FACTORS INFLUENCING INTEGRATED FOREST MANAGEMENT ON PRIVATE INDUSTRIAL FOREST LAND

R.D. KREUTZWISER
C.S. WRIGHT

Department of Geography
University of Guelph
Guelph, Ontario
N1G 2W1

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Summary

Integrating nontimber values with timber management on private forest land may be considered by many to be incongruous with profit motivated timber companies; however this report identifies several benefits of integrated forest management (IFM) for timber companies. Perhaps most notable of these are increasing opportunities to generate income from recreation on private land; but other less direct benefits such as improved public relations, reduced vandalism and, in some instances, improved timber growth are also possible. Costs of IFM are still very real to timber companies and may not always outweigh benefits.

This research has examined some factors that may influence the decision of private industrial forest (PIF) owners in the level of IFM that they choose to practise. Decision making behaviour of corporations is complex and subject to a range of influences from personal attitudes and motivations to such external influences as market forces and societal pressures. This study focused on the influence of external factors that vary regionally and some of the more readily identifiable internal influences. More specifically, the influences of government policy, land tenure patterns, size of corporate landholdings, size of corporation, and corporate policy were examined. Of special interest was an analysis of the role government legislation may have in encouraging IFM on PIF land.

In order to look at the influence of a range of government forest practice legislation and of land tenure patterns, this research focused on timber companies operating in the 26 states where more than five percent of forest land is owned by private industry. A questionnaire on corporate forest management practices was sent to 270 addresses for 239 companies. Ninety-seven responses were received which represented a 43 percent response rate after adjustments for undeliverable questionnaires and companies that had been incorrectly identified as landowners. This is a reasonable response rate for a mailout questionnaire and analysis showed no significant differences between early and late respondents, suggesting minimal nonresponse bias.

In addition to surveying companies in the United States, 13 major PIF landowners in Ontario were sent a similar questionnaire. The purpose of conducting the Ontario survey was to assess the level of IFM practised and, where appropriate, to make recommendations for improving the level of IFM practised. Of the 13 companies surveyed in Ontario, seven responded.

A consistent assessment of IFM that could be applied to a diversity of forest regions and ownerships was needed. To meet this purpose an index was developed (Chapter 2) that used a scoring system to rank alternative timber management practices with respect to the extent that those practices protected or enhanced nontimber values. Weighting was also incorporated into the index to favour those practices that were most obviously modified to enhance nontimber values and hence reflected a stronger commitment to IFM. The index focused on stages of timber management (e.g. preharvest, harvest) but also included important nontimber management activities, i.e. corporate recreation policies and IFM research.

For the purpose of this research there was substantial evidence that the index performed adequately. The distribution of index scores approximated a normal curve ranging from -5.50 to +20.25, from a possible range of -18.50 to +24.50. It was possible to compare scores of some companies with assessments of those companies given in the literature and on the whole scores were substantiated. Furthermore companies that responded that they saw no benefits to IFM or had no associated policy, tended to score low.

Overall, the IFM scores for companies in the United States tended to be higher than the Ontario scores (a mean of 7.32 compared to 4.63). Analysis of the United States data indicated that IFM scores were statistically higher for companies that owned more land within a state and where there were comprehensive government policies which encourage IFM and higher percentages of PIF land. There was, however, multicollinearity among these factors. There was a strong correlation between the percentage of PIF land and the amount of land that corporations owned within a state and between the percentage PIF land and government policy rankings. Consequently, the relationship between the percentage of PIF land and IFM scores was not significant when the influence of policies and amount of land owned were controlled.

Although the amount of land owned within a state appeared to be the strongest influence on IFM, analysis showed that its influence was diminished where there were government policies to encourage IFM. In particular, an increase in scores of smaller companies (sales less than $500 million) was observed where there was government forest practice legislation.

The results of this research show that corporate IFM decision making is indeed complex. The factors chosen for study in this research accounted for only 12 percent of the variation in IFM scores for all respondents (although as much as 22 percent of the variation was explained for a subgroup). The large unexplained variation scores probably results from both limitations in measuring the influencing factors and IFM. Chapter 3 discusses in some detail possible influences on corporate IFM practices, only some of which were examined in this research. Furthermore, some factors that were studied are in fact only indirect measures of socio-political and economic influences. Also, although the index developed to measure IFM was adequate, it is a simplification of a complex array of practices which are motivated by both nontimber and timber management objectives. Nonetheless some conclusions may be drawn from some of the more specific findings of the analysis of the United States questionnaire responses.

The strictly applied, environmentally-oriented forest practice legislation of the western United States was not always associated with the highest IFM scores. Mean IFM scores were highest in the Northeast where state policies explicitly included management of nontimber forest values, particularly wildlife and aesthetics objectives. This indicates the importance of specifically incorporating objectives for nontimber values into government policies if it is a priority to improve IFM. Furthermore this suggests that strict regulation of forest practices is not always necessary to achieve improved management of nontimber values.

There was other evidence that other types of government programs such as cooperative wildlife management programs and tax incentive programs are as important, if not more so, than forest practice legislation. For example, companies that participated in government wildlife management programs had much higher scores than those who did not. From this research it cannot be concluded that such programs heighten the awareness of IFM or if companies predisposed to IFM are attracted to these programs. There was quite a high participation rate in wildlife management programs which indicates that they could be a popular way to encourage IFM. State programs directed towards increased wildlife management and public access on private land give companies public relations advantages and some also provide economic incentives.

This research found that public relations was an important consideration in private forest land management. Large companies, both in terms of the amount of land owned and sales, were particularly cognizant of the public relations value of managing nontimber values. Economic benefits were also important and also more often identified by large companies. A large landholding no doubt facilitates IFM by providing managers with a greater diversity of resources and more opportunity to spatially or temporally separate land uses. The influence of public relations on corporate behaviour, however, cannot be ignored. A review of annual reports of some large companies indicated that many of these companies

have recently given more attention to IFM than was found by research done in the late 1970's and early 1980's. It could be argued that companies are responding to the wave of environmental interest raised in the 1970's. The physical advantages of large land resources plus the fact that large companies have a more visible corporate image and may respond more rapidly to public pressure could account for the trend of higher levels of IFM for large companies that were measured in this research regardless of government policy.

Small companies, while perhaps less visible to the public and often owning less land, scored significantly higher where there was state forest practice legislation concerning IFM. Where PIF land is fragmented and particularly where companies are small (such as in much of the Lake states region), greater societal involvement may be required to overcome these constraints to increase IFM. Tax incentives, cooperative wildlife management programs and other programs to increase public relations would probably be most useful in these areas. While some nongovernmental organizations that assist in wildlife management on private land were identified in the literature, few examples of this type of cooperating program were found. This is perhaps an area for further development of improved private land management.

In addition to the conclusions that can be drawn from the analysis of the questionnaire data, some judgments can be made on the IFM index. While the index proved adequate to discriminate levels of IFM for the purposes of this research, there could be advantages to further development and modification of the index. More attention could be given to the weighting that was used which, as applied, had only a minor effect on scores but was intended to modify scores to more accurately assess the commitment a corporation made to IFM.

The basic structure of the index could be added to and field checked to develop a more site-specific tool applicable at a regional level for managers to monitor the development IFM on both private and public forest land over time. For example, modifications could be made to provide a regional assessment of the impact of timber management on nontimber values for specific soil types, topography, vegetation and wildlife species which would result in changes to the scores used in different categories. Modifications may also be necessary to reflect different types of ownership (public or private; nonindustrial or industrial) and corresponding land management objectives. These modifications could lead to IFM indices developed for particular regions that would be useful for further research on the influence of changes in government policy on IFM practices.

Recommendations

There has been very little action in terms of public sector encouragement of IFM on PIF land in Ontario beyond very general statements in provincial strategic land use plans. Nevertheless this study measured high IFM scores for a few companies and found that most were quite active in encouraging recreation use of their land. It should be noted that despite the relatively low percentage of PIF land in Ontario, the average amount of land owned per company is comparable to the average in the United States (284,800 acres in Ontario and 243,900 acres in the United States). Furthermore, PIF land in Ontario tends to be concentrated and therefore relatively important at the regional level (particularly in northeastern Ontario).

It must be acknowledged that differences exist in the environmental, economic, social and institutional context in which private industrial forest land is managed in the United States and Ontario. At the same time, considerable variation in context exists among the 26 states included in this research. Moreover, it is this variation in context which has been the focus of study, as represented particularly by the hypothesized external influences. Consequently, an understanding of these influences can provide a basis for several recommendations aimed at increasing IFM on PIF land in Ontario.

1. Ontario Ministry of Natural Resources (OMNR) should develop policies to encourage IFM on PIF land. Such an initiative could be part of a broader effort to enhance management on private forest land (both industrial and nonindustrial), for example through comprehensive forest practice legislation. This report has highlighted the timber management activities (practices) which most significantly affect nontimber forest values. It appears, however, that stressing nontimber values in any provincial policies and programs will be even more important than stringent forest practice regulations.

2. OMNR should also foster IFM on PIF land through existing and new cooperative programs for wildlife management and recreation access. The existing interest and activity in this area expressed by most of the Ontario respondents suggests that such programs can be a key to opening doors to IFM. This is likely to be particularly so within Ontario's Great Lakes-St. Lawrence forest region because of the importance of the region's recreation, wildlife and other nontimber forest values to the regional economy and people of Ontario.

3. OMNR should consider technical assistance, tax incentives and additional programs to offset costs associated with IFM. Such incentives will be particularly important to small industrial forest landowners.

4. Public awareness of private land management and in particular the role of the timber industry as land managers must be heightened. OMNR and the Canadian Forestry Service (CFS) should encourage the development of awards to industry, perhaps sponsored by a nongovernmental agencies, which would raise the public profile of companies that make special contributions to environmental protection. This report has shown that larger companies are especially aware of the public relations implications of their land management decision making.

5. OMNR and CFS should encourage professional forest management standards. Some examples of this are described in Chapter 3 (in Mississippi and Vermont). This would heighten the awareness within the industry of the value of IFM both to the landowner and to society. Incresed public awareness of IFM on PIF land would improve public relations and further public understanding of forest management.

6. OMNR should develop an index which could be used to monitor IFM on PIF and to assess the effectiveness of IFM policies and programs. The index described in this report could be modified to reflect more specifically the foerst environment of Ontario.

CHAPTER 1

INTRODUCTION

1.1 Overview of the Problem

After an analysis of the land use decision making behaviour of 29 of the largest forest products companies in the United States, Enk (1975 p.110) concluded that "factors outside the firm itself (social and legal) had had minimal impact on the land use policies of [these] firms." However, prior to Enk's research (done in 1969) state governments in the United States had implemented forest practice legislation to ensure minimum forest practice standards for environmental protection and since that time several western states have developed very strong, environmentally-oriented forest practice acts (Ellefson and Cubbage 1980a). Beyond Enk's study there has been little comprehensive study of private industrial forest (PIF) land use (Shands 1981). Yet Denman and Prodrano (1972) pointed out the necessity of studying the nature of the private land unit and behaviour of its owner to develop successful policy. More specifically related to forestry, "because private forest decisions are affected by a variety of government programs, an understanding of private forest practices and the forces shaping them is necessary for the evaluation of public policy" (Deacon and Johnson 1985 p.18).

Researchers have found that private nonindustrial forest landowners are strongly influenced by social and legal factors, economic and environmental conditions and their personal and landholding characteristics (Carroll 1978; Hickman and Gehlhausen 1981). It would seem reasonable to expect that PIF landowners are subject to a similar range of influences, in contrast to the conclusions reached by Enk (1975). In fact, Vaux (1983) observed that there was improved management of soil and water resources on PIF land in California after regulations were implemented. In another example it was found that timber corporations modified land use practices to provide recreation amenities in response to public pressure (Cordell and Maddock 1969).

In particular, this research is concerned with private land management practices related to integrated forest management (IFM), the concept of considering all forest values (timber, wildlife, water, soil, recreation and aesthetics) in land use decision making. Integrated forest management, which has evolved from the older concept of multiple use, requires assessment of environmental, economic and social costs and benefits of alternative uses before making land use allocations. Through the development of IFM practices on public land, much has been learned about the ecological interrelationships of forest land uses (for example, Schultz 1973; Finnis 1973). The economic and social costs and benefits are more controversial because of the difficulty of assigning values to nonmarket resources and of generally managing externalities (Coleman 1980; Zivnuska 1974). Little effort has been given to synthesizing environmental and economic benefits and costs of IFM from the perspective of the PIF landowner who, in contrast to the public or nonindustrial forest land manager, has one dominant land use, timber production. This information could alter the trend of single purpose timber management and encourage greater consideration of other forest values (Clawson 1975).

The practice of IFM has been adopted on public land in both Canada and the United States and the Government of Ontario has indicated an intention to increase IFM on private forest land (OMNR 1982a). Although only eight percent of Canada's productive forest land is privately owned, it supplies more than 23 percent of Canada's raw wood fibre (Pollock 1973). In Ontario the forest industry owns only approximately 3.5 percent of the productive forest land (OMNR 1982b). Nevertheless there is a concern over the lack of government regulation of private forest land:

"There is no federal legislation to control forestry practices on private lands and there is very little provincial enforcement of regulations governing forestry practices on private lands.... There are few fiscal incentives for sound environmental practices [so] some of the most destructive logging practices occur in the most accessible and visible private forests close to Canadian cities" (Weetman 1983 p.293).

1.2 Purpose and Objectives

The purpose of this research is to determine factors influencing the level of IFM on privately owned industrial forest lands with the goal of offering recommendations to encourage IFM on PIF land in Ontario.

