	0.6	1.7
EASTERN WASHINGTON	0.0	0.2	0.1	0.6	0.4	0.3

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 70-ACRE RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	37.7
PERCENT OF 1992 TIMBER HARVEST	0.8

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	0.8
SAWMILLS	0.7
PLYWOOD	0.8
OTHER WOOD	0.8
PULP MILLS	0.4
PAPER MILLS	0.4
OTHER PAPER	0.1

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	6.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	12	15	6	1	34
WOOD PRODUCTS EMPLOYMENT*	164	53	45	28	290
PAPER PRODUCTS EMPLOYMENT*	15	5	19	2	41
PERSONAL INCOME (MILS. $92)**	4.1	0.4	0.4	1.1	6.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 70-ACRE RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	30.5	10.8	—	41.3	—
EMPLOYMENT	211	34	—	245	—
LABOR INCOME (MILS. $92)	6.9	1.7	—	8.5	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	6.0	6.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	38.4	11.1	6.7	56.2	0.0
OUTPUT (MILS. $92)	75.6	24.8	7.3	107.8	0.1
RESOURCES	6.5	0.5	0.2	7.2	0.1
MANUFACTURING	46.5	16.5	0.9	63.9	0.1
NONMANUFACTURING	22.6	7.9	6.2	36.7	0.0
EMPLOYMENT	901	240	178	1319	0.0
PROPRIETORS	127	33	32	192	0.0
WAGE AND SALARY EMPLOYEES	774	208	146	1128	0.0
RESOURCES	27	3	1	30	0.1
MANUFACTURING	281	61	7	348	0.1
WOOD PRODUCTS	254	12	0	266	0.7
PAPER PRODUCTS	1	40	0	41	0.2
OTHER MANUFACTURING	26	9	7	41	0.0
NONMANUFACTURING	361	114	103	578	0.0
CONSTRUCTION	6	3	3	12	0.0
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	26	10	5	40	0.0
TRADE	140	46	38	223	0.0
FINANCE, INSURANCE, AND REAL ESTATE	29	8	8	46	0.0
SERVICES	160	48	49	257	0.0
GOVERNMENT	105	30	37	171	0.0
PERSONAL INCOME (MILS. $92)*	35.0	9.9	12.3	57.2	0.1
LABOR INCOME	24.7	7.1	4.3	36.2	0.0
OTHER PERSONAL INCOME*	10.3	2.7	8.0	21.0	0.1
POPULATION	1666	446	313	2425	0.0
STATE AND LOCAL TAX REVENUE (MILS. $92)	4.3	1.2	0.8	6.3	0.0

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 70-ACRE RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	774	200	198	148	1319
PROPRIETORS	98	39	33	21	192
WAGE AND SALARY EMPLOYEES	675	161	165	126	1128
RESOURCES	11	13	5	1	30
MANUFACTURING	196	55	62	35	348
WOOD PRODUCTS	151	49	41	26	266
PAPER PRODUCTS	15	5	19	2	41
OTHER MANUFACTURING	31	1	2	7	41
NONMANUFACTURING	376	62	75	65	578
CONSTRUCTION	8	1	2	1	12
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	26	5	6	3	40
TRADE	142	25	30	26	223
FINANCE, INSURANCE, AND REAL ESTATE	32	4	6	4	46
SERVICES	168	26	31	32	257
GOVERNMENT	92	31	22	26	171
PERSONAL INCOME (MILS. $92)*	34.0	8.3	9.3	5.5	57.2
LABOR INCOME	22.2	5.1	5.8	3.1	36.2
OTHER PERSONAL INCOME*	11.8	3.3	3.5	2.4	21.0
POPULATION	1267	432	458	268	2425
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.0	0.1	0.1	0.0	0.0
PERSONAL INCOME*	0.0	0.1	0.1	0.0	0.1
POPULATION	0.0	0.1	0.1	0.0	0.0

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 500-ACRE RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	243.0
PERCENT OF 1992 TIMBER HARVEST	4.8

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	4.8
SAWMILLS	4.7
PLYWOOD	4.8
OTHER WOOD	5.2
PULP MILLS	2.4
PAPER MILLS	2.4
OTHER PAPER	0.8

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	41.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	73	104	38	9	224
WOOD PRODUCTS EMPLOYMENT*	1001	362	302	207	1872
PAPER PRODUCTS EMPLOYMENT*	92	36	124	12	264
PERSONAL INCOME (MILS. $92)**	27.8	3.0	2.6	7.6	41.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 500-ACRE RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	196.4	69.7	—	266.0	—
EMPLOYMENT	1362	216	—	1579	—
LABOR INCOME (MILS. $92)	44.4	10.7	—	55.1	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	41.0	41.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	247.8	71.6	45.7	365.1	0.3
OUTPUT (MILS. $92)	487.5	160.0	50.0	697.5	0.4
RESOURCES	42.2	3.3	1.1	46.5	0.7
MANUFACTURING	299.5	106.0	6.4	411.9	0.6
NONMANUFACTURING	145.8	50.7	42.6	239.1	0.2
EMPLOYMENT	5806	1550	1218	8573	0.3
PROPRIETORS	818	211	217	1247	0.3
WAGE AND SALARY EMPLOYEES	4988	1338	1000	7326	0.3
RESOURCES	174	17	4	196	0.4
MANUFACTURING	1810	393	45	2248	0.6
WOOD PRODUCTS	1637	78	0	1716	4.6
PAPER PRODUCTS	5	258	0	264	1.5
OTHER MANUFACTURING	167	56	45	269	0.1
NONMANUFACTURING	2329	737	701	3767	0.2
CONSTRUCTION	41	17	21	79	0.1
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	164	63	33	260	0.2
TRADE	900	294	258	1452	0.3
FINANCE, INSURANCE, AND REAL ESTATE	190	55	57	302	0.2
SERVICES	1032	310	332	1674	0.3
GOVERNMENT	675	191	250	1116	0.2
PERSONAL INCOME (MILS. $92)*	225.7	63.6	83.8	373.2	0.3
LABOR INCOME	159.3	46.0	29.4	234.7	0.3
OTHER PERSONAL INCOME*	66.4	17.6	54.4	138.4	0.4
POPULATION	10737	2876	2140	15753	0.3
STATE AND LOCAL TAX REVENUE (MILS. $92)	27.6	7.8	5.2	40.7	0.3

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 500-ACRE RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	4846	1368	1312	1048	8573
PROPRIETORS	609	266	218	155	1247
WAGE AND SALARY EMPLOYEES	4238	1102	1094	893	7326
RESOURCES	64	91	33	8	196
MANUFACTURING	1209	374	415	250	2248
WOOD PRODUCTS	917	332	277	190	1716
PAPER PRODUCTS	92	36	124	12	264
OTHER MANUFACTURING	200	7	15	48	269
NONMANUFACTURING	2380	429	499	459	3767
CONSTRUCTION	48	10	14	7	79
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	166	32	40	22	260
TRADE	896	175	199	182	1452
FINANCE, INSURANCE, AND REAL ESTATE	201	31	43	27	302
SERVICES	1069	181	203	221	1674
GOVERNMENT	585	208	147	176	1116
PERSONAL INCOME (MILS. $92)*	213.5	57.7	62.2	39.8	373.2
LABOR INCOME	137.9	35.2	39.0	22.6	234.7
OTHER PERSONAL INCOME*	75.6	22.4	23.2	17.2	138.4
POPULATION	7873	2951	3035	1893	15753
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.3	0.7	0.8	0.2	0.3
PERSONAL INCOME*	0.3	0.7	0.9	0.2	0.3
POPULATION	0.2	0.7	0.8	0.2	0.3

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: WFPA RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	191.6
PERCENT OF 1992 TIMBER HARVEST	3.8

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	3.8
SAWMILLS	3.7
PLYWOOD	3.8
OTHER WOOD	4.1
PULP MILLS	1.9
PAPER MILLS	1.9
OTHER PAPER	0.6

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	10.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	131	17	16	10	174
WOOD PRODUCTS EMPLOYMENT*	1188	39	85	164	1476
PAPER PRODUCTS EMPLOYMENT*	145	5	45	13	208
PERSONAL INCOME (MILS. $92)**	6.8	0.7	0.6	1.9	10.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: WFPA RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	154.8	54.9	—	209.8	—
EMPLOYMENT	1074	171	—	1245	—
LABOR INCOME (MILS. $92)	35.0	8.4	—	43.4	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	10.0	10.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	195.4	56.5	11.1	263.0	0.2
OUTPUT (MILS. $92)	384.4	126.2	12.2	522.8	0.3
RESOURCES	33.3	2.6	0.3	36.1	0.5
MANUFACTURING	236.2	83.6	1.5	321.4	0.5
NONMANUFACTURING	115.0	40.0	10.4	165.3	0.1
EMPLOYMENT	4578	1222	297	6097	0.2
PROPRIETORS	645	167	53	865	0.2
WAGE AND SALARY EMPLOYEES	3933	1055	244	5232	0.2
RESOURCES	137	14	1	152	0.3
MANUFACTURING	1427	310	11	1748	0.5
WOOD PRODUCTS	1291	62	0	1353	3.6
PAPER PRODUCTS	4	204	0	208	1.2
OTHER MANUFACTURING	132	45	11	187	0.1
NONMANUFACTURING	1836	581	171	2589	0.2
CONSTRUCTION	32	13	5	51	0.0
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	130	49	8	187	0.2
TRADE	710	231	63	1004	0.2
FINANCE, INSURANCE, AND REAL ESTATE	150	43	14	207	0.2
SERVICES	814	244	81	1139	0.2
GOVERNMENT	532	150	61	744	0.1
PERSONAL INCOME (MILS. $92)*	178.0	50.2	20.4	248.6	0.2
LABOR INCOME	125.6	36.3	7.2	169.1	0.2
OTHER PERSONAL INCOME*	52.4	13.9	13.3	79.5	0.3
POPULATION	8466	2267	522	11255	0.2
STATE AND LOCAL TAX REVENUE (MILS. $92)	21.8	6.1	1.3	29.2	0.2

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: WFPA RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	4820	220	412	645	6097
PROPRIETORS	662	32	66	105	865
WAGE AND SALARY EMPLOYEES	4158	187	346	540	5232
RESOURCES	114	15	14	9	152
MANUFACTURING	1373	45	133	197	1748
WOOD PRODUCTS	1089	36	78	150	1353
PAPER PRODUCTS	145	5	45	13	208
OTHER MANUFACTURING	139	5	10	34	187
NONMANUFACTURING	2154	53	149	232	2589
CONSTRUCTION	42	1	4	4	51
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	164	2	11	10	187
TRADE	831	21	60	93	1004
FINANCE, INSURANCE, AND REAL ESTATE	183	2	11	10	207
SERVICES	934	27	63	115	1139
GOVERNMENT	517	74	50	103	744
PERSONAL INCOME (MILS. $92)*	201.4	7.0	17.7	22.4	248.6
LABOR INCOME	140.8	3.9	10.7	13.7	169.1
OTHER PERSONAL INCOME*	60.6	3.2	7.0	8.7	79.5
POPULATION	8312	604	969	1370	11255
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.3	0.1	0.3	0.1	0.2
PERSONAL INCOME*	0.3	0.1	0.3	0.1	0.2
POPULATION	0.3	0.1	0.3	0.1	0.2

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: DNR RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	690.4
PERCENT OF 1992 TIMBER HARVEST	13.8

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	13.8
SAWMILLS	13.3
PLYWOOD	13.8
OTHER WOOD	14.9
PULP MILLS	6.9
PAPER MILLS	6.9
OTHER PAPER	2.2

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	149.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	107	402	101	29	639
WOOD PRODUCTS EMPLOYMENT*	1799	1707	983	829	5318
PAPER PRODUCTS EMPLOYMENT*	158	162	382	48	750
PERSONAL INCOME (MILS. $92)**	101.0	11.0	9.3	27.8	149.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: DNR RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	557.9	198.0	—	755.9	—
EMPLOYMENT	3870	615	—	4485	—
LABOR INCOME (MILS. $92)	126.2	30.3	—	156.5	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	149.0	149.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	704.0	203.5	166.1	1073.6	0.9
OUTPUT (MILS. $92)	1385.2	454.7	181.6	2021.5	1.1
RESOURCES	119.9	9.4	3.8	133.1	2.0
MANUFACTURING	851.1	301.3	23.1	1175.4	1.7
NONMANUFACTURING	414.3	144.0	154.7	713.0	0.6
EMPLOYMENT	16496	4403	4425	25324	0.9
PROPRIETORS	2325	600	790	3715	0.8
WAGE AND SALARY EMPLOYEES	14171	3802	3636	21609	0.9
RESOURCES	494	50	15	559	1.3
MANUFACTURING	5143	1116	164	6423	1.8
WOOD PRODUCTS	4652	222	0	4874	13.0
PAPER PRODUCTS	16	733	0	749	4.2
OTHER MANUFACTURING	475	160	164	800	0.3
NONMANUFACTURING	6616	2095	2548	11259	0.7
CONSTRUCTION	117	48	75	240	0.2
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	467	178	119	765	0.7
TRADE	2558	834	939	4331	0.8
FINANCE, INSURANCE, AND REAL ESTATE	540	155	209	904	0.7
SERVICES	2933	880	1207	5020	0.8
GOVERNMENT	1918	542	909	3368	0.7
PERSONAL INCOME (MILS. $92)*	641.3	180.8	304.5	1126.6	1.0
LABOR INCOME	452.5	130.8	106.8	690.2	0.9
OTHER PERSONAL INCOME*	188.7	50.0	197.7	436.4	1.4
POPULATION	30505	8170	7778	46453	0.9
STATE AND LOCAL TAX REVENUE (MILS. $92)	78.5	22.1	19.0	119.7	0.9

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: DNR RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	11066	6026	4201	4031	25324
PROPRIETORS	1226	1197	690	602	3715
WAGE AND SALARY EMPLOYEES	9840	4829	3511	3430	21609
RESOURCES	94	351	88	25	559
MANUFACTURING	2400	1746	1326	951	6423
WOOD PRODUCTS	1649	1565	901	760	4874
PAPER PRODUCTS	158	162	382	48	749
OTHER MANUFACTURING	593	20	43	143	800
NONMANUFACTURING	5884	1930	1627	1818	11259
CONSTRUCTION	112	49	50	29	240
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	389	148	130	97	765
TRADE	2172	790	646	722	4331
FINANCE, INSURANCE, AND REAL ESTATE	496	144	142	122	904
SERVICES	2715	798	659	848	5020
GOVERNMENT	1462	801	470	636	3368
PERSONAL INCOME (MILS. $92)*	487.4	270.3	207.3	161.6	1126.6
LABOR INCOME	291.4	170.7	132.2	96.0	690.2
OTHER PERSONAL INCOME*	196.1	99.6	75.2	65.6	436.4
POPULATION	16707	13006	9661	7078	46453
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.6	2.9	2.6	0.6	0.9
PERSONAL INCOME*	0.7	3.4	3.1	0.8	1.0
POPULATION	0.5	2.9	2.6	0.6	0.9

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 4D RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	467.6
PERCENT OF 1992 TIMBER HARVEST	9.3

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	9.3
SAWMILLS	9.0
PLYWOOD	9.3
OTHER WOOD	10.1
PULP MILLS	4.7
PAPER MILLS	4.7
OTHER PAPER	1.5

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	99.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	64	341	12	15	432
WOOD PRODUCTS EMPLOYMENT*	1252	1705	141	503	3601
PAPER PRODUCTS EMPLOYMENT*	157	232	78	41	508
PERSONAL INCOME (MILS. $92)**	67.1	7.3	6.2	18.4	99.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 4D RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	377.9	134.1	—	511.9	—
EMPLOYMENT	2621	416	—	3038	—
LABOR INCOME (MILS. $92)	85.5	20.6	—	106.0	—
TIMBER TRUST REVENUE (MILS. $92)	—	—	99.0	99.0	—
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	476.8	137.9	110.3	725.0	0.6
OUTPUT (MILS. $92)	938.2	307.9	120.7	1366.8	0.7
RESOURCES	81.2	6.3	2.6	90.1	1.3
MANUFACTURING	576.4	204.1	15.3	795.8	1.1
NONMANUFACTURING	280.6	97.6	102.8	480.9	0.4
EMPLOYMENT	11173	2982	2940	17095	0.6
PROPRIETORS	1575	406	525	2506	0.5
WAGE AND SALARY EMPLOYEES	9598	2575	2416	14589	0.6
RESOURCES	335	34	10	378	0.9
MANUFACTURING	3483	756	109	4348	1.2
WOOD PRODUCTS	3151	151	0	3301	8.8
PAPER PRODUCTS	11	497	0	507	2.9
OTHER MANUFACTURING	322	109	109	539	0.2
NONMANUFACTURING	4481	1419	1693	7593	0.5
CONSTRUCTION	79	33	50	162	0.1
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	316	121	79	516	0.4
TRADE	1733	565	624	2921	0.5
FINANCE, INSURANCE, AND REAL ESTATE	366	105	139	609	0.5
SERVICES	1987	596	802	3384	0.6
GOVERNMENT	1299	367	604	2270	0.5
PERSONAL INCOME (MILS. $92)*	434.3	122.5	202.3	759.1	0.7
LABOR INCOME	306.5	88.6	71.0	466.1	0.6
OTHER PERSONAL INCOME*	127.8	33.9	131.4	293.0	0.9
POPULATION	20660	5534	5168	31362	0.6
STATE AND LOCAL TAX REVENUE (MILS. $92)	53.2	15.0	12.6	80.8	0.6

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: 4D RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	7746	5886	877	2587	17095
PROPRIETORS	842	1172	123	369	2506
WAGE AND SALARY EMPLOYEES	6904	4714	754	2217	14589
RESOURCES	56	299	11	13	378
MANUFACTURING	1705	1808	236	599	4348
WOOD PRODUCTS	1148	1563	129	461	3301
PAPER PRODUCTS	157	232	78	41	507
OTHER MANUFACTURING	400	13	29	97	539
NONMANUFACTURING	4124	1899	383	1187	7593
CONSTRUCTION	81	51	10	19	162
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	277	149	27	63	516
TRADE	1523	780	148	470	2921
FINANCE, INSURANCE, AND REAL ESTATE	354	144	31	80	609
SERVICES	1889	775	166	555	3384
GOVERNMENT	1019	708	124	418	2270
PERSONAL INCOME (MILS. $92)*	343.0	270.3	42.1	103.7	759.1
LABOR INCOME	208.0	172.6	24.3	61.2	466.1
OTHER PERSONAL INCOME*	135.1	97.6	17.9	42.5	293.0
POPULATION	11958	12892	1920	4592	31362
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.4	2.8	0.6	0.4	0.6
PERSONAL INCOME*	0.5	3.4	0.6	0.5	0.7
POPULATION	0.4	2.9	0.5	0.4	0.6

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

CASE ASSUMPTIONS

1992 TIMBER HARVEST (MIL. BD. FT.)	5017.7
CHANGE IN TIMBER HARVEST (MIL. BD. FT.)	299.4
PERCENT OF 1992 TIMBER HARVEST	6.0

PERCENT CHANGE IN FOREST PRODUCTS FINAL SALES:

LOGGING	6.0
SAWMILLS	5.8
PLYWOOD	6.0
OTHER WOOD	6.4
PULP MILLS	3.0
PAPER MILLS	3.0
OTHER PAPER	1.0

CHANGE IN TIMBER TRUST REVENUE (MILS. $)	45.0

CHANGE IN EMPLOYMENT AND INCOME BY REGION DUE TO RULE:

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
FORESTRY EMPLOYMENT*	107	17	115	30	269
WOOD PRODUCTS EMPLOYMENT*	1075	42	666	523	2306
PAPER PRODUCTS EMPLOYMENT*	80	3	217	25	325
PERSONAL INCOME (MILS. $92)**	30.5	3.3	2.8	8.4	45.0

*DIRECT AND INDIRECT EMPLOYMENT CHANGE IN FOREST PRODUCT SECTORS
**EFFECTIVE CHANGE IN INCOME DUE TO TAX INCREASE TO OFFSET TIMBER TRUST REVENUE LOSS

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

TABLE 1. WASHINGTON STATE ECONOMIC IMPACT

	TOTAL WOOD	TOTAL PAPER	TRUST REVENUE	TOTAL IMPACT	PERCENT OF 1992 TOTAL
DIRECT IMPACT (FINAL SALES AND TRUST REVENUE)					
OUTPUT (MILS. $92)	241.9	85.9	---	327.8	---
EMPLOYMENT	1678	267	---	1945	---
LABOR INCOME (MILS. $92)	54.7	13.2	---	67.9	---
TIMBER TRUST REVENUE (MILS. $92)	---	---	45.0	45.0	---
TOTAL IMPACT					
GROSS STATE PRODUCT (MILS. $92)	305.3	88.3	50.2	443.7	0.4
OUTPUT (MILS. $92)	600.7	197.2	54.8	852.7	0.5
RESOURCES	52.0	4.1	1.2	57.2	0.9
MANUFACTURING	369.1	130.7	7.0	506.7	0.7
NONMANUFACTURING	179.7	62.5	46.7	288.8	0.3
EMPLOYMENT	7154	1909	1337	10400	0.4
PROPRIETORS	1008	260	239	1507	0.3
WAGE AND SALARY EMPLOYEES	6145	1649	1098	8892	0.4
RESOURCES	214	22	5	240	0.5
MANUFACTURING	2230	484	50	2764	0.8
WOOD PRODUCTS	2017	96	0	2114	5.6
PAPER PRODUCTS	7	318	0	325	1.8
OTHER MANUFACTURING	206	70	50	325	0.1
NONMANUFACTURING	2869	909	770	4547	0.3
CONSTRUCTION	51	21	23	94	0.1
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	203	77	36	316	0.3
TRADE	1109	362	284	1755	0.3
FINANCE, INSURANCE, AND REAL ESTATE	234	67	63	364	0.3
SERVICES	1272	381	365	2018	0.3
GOVERNMENT	832	235	275	1341	0.3
PERSONAL INCOME (MILS. $92)*	278.1	78.4	92.0	448.5	0.4
LABOR INCOME	196.3	56.7	32.3	285.3	0.4
OTHER PERSONAL INCOME*	81.8	21.7	59.7	163.2	0.5
POPULATION	13229	3543	2349	19121	0.4
STATE AND LOCAL TAX REVENUE (MILS. $92)	34.0	9.6	5.7	49.4	0.4

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

ECONOMIC IMPACT OF FOREST PRACTICE RULE (LOSSES RELATIVE TO NO RULE)

CASE: PROPOSED NEW RULE

TABLE 2. ECONOMIC IMPACT BY REGION

	PUGET SOUND	OLYMPIC PENINSULA	LOWER COLUMBIA	EASTERN WASHINGTON	WASHINGTON STATE
EMPLOYMENT	5312	358	2655	2075	10400
PROPRIETORS	665	43	452	347	1507
WAGE AND SALARY EMPLOYEES	4647	315	2202	1728	8892
RESOURCES	96	15	103	27	240
MANUFACTURING	1307	50	845	563	2764
WOOD PRODUCTS	985	38	610	479	2114
PAPER PRODUCTS	80	3	217	25	325
OTHER MANUFACTURING	241	8	18	58	325
NONMANUFACTURING	2607	115	977	848	4547
CONSTRUCTION	50	2	28	14	94
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	181	6	81	48	316
TRADE	976	44	392	342	1755
FINANCE, INSURANCE, AND REAL ESTATE	216	6	86	56	364
SERVICES	1183	58	391	387	2018
GOVERNMENT	638	135	277	291	1341
PERSONAL INCOME (MILS. $92)*	230.9	12.5	124.4	80.7	448.5
LABOR INCOME	149.0	6.2	79.5	50.6	285.3
OTHER PERSONAL INCOME*	81.9	6.3	44.9	30.1	163.2
POPULATION	8462	643	6186	3830	19121
PERCENT OF 1992 TOTAL					
EMPLOYMENT	0.3	0.2	1.7	0.3	0.4
PERSONAL INCOME*	0.3	0.2	1.8	0.4	0.4
POPULATION	0.3	0.1	1.7	0.3	0.4

*INCLUDES EFFECTIVE LOSS OF INCOME DUE TO STATE AND LOCAL TAX INCREASE

PART III
APPENDIX C

IMPACT ANALYSIS ARTICLES

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The Washington Projection and Simulation Model: A Regional Interindustry Econometric Model

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ABSTRACT Originally built in 1977, the Washington Projection and Simulation Model (WPSM) is a regional interindustry econometric model designed for forecasting and impact analysis. This article describes the most recent formulation of WPSM, analyzes the accuracy of the long-range forecasts prepared with the original model in 1976, and evaluates the model's simulation properties. The experience of developing and applying WPSM over the past ten years provides a basis for assessing the relative merits of this seldomly followed approach to regional economic modeling.

1. Introduction

In spite of Glickman's (1977) suggestion to integrate regional input-output tables with econometric models, "thus combining the good qualities of both devices" (p. 196), there has been relatively little research on regional econometric models built around explicit interindustry frameworks. One exception is the Washington Projection and Simulation Model (WPSM), which was originally developed at the University of Washington in 1977 (Bourque, Conway, and Howard 1977; Conway 1979). Designed for forecasting and impact analysis, this model has been used in 25 studies of the Washington economy during the past ten years (e.g., Conway 1983; Joun and Conway 1983). In 1987, in order to incorporate information from the recently completed 1982 Washington input-output study (Bourque 1987), the model was reformulated for the second time.

The purpose of this article is to describe the latest specification of WPSM and to evaluate the model's forecasting and simulation

The author expresses his appreciation to the public and private entities that have directly and indirectly provided financial support for this research over the past ten years. Current supporters include Seattle City Light, which makes use of the model in its long range electrical energy forecasting system, and the Washington Department of Trade and Economic Development, which has recently employed the model to study the impact of foreign trade on the state economy. The author would also like to give special recognition to Professor Philip J. Bourque of the University of Washington's Graduate School of Business Administration for updating the Washington input-output tables. Without his significant contributions to regional input-output analysis, the Washington Projection and Simulation Model would not have been possible.

capabilities.[1] The experience of developing and applying WPSM over the past ten years provides a basis for assessing the relative merits of interindustry econometric models for regional economic analysis.

The article has three parts. The first part describes the formulation of WPSM III, the most recent version of the model, and focuses upon the problem of estimating final demand equations, the principal obstacle in the development of regional input-output forecasting models. It also discusses the specification of the output equations, the related topic of projecting input-output coefficients, and the means by which the demographic submodel is incorporated into the economic model.

The second part analyzes the accuracy of the forecasts prepared with the original model in 1976 (Bourque, Conway, and Howard 1977). The longevity of WPSM presents a rare opportunity to measure the ex ante prediction errors of a set of long-range projections. WPSM is evaluated not only in terms of its forecasting accuracy for selected economic and demographic variables, but also in terms of its ability to depict the changing structure of the state economy over time.

