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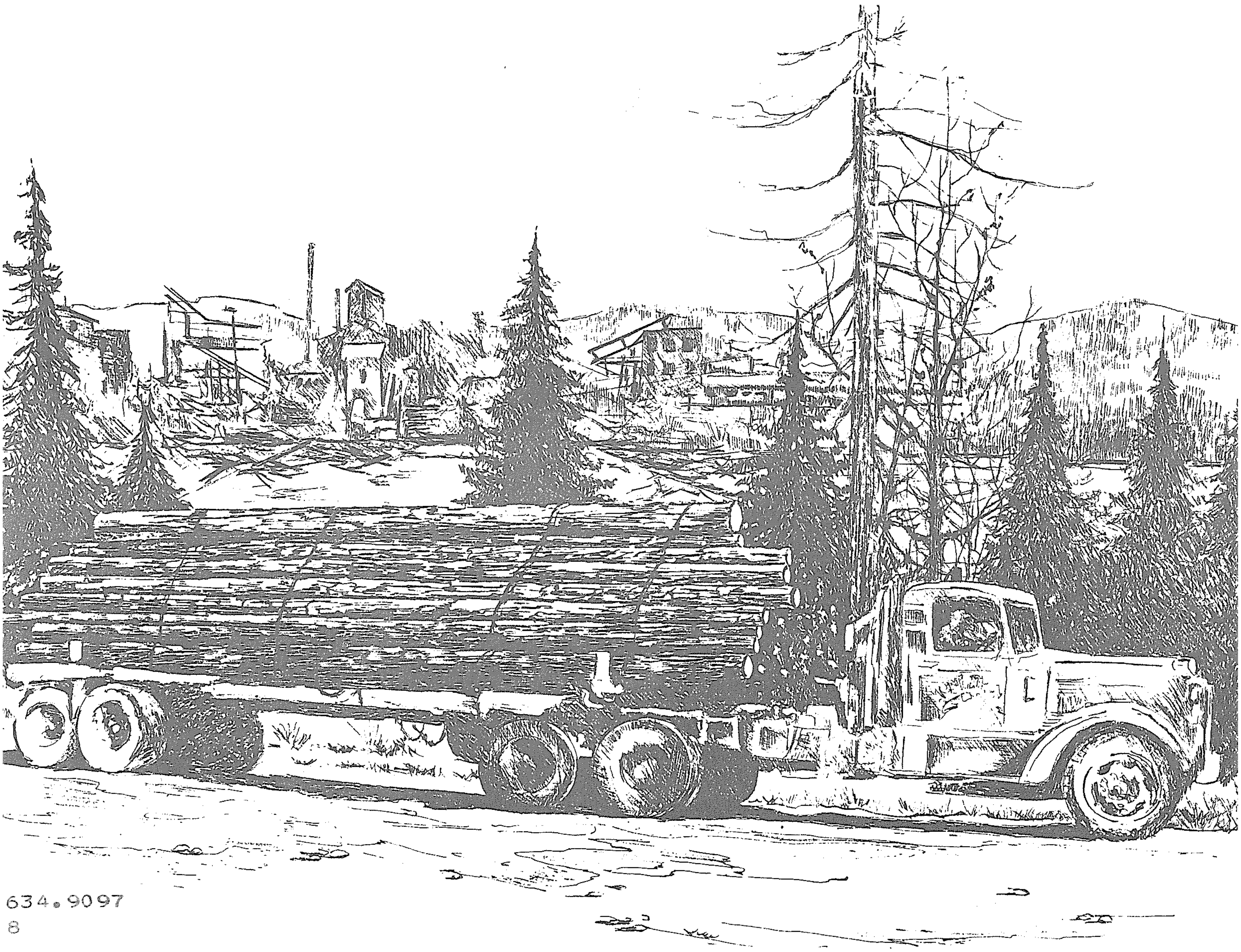
George R. Sampson, David R. Betters, and Robert N. Brenner



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Mountain Pine Beetle, Timber Management, and Timber Industry in Colorado's Front Range: Production and Marketing Alternatives

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Abstract

Current harvest levels and processing capacity do not take full advantage of timber potentially available in six Front Range timbersheds. Four alternatives for utilizing this resource were analyzed using a goal programming technique. Multiproduct operations based on numerous small sawmills appear to offer the best solution.