There are three objectives:

1. To describe the concept of IFM and discuss the benefits and costs to PIF landowners

2. To identify factors which facilitate or constrain the practice of IFM on privately owned industrial forest land

3. To recommend changes in policy, institutional arrangements and attitudes which could be implemented or encouraged in Ontario to improve IFM on PIF land

1.3 Approach and Outline

To fulfill the first objective, the literature on the environmental and economic benefits and costs of IFM was synthesized from the perspective of PIF landowners and is presented in Chapter 2. This information was used to develop an index to measure IFM which is also presented in Chapter 2.

The literature of corporate decision making and, in particular, factors influencing private forest land use decision making is summarized in Chapter 3. From this literature review a model of influences on corporate IFM decision making was formed which led to hypotheses of the relationship between the level of IFM practised and factors both external and internal to the corporation. The hypotheses and a description of the methodology applied are also presented in Chapter 3.

To test the hypotheses, IFM practices of corporations in the United States were studied. The United States provided an opportunity to examine the effect of several approaches to government intervention in forest land management as well as the other hypothesized influences. Also, the literature review had indicated that there was a range of IFM practised in the United States. A questionnaire similar to the one used to collect information on corporate forest management practices in the United States was also sent to industrial forest landowners in Ontario. This provided an assessment of the current level of IFM practised in Ontario which is presented in Chapter 4. Results and discussion of the United States data analysis are given in Chapter 4.

CHAPTER 2

INTEGRATED FOREST MANAGEMENT

2.1 Concept of Integrated Forest Management

Integrated forest management (IFM) is a relatively new term used to describe a decision making process that acknowledges the biophysical relationships that exist in forests to manage compatible forest land uses. The focus of IFM has been on publicly owned forest land where there is a responsibility to manage nonmarket forest benefits and therefore a need for a process to adequately incorporate social values with economic and ecological information.

Rapid population growth, urban expansion and a growing environmental concern have all contributed to a broader valuation of forests. Society is demanding more forest products (recreation, timber, etc.) at the same time that forest land is being lost to nonforest purposes (Duerr et al. 1979). Carroll (1978) stated that "an increase in social accountability in both the public and private sectors has led to more emphasis on the need to obtain, for the benefit of society as a whole, secondary benefits from woodlands."

Integrated forest management on industry-owned forest land has received little attention because it is often assumed that although private lands are typically managed for multiple uses, market forces and established priorities among owner objectives direct dominant and secondary uses (Zivnuska 1980). However, private landowners are not immune from the need to recognize societal values of forests (Carroll 1978; Duerr et al. 1979) and could derive benefits from IFM (Hicks 1985).

Integrated forest management on PIF land differs from that on public land. First, it must be assumed that the dominant use is timber production although this may not be the actual use over all of a landholding. Second, industrial landowners are constrained in the extent to which nontimber product objectives can be met by the need to generate sufficient income and return on investment to stay in business. Consequently, the private industrial landowner must weigh social demands for nontimber resources against economic returns to the landowner. This would preclude integration of certain forest uses such as wilderness which Clawson (1975) viewed as being completely incompatible with timber production. However, other uses of forests such as wildlife habitat, watershed stability, soil conservation, recreation and aesthetics are all to some extent compatible or even complementary with timber production (Clawson 1975).

While these nontimber values of a forest are generally assumed to provide nonmarket benefits to society, there are some non-economic benefits that may accrue to the landowner, or benefits that could provide economic advantages only over the long-term. The remainder of this chapter will review the environmental effects of timber management on nontimber forest values and then examine the benefits and costs in the traditional economic sense and from a broader perspective that a private industrial forester might incur in practicing IFM.

2.2 Overview of Environmental Effects of Timber Management

Forest environments are a complex mosaic of vegetation and wildlife species, soil types and topography that can vary substantially even at the very local scale. An understanding of the biophysical interrelationships among diverse forest components is necessary to select the most appropriate timber management strategies to protect other forest values. Hynard (1985) observed that with a better

knowledge of the impacts of timber harvesting on wildlife, useful measures for wildlife management could be easily instituted at little cost.

Several reports describe biophysical interrelationships of different forest ecosystems and make recommendations for appropriate timber management practices to protect or enhance other forest values. For example, Finnis (1973) summarizes the impact of timber production on forests in British Columbia; Schultz (1973) makes recommendations to minimize the environmental impacts of timber harvesting in central Alberta; based on a description of physiographic regions in Ontario, OMNR (n.d.) provides guidelines for timber management in Ontario; Minckler (1975) gives IFM strategies for woodlot owners in the eastern United States; Society of American Foresters (1981) recommends appropriate cutting practices for different forest types throughout the United States; and Weetman (1983) summarizes major impacts of timber management across Canada. All of these studies point to ways that timber management practices can be executed to minimize environmental impacts but some, particularly Minckler and the Society of American Foresters, cite ways in which timber production and other objectives can be combined. There are also comprehensive methodologies for integrating timber management with specific forest components such as Thomas' (1979) work on a strategy to coordinate timber management with wildlife.

While recognizing the variability of forest environments and therefore the complexity of impacts, the purpose here is to briefly look at timber management practices and how these might affect nontimber values. This will provide some insight into the benefits and costs of integrating timber management with management of other forest values which follows.

Timber management practices may be grouped into four categories: preharvest, harvest, post-harvest and protection. Development and management of a forest is a cyclical process so that activities may be repeated at different stages or may overlap with objectives and practices of another stage. Therefore, the distinction of these stages is somewhat simplified. However, classification into four stages avoids repetition and provides a useful framework for the discussion that follows on the interrelationships between timber management and other forest uses.

Preharvest Management

Timber outputs can be increased by management practices that improve tree and stand quality. A manager's goal may be to encourage growth to reduce the rotation age (age at which timber is cut) and to increase yield. Preharvest treatment may include pruning individual trees, removing undesirable species, precommercial thinning to remove slow-growing surplus stems and commercial thinning which occurs later to encourage growth in the final stages. Fertilization is another means of improving growth that may actually be done at the time of regeneration.

Decisions on preharvest requirements are usually based on costs and expected economic returns from harvesting the stand but could also be influenced by objectives for other compatible forest resources. If properly planned, preharvest treatment can increase forage and habitat diversity for wildlife (McComb 1982), increase water yields (Aussenac et al. 1982), improve soil nutrients (Kimmins 1972) and enhance aesthetics (Litton and McDonald 1980). However, loss of specific habitat types such as snag trees can also occur (Schoen et al. 1981). In addition, fertilizer application without adequate protection of water courses can adversely affect water quality (Sopper 1975). Improper slash disposal in areas of scenic value may detract from any potentially enhanced visual qualities (Brown and Daniel 1984). There may also be conflicts (particularly in the short-term) between nontimber objectives; for example, alternative slash disposal practices will create different opportunities for wildlife, recreation and aesthetics.

Harvest

This discussion on harvesting includes all activities associated with cutting and removing timber from a forest. The impact of harvesting on other forest values depends on many factors such as method and equipment used in cutting, location and construction standards of roads and landings, extent of area logged, volume of timber removed, season of cutting, and rotation age. Decisions with respect to these factors are interrelated and also dependent on timber species, stand condition, topography, product type and other management considerations (such as size of firm and its long-term objectives).

Cutting methods can be classed into two groups, depending on the age characteristic of the new stand. Cutting methods that produce even-aged stands are: clearcutting (all trees in a stand or area are removed); seed-tree (a few good seed-producing trees per acre remain after logging); and shelterwood (strips or patches of trees remain for seed production and shelter but are subsequently removed). Selection cutting, either single-tree or group, results in uneven-aged stands. Group selection creates miniature clearcuts but the resulting regeneration occupies too small an area to be considered even-aged management (Minckler 1971; Society of American Foresters 1981).

The relationship between harvesting and wildlife is perhaps the best example of the variability of the impact of timber management on nontimber values. Many wildlife species can benefit from openings created by cutting but for some species, such as ruffed grouse, the most beneficial opening is five to ten acres (Gullion 1985) while moose habitat can be improved with openings as large as 200 acres (Peek 1971). Several researchers have observed that cutting may not change the density of birds in an area but may have substantial affect on species composition (Freedman et al. 1981; James and Wamer 1982; Resler 1972; Webb et al. 1977).

The extent of cutting may also have variable effects on aesthetics. Small, irregularly shaped cuts or selection cutting may have minimal affect or may actually enhance vistas (Benson 1982; McDonald and Whitely 1972). On the other hand, large, regularly shaped cutblocks with stumps and bare soil evoke strong negative reactions to logging (McDonald and Whitely 1972).

Water yields may be increased to the benefit of downstream users when greater than 20 percent of the watershed is logged (Johnston 1984; Patric and Evans 1982). However, where logging results in increased over-land flow, greater storm flow or loss of streamside vegetation, water quality and fish habitat may be seriously impaired (Bormann and Likens 1979; Lynch et al. 1977; Robinson 1958).

Road construction also potentially has negative effects on water quality. One study in California found that 40 percent of the total erosion associated with timber management activities was derived from the road system (McCashion and Rice 1983) and similar results were found in northern Ontario (Mattice 1977). Logging roads may interfere with wildlife migration routes or breeding grounds. Although recreationists benefit from improved access, roads, skid trails and landings can detract from scenic views (McDonald and Whitely 1972).

Post-harvest Treatment

Post-harvest treatment is closely linked to harvesting because slash disposal, site preparation and regeneration requirements will largely depend on harvesting methods. With selection cutting, the amount of slash debris may be minimal and because some ground cover and seed trees remain, post-harvest treatment can be inconsequential. In contrast, with any form of even-aged management where entire areas

are harvested, treatment of slash and regeneration may affect other forest values. When access is no longer required, road and landing abandonment may have impacts on other forest resources.

Slash debris in moderate amounts performs several ecological functions. It is a source of forage and shelter for some wildlife including birds (Gullion 1985; Medin 1985). Initially slash protects soil from erosion and protects young seedlings (Benson 1982). As slash decomposes, it may also serve as a source of soil nutrients (Covington 1981; Weetman 1983). Too much slash is a fire hazard, impedes wildlife movement and has a low aesthetic appeal and therefore requires treatment. Slash is disposed of by burning, chipping, crushing or chopping and spread over logged sites, or by complete removal. Each of these methods has variable impacts on nontimber values (Benson 1982).

The decision to seed, plant or rely on natural regeneration is usually based on the availability and quality of seed trees on site and the desired species for regeneration, as well as site accessibility and cost factors. Rapid regeneration ensures prompt return to normal water flows and nutrient cycles (Hornbeck et al. 1984). To the timber manager early regeneration of commercial timber species means more efficient wood production. However, certain noncommercial species may have great value as nutrient sources (Marks and Bormann 1972) and some early successional species are known to provide better browse (Resler 1972). Therefore it may be an asset to achieving some resource values in certain areas to use regeneration methods that permit noncommercial species in early stages of the forest cycle.

Access roads and landings left after harvesting can also affect nontimber values. Roads and landing can be maintained or converted to provide trails or campsites to meet recreation objectives. This, however, can create problems for wildlife management where hunting pressures are increased. Where roads and landings are abandoned without adequate reclamation, erosion and increase sedimentation of water bodies may result, particularly at stream crossings (Lynch et al. 1977; McCashion and Rice 1983).

Forest Protection

Forest protection from the perspective of a timber manager involves control of wildfire, insects, disease and other destructive agents.

There are two primary aspects of fire prevention: 1) prevention of a fuel build-up (slash debris, dead standing timber etc.); and 2) maintenance of firebreaks. The former limits the possibility of intense burning that could occur with wildfire and that could adversely alter soil and water regimes. A negative aspect is the potential loss of wildlife habitat if old growth timber and snags are removed. Firebreaks may be created by maintaining a diversity of species and ages, particularly hardwood stands interspersed through conifers. This diversity is compatible with wildlife and aesthetic management as well as pest management (Minckler 1975). If the number and extent of fires are successfully reduced, then the impacts of fire fighting, such as the use of chemical retardants and bulldozing firebreaks, are reduced.

Insect and disease control can similarly be aided by maintaining a diversity of species and ages of timber and by cutting diseased and endangered timber. When infestations are extensive, chemical or biological controls are more common. Chemical insecticides and fungicides tend to give the most rapid and certain results but raise more environmental concerns including the development of genetically resistant strains of insects (Takekawa et al. 1982). The impact depends on the toxicity of the chemical to target and nontarget organisms, how the chemical reacts in the environment and how rapidly the chemical breaks down. There are concerns with mortality and chronic effects on nontarget organisms, particularly birds which may help to control endemic populations of insects (Hall and Chant 1979; Takekawa et al. 1982). The impact on other aquatic ecosystems is also a concern, especially in aerial spraying near water bodies

(Hornbeck et al. 1984). Biological insecticides such as *Bacillus thuringiensis*, a bacteria, are sometimes used as an alternative to chemical insecticides.

The use of herbicides in forestry has also raised concerns, particularly with toxicity to wildlife (Morrison and Meslow 1983). Kennedy et al. (1982) summarize some of the contradictions that exist over the safety of herbicides, particularly 2,4-D which is the most common herbicide in forestry (Morrison and Meslow 1983). Herbicides, however, are frequently used in wildlife management to increase deer browse or shrub habitat for a number of species (Landes 1976). Herbicides also increase water flow when vegetation is suppressed and evapotranspiration is reduced (Hornbeck et al. 1984; Likens et al. 1977).

Summary

The foregoing demonstrates the extent to which timber management may be compatible with other forest values and, with appropriate management techniques, may enhance certain other forest resources. Some potentially detrimental effects have been identified. Figure 2.1 summarizes, in a general way, the ecological impact of timber management activities on other forest resources and presents management techniques that could be part of an IFM strategy.