The final part describes the simulation properties of WPSM, highlighting the differences between the implied multipliers of WPSM and the multipliers derived from the 1982 Washington input-output table. WPSM's multipliers are significantly higher than the input-output multipliers primarily because of WPSM's greater degree of closure (i.e., the inclusion of endogenous investment and government submodels). WPSM also permits one to distinguish between short-run and long-run multipliers.

2. Model Specification

General Structure

Features of WPSM III are reported in table 1. Similar to other regional econometric models, it recognizes two sets of economic demands placed upon the region, external (primarily export) demands and internal demands. Referring to figure 1, export production is the principal driving force behind regional economic growth. In general, Washington exports are forecast on the basis of national market demand, as represented by the production index of the corresponding United States industry, and the extent to which the state industry can satisfy this demand. Projections of United States industrial requirements, as well as other exogenous variables, are provided by TRENDLONG, a national econometric model of Data Resources, Inc.

Local export production triggers the first set of internal demands,

[1] Previous articles on WPSM have dealt only with aspects of the model. This article is the first comprehensive discussion of the model's specification and application.

TABLE 1
WASHINGTON PROJECTION AND SIMULATION MODEL III

Projection Horizon	
	1–25 years
Model Size	
	151 endogenous variables and 68 exogenous variables
	123 behavioral equations and 28 identities
Industry Detail	
	26 industries (with projections of output, employment, and earnings)
	3 public sectors
Other Selected Endogenous Variables	
	Gross state product
	Personal consumption expenditures
	Housing construction and nonresidential investment
	State and local government expenditures
	Exports (including federal government expenditures) and imports
	Labor force and unemployment rate
	Personal income and per capita income
	Net migration and population by age and sex
	Consumer price index and price of single-family house

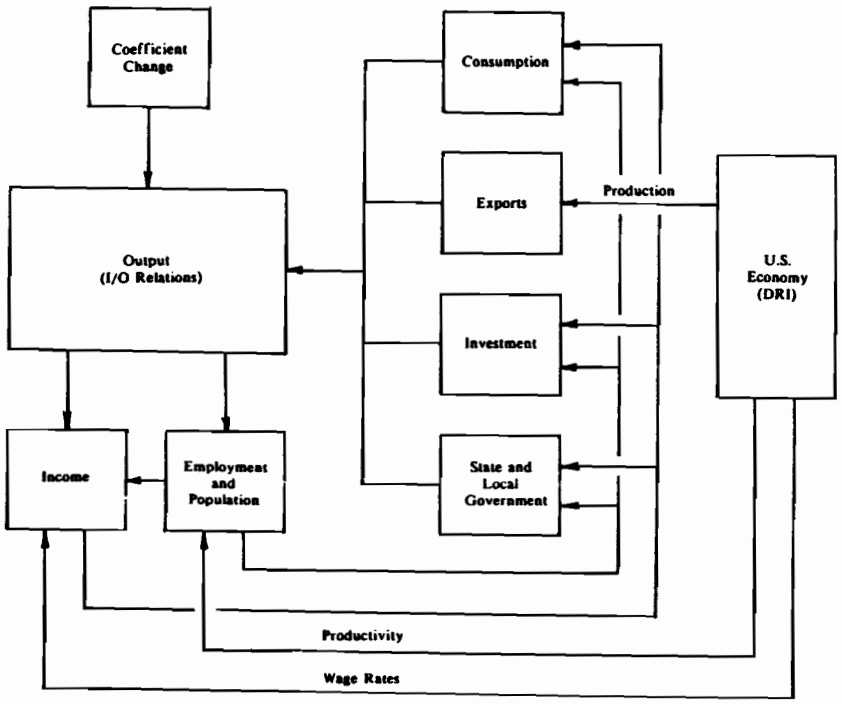
the regional interindustry demands. The induced output in local industries sets up further intermediate demands, all of which are depicted by the equations in the output submodel. These input-output relations, modified over time by projections of changes in interindustry coefficients, constitute the core of WPSM.

Forecasts of output, labor productivity, and wage rates combine to predict industrial employment and earnings. When coupled with predictions of the labor force participation and unemployment rates, total employment leads to a forecast of population. Supplemented by predictions of property income, transfer payments, and personal contributions to social insurance, total earnings lead to a forecast of personal income.

Personal income and population in turn are important variables explaining the second tier of internal demands, the final demands of the consumption, investment, and state and local government sectors. Personal consumption expenditures are a function of per capita income, population, and the relative prices of goods and services; investment is a function of population and income as well as the stock of capital, interest rates, and the cost of construction; and state and local government spending is a function of school-aged population and federal highway funding, in addition to income and population.

In some ways, as in the employment and income equations, WPSM's specification is similar to that of other regional econometric models. On the other hand, it has several distinctive features. Three features in particular warrant further discussion: final demand equations, output equations which are specified with an explicit input-output structure, and the demographic submodel.

FIGURE 1
WASHINGTON PROJECTION AND SIMULATION MODEL III



Final Demand

WPSM is one of only a handful of regional interindustry econometric models primarily because of the lack of data with which to estimate final demand equations. Developing final demand data is the critical task in constructing this type of model. Final demand includes consumption, investment, state and local government expenditures, and exports (including federal government expenditures). Since exports are predicted in the output submodel, this section discusses only the first three components of final demand.

Consumption

There are stochastic equations for four categories of consumption: motor vehicles and parts, other durable goods, nondurable goods, and services. No suitable data exist for measuring Washington consumption expenditures over time. The four consumption equations are therefore estimated using United States data from the Gross National Product accounts, assuming that household purchasing behavior in the United States and Washington is fundamentally the

TABLE 2
OTHER DURABLE GOODS CONSUMPTION IN THE U.S.

Independent Variable	Regression Coefficient	t-Statistic
Constant	-3.6010	-8.27
log(USYP/USPOP)	1.3710	8.27
log(USPCOD/USPC)	-0.6159	-3.03
log(USUNRT)	-0.0782	-2.54
Rho(1)	0.5825	3.30
R^2	0.9956	
Standard Error of Regression	0.0215	
Durbin–Watson Statistic	1.3500	
Generalized Least Squares	1962–85	

Dependent Variable = log(USCOD/USPOP)
USCOD = U.S. other durable consumption ($82 billion)
USPOP = U.S. population (million)
USYP = U.S. personal income ($82 billion)
USPCOD = U.S. other durable consumption deflator (1982 = 1.000)
USPC = U.S. consumption deflator (1982 = 1.000)
USUNRT = U.S. unemployment rate (%)

same on a per capita basis. The estimated equation for other durable goods consumption in the United States is listed in table 2. The Generalized Least Squares (GLS) corrects for first-order autocorrelation in the residuals and the regression coefficients are elasticities.

Following the theory of consumer behavior, the important explanatory variables include population, per capita income, and the relative price of other consumer durables. The unemployment rate variable reflects the business cycle. Note the high income and price elasticities.[2]

The United States consumption equations are in turn used to generate historical estimates of consumption in Washington by substituting Washington personal income and population into each equation and calculating the resulting prediction for each year between 1962 and 1985. These synthetic series are required for estimating the output equations as noted in the following section.

The use of equations based on United States data in a regional model and the generation of regional consumption estimates are, of course, questionable practices. However, the ultimate objective of WPSM is not to predict Washington consumption, which cannot be measured, but to predict output, employment, and income of consumer-related industries, such as trade and services, which can be measured. The consumption functions, as well as the other final demand equations, are only a means to produce output, employment,

[2] For the sake of brevity, the reported equations do not show dummy variables, which are occasionally used to depict the effects of discrete events, such as labor strikes.

TABLE 3
RESIDENTIAL INVESTMENT

Independent Variable	Regression Coefficient	t-Statistic
Constant	24608.0	3.16
WYP(-1)	0.5387	7.19
USRAAA(-1)-USRPRM(-1)	361.57	9.09
SSPDEM(-1)	37.627	5.52
USCC/USPC	-3029.9	-2.67
WK(-1)	-0.5378	-8.66
WM(-1)	-28877.3	-4.73
R^2	0.9281	
Standard Error of Regression	225.53	
Durbin-Watson Statistic	2.4602	
Ordinary Least Squares	1962-85	

Dependent Variable = WIR
WIR = Washington residential investment ($82 million)
WYP = Washington personal income ($82 million)
USRAAA = U.S. AAA bond interest rate (%)
USRPRM = U.S. prime interest rate (%)
SSPDEM = Seattle speculative demand index (%)
USCC = U.S. construction cost index (1972 = 1.000)
WK = Washington stock of housing built since 1961
WM = Remaining fraction of Washington housing stock that existed in 1961

and income predictions. To the extent that such final demand equations improve the forecasting capability of the model and impart reasonable simulation properties, their use is justified.

Investment

There are three investment equations: residential structures, nonresidential structures, and equipment. Data on equipment expenditures in Washington are limited to investment by manufacturing industries. The result is a relatively weak forecasting equation. However, this shortcoming has little bearing on the overall performance of the model, because imports, not Washington production, satisfy most of the demand for equipment. In contrast, information on investment in structures is excellent; statistics on contract construction and the value of building permits provide the basis for reliable estimates of residential and nonresidential investment. The price deflators used for the various components of investment are national deflators.

The equation for residential investment, which is one of the few equations in WPSM not estimated in double-log form, includes both demand and supply variables, as shown in table 3.[3]

[3] See Conway and Howard (1980) for a more complete discussion of the housing model.

TABLE 4
OTHER OPERATING EXPENDITURES, STATE AND LOCAL GOVERNMENT

Independent Variable	Regression Coefficient	t-Statistic
Constant	-3.8672	-41.48
log(WYP/WPOP)	1.2850	25.07
log{[WUNRT + WUNRT(-1)]/2}	0.2538	8.52
R^2	0.9888	
Standard Error of Regression	0.0270	
Durbin-Watson Statistic	1.6439	
Ordinary Least Squares	1962-85	

Dependent Variable = log(WGSLO/WPOP)
WGSLO = Washington other state and local government expenditures ($82 million)
WUNRT = Washington civilian unemployment rate (%)

The volatility of housing construction is attributable to fluctuations in the availability of credit (represented by an interest rate spread) and the interaction between the demand for shelter and the existing stock of homes (represented by the last two terms of the equation). The speculative demand term (the difference between the percent change in the price of Seattle single-family homes and the average Seattle mortgage rate) shows that people also buy homes during periods of rapidly escalating housing prices for investment purposes.

State and Local Government

Census financial data are sufficient to measure three components of state and local government expenditures: educational operating expenditures, other operating expenditures, and construction.

The two equations for operating expenditures are similar to the consumption functions. The dependent variable in the educational operating expenditures equation is expenditures per population aged 5 to 24. The dependent variable in the other operating expenditures equation is expenditures per capita. In the case of other operating expenditures, the estimated equation is listed in table 4. The positive sign for the unemployment rate term suggests that public expenditures run counter to the business cycle. This is not unexpected, since welfare payments are included in other operating expenditures.

Output

Industrial output variables present fewer data problems than the final demand variables. Various sources, including the U.S. Bureau of the Census and the Washington Department of Agriculture, provide good information on the value of Washington output (production or sales) for agriculture, forestry, fishing, mining, manufacturing, con-

TABLE 5
EXPECTED OUTPUT FOR PAPER PRODUCTS

Independent Variable[a]	Coefficient
WXAGR	0.0014
WXFOOD	0.0265
WXAPP	0.0106
WXWOOD	0.0022
WXPAP	0.1106
WXPRNT	0.0832
WXSERV	0.0015
WCND	0.0045
WGSLO	0.0032
USXPAP	1684.4

[a]Partial list; all independent variables are not shown.
Dependent Variable = WZPAP
WZPAP = Washington expected paper products output ($82 million)
WXAGR = Washington agriculture output ($82 million)
WXFOOD = Washington food products output ($82 million)
WXAPP = Washington apparel output ($82 million)
WXWOOD = Washington wood products output ($82 million)
WXPAP = Washington paper products output ($82 million)
WXPRNT = Washington printing and publishing output ($82 million)
WXSERV = Washington services output ($82 million)
WCND = Washington nondurable consumption ($82 million)
USXPAP = U.S. paper products production index (1977 = 1.000)

struction, communications, utilities, and selected trade and service industries. For the remaining industries, estimates are made using a variation of the Kendricks-Jaycox method, a commonly employed estimating procedure in regional economic modeling. For example, transportation services output is estimated by multiplying state earnings by the ratio of national output (from the U.S. Bureau of Labor Statistics) to earnings (from the U.S. Bureau of Economic Analysis). U.S. Bureau of Labor Statistics national price indices are the deflators.

WPSM III differs from the original model in using time-series data to estimate each output equation. The equations also incorporate cross-section data, in this case the 1982 Washington input-output purchase coefficients.

Estimating the output equations is a two-step procedure. The first gives an equation for expected output, which in effect is a conditional prediction of output assuming constant (1982) input-output coefficients. This is not a regression equation; the expected output equation for one example, paper products, is shown in table 5.

The coefficients of the output variables (not all of which are shown) are the estimated regional purchase coefficients from the paper products row of a 26-industry aggregation of the 1982 Washington input-output table. The last term captures exports, the coefficient being the ratio of 1982 Washington paper products exports to the 1982 United States industrial production index for paper

TABLE 6
OUTPUT FOR PAPER PRODUCTS

Independent Variable	Regression Coefficient	t-Statistic
Constant	0.5112	0.42
log(WZPAP)	0.9377	6.30
Rho(1)	0.9149	15.11
R^2	0.9450	
Standard Error of Regression	0.0302	
Durbin-Watson Statistic	1.9631	
Generalized Least Squares	1962–85	

Dependent Variable = log(WXPAP)

products. In this manner, the final demand sectors in WPSM are handled just like local industries in the output equations.

Except for 1982, the year for which input-output coefficients are available, predicted output generally differs from actual output because of changes in the coefficients (including final demand coefficients). Therefore, the second step involves estimating an equation for actual output. With 24 annual observations for each of the independent variables, actual output (WXPAP, in the paper products example) is regressed on expected output (WZPAP) to capture the changes in input-output coefficients over time. For paper products, the estimated equation is listed in table 6.

The coefficient of expected output is less than 1.0, indicating that actual output is rising slower than expected output. This means that the input-output purchase coefficients for paper products are declining over time.[4] Declining input-output coefficients are typical of Washington's resource-based industries, such as agriculture and forest products, since their production is somewhat constrained by the limited supply of natural resources, such as land and timber. Rising coefficients are found in equations for aerospace, nonelectrical machinery, electrical machinery, and other manufacturing, which includes scientific instruments.[5]

Of course, this specification of the output equation gives no information about changes in particular input-output coefficients. In the case of paper products, it also does not explain the tendency of

[4] Another interpretation of this result is that the marginal input-output coefficients are, in general, less than the average input-output coefficients for paper products.

[5] In WPSM, the actual and expected output equations for an industry are combined by substituting the equation for expected output (the first equation) into the equation for actual output (the second equation). In this form, it is more clearly evident that the actual output of a product is a function of the actual output of other Washington industries as well as the expenditures for final demand. Unlike an input-output model, the output equations in WPSM are not solved by inverting a matrix. Instead, the entire simultaneous-equation model (i.e., the final demand, output, employment, income, and population equations) is solved using the Gauss-Seidel search procedure.

coefficients to decline. In other output equations, additional explanatory variables have been included to help explain input-output coefficient change. For example, the output equation for wood products includes the trade-weighted foreign exchange value of the dollar because of the importance of international markets to that industry.

Population

WPSM makes population endogenous. However, rather than adopting the commonly used cohort-survival method of forecasting population, the model explains population growth by changes in the demand for labor. The forecast of total population is then disaggregated into age and sex categories. Attesting to the effectiveness of this forecasting procedure, the specification of the population submodel has remained unchanged since WPSM I.[6]

Given projections of civilian persons employed from the employment submodel, population is forecast by predicting the labor force participation rate (ratio of civilian labor force to population) and the unemployment rate.[7] More specifically, population is forecast with the following identity:

$$WPOP = WN/[WLFRT(1 - WUNRT/100)],$$

where WN = Washington civilian persons employed (thousands); WLFRT = Washington labor force participation rate (fraction) = WLF/WPOP; WLF = Washington civilian labor force (thousands); and WUNRT = Washington civilian unemployment rate (percent).

The behavioral equations for the labor force participation and unemployment rates have similar specifications. For example, the labor force participation rate is related to the United States rate in the long run and the relative change in state employment in the short run as shown in table 7.

The estimated equation for the Washington unemployment rate is shown in table 8. The labor force participation and unemployment rate equations are based on labor market equilibrium assumptions and imply that the supply of labor expands (contracts) in response to increases (decreases) in the number of persons employed such that the labor force participation and unemployment rates follow (but do

[6] Out-of-sample prediction tests of Washington population and net migration using this model are reported in Joun and Conway (1983).

[7] This article does not describe either the employment submodel or the income submodel of WPSM, since their formulations are similar to those found in other regional econometric models. For example, employment in each industry is a function of output, a national index of productivity, and lagged employment (to depict the short-term adjustment process between output and employment). Forecasts of private and public employment (measured by place of work) lead to a prediction of civilian persons employed (measured by place of residence) and eventually to a forecast of population.

TABLE 7
LABOR FORCE PARTICIPATION RATE

Independent Variable	Regression Coefficient	t-Statistic
Constant	-0.0498	-4.54
log[WLF(-1)/WPOP(-1)]	0.4397	7.05
log(USLF/USPOP)	0.4907	8.38
log{[WN/WN(-1)]/[USN/USN(-1)]}	0.6203	13.90
R^2	0.9969	
Standard Error of Regression	0.0047	
Durbin-Watson Statistic	2.3787	
Ordinary Least Squares	1962–86	

Dependent Variable = log(WLF/WPOP)
USLF = U.S. civilian labor force (millions)
USN = U.S. civilian persons employed (millions)

not necessarily equal) the national rates in the long run. The supply of labor ultimately adjusts to the demand for labor through migration. Thus, population growth is strongly related to employment growth, albeit with a delay.

The employment and population forecasts imply a projected level of net migration. The implied prediction of net migration provides a check of the employment and population forecast. Net migration is calculated from the following identity:

$$WMIG = [WPOP - WPOP(-1)] - WBIRTHS + WDEATHS,$$

where WMIG = Washington net migration (thousands); WBIRTHS = Washington births (thousands); and WDEATHS = Washington deaths (thousands). Births and deaths are forecast from projected birth and death rates.

TABLE 8
UNEMPLOYMENT RATE

Independent Variable	Regression Coefficient	t-Statistic
Constant	0.3864	3.18
log[WUNRT(-1)]	0.4786	5.58
log(USUNRT)	0.4055	5.43
log[WN/WN(-1)]/[USN/USN(-1)]	-3.4132	-5.42
Adjusted R^2	0.9408	
Standard Error of Regression	0.0663	
Durbin-Watson Statistic	2.3765	
Ordinary Least Squares	1962–86	

Dependent Variable = log(WUNRT)

TABLE 9
PREDICTION ERRORS FOR SELECTED WASHINGTON AND U.S. VARIABLES, 1985

	1972 Revised Estimate	1985 Adjusted Forecast	1985 Estimate	Percent Error
Washington				
Gross state product ($82 million)	42,944	71,214	67,464	5.6
Labor force (thousands)	1435	1945	2091	-7.0
Persons employed (thousands)	1298	1782	1921	-7.2
Resident population (thousands)	3447	4414	4409	0.1
Personal income ($82 million)	34,604	59,103	55,719	6.1
Per capita income ($82)	10,039	13,390	12,638	6.0
United States				
Gross national product ($82 billion)	2609	3667	3570	2.7
Labor force (million)	87	106	116	-8.3
Persons employed (million)	82	100	107	-6.7
Resident population (million)	210	235	239	-1.9
Disposable income ($82 billion)	1797	2622	2509	4.5
Per capita income ($82)	8559	11,161	10,480	6.5

3. Forecasting Accuracy

Long-Range Prediction Errors

There are two principal applications of regional econometric models, forecasting and impact analysis. With regard to the first, WPSM has been designed primarily as a long-range forecasting model. Several public agencies and businesses have relied upon the model to develop five-, ten-, and 25-year outlooks for the state and substate regions. For example, the Puget Sound Council of Governments has incorporated WPSM as part of its forecasting system to generate economic and demographic projections for the Central Puget Sound Region. WPSM is also a component of Seattle City Light's electrical energy forecasting model.

The ultimate test of a forecasting model is the size of its ex ante prediction errors. Unfortunately, long-range projection models typically fail to survive long enough to test their out-of-sample forecasting capabilities. WPSM is a notable exception. The initial report (Bourque, Conway, and Howard 1977) published two sets of annual forecasts for 1973-85, which were prepared in 1976 using a model estimated with data through 1972. Both were based on national projections produced by the INFORUM model in the summer of 1976 (see Almon et al. 1974 for a description of INFORUM). The only difference in the two forecasts was the projection for the aerospace industry, which is a major and highly unpredictable factor in the Washington economy.

Table 9 shows the prediction errors for selected Washington and United States variables from the set of forecasts based on the high aerospace outlook.[8] The first column shows the estimate of each variable in 1972, the last year of the model's historical period, based on the latest revised data available (in spring 1988); the second column reports the 1985 forecast, adjusted to take into account the revised estimate for 1972; the third column shows the estimate of the variable in 1985; and the fourth column gives the 1985 prediction error expressed as a percentage. For example, consider Washington resident population. The unrevised estimate of population in 1972, which was the figure reported in the original forecast, was 3,355 (thousand persons). The original forecast for 1985 was 4,296. Since the 1980 census of population ultimately led to a 2.7 percent upward revision of the 1972 population estimate to 3,447 (first column), the 1985 forecast has been adjusted by the same relative amount. Thus, the adjusted 1985 forecast is 4,414 (second column).

The prediction errors in table 9 indicate that WPSM did a reasonable job of forecasting the long-term growth of the Washington economy, at least in terms of these aggregate measures, during the late 1970s and early 1980s. Considering the length of the forecast period, the absolute size of the 1985 errors is relatively small, ranging from 0.1 percent for resident population to 7.2 percent for civilian persons employed.[9] In fact, the prediction errors are no larger than the prediction errors for the United States forecasts made by the INFORUM model.

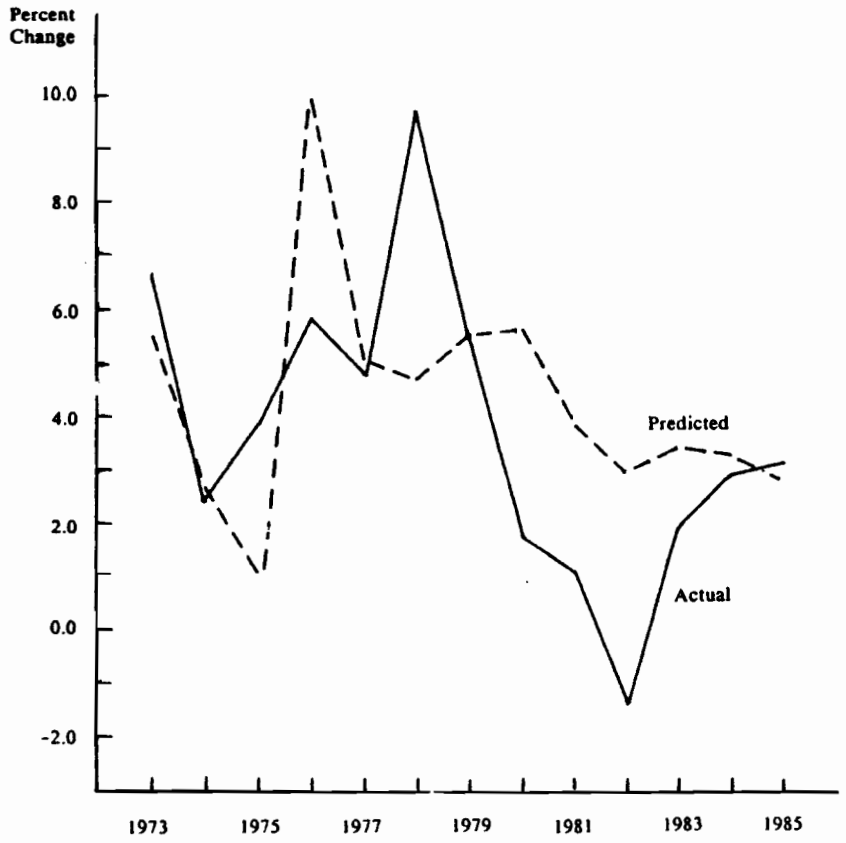
One interesting finding in table 9 is the remarkable similarity of the state and national error patterns, which suggests that much of the state model's forecasting error is attributable to errors in the exogenous variables.[10] WPSM and the INFORUM model both tended to overestimate the growth of production and income and underestimate the growth of employment. As with other long-range forecasting models at the time, WPSM and the INFORUM model failed to anticipate two interrelated developments, the substantial rise in labor force participation and the slowdown of labor productivity gains. The most noticeable trend was the movement of women into the labor force. After ten years of comparatively little change, the labor force participation rate (ratio of civilian labor force to civilian population over 16) rose from 59.1 percent in 1970 to 63.8 percent

[8] The high aerospace forecast is the one that more accurately projected the course of the industry. For purposes of comparison, the 1985 prediction errors for Washington persons employed and personal income from the low aerospace forecast are −12.4 percent and −0.2 percent, respectively.

[9] As reported in the original document on WPSM (p. 109), the within-sample (1963-72) mean absolute prediction errors for these two variables were 2.6 percent and 2.5 percent, respectively.

[10] An informative experiment would be to rerun the original version of WPSM under the assumption of known exogenous variables for the 1973-85 period. This would permit one to decompose the prediction errors into errors caused by the exogenous variables and errors associated with the estimated model. Since the original model is no longer assembled, this test is not feasible.

FIGURE 2
PREDICTED AND ACTUAL WASHINGTON PERSONAL INCOME, 1982 DOLLARS



in 1985. More than 60 percent of the labor force growth during that time was contributed by women. Taking advantage of this large pool of relatively inexperienced, unskilled, and inexpensive labor, the national and state economies turned to more labor intensive activities, thereby creating jobs at historically high rates but paying for this adjustment with smaller advances in productivity.