[1]*Headquarters is at Fort Collins, in cooperation with Colorado State University.*

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Management Implications

Marketing and management costs aside, the most profitable type of industry expansion would be a multiproduct operation that could convert each size and species of timber into the highest value end product. Such an operation would be selling finished lumber, some rough lumber, fenceposts, blue-stain paneling, timbers, firewood, and a host of other items. Determining marketing and management costs of a complex multiproduct firm were not included in the scope of this study, so potential profitability of such a firm cannot be accurately estimated. Along conventional lines, the best possibilities for industry expansion are probably small sawmills, due to the nature of the timber supply and industry uncertainty about long-term timber availability.

It is not clear whether the recent surge in firewood volume use along the Front Range will continue. It is likely that firewood use will remain high, but value for firewood will remain low enough relative to sawn or roundwood products that firms with manufacturing capabilities will continue to find it profitable to channel suitable timber into manufacture of these other products. Most primary manufacturers of forest products probably will find it necessary to produce and market firewood from harvesting and mill residue to maintain profits.

Introduction

This study is the third in a series, conducted to determine the potential for increasing timber harvest and utilization to facilitate forest management in Colorado's Front Range. It includes examination of product possibilities or mixes for local areas, based on existing markets, local timber processing capabilities, and harvesting, processing, and marketing costs.

The analysis here follows two previous, related studies. The first (Sampson et al. 1980) identified existing and potential processing centers and current processing capacity along Colorado's Front Range, defined the timbershed tributary to each, and determined the potential annual timber harvest (silvicultural harvest that could be maintained in perpetuity) for each timbershed. The second (Troxell et al. 1980) examined the suitability of beetle-killed pine for wood and fiber products.

Forest Management Objectives

Timber harvests from National Forest land in the Front Range generally have been well below the potential, probably because of a lack of suitable, local, industrial processing capacity, combined with a lack of high value markets for products from local timber species. Economic incentives are needed to increase timber harvest, and thereby provide the vegetation management necessary to meet long-range multiple use goals which are similar for National Forest, Bureau of Land Management, and State of Colorado lands.

Private forest land in the Front Range lacks this clear management goal. Prior to the recent mountain pine beetle infestations, very little timber was being harvested from private lands. However, after the beetle infestations and the resulting patches of dead timber, many private owners changed their attitudes. A recent survey for parts of the Front Range indicated that more than half of the private land owners would sell timber in the future (Colorado State Forest Service and U.S. Forest Service 1977).

Study Assumptions and Purpose

This study is based on the premise that increased annual timber removals from the Front Range forests (up to the limit of potential annual harvest) will help meet long range, forest management goals. One purpose of this study is to determine how short-run shifts in harvesting and processing priorities might affect the forest industry profitability in the Front Range. Another purpose is to determine if increased timber harvesting and utilization are physically and economically possible, given existing timber supplies, product markets, and harvesting, processing, and transportation costs.

Study Area

The Front Range area generally stretches from the Wyoming border to the vicinity of Canon City, Colo., and lies east of the Continental Divide. Colorado's Front Range forests include ponderosa pine, Douglas-fir, Engelmann spruce, true firs, and lodgepole pine.

The forest land in this study area (fig. 1) includes five National Forests including two Wilderness Areas, a National Park, private lands, forests owned by the State of Colorado, and some forests administered by the Bureau of Land Management. Much of the ponderosa pine type is under private ownership, primarily small parcels used for residential purposes.

The ponderosa pine stands of the Front Range have a long history of mountain pine beetle infestations, and in the mid-1970's were in the midst of a major outbreak (Stevens et al. 1975). Estimates of annual timber losses varied from 5.5 to 27.3 million cubic feet.[2,3] In addition to depreciating esthetics, and thereby land values, the dead trees are also a fire hazard (McCambridge et al. 1979). Many stands of ponderosa pine in the Front Range are overcrowded and vulnerable to mountain pine beetle as well as other insects and diseases.