2.3 Benefits and Costs of Integrated Forest Management

There are limitations to assessing the benefits and costs of IFM in a quantitative sense. Only one study was found that attempted to quantitatively assess the costs of managing nontimber values when harvesting timber (Benson and Niccolucci 1985). That study was constrained, in part by lack of data, to reviewing only actual timber harvesting costs (not administrative or opportunity costs) and no attempt was made to look at other timber management activities. Other empirical work tends to focus on the cost of integrating only one other land use with timber management (for example, Halls 1975; McDonald and Whitely 1972). A comprehensive, quantitative benefit-cost analysis of IFM would have to be site-specific because of the variability of forest environments and local markets, and the multitude of management objectives and practices that may be appropriate for any particular forest environment.

There are many examples of theoretical analysis of the economic effect of nontimber resource management on timber production (for example, Anderson 1985; Calish et al. 1978; Coleman 1968; Hartman 1979; Samuelson 1976). Much of the economic forestry research attempts to describe joint production functions, an economic concept that describes the relationship between two outputs generated by a given level of input. The concept of joint productions in forestry has been explored in detail by Coleman (1968, 1980) and by Teeguarden (1979). The premise of joint production functions is that while a forest provides many outputs, the relationship between those outputs can be varied.

At one extreme, two outputs may incompatible so that production of one output is in conflict with another (Figure 2.2(a)). Figure 2.2(b) depicts a competitive relationship between two products. A tradeoff between the products must be made to determine the appropriate output of each because they compete for the same inputs (land, labour and capital). The relationship between two outputs may be complementary where increasing output of one product results in an increase in output of the other. Usually this is true only over part of the range of output as shown in Figure 2.2(c). The relationship between two products is independent if efforts to increase the output of one do not interfere with the output of the other. Figure 2.2(d) depicts an independent relationship which again is usually only true within a certain range of output.

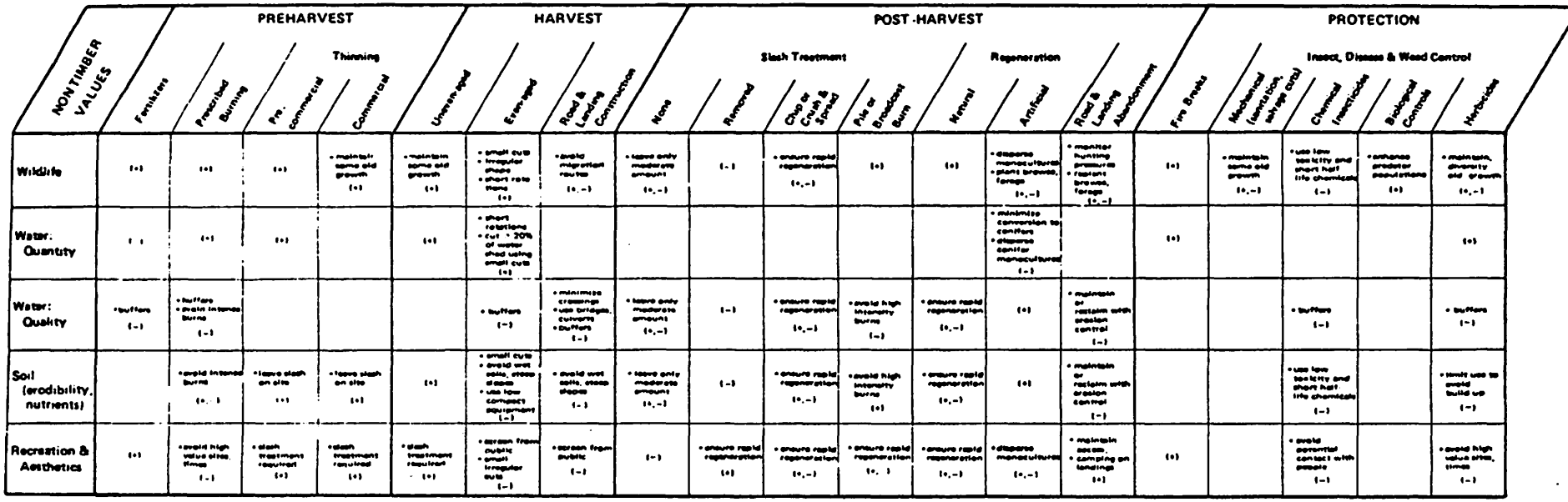

Figure 2.1. Integrated timber management practices to control impact on nontimber values. Some management requirements to minimize negative impacts (−) or to enhance positive impacts (+) are given. Some timber practices may have either positive or negative impacts depending on the nature and timing of treatment, species involved and other environmental considerations (e.g. slopes).

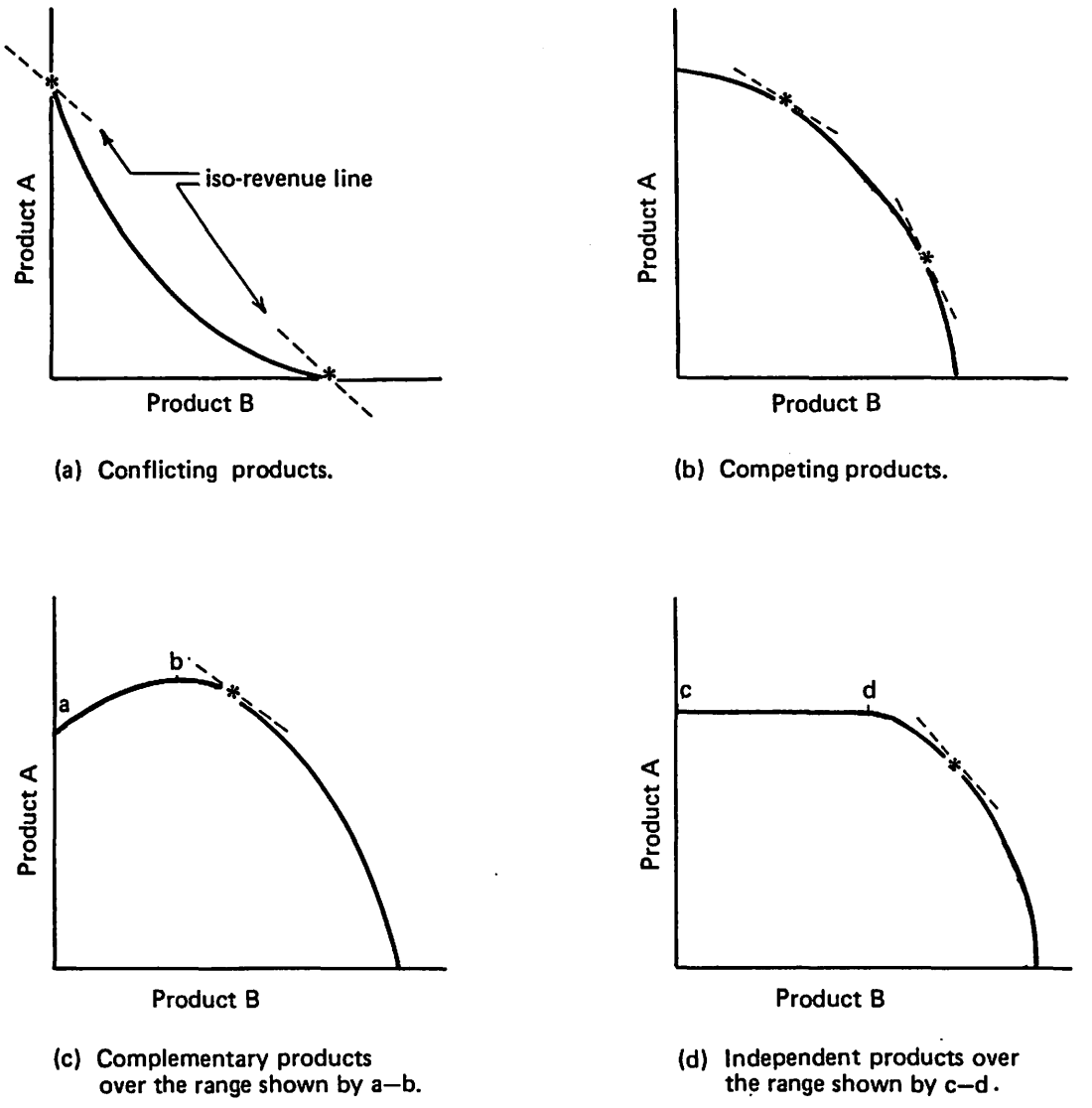

Figure 2.2. Alternative relationships between forest products. "*" indicates the optimum product "mix" for the relative values shown by the slopes of specific iso-revenue lines (dashed lines).

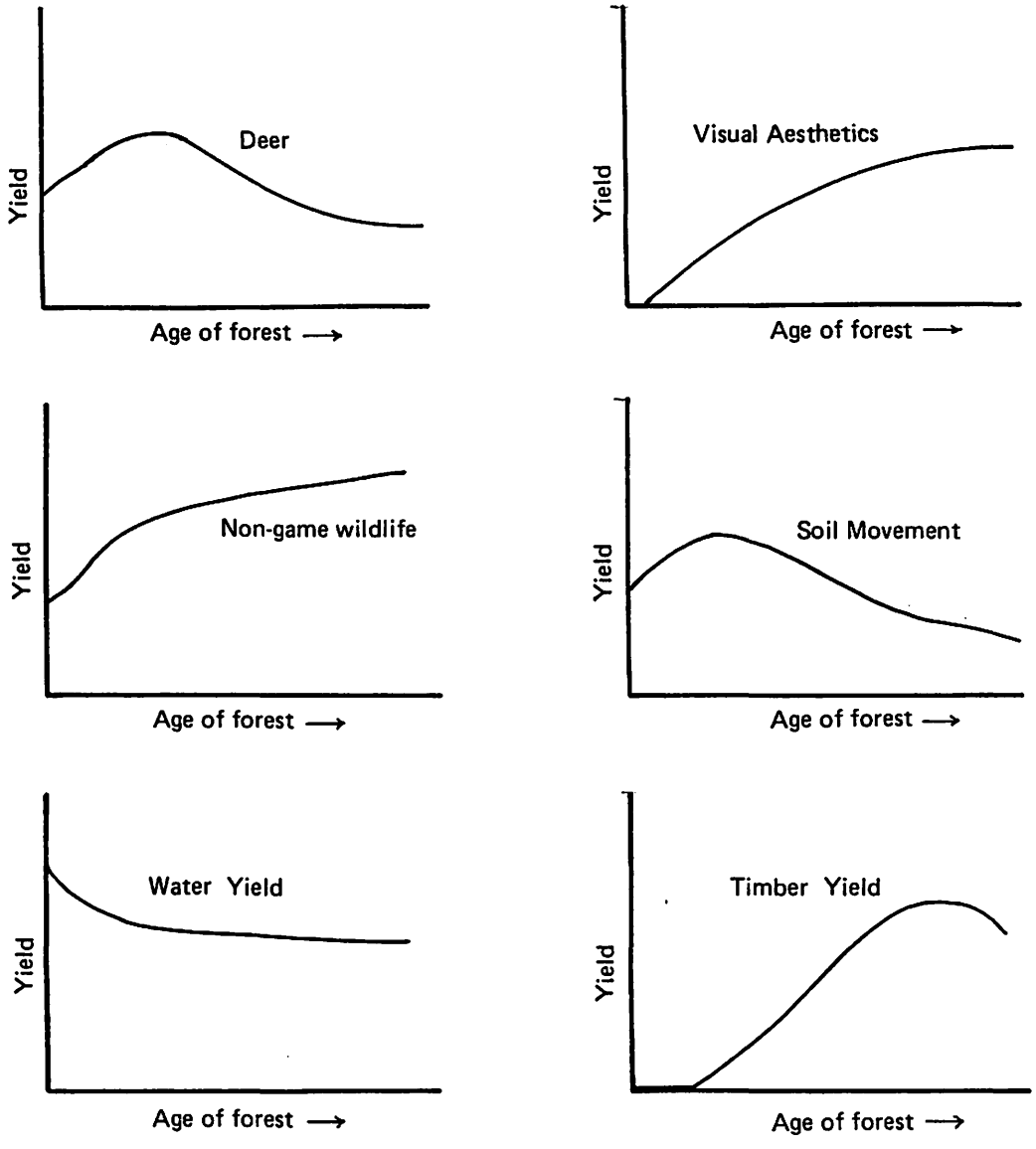

Figure 2.3. "Yields" for nontimber and timber products over time. Curves for nontimber resources are adapted from Calish et al (1978) who derived curves from research in Douglas-fir stands.