Figure 2 illustrates how well WPSM predicted the growth path of the economy. Not surprisingly, the model did not forecast the extreme movements of the business cycle accurately. It failed to predict the exceptional growth in 1978 and the severe slowdown centered around the 1982 recession. It even incorrectly predicted the reaction to the 1975 national recession. Nevertheless, because WPSM effectively depicted Washington's (decelerating) long-term growth trend, the absolute prediction error for the level of real personal income never exceeded 6.4 percent. The prediction error

TABLE 10
PREDICTION ERRORS FOR WASHINGTON INDUSTRIAL OUTPUT, 1985[a]

	1972 Revised Estimate	1985 Adjusted Forecast	1985 Estimate	Percent Error
Industrial output[b]	64,753	108,934	102,272	6.5
Resources	3493	5128	4691	9.3
Manufacturing	24,689	40,216	38,400	4.7
Food products	3934	5733	5870	-2.3
Forest products	6858	9592	7355	30.4
Transportation equipment	6123	11,782	13,190	-10.7
Other manufacturing	7773	13,110	11,986	9.4
Nonmanufacturing	36,572	63,590	59,181	7.5
Construction	5781	8232	7444	10.6
Transportation, communication, utilities	7341	12,520	10,373	20.7
Trade	9022	17,128	15,618	9.7
Finance, insurance, real estate	5416	8811	8918	-1.2
Services	9012	16,899	16,828	0.4

[a]Expressed in millions of 1982 dollars.
[b]Excludes petroleum refining.

in 1985 (6.1 percent), the thirteenth year of the forecast period, was not significantly greater than the one in 1975 (−5.6 percent), the third year of the forecast period. Moreover, had the model forecast beyond 1985, the forecast error would have declined. WPSM would have predicted about 3 percent growth for real personal income in 1986 and 1987. Since actual growth was somewhat higher, in part because of the economic rebound from the slump of the early 1980s, the prediction error for 1987 personal income would have been closer to 4 percent.

The prediction errors associated with more detailed indicators are sometimes large. As an example, table 10 reports errors for real output in 1985 for selected industries. Reflecting WPSM's tendency to overestimate growth in 1972-85, the prediction error for total industrial output is 6.5 percent. For individual industries, the absolute error ranges from 0.4 percent for services to 30.4 percent for forest products. The latter stems from the highly cyclical nature of lumber and plywood production. In 1985, the industry was still suffering from the effects of a sharp housing downturn during the first half of the 1980s and operating well below its long-term growth path. Since 1985 the industry has expanded by about 25 percent, as indicated by Washington lumber production statistics. The high prediction error for transportation, communications, and utilities was primarily the result of the model's inability to predict the substantial rise in energy costs and its dampening effect on the demand for electricity and natural gas. The seemingly negligible prediction errors

TABLE 11
PREDICTIONS OF WASHINGTON OUTPUT AND EMPLOYMENT, 1985

	1972 Revised Estimate	1985 Adjusted Forecast	1985 Estimate
Industrial output	100.0%	100.0%	100.0%
Resources	5.4	4.7	4.6
Manufacturing	38.1	36.9	37.5
Nonmanufacturing	56.5	58.4	57.9
Employment	100.0%	100.0%	100.0%
Resources	5.3	3.1	4.2
Manufacturing	15.9	14.6	13.3
Nonmanufacturing	56.0	62.0	64.1
Government	22.9	20.3	18.3

for finance, insurance, and real estate and services are deceiving, since they are the result of two compensating errors. In both cases, the model's overestimation of income and production growth virtually offsets its underestimation of the shift in demand toward these sectors.

Structural Change

One criticism leveled against interindustry models in forecasting exercises is the assumption of constant input-output coefficients. As previously described, WPSM attempts to model, at least implicitly, coefficient change and the evolving interindustry structure of the economy.

Forecasts of structural changes, as measured by the composition of output and employment in 1972 and 1985, are evaluated in table 11. For the broad sectors of the economy (resources, manufacturing, nonmanufacturing, and government), WPSM accurately predicted the direction of structural change and, to a lesser extent, the degree of change. More specifically, WPSM correctly recognized that, while most of the employment growth would occur in the service-producing sector (nonmanufacturing and government), the distribution of output between the service-producing sector and the goods-producing sector (resources and manufacturing) would remain relatively constant. For example, referring to the private sector, WPSM predicted that the nonmanufacturing industries would account for 90 percent of the jobs created between 1972 and 1985 but only 61 percent of the output growth. The actual changes were 87 percent and 60 percent, respectively.

4. Multiplier Estimates

Multiplier Size

The second principal application of regional economic models is impact (or multiplier) analysis. WPSM has been used to assess the economic effects of several major developments in Washington, including a state convention center, a navy base, and the termination of two nuclear power plants. The model has also been used to study the Boeing Company's contribution to state business cycles, the impact of foreign trade on the Washington economy, and the interaction between employment growth, population change, and the unemployment rate.

TABLE 12
SELECTED OUTPUT, EMPLOYMENT, AND INCOME MULTIPLIERS FROM WPSM AND WASHINGTON INPUT–OUTPUT MODEL, 1982[a]

	Output Multiplier ($82's/$82)	Employment Multiplier (jobs/job)	Income Multiplier ($82's/$82)
WPSM[b]			
Agriculture	2.88	2.61	2.85
Wood products	2.68	4.66	3.75
Aerospace	1.72	3.36	2.19
Trade	2.79	2.35	2.52
Washington input–output model			
Agriculture	1.97	1.84	2.07
Wood products	2.65	3.92	2.91
Aerospace	1.47	2.42	1.60
Trade	1.81	1.71	1.78

[a] Total change in economy per unit change in industry.
[b] Based on cumulative changes, as described in text.

A long-standing issue in impact studies is the size of the regional multiplier. Of course, impact analyses may be influenced, perhaps not insignificantly, by the analyst's choice of model. Table 12 shows multipliers of output, employment (wage and salary employees and proprietors), and income (labor earnings) for 1982 as estimated by WPSM and by the 1982 Washington input-output model. The multipliers assume that the industries in question undergo permanent expansions amounting to $1 billion of real output per year. The multiplier for each industry is the sum of the total changes in the economy over the eight-year simulation period, 1975-1982, divided by the sum of the direct changes in the industry. The input-output multipliers reported in the table are type II multipliers, the type of input-output multipliers most commonly used in impact analyses. (Type I multipliers, which exclude the effects of household income and consumption, have been the subject of considerable academic research — e.g., estimating multipliers without survey-based input output tables — but have very little usefulness in practice. Type III multipliers, which include state and local government as an endogenous sector, are also rarely used in input-output applications.)

Table 12 shows that multipliers from the two models often differ substantially. For example, consider the agriculture employment multiplier. The interindustry econometric model estimates that each

TABLE 13
AEROSPACE OUTPUT, EMPLOYMENT, AND INCOME MULTIPLIERS FROM WPSM, 1982[a]

	Output Multiplier[b] ($82's/$82)	Employment Multiplier[b] (jobs/job)	Income Multiplier[b] ($82's/$82)
Closed	1.72	3.36	2.19
Investment open	1.54	2.89	1.92
Investment, state and local open	1.43	2.27	1.61

[a]Total change in economy per unit change in industry.
[b]Based on cumulative changes.

agricultural job, through the regional respending process, leads to 1.61 additional jobs in the economy. In contrast, the input-output model estimate is only 0.84 job. The relative differences between the output and income multipliers for agriculture are about the same.

In general, the interindustry econometric model yields higher multipliers than the input-output model. For the four industries shown in Table 12, the average difference is about 30 percent for the output multipliers and slightly more for the employment and income multipliers.

Degree of Closure

WPSM gives higher multipliers principally because of its greater degree of closure. Type II input-output multipliers do not take into account the indirect effects on investment or state and local government expenditures. Housing construction and public educational expenditures, for example, are assumed to be independent of the general level of economic activity. In contrast, in the interindustry econometric model, regional economic growth, as measured by changes in population and per capita income, does affect investment and state and local government spending.

Table 13 reports an experiment conducted with WPSM which provides further insight into the nature of model closure. It shows three sets of aerospace multipliers for 1982. In the first case, the model is closed with respect to investment and state and local government. In the second case, it is closed with respect to state and local government but not investment. In the third case, neither investment nor state and local government is endogenous.

The multipliers for the closed model are the same as those in table 12. When investment is not endogenous, the multipliers drop by about 10 percent. Further excluding state and local government as an interactive component results in additional reductions. The output multiplier declines another seven percent, while the employment and income multipliers fall 21 and 16 percent, respectively. A comparison shows that the multipliers from the interindustry econometric model with investment and state and local government exogenous are not only conceptually but also empirically similar to the type II input-output multipliers in table 12.

The fact that degree of closure has a significant bearing on the size of multipliers should not be surprising, considering the major role played by investment and state and local government in the economy. In 1982, the construction industry, the primary producer of fixed capital for the regional market, and state and local government accounted for more than one-sixth of total jobs and labor income, according to the Washington input-output table. Therefore, neglecting the response of these sectors in economic impact analyses, as does the type II input-output model, in effect disregards one-sixth of the economy. When one recognizes that these sectors in turn place additional demands upon the economy, it becomes clear why interindustry econometric model multipliers can exceed their input-output counterparts by as much as 50 percent.

Short-Run and Long-Run Multipliers

Another issue is whether there is a significant difference between short-run and long-run regional multipliers. Input-output models are restricted to comparative static analysis, since impacts are not measured with respect to time. On the other hand, WPSM is dynamic, permitting one to estimate short-run and long-run multipliers.

Table 14 shows the reaction of the Washington economy in terms of output, employment, and income to a permanent increase in aerospace exports beginning in 1975, according to WPSM. As in previous tables, the first set of multipliers is based on cumulative changes. For example, the aerospace output multiplier in 1976, which is 1.56, is the sum of total output change for 1975 and 1976 divided by the sum of direct aerospace output change for those years [1.56 = (1304 + 1816)/(1000.0 + 1000.0)]. On the other hand, each multiplier in the second set is the ratio of the total change to the direct change at each point in time. Thus, in this case, the 1976 aerospace output multiplier is 1.82 (= 1816/1000).

The simulation reveals a delay in the economy's response to the aerospace impact. The long-run indirect effect is about twice the short-run indirect effect. Several factors cause the economy's slow adjustment to the expansion, but two are noteworthy. First, housing construction is delayed because inmigration triggered by new job opportunities is not immediate.[11] In fact, investment activity does not

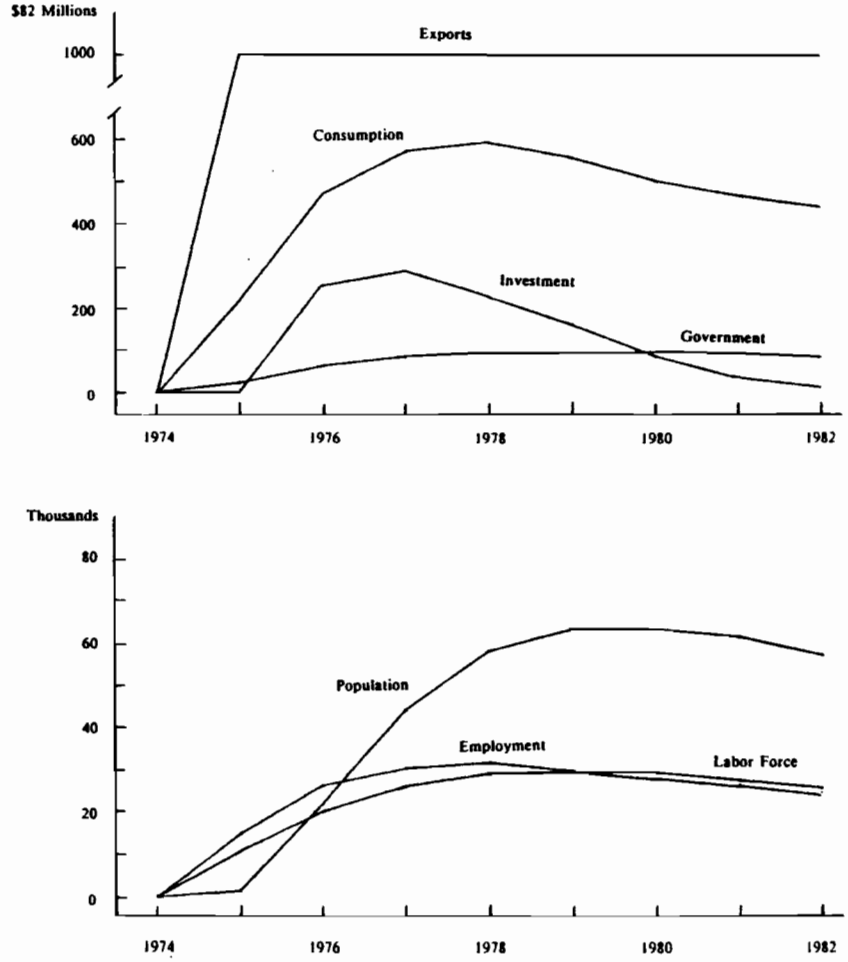
[11] The simulation properties of the WPSM have been described in Conway (1979). Note that the simulations in this study are conducted with a reformulated version of the model. Also, see Joun and Conway (1983) for information on the demographic submodel and its interaction with the economic submodel.

TABLE 14
AEROSPACE OUTPUT, EMPLOYMENT, AND INCOME MULTIPLIERS FROM WPSM, 1975–1982[a]

	1975	1976	1977	1978	1979	1980	1981	1982
Direct aerospace change								
Output ($82 million)	1000	1000	1000	1000	1000	1000	1000	1000
Employment (thousands)	8200	8100	7900	7700	7600	7400	7300	7100
Income ($82 million)	258	260	265	271	259	256	252	254
Total change in economy								
Output ($82 million)	1304	1816	1954	1936	1841	1714	1634	1597
Employment (thousands)	15,300	25,800	29,900	30,600	29,000	26,700	24,700	23,700
Income ($82 million)	397	595	663	672	619	565	523	512
Multipliers[b]								
Output ($82's/$82)	1.30	1.56	1.69	1.75	1.77	1.76	1.74	1.72
Employment (jobs/job)	1.87	2.52	2.93	3.18	3.31	3.35	3.36	3.36
Income ($82's/$82)	1.54	1.91	2.11	2.21	2.24	2.24	2.22	2.19
Multipliers								
Output ($82's/$82)	1.30	1.82	1.95	1.93	1.84	1.71	1.63	1.60
Employment (jobs/job)	1.87	3.19	3.78	3.97	3.82	3.41	3.38	3.34
Income ($82's/$82)	1.54	2.29	2.50	2.48	2.39	2.21	2.08	2.02

[a] Permanent impact
[b] Based on cumulative changes

FIGURE 3
IMPACT OF AEROSPACE EXPORTS ON WASHINGTON ECONOMY, 1975–1982



pick up until the expansion enters its second year (see upper half of figure 3). Second, state and local government spending does not rise as quickly as tax revenues in the early stages of the impact, resulting in a marginal surplus in the public accounts and a temporary leakage of funds from the respending process. The small effect that does stem from these two components of final demand in the first year is largely offset by adjustments taking place elsewhere in the economy.[12]

[12] Also influencing short-run behavior are a rise in labor productivity, an increase in the propensity to import, and a decrease in transfer payments, as aerospace

That is why the first-year multipliers from the interindustry econometric model are similar in size to the type II input-output multipliers.

One factor contributing to a higher long-run multiplier is the eventual increase in population. The lower half of figure 3 shows the lagged response of population to employment. In the initial year of the aerospace expansion, employment jumps by 15,300, but virtually all of this new demand for labor is accommodated by the existing labor pool, as the labor force participation rate rises and the unemployment rate declines. However, because of improved conditions in the labor market, inmigration causes population to increase 22,000 in the second year and another 21,000 in the third year. After the fourth year, the total increase in population amounts to 60,000 persons. The increase in population places downward pressure on the labor force participation rate and upward pressure on the unemployment rate, eventually returning them back to their previous long-term paths. Consequently, in the long run, the aerospace expansion has no favorable effect on the employment rate.

5. Conclusion

During the past ten years, regional analysts who have worked with WPSM have raised several questions about its specification and application. In concluding this article, four of the most commonly asked questions are addressed.

Is long-range forecasting a worthwhile exercise? This question is often asked with a double negative, using the words "isn't" and "worthless." There are at least three responses. First, for certain types of planning, such as decisions whether or not to build multibillion dollar nuclear power plants, long-range forecasts are necessary. Second, building a model with an explicit and logical structure like WPSM's adds substantially to one's understanding of how regional economies behave. If nothing else, model specification and estimation permit the model builder to make better informed judgments regarding the future course of the economy. Finally, as the INFORUM model and WPSM have demonstrated, it is technically possible to develop reasonably accurate long-range projections for both the nation and its regions.

Of course, the accuracy of forecasts is also partly a matter of luck. In the case of Washington, had the forecast of a key export sector widely missed its mark, the entire set of projections could have experienced significant prediction errors. For example, as simulations with the aerospace industry demonstrate, every 10,000 aerospace workers directly and indirectly support about 80,000 people living in the state, or about 1.8 percent of the current population. Since

production rises. In each case, the effect tends to minimize the indirect effects of the expansion in the first year.

aerospace employment has fluctuated by plus or minus 30,000 workers around a mean of 65,000 during the past 25 years, this industry alone subjects the population forecast to a five percent error.

Are the multipliers from WPSM too high? The fact that forecasts are bound to be wrong, at least to a degree, makes it important that long-range projection models are constructed with good simulation properties. Models with such characteristics enable analysts to prepare alternative sets of forecasts that display both external consistency (i.e., compatibility between endogenous and exogenous variables) and internal consistency (i.e., compatibility among endogenous variables). If this modeling objective is achieved, forecasters have an effective method with which to analyze and quantify the uncertainty of the future.

The most common criticism of WPSM's simulation properties is that the multipliers appear to be too high, particularly when compared to the multipliers from the Washington input-output model. As revealed in the simulation experiments, the only fundamental difference between the two models is their treatment of investment and state and local government. Since WPSM, unlike the frequently used type II input-output model, incorporates these two sectors as endogenous components of the model, its multipliers are substantially higher, especially in the long run.

Observers have advanced several reasons for not making investment and state and local expenditures endogenous. One is that capital formation (e.g., housing construction) and local public spending (e.g., educational expenditures) are unrelated to population and income. A second is that these sectors, especially investment, are difficult to model in a system of linear equations. As the final demand equations of WPSM demonstrate, neither of these reasons has much merit.

Still a third reason is that the lower type II multipliers yield conservative estimates of impacts. The argument implies a desire not to overstate the effects of the development in question. This approach may be preferable in certain kinds of impact analyses, such as an economic feasibility study of a publicly financed convention center. However, in other impact studies, such as an environmental impact statement for a navy base, a downward bias may lead to a serious underestimation of social and environmental costs. While it is undesirable to overestimate the number of jobs created, it is also undesirable to underestimate population growth and the needs for schoolrooms, social services, waste disposal, and traffic control. In general, a more rational approach to impact analysis is to make the best estimates of the impact, by, among other things, selecting the model that most accurately replicates the regional economic behavior in question. Then, if one wants, for example, a conservative estimate of a benefit-cost ratio, one can make explicit adjustments to the impact results. Considering the inherent imprecision of models and

impact estimates, such adjustments are certainly justified, but they should be an *explicit* step of the analysis.

Since the formulation of WPSM is demand oriented, is it misspecified? Implicit in the theory underlying demand models is that the supply of resources, labor, capital, and other inputs to production can adjust to any level of demand without an adverse effect on production costs. Although WPSM, like many regional econometric models, is demand oriented, it does have supply side considerations. These are most notable in the labor force submodel, which effectively depicts the drawn out adjustment of labor supply to a rise or decline in regional economic activity.

Nevertheless, WPSM assumes that *in the long run* there are no supply constraints on growth and no perceptible loss of regional competitive advantage. There are two reasons why the model does not attempt to portray regional production costs and comparative advantage. First, regional data are not sufficient — in terms of type, quantity, and quality — to support models of regional production functions and comparative advantage. Thus, while models like the Massachusetts model (Treyz, Friedlaender, and Stevens, 1980) are very elegant in theory, it is not clear that their parameter estimates are reliable. This in turn raises questions about their effectiveness in forecasting and simulation exercises.

Second, with the exception of natural resources (e.g., agricultural land, timber, and fish), the assumption of perfectly mobile factors of production in the long run is a reasonable one for a small and open economy, at least based on the economic history of Washington. While the state has grown one-third faster than the United States during the past thirty years, there is no evidence that it has lost competitive advantage because of higher production costs due to the inelasticity of the supply of labor or capital. Indeed, there is substantial evidence in the state's boom and bust history that labor supply is highly responsive to labor demand.

Can a regional interindustry econometric model be built without an expensive survey-based input-output study? The answer to this question is yes and no. Experiments with WPSM have demonstrated that an effective model — one with similar forecasting capabilities and simulation properties — can be built around an input-output structure estimated from national coefficients, published regional economic data (e.g., data from the economic censuses), and accurate information on each industry's out-of-state sales (i.e., each industry's aggregate regional purchase coefficient). For this reason, it is felt that an input-output survey is a necessary step to building a regional interindustry econometric model but primarily to obtain information on the split between internal and external sales. This means that the survey need not be expensive, certainly not as costly as the survey administered during the 1972 Washington input-output study.

The out-of-pocket cost for the Washington Projection and Simulation Model in 1977 was $125,000. The budget for the 1972 Washington input-output study was also $125,000, bringing the total cost of WPSM to $250,000. However, with advances in regional econometric modeling, improvements in the methods of estimating regional input-output tables, better regional data, and the advent of personal computers and related software, a model like WPSM currently can be built for less than that amount, even in today's dollars.

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Regional Input–Output Modelling

New developments and interpretations

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9 An empirical comparison of regional multipliers

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1 Introduction

The selection of models for impact analysis frequently depends not upon the models' theoretical or empirical merits but upon the availability of time and money for their development. Sometimes unrecognized, or at least unacknowledged, is the fact that the choice of models can appreciably affect the results of impact analysis, since different models sometimes have multipliers of significantly different size.

This study compares multipliers from three models of the Washington state economy: an economic base model; an input-output model; and an interindustry econometric model. Among the questions addressed in this investigation are the following: How do multipliers from the three different models compare in size? How does model specification affect the size of multipliers? How stable are multipliers over time? What are the differences between short-run and long-run multipliers?

2 Regional Economic ...

Economic Base Model

Of the three models considered in this study, the economic base model i the simplest.[1] This model, whose roots extend back to the 1930s (Hoyt 1933), identifies only two sectors of the regional economy, the sectc producing goods sold outside the region (the export or basic sector) ar the sector producing goods sold inside the region (the service c nonbasic sector). According to economic base theory, regional growtl whether measured in terms of output, employment, or income, is relate to the growth of the basic sector. Specifically, an expansion c exports generates a respending (multiplier) process that leads to proportional increase in production by the service sector.

Mathematically, the economic base model can be specified in tl following manner:

$$x = w + y \qquad (1$$

where

x = total regional output

w = nonbasic output

y = basic output (exogenous).

Assuming that the nonbasic output required by the economy proportional to total output,

$$w = rx. \qquad (2$$

Substituting Equation (2) into Equation (1) and rearranging terms lea to

$$x = (1-r)^{-1}y. \qquad (3$$

The term $(1-r)^{-1}$ is called the economic base multiplier. In th case, the multiplier is defined as the total change in regional outp per unit change in basic output (exports). An estimate of the outp multiplier requires only an estimate of r, the ratio of nonbasic outp to total output in the region.

Employment and income variants of the economic base model can also formulated, which permits estimates of employment and inc multipliers.

Input-Output Model

The development of the regional input-output model began in the early 1950s with the work of Isard (1951). Although emanating from the same theoretical foundation as the economic base model, the input-output model recognizes the fact that the economic impact on a region from export expansion varies with the industry from which the exports are produced. The size of the multiplier depends upon the degree to which the export industry is linked, through the respending process, to the rest of the economy.

The first proposition of the input-output model states that each industry is related to every other sector in the region. In terms of industry output in an n-industry economy, this relationship can be expressed by the following identity:

$$X_i = X_{i1} + X_{i2} + \ldots + X_{in} + Y_i , \quad i=1,n \tag{4}$$

where

X_i = total output from industry i

X_{ij} = output sold from industry i to regional industry j

Y_i = output sold from industry i to sectors of final demand.

The second proposition, which is based on theories of production and trade, holds that the ratio of input required by industry j from regional industry i to the total output of industry j is constant:

$$r_{ij} = X_{ij} / X_j. \tag{5}$$

Estimates of the direct regional input coefficients, r_{ij}, are obtained from base-year input-output tables.

Substituting Equation (5) into Equation (4) gives

$$X_i = r_{i1}X_1 + r_{i2}X_2 + \ldots + r_{in}X_n + Y_i , \quad i=1,n \tag{6}$$

or, using matrix notation,

$$X = RX + Y. \tag{7}$$

In its solution form, Equation (7) is rewritten as

$$X = (I-R)^{-1}Y. \tag{8}$$

The matrix $(I-R)^{-1}$ is called the Leontief inverse matrix. Noting the similarity between Equation (8) and Equation (3), the inverse matrix can also be called the output multiplier matrix. Each element in the matrix

can be interpreted as the direct and indirect output required fr regional industry i per unit of output delivered as final demand fr industry j. Summing the elements down the column of the matrix (i.e across all industries i) gives the total output required in the regi per unit of output from industry j. With additional information employment-output and income-output ratios, employment and inc multipliers can be derived from the Leontief inverse matrix.

Interindustry Econometric Model

The input-output model represents a step forward in the evolution regional economic models, but it is not without shortcomings. T interindustry econometric model, which incorporates an input-out framework into an econometric model, strives to overcome some of t major deficiencies of the traditional input-output model.[2] Structura similar to national interindustry forecasting models built by Almon al. (1974) and Preston (1972), the regional interindustry econome model differs from the input-output model in a number of import respects.[3] Among its distinguishing features are estimation wi cross-sectional and time-series data, dynamic depiction of econon behavior, projection of input-output coefficients, inclusion of population submodel, use of selected price variables, and integrati with a national econometric model, which gives the regional model t capability of producing long-range economic and demographic projectio

With regard to its application in impact studies, one of the m important characteristics of the model is closure with respect private investment and state and local government expenditures. Where the typical input-output model takes into account interactions am industrial production, labour income, and household consumption, disregards the effects of induced capital and government spending. contrast, the interindustry econometric model attempts to capture s effects, thereby providing a more complete picture of the operation the regional economy.

As a consequence of the complexity of the interindustry econome model, it is not possible to derive specific mathematical expressi like Equations (8) and (3) for the model's multipliers. Inste multipliers have to be estimated from simulations. The simulat procedure is a relatively straightforward exercise. Consider estimat

various multipliers related to an industry's exports. Using the interindustry econometric model, the behaviour of the regional economy is first simulated without taking into account the industry's exports, generating a so-called baseline projection over a designated period of time. The simulation is then repeated with consideration of the exports to yield a conditional projection. The difference between the two projections, at any given point within the time period, is a measure of the total (direct and indirect) impact on the economy of the industry's export production. Since the model is comprehensive, the impact can be expressed in terms of output, employment, and income by industry, total labour force, the unemployment rate, resident population, personal income, household consumption, fixed investment, and state and local government expenditures, among other economic and demographic variables.