Because direct control methods of felling and burning or other treatments for destroying the beetles in infested trees have not been very successful, silvicultural treatments have been suggested as a means for creating healthier, beetle-resistant ponderosa pine stands (Myers 1974, Sartwell and Stevens 1975). However, current forest industry processing capacity along the Front Range is far less than the potential annual harvest (Sampson et al. 1980).

Methods

The phases involved in this study included: (1) identifying existing or potential forest products processing centers; (2) defining timbersheds tributary to each processing center; (3) developing information on timber supply (including harvesting and processing costs) for each timbershed; (4) determining existing industry processing capacity and level of production; (5) defining market areas for Front Range forest products; (6) estimating product values within the market areas; (7) developing alternative harvesting policies for Front Range timber; and (8) analyzing the alternative harvesting policies. Phases 1 through 4 were accomplished in an earlier study (Sampson et al. 1980).

Tributary timbershed boundaries for the processing centers are shown in figure 1. The boundaries are based on the subjective judgement of federal and state timber managers. Overlap in timbershed areas obviously does occur, but this study assumed fixed boundaries between timbersheds to allow use of goal programming for analysis. Data on actual procurement areas was reported in another paper (Sampson et al. 1980).

[2]*Love, Robert, David R. Betters, Harry E. Troxell, and Warren E. Frayer. 1977. Assessment of wood raw materials in Colorado's Front Range. Unpublished report, 143 p. Colorado State University, Fort Collins.*

[3]*U.S. Department of Agriculture, Forest Service. [1976]. Western forest insect problem area analysis. Unpublished report, 6 p. U.S. Department of Agriculture, Forest Service, Rocky Mountain Region, Denver, Colo.*

Market areas were determined by finding where Front Range forest products are currently being sold or where they could be sold profitably. This was accomplished by contacts with Front Range processors and wholesalers in potential market areas.

In general, the market areas extended from the Front Range south to New Mexico, north to Wisconsin, and east to Ohio. The market area was further defined by distance zones. These distance zones were 0-5 miles, 5-80 miles, 80-200 miles, 200-900 miles, and 900-1,300 miles. Each market zone was an area of similar product values. The relative marketability of each product for each of these zones was determined through marginal analysis. This was determined by subtracting production costs from the estimated wholesale value of the product in the zone. These costs included stumpage, harvesting, milling, and transportation, and an allowance for profit and risk.

The alternative harvesting policies developed were based on actions that might be taken on a large scale basis either to thin stands to create mountain pine beetle resistant residual timber or to salvage timber that had already been killed. The first harvesting alternative involved a hypothetical thinning program.

Because mountain pine beetle outbreaks usually occur in timber stands where the basal area is greater than 150 square feet per acre, a thinning program which would reduce growing stock level to about 80 square feet per acre should be successful in creating beetle resistant residual stands (Myers 1974, Sartwell and Stevens et al. 1975). A theoretical Front Range thinning program was assumed for this analysis. It was assumed that (1) thinning should occur on all of the ponderosa pine sawtimber acreage and 25% of the ponderosa pine poletimber acreage, and (2) the program should cover a 5-year period. Average removals would be about 300 cubic feet per acre.

A second alternative harvesting policy required giving top priority to harvesting ponderosa pine that had been beetle-killed in the two previous years. The third alternative policy was the existing harvesting situation with no preference given to any class of timber.

Alternative production and marketing alternatives were analyzed using goal programming.[4] A goal program was formulated for each processing center on a case study basis. Each goal program was solved four times with each solution based on a different set of assumptions. The goal program was used to analyze the effects of changing priorities on the following alternatives: (1) making maximum, economical use of the recommended ponderosa pine thinnings while maximizing residual profits with potential annual harvests of other species, (2) utilizing as much of the ponderosa pine mortality as possible while maximizing residual profits with potential annual harvests of all species, and (3) maximizing residual profits with potential annual harvest of all species along with ponderosa pine

[4]*Goal programming is a mathematical technique analogous to linear programming, except that it permits ranking of goals according to the decisionmaker's ordinal priority.*

Figure 1.—Processing centers and associated timbersheds.

mortality. These three alternatives were constrained by the maximum production capacity for each product. A fourth alternative was similar to the third, except current mill production and current harvest levels for each type timber were used as constraints instead of maximum capacity and potential annual harvest.