TABLE 2.1. Potential Benefits and Costs of Integrated Forest Management

NONTIMBER MANAGEMENT	BENEFITS	COSTS
WILDLIFE	• direct economic gain: leases or fees to hunt (Halls 1975)	• direct costs: inputs e.g. noncommercial forage plantings; road construction to avoid critical habitats (Benson and Niccolucci 1985)
	• control of wildlife depredation: manage habitat changes to stabilize populations (Campbell and Evans 1975; Cheeseman 1979; Gould 1962; Jordan 1967; Marquis 1981; Nelson 1975; Verme and Ozaga 1981)	• opportunity costs: e.g. buffers around nesting sites; maintenance of hardwoods for diversity instead of softwood conversion
	• mitigate insect infestations: manage avian predators of common forest pests (Crawford et al. 1983; Takekawa et al. 1982; Takekawa and Garton 1984; Thomas 1979)	• administrative costs
	• complementary practices: e.g. thinning; prescribed burning may improve habitat	• secondary costs: e.g. controlling access for hunting
	• public relations (Almy 1982)	
SOIL PROTECTION	• complementary practices: e.g. slash disposal (leaving or burning debris) may improve soil nutrients, minimize erosion, reduce need for fertilizing, promote regeneration (Benson 1982; Cramer 1974; Weetman and Webber 1972)	• direct costs: e.g. increased harvesting costs with use of specialized equipment and skid road restrictions (Benson and Niccolucci 1985); road and landing reclamation
	• reduced road maintenance costs when areas of sensitive soils are avoided (Benson and Niccolucci 1985; Haines and Haines 1981)	• opportunity costs: e.g. slash left on site instead of marketing chips
		• administrative costs
		• public relations: e.g. slash and stumps left to control erosion may distract from aesthetics
WATERSHED	• complementary practices: e.g. thinning; short rotations increase water flow; stream flow regulation techniques (e.g. reservoir construction) may provide water for fire fighting (Edwards et al. 1956)	• direct costs: road construction (Benson and Niccolucci 1985)
	• compatible practices: e.g. small clearcuts; modified cutting in buffers	• opportunity costs: e.g. buffers (Vaux 1983); productive land lost to water reservoirs; less softwood conversion to maintain water yields
	• public relations	• administrative costs
RECREATION, AESTHETICS	• direct economic gain: hunting, fishing, camping, cabin leases and fees	• direct costs: income may not exceed costs of recreation facilities & operations; information and education programs; liability (Cullington 1980; Tomlinson 1979); aesthetic logging requirements e.g. comprehensive slash disposal, directional felling, road construction
	• control of level and location of use to minimize conflict with timber management (Tomlinson 1979)	• opportunity costs: e.g. buffers to screen harvesting; land occupied by recreation facilities
	• reduced vandalism and trespass (Frye 1967)	• administrative costs
	• complementary practices: e.g. small irregular shaped cutblocks leave windfirm edges (Finnis 1973); cutting that maintains vegetation diversity may reduce pest problems; reservoirs for mill or fire control may be used for recreation (Allen 1979); thinning	
	• public relations: recreation facilities; education programs may increase tolerance of harvesting (Litton and McDonald 1980)	

Theoretically the optimum product "mix" for each type of relationship lies at the point of intersection of an iso-revenue line with the joint production function line. The slope of an iso-revenue line is determined by the relative values or prices of the two products. Teeguarden (1979), recognizing that revenue may not be the only measure of value from outputs, also uses the term iso-benefit line instead of iso-revenue line.

Another important concept from theoretical research on the benefits and costs of combining nontimber management and timber production is the changing value of a forest for different uses over time (Figure 2.3). While these models have been used to examine the length of timber rotation periods when nontimber values are considered (Calish et al. 1978), the also illustrate the potential for reaping benefits from nontimber outputs as a stand develops to maturity for harvest. Table 2.1 presents potential benefits and costs to the PIF landowner who integrates nontimber resource management with timber production. Actual benefits and costs would vary depending not only on the nature of the forest environment and timber production goals but also on goals and management strategies for nontimber resources. For example, wildlife management may aim for management of a diversity of species or for featured species (unique, endangered or game species) which demand specific habitat conditions.

Many of the benefits of IFM result from using complementary practices that achieve multiple objectives. Thinning, for example, may promote timber growth as well as improve wildlife habitat, aesthetics and water yields. However, few practices aimed at enhancing nontimber values produce direct economic gains for the landowner with the exception of income from hunting and other recreation activities. Fees and leases can make substantial contributions to a landowner's return on investment (Hintze and Lovaglio 1987). More often economic returns are more difficult to assess and may occur over a long-term period such as improved timber growth or ecological solutions to pest control or soil management. There have been attempts to quantify such benefits; for example a benefit-cost analysis calculated that avian predators would be worth a minimum of $703 per square mile in a year of western spruce budworm outbreak in Washington as a substitute for a major insecticide, Sevin-4-oil (Takekawa and Garton 1984). Benefits such as improved public relations are even more difficult ot quantify and others, for example increased water yields, may not accrue directly to the private landowner.

Costs, on the other hand, are often more obvious and occur in the short-term. Where nontimber management objectives compete with timber production, modified timber practices may be implemented that are compatible with nontimber objectives but at a cost to the landowner. Buffers around nesting sites or water bodies are an example where timber harvesting may be permitted but only at certain times or with special equipment or at lower volumes. Vaux (1983) estimated that stream protection zones in California cost industrial landowners an average of $0.50 per acre of land owned per year but costs ranged from $0 under selection management to $3.15 per acre per year under clearcutting.

Costs of IFM can be divided into three types: opportunity costs, administrative/planning costs and direct costs. Opportunity costs are costs generated by foregoing certain actions that would maximize income (Benson and Niccolucci 1985). These can represent short-term losses where, for example,there are seasonal restrictions on cutting or costs may continue over a longer time period where the rotation period is extended. In extreme cases opportunity costs might carry over an indefinite time period if land is excluded from the productive timber land base.

An example of administrative/planning costs is the cost of a wildlife biologist to identify important habitats to avoid in road construction. In some cases it may be difficult to assess exactly what administrative costs are attributable to nontimber objectives. Costs associated with additional field and paper work, which may result in frustration and resentment, have been recognized as psychological costs that may be as important as dollar costs (Vaux 1983).

Direct costs include the costs of specific equipment and supplies (e.g. special low compaction skidding equipment, seedlings for erosion control, campground facilities etc.). These costs represent actual costs that must be incurred immediately by companies practicing IFM while many of the benefits may accrue only over time.

Start-up costs associated with new staff and equipment or training for staff may create barriers to initiating IFM practices. This may be a great impediment when the market value of timber is depressed or for small companies which may be less able to absorb the additional costs than large companies. On the other hand, a company that is already integrating timber management with, for example, wildlife management, may find that the additional costs associated with management of other nontimber values are minimal. The increased management effort may in fact enable such a company to reap economic returns from the improved quality of hunting.

The extent to which benefits may exceed costs is debatable. McDonald and Whitely (1972) concluded that the high felling, skidding and slash disposal costs of harvesting in a roadside stand were justified given the healthier, more aesthetic forest that remained. The thinned stand was expected to experience improved growth and there were public relations benefits. Some researchers argue that aesthetic logging practices are inefficient (Dowdle 1980) but Benson and Niccolucci (1985) found that practices to meet visual quality objectives have only a minor effect on harvesting and road costs. This finding may be somewhat misleading because some requirements for aesthetic logging may have been attributed to what Benson and Niccolucci (1985) termed "cultural" objectives, practices to protect the interests of local residents and popular recreation areas.

Actual costs and benefits vary substantially with the requirements of achieving nontimber objectives. Halls (1975) concluded that keeping clearcuts small (less than 100 acres) and thinning adds little or nothing to timber management costs and benefits pine growth. Frequent cuttings that aid wildlife may also provide better distribution of harvesting income for small landowners. However, where habitat improvement involves permanent forest openings with forage planting and fertilizing, costs may be over $100/acre plus the loss of timber volume (Halls 1975).

Obviously the PIF landowner will forego practices that substantially increase costs without returning identifiable benefits. However the benefits may be important to society and therefore compensation to the landowner may be justified and necessary to protect nontimber values on private land.

2.4 An Index to Measure Integrated Forest Management

To accomplish the purpose of this research, it was necessary to have an objective measure of IFM. Yet IFM is a complex concept that cannot be identified adequately by one item or factor. It is a decision making process based on site specific information and objectives. The scale of this research prohibited examining in detail the process and outcome of each company's forest management decision making to assess to what extent IFM is practised. Lassiter (1985a) coped with a similar problem by using key indicators of integrated wildlife and timber management to provide a general picture of the extent to which timber companies had explicitly considered wildlife in selecting timber management practices.

From an examination of the ecological relationships between timber management and other forest values, certain practices can be identified that are particularly beneficial to nontimber resources. In this research it was assumed that a company practicing IFM would tend to adopt more of these practices than a company not practicing IFM. This assumption is supported by a statement from Tomlinson (1979):

> "To insure that adequate consideration is given to multiple-use benefits some companies have specific policies...to protect multiple-use values. These policies may include environmental concerns such as water quality, road construction, site preparation and maintenance, timber harvesting, reforestation, prescribed burning, environmentally sensitive areas and the use of chemicals. Other policies dealing specifically with wildlife, recreation and aesthetics...may include the management of endangered or threatened species, the types of hunting and fishing programs allowed, and the allowable size and shape of harvested areas. Construction of nature trails, roadside parks,...campsites and second home sites may also be regulated by policy."

Using the full range of policy areas listed by Tomlinson (1979) would have required a very lengthy questionnaire, costly to produce and analyse, and tedious for respondents to complete. Thus certain management practices were selected as key indicators of IFM. The focus was primarily on timber management activities because it was assumed that timber production was the dominant land use of the companies studied but that specific timber management practices can be modified to accommodate secondary uses. A few additional items not directly related to timber management, but associated with IFM were also chosen. The index focuses on management outputs or actions to assess what is actually done rather than looking at intents such as those that may be reflected in policy statements or reflections of policy such as staff expertise.

The key indicators of IFM were developed into an index, presented in Table 2.2, which permitted measurement of each company on a number of variables that together gave a relative indication of the extent to which that company practised IFM compared to other companies studied. There were two aspects of the index: for each management category, alternative practices were assigned a score; and each category was given a weighting.

The index assigned a positive score to practices that appear to benefit nontimber resources and a negative score to practices that are likely to be detrimental to nontimber resources. Therefore even if management practices may be acceptable from the perspective of timber production but may, for example, reduce water quality, these practices were given negative scores. Practices that are neither overtly harmful nor beneficial to other resources are assigned a value of 0. Within each category an attempt was made to maintain an equal range of -2 and +2, although it was not rational to use the full range for some practices.

Not all possible variations in timber management practices were included in the index. The intent was to select common practices which are significant to IFM. Some companies apply a range of techniques, varying with timber species, site conditions and management objectives among other factors. A range of practices may still be indicative of IFM because, given the nature of IFM, no one practice is likely to be applicable over an entire property. Where a company reported that a combination of alternatives (that had not already been incorporated into the index) was used, the higher score was assigned if the practice associated with that score was done on a regular basis. So for example, if a company artificially regenerated where wild fire had destroyed timber, but this was not a normal practice on their land, the higher score for artificial regeneration was not used.

Weighting was used to favour practices that reflect a strong commitment towards IFM. Some practices that benefit nontimber resources may be techniques that are commonly used to improve timber production; therefore it is difficult to determine if these practices have been selected to achieve IFM or just to enhance timber production. As Lassiter (1985a) explained, "a number of forest management practices are highly beneficial to wildlife but are not 'chargeable' to wildlife" and he used the example of prescribed burning. On the other hand, some practices enhance or protect nontimber resources while producing no direct benefits for timber production and may in fact increase costs of timber production. It was assumed that

TABLE 2.2. Integrated Forest Management Index

Component	Score	Weight
1. Preharvest Management		X 1
- none	0	
- fertilizing; commercial thinning	1	
- burning; precommercial thinning	2	
2. Cutting Practices		X 1.5
- clearcuts >200 acres	-2	
- clearcuts 100-200 acre	-1	
- clearcuts (shelter or strip) <100 acres; selection cut	0	
- irregular clearcut shape..+0.5		
- wildlife management area..+0.5		
- public road buffers.....+0.5		
- water body buffers.....+0.5	Max.=2	
3. Road, Trail and Landing Construction		X 2
- unimproved stream crossings and no buffers	-2	
- improved crossings over fish-bearing streams or buffers	0	
- buffers around water bodies and improved crossings	2	
4. Road, Trail, Landing Abandonment		X 2
- neither reclaim nor maintain	-2	
- remove structures, no additional erosion control	-1	
- maintain roads for other purposes; plow abandoned roads, trails and landings	0	
- recontour roads, landings	1	
- recontour and reseed or replant	2	

Component	Score	Weight
5. Post-harvest Treatment		X 1
- all debris removed or heavy debris left with natural regeneration	-2	
- heavy debris with artificial regen	-1	
- all debris removed with artificial regen; select cut with no treatment	0	
- mechanical slash disposal with natural regen	1	
- mechanical slash disposal with artificial regen; burning with natural regen	1.25	
- burning with artificial regen	1.5	
- seeding or planting noncommercial artificial regen.....+0.5	Max.=2	
6. Forest Protection		X 1.5
- chemical pesticides only	-1	
- no treatment; chemicals combined with biological or mechanical controls	0	
- biological or mechanical controls	1	
7. Provision for Recreation		X 2
- prohibit access at all times and all locations	-2	
- allow access (with or without seasonal or locational restrictions for safety or management reasons)	0	
- provide facilities	1	
- set aside proportion of land predominantly or exclusively for recreation	2	
8. Integrated Forest Management Research		X 2
- no involvement	0	
- cooperation with other researchers (e.g. allow access)	1	
- participate in or fund research	2	

these practices were more discriminating of a commitment to IFM; consequently these were given a higher weight.

The total value possible for the index ranged from -18.50 to +24.50. A negative score does not necessarily mean that a company opposes the principle of IFM but rather that their practices may be causing harm to some nontimber forest uses and that their selected practices are not indicative of a commitment to IFM.

A draft of the index was sent to ten foresters working in government, industry and academic settings who were familiar with IFM to obtain criticisms of the index. Six responded and their remarks resulted in revisions. The revised version was also reviewed by another government forester. What follows is the rationale of each of the components, scores and weights of the index.