3 Comparison of Multipliers

Multiplier Size

Alternative specifications of regional models give rise to the possibility that the results of impact analyses depend, perhaps not insignificantly, upon the choice of models. Table 1 shows multipliers estimated for 1982 from three models of the Washington state economy: an economic base model; the 1982 input-output model (Bourque, 1987); and the Washington Projection and Simulation Model (Bourque, Conway, and Howard, 1977; Conway, 1990). The economic base multipliers, which follow Equation (3), are calculated from information found in the 1982 input-output table.[4] The input-output multipliers are Type II multipliers, which consider the interactions between the industrial and household sectors of the economy.[5] The interindustry econometric model multipliers are calculated from simulations under the assumption that the industry in question undergoes a permanent expansion amounting to $500 million (in 1982 dollars) of production per year. The multiplier for each industry is the sum of the total changes in the economy over a seven-year period centered about 1982 (1979-85) divided by the sum of the direct changes in the industry.

As reported in Table 1, there are substantial differences among the models in their measurements of a given multiplier. For example,

Table 1 Selected Output, Employment, and Income Multipliers, 1982

Total Change in Economy Per Unit Change in Industry

	Output Multiplier ($82's/$82)	Employment Multiplier (jobs/job)	Income Multiplier ($82's/$82)
Economic base model			
Agriculture	2.23	3.11	2.74
Wood products	2.23	3.11	2.74
Aerospace	2.23	3.11	2.74
Trade	2.23	3.11	2.74
Input-output model			
Agriculture	1.97	1.84	2.07
Wood products	2.65	3.92	2.91
Aerospace	1.47	2.42	1.60
Trade	1.81	1.71	1.78
Interindustry econometric model			
Agriculture	2.55	2.80	3.14
Wood products	3.31	5.20	4.44
Aerospace	1.82	3.88	2.41
Trade	2.60	2.70	2.93

consider the wood products employment multipliers (defined as the total number of jobs--full-time and part-time wage and salary employment and self-employed persons--generated in the economy per job in the industry). The interindustry econometric model estimates that each wood products job, through the regional respending process, leads to 4.20 additional jobs in the economy. This is about double the indirect impact estimated by the economic base model (2.11 jobs) and about 44 percent higher than that estimated by the input-output model (2.92 jobs). Similar differences among the models occur with the wood products output (total dollars of output per dollar of industry output) and income (total dollars of income per dollar of industry income)

multipliers.[6]

In general, the input-output model yields the lowest multipliers. The economic base model, which does not discriminate among industries with regard to multiplier size, gives multipliers closer in magnitude to those of the interindustry econometric model. The four output multipliers from the interindustry econometric model are on average 30 percent higher than the corresponding input-output multipliers. The relative differences between employment and income multipliers from these two models are even greater.

Degree of Closure

The interindustry econometric model gives higher multipliers than the input-output model principally because of its greater degree of closure.[7] Type II input-output multipliers do not take into account the induced effects of economic change on the investment or state and local government sectors. Thus, housing construction and public expenditures for education, for example, are assumed to be independent of the general level of regional economic activity. In contrast, the interindustry econometric model postulates that regional economic growth, as measured by population and per capita income, does have an effect on investment and state and local government spending.

How the degree of closure of a model can affect the size of multipliers is illustrated with the following experiment. Using the interindustry econometric model, three sets of aerospace multipliers are estimated for 1982. In the first case, the model is closed with respect to the investment and state and local government sectors. In the second case, the investment but not the state and local government sector is open, under the assumption that capital spending is not influenced by changes in regional economic activity. In the third case, both the investment and state and local government sectors are open.

The results of these simulations are given in Table 2. The aerospace output, employment, and income multipliers for the closed model have the same values as those found in Table 1. When the link to the investment sector is severed in the model, the multipliers drop between 19 and 25 percent. Further, excluding state and local government as an interactive component of the economy results in additional reductions in the multipliers. The output multiplier declines another eight percent,

Table 2 Aerospace Output, Employment, and Income Multipliers from Interindustry Econometric Model, 1982

Total Change in Economy Per Unit Change in Industry

	Output Multiplier ($82's/$82)	Employment Multiplier (jobs/job)	Income Multiplier ($82's/$82)
Closed	1.82	3.88	2.41
Investment open	1.47	2.92	1.90
Investment and state and local open	1.35	2.14	1.50

while the employment and income multipliers fall an additional 27 and 21 percent, respectively. A comparison shows that the multipliers from the interindustry econometric model with investment and state and local government open are not only conceptually but also empirically similar to the Type II input-output multipliers in Table 1.[8]

The fact that the degree of closure has a significant bearing on the size of multipliers should not be surprising, considering the large role played by investment and state and local government in the economy. For example, in 1982, the construction industry, which is the primary producer of capital for the regional market, and state and local government accounted for more than one-sixth of the jobs and labour earnings in the Washington economy, according to the input-output table. Therefore, neglecting the response of these sectors in economic impacts, as does the Type II input-output model, in effect disregards one-sixth of the economy. Recognizing that these sectors in turn place additional demands upon the regional economy, it becomes clear why the interindustry econometric model multipliers can exceed their input-output counterparts by as much as 60 percent.

Stability of Multipliers

Another practical consideration in the choice of models is whether

multipliers change over time. Since input-output models are estimated at single points in time, analysts run the risk of using outdated multipliers if the models are not applied to their base years. Several factors such as technology, trading patterns, productivity, wage rates, and consumer habits affect the size of multipliers. Moreover, there is no a priori reason to expect that multipliers tend to rise or decline over time. Thus, the stability of multipliers is essentially an empirical question.

One advantage of the interindustry econometric model is that it depicts the evolving structure of the economy, thereby portraying temporal changes in multipliers, at least in principle. Shown in Table 3 are estimates of multipliers from simulations with the interindustry econometric model for 1972, 1977, and 1982. These three years are within the estimation period of the model.[9] Once again the multipliers are calculated from simulations assuming a permanent $500 million expansion of output.

As evident in the results of this exercise, the multipliers increase over time.[10] In a few cases, such as the wood products and aerospace employment multipliers, the rise is great. On the other hand, the output multipliers tend to be much more constant.

The employment multipliers in Table 3 exhibit the largest changes. In light of the variations in the gains in labour productivity (output per job) among industries, this result is not unexpected. Even if the output multiplier for a given industry were constant, its employment multiplier would rise if labour productivity in that industry increased at a faster rate than labour productivity in its supporting sectors (i.e., those sectors affected through the respending process). For most manufacturing industries, this is in fact the situation. Much of the indirect impact of manufacturing stems from its effect on household income and is therefore felt in trade, services, and state and local government, which are sectors experiencing comparatively small gains in labour productivity.

Explaining the increase in output multipliers over time is more difficult because of the various forces impinging upon them. However, one development in the structure of the state economy contributing to this change should be noted. Like the United States, Washington is becoming a more service-orientated economy.

Between 1960 and 1987, nonmanufacturing output in constant dollars as a fraction of the state's total production in the private sector increased from 40 to 45 percent.[11] Increasing discretionary income giving rise to a larger share of household budgets devoted to consumer services and a greater use of specialized services by industry accounted for this increase. Since such services tend to be provided locally, there was in effect a rise in the economy's propensity to purchase from state producers over time, which in turn contributed to higher output multipliers.

Table 3 Selected Ouput, Employment, and Multipliers from Interindustry Econometric Model, 1972, 1977, and 1982

Total Change in Economy Per Unit Change in Industry

	1972	1977	1982
Agriculture			
Output ($82's/$82)	2.52	2.53	2.55
Employment (jobs/job)	2.70	2.74	2.80
Income ($82's/$82)	3.08	3.10	3.14
Wood products			
Output ($82's/$82)	2.98	3.20	3.31
Employment (jobs/job)	4.51	4.93	5.20
Income ($82as/$82)	3.67	4.12	4.44
Aerospace			
Output ($82's/$82)	1.78	1.80	1.82
Employment (jobs/job)	3.18	3.50	3.88
Income ($82's/$82)	2.20	2.31	2.41
Trade			
Output ($82's/$82)	2.56	2.58	2.60
Employment (jobs/job)	2.56	2.64	2.70
Income ($82's/$82)	2.76	2.86	2.93

4 Short-Run and Long-Run Multipliers

From the standpoint of planning, it is sometimes important to know how an impact plays itself out over time. Are the effects of a new development, particularly if it is short-lived, felt immediately, or do they spill over into subsequent periods?

Economic base and input-output models are restricted to comparative static analysis, since impacts are not measured with respect to time. On the other hand, the interindustry econometric model is dynamic, permitting one to estimate short-run and long-run multipliers.

Table 4 shows the reaction of the Washington economy in terms of output, employment, and income to a permanent increase in aerospace exports beginning in 1979, according to the Washington Projection and Simulation Model. As before, the implied multipliers are based on cumulative changes. Note that the multipliers in Table 4 (under the column headed "1985") are the same as those in Table 1.

Table 4 Aerospace Output, Employment, and Income Multipliers from Interindustry Econometric Model, 1979-1985

Permanent Impact

	1979	1980	1981	1982	1983	1984	1985
Direct aerospace change							
Output ($82 mil.)	500.0	500.0	500.0	500.0	500.0	500.0	500.0
Employment (thous.)	4.5	4.4	4.3	4.2	4.1	4.0	3.9
Income ($82 mil.)	154.9	153.4	149.9	151.3	145.3	139.3	133.0
Total change in economy							
Output ($82 mil.)	667.5	955.6	1040.1	1020.5	966.6	891.5	818.6
Employment (thous.)	9.4	16.7	19.4	19.5	18.5	16.7	14.7
Income ($82 mil.)	245.3	370.3	408.3	412.2	386.6	346.5	304.9
Multipliers							
Output ($82's/$82)	1.34	1.62	1.78	1.84	1.86	1.85	1.82
Employment (jobs/job)	2.07	2.91	3.42	3.71	3.85	3.90	3.88
Income ($82's/$82)	1.58	2.00	2.23	2.36	2.41	2.43	2.41

The results of this simulation reveal a hesitancy in the economy's response to the impact. As indicated by the multipliers, the indirect effects on output, employment, and income in the initial year are about 40 percent of the size of the indirect effects in the long run. Several factors cause the economy's slow adjustment to the expansion, but two are noteworthy. First, because in-migration triggered by new job opportunities is not immediate, housing construction is delayed.[12] In fact, investment activity in general does not pick up substantially until the expansion enters its second year, as depicted in Figure 1. Second, state and local government spending does not rise as quickly as revenues in the early stages of the impact, resulting in a marginal surplus in the public accounts and a temporary leakage of funds from the respending process. The small effect that does stem from these two components of final demand in the first year is largely offset by adjustments taking place elsewhere in the economy.[13] Therefore, because of the lack of much response in the capital and public sectors, it is not coincidental that the first year multipliers from the interindustry econometric model are similar in size to the Type II input-output multipliers.

Another perspective of the temporal adjustment of the state economy to impacts is shown in Table 5. In this simulation, the increase in aerospace exports is temporary, occurring only in 1979. According to the interindustry econometric model, the indirect effects are still substantial in the second and third years. As a consequence, between 1979 and 1981, the aerospace output and income multipliers increase by about 60 percent, while the employment multiplier more than doubles. In subsequent years, the economy actually operates below its baseline projections, causing the multipliers to drop in value. These losses are due to the behavior of the investment sector. The capital (houses, buildings, and equipment) created because of the aerospace expansion is not needed in the long run, since the direct impact is temporary. Thus, investment activity in the later years of the simulation period falls below what it would have been had there been no jump in aerospace exports in 1982. In the long run, investment on net for this impact approaches zero.

Table 5 Aerospace Output, Employment, and Income Multipliers from Interindustry Econometric Model, 1979-1985

Temporary Impact

	1979	1980	1981	1982	1983	1984	1985
Direct aerospace change							
Output ($82 mil.)	500.0	0	0	0	0	0	0
Employment (thous.)	4.5	0	0	0	0	0	0
Income ($82 mil.	154.9	0	0	0	0	0	0
Total change in economy							
Output ($82 mil.)	667.5	290.5	87.8	-21.3	-68.0	-74.1	-58.8
Employment (thous.)	9.4	7.5	2.9	0.1	-1.2	-1.6	-1.5
Income ($82 mil.)	245.3	129.3	47.0	-1.5	-24.2	-30.5	-26.1
Multipliers							
Output ($82's/$82)	1.34	1.92	2.09	2.05	1.91	1.76	1.65
Employment (jobs/job)	2.07	3.72	4.35	4.38	4.11	3.75	3.43
Income ($82's/$82)	1.58	2.42	2.72	2.71	2.56	2.36	2.19

5 Conclusion

Although this investigation has been restricted to a family of demand-orientated models, the central conclusion is clear: the choice of models for impact analysis can significantly influence the final results. Regional input-output models have an advantage over economic base models because of their ability to distinguish multipliers among industries. Nevertheless, the commonly used Type II input-output multipliers can in some cases seriously underestimate impacts because of their neglect of the role of investment and state and local government in the regional economy. Moreover, since multipliers are subject to change over time, application of outdated input-output multipliers can

introduce additional imprecision into the analysis. Being derived from static models, input-output multipliers are also unable to depict the time paths of impacts. Interindustry econometric models attempt to correct some of the deficiencies of input-output models, but they too fail to consider the effects of certain possibly significant variables, such as production costs. Of course, the debate over the superiority of regional economic models will continue, since analysts cannot conduct the controlled experiments in the economy that would truly validate their models. In the meantime, users need to be aware of the models' limitations.

Acknowledgments

This paper is the result of research related to the ongoing development of the Washington Projection and Simulation Model. The author would like to express his appreciation to the public and private entities that have directly and indirectly provided financial support for this research over the past fifteen years. Current supporters include Seattle City Light, which makes use of the model in its long-range electrical energy forecasting system, the Washington Department of Trade and Economic Development, which has recently employed the model to study the impact of foreign trade on the state economy, and the The Boeing Company, which has assessed its impact on the Puget Sound community.

Notes

1. See Glickman (1977) for a more complete discussion of the specification of regional economic models.
2. There is another family of regional econometric models, namely models without an input-output framework, whose multipliers are not analyzed in this study. One of the earliest examples of this type of model is found in the work of Bell (1967).
3. For a description of the specification of a regional interindustry econometric model, see Conway (1990).
4. For the output version of the economic base model, exports are defined to include sales by industries to the rest of the U.S.,

foreign countries, and the federal government. The remaining output is nonbasic output. The parameter, r, from which the multiplier is derived, is calculated as the ratio of nonbasic output to total output.

5. Type II multipliers are the input-output multipliers most commonly used in impact analysis. Type I multipliers, which exclude the effects of household earnings and spending, have been the subject of some academic research (e.g., estimating multipliers without survey-based input-output tables) but have very little value in practice. Type III multipliers, which include state and local government as an endogenous sector, are also rarely used in applications of input-output models.
6. Income is defined as wages and salaries, proprietors' income, and other labour income. This is the definition of earnings used by the U.S. Bureau of Economic Analysis in its personal income tables.
7. Closure refers to whether sectors of the economy are included as endogenous sectors of the model. A relatively closed model has more endogenous sectors.
8. The multipliers from the interindustry econometric model in this case are in fact slightly lower than the Type II input-output multipliers. The two sets of multipliers are not the same because of other differences in the models' specifications, most notably the formulations of the household consumption function.
9. As previously noted, equations of the Washington Projection and Simulation Model are estimated with cross-sectional and time-series data. The principal source of cross-sectional information, which is used in the output equations, is the 1982 input-output study. The time-series data run annually from 1960 to 1987.
10. Bear in mind that these remarks about multipliers apply only to those given in Table 3. Generalizations about multipliers are difficult to make. Multipliers for other industries or multipliers for the same industries but defined differently--for example, employment multipliers defined as the change in total jobs per million dollars of output--may exhibit different movements.
11. Nonmanufacturing includes transportation services, communications, utilities, trade, finance, insurance, real estate, and services.
12. The simulation properties of the Washington Projection and Simulation Model have been described in Conway (1979). Note that the simulations in this study are conducted with a reformulated version of the model (Conway, forthcoming). Also, see Joun and Conway (1983) for information on the interaction between the demographic and economic submodels of the interindustry econometric model.
13. Also influencing the short-run behaviour of the economy in its attempt to accommodate the additional aerospace production are a rise in labour productivity, an increase in the propensity to import, and a decrease in transfer payments. In each case, the effect tends to minimize the indirect effects of the expansion in the first year.

PART III
APPENDIX D

"THE FOREST PRODUCTS ECONOMIC IMPACT STUDY CURRENT CONDITIONS AND ISSUES"

Paper by Richard S. Conway, Jr.
Dick Conway & Associates

THE FOREST PRODUCTS ECONOMIC IMPACT STUDY

CURRENT CONDITIONS AND ISSUES

Prepared for

Washington Forest Protection Association
Washington State Department of Natural Resources
Washington State Department of Trade and Economic Development

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PREFACE

Sponsored by the Washington Forest Protection Association, Washington State Department of Natural Resources, and the Washington State Department of Trade and Economic Development, this study is an update of "The Forest Products Economic Impact Study" published in 1991. As in the previous study, the centerpiece is an economic impact analysis of the forest products industry on the Washington state economy. Impact estimates are made for seven major industry groups (logging, sawmills, paper mills, etc.) and for six categories of public and private land ownership. The forest products industry's impact is estimated for 1992, the latest year for which there is sufficient information to conduct the analysis.

The study also investigates the economic impact of two public policies that will affect the forest products industry in Washington state for years to come: the reduction in timber harvests on forest lands to protect the northern spotted owl and other endangered species; and the log export ban on timber harvested from state trust lands. It should be stressed that this part of the study, like the section on the industry's prospects, is more speculative than the rest. Nevertheless, considering the significance of these policies, we felt that it was important to estimate their impact on the forest products industry and the rest of the Washington economy.

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February 28, 1994

THE FOREST PRODUCTS ECONOMIC IMPACT STUDY

Executive Summary

This study is an update of "The Forest Products Industry Impact Study," which analyzed the economic impact of the forest products industry on the Washington State economy in 1988. The current study covers recent developments in the industry, it's impact on the economy in 1992, and the industry's prospects for the rest of the 1990s. In addition, the study assesses the impact of two important public policies affecting the industry: timber harvest restrictions to protect the northern spotted owl and other endangered species; and a log export ban on timber removed from state trust lands. As in the previous study, this investigation draws upon the analytical capabilities of the Washington Projection and Simulation Model, an interindustry econometric model designed to measure the impact of changes in one industry on the rest of the state economy.

Since 1988 the forest products industry has endured a national recession, severe restrictions placed on public timber supply in the Pacific Northwest, a slump in the Japanese housing market, and heightened price competition from new suppliers in world markets:

- In response to a 16 percent drop in real housing investment between 1988 and 1991, U.S. softwood lumber production fell 23 percent, while structural panel production declined 11 percent.

- In Washington State, every performance measure of the lumber and wood products industry has dropped significantly over the last five years.

- Exacerbated by timber harvest restrictions on public lands, Washington's timber harvest in 1992 was 29 percent below the 1988 volume.

- Between 1988 and 1992, Washington log exports fell 38 percent, structural panel production dropped 27 percent, and lumber output declined 8 percent.

- During the period, the Washington lumber and wood products industry lost about 5,000 jobs, most of them in the Olympic Peninsula and Lower Columbia regions, where lack of access to timber on national forest lands shut down many mills.

- Compared to the lumber and wood products industry, the pulp and paper products industry fared better, as it expanded output by 10 percent between 1988 and 1992 and added 1,000 jobs.

In spite of problems in the forests and the mills, forest products is still Washington's second largest manufacturing industry, behind transportation equipment (primarily aircraft):

- In 1992, the forest products industry produced $11.5 billion of output, employed more than 58,000 people, and paid $2.2 billion in wages, salaries, and other labor income.

- The industry accounted for 17 percent of manufacturing output, 16 percent of manufacturing employment, and 15 percent of manufacturing labor income in Washington.

- Lumber and wood products continued to be the larger of the two forest products sectors, producing $6.2 billion of output, employing 40,850 workers, and paying $1.4 billion in labor income.

- In 1992, the pulp and paper products industry produced $5.3 billion of output, employed 17,660 people, and paid $800 million in income.

- According to the 1992 Washington forest products input-output table constructed for this study, the forest products industry spent $5.9 billion for goods and services in the state.

The forest products industry's contribution to the Washington economy is much larger than its value of production or the number of people that it employs. Taking into account its direct and indirect impact (through the so-called multiplier process), the forest products industry supported nearly eight percent of Washington's total economic activity in 1992:

- Forest products directly and indirectly accounted for $9.4 billion or 7.7 percent of total Gross State Product.

- The industry supported about 213,000 jobs, representing one out of every thirteen jobs in the state.

- Washington's dependence on forest products declined from 14 percent of total employment in 1960 to 7 percent in 1992.

- In 1992, forest products directly and indirectly accounted for $8.5 billion or 7.8 percent of personal income in the state.

- Along with transportation equipment (primarily aircraft) and agriculture (including food processing), forest products remains one of the state's three most important basic (exporting) industries.

- The impact of lumber and wood products amounted to 4.1 percent of Gross State Product, 4.1 percent of employment, and 4.3 percent of personal income.

- In 1992, pulp and paper products accounted for 3.6 percent of Gross State Product, 3.3 percent of employment, and 3.6 percent of personal income.

Nearly three-fourths of the logs used by the forest products industry in 1992 came from private lands. As a consequence, private lands accounted for the major portion of the industry's impact on the Washington economy:

- In 1992, private lands, largely owned by the forest industry, provided 74 percent of the logs for consumption.

- National forest lands accounted for another 12 percent of the logs, while state lands accounted for 9 percent.

- Washington timber lands directly and indirectly supported about 160,000 jobs in the economy.

- The remaining 53,000 jobs were supported by wood fiber (primarily chips and mill residue for pulp and paper) obtained from other states and Canada.

- Private lands owned by the forest industry had the largest economic impact on the state, generating 83,000 jobs or 2.9 percent of state employment.

- About 24,000 jobs were dependent upon federal lands, while 15,000 jobs were dependent upon state lands.

Restrictions on federal timber lands to protect the northern spotted owl, which became effective in late 1990, coincided with a sharp decline in lumber demand, as the national economy succumbed to a recession. Unlike previous slumps in the forest products industry, however, this one will not be followed by a rebound because of restrictions placed on logging:

- Option 9, the Clinton administration's preferred alternative for timber harvests on federal lands, calls for a 81 percent logging reduction in national forests.

- The annual timber harvest in Washington is expected to decline from 6.1 billion board feet, the 1980-89 average, to 4.5 billion million board feet.

- The timber harvest restrictions will result in a loss of about 10,600 jobs in lumber and wood products and 1,300 jobs in pulp and paper products.

- The total economic impact on the Washington economy will amount to $1.8 billion in Gross State Product (in 1992 dollars), 40,000 jobs, and $1.6 billion in personal income, about 1.3 percent of the economic activity projected for the state in 1995.

The decision to preserve forests as habitat for the northern spotted owl has prompted several responses to mitigate the adverse economic effects of reduced timber harvests. One measure, enacted by the state, prohibits the export of timber removed from trust lands managed by the Washington Department of Natural Resources. This restriction will cut job losses in local mills, but it will also reduce revenue from state trust lands, since exported logs are sold at a premium, and will lead to fewer jobs at log-exporting ports:

- In the past, approximately 60 percent of the timber removed from state lands was exported.

- In 1992, a partial ban diverted 136 million board feet of timber into the domestic market that otherwise would have been exported, thereby reducing log exports to only 32 percent of the harvest from state lands.

- This addition to domestic supply had the potential of increasing Washington mill jobs by 1,120 but decreasing log-exporting port jobs by 180.

- The foregone revenue to the state that would have been earned from the export premium amounted to $18.7 million.

- Taking into account the indirect effects on the state economy, the log export restrictions had the potential of saving, on net, about 2,500 jobs in Washington State.

- There are several reasons to believe that the policy was less effective than the potential impact, including the fact that some of the restricted timber was sold to mills in Oregon.

- Even in the best case, the cost of saving mill jobs is high, amounting to nearly $17,000 per worker.

The forest products industry, especially lumber and wood products, faces a difficult future, primarily because of the public policies to restrict timber harvests on public lands:

- The total timber harvest in the state during the latter half of the 1990s is expected to be one-fourth less than the 1980-89 average harvest level.

- A ban on log exports from state-owned lands and responses to higher domestic log prices will divert some log exports into local mills for further processing.

- In spite of policies to encourage domestic processing, the lumber and wood products industry is expected to have 11,000 fewer jobs in 2000 than it did in 1988, when industry employment last peaked.

- The pulp and paper industry will experience some shortage of wood fiber but should experience modest gains in output and relatively stable employment.

- The number of Washington jobs dependent upon the forest products industry is projected to drop to about one in eighteen by the end of the decade.

Although increasingly smaller numbers of people will be engaged in the forest products industry, it will continue to give the Washington economy a firm foundation. In some ways, it will emerge from its current problems a much stronger industry. The scarcity of timber created by the forest preservation policies will enhance the value of the state's timber resource. This should financially bolster the state's forest products companies, particularly the land-owning companies. Higher financial returns to the resource will encourage more intensive and careful management of commercial forest land. A higher valued resource will further spur the trend towards more efficient wood use and higher value-added products. In the short-term, the outlook is bleak, especially in the timber-dependent communities along Washington's ocean coast, which are coping with mill closures, double-digit unemployment rates, declines in real income, and an out-migration of people. Once the forest products industry makes the transition to lower harvest levels, however, prospects should brighten.

THE FOREST PRODUCTS ECONOMIC IMPACT STUDY

1. INTRODUCTION

This study is an update of "The Forest Products Industry Impact Study" published in 1991, which analyzed the economic impact of the forest products industry on the Washington State economy in 1988. During the ensuing years, the industry has dealt with a recession, timber harvest restrictions on national forest lands, and a ban on exporting logs from state trust lands. While the forest products industry, especially lumber and wood products, has been adversely affected by these events and is now operating below its 1988 level, it remains an important part of the Washington economy.

The purpose of this study is to review developments in the forest products industry since 1988, estimate the industry's impact on the state economy in 1992, and assess the industry's prospects for the rest of the 1990s. In addition, the study analyzes the impact of two important public policies affecting the industry: timber harvest reductions designed to protect the northern spotted owl and other endangered species; and a log export ban on timber removed from state trust lands. As in the previous study, the investigation draws upon the analytical capabilities of the Washington Projection and Simulation Model, an interindustry econometric model designed to measure the impact of changes in one industry on the rest of the state economy.

2. RECENT INDUSTRY DEVELOPMENTS

National Recession and Recovery

In recent years, the U.S. forest products industry has been hit by a national recession, severe restrictions placed on public timber supply, and heightened price competition from new suppliers in world markets. Lumber and wood products suffered a production slump between 1988 and 1991, while paper products managed only slight gains. Output picked up in both industries in 1992 and 1993 but without much recovery in jobs.