Each of the four goal program formulations was modified by adding market constraints to reflect more realistic market situations. In this sensitivity analysis, only 10% of the total volume of a product produced and sold under the basic goal program solution was permitted to be sold in the 0-to-5 miles marketing zone. The timber supply assumptions, mill capacity assumptions, market assumptions, and priority goals used in formulating each of the goal programming alternatives are summarized in table 1.

Results and Discussion

Potential Annual Timber Removals

It was assumed that estimated potential annual removals from private ownerships would be available. Current (1976) annual removals, potential annual removals, and existing forest products industry's processing capacity for each of the tributary timbersheds are shown in figure 2. This mill capacity was based on

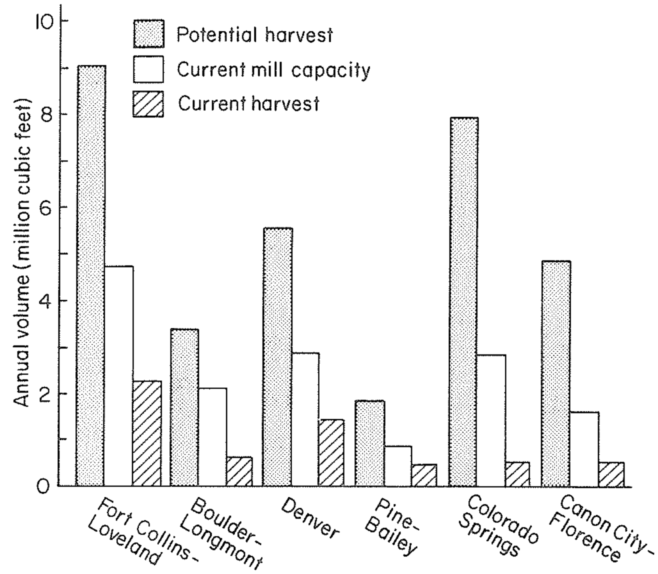

Figure 2.—Potential annual harvest, current mill capacity, and current annual harvest by timbershed.

operations as of 1976. There was a closure of one of the major mills in the Fort Collins-Loveland timbershed in 1979 which would reduce mill capacity there by about 2 million cubic feet. However, more timber is now being exported out of that timbershed for processing.

Potential annual harvest is far greater than existing forest products processing capacity for each of the tributary timbershed areas. Actual annual removals are well below the mill capacity for each of the timbersheds. The greatest difference between potential and actual annual harvest is in the Colorado Springs area, followed closely by the Fort Collins-Loveland area, then the Canon City-Florence area. The greatest difference between mill processing capacity and annual harvest is in the Fort Collins-Loveland area, followed by Colorado Springs and then Canon City-Florence.

Table 1.—Constraints included in the four goal program alternatives for the basic solution and the sensitivity analysis for each processing center

	Basic solution alternative				Sensitivity analysis alternative			
	1	2	3	4	1	2	3	4
Timber supply								
Potential annual harvest								
Spruce-fir	X	X	X		X	X	X	
Lodgepole pine	X	X	X		X	X	X	
Ponderosa pine		X	X			X	X	
Ponderosa pine thinnings (special 5-year program)	X[1]				X[1]			
Ponderosa pine, dead <5 years	X	X[1]	X	X	X	X[1]	X	X
Ponderosa pine, dead >5 years (for firewood)	X	X	X	X	X	X	X	X
Current harvest level								
Spruce-fir				X				X
Lodgepole pine				X				X
Ponderosa pine				X				X
Mill capacity								
Current capacity	X	X	X		X	X	X	
Current production				X				X
Market constraint								
Volume marketed in 0-5 mile market area ≤10% of basic solution					X	X	X	X

[1] *This segment of the timber supply is given priority in harvesting and utilization. All of this segment that is economical to process into products must be utilized before other segments of the timber supply can be taken.*

Potential Products

The six potential Front Range products with the highest marginal values are shown in table 2. The highest value product per unit of volume is decorative paneling made from blue-stained wood of beetle-killed ponderosa pine. Four of the six processing centers were producing blue-stain paneling. Sawn timbers command high prices per unit of volume, and all processing centers except one are producing them. Fence posts are a high value product locally, but become uneconomic beyond 500 miles because of transportation costs and competition from other regions. The market volume for fenceposts within this economic area appears to be very high.