Preharvest Management

Research on preharvest management techniques demonstrates that many of these practices are beneficial to wildlife, aesthetics, water and soil management. While the absence of preharvest treatment is not necessarily harmful to other forest uses (for example on fertile sites with well-spaced growing stock), some preharvest management would aid nontimber resources. Therefore the scores in the preharvest component only ranged from 0 to 2.

Prescribed burning has been shown repeatedly to be very beneficial to wildlife and in fact was one of the key indicators selected by Lassiter (1985a). In some soils prescribed burning may improve soil nutrients (Finnis 1973). This treatment and precommercial thinning scored the highest in this component of the index. Thinning also usually enhances wildlife habitat as well as aesthetic values (Litton and McDonald 1980) and potentially water yields, if enough cutting is done (Douglass 1980) and soil, if slash residue is properly treated (Kimmins 1972). Commercial thinning scored slightly lower than precommercial thinning because of the possible loss of old growth timber that supports some wildlife (Schoen et al. 1981) and because precommercial thinning potentially improves aesthetics more when dense small stems are thinned (Brown and Daniel 1984). Research is inconclusive about the effects of fertilizers on nontimber values but, although concerns have been raised (Sopper 1975), if properly applied, wildlife could potentially benefit (Thomas 1979). Therefore this practice scored 0.

All of these preharvest treatments promote timber growth and in most cases, decisions to use these practices are more likely to be precipitated by this objective rather than to enhance nontimber values. In fact, one forester commented that "practices...such as prescribed fire have rarely been implemented in past years, unless timber also benefitted (Allen 1979). Therefore the weight assigned to preharvest management scores was one.

Cutting Practices

The research effort devoted to the study of the impact of timber cutting practices on other forest values indicates the extent of the impact that this activity can have on other forest resources. The effects of cutting can vary substantially depending on the amount cut, slope, soil and many other factors. However, there is significant evidence to suggest that large clearcuts are aesthetically displeasing (Brown and Daniel 1984), regenerate slowly (particularly if seed sources are inadequate) and therefore, increase opportunities for soil erosion and water quality deterioration (Finnis 1973). Few wildlife species benefit from large clearcuts compared to those which benefit from the increased food on small clearcuts that still afford

shelter (Gullion 1985; Nelson 1975). Consequently large clearcuts (greater than 200 acres) scored -2 and clearcuts of 100 to 200 acres scored -1.

Small clearcuts (or patch and strip cutting) or selection cutting greatly reduce the possible negative impacts of harvesting. Generally the choice between these cutting methods would be more dependent on timber species than IFM but their benefits and costs to IFM vary. Small clearcuts may provide greater water yields and provide more food for wildlife than selection cutting, yet selection cutting may have less impact on soils and may be more beneficial aesthetically than clearcutting. Therefore both small clearcuts and selection cutting scored 0. (Also a 0 score for selection cutting avoided double scoring for commercial thinning, which scored 1 under preharvest and could, in some instances, be considered selection cutting). Other management practices combined with small clearcuts or selection cuts can further enhance benefits to other forest resources or at least lessen negative effects. One-half point was added to the initial score (of -2, -1 or 0) for each of the following practices that were used: irregular cutblock edges (such as following contours or timber types), wildlife management programs, buffers along public roads and buffers along water bodies. This potentially biased the index against selection cutting since irregular cutblock shape would not apply; this may be justified because irregular shapes mitigate some of the negative impacts on aesthetics while giving the added benefit of increased edges for wildlife along open forage sites. Also small cutblocks can be used successfully for integrated management in deciduous forests which are managed under uneven-aged practices (Minckler 1971).

There was some concern that scoring specifically for implementing wildlife management programs would result in double counting if it primarily involved, for example, prescribed burning or thinning. However, several individuals who reviewed the index felt it was important and the possibility of adding only 0.5 (or 0.75 when the weighting is considered) did not appear to strongly bias final scores given the significance many attach to wildlife.

Buffers along roads and water bodies serve many functions, for example to protect aesthetic values and wildlife habitat and to minimize soil erosion and deterioration of water quality. A strong case could be made for scoring these much higher, particularly water buffers, but again it was felt that would unnecessarily bias the index against selection cutting. In fact, no attempt was made to score a no-cut buffer differently from a buffer in which selection cutting was done because of the possible additional benefits of selection cutting in a buffer to remove diseased trees or those susceptible to windthrow (Hornbeck et al. 1984) and to improve aesthetics (OMNR n.d.).

Most of the activities associated with positive scores in this component of the index are likely to be associated with decisions to protect or enhance other forest resources. Nevertheless, as some researchers (for example, Halls 1975) and some reviewers of this index noted, the cost of implementing many of these practices over and above normal timber management costs may be negligible. The cutting component of the index was assigned a weight of 1.5.

Road, Trail and Landing Construction

There are many factors that could have been included in this component such as maximum slopes of roads, treatment of wet areas or use of soil surveys and wildlife habitat maps to plan roads and landings. These would have substantially expanded the questionnaire so it was decided to focus on one key area of access construction, i.e. the treatment of water bodies. This activity causes the most concern because of the high potential for erosion caused by improper location and construction of roads, skid trails and landings (McCashion and Rice 1983). Unimproved stream crossings and no buffers between roads and landings and water bodies scored -2. Bridges or culverts over major streams (described as fish-bearing

streams) only, or buffers only, scored 0 because without both practices erosion is still a potential problem (Patric and Aubertin 1977). Buffers around at least major streams combined with improved crossings scored +2.

These practices provide no advantage to timber production but may substantially increase harvesting costs and so the weight assigned to this component was 2.

Road, Trail and Landing Abandonment

Proper treatment of roads, trails and landings after harvesting can greatly reduce the negative impacts of harvesting access. Without either reclamation or maintenance, erosion problems may be exacerbated (Lynch et al. 1977) and accordingly this scored -2. Removing structures such as bridges or culverts without proper erosion control measures can still create erosion problems but at least discourages access over improperly maintained roads and hence this practice scored -1. Maintaining roads for other purposes (which may include recreation) and/or plowing roads, trails and landings to promote natural regeneration minimizes erosion potential and scored 0. Recontouring access routes and landings back to the original contours restores the natural appearance of the landscape and this scored +1. The additional effort of reseeding or replanting landings, roads or trails may benefit wildlife and further reduce erosion hazards (Lassiter 1985a) and to reflect these added advantages this practice, when combined with recontouring scored +2. If reseeding or replanting was combined with any of the other practices, 0.5 was added to the base score.

As with road and landing construction, abandonment practices do not benefit timber production and may increase costs significantly; therefore the weight given to this component was also 2.**Post-Harvest Treatment**

There are a number of alternative practices related to this component and many combinations to suit different environmental conditions, harvesting practices and other objectives. The work of Benson (1982) strongly influenced assignment of scores and weight in this component as that research was the only example found that examined the impact of several possible post-harvest treatments on each of wildlife, soils, water and aesthetic values; other research dealing with more specific relationships in different environments also supports the scores used.

Large amounts of slash debris left on site obstruct wildlife movement and retard natural regeneration resulting in potentially greater soil erosion and prolonged aesthetic deterioration of the site (Benson 1982). Complete removal of slash robs the soil of natural nutrient sources (Covington 1981) and soil protection and seedling protection that is afforded by moderate amounts of debris (OMNR n.d.). As well, the short-term benefits of food source and shelter for small wildlife are lost when all debris is removed (Gullion 1985). However, short-term aesthetic values are improved with slash removal (Brown and Daniel 1984) but because natural regeneration may be retarded, long-term aesthetics are compromised (Benson 1982). Both complete slash removal or heavy amounts left on site with natural regeneration scored -2. Heavy debris remaining on site with artificial regeneration still detracts from aesthetic qualities and deters wildlife movement but does encourage return to vegetative cover so this scored -1. Complete debris removal, combined with artificial regeneration, ranked slightly higher because of improved aesthetics as well as accelerated regeneration and scored 0.

Preferred post-harvest treatments leave a moderate amount of debris to protect soil and regeneration and to improve wildlife habitat without detracting substantially from aesthetics. The objective is to encourage a rapid return to vegetative cover. Selection cutting, without any slash treatment, may do this where

cutting is light, but usually some slash treatment such as piling and burning is preferred, at least from an aesthetic perspective (McDonald and Whitely 1972). Therefore selection cutting without slash treatment scored 0.

Chipping, crushing or other mechanical treatment of slash, or burning either in piles or spread over the site (broadcast) are effective ways of reducing slash debris to moderate amounts. Benson (1982) found mechanical means to be slightly less effective from the perspectives of soil nutrient improvement, wildlife forage and regeneration. As a result, mechanical slash disposal with natural regeneration scored +1 and, with artificial regeneration, scored +1.25. Burning, either piled or broadcast, improves soil nutrients and speeds regeneration and forage growth for wildlife as well as still providing habitat for small mammals in residual material (Benson 1982). Burning with natural regeneration scored +1.25 and with artificial regeneration scored +1.5.

Artificial regeneration scored slightly higher than natural regeneration because of the benefits of more rapid revegetation (Duerr et al. 1979). The difference in scores is only slight, however, because natural revegetation may be as successful as artificial in certain environments and because of some of the controversial results of artificial regeneration. Artificial regeneration may entail conversion from hardwood stands to coniferous which has negative implications for water yields and forest diversity. Place (1973) argues that artificially regenerated forests of monocultures may be genetically inferior and more susceptible to insects and diseases. Yet Weetman (1983) points out that stands composed of only one dominant species are not necessarily less stable than more complex ones. Diversity of timber types within a stand may not necessarily be as critical as diversity over the larger area. Timber stand monocultures are still associated with a diversity of species found in the understory growth and hence are not the same as agricultural monocultures. Furthermore many seeds or seedlings for artificial regeneration are bred to be more resistant to insects and diseases and better adapted to growing conditions (Malac 1980).

Artificial regeneration with noncommercial species for either wildlife or erosion control was awarded an additional +0.5.

The weight assigned to the post-harvest treatment component was 1. With the exception of noncommercial artificial planting, these treatments are usually associated with intensive timber management to provide rapid growth of desired timber species.

Forest Protection

The value and impact of forest protection are difficult to assess without detailed information on treatments used, frequency of treatment and protection problems. Therefore it was decided to assess the general approach taken: chemical, biological and/or mechanical controls. No treatment was assumed to be neither benefitting nor harmful to other forest uses and so scored 0.

Exclusive reliance on chemicals as a means of treating pests (insects, diseases or weeds) has been criticized as a simplified solution to a complex problem (Johnson 1972; Thatcher 1979). Potential harm to water, soil, wildlife and human health have all been raised as concerns (Hall 1981; Hornbeck et al. 1984). Although it is often argued that insecticides are more harmful than herbicides, this is not always true depending on chemicals used, rates and frequency and location of application (Hall 1981; Kennedy et al. 1982); therefore both scored -1. The score of -2 was not used because recent developments have produced chemicals that cause relatively little impact and regulations have further reduced hazards by controlling frequency, extent and location of use (Morrison and Meslow 1983). Also some herbicides may result in improved wildlife habitat for some species (Landes 1976).

Where chemicals were combined with either biological or mechanical controls, the score was 0. This reflected the assumption that greater consideration was being given to select the most suitable method to result in less impact where other resource values were given some priority. If chemical use was very low (less than 1 percent of the property treated over the life cycle of the stand) and combined with other methods, or if only biological and mechanical control methods were used, the score was +1. While biological and mechanical controls may provide some benefits for wildlife, (e.g. those associated with encouraging natural predators) there may be some negative implications for some species; for example, where sanitation cutting removes old growth (Schoen et al. 1981), or where foreign predators may affect existing populations (Pimental 1980).

A weight of 1.5 was applied to forest protection scores. Forest protection, over and above harvesting (which can be used to remove decadent timber or timber susceptible to insects and diseases) may not be necessary, particularly from an IFM perspective. The weighting does indicate that, where protection is necessary, it is important to protect other forest values and that protection measures such as biological and mechanical controls may not always be most efficient from the timber production perspective.

Provision for Recreation

This component was included in the index to acknowledge the social importance of public access to private land. Public use of private land is generally at the discretion of landowners, although access is commonly permitted. Prohibiting access at all times and all locations scored -2. Often it is necessary to restrict access at certain times or in certain areas where human safety may be at risk due to timber management activities, or to protect recently regenerated sites or wildlife habitat. Access with or without seasonal or locational restrictions, if unaccompanied by any other recreation policy, scored 0.

If any recreation facilities (campsites, day use areas, trails, boat launches etc.) were provided, even if access was restricted in other areas, the score was +1. Where some land was set aside exclusively for recreation use the score was +2.

There may be many costs associated with providing recreation access, whether or not facilities are provided, ranging from costs of notifying users of restricted areas to maintenance and potential reduction of timber volumes. Although there may be benefits from reduced vandalism and controlled use, these probably do not substantially affect timber production. Therefore the weight of this category is 2.

Integrated Forest Management Research

Although IFM research does not necessarily represent a forest output, it is an action that is perhaps the ultimate commitment to IFM leading to improved practices in all other components (Perkins 1969; Rochelle and Melchiors 1985). Lack of involvement in IFM research then is not harmful and so scored 0. Cooperation with other researchers that was limited to allowing access to corporate property scored +1. Funding or actual staff involvement in research scored +2. This component was weighted 2 to indicate that there are little, if any, direct benefits to timber production but there may be significant corporate expenses.