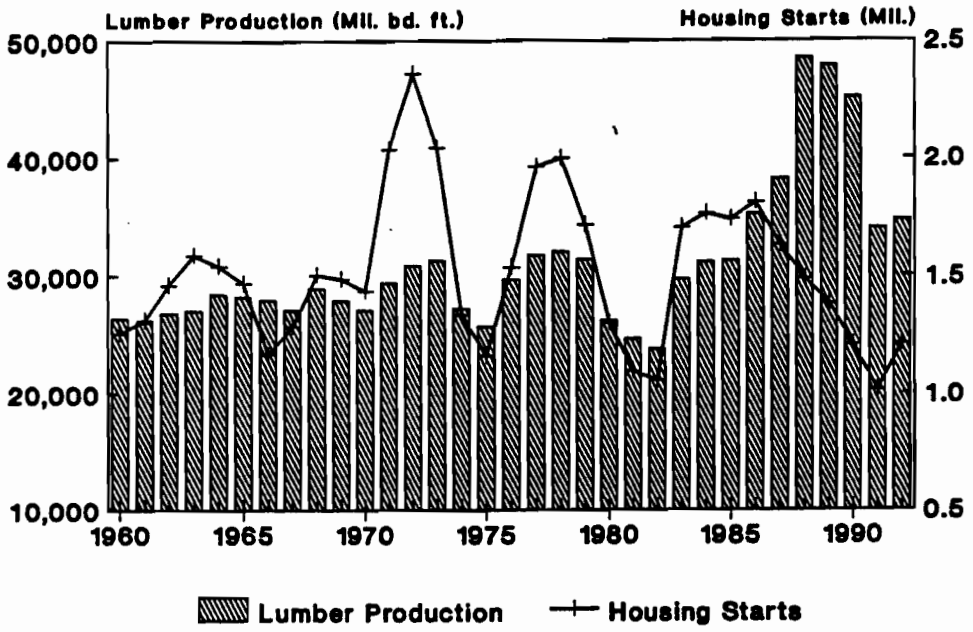
The 1990-91 national recession was, in one sense, short and mild. Between the peak in the second quarter of 1990 and the trough in the first quarter of 1991, real Gross Domestic Product (GDP) declined about two percent, close to the average loss of the six previous recessions. Industrial production fell much less than in past recessions, leading to a smaller than usual decline in employment. At its highest point, the unemployment rate reached 7.5 percent, a full two percentage points below the peak rate of the 1981-82 recession.

But the economy was in much worse shape than indicated by the small peak-to-trough changes in output and employment. The three-year period encompassing the recession was among the weakest on record since World War II. Between the second quarter of 1989 and the third quarter of 1992, real GDP managed to expand only 2.4 percent.

Construction and related activities incurred significant losses because of this prolonged period of sluggish growth. Between 1988 and 1991, housing investment in constant dollars declined 16 percent. National housing starts slumped from a high of 1.6 million units in 1987 to a low of 1.0 million in 1991, resulting in a 23 percent drop in lumber production and a 11 percent decline in structural panel production between 1988 and 1991. The U.S. production index for lumber and

Figure 2-1

U.S. SOFTWOOD LUMBER PRODUCTION
AND HOUSING STARTS



wood products, the most comprehensive measure of output in the industry, fell nearly 10 percent. Of the 769,000 employees working in the lumber and wood products industry in 1988, roughly 100,000--nearly one out of every eight--lost their jobs during the following three years.

While the recovery from the national recession has been anemic, at least by historical standards, housing starts have rebounded nearly 30 percent since 1991, helped by the lowest mortgage rates in two decades. This has boosted the demand for lumber, but has created only a handful of new jobs in the lumber and wood products industry.

The ability of the industry to respond to the upturn in the housing industry has been hampered by a 75 percent reduction in timber harvests on federal lands in the Pacific Northwest. In 1990, the U.S. Fish and Wildlife Service designated more than five million acres of land in California, Oregon, and Washington as critical habitat for the northern spotted owl. Federal courts have virtually halted timber sales on all federal lands managed by the U.S. Forest Service and the Bureau of Land Management until the agencies submit forest plans that adequately protect the endangered owl. The shortage of timber caused by these actions has closed more than 100 lumber and plywood mills in the region and doubled the price of Douglas fir. To meet material requirements of the housing market, buyers have turned to foreign suppliers. According to U.S. Department of Commerce figures, the value of lumber and wood products imported into the United States has increased nearly 50 percent since 1991.

High timber prices, combined with a stumbling Japanese economy and pressure on Japan to import more lumber, have also reduced the demand for log exports. Trade figures show that the volume of

Table 2-1

WASHINGTON STATE FOREST PRODUCTS OUTPUT, EMPLOYMENT, AND LABOR INCOME, 1960-1992

Millions of 1992 Dollars and Number of Jobs

	Lumber and Wood Products			Pulp and Paper Products		
Year	Output	Employment	Labor Income	Output	Employment	Labor Income
1960	3,461.5	47,760	1,107.0	2,265.7	18,020	506.0
1961	3,450.3	44,730	1,059.9	2,365.9	17,900	516.5
1962	3,652.6	46,080	1,113.7	2,444.9	18,360	534.0
1963	3,827.0	46,700	1,189.4	2,593.8	18,860	561.8
1964	4,283.4	49,550	1,324.0	2,724.1	19,310	594.8
1965	4,430.1	49,480	1,359.2	2,818.8	19,840	623.4
1966	4,499.8	48,900	1,381.3	2,904.1	20,330	652.1
1967	4,461.4	45,880	1,303.7	2,844.4	19,940	643.4
1968	4,737.4	48,600	1,435.0	3,028.0	19,990	675.5
1969	4,626.0	48,600	1,453.7	3,106.6	20,030	701.3
1970	5,307.6	45,350	1,405.3	3,071.8	19,840	707.4
1971	5,428.8	46,270	1,459.6	2,918.6	18,070	665.0
1972	5,931.5	49,440	1,662.9	3,098.6	18,230	714.1
1973	5,810.9	52,280	1,789.4	3,116.0	17,640	703.1
1974	6,054.1	51,310	1,718.0	2,893.5	17,640	706.9
1975	6,813.6	49,990	1,664.2	2,732.4	16,460	682.1
1976	7,605.7	53,900	1,940.9	3,211.1	17,430	766.4
1977	7,990.0	57,570	2,126.0	3,634.7	17,640	810.4
1978	7,649.4	59,330	2,295.7	3,139.6	13,980	683.9
1979	7,348.2	57,710	2,254.5	3,542.1	15,830	795.7
1980	6,961.7	50,660	1,954.5	3,640.6	17,540	845.7
1981	6,748.5	47,540	1,747.1	3,546.5	17,280	824.7
1982	6,233.2	42,090	1,509.3	3,466.9	16,090	774.3
1983	6,621.6	45,050	1,622.2	3,808.1	15,800	787.0
1984	6,811.8	44,300	1,565.2	4,028.7	16,120	832.9
1985	6,693.7	41,410	1,433.2	4,390.8	16,660	846.8
1986	7,054.4	41,880	1,459.3	4,667.2	16,670	843.2
1987	7,401.1	43,930	1,482.9	4,731.1	16,670	840.8
1988	7,284.5	45,550	1,497.8	4,855.4	16,750	827.2
1989	7,112.3	45,430	1,494.4	5,247.5	17,980	876.4
1990	6,563.3	43,680	1,407.7	5,335.4	18,400	867.4
1991	6,075.4	40,490	1,318.8	5,102.7	17,940	849.5
1992	6,211.8	40,850	1,371.2	5,312.3	17,660	822.3

Sources: U.S. Bureau of the Census and U.S. Bureau of Economic Analysis.

softwood logs shipped to Japan from all countries declined 25 percent between 1989 and 1992. Data on Washington and other west coast ports indicate that U.S. log shipments dropped 32 percent, implying that U.S. log exporters have lost market share to exporters in New Zealand and the former countries of the Soviet Union.

The story for lumber exports is much the same. Following a three-year period of slow decline, Japanese lumber imports jumped in 1993 to a record level, as increased public funding spurred housing starts. Not only did the demand for imported lumber rise between 1989 and 1993, but the market share captured by North American suppliers climbed from 69 percent to 76 percent. But only Canada increased penetration of the Japanese lumber market. According to customs data, softwood lumber exports from U.S. ports declined by 25 percent during this time period, primarily because of the timber shortage in the Pacific Northwest.

Benefiting from more stable and diversified markets, pulp and paper production did not succumb to the 1990-91 recession. Instead, it has experienced slow but steady advances in recent years. As in the past, the industry has in general grown along with the national economy. Between the 1988 and 1992, the production index for pulp and paper increased five percent, nearly matching the six percent gain in real GDP. In response to the pick-up in the economy, which led to improved sales of corrugated packaging, newsprint, and office supplies, pulp and paper output increased about four percent in 1993. But, in spite of increasingly higher production levels, industry employment in the United States has remained around 690,000 jobs over the past five years.

Developments in Washington

Since 1960 the forest products industry in Washington has experienced substantial long-run gains in real output and real labor income (wages, salaries, proprietors' income, and other labor income).[1] While industry employment declined from 65,780 jobs in 1960 to 58,510 in 1992, output doubled and income increased by more than one-third (Table 2-1).[2] In general, the

Table 2-2

WASHINGTON STATE FOREST PRODUCTS GROWTH RATES, 1960-1992

Average Annual Percent Change

	Output	Employment	Labor Income
Forest products	2.2	-0.4	1.0
Lumber and wood products	1.8	-0.5	0.7
Pulp and paper products	2.7	-0.1	1.5

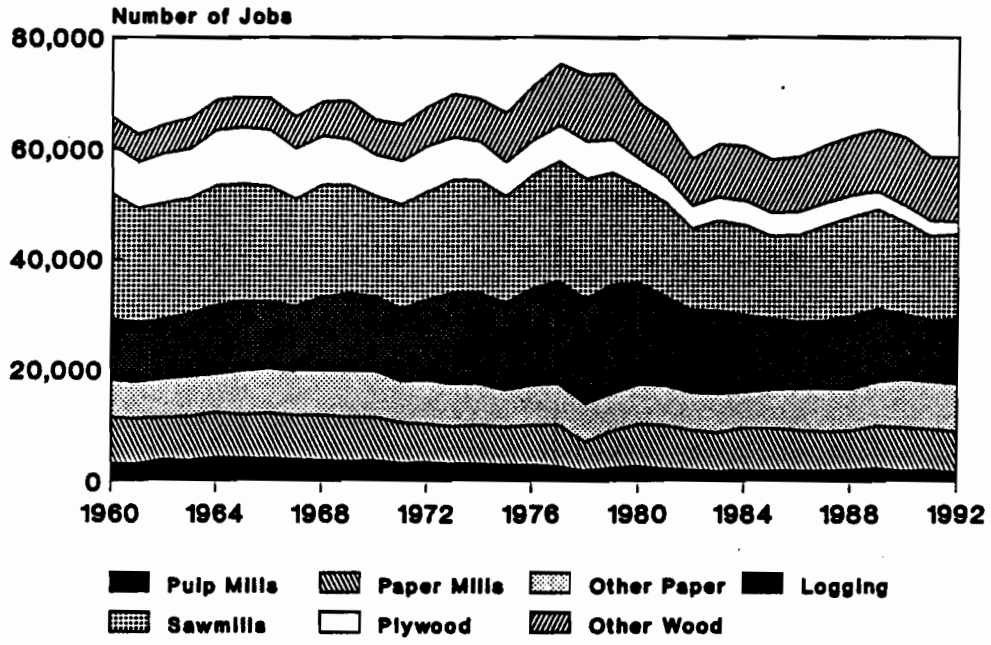
[1]For further information on growth trends and market factors in the forest products industry, refer to the "Forest Products Economic Impact Study" published in 1991.

[2]Sources of data in tables are shown except in cases where figures are study estimates.

secondary sectors of the industry have expanded more rapidly than the primary sectors. The primary sectors are those industries--logging, sawmills and planing mills, veneer and plywood mills, and pulp mills--engaged in first-stage processing of timber. With the exception of logging, the primary sectors have seen relatively little growth in output and substantial declines in employment (Figure 2-2). In other wood products, the strongest segment of the industry, output and labor income have tripled and employment has doubled over the past three decades. This growth in other wood products is indicative of the continuing diversification of the forest products industry and an increasing reliance on secondary ("value-added") production.

Figure 2-2

WASHINGTON STATE FOREST PRODUCTS EMPLOYMENT



In recent years, the forest products industry, especially on the wood side, has not fared as well. In fact, because of a relatively weak housing market in the United States, reduced exports overseas, and timber harvest restrictions on public lands, every performance measure of the Washington lumber and wood products industry has dropped significantly since 1988 (Table 2-3). The timber harvest in Washington declined from 7.0 billion board feet (Scribner scale) in 1988 to 5.0 billion board feet in 1992, and early reports point to an even lower harvest in 1993 (Figure 2-3). The harvest from public lands has dropped by more than one half. Between 1988 and 1992, log exports fell 38 percent, while structural panel production declined 27 percent. The large reduction in log exports did help domestic lumber production by making more wood available for milling. As a consequence, lumber production declined only 8 percent, resulting in a loss of 2,000 sawmill jobs. Overall, output in the state's lumber and wood products industry dropped 15 percent between 1988 and 1992, while employment fell 10 percent and labor income declined 8 percent.

Table 2-3

PERFORMANCE MEASURES OF WASHINGTON STATE FOREST PRODUCTS INDUSTRY, 1988 AND 1992

	1988	1992	Percent Change
Timber harvest (mil. bd. ft.)	7,045	5,018	-28.8
Private lands	4,406	3,844	-12.8
Public lands	2,639	1,174	-55.5
Timber sold on public lands (mil. bd. ft.)	2,301	692	-69.9
Uncut timber under contract (mil. bd. ft.)	3,919	1,821	-53.5
National forest lands	3,095	1,040	-66.4
State trust lands	824	781	-5.2
Log exports (mil. bd. ft.)	2,847	1,771	-37.8
Lumber production (mil. bd. ft., lumber tally)	4,408	4,072	-7.6
Structural panel production (thous. sq. ft.)	1,586	1,156	-27.1
Pulp production (mil. short tons)	4,597	4,574	-0.5

Sources: Washington State Department of Natural Resources, U.S. Forest Service, and American Paper Institute.

Table 2-4

WASHINGTON STATE LUMBER AND WOOD PRODUCTS WAGE AND SALARY EMPLOYMENT BY REGION, 1988 AND 1992[1]

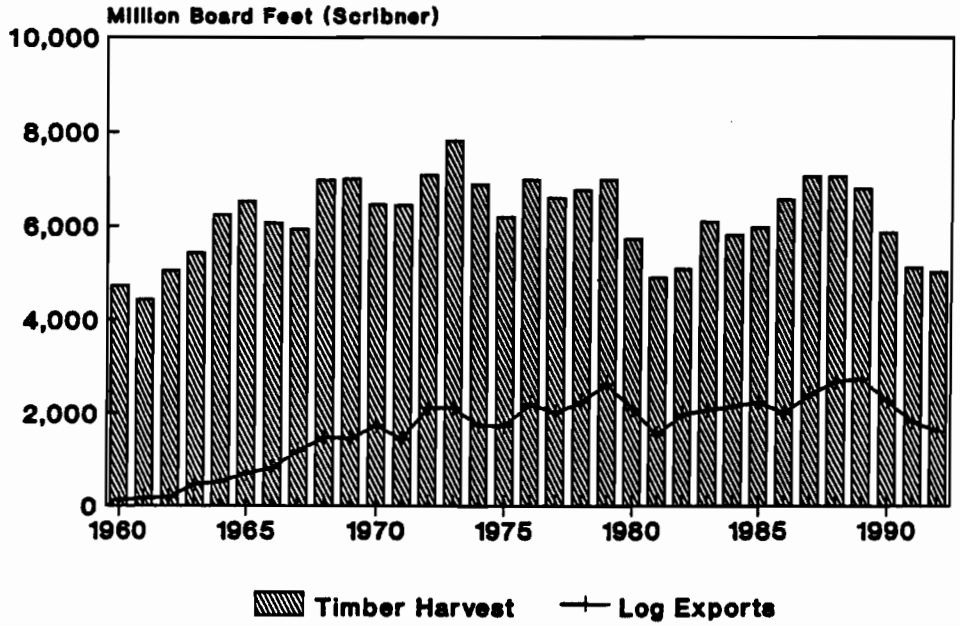
	1988	1992	Change	Percent Change	Percent of Total Change
Puget Sound Region	16,460	15,480	-980	-6.0	18.3
Olympic Peninsula Region	11,240	8,780	-2,460	-21.9	46.0
Lower Columbia Region	6,860	5,140	-1,720	-25.1	32.1
Eastern Washington	6,640	6,450	-190	-2.9	3.6
Washington State	41,200	35,850	-5,350	-13.0	100.0

[1]Excludes self-employed workers and not strictly comparable to other employment figures in this report.

Source: Washington State Employment Security Department.

Figure 2-3

WASHINGTON STATE TIMBER
HARVEST AND LOG EXPORTS



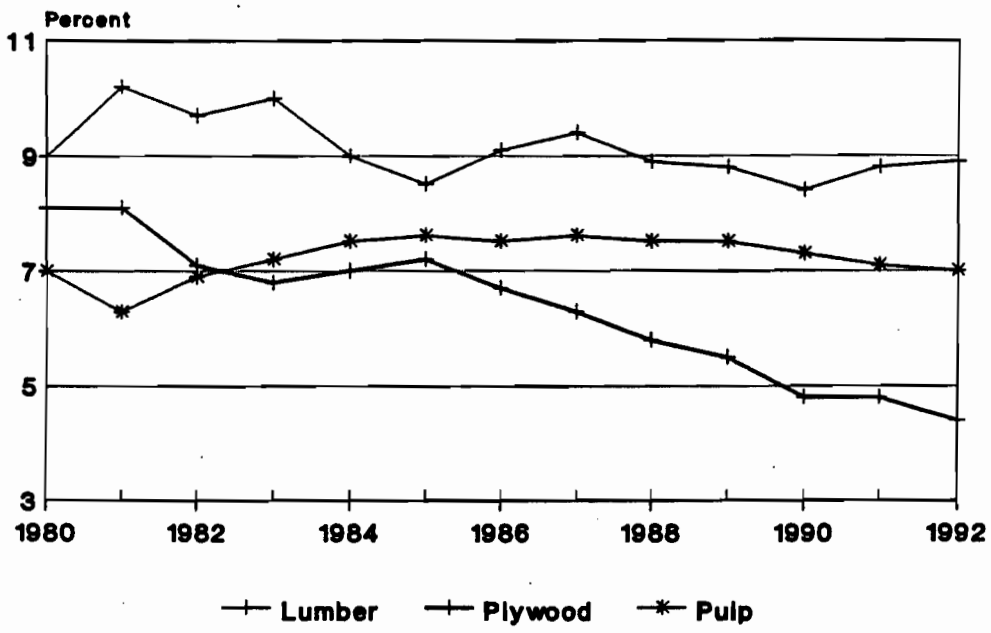
The severe harvest restrictions placed on federal timber lands meant that the downturn was highly concentrated in regions of the state whose mills relied on public timber. The hardest hit regions were the Olympic Peninsula and Lower Columbia, where nearly one-fourth of the workers in lumber and wood products lost their jobs (Table 2-4). Those two regions accounted for 4,180 of the 5,350 wage and salary jobs lost in Washington between 1988 and 1992. In other words, with only 44 percent of the state's lumber and wood products jobs in 1988, the Olympic Peninsula and Lower Columbia regions bore 78 percent of the job loss. Not surprisingly, counties like Pacific and Grays Harbor are currently running double-digit unemployment rates.

There is no doubt that timber harvest restrictions hurt the industry, but lumber and wood products would have still suffered output, employment, and income losses because of the national housing slump and the downturn in log exports to Japan. In some respects, the timber downturn was no worse in Washington than the rest of the nation. As noted previously, the U.S. lumber and wood products industry lost one-eighth of its jobs in just three years. The loss in Washington, though still substantial, amounted to only one in nine jobs. Much of the employment loss took place in sawmills, especially those located along the Pacific coast, but lumber production fell no more in Washington than elsewhere. The state's share of U.S. lumber production remained at 9 percent during the course of the industry's nationwide slump (Figure 2-4). The Washington veneer and plywood industry did lose market share, but that was in part the continuation of a 20-year trend.

Compared to lumber and wood products, paper products held up reasonably well, though it too had to cope with a shortage of raw material. Between 1988 and 1992, Washington pulp and

Figure 2-4

WASHINGTON STATE SHARE OF
U.S. FOREST PRODUCTS



paper production in constant dollars increased 9 percent, with most of the gain coming in 1989 and 1990. The 1990-91 recession not only softened the demand for paper but also resulted in a smaller supply of wood chips, the chief ingredient for pulp, as Washington sawmills curtailed lumber production. The rising cost of chips, coupled stable paper prices, damaged the local industry's competitiveness and cut deeply into profits. The loss of market share resulted in a slight dip in output in 1991. In an effort to rein in costs, the Washington pulp and paper industry has eliminated nearly 1,500 jobs since 1990 and kept wage hikes below the general inflation rate. As a result, there has been a six percent decline in the real income earned by pulp and paper workers.

In spite of problems in the forests and mills--timber shortages, rising production costs, loss of market share, and fewer jobs--the forest products industry is second only to transportation equipment as Washington's largest manufacturing industry. In 1992, the last year for which there is a complete set of industry statistics, the forest products industry produced $11.5 billion of output, as shown in Table 2-5. Counting both employees on payroll and self-employed workers, the industry employed more than 58,000 people and paid $2.2 billion in wages, salaries, and other labor income. The industry accounted for 17 percent of manufacturing output, 16 percent of manufacturing employment, and 15 percent of manufacturing income in the state (Figure 2-5).

Lumber and wood products is still the larger of the two forest products sectors. In 1992, the $6.2 billion industry employed 40,850 workers, accounting for seven out of every ten jobs in forest products. The largest industry in lumber and wood products was sawmills (15,240 workers) and the smallest was plywood mills (2,230). Logging (11,580) and the fast-growing other wood products (11,800) were similar in size. Other wood products encompasses a variety of products

and activities. Its major components in 1992, according to wage and salary employment figures, were millwork (4,380), wood kitchen cabinets (1,320), structural wood members (960), mobile homes (820), wood preserving (570), wood pallets and skids (530), and prefabricated wood buildings (510). Other wood products also included wood containers, particleboard, poles, wood fencing, dowels, and miscellaneous wood products, which together accounted for approximately 1,300 jobs.

Table 2-5

WASHINGTON STATE FOREST PRODUCTS OUTPUT, EMPLOYMENT, AND LABOR INCOME, 1992

Millions of Dollars and Number of Jobs[1]

	Output	Percent of Total	Employment	Percent of Total	Labor[2] Income	Percent of Total
Forest products	11,524.1	100.0	58,510	100.0	2,193.5	100.0
Lumber and wood products	6,211.8	53.9	40,850	69.8	1,371.2	62.5
Logging	2,377.6	20.6	11,580	19.8	408.2	18.6
Sawmills	2,190.2	19.0	15,240	26.0	578.3	26.4
Plywood	378.2	3.3	2,230	3.8	72.0	3.3
Other wood	1,265.8	11.0	11,800	20.2	312.7	14.3
Pulp and paper products	5,312.3	46.1	17,660	30.2	822.3	37.5
Pulp mills	500.2	4.3	1,800	3.1	92.7	4.2
Paper mills	2,525.2	21.9	7,240	12.4	374.9	17.1
Other paper	2,286.9	19.8	8,620	14.7	354.7	16.2

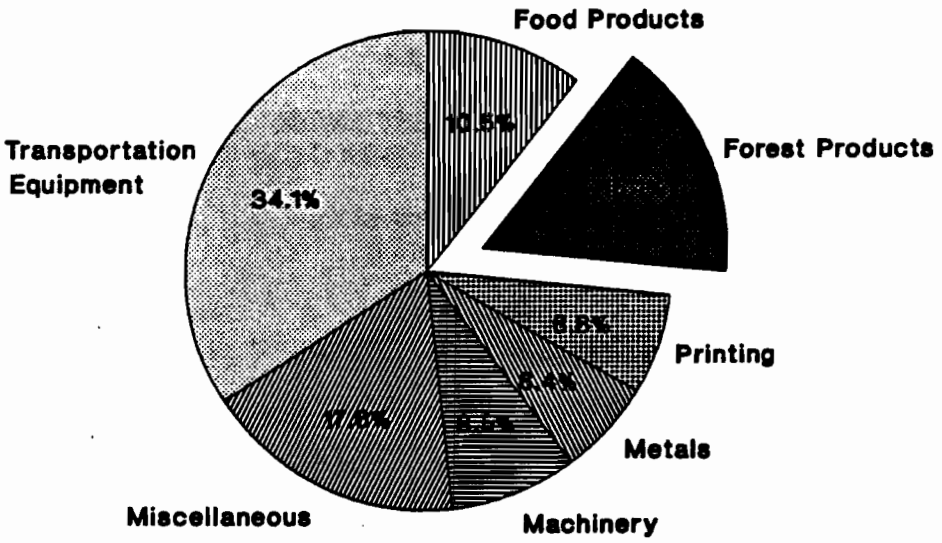
[1]Includes full-time and part-time wage and salary employees and proprietors.
[2]Includes wages, salaries, proprietors' income, and other labor income.

In 1992, paper products was a $5.3 billion dollar industry and employed 17,660 people. Pulp and paper mills accounted for 9,040 jobs or more than one-half of the total industry employment.[3] Other paper products employed 8,620 people. The major components of other paper products included corrugated and solid fiber boxes (1,630), paperboard mills (1,580), plastic, foils, and coated paper bags (1,060), folding paperboard boxes (620), sanitary paper products (480), uncoated papers and multi-wall bags (370), fiber cans and drums (300), envelopes (230), sanitary food containers (140), and die-cut paper, paperboard, and cardboard (110).

[3]The data on pulp mills in Table 2-5 understate the importance of pulping activity in the state. Since establishments are classified according to their primary activity, pulp produced by integrated paper mills is included as part of the output of paper mills. The estimates of output, employment, and labor income presented in this study are consistent in definition with the estimates published in the *Census of Manufactures*.

Figure 2-5

WASHINGTON STATE MANUFACTURING EMPLOYMENT 1992



Note: Transportation equipment includes primarily aircraft.

Table 2-6

WASHINGTON STATE TIMBER TAXES, 1992

Millions of Dollars

	Taxes
Business and occupation tax	$44.9
Lumber and wood products	29.6
Pulp and paper products	14.1
Forestry	1.3
Property tax on forest lands	5.7
Timber excise tax	63.0
Private timber harvest	50.0
Public timber harvest	13.0
Total	$113.6

Source: Washington State Department of Revenue.