Utility poles are also a high value product, but only a small proportion of the resource is suitable for manufacture into this product. A recent study found that utility poles account for only 3% of the volume of pole and post products produced in Colorado (Betters et al. 1977). The fifth highest value product per unit of

Table 2.—Product values f.o.b. mill for highest value Front Range products

Product	Marginal value f.o.b. processing center[1]
	dollars per thousand cubic feet
Blue-stain paneling	2,119
Timbers	2,057
Fence posts	1,503
Utility poles	1,326
Beams	977
Finished boards	871

[1]*Marginal value is determined by deducting all costs (including stumpage harvesting, hauling, processing, overhead, and allowance for profit) from estimated sales value.*

output is beams which are used in construction of various kinds. The product ranking sixth in value per unit of output is finished boards (usually 1 inch in thickness). Twenty-one broad product classes were included in the analysis for this study. These combined with species classes and condition classes (whether live or dead when harvested) produced 57 product classes.

In recent years, particularly in fall 1979, there has been a dramatic increase in demand for and use of firewood along the Front Range. Most of this firewood has come from readily accessible dead timber and logging slash, although the USDA Forest Service has sold some live timber for commerical fuelwood. A recent survey of firewood use in the Denver metropolitan area by the Colorado State Forest Service found that more than 90% of the firewood used was being consumed by homes with fireplaces (Hostetler 1980). Firewood for use in stoves (less than 4% of total firewood consumed in the Denver metro area) is expected to increase in future years.

Goal Program Analysis

The solutions of the goal program for the four alternatives generally followed the same pattern among the six processing centers. Greatest annual returns were achieved by alternative 3 in every case. Alternative 1 provided the ponderosa pine sawtimber and poletimber supply that would be removed under an accelerated thinning program, but did not include the annual allowable cut foı ponderosa pine. The net returns were usually slightly lower than for alternatives 2 and 3 (fig. 3). Alternative 2 provided for annual potential cut of all species but required that recently killed ponderosa pine be given first priority for utilization. This strategy resulted in net returns that were usually greater than alterative 1, but always less than alternative 3. Alternative 4 constrained potential annual harvest to current harvest levels and also limited mill capacity to current production levels.