CHAPTER 3

MEASURING INFLUENCES ON INTEGRATED FOREST MANAGEMENT

3.1 Decision Making of Private Industrial Forest Owners

Organizational theory suggests that corporations exist as institutions in the society in which they operate and therefore, must serve the interests of that society (Drucker 1972). Traditional economic behavioural theory would suggest that a private organization takes into consideration only those consequences of the decision which affect it, but even 30 years ago Simon could state that "an increasing number of private executives are concerning themselves with their responsibilities of trusteeship toward the community, even beyond the limits that the law imposes on them" (Simon 1957 p.70).

Timber companies are subject to the same considerations as other corporations but face additional limitations as landowners (Clawson 1975). The factors which limit both private and public forest land managers were divided into a threefold framework by Barlowe (1978) and are shown in Figure 3.1. The three groups of factors are physical and biological factors, economic considerations and institutional arrangements. Physical and biological factors provide the physical base and raw materials that affect the capability of land to support alternative uses. Economic factors are those a decision maker must consider to select profitable uses while institutional factors are the cultural influences that affect the acceptability of decisions.

These factors must be considered in the formation of corporate strategies which are the decision rules that provide general and specific objectives to direct a company and the criteria to measure its own relative success (Drucker 1977). Strategies are used to define the role of land within a corporation which in turn directs land use (O'Laughlin and Ellefson 1982). In two studies it was found that companies whose strategies regarded land of fundamental importance have the highest rate of return on investment (Enk 1975; O'Laughlin and Ellefson 1982). Strategies change over time "malleable by forces both internal and external to the company" (Enk 1975 p.91) and by 1982, O'Laughlin and Ellefson observed that corporations were placing greater strategic value on their forest land than at the time of Enk's study in 1969. "Although the evidence is scanty, it appears that all companies realize the importance of their timberlands and are willing to make investments to keep them productive" (O'Laughlin and Ellefson 1982 p.788).

Despite Enk's suggestion that land use strategies are shaped by factors both internal and external to a company, he found little evidence that societal intervention had **direct** effects on corporate land use decisions (Enk 1975). Income taxes, property taxes, zoning and land use and forest practice had only minor effects on land use strategies. Only water quality standards, which affected location of harvesting and road location and construction, were frequently cited as influencing corporate land use decisions. Several companies, however, noted that the threat of regulation modified decisions and Enk stated that public policy provided an environment favourable to the corporations (Enk 1975). Furthermore there are indications that some companies are guided by what they perceive as societal expectations of them as land managers. Enk (1975 p.94) quoted one corporate manager, "we are stewards of the land under a public franchise"; however a second stated "we own the land, and do with it what we want."

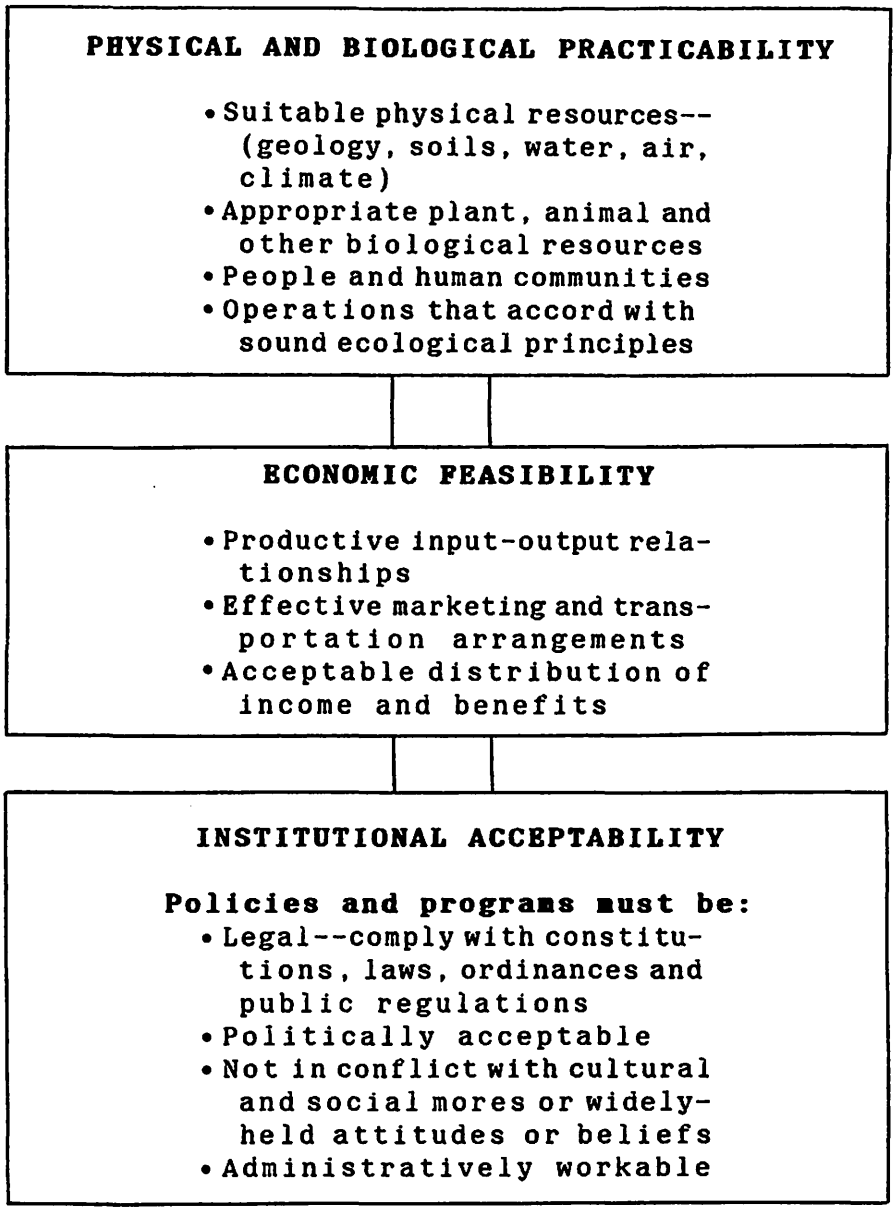

Figure 3.1. Threefold framework of factors influencing land use decisions. (Barlowe (1978 p.6)

3.2 Private Industrial Integrated Forest Management Decision Making

Statements in the literature made by both corporate foresters and researchers studying industrial forest management suggest that there may be factors both external and internal to a company that facilitate or constrain integrated forest management (IFM) on PIF land.

3.2.1 Internal Influences

Personnel and organizational goals and objectives have been cited as influences on forest management. Corporate strategies, or broad policy directives, in large timber companies are made by senior executives in a central head office (Davis 1966; Enk 1975). In some examples, corporate decision makers' attitudes towards conservation and their responsibilities as land managers have a marked effect on corporate land use policies. Hidy et al. (1963) cited that Frederick Weyerhaeuser's enlightened attitude towards progressive forestry led to the Weyerhaeuser Company's policy of managing their forest as an important, sustainable resource. Weyerhaeuser's historical corporate policy to manage their land "in concert and in harmony with nature and the public interest" has led, over the past two decades, to the development of specific integrated management practices directing logging and management of riparian zones and wildlife (Rochelle and Melchiors 1985 p.272).

Corporate policy provides the broad direction for an organization but specific tasks are performed by operational staff. A corporate policy that emphasizes land stewardship is a directive to provide operational and technical expertise to execute that policy. Davis (1966) described that there is often both a physical and administrative distance between corporate policy makers and woodland managers so the operational staff often have considerable discretion. However, individuals are conditioned to conform to corporate policies through organizational structure, education, training, incentives and operational plans.

Educational and technological background and skills, previous technological and managerial skills and availability of manpower are important elements of organizational personnel in the practice of IFM (Tomlinson 1979). Miles (1967) described how his previous technical and managerial experience with the United States Forest Service was instrumental in the formation of Gulf State Paper Company's wildlife management program.

The nature of the landholding, both its size and diversity are also important factors in corporate IFM policies. Miles (1967) stated that by 1942 with the acquisition of 100,000 acres, Gulf State Paper was in a position to practise multiple use. Without giving a particular size, Kozicky (1967 p.6) observed that multiple use can only be applied on areas "large enough to provide latitude for adjustment to conform to changing needs and conditions." Larger ownerships present a greater range of timber size, age and quality which afford greater opportunities for integrated management (Gould 1962). Although not necessarily related to IFM, Weyerhaeuser found that the large, contiguous properties that they acquired in the Pacific Northwest were better suited to "sound forest management" than their original scattered holdings in the Lake states (Hidy et al. 1963 p.380). Hintze and Lovaglio (1987) observed that it is not always practical to implement user fees where landholdings are remote and noncontiguous.

3.2.2 External Influences

Corporate decision makers may consider factors in three components of their external environment when considering policies: opportunities for economic gain, socio-political and technological components (Duncan 1972). With respect to IFM policies, the socio-political component consists of government

regulatory control and the public political attitude towards the forest industry. Opportunity for economic gain and the socio-political component correspond to Barlowe's (1978) frameworks of economic feasibility and institutional acceptability. The technological component may range from new harvesting equipment that minimizes soil compaction to a better understanding and management of the connections between timber management and other forest resources.

Opportunity for Economic Gain

Aldo Leopold was perhaps the first forest manager to identify the need for private forest landowners to be compensated for their efforts in wildlife management either in the market place or by public assistance (Leopold 1933). Since that time countless corporate forest managers have made the same observation (for example Allen 1979; Carlton 1967; Owen et al. 1985; Perkins 1969). Clawson (1982 p.289) went as far as to state that "without a monetary reward for providing nonwood outputs from the forest, private forest owners, both industrial and nonindustrial, have no incentive to invest in the production of such outputs or to manage the forest to produce more of them."

The opportunities for economic returns on nontimber outputs, particularly those associated with wildlife for hunting, are expanding in certain areas of the United States. Increasingly hunters in the southeastern United States, where hunting opportunities on public land are limited and the demand for hunting is great, are willing to pay for quality hunting experiences on PIF (Allen 1979). The most common form of compensation for hunting access is leases to hunting clubs. Lassiter (1985a) found that 55 firms or branches owning land in Alabama, Florida, Georgia or Tennessee lease land to hunting clubs at rates ranging from $0.25 to $8.00 per acre (mean = $1.38). Income from leases is often enough to cover ad valorem taxes (Owen et al. 1985) or to pay for wildlife management (Allen 1979). Rates of $3.00 to $5.00 per acre per year appear to justify modification of forest management practices to benefit wildlife (Lassiter 1985a).

Less common are fees (or admission prices) for hunting but they are used in some states such as Alabama (Halls 1975) and particularly in Texas where fee hunting has been practised for over fifty years (Allen 1979). Fees for hunting permits can range from $10.00 to as much as $250.00 for daily permits and from $5.00 to $125.00 for seasonal fees depending on the range of services provided and intensity of management (Yoho 1981). Hunting permits appear to be on the decline because of administrative burden (to prepare maps, permits and advertisements) and the low return per acre (Tomlinson 1979).

Firms receiving the highest income from wildlife are more likely to incorporate wildlife into forest management practices; for example leave mast trees and practise uneven-aged management (Lassiter 1985b). Income from hunting fees on Gulf States Paper Company's land in Alabama is sufficient to warrant changes to timber management practices such as small block sizes, thinning, prescribed burning every three years, and distributing cuts over a larger area and over a longer time (Halls 1975).

Competition with the public sector which often provides free outdoor recreation (or at a price far below costs) is frequently cited as disincentive to private sector involvement (Bjorkland 1984; Clawson 1977). In the southern United States only 10 percent of the forests are publicly owned and the forest industry owns 18 percent; the remaining 72 percent is owned by small landowners (Council of State Governments 1982). Lack of public land with free access to hunting in Texas spawned commercialized hunting in Texas in the 1920's (Burger and Teer 1981). Similarly in Maine, Vermont and New Hampshire where private landowners control three times more forest land than the public sector, large industrial landowners have had detailed recreation plans since the 1960's (Patrick 1969).

In contrast, in the western states a much higher proportion of the forest is publicly owned (62 percent). This, combined with the common alternate-section ("checkerboard") ownership pattern in parts of the West stemming from old railroad land grants, limits industrial landowners in the West in their opportunities to generate income from recreation and wildlife management (Hicks 1985). Although 65 percent of forest industrialists in the Pacific Northwest feel that dispersed recreation and timber management are compatible, only 20 percent believe that benefits from recreation management outweigh associated problems (Downing and Moutsinas 1978).

Socio-Political Component

Although direct economic motivations for IFM are greater in the southeastern United States, government regulatory control of forest practices relating to IFM is strongest in the western states. Oregon and Washington were the first states to pass forestry legislation in 1903 (Hidy et al. 1963). The thrust of this and similar legislation following shortly after in Minnesota, New Hampshire and Massachusetts was fire protection. Since that time, the western states have led the way in the development of forest practice legislation.

Sixteen states now have forest practice legislation and Maine has a Land Use Regulation Law which regulates forest practices. There are several examples of classification and evaluation of these acts with respect to comprehensiveness of objectives and forest practice rules, extent of application (both geographical and in terms of forest landownership) and strength of enforcement (Crichton and Kreutzwiser 1985; Ellefson and Cubbage 1980a and 1980b; Klein 1980; Siegel 1974). All of the acts theoretically apply to PIF landowners although some legislation is not actively enforced or compliance is voluntary or regulations may only apply to designated areas. There is also great variation in the extent to which state forest practice acts address nontimber forest values.