In addition to being a major employer, the forest products industry paid $113.6 million in timber related taxes in 1992 (Table 2-6). The largest payment was $63.0 million for the timber excise tax, a five percent tax on the stumpage value of timber harvested for commercial purposes. This tax is imposed on property in lieu of assessment and taxation under the property tax. The business and occupation tax, a 0.484 percent tax on gross receipts for the privilege of engaging in business in the state, amounted to $44.9 million. The taxes on forest lands subject to the property tax totaled $5.7 million.[4]

3. IMPACT OF FOREST PRODUCTS

Note on Methodology

The ability of a region to export is a key determinant of its economic health. In the context of the Washington State economy, exports are broadly defined to include sales of locally produced goods and services to foreign markets and customers in the rest of the United States (including the federal government).[5] Sales outside the region not only create employment opportunities in the state's export industries but also support jobs in other industries, such as retail trade and consumer services, through the so-called multiplier process.

The Washington Projection and Simulation Model (WPSM) is a means of measuring the total (direct and indirect) impact of forest products exports on the state economy. Using WPSM, the behavior of the economy is first simulated with forest products exports to produce a baseline projection over a period of time. The simulation is then repeated but without forest products exports to yield a conditional projection of the state economy. The difference between the two projections is a measure of the total impact of forest products exports. Since WPSM is a comprehensive model of the Washington economy, the impact can be expressed in terms of production, employment, and income by industry, labor force, the unemployment rate, resident population, personal income, consumption expenditures, state and local government spending, and fixed investment, among other economic and demographic variables.

In order to gauge the forest products industry's total impact on the state economy, the simulation is run by reducing the industry's final sales to zero. Final sales for manufacturing industries are composed largely of exports (i.e., out-of-state sales). For forest products, exports account for 90 percent of the industry's final sales. Other forest products final sales include, for example, sales of lumber to the Washington construction industry. If the simulation were run only with regard to exports, the simulation would show that some of the forest products industry remained (e.g., lumber production for Washington housing). In other words, by including all final sales in the industry's direct impact, the simulation is effectively showing what the Washington economy would be like without any forest products activity at all.

Industry Structure

The impact of the forest products industry on the Washington economy stems from its employment, labor income, and expenditures for goods and services in the state associated with final sales.

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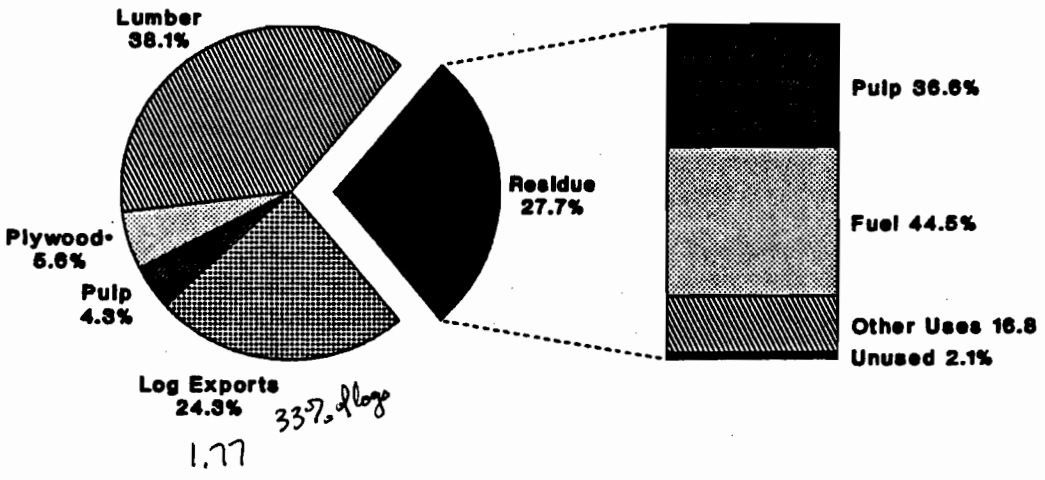
[4]The industry pays other taxes, such as the retail sales tax and the motor fuel tax, but information on their amounts is unavailable.

[5]The technical appendix provides additional information on the definitions, conventions, data, and methodology used in this study.

Compared to other industries in the state, the forest products industry has strong ties to the rest of the economy. As indicated in Figure 3-1, which describes the use of logs, the seven forest products industries themselves are highly interrelated. According to estimates based on mill surveys conducted by the Washington State Department of Natural Resources, forest products operations in the state used the equivalent of 7.3 billion board feet of logs in 1992. The primary uses of logs (principally log exports, lumber, plywood, and pulp) consumed 5.3 billion board feet.[6] Mill residue, originating largely from lumber and plywood mills, accounted for the remaining 2.0 billion board feet. The two major uses of logs were lumber (2.8 billion board feet) and log exports (1.8 billion board feet). Plywood mills consumed 0.4 billion board feet, while pulp mills used 0.3 billion board feet. However, pulp mills also received wood fiber in the form of chips, sawdust, and shavings. As shown in the figure, pulp mills consumed about one-third of the mill residue (sawdust and shavings) generated in the state. After taking into account other uses of mill residue (e.g., fuel), very little of the wood fiber harvested in 1992 (about 0.6 percent) was wasted.

Figure 3-1

LOG USE IN WASHINGTON STATE, 1992



*Includes shake, shingle, post, and pole (1.4%)

Figure 3-1 illustrates the basic links within the forest products industry but does not provide a complete picture of the industry's structure, especially with regard to its ties to other sectors of the state economy. An input-output table shows how industries, households, and other sectors of the economy are interrelated. Shown in Table 3-1 is a Washington forest products industry input-

[6]The total primary use of logs in a given year is approximately equal to that year's timber harvest. In 1992, the Washington timber harvest was 5.0 billion board feet, compared to 5.3 billion board feet of logs consumed for primary use.

output table for 1992. This table, which has been developed specifically for this study, represents a partial update of the 1987 Washington input-output table (Chase, Bourque, and Conway, 1993).

The sales (i.e., the distribution of output) of an industry, expressed in millions of dollars, are shown across the row, while the purchases (i.e., the distribution of input) are shown down the column. For example, in 1992, sawmills produced $2,190.2 million of output. Looking across the sawmills' row, exports to the rest of the United States and exports to foreign countries represented the sawmill industry's two largest markets, together accounting for $1,285.8 million in sales. Sawmills also sold output to other firms in the forest products industry, including $48.2 million of mill residue and wood chips to pulp mills. Other sales (e.g., sales to the Washington construction industry) were estimated to be $228.6 million.

Looking down the sawmill column, sawmills purchased $658.6 million of logs from logging and $88.0 million of services from transportation (primarily trucking) in the course of production. Overall, sawmills purchased $1,470.6 million of goods and services from other industries, of which $160.0 million were imported. The industry employed 15,240 people, who earned $578.3 million in wages, salaries, proprietors' income, and other labor income. Another $141.3 million in expenditures covered the non-wage categories of value added, such as employers' contributions to social insurance, depreciation, rent, net interest payments, indirect business taxes, and profit. Note that, following input-output accounting conventions, total industry output (the sum of sales across the row) equals total industry input (the sum of purchases down the column).

Regarding the nature of the impact of the forest products industry on the Washington economy, the input-output table reveals several noteworthy characteristics:

1. Exports and other final sales. As in the past, the forest products industry is highly dependent upon external markets. In 1992, 59 percent of the industry's $11.5 billion in products were sold out of state, including 23 percent to foreign countries. These exports, along with other final sales (which are shown in the input-output table as part of other sales), represent the source of the industry's direct economic impact on the state economy.

2. Intra-industry transactions. The forest products industry is highly integrated, as indicated by large intra-industry transactions (purchases and sales). In 1992, sales among the seven components of the forest products industry amounted to $2.9 billion, accounting for more than one-fourth of total sales. These include not only sales among different companies but also sales among different establishments of the same company. In addition to the sale of logs to mills for processing, which were valued at $1.2 billion, there were transactions among the industry's primary and secondary processors. Examples of these transactions included $201.8 million in sales from sawmills to other wood products and $193.1 million in sales from pulp mills to paper mills.

3. Other in-state expenditures. The industry spent another $3.0 billion for other goods and services in the state. Major purchases were $1,076.4 million from forestry (timber), $184.9 million from chemicals, $344.8 million from utilities (primarily electricity), $296.4 million from transportation (primarily trucking), $442.5 million from trade (wholesale mark-ups), and $230.2 million from services (primarily business and professional services).

Table 3-1

WASHINGTON STATE FOREST PRODUCTS INPUT-OUTPUT TABLE, 1992

Millions of Dollars

	Forestry	Logging	Sawmills	Plywood	Other Wood	Pulp Mills	Paper Mills	Other Paper	U.S. Exports	Foreign Exports	Other Sales	Total Output
Forestry	44.5	970.2	94.7	11.5	0.0	0.0	0.0	0.0	101.3	5.6	50.4	1278.2
Logging	2.6	162.7	658.6	77.1	27.8	36.0	145.9	53.7	28.2	1185.0	0.0	2377.6
Sawmills	0.0	22.5	195.1	10.0	201.8	48.2	165.6	32.6	821.0	464.8	228.6	2190.2
Plywood	0.0	0.0	5.3	25.6	25.7	4.1	0.0	0.0	212.3	46.3	58.9	378.2
Other Wood	0.0	0.0	3.1	7.0	56.8	0.0	2.7	2.2	799.5	124.5	270.0	1265.8
Pulp Mills	0.0	0.0	0.0	0.0	0.0	9.6	193.1	17.5	106.3	171.3	2.4	500.2
Paper Mills	0.0	0.0	0.0	0.0	0.0	1.7	12.0	294.7	1283.1	329.4	604.3	2525.2
Other Paper	0.0	2.4	1.6	0.3	10.3	0.3	16.6	406.6	830.4	364.1	654.3	2286.9
Agriculture	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Mining	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0				
Food Products	0.0	0.0	0.0	1.6	0.0	0.0	11.9	5.5				
Apparel	0.0	2.2	5.0	0.0	0.0	0.0	0.0	0.0				
Printing	1.8	0.0	0.0	1.9	0.0	0.0	0.0	0.0				
Chemicals	18.8	2.3	10.5	13.3	3.6	22.3	93.3	39.6				
Petroleum	6.5	11.3	11.7	3.5	0.9	23.3	45.8	25.5				
Stone and Glass	0.0	1.1	0.0	0.0	3.5	0.0	1.9	0.0				
Primary Metals	0.0	1.2	0.0	0.0	1.9	0.0	2.1	0.0				
Fabricated Metals	0.0	11.9	7.5	4.9	10.3	1.2	1.9	0.0				
Nonelec. Machinery	1.5	7.6	2.5	3.2	1.7	1.2	1.9	0.0				
Elect. Machinery	0.0	2.1	2.5	1.6	1.7	0.0	0.0	0.0				
Oth. Manufacturing	0.0	5.5	7.5	0.0	3.5	0.0	10.0	0.0				
Construction	16.2	19.0	10.8	3.6	5.6	4.1	21.4	11.6				
Transportation	6.1	25.1	88.0	13.2	19.3	10.2	84.2	56.4				
Communications	1.8	2.5	5.8	1.8	7.9	1.5	4.6	4.2				
Utilities	1.5	3.2	34.2	16.0	6.7	64.9	142.0	77.8				
Trade	9.1	27.4	95.6	19.3	48.6	23.1	128.3	100.2				
Finance and Insur.	1.9	8.1	25.0	4.1	10.8	3.2	14.9	11.3				
Services	16.5	52.8	45.6	4.0	21.0	4.7	58.2	43.9				
Labor Income	140.9	408.2	578.3	72.0	312.7	92.7	374.9	354.7				
Other Value Added	991.3	269.5	141.3	32.3	230.2	51.7	319.3	415.4				
Imports	14.3	358.9	160.0	50.4	253.5	96.2	670.8	333.5				
Total Input	1278.2	2377.6	2190.2	378.2	1265.8	500.2	2525.2	2286.9				
Employment	5770	11580	15240	2230	11800	1800	7240	8620				

Table notes: 1. Industry sales are read across the table, while industry purchases are read down the table.
2. Industry transactions are measured in producers' prices.
3. Other sales primarily include sales to households and other industries in Washington.

4. Imported goods and services. The forest products industry imported $1.9 billion worth of goods and services. Mirroring its strong links to the state economy, the industry's propensity to import, measured by the ratio of total imports to total production, is only 0.17--17 cents of imports per dollar of production--one of the lowest among Washington industries. By comparison, the aerospace propensity to import is around 0.60.

5. Value added. In 1992, value added (or Gross State Product originating) in the forest products industry amounted to $3.7 billion. This represented 3.0 percent of total Gross State Product in Washington. If the value added of forestry were added to that figure, the industry would account for almost four percent of Gross State Product.[7]

6. Employment and labor income. The seven forest products industries employed 58,510 people, including 3,420 self-employed persons, who earned $2.2 billion in labor income. Annual income in the industry averaged $37,490 per person, compared to the $26,800 average income for all workers in the state. Labor income represented 60 percent of the industry's value added.

Economic Impact

The economic impact of forest products on Washington emanates from the employment, labor income, and in-state expenditures for goods and services associated with the industry's final sales. In 1992, forest products final sales amounted to nearly $8.0 billion. Production for final sales engaged 40,850 workers, who earned $1.5 billion in labor income. As indicated by these figures, the forest products industry's direct economic impact on the state was significant. Its output for final sales represented more than four percent of the total value of industrial production in the state. The employment required to produce these goods represented 12 percent of Washington's manufacturing work force, while the income paid to these workers represented 10 percent of the manufacturing labor income.

Tables 3-2 and 3-3 show the forest products industry's total impact on the Washington economy. In terms of the aggregate measures of economic activity, such as Gross State Product and total employment, the industry directly and indirectly supported about eight percent of Washington's total economic activity in 1992:

1. Gross State Product. Gross State Product, like its national counterpart, is the broadest measure of economic activity. In 1992, Washington Gross State Product was estimated at $122.6 billion. Forest products directly and indirectly accounted for $9.4 billion or 7.7 percent of total Gross State Product. Lumber and wood products, contributing $5.1 billion of the total, accounted for approximately four percent of Gross State Product.

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[7]Since the end-product of forestry, namely timber, is used as an input to production by the seven forest products industries, forestry's production, employment, and labor income are counted as part of the indirect impact of forest products on the state economy in the impact analysis. Specifically, forestry is shown as part (the major part) of the indirect economic impact in the resources sector (see Table 3-2).

Table 3-2

FOREST PRODUCTS IMPACT IN WASHINGTON STATE, 1992

	1992 Actual	Without Forest Products	Difference	Percent Difference
DIRECT ECONOMIC IMPACT				
Final sales[1] (mil. $)	8,031.4	0	8,031.4	—
In-state expenditures (mil. $)	4,071.0	0	4,071.0	—
Employment	40,850	0	40,850	—
Labor income (mil. $)	1,525.3	0	1,525.3	—
TOTAL ECONOMIC IMPACT				
Gross State Product (mil. $)	122,614.0	113,186.5	9,427.5	7.7
Output (mil. $)	187,544.1	168,119.2	19,424.9	10.4
Resources	6,700.8	5,640.3	1,060.5	15.8
Manufacturing	69,377.4	56,996.4	12,381.0	17.8
Nonmanufacturing	111,465.9	105,482.5	5,983.4	5.4
Employment	2,889,160	2,676,080	213,080	7.4
Proprietors	469,010	439,460	29,550	6.3
Wage and salary employees	2,420,150	2,236,620	183,530	7.6
Resources	44,170	39,570	4,600	10.4
Manufacturing	348,260	286,540	61,720	17.7
Lumber and wood products	37,450	0	37,450	100.0
Pulp and paper products	17,640	0	17,640	100.0
Other manufacturing	293,170	286,540	6,630	2.3
Nonmanufacturing	1,530,710	1,438,900	91,810	6.0
Construction	123,960	122,100	1,860	1.5
Transportation and utilities	114,940	107,950	6,990	6.1
Trade	553,150	517,120	36,030	6.5
Services[2]	738,660	691,730	46,930	6.4
Government	497,010	471,610	25,400	5.1
Personal income (mil. $)	108,301.1	99,811.3	8,489.8	7.8
Labor income	77,443.2	71,383.2	6,060.0	7.8
Other income	30,857.9	28,428.1	2,429.8	7.9
Per capita income ($)	21,088	21,053	35	0.2
Population	5,135,680	4,741,030	394,650	7.7

[1]Primarily includes foreign exports and sales to rest of United States.
[2]Includes finance, insurance, real estate, and services.

Table 3-3

FOREST PRODUCTS IMPACT IN WASHINGTON STATE, 1992

	Lumber and Wood Products	Pulp and Paper Products	Forest Products	Percent of State Total
DIRECT ECONOMIC IMPACT				
Final sales (mil. $)	4,011.1	4,020.3	8,031.4	—
In-state expenditures (mil. $)	2,109.8	1,961.2	4,071.0	—
Employment	27,620	13,230	40,850	—
Labor income (mil. $)	907.0	618.3	1,525.3	—
TOTAL ECONOMIC IMPACT				
Gross State Product (mil. $)	5,070.5	4,357.0	9,427.5	7.7
Output (mil. $)	9,982.7	9,442.2	19,424.9	10.4
Resources	875.7	184.8	1,060.5	15.8
Manufacturing	6,121.4	6,259.6	12,381.0	17.8
Nonmanufacturing	2,985.6	2,997.8	5,983.4	5.4
Employment	118,600	94,480	213,080	7.4
Proprietors	16,780	12,770	29,550	6.3
Wage and salary employees	101,820	81,710	183,530	7.6
Resources	3,600	1,000	4,600	10.4
Manufacturing	36,760	24,960	61,720	17.7
Lumber and wood products	33,220	4,230	37,450	100.0
Pulp and paper products	110	17,530	17,640	100.0
Other manufacturing	3,430	3,200	6,630	2.3
Nonmanufacturing	47,660	44,150	91,810	6.0
Construction	850	1,010	1,860	1.5
Transportation and utilities	3,370	3,620	6,990	6.1
Trade	18,420	17,610	36,030	6.5
Services	25,020	21,910	46,930	6.4
Government	13,800	11,600	25,400	5.1
Personal income (mil. $)	4,615.2	3,874.6	8,489.8	7.8
Labor income	3,259.5	2,800.5	6,060.0	7.8
Other income	1,355.7	1,074.1	2,429.8	7.9
Per capita income ($)	-1	36	35	0.2
Population	219,190	175,460	394,650	7.7

2. Output. Forest products total impact on output in the private sector amounted to $19.4 billion. This represented about one out of every ten dollars of production in the state. Since this figure included the industry's output for final sales ($8.0 billion), its indirect impact on industry output was $11.4 billion. More than one-half of the indirect effect ($6.0 billion) fell in the nonmanufacturing sector (chiefly trade and services).

3. Employment. Including the indirect impact, 213,080 jobs were related to the forest products industry. Thus, one out of every thirteen jobs in Washington was linked to the industry. Most of the indirect jobs were found in the nonmanufacturing and government sectors. The implied employment multiplier for forest products was 5.2 (=213,080/40,850), meaning that for every forest products job producing goods for final sales there were 4.2 supporting jobs in the economy. Looking at the total employment impact from another perspective, the industry created 40 (=213,080/5,264) jobs per million board of timber, since log consumption amounted to 5,264 million board feet in 1992.

4. Personal income. Directly and indirectly, forest products accounted for $8.5 billion in personal income. This was about eight percent of Washington personal income in 1992. Lumber and wood products contributed $4.6 billion, while pulp and paper products contributed $3.9 billion.

5. Per capita income. Per capita personal income in Washington would have been $35 lower without forest products. This difference represented 0.2 percent of the state's per capita income. Primarily because of the high wage rates in pulp and paper products, that industry accounted for all of the difference in per capita income.

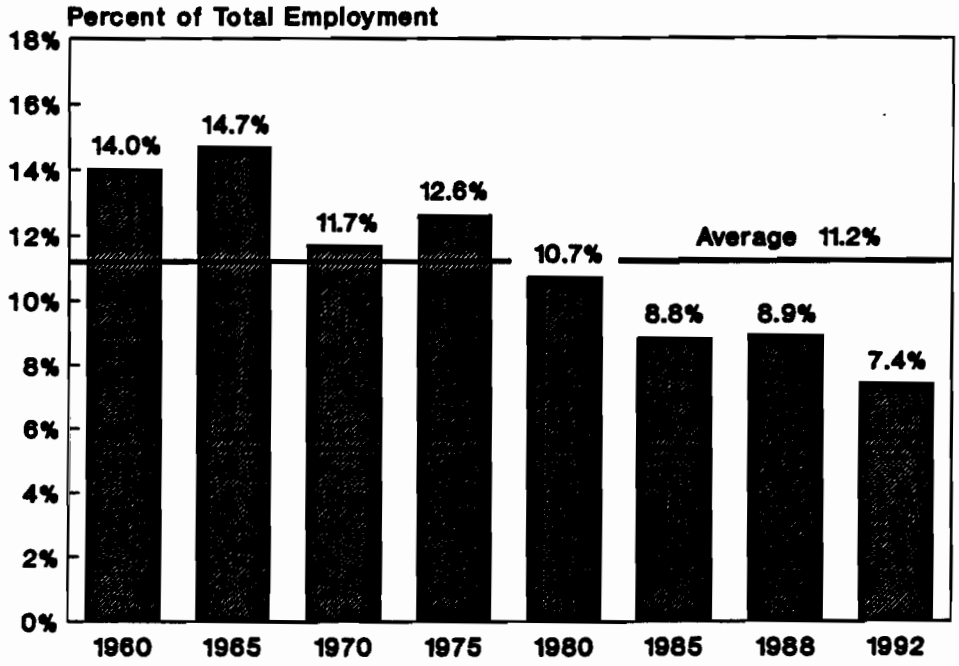
6. Population. Without forest products, there would have been 394,650 fewer people living in Washington. The industry's relative impact on state population is about the same as that on employment. This means that, lacking the job opportunities created directly and indirectly by the forest products industry, about eight percent of the working population and their families would have had to live in another state to find employment. The industry's population multiplier was 9.7 (=394,650/40,850), implying that each forest products worker directly and indirectly supported close to ten people living in the state.

The implied forest products employment multiplier, and thus the industry's total employment impact, in this study may be higher than that found in other studies. There are four potential reasons for this: (1) Compared to input-output models, which are commonly used in impact analysis, the Washington Projection and Simulation Model captures more of the industry's indirect effects on the economy, such as the employment impact stemming from induced capital investment and government spending.[8] (2) The concept of employment used in this study, encompassing self-employed as well as wage and salary workers, is broadly defined. (3) The analysis takes into account recent changes in the forest products industry's structure, in particular the increases in labor productivity since 1982, which have increased the size of the forest products employment multiplier. According to simulations with WPSM, the forest products employment multiplier in

[8]Refer to the technical appendix and the article by Conway (1990) for further discussion on the measurement of multipliers.

Figure 3-2

FOREST PRODUCTS TOTAL IMPACT
ON WASHINGTON STATE EMPLOYMENT



1982 was about 4.9. (4) Finally, this analysis defines the direct impact only with regard to the employment associated with final sales. If one were to define the direct impact to include all jobs in forest products, the implied multiplier would be 3.6 (=213,080/58,510), since there were 58,510 wage and salary employees and proprietors engaged in the industry in 1992.

Because of the tendency for the forest products employment multiplier to increase over time, the industry supported more jobs in 1992 than it did thirty years ago. According to simulations with WPSM, the industry's impact on the Washington economy amounted to 157,000 jobs in 1960. In 1992, with nearly 7,000 fewer jobs in the forest products industry, the industry supported about 213,000 jobs. Relative to total employment in Washington, however, the industry's importance has declined over time (Figure 3-2). In 1960, 14 percent of the state's total employment directly or indirectly depended upon the forest products industry, compared to just 8 percent in 1992.

Industry Impacts

Estimating the economic impact of forest products involved estimating the economic impact of each of its seven industry groups. Table 3-4 shows the impact for the four lumber and wood products industries, while Table 3-5 shows the impact for the three pulp and paper products industries. In spite of the evolution of the lumber and wood products industry toward a greater variety of products, lumber mills continued to be the industry's most important sector. In 1992, sawmills and planing mills, with $1.4 billion of final sales (including $1.3 billion in exports),

supported about 49,000 jobs in the state. In general, sawmills contributed slightly less than two percent of the economic activity in the state. Logging accounted for more than 26,000 jobs or 0.9 percent of Washington's total employment. The logging impact shown in Table 3-4 is essentially the impact of log exports to foreign countries.[9] Veneer and plywood mills, which in recent years have been losing national market share, accounted for only 0.3 percent of the state's employment. Other wood products, the fastest-growing component, supported 35,000 jobs or 1.2 percent of Washington total employment in 1992.

Table 3-4

LUMBER AND WOOD PRODUCTS IMPACT IN WASHINGTON STATE, 1992

	Logging	Sawmills	Plywood	Other Wood	Total
DIRECT ECONOMIC IMPACT					
Final sales (mil. $)	1,213.3	1,420.8	293.4	1,083.6	4,011.1
In-state expenditures (mil. $)	684.3	850.3	173.4	401.8	2,109.8
Employment	5,910	9,880	1,730	10,100	27,620
Labor income (mil. $)	208.3	375.1	55.9	267.7	907.0
TOTAL ECONOMIC IMPACT					
Gross State Product (mil. $)	1,130.0	2,172.4	369.6	1,398.5	5,070.5
Employment	25,960	49,040	8,830	34,770	118,600
Personal income (mil. $)	1,007.3	1,957.5	339.5	1,310.9	4,615.2
Population	45,820	91,050	16,410	65,910	219,190
PERCENT OF STATE TOTAL					
Gross State Product	0.9	1.8	0.3	1.1	4.1
Employment	0.9	1.7	0.3	1.2	4.1
Personal income	0.9	1.8	0.3	1.2	4.3
Population	0.9	1.8	0.3	1.3	4.3

In the pulp and paper products industry, paper mills and other paper products have similar impacts on the economy. Paper mills, with $2.1 billion in final sales, directly and indirectly generated about 43,000 jobs and $1.8 billion in personal income. Other paper products, with only $1.7 billion in final sales but a longer chain of processing, supported 45,000 jobs and $1.8 billion in

[9]As noted, the logging impact shown in Table 3-4 is the impact of log exports (i.e., the final sales of the logging industry). The rest of the logging industry supplies wood to domestic mills for processing. This activity--the logging output, employment, and labor income--is counted as part of the indirect impact of the other forest product industries (e.g., sawmills and pulp mills). In 1992, there were 11,580 logging jobs in Washington (Table 2-5). Log exports accounted for 5,910 direct jobs (Table 3-4) and 400 indirect jobs in the logging industry (through the multiplier process). The other 5,270 logging jobs are included in the indirect impacts of the other six forest products industries.

personal income. Each industry accounted for slightly less than two percent of the total state economy. With less than $0.3 billion in final sales, pulp mills accounted for only 0.2-0.3 percent of the jobs and income in Washington. However, because of the definition of the pulp mill industry used in this study--establishments whose primary output is pulp--these figures tend to understate the economic significance of pulp operations.