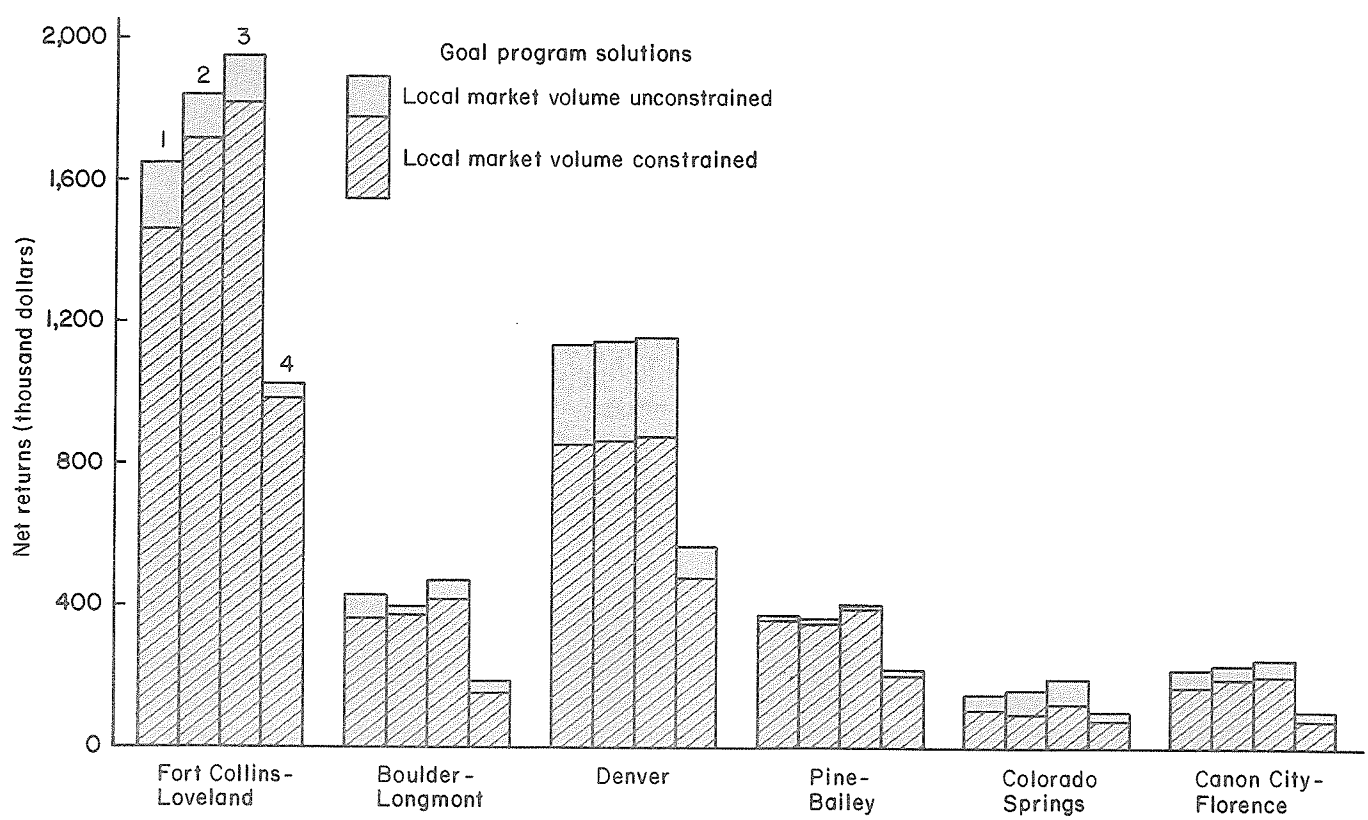

Figure 3.—Comparison of predicted returns to stumpage by the goal program for each alternative for each timbershed. (1) Priority to ponderosa pine thinnings; mill capacity; (2) priority to ponderosa pine dead less than 2 years; mill capacity; (3) priority to profits; mill capacity; (4) priority to profits; current mill production.

As a result, the net returns were far below that of the other three alternatives.

Because the goal programming sensitivity analyses limited the market for each product in the 0- to 5-mile marketing zone to 10% of the volume marketed there in the initial solution, there was a substantial decrease in returns for most processing centers for all alternatives. Net returns under the goal programming model cannot be compared with returns to stumpage under actual operation because this information is not known. However, the volume of timber harvested under the various assumptions of the model can be compared with the approximate volumes of actual timber utilization for each processing center (fig. 4). The actual timber harvest was approximately equal to the timber harvest level given for goal programming alternative 4 for all areas except Denver. For Denver, the predicted harvest volume was only 60% of the actual processed volume in 1976.

Conclusions

The results of the goal program indicate that special efforts to divert harvesting priorities to either thinning or removal of recently killed timber would have the most effect on residual values and volume of timber harvested in the Fort Collins-Loveland timbershed. Even with the constraints imposed by these special policies, optimum harvest levels predicted by the goal program are far in excess of actual removal levels (fig. 4). Institutional factors not included in the model appear to be limiting harvesting, processing, and marketing. When current harvest and processing levels are imposed in alternative 4, only the Denver timbershed has an actual processing level in excess of the model prediction.

The reason for this anomaly isn't clear, but it likely occurred because cost allowances for the model were too high, product prices for the model were too low, or entrepeneurs in the Denver area are operating at a lower profit and risk than provided in the model. Another possibility is that some of the local mills were importing timber from outside the timbershed.

Theoretically, actual harvest should be closer to mill capacity. The fact that it is not may be an indication that existing capacity is partially for different kinds of products. However, it may also be that the mill capacity figures used were too high, and/or that mills cannot get low cost timber sales. The goal program predicted that some shifts in product emphasis would be profitable.