Between 1971 and 1974, five western states (Oregon, California, Washington, Nevada and Idaho) adopted new forest practice acts that were classed as "mandatory-comprehensive" by Crichton and Kreutzwiser (1985). These acts all purport to protect nontimber values but there is some variation in their comprehensiveness from Nevada, which gives recognition to only timber supplies, water and soils, to California and Washington which aim to protect timber productivity, recreation, watersheds, wildlife, range and forage, fisheries and aesthetic enjoyment (Ellefson and Cubbage 1980a). Regulations under these acts are developed by regional forestry boards that include representatives from government, industry and private citizens.

Forest regulation in the South has been scant--only six states (Louisiana, New Mexico. Florida, Mississippi, Missouri and Virginia) have forest practice acts that were promulgated between 1922 and 1950. The purpose of these laws is to ensure future timber productivity and to prevent forest devastation from fire and because of the emphasis on regeneration, they have been called "seed tree laws" (Ellefson and Cubbage 1980a). Only Virginia's law indicates that there is an objective to improve the quality of the environment and New Mexico's law gives some attention to soil erosion (Ellefson and Cubbage 1980a).

Not only is the southern legislation very limited in scope but the laws are not strongly enforced. In fact, the Florida law has never been used, Louisiana's is not currently used and Missouri's legislation applies only to landowners who request to be enrolled in the yield tax program (Ellefson and Cubbage 1980a).

Minnesota is the only state in the Lake region that has had forest legislation but this seed tree law was repealed in 1967. Minnesota has been working towards a forest practice act similar to that of Oregon (Ellefson and Cubbage 1980b; Herbst 1976).

The northeastern states have a diversity of approaches to forest regulation. Maryland, Massachusetts, New York, New Hampshire and Vermont have all had forest practice legislation since the 1940's. All of these laws give some regard to nontimber values. Massachusetts and New York both have objectives to protect soil, wildlife, recreation and watershed parameters (Siegel 1974). Vermont's legislation is the least comprehensive with regard to nontimber values and only aims to control runoff and soil erosion (Ellefson and Cubbage 1980a). Maryland and New Hampshire revised their legislation in the 1970's and gave greater emphasis to nontimber values. New Hampshire's act gives particular attention to protection of water quality and cutting and slash disposal near highways. Maryland's act still focuses on regeneration but also includes objectives to protect soil resources and wildlife production (Ellefson and Cubbage 1980a). Maine's Land Use Regulation Law, passed in 1969, applies to more than just forestry but with regards to timber harvesting, the law aims to ensure that there is minimal impact on soil, water and other environmentally or aesthetically sensitive areas.

Despite the generally comprehensive nature of northeastern forestry legislation with respect to nontimber values, all of these laws are applied on a limited basis (Ellefson and Cubbage 1980a). Maine uses a zoning approach to identify sensitive areas where timber harvesting permits are required. New Hampshire's legislation applies to areas within a specified distance to water bodies and public roads. While the district forestry boards established under the Maryland law have the right to enforce regulations, they have chosen to make rules only advisory in nature. Similarly Massachusetts' law has not been fully implemented due to inadequate funding (Klein 1980). Compliance with both Vermont's and New York's legislation is voluntary although New York provides participating landowners with free management assistance.

There have been other approaches to regulation of forestry practices by governments in the United States that may affect management of nontimber values. County governments in Michigan have used a zoning approach to recommend uses for prime forest lands (Maurer 1982). Vermont's Water Quality Bureau, in cooperation with the Timber Truckers and Producers Association, has a strategy for dealing with water quality impairment arising from timber management practices that involves cooperation, education and as a last resort, enforcement (Irland 1985). Most states also have some form of land use planning; however most of this is in the development stage and has little regulatory power over private land use at this time (Brooks et al. 1982).

Because comprehensive legislation is quite recent and not widespread, it is perhaps not surprising that a review of the literature indicates that it is the threat of legislation primarily, rather than legislation itself, that appears to motivate decisions with respect to IFM. The threat of legislation has motivated forest companies to voluntarily leave stream and roadside buffers (Moody 1967), practise wildlife and recreation management (Allen 1979) and flag areas of cultural, historical or natural significance for special management (Hutcherson 1979). These examples are all large companies in the southern United States.

Siegel (1974) speculated that the threat of mandatory, comprehensive legislation spurred most timber companies in Mississippi to adopt voluntarily regulatory guidelines issued jointly by the Mississippi Manufacturing Association and the Mississippi Forestry Association in 1973. The purpose of these guidelines is not only to ensure timber supplies but also to improve wildlife, recreation, aesthetic and environmental values.

The second factor of the socio-political component of the external environment identified by Duncan (1972) is the public attitude towards the industry. A critical public attitude towards forestry is a first step towards regulation, a point which has not been missed by industrial foresters. "The intangible returns of good public relations, which otherwise could ultimately lead to costly government regulations, may be the most important reason for implementing multiple use concepts" (Allen 1979 p.188). One corporate forester emphasized that corporations will have to adopt policies and practices that protect and enhance nontimber resource values to meet new expectations arising from a change in the public attitude towards landowners and their obligations to minimize social impacts of their land use practices (Binger 1975).

While social pressures may encourage IFM, anti-social behaviour is a disincentive to public use of private land. Researchers have found that vandalism, fire, damage to roads, littering and danger of accidents with logging traffic are problems that corporate foresters associate with public access on private land (Downing and Moutsinas 1978; Enk 1975; Hicks 1985; Owen et al. 1985). Where lands are closed to the public, it is most often because of hazards arising from harvesting operations, concern for preventing damage to young stands, protection of wildlife habitat or fear of increased liability (Cheeseman 1979). The costs, however, of keeping recreationists out can be very expensive and closures can result in increased vandalism (Enk 1975).

The problems associated with inadequate trespass laws and liability protection are frequently cited as a major concern of corporate foresters (Carleton 1967; Cordell and Maddock 1969; Evans 1984; Kozicky 1967; Owen et al. 1985; Tomlinson 1979; Yoho 1981). Landowner liability laws vary from state to state but generally the private landowner has a duty to protect all visitors to his land, whether invited or not, from physical harm (Siegel et al. 1984). Some southern states (Louisiana for example) have passed laws that limit landowner liability (Carleton 1967); most states have reduced landowner liability where no fees are paid for entry to private land (Lawrence and Rochelle 1981). In a study of 38 companies operating in the South, only one had actually encountered liability suits involving individuals injured on company lands (Cordell and Maddock 1969). Still many companies feel legislation is inadequate to protect the owner (Tomlinson 1979).

Trespass laws also vary from state to state. Strong trespass laws in Texas allow private landowners to develop profitable hunting programs while neighbouring states, such as Oklahoma, with weaker laws have no industrial sponsored hunting clubs or wildlife management areas (Yoho 1981). Many companies find that leases with hunting clubs are a way to control use and to promote public relations while limiting abuses because club members help to regulate access and police vandalism (Cheeseman 1979).

In an effort to encourage private industrial foresters to manage wildlife and to allow hunting access, most states have developed cooperative management programs. By 1979, 44 states had such programs (Burger and Teer 1981). Through such programs, state wildlife management agencies provide protection from trespass, vandalism and fire, control access, give technical advice and plant materials and, in some cases, remove litter (Burger and Teer 1981; Kimball 1963). New York, Wisconsin, Maryland and Virginia typify states with this type of cooperative agreement. Other states provide more direct economic incentives by sharing revenue from hunting permits that are issued for private lands registered in a wildlife management program. Florida, North Carolina, South Carolina, and Minnesota, for example, provide revenue-sharing agreements in addition to other management services. Minnesota also gives tax credits and/or direct payments to landowners who set aside wildlife habitat (Burger and Terr 1981). Vermont has purchased hunting rights from major forest landowners (Kimball 1963).

There are many examples of cooperative programs between forest companies and federal resource management agencies and nongovernmental organizations (e.g. Mason and Henze 1959; Tomlinson 1979).

Cooperative agreements vary in their acceptance. In Florida companies in cooperative agreements benefit from improved public relations and a decline in vandalism. The program was so popular that the state dropped the $.02/acre initial payment to companies (Frye 1964). A study in Arkansas (Owen et al. 1985) found that only four of 94 corporations had entered into cooperative agreements with the Arkansas Game and Fish Commission. Tomlinson (1979) identified two problems with state programs. First, hunters often identify the land as state-owned so companies may not achieve public relations benefits. Second, the income generated from cooperative agreements is usually less than for company-operated club leases. Many foresters express a need for greater tax incentives to induce industry to participate in wildlife and recreation management (Binger 1975; Cheeseman 1979; Funderburke 1977; Tomlinson 1979; Yoho 1981).

Technological Component

Technological and information developments have expanded opportunities for IFM. Innovation in harvesting equipment and techniques such as low compaction skidders and high lead logging provide more opportunities for harvesting while protecting environmental values. Greater understanding of the interrelationships between timber management and other forest uses has enabled foresters to increase forest outputs.

Although wildlife management and timber production are generally viewed by foresters as compatible, overbrowsing by wildlife is a costly problem. Research on development of repellents, habitat manipulation and hunting to control damage remained the focus of Weyerhaeuser's research from 1960 until the 1970's (Lawrence and Rochelle 1981). Industrial foresters realize that wildlife management in conjunction with timber management can be a tool to minimize damage from overbrowsing (Kitchens 1962), and recreation plans incorporating hunting remain an important tool to control depredation (Bjorkland 1984).

Land classification using soil types has been applied by International Paper Company to develop management practices that will maximize timber yields without jeopardizing the environment or wildlife habitat and without unnecessary expense (Haines and Haines 1981).

By using information from research in integrated forest management planning Weyerhaeuser has been able to maintain logging operations in eagle nesting areas (Anderson 1985) and along streams while increasing growth rates in salmon (Rochelle and Melchiors 1985).

3.3 A Model of Factors Influencing IFM

The internal and external influences combine to encourage or constrain timber companies in the decision to practise IFM. Figure 3.2 presents these influences in a model of the decision making environment of private industrial foresters. The model illustrates that there are interrelationships between the external and internal organizational decision making environment. As this chapter has shown, a forestry corporation does not act independently of external factors which affect the economic feasibility and institutional acceptability of land use decisions but at the same time, a corporation may influence the external factors. For example, a company may make technological innovations, influence government policy and strive to create a public attitude that is favourable towards the timber industry. It is perhaps even possible for a company to encourage a willingness to pay for recreation by enhancing wildlife and recreation values of their land.

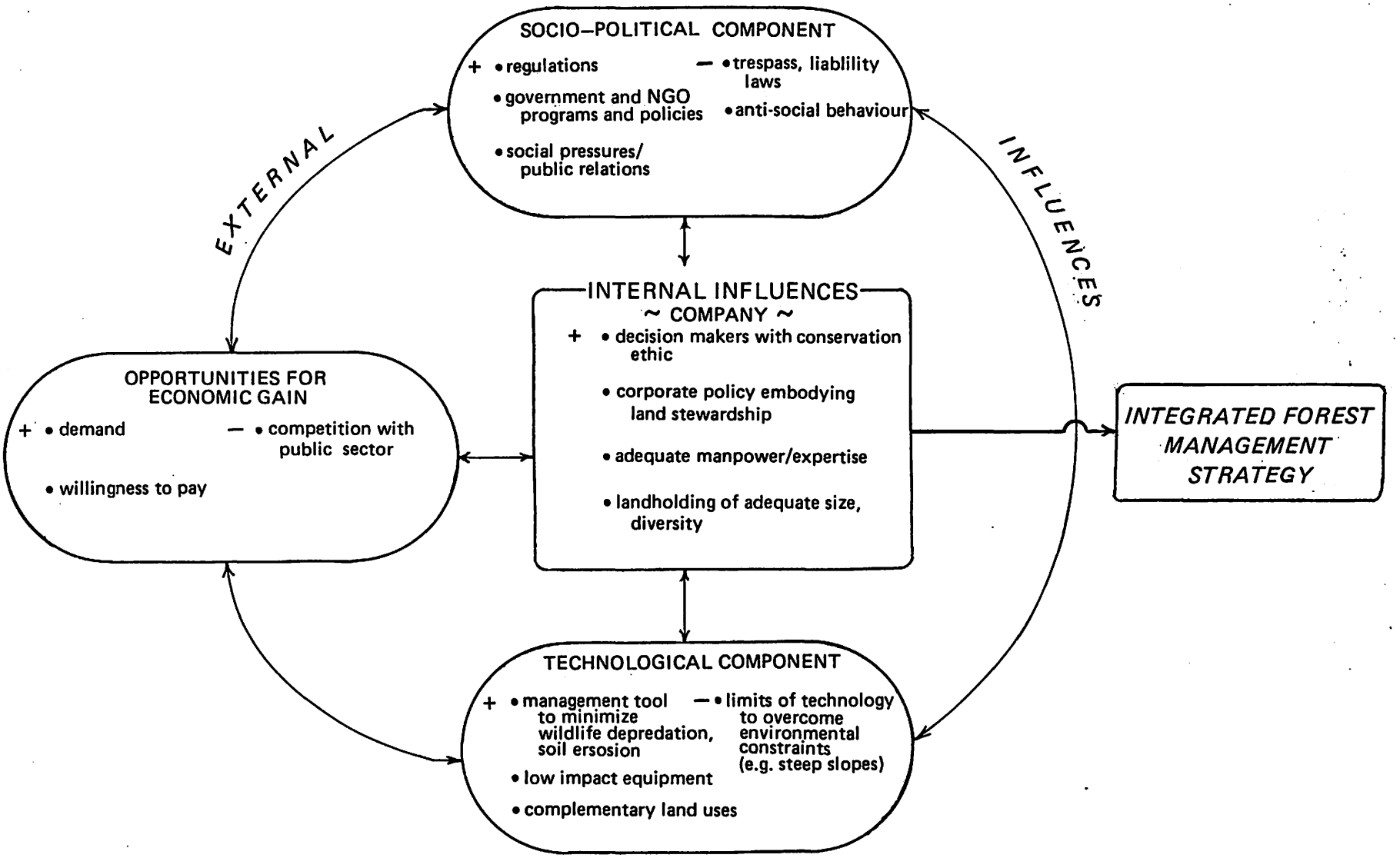

Figure 3.2. Decision making environment of private industrial foresters.