Table 3-5

PULP AND PAPER PRODUCTS IMPACT IN WASHINGTON STATE, 1992

	Pulp Mills	Paper Mills	Other Paper	Total
DIRECT ECONOMIC IMPACT				
Final sales (mil. $)	279.2	2,061.0	1,680.1	4,020.3
In-state expenditures (mil. $)	144.9	946.9	869.4	1,961.2
Employment	1,010	5,910	6,310	13,230
Labor income (mil. $)	51.7	306.1	260.5	618.3
TOTAL ECONOMIC IMPACT				
Gross State Product (mil. $)	315.2	1,985.2	2,056.6	4,357.0
Employment	6,610	43,040	44,830	94,480
Personal income (mil. $)	277.7	1,764.1	1,832.8	3,874.6
Population	12,330	79,740	83,390	175,460
PERCENT OF STATE TOTAL				
Gross State Product	0.3	1.6	1.7	3.6
Employment	0.2	1.5	1.6	3.3
Personal income	0.3	1.6	1.7	3.6
Population	0.2	1.6	1.6	3.4

Land Ownership Impacts

Another perspective on the forest products industry is given by estimates of the industry's economic impact by land ownership categories. There are five categories of land owners: state government, federal government (excluding the U.S. Bureau of Land Management), other public, the forest industry, and farmers and other private owners. For purposes of this analysis, there is a sixth category, out of state, which must also be considered, since some of the wood fiber used by the forest products industry in Washington is imported from other states and Canada.

Table 3-6 shows estimates of log use by land ownership based on mill surveys conducted by the Washington State Department of Natural Resources. Of the 5.3 billion board feet of logs consumed by primary processors, 3.9 billion board feet came from private lands and 1.4 billion board feet came from public lands. In recent years, more logs have been cut from private lands than public lands. Private lands' 74 percent share of total log use was up from a 65 percent share

in 1988 due to the timber harvest restrictions on public land. The largest source of logs, 55 percent of the total, was timber lands owned by the forest industry, which over the past two decades have provided about one-half of the supply. Farmers and other private land owners added another 1.0 billion board feet, accounting for 19 percent of the total supply. Federal lands, which provided 0.7 billion board feet or one-eighth of the total wood consumed by primary operations, was the largest public source of logs in 1992. The harvest on state trust lands, which was down 41 percent from 1988, accounted for 9 percent of the logs. Other public lands provided less than 0.3 billion board feet.

Table 3-6

WASHINGTON STATE LOG USE BY LAND OWNERSHIP, 1992

Millions of Board Feet

	State	Federal	Other[2] Public	Forest Industry	Other Private	Total
Log export	156	0	30	1,203	382	1,771
Lumber	232	492	136	1,425	488	2,773
Veneer and plywood	26	69	15	131	63	304
Other wood products[1]	16	7	48	25	4	100
Pulp	57	87	21	103	48	316
Total	487	655	250	2,887	985	5,264
Percent of Total Log Use	9.3	12.4	4.7	54.8	18.7	100.0

[1]Includes shake, shingle, posts, poles, and piling.
[2]Includes U.S. Bureau of Land Management lands.

Although there is a relationship between the amount of wood supplied by each land owner and its economic impact, it is not a simple one, since logs from different lands tend to be used differently. For example, two-fifths of the logs cut on private lands were exported abroad. In contrast, no logs were exported overseas from federal lands, since they were subject to an export ban. In 1992, three-fourths of the logs from federal lands were used for lumber, compared to only one-half from forest industry lands. Compounding the problem of estimating forest products impacts by land ownership is the difficulty of tracing the source of wood fiber used by Washington mills to manufacture pulp, the principal material of the paper industry. Part of the fiber comes directly from logs, the source of which is easy to trace. But part of the fiber comes from lumber and plywood mills in the form of wood chips, sawdust, and shavings, much of which originates out of state.

Bearing in mind the problems of estimating land ownership impacts, the results of the analysis are displayed in Table 3-7 and Figure 3-3. Roughly one-fourth of the forest products industry's impact on the Washington economy can be traced to out-of-state lands. This impact, which in terms of employment amounts to 53,000 jobs, is primarily associated with imported wood fiber used by the

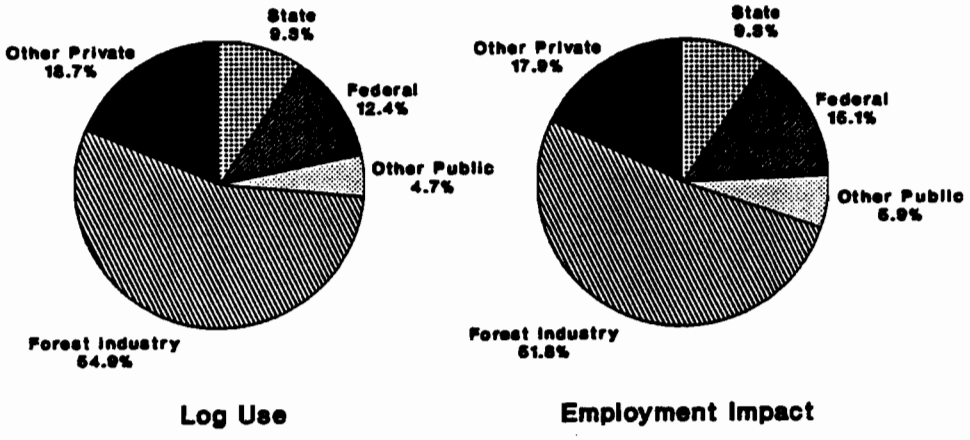
Table 3-7

FOREST PRODUCTS IMPACT IN WASHINGTON STATE BY LAND OWNERSHIP, 1992

	State	Federal	Other Public	Forest Industry	Other Private	Out of State	Total
DIRECT ECONOMIC IMPACT							
Final sales (mil. $)	542.7	833.2	325.5	3,059.0	1,057.6	2,213.4	8,031.4
In-state expenditures (mil. $)	275.7	419.9	154.7	1,584.9	548.5	1,087.3	4,071.0
Employment	3,040	4,790	2,120	17,070	5,840	7,990	40,850
Labor income (mil. $)	108.3	172.4	69.6	610.4	209.9	354.6	1,525.3
TOTAL ECONOMIC IMPACT							
Gross State Product (mil. $)	650.0	1,055.2	407.1	3,626.0	1,255.0	2,434.2	9,427.5
Employment	14,850	24,070	9,480	82,830	28,640	53,210	213,080
Personal income (mil. $)	587.4	955.4	371.3	3,273.1	1,132.7	2,169.9	8,489.8
Population	27,510	44,900	17,720	152,870	52,890	98,760	394,650
PERCENT OF STATE TOTAL							
Gross State Product	0.5	0.9	0.3	3.0	1.0	2.0	7.7
Employment	0.5	0.8	0.3	2.9	1.0	1.8	7.4
Personal income	0.5	0.9	0.3	3.0	1.0	2.0	7.8
Population	0.5	0.9	0.3	3.0	1.0	1.9	7.7

Figure 3-3

WASHINGTON STATE LOG USE AND EMPLOYMENT IMPACT BY LAND OWNERSHIP, 1992



Excludes out-of-state impacts.

pulp and paper industry. Information from the mill survey implied that about 50 percent of the wood fiber used to make pulp was procured from outside Washington. Thus, approximately one-half of the pulp and paper products industry's impact on the Washington economy is attributable to wood fiber from other states.

Timber lands in Washington supported about 160,000 jobs. The forest industry had the largest impact on the state economy, directly and indirectly generating 83,000 jobs or 3.0 percent of the total employment in the state. Altogether, private lands supported seven out of every ten jobs associated with logs procured from timber lands in Washington. About 24,000 jobs or 0.8 percent of state employment were dependent upon federal lands, while 15,000 jobs or 0.5 percent of state employment were dependent upon state lands.

As shown in Figure 3-3, there is a strong relationship between the logs supplied by each land owner and its total employment impact. For example, farmers and other private land owners provided 19 percent of the logs and accounted for 18 percent of the total employment impact in Washington. However, the figures are also reveal some notable differences. Whereas public lands supplied 26 percent of the logs, they generated 30 percent of the forest products employment impact. Private lands, on the other hand, accounted for 74 percent of the logs but only 70 percent of the jobs. The differences in these two cases can be largely explained by the extent to which unprocessed logs are exported from these lands. Although logs that are exported create thousands of local jobs--in logging, trucking, and shipping--logs that are processed, especially those that enter into second-stage processing, tend to create more jobs in the state economy.

4. IMPACT OF TIMBER HARVEST RESTRICTIONS

Several Questions

Restrictions on federal timber lands, which became effective in 1990, coincided with a sharp decline in lumber demand, as the national economy entered into a recession. Unlike previous downturns in the forest products industry, however, this one will not be followed by a rebound because of restrictions placed on logging. There is no debate over whether the decision to preserve old-growth forests as habitat for the northern spotted owl will result in reduced timber harvests, mill closures, and lost forest products jobs in Washington. There is, however, considerable argument over the degree to which this policy will adversely affect industry activity and the rest of the state economy.

The exact size of the economic impact depends upon the answers to several questions: How many acres of timber will be set aside as habitat for spotted owls and other endangered species? To what extent will this reduce future timber harvests? What will be the effect of increased harvest restrictions on timber prices? Will the rate of logging on unpreserved forest land increase in response to higher timber prices? How much will higher timber prices reduce the flow of unprocessed logs to Asia? Will higher material costs affect the mix of products coming from Washington lumber and plywood mills? How will higher material costs and mill closures affect labor productivity and wage rates in the lumber and wood products industry? Will reduced logging and milling result in a shortage of wood fiber for pulp production? For each job lost in the forest products industry, how many other jobs will be lost in the Washington economy? How long will it take before the economic effects of the timber harvest reductions are fully felt?

From the standpoint of the impact of timber harvest restrictions on the Washington economy, these questions boil down to three critical ones:

1. How much will the timber harvest decline because of the decision to preserve critical habitat for the northern spotted owl and other endangered species?

2. To what extent will the timber harvest reductions affect output and jobs in the forest products industry?

3. How will the state economy react to the loss of jobs in the forest products industry?

Timber Harvest Restrictions

Even before there were proposals to protect the spotted owl, the U.S. Forest Service had already embarked on a policy that would have reduced commercial logging on national forest lands. After ten years of analysis and deliberation, a comprehensive forest management plan was adopted that would have lowered harvest levels by nearly 30 percent in Washington national forests. A careful analysis by Rasmussen (1990) concluded that, considering the likely reaction by other private and public timber owners, the overall harvest reduction in Washington would have amounted to about ten percent of the 1983-87 average harvest.

Since 1990 the federal government has been considering several alternatives to protect the northern spotted owl and other threatened species, such as the marbled murrelet. Following the Forest Conference in Portland, Oregon in the spring of 1993, President Clinton created the Forest Ecosystem Management Assessment Team to develop a management plan for federal lands that

"would comply with existing (endangered species) laws and produce the highest contribution to economic and social well being." Comprised of 600 scientists, technicians, and support personnel, the team developed and analyzed ten options. The amount of forest land set aside as reserves, as well as the silvicultural activities permitted inside and outside the reserves, varies substantially among the options. The size of the "matrix," the land upon which most commercial logging would be permitted, ranges from 2.8 million acres (Option 1) to 8.5 million acres (Option 7).

Table 4-1

PROJECTED WASHINGTON STATE TIMBER HARVEST

Millions of Board Feet

	1980-89 Average	Projected Timber Harvest	Change
Private	3,899	3,563	-336
U.S. National Forest	1,153	222	-931
Washington State	771	400	-371
Other public	280	265	-15
Total	6,103	4,450	-1,653

The option currently preferred by the Clinton administration is Option 9. Of the 24.3 million acres owned by the federal government in northern California, Oregon, and Washington, this plan would allocate 3.9 million acres to the matrix. Under this option, the timber harvest on national forest land in Washington would be 81 percent lower than the average harvest of the 1980s. During the first ten years of the plan, it is estimated that the harvest would average 222 million board feet per year, compared to the average harvest of 1,153 million board feet during the last decade (Table 4-1). The allowable cut under Option 9 is even less than the 1992 harvest, which totaled 461 million board feet, despite federal court injunctions halting timber sales.

The Clinton administration's current plan is designed to minimize logging restrictions on most state and private forests inhabited by the northern spotted owl. Nonetheless, under current law, state and private landowners will be required to preserve some land to protect the owl. Based on a survey of land-owning timber companies, it is estimated that maintenance of critical habitat will reduce private harvests about 9 percent. The Washington State Department of Natural Resources, which manages lands owned by the state, expects a 48 percent curtailment in its average annual harvest. Overall, the public and private timber harvest in Washington is projected to decline from 6.1 billion board feet (the 1980-89 average) to 4.5 billion board feet, a 27 percent reduction. Prior to 1993, the state had not seen harvest levels this low since 1961.

Impact on Forest Products Industry

Perhaps the greatest uncertainty regarding the economic impact of the critical habitat proposal is how the wood and paper markets in Washington will react to a reduced supply of logs. Previous studies suggest two distinctly different scenarios. Implicit in the studies that use input-output

models is the assumption that all sectors directly or indirectly using logs will share equally in the shortfall. This means that each of the four primary uses of logs--log exporting, sawmilling, plywood milling, and pulping--will be reduced in proportion to the reduction in supply.

Analysts who take into account the impact of higher timber prices postulate a somewhat different view of the forest products industry's response to market conditions. In their view, even a modest shortfall in timber supply would substantially raise stumpage prices and affect the mix of primary uses of logs. In particular, higher stumpage prices would have an impact on the log export market, substantially reducing overseas shipments. This diversion of logs back into the domestic market would mitigate the adverse effects of lower timber harvests on northwest lumber and plywood mills.

Not only do the prospects of higher timber values make it difficult to predict future changes in product mix and production levels, but they also complicate the determination of the eventual impact on forest products employment. As the experience of the latter part of the 1970s suggests, higher stumpage prices may lead to efforts to produce more output from a given volume of wood--to "squeeze" more product out of a log--as well as lead to a substitution of labor for the relatively higher cost material in the production process (Figures 4-1 and 4-2). If this were to happen, a 27 percent harvest cutback would result in a somewhat smaller reduction in mill employment. On the other hand, considering the nature of the mills facing closure because of reduced logging on public lands, it is possible that the employment loss would be greater than the production loss. The logging companies and lumber mills at risk, especially those located on the Olympic Peninsula, are relatively labor-intensive. If these at-risk operations required more labor per unit volume of wood processed than the industry average, a 27 percent reduction in timber harvest could conceivably result in a larger reduction in lumber and wood products employment.

In this study, the reasoning underlying the estimate of the direct effect on forest products employment of reduced timber harvests is similar to that adopted by the Ecosystem Management Assessment Team in their socio-economic impact analysis:

1. Lumber and wood products employment. Not all industries classified in lumber and wood products--for example, mobile homes and prefabricated buildings--would be affected by a shortage of wood. Other industries would lose employment in proportion to the reduction in timber supply.

2. Pulp and paper products employment. A wood shortage would not have an impact on the market-oriented converted paper industry. It would, however, affect other segments of the pulp and paper industry, especially the primary facilities (pulp mills and integrated pulp and paper mills) that are located in close proximity to the region's extensive wood fiber resources. A wood shortage would drive up the price of chips, damage the industry's competitiveness, and close some operations, but the relative impact on output and employment would be considerably smaller than that felt in lumber and wood products.

As in the study by the Ecosystem Management Assessment Team, it is assumed that the number of jobs supported per million board feet of timber is the same as that recorded during the 1985-89 period (Table 4-2). As shown in Figure 4-2, the employment-harvest ratio is sensitive to year-to-year fluctuations in harvest levels. There is a tendency for the ratio to rise during periods of harvest declines and fall during expansions. This phenomenon, which is related to delays in the industry's adjustment to changes in market conditions--for example, the reluctance to lay people off during a slowdown--is again being repeated during the current downturn. The 1985-89

employment-harvest ratios, which are not subject to this short-term distortion, are therefore deemed to be more indicative of the ratios expected in the future.

Table 4-2

WASHINGTON STATE TIMBER HARVEST AND FOREST PRODUCTS EMPLOYMENT, 1985-1989

	1985-89 Average	Employment per Million Board Feet[1]
Timber harvest (mil. bd. ft.)	6,690	—
Lumber and wood products employment	42,750	6.39
Logging	12,670	1.89
Sawmills	16,690	2.49
Plywood	3,960	0.59
Other wood[2]	9,430	1.41
Pulp and paper products employment	10,680	1.60
Pulp mills	2,180	0.33
Paper mills	7,240	1.08
Other paper[3]	1,260	0.19
Forest products employment	53,430	7.99

[1]Employment per million board feet of timber harvest.
[2]Excludes mobile homes and prefabricated wood buildings employment.
[3]Excludes converted paper employment.

Referring to Table 4-2, each million board feet of timber harvest supports 6.39 jobs in lumber and wood products. This means that the projected reduction in timber harvest to protect the northern spotted owl, amounting to 1,653 million board feet under the Option 9 scenario, would cost the state 10,560 lumber and wood products jobs. Assuming that the pulp and paper industry would take measures to mitigate the material shortage--by reducing pulp exports, increasing chip imports, and processing more waste paper--the job loss would likely amount to about one-half of that implied by the 1985-89 employment-harvest ratio or about 1,320 jobs. Taken together, the projected employment loss in forest products would total 11,880 direct jobs or about 18 percent of the employment that the industry would have maintained had timber harvests been kept at their 1980-89 average level.

Total Economic Impact

Based on simulations with the Washington Projection and Simulation Model--comparing the state economy with and without the timber harvest restrictions--the total direct and indirect economic loss under the Option 9 scenario would amount to about 40,000 jobs and $1.6 billion of personal income in 1995 (Table 4-3). In other words, if the 1980-89 average harvest level were permitted in 1995, the Washington economy would have 40,000 more people working than that now expected

Figure 4-1

WASHINGTON STATE TIMBER HARVEST AND FOREST PRODUCTS EMPLOYMENT

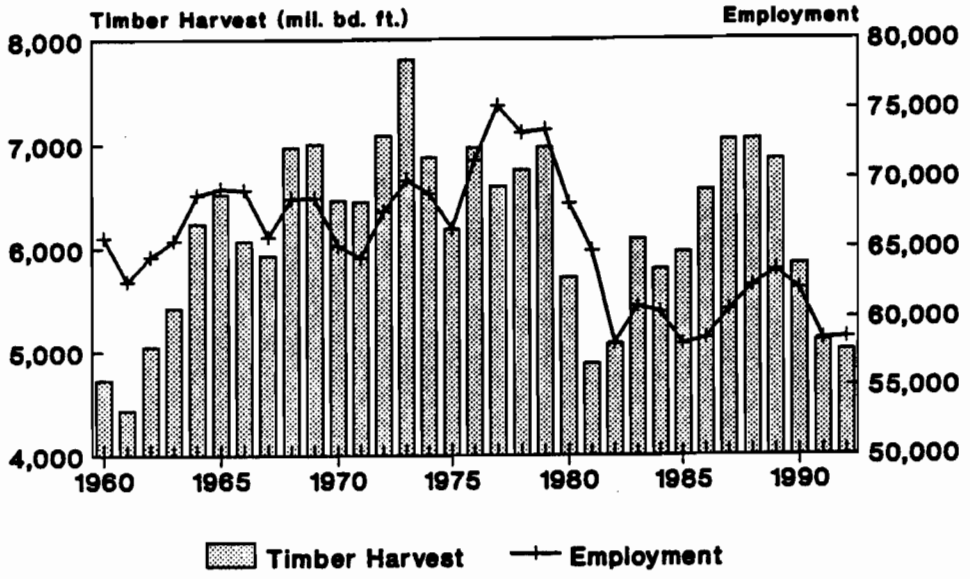
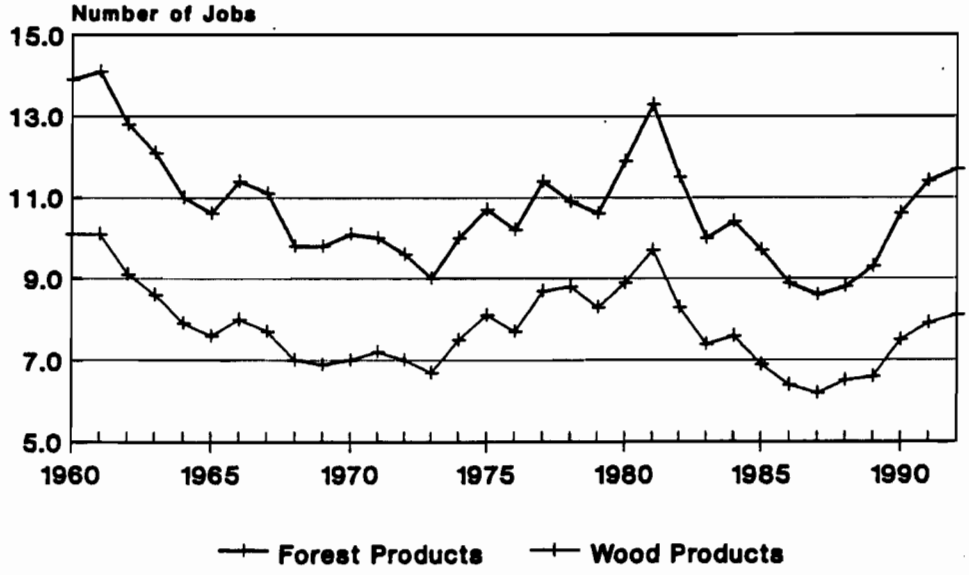


Figure 4-2

WASHINGTON STATE FOREST PRODUCTS EMPLOYMENT PER MILLION BOARD FEET



under the proposed forest plans. Most of the 29,000 jobs indirectly affected by this policy are found in transportation, trade, services, and government. The total losses constitute about 1.3 percent of the projected employment and income for Washington in 1995.

Table 4-3

PROJECTED IMPACT OF TIMBER HARVEST RESTRICTIONS ON WASHINGTON STATE ECONOMY, 1995

	Without Timber Harvest Restrictions	Change Due to Timber Harvest Restrictions	Percent Change
DIRECT ECONOMIC IMPACT			
Timber harvest (mil. bd. ft.)[1]	6,103	-1,653	-27.1
Wood products employment[2]	48,260	-10,560	-21.9
Paper products employment[2]	17,820	-1,320	-7.4
TOTAL ECONOMIC IMPACT[3]			
Gross State Product (bils. $92)	130,483.8	-1,758.1	-1.3
Employment	3,021,280	-40,380	-1.3
Proprietors	489,570	-5,670	-1.2
Wage and salary employees	2,531,710	-34,710	-1.4
Resources	49,400	-1,100	-2.2
Manufacturing	331,590	-12,190	-3.7
Lumber and wood products	43,020	-9,680	-22.5
Pulp and paper products	17,820	-1,320	-7.4
Other manufacturing	270,750	-1,190	-0.4
Nonmanufacturing	1,621,570	-16,670	-1.0
Construction	123,930	-320	-0.3
Transportation and utilities	116,640	-1,200	-1.0
Trade	573,910	-6,480	-1.1
Services	807,090	-8,670	-1.1
Government	529,150	-4,750	-0.9
Personal income (mils. $92)	116,487.2	-1,585.3	-1.4
Population	5,466,760	-74,660	-1.3

[1]Equal to 1985-89 average timber harvest.
[2]Includes proprietors (self-employed workers).
[3]Based on 1995 economic projections (see Table 6-1).

Because the state economy is expected to continue growing during the next few years, some observers have contended that the economy would actually suffer no job loss--that is, there would

be no decline in total state employment. In a literal sense, this contention is correct. However, it is subject to two important qualifications. First, the economy does incur a job loss in the sense that the total employment level in Washington would be higher without the timber harvest restrictions than with them, as demonstrated by the model simulations. Second, in those rural timber communities where most of the jobs losses will occur, there is little or no economic growth from other industries to compensate for the timber downturn. As a consequence, these communities will experience absolute declines in total employment and personal income, which in turn will exacerbate the economic disparity between our state's rural and urban areas.

5. IMPACT OF LOG EXPORT RESTRICTIONS

Log Export Ban on State Trust Lands

The decision to preserve old-growth forests as habitat for the northern spotted owl has prompted public officials to institute policies to mitigate the adverse economic effects of reduced timber harvests in Washington State. One measure, enacted under the Forest Resources Conservation and Shortage Relief Act of 1990 and related regulations of Washington State, prohibits the foreign export of timber harvested from trust lands managed by the Washington State Department of Natural Resources (DNR). The log export ban covered 75 percent of the timber sales from trust lands until 1992, when the ban was extended to all sales. The intent of this restriction is to save jobs in the state's timber communities by increasing the supply of logs for domestic processing. While the restriction will undoubtedly cut losses in local lumber and wood product mills, it will also reduce revenue from state trust lands, since exported logs are sold at a premium, and will lead to fewer jobs at log-exporting ports.

The Department of Natural Resources is responsible for the management of lands owned by the state. These lands include federal grant lands, county lands deeded to the state, and other state lands. Commercial activities conducted on state trust lands--timber sales, commercial real estate, grazing, mining, and other activities--earned $188 million in trust revenue in FY (fiscal year) 1992 and $214 million in FY 1993. About 40 percent of the revenue was distributed to common schools for construction and 20 percent went to counties for operations and capital expenditures. The remaining revenue was distributed into several other trust accounts (e.g., the State Building Construction Account) or used to manage state forest lands. The largest source of trust revenue is timber sales. In FY 1992, the Department of Natural Resources received $165 million from timber removals, constituting 88 percent of the trust revenue. In the future, timber sales are expected to account for as much as 95 percent of the total revenue.

Prior to the Shortage Relief Act, approximately 60 percent of the timber sold from state lands was exported. According to the 1988 mill survey conducted by the Department of Natural Resources, for example, primary log consumption from state lands totaled 810 million board feet in 1988. Overseas sales of logs in that year accounted for 477 million board feet or 59 percent of the total log consumption.

The reason for the large proportion of exports in the past has been the relatively high prices offered for logs by overseas buyers. Precise measurement of the so-called log export premium, the difference between the export and domestic price, is difficult to make. One method has been to compare the price of unrestricted timber on state lands with the price of timber on federal lands, since log exports have long been banned from federal lands. The most careful analysis of the log export premium was conducted by McKillop (1991) for the Department of Natural Resources. McKillop analyzed 4,600 sales from state lands and 4,800 sales from federal lands that occurred between 1983 and 1990. After adjusting for quality differences, terms of the contract, discounts

for early harvests, and other factors affecting prices, McKillop concluded that the "export premiums result in DNR export timber selling for 135 percent more, on a weighted average basis, than comparable timber restricted from export."