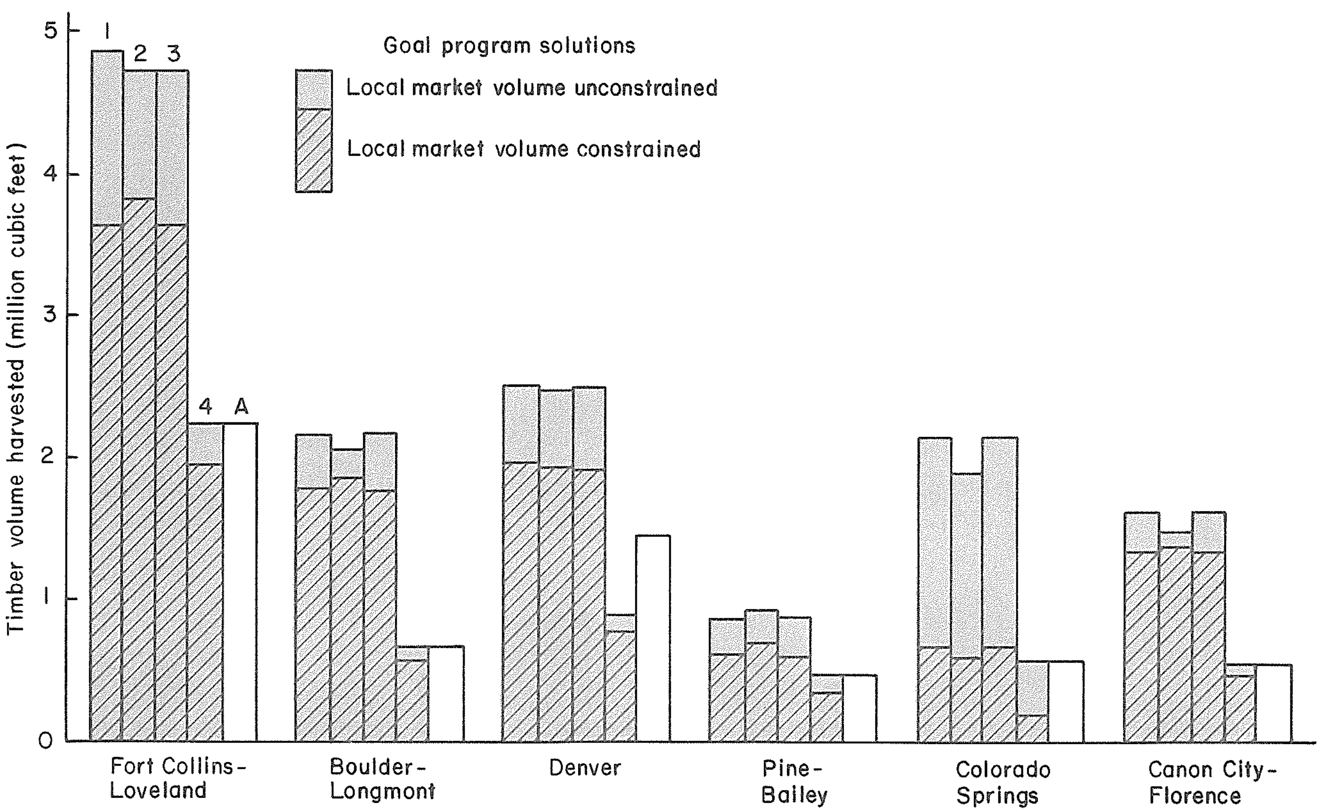

Figure 4.—Comparison of predicted timber volume harvested by the goal program for each alternative and estimated actual volume harvested for each timbershed. (1) Priority to ponderosa pine thinnings; mill capacity; (2) priority to ponderosa pine dead less than 2 years; mill capacity; (3) priority to profits; mill capacity; (4) priority to profits; current mill production; (A) estimated actual production—1976.

Ideally, the local annual production of forest products should equal potential annual removals from the tributary timbershed. This is difficult to achieve on a regular basis because of the uncertainty of demand for forest products from year to year and uncertainty about the amount of timber that may be available in any given year.

On the supply side, the amounts of timber from public land that can be made available annually for conversion into timber products are quite definitive. For private lands, however, there is in most cases no timber management plan specifying the amounts of timber that can be removed. However, based on experience from the South and the West, where local forest products industries processing capacity is high, most of the private landowners will sell timber under certain conditions. In areas where there are many owners with small acreages, timber sales need to be coordinated among owners to harvest timber economically.

There has been an increase in the number of low investment, small sawmills in some areas, largely as a result of a supply of beetle killed timber and interest by private owners in thinning timber for beetle control purposes. For example, the 1970 Colorado Forest Products Directory lists only one sawmill in Boulder county, but the 1977 version of this same Directory lists 12 sawmills or post and pole mills in this same county. However, the total production of these dozen operators was only about 30,000 board feet per day.

Marketing problems also have limited timber harvesting in the Front Range. The timber is not suitable for conventional manufacture into products for high volume markets such as framing for residential and light commercial construction. Instead, Front Range timber is manufactured into a variety of different products such as pallets, fencing, posts and poles, mine props, house logs, decorative paneling, and a variety of lumber items for general use (Colorado State Forest Service 1977). Individual sale volumes from mills to wholesalers are relatively small, making sales effort and expense per unit of product relatively high.

Because many of the existing Front Range lumber producers do not have planing equipment and do not produce and market grade stamped lumber, market opportunities are limited. In 1970, Colorado lumber producers exported more than 60% of annual production. Meanwhile, Colorado's annual consumption of lumber was 2.8 times annual production (Larson 1973). One or more centers which would concentrate lumber production from the small operators, and then plane, grade, and market it might prove to be successful.

National Forests

The less than potential harvest from National Forests in the Front Range results from several factors, including inadequate staff for timber sale preparation, policy changes, but probably most often, insufficient industry demand. It is not always clear when demand is satisfied. Some timber sales that are advertised may not be sold because industry perceives them to be uneconomic, even though, at the same time, some operators may need to purchase additional timber.

Where existing industry processing capacity is below potential annual harvest, no expansion in suitable industry processing capacity will be likely to occur unless industry is confident that long term potential harvest will be put up for sale. A trend in recent years in the central and southern Rocky Mountain National Forests has been a reduction in potential annual harvest due mainly to wilderness set-asides (USDA Forest Service 1979).

Other Forest Ownerships

Industry needs better information on the total local timber supply. Information on the potential annual harvest from private lands will be available only after timber management plans covering much of the private timber lands have been prepared. The Colorado State Forest Service has been attempting to develop a program for these private lands. If successful, this program would provide planned annual harvests from private forest lands which would benefit existing and future forest products industries.

Forest Industry

Much Front Range produced lumber is marketed as rough-sawn, and this and much of the surfaced lumber is never graded. An operation which would acquire rough lumber from the small operators, plane, grade, and market it could be valuable. The major requirement for such a firm is marketing expertise.

More definitive information about the kinds and grades of lumber sold locally in Colorado would benefit local firms, which now must import many wood products from states outside the area. Additional information on the volumes, sources, and kind and grade of lumber being handled by local wholesalers and retailers could be obtained by survey.

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Keywords: Timber marketing, timber economics, *Pinus ponderosa*, *Dendroctonus ponderosae*

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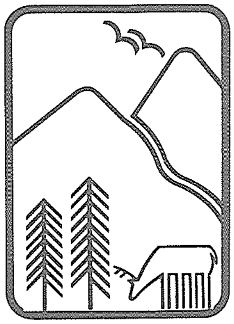
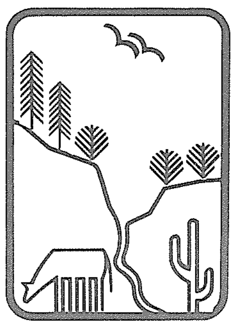
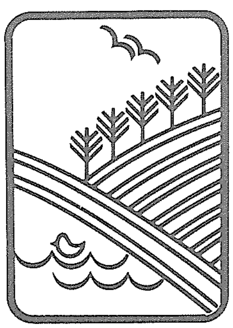


Rocky Mountains



Southwest



Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

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