Table 5-1

BID PRICES FOR WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES TIMBER , 1991 AND 1992

Dollars per Thousand Board Feet

	Unrestricted Timber	Restricted Timber
1991	353	271
1992	442	359

Source: Washington State Department of Natural Resources

In 1992, when the partial ban on exports from state trust lands was still in effect, the log export premium was low by historical standards. According to the Department of Natural Resources, the bid price for unrestricted timber (i.e., the timber that could be exported) was $442 per thousand board feet (Table 5-1). The bid price for restricted timber was $359 per thousand board feet or $83 lower. Virtually the same "export premium," amounting to $82, existed in 1991.[10] Variations in the export premium over time reflect the comparative strengths of the domestic and overseas markets. In 1992, the domestic price for timber was high considering the national recession and the reduced demand for lumber. The anticipation of log shortages because of the decision to protect the spotted owl had the effect of propping up domestic prices during the downturn. At the same time, in the overseas market, an economic slowdown in Japan substantially decreased housing starts and the demand for logs. This in turn lowered the export price and, combined with the relatively high domestic price, sharply reduced the export premium.

Even with a low premium in 1992, log export restrictions on state lands meant a significant revenue loss for timber trusts. Of the 487 million board feet of timber removed from trust lands in that year, 226 million board feet were restricted to the domestic market. Without the restriction, this timber would have sold for an additional $18.7 million (=225,700 x 83). The trust revenue loss in turn ultimately meant some loss of jobs and personal income in the Washington economy. The trust revenue is used primarily for three purposes: school construction; local government operations and capital outlays; and forest management by the Department of Natural Resources. Thus, a cutback in timber trust revenue means either a reduction in construction and state and local government jobs or higher taxes to replace the lost revenue.

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[10]This understates the true value of the log export premium, since not all timber included in the unrestricted sales lot is of sufficient quality to be sold overseas.

Table 5-3

IMPACT ON WASHINGTON STATE OF LOG EXPORT RESTRICTIONS ON STATE TRUST LANDS, 1992

	Mill Impact	Port Impact	Revenue Impact	Net Impact
DIRECT ECONOMIC IMPACT				
Forest products mill employment	1,120	—	—	1,120
Port employment	—	-180	—	-180
Timber trust revenue (mils. $)	—	—	-18.7	-18.7
TOTAL ECONOMIC IMPACT				
Gross State Product (bils. $)	162.0	-30.8	-20.9	110.3
Employment	3,720	-700	-550	2,470
Proprietors	470	-120	-100	250
Wage and salary employees	3,250	-580	-450	2,220
Resources	50	-0	-0	50
Manufacturing	1,210	-20	-20	1,170
Lumber and wood products	930	-0	-0	930
Pulp and paper products	160	-0	-0	160
Other manufacturing	120	-20	-20	80
Nonmanufacturing	1,560	-480	-320	760
Construction	30	-10	-20	0
Transportation and utilities	130	-210	-20	-100
Trade	610	-100	-110	400
Services	790	-160	-170	460
Government	430	-80	-110	240
Personal income (mils. $)	147.4	-27.4	-38.3[1]	81.7
Population	7,010	-1,230	-970	4,810

[1]Includes effective loss of income due to state and local tax increase.

for logs off of public lands in the export market, however, there will be no gain in the amount of wood available for domestic processing.

3. Out-of-state log sales. The log export ban does not prohibit exports to other states. There is evidence that, because of the timber shortage in the Pacific Northwest, lumber companies in Oregon are buying significant amounts of timber from Washington trust lands. According to the Department of Natural Resources, 48 percent of its timber was sold to out-of-state buyers during the last six months of 1993. As a result, a large number of the mill jobs saved by the export ban are not in Washington. If Oregon continues to buy one-half of the timber on trust lands, the log export ban will have little, if any, positive impact on the Washington economy.

4. Log export premium. The net impact of the log export ban also depends upon the size of the log export premium. McKillop's study suggests that future log export premiums will be much higher than those of the past two years. In 1992, if the log export premium had been $166 per thousand board feet of restricted sales, twice the actual premium of $83 but in line with McKillop's expectations for the future, the estimated net employment impact on the Washington economy would have dropped from 2,470 jobs to 1,920. If at the same time one-half of the timber had been exported to Oregon, the net employment impact would have been negligible, amounting to only 60 jobs.[12]

Even in the best case, the cost of saving mill jobs is high. The direct cost of saving 1,120 mill jobs is $18.7 million in lost timber trust revenue and 180 port jobs. Neglecting the port jobs, the effective subsidy amounts to nearly $17,000 per mill job or three-fifths of the $27,000 in annual income currently earned by production workers in the lumber and wood products industry. If only one-half of the mill jobs saved were in the state, because of log exports to other states, the subsidy would approach $34,000 per job.

6. INDUSTRY PROSPECTS

For the Washington forest products industry, the present looks much like ten years ago but for a different reason. The 1980s, like the current decade, began with a national recession, a sharp drop in housing starts, and thousands of lay-offs in logging camps and lumber mills. Although the downturn was followed by a rebound, one in which lumber production eventually hit record highs, there was little recovery in industry employment, as labor productivity soared because of heavy investment in labor-saving equipment. Once again, the national economy is recovering, causing a jump in housing starts and an upturn in the demand for lumber. But this time Washington mills, handicapped by a virtual halt to timber sales on federal lands, are not participating in the national industry's resurgence. Consequently, much like a decade ago, the loss of forest products jobs that occurred because of a recession will become permanent.

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[12]Referring to Table 5-3, if Oregon had obtained one-half of the logs previously exported overseas, the mill impact on the Washington economy in 1992 would have been 1,860 jobs instead of 3,720. If the log export premium had been double the actual value in 1992, the impact of lost tax revenue on state employment would have amounted to -1,100 jobs. Assuming no change in the port job impact, the net employment impact in this case would have been just 60 (=1,860-700-1,100) jobs.

In general, how the industry performs over the rest of the decade depends upon forces that are to a large extent outside its control:

1. Public policy. At no other time in its history has the Washington forest products industry been so affected by public policy. The proposed plans to protect the northern spotted owl and other threatened species will reduce the long-term timber harvest by at least 25 percent and cost the state about 12,000 forest products jobs. Measures have been taken to ease the impact of a timber shortage, such as banning the export of logs from state trust lands and encouraging value-added production, but these policies are likely to produce only marginal benefits, especially for the rural communities most affected by the reduced timber supply.

2. National housing market. Homebuilding is the largest market for lumber and wood products. Although housing starts in the United States will peak around 1.5 million units per year during the 1990s, 300,000 units less than the previous high achieved in 1986, single-family construction activity will remain strong, as the nation's baby-boomers continue to enter the prime home-owning age. Since single-family construction is the most wood-intensive type of building, this will ensure a strong demand for lumber and plywood for most of the decade. In the wood-strapped Pacific Northwest, however, this will mean higher lumber prices rather than greater production and more jobs.

3. Log exports. Export restrictions coupled with high timber prices reduced overseas log shipments from 2.8 billion board feet in 1988 to 1.7 billion board feet in 1992. When the Japanese economy recovers from its current malaise, log exports are likely to pick up. However, in light of rising timber prices at home, pressure on Japan to import more lumber, and increased competition overseas from timber-rich countries like Russia, it is unlikely that log exports will ever return to the levels of the 1980s. Reduced log exports, along with the industry's trend towards producing more secondary products, will help to limit the number of jobs lost in forest products mills because of reduced harvest levels.

In 1988, the Washington lumber and wood products industry produced $7.3 billion in output (measured in 1992 dollars) and employed 45,550 workers. In spite of strong national demand, output is expected to drop to $5.9 billion in 1995, while employment is projected to fall to less than 38,000, as a result of the timber shortage. The picture is somewhat different for pulp and paper products, although it too is not expected to maintain the economic performance of the past several years. High material costs and a glut of pulp on the world market have shut down some pulp and paper operations in recent months, limiting production gains and reducing employment. Real output is projected to reach $5.5 billion in 1995, but employment will decline to nearly 16,000 jobs, down 2,000 from five years earlier.

Growth in secondary wood and paper production will result in a modest gain in forest products output during the latter half of the 1990s, but industry employment will continue its downward trend. By the turn of the century, there will likely be 11,000 fewer people working in the forest products industry than in 1988. Since the Washington economy is expected to rebound from its current period of lackluster growth, in part because of an anticipated upturn in aircraft production and employment, the state will continue to reduce its dependence upon the forest products industry. Currently, one out of every thirteen jobs in Washington depends on the industry. By 2000, the number will decline to about one in eighteen.

Table 6-1

WASHINGTON STATE ECONOMIC FORECASTS, 1985-2000

	1985	1990	1995	2000
Forest products output (bils. $92)	11.1	11.9	11.4	12.1
Lumber and wood products	6.7	6.6	5.9	6.1
Pulp and paper products	4.4	5.3	5.5	6.0
Forest products employment	58,070	62,080	54,200	51,100
Lumber and wood products	41,410	43,680	37,700	34,800
Pulp and paper products	16,660	18,400	16,500	16,300
Forest products labor income (bils. $92)	2.3	2.3	2.0	2.1
Lumber and wood products	1.4	1.4	1.2	1.2
Pulp and paper products	0.8	0.9	0.8	0.9
Gross State Product (bils. $92)	91.0	112.7	128.7	146.6
Output (bils. $92)	139.7	178.7	189.3	220.4
Resources	6.1	6.6	6.9	7.2
Manufacturing	49.5	68.3	65.5	79.2
Nonmanufacturing	84.1	103.8	116.9	134.0
Labor force	2,091,000	2,503,000	2,686,000	2,902,000
Persons employed	1,921,000	2,381,000	2,479,000	2,702,000
Persons unemployed	170,000	122,000	207,000	200,000
Unemployment rate (%)	8.1	4.9	7.7	6.9
Employment	2,278,910	2,817,840	2,980,900	3,354,500
Proprietors	382,520	449,960	483,900	527,500
Wage and salary employees	1,896,390	2,367,880	2,497,000	2,827,000
Resources	44,790	56,650	48,300	45,400
Manufacturing	296,860	371,860	319,400	337,900
Nonmanufacturing	1,139,310	1,464,460	1,604,900	1,857,800
Government	415,430	474,910	524,400	585,900
Personal income (bils. $)	62.8	92.7	124.9	166.5
Personal income (bils. $92)	83.4	99.7	114.9	130.0
Labor income	58.3	71.0	82.1	92.9
Other income	25.1	28.7	32.8	37.1
Per capita income ($92)	18,960	20,300	21,310	22,710
Population	4,400,600	4,909,200	5,392,100	5,723,500

Table 6-2

WASHINGTON STATE AND U.S. ECONOMIC GROWTH RATES, 1985-2000

	1985-90	1990-95	1995-2000
Washington			
Employment	4.3	1.1	2.4
Personal income ($92)	3.6	2.9	2.5
Per capita income ($92)	1.4	1.0	1.3
Population	2.2	1.9	1.2
United States			
Employment	2.3	1.0	1.7
Personal income ($92)	2.3	1.9	2.1
Per capita income ($92)	1.3	0.8	1.2
Population	1.0	1.0	0.9

Although increasingly smaller numbers of people will be engaged in the forest products industry, it will continue to give the economy a firm foundation. In some ways, it will emerge from its problems a much stronger industry. The scarcity of timber created by the forest preservation policies will enhance the value of the state's timber resource. Already prized as a construction material, Douglas fir will continue to command premium prices. This should financially bolster the state's forest products companies, particularly the land-owning companies. Higher financial returns to the resource will encourage more intensive and careful management of commercial forest land. A higher valued resource will further spur the trend towards more efficient wood use and higher value-added products. In the short-term, the outlook is bleak, especially in the timber-dependent communities along Washington's ocean coast, which are coping with mill closures, double-digit unemployment rates, declines in real income, and an out-migration of people. Once the forest products industry makes the transition to lower timber harvests, however, prospects should brighten.

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TECHNICAL APPENDIX

A-1. DEFINITIONS AND CONVENTIONS

Forest Products Industry

The forest products industry refers to two industries as defined by the Standard Industrial Classification (SIC) code: lumber and wood products (SIC 24) and pulp and paper products (SIC 26). These two industries are further disaggregated into seven components: logging (SIC 241), sawmills (SIC 242), veneer and plywood mills (SIC 2435 and 2436), other wood products (other SIC 24), pulp mills (SIC 261), paper mills (SIC 262), and other paper products (other SIC 26). A distinction is also made between primary and secondary forest products. Primary products include logs for export, lumber, plywood, and pulp. Other wood and paper products are secondary products.

Gross State Product

Gross State Product is the value of the state's total production of goods and services for final use. Gross State Product can be measured in two ways. First, it is the sum of purchases of goods and services by households (personal consumption expenditures), government (federal, state, and local government expenditures), the capital sector (gross private domestic investment), and the foreign sector (net exports). Second, it is the sum of value added (gross product originating) in industry, households, and government. Gross State Product, which in this study is valued in 1992 dollars, is the most comprehensive indicator of economic activity in the state.

Output

For every industry except trade and transportation services, output is the value of production or sales. Output is valued at producers' prices in constant 1992 dollars. For trade and transportation services, output is the value of the trade and transportation margins (or mark-ups). Output in purchasers' prices is the output in producers' prices plus the value of the trade and transportation margins.

Employment

Adopting the concept used by the U.S. Bureau of Economic Analysis, employment includes the annual average number of full-time and part-time wage and salary employees and self-employed workers. In a given year, the total employment count exceeds the U.S. Bureau of Labor Statistics' estimate of the number of persons employed because of workers holding more than one job.

Income

Income refers to personal income, the major component of which is labor income. Labor income includes wages, salaries, proprietors' income, and other labor income earned by job-holders working in the state. Personal income is valued in 1992 dollars. Following standard conventions, the current-dollar personal income estimates are deflated by the U.S. implicit price deflator for personal consumption expenditures in order to obtain constant-dollar estimates.

Table A-1

STANDARD INDUSTRIAL CLASSIFICATION OF INDUSTRIES

Industry	SIC Code
Agriculture	01-02
Forestry	08
Fishing	09
Mining	10-14
Food products	20
Apparel	23
Logging	241
Sawmills	242
Veneer and plywood mills	2435 and 2436
Other wood products	Other 24
Pulp mills	261
Paper mills	262
Other paper products	Other 26
Printing and publishing	27
Chemical products	28
Petroleum products	29
Stone, clay, and glass products	32
Primary metals	33
Fabricated metals	34
Nonelectrical machinery	35
Electrical machinery	36
Aerospace	372,376
Shipbuilding	373
Other transportation equipment	Other 37
Other manufacturing	22,25,30,31,38,39
Construction	15-17
Transportation services	40-42,44-47
Communications	48
Utilities	49
Trade	50-59
Finance, insurance, and real estate	60-67
Services	07,70-86,88-89

Industry Classification

For this analysis, the Washington economy is comprised of 32 industries. Table A-1 shows the definition of each of the 32 industries according to its SIC code.

A-2. IMPACT ANALYSIS METHODOLOGY

Input-Output Models

The input-output model, as represented by the table of output (production or sales), employment, and income multipliers, is the analytical method most commonly used to measure regional economic impacts. Five survey-based input-output models for Washington State have been constructed, the most recent one being for 1987 (Chase, Bourque, and Conway, 1993).

An input-output model shows how industries and households in the economy are interrelated. When one industry expands or declines, the model estimates the production, employment, and income changes in other industries affected directly or indirectly by the demands of that industry. For example, a reduction in lumber production reduces the demand for business services. The decline in business services leads to lower levels of employment and income in that industry, which in turn means less household income in Washington and lower demands for consumer goods, among other things.

Although the Washington input-output model attempts to capture the interactions among industries and households in the state, it still represents a somewhat simplified depiction of regional economic behavior. The model is subject to four restrictions that affect the precision of the impact estimates: (1) static depiction of impacts; (2) constant input-output coefficients; (3) a simple specification of the interactions among production, income, and personal consumption; and (4) neglect of the effects of induced private investment, state and local government spending, and migration. In estimating impacts, the fourth restriction is the most significant. Because the input-output model does not take into account investment, public expenditures, and population changes, it tends to yield systematic and sizable under-estimates of the magnitude of economic impacts. For a more complete account of the properties of the Washington input-output model in the context of an impact study, refer to Chapter 5 in *The 1972 Washington Input-Output Study* (Bourque and Conway, 1977).

Washington Projection and Simulation Model

The Washington Projection and Simulation Model (Bourque, Conway, and Howard, 1977, and Conway, 1990) is a regional interindustry econometric model. WPSM IV, whose structure is described here, is the third re-estimation of a model originally developed at the University of Washington seventeen years ago.

As shown in Table A-2, WPSM generates economic projections on an annual basis, the forecasting horizon extending up to 25 years. The system of equations is formulated to predict the behavior of 151 endogenous variables. The model consists of 123 behavioral equations, 28 accounting identities, and 68 exogenous variables, the last of which primarily express economic conditions in the United States. WPSM identifies 26 Washington industries--two of which, lumber and wood products and pulp and paper products, are further disaggregated into seven industries for purposes of this analysis--and three public sectors. For each industry, there are projections of output, employment, and labor income. Among the other economic and demographic variables predicted by the model are Gross State Product, personal consumption expenditures, investment, state and

local government spending, labor force, the unemployment rate, personal income, population by age and sex, and the Seattle consumer price index.

With a more comprehensive formulation of the structure of the state economy, WPSM is designed to overcome many of the shortcomings of regional input-output models. Its specification differs from that of traditional input-output frameworks in a number of important respects:

1. Estimation with cross-sectional and time-series data using linear and nonlinear equations;

2. Dynamic characterization of economic behavior, yielding estimates of short-run and long-run multipliers;

3. Depiction of induced private investment and state and local government expenditures;

4. Complex specification of the interrelationships among production, income, and consumption;

5. Projection of input-output coefficients;

6. Inclusion of a demographic submodel;

7. Use of selected price variables;

8. Integration with a national econometric model, permitting the development of long-range forecasts.

Primarily because of the depiction of induced investment, state and local government spending, and population change, WPSM shows higher impacts than does the input-output model. This is one reason why the estimate of the number of jobs related to the forest products industry is greater in this study than in some previous investigations (see comments below on the employment multiplier).

Impact Estimation Procedure

This study draws upon the simulation capabilities of the Washington Projection and Simulation Model to measure the direct and indirect impact of the forest products industry on the Washington economy. The impact estimation procedure is in general a straightforward exercise. Employing WPSM, the behavior of the economy is first simulated with forest products output (and thus its employment and labor income) to produce a baseline projection over a period of time. The simulation is then repeated but without forest products output to yield a conditional projection of the economy. The difference between the two projections is a measure of the forest products industry's total (direct and indirect) impact on the state economy. Since WPSM is a comprehensive model, the impact can be expressed in terms of employment and income by industry, population, personal income, personal consumption expenditures, state and local government spending, and fixed investment, among other economic and demographic variables.

Because the impact analysis is conducted for seven forest product industries not specifically defined in WPSM, one important modification to the usual simulation procedure is required. Since WPSM defines the lumber and wood products industry (SIC 24) but not the logging industry

Table A-2

FEATURES OF WASHINGTON PROJECTION AND SIMULATION MODEL IV

Projection Horizon

1-25 years

Model Size

151 endogenous variables
68 exogenous variables
123 behavioral equations
28 identities

Industry Detail

26 industries, each having projections of
output
employment (including proprietors)
labor income (wages, salaries, and proprietors' income)

Other Selected Endogenous Variables

Gross State Product
personal consumption expenditures
housing construction
nonresidential investment
state and local government expenditures
exports (including federal government expenditures)
imports
labor force
unemployment rate
personal income
per capita income
net migration
population by age and sex
consumer price index
price of single-family house

(SIC 241), for example, it is necessary to take into account the differences between the two industries--in terms of their interindustry purchases, use of employment, and wage levels--in simulating the economic impact of the logging industry. Although logging is part of lumber and wood products, simulating changes in the broader industry would not estimate the desired logging impact. It is therefore necessary to alter the model in accordance with the observed differences. Through the use of so-called ADD-FACTORS, one needs to alter the lumber and wood products employment-output ratio specified in WPSM, for example, to give an employment-output ratio that is equal to that for logging. Similar adjustments to the lumber and wood products simulation are required to take into account differences in wage rates (income-employment ratios) and in-state expenditures for goods and services (in-state expenditures-output ratios). In effect, the ADD-FACTOR adjustments are tantamount to introducing a new industry, in this case logging, into the simulation model. This procedure is repeated for the six other forest products industries to complete the impact analysis.

Employment Multiplier

Employment multipliers are standardized measurements of economic impacts for purposes of comparison. The employment multiplier is commonly defined as the ratio of the total employment impact to the direct employment impact. As an example, consider the impact of the final sales (primarily exports) of sawmills. In 1992, final sales of $1,420.8 million directly supported 9,880 jobs in sawmills and indirectly supported another 39,160 jobs in the rest of the Washington economy, according to a simulation with WPSM. The sawmill employment multiplier is therefore 4.96 (=[9,880+39,160]/9,880). In this case, the employment multiplier can be interpreted to mean that, on average, each sawmill job directly and indirectly supported 4.96 jobs (including the original sawmill job) in the state economy.

Alternatively, the employment multiplier can be defined as the ratio of the total employment supported by the industry to the number of jobs in the industry. According to this definition, the forest products industry employment multiplier is 3.64 (=213,080/58,510). When comparing multipliers from different studies, it is important to take into account the various definitions of multipliers.

As noted previously, because the interindustry econometric model gives a more comprehensive depiction of regional economic behavior, the employment multipliers derived from the Washington Projection and Simulation Model tend to be substantially higher than those obtained from input-output models. For example, the sawmill employment multiplier from the 1987 Washington input-output model is 4.17.

A-3. FOREST PRODUCTS DATA

Output, Employment, and Income

For purposes of this study, annual estimates of forest products output (value of production), employment, and labor income in Washington from 1960 to 1992 have been made. There are output, employment, and income estimates for four lumber and wood products industries (logging, sawmills, veneer and plywood mills, and other wood products) and three pulp and paper products industries (pulp mills, paper mills, and other paper products). These estimates are derived from a variety of data sources, including the U.S. Bureau of Economic Analysis employment and personal income tables for Washington, the Washington State Employment Security Department series on employment and payrolls by industry, the Washington input-output tables, and various issues of the *Census of Manufactures*.

Forest products output estimates in current dollars are converted into 1992 dollars using forest products industry price deflators from BLS. Labor income (employee compensation less employers' contributions to social insurance) is deflated by the U.S. implicit price deflator for personal consumption expenditures. Employment is defined as the average employment (full-time and part-time employees and proprietors) over the year.

The employment and labor income estimates correspond to the employment and income series compiled by the U.S. Bureau of Economic Analysis (BEA). This means that when, for example, the four lumber and wood products employment series are summed for a given year, the total employment figure is the same as that reported for lumber and wood products by BEA for that year. The employment and income estimates for the seven individual forest products industries correspond most closely (but not exactly) to estimates reported in the *Census of Manufactures*. Consequently, the employment series are not the same as those reported by the Washington State Employment Security Department (ESD). The census and ESD estimates differ, though often not significantly, because of differences in the definition of employment and the classification of establishments within industry groups. In general, the employment and income series probably contain little measurement error.

The industry output estimates, especially for the seven individual industries, are subject to greater measurement error. The output estimates also correspond to the series reported in the *Census of Manufactures*. However, since the economic censuses are conducted only every five years--and 1987 data are the latest information available--the estimating procedure used to derive the interim annual estimates involves a complicated interpolation procedure. This procedure plus the need to use national price deflators to develop constant-dollar output figures undoubtedly results in some measurement error. Whenever possible, the final output series are checked for reasonableness against similar estimates at the national level or against production measures in physical units (e.g., Washington lumber production in board feet).

Forest Products Input-Output Table

In addition to estimates of output, employment, and income, the impact analysis requires estimates of in-state purchases of goods and services by the forest products industry in 1992. A forest products input-output table has been constructed for this purpose. An input-output table shows the distributions of sales and purchases among industries, households, and other sectors of the economy.

The 1992 forest products input-output table represents a partial update of the 1987 Washington input-output table. The updating procedure involves revising estimates of industry output, employment, labor income, value added, and other input-output transactions (e.g., log exports) for which there are published data. These updated estimates are inserted into the 1987 input-output table and the table is re-balanced. The balancing routine is designed to keep the interindustry structure (i.e., the purchase and sales distributions of each forest products industry) of the 1992 table as similar as possible to that of the 1987 table. This procedure implicitly assumes that the input-output structure of the Washington forest products industry changes slowly over time.

A-4. ESTIMATING LAND OWNERSHIP IMPACTS

The updated input-output table and WPSM provide the means for estimating the economic impact of the forest products industry and each of its seven components. In order to assign the seven industry impacts to land ownership categories, it is necessary to trace the flow of wood fiber from the land through the production system to the disposition of final products. In the case of log

exports, which constitute the final sales of logging, this is not a difficult task, since there are published data (e.g., the "1990 Mill Survey") upon which to make estimates of log exports by land ownership. It is assumed that, for example, state lands accounted for 8.5 percent of logging's total economic impact, since lands managed by state government accounted for 8.5 percent of the logs shipped overseas.

In the case of paper mill final sales, allocating the economic impact to land ownership categories is a considerably more difficult task, because of the multiple sources of wood fiber used to make pulp. For pulp logs, mill survey data are sufficient to make reasonable land allocation estimates, following the same procedure used in the case of log exports. However, for mill residue and wood chips, which are the primary sources of wood fiber for pulp, it is difficult to trace the flow of fiber back to the land ownership categories. In order to make these estimates, two key assumptions are adopted: (1) About one-half of the wood fiber used to make pulp comes from out of state. (2) The principal in-state source of chips and mill residue used to make pulp is sawmills and planing mills. The first assumption, which is based in part on mill survey data, implies that about one-half of the paper mills' economic impact is assigned to the "out-of-state" category. The second assumption permits one to allocate the chips and mill residue used by pulp operations to land ownership categories in accordance to the sawmills' procurement of logs. Thus, since lumber mills obtained one-fifth of their logs from federal lands, it was assumed that federal lands were the source of one-fifth of the chips and mill residue produced by lumber mills used to make pulp.

After allocating each of the seven industries' impacts to land ownership categories, the impacts are summed to obtain the forest products total economic impact by land ownership. Following the mill survey classification scheme, the analysis estimates impacts for six land ownership categories: state; federal; other public; forest industry; other private; and out of state.

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