The model also indicates that factors in the external environment are interrelated. This is particularly true of the relationship between the socio-political factors and opportunities for economic gain where government programs and public attitudes may affect the economic feasibility of nontimber outputs.

A corporate IFM strategy may vary over time in response to both internal and external influences. Some factors may have a greater role in influencing the initiation of IFM while others may encourage a company to increase management of nontimber values. For example, government regulations or programs may be critical in the development of new IFM initiatives while a willingness to pay for hunting may encourage a company to increase its efforts in wildlife management.

3.4 Hypotheses

Hypotheses were developed to test some of the relationships between IFM and influencing factors that are presented in the model of PIF decision making (Figure 3.2). A major focus was to determine what effect external influences which vary geographically in the United States have on the level of IFM practised. The first three hypotheses, which describe socio-political and customer/competitor influences, related to this aim. The remaining three hypotheses were tied to internal influences. The hypotheses were tested using the data collected from American companies.

Hypothesis 1

Integrated forest management scores will be positively influenced by comprehensive and stringent forest land management policies of state governments.

Two studies, Crichton and Kreutzwiser (1985) and Ellefson and Cubbage (1980a), that analysed and classified state forest policies with respect to comprehensiveness and effectiveness were examined. Drawing on these studies, policies were ranked on an ordinal scale from least effective with regard to IFM to most comprehensive and stringent. A scale of 1 to 4 was used although it could be argued that there is actually much more variation (particularly within the northeastern states), but a more detailed ranking would require an indepth analysis.

Thirteen states without policies were ranked 1. Those with a rank of 2 are four states with older legislation, described as "seed tree laws" in Section 3.2.2, which deal primarily with regeneration. Five states with older forest practice acts (including Maine's Land Use Regulation Law) which have comprehensive but unenforced or voluntary forest practice standards were ranked 3. The four western states with comprehensive, mandatory forest practice acts were ranked 4. Table 3.1 gives the rankings for each state in the study.

Hypothesis 2

Integrated forest management scores will be higher in states where a greater percentage of forest land is privately owned.

TABLE 3.1. State Policy and Land Tenure

State	Policy Rank	Private Forest Land (%)	Private Industrial Forest Land (%)	Publicly Owned Recreation Land (acres per 1000 pop.)
Alabama	1	94	19	408
Arkansas	1	82	21	1,684
California	4	46	16	2,274
Florida	2	85	34	1,054
Georgia	1	93	17	646
Idaho	4	21	6	50,041
Louisiana	2	92	25	797
Maine	3	97	48	361
Maryland	3	89	5	103
Michigan	1	65	12	908
Minnesota	1	47	5	1,952
Mississippi	2	89	14	1,194
Montana	1	31	7	42,657
New Hampshire	3	87	20	1,153
New York	3	93	8	216
North Carolina	1	90	10	483
Oklahoma	1	85	22	620
Oregon	4	36	21	16,842
South Carolina	1	90	16	378
Tennessee	1	89	8	536
Texas	1	93	30	275
Vermont	3	90	15	978
Virginia	2	87	10	499
Washington	4	48	24	5,330
West Virginia	1	89	7	674
Wisconsin	1	66	7	1,179

Hypothesis 3

Integrated forest management scores will be higher in states which have low levels of publicly owned recreation land per capita.

These hypotheses reflect two assumptions. First, that the ratio of private to public forest land and public recreation land per capita are both indicators of the extent of competition for recreation users. It was assumed that where there is less publicly owned forest land available for forest recreation, there would be greater economic advantages for forest companies to develop their land for outdoor recreation. The opportunity for recreational development of private land was expected to most strongly influence the recreation component of the index. In association with greater concern for recreation, it was also anticipated that there would be more awareness of other forest resources such as wildlife and water; therefore the total index score would be driven upwards. In essence, this is the second assumption: that the percentage of private land and the amount of public recreation land per capita are also indicators of social pressures for greater private land management and stewardship. Without the diversion of large tracts of public forest land, it was assumed that society would pay greater attention to private landholdings and demand more IFM on that land. Carroll (1978) used population density around nonindustrial forest land as a similar measure of social pressure.

The percentage of forest land privately owned for each state included in this research was obtained from the Council of State Governments (1982). The proportion of privately owned forest land was measured in two ways: private forest land, which includes both industrial and nonindustrial forest land, and PIF land. States frequently show a similar trend in both private forest land and PIF land but some states, such as New York, have a relatively large proportion of private forest land but little of that is industrial forest land. Other states such as Florida and New Hampshire have only a moderate proportion of private forest land but a relatively high percentage of industrial forest land.

The amount of recreation land per capita was taken from the United States Department of the Interior (1971) which had the most recent figures readily available for all states. These figures are also presented in Table 3.1.

Hypothesis 4

Integrated forest management scores will be higher for companies with larger landholdings, in predominantly contiguous parcels.

In the literature it was suggested that companies with larger landholdings have greater opportunity to practise IFM. Each company surveyed was asked for the total acreage of landholdings in the state, number of noncontiguous parcels and size of the largest parcel.

Hypothesis 5

Integrated forest management scores will be higher for larger companies.

It was expected that larger companies would have more manpower and a greater diversity of staff expertise to practise IFM, as well as financial resources to consult outside experts. Large companies were also considered to be in a better financial position to absorb costs of IFM. Furthermore, it was felt that larger

companies figure more prominently in the public eye and therefore respond more to public relations/social pressure influences.

Sales and number of employees were available for most companies in Ward's (1984) and Standard and Poor's (1986). Others were obtained from the Forest Industries Publication (1985). Figures for the smallest companies (i.e sales less than $1 million) were unavailable. This information was not requested in the questionnaire because the sensitivity that corporations have towards releasing economic data might have reduced returns.

Hypothesis 6

Integrated forest management scores will be higher for companies that identify their role as stewards of the land or as conservationists.

A corporate policy that includes land stewardship was identified in the literature as an influence on IFM. Since staff attitudes and opinions are influenced by corporate policies (March and Simon 1958), it was hypothesized that where respondents identify conservation/stewardship benefits to managing nontimber resources, IFM scores would be higher. Annual reports, journal articles and conference papers, where available, were used to provide additional description of corporate policies with respect to IFM. This type of information was not available for all companies and therefore could not be used to statistically test the hypothesis but did assist in a qualitative analysis of the hypothesis.

3.5 Methods of Analysis

There were two objectives for the analysis of data collected from the companies in the United States. The first objective was to test the hypotheses to identify which, if any, of the external and internal factors influence the level of IFM practised by companies. The second objective was to observe the combined influence of these factors on IFM and the relative importance of each factor. The term "influence" is used to describe the relationship between external or internal factors and the level of IFM, although statistical tests can not be used to demonstrate a cause and effect relationship. A factor was assumed to be an influence on IFM where a statistically significant relationship was identified.

The significance level chosen was 0.10 (or a 90 percent confidence limit); in other words it was accepted that there was a 10 percent chance that an association between IFM and a hypothesized influence was accepted when in fact that association was merely due to chance. This relatively low confidence limit was chosen to acknowledge that this research is a somewhat simplistic study of the complex influences on IFM decision making.

The index was developed to give a relative indication of the extent to which a company practises IFM compared to the other companies surveyed, and hence is an ordinal measure. In application, the index provided a relatively continuous measurement that approximated a normal distribution and apparently provided adequate discrimination of commitment to IFM among respondents. Therefore the scores on the index were treated as interval data and parametric statistical analysis was used where appropriate. Supplementary analysis using nonparametric tests gave results that were very close to the results from equivalent parametric tests.

Pearson's Product Moment Correlation Coefficient was used to measure the association between IFM and each factor separately. However, for the purposes of graphic presentation of the results, data were grouped into categories for each factor.

Policy, as a variable, was measured only on an ordinal scale with just four levels. Therefore, Pearson's Correlation Coefficient was inappropriate to test the association between policy and IFM. Analysis of variance was used to determine if index scores differed significantly where there were different approaches (ranks) to policy.

Similar to the correlation coefficient, a multiple correlation coefficient (R) was used to describe the association between all of the external and internal factors considered together and IFM scores. The square of this value is the multiple coefficient of determination (R^2) which describes how much of the total variation in a dependent variable is explained by all of the independent variables acting together (Blalock 1972). This method of analysis assumes that all variables have been measured on an interval or ratio scale. Policy, however, was measured on an ordinal scale and although sales were measured on an interval scale, there were a large number of missing cases where sales were below $1 million. Therefore, these two variables had to be converted to dummy or indicator variables. Backward elimination was the procedure used to form the regression equation because all variables are included in the initial equation and therefore, the effects of all of the independent variables could be examined (Draper and Smith 1968).

All statistical analysis was done using the SPSSx package on the mainframe computer at the University of Guelph, except for the calculation of the multiple coefficient of determination for the combined influence of all of the independent variables which was done a microcomputer using Statgraphic (Statistical Graphics Corporation Inc. 1986).

3.6 Sample Frame

United States

State forestry agencies in the 27 states with greater than five percent of their commercial forest land base owned by industry were requested to supply a list of companies. This provided a cross-section of states in terms of extent of private landownership and forest management policies. After two reminder letters all of the state forestry agencies responded; however, the Nevada agency indicated that there were no industrial forest landowners in that state. Incomplete address information received from states was supplemented by the Forest Industries Publication (1985), Ward's (1984) and Standard and Poor's (1986). Every effort was made to get names of the most senior executive at that address, position titles and correct addresses, but it was not possible to obtain names for all addresses.

Initially 355 addresses were listed but when the very local or district offices were removed, 270 addresses for 239 companies remained. Local offices were not included in the sample frame to avoid having several questionnaires forwarded to the same regional office which might have been confusing or offensive. Two hundred and seventy is not an unreasonable number to survey and given the low response rates often associated with mail surveys, all 270 addresses were sent questionnaires. This afforded a wide range in company size from very small companies with less than 20 employees to the largest multi-national firms. Regional addresses for larger firms gave an opportunity to compare more carefully, for those cases, the influence of external factors, assuming corporate objectives do not vary regionally. Enk (1975) found that only one of twenty companies interviewed varied their timber land strategies regionally.

Ontario

The Ministry of Natural Resources in Toronto identified districts in Ontario where there are significant PIF landholdings. The Ministry of Natural Resources district offices for these areas were contacted for

names and addresses of timber companies that owned land within these districts. Fourteen addresses were obtained for 13 companies, three of which were in southern Ontario and the remainder in northern Ontario.

3.7 Questionnaire Design

A copy of the mail-out questionnaire used to obtain information on the United States companies is provided in Appendix 1. The Ontario companies were sent a slightly modified (to be pertinent to Ontario) version of the questionnaire. The questionnaire was designed to provide information on forest management practices for application of the index as well as to give some information on possible influences on management practices. Most of the questions were closed-ended in the interest of making the questionnaire easy for the respondent to complete and therefore to encourage a higher response rate.

The first half of the questionnaire dealt with timber management practices: cutting, regeneration, stand treatment, road and landing construction and abandonment. This information was required primarily for the index analysis. As well, information was requested on the size and number of landholdings for testing the hypothesized relationship between size of landholdings and IFM. Questions dealing with timber management practices were prefaced with a lead-in that demonstrated the acceptability of any response to avoid biasing responses. Also, each of these questions gave respondents the option to answer with a more specific description of management practices, recognizing the variability in timber management and that it would not be possible to include all alternatives in closed-ended questions. One question gave respondents an opportunity to identify factors considered in developing cutting practices.

The second half of the questionnaire collected information on forest land uses other than timber production primarily for index analysis. It was prefaced with an open-ended question on the possible benefits that respondents felt their companies might obtain by managing forest land for purposes other than timber production. This provided an opportunity to identify attitudes towards IFM and motivations for IFM from the perspective of the respondent. One other question, involving a chart linking management practices with potential influences, also afforded a chance to observe motives for IFM. The final three questions provided information to ensure companies were primarily timber companies and also to identify the extent of monetary returns from nontimber land uses.

Recipients of questionnaires were also asked to send a company annual report, if available. These were reviewed to determine if any corporate policies towards IFM or land management in general were expressed.

The questionnaire was pretested on twelve companies selected from Oregon, Michigan, Maine and South Carolina. The companies were deliberately selected to check if the questionnaire was comprehensible to both large and small companies and to determine if it was appropriate to send questionnaires to regional offices. Five completed questionnaires were returned from the pretest after one reminder letter. As a result of these responses, only minor wording changes were made to clarify a few of the questions.

The questionnaire was preceded, by one week, by a letter to each company informing them of the purposes and sponsor of the research and asking for their cooperation when they received the questionnaire (in Ontario a telephone call replaced this letter). The questionnaire itself was accompanied by a letter giving more explanation of the questionnaire. After six weeks a reminder letter was sent to all nonrespondents. One month subsequent to this, a second reminder was sent to a sample of nonrespondents to encourage greater response in certain regions. After three weeks nonrespondents in Ontario were contacted by telephone.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Questionnaire Returns

4.1.1 Companies Operating in the United States

Questionnaires were mailed to 258 companies in 26 states but 43 (17percent) of the questionnaires were returned uncompleted, most of which were from companies who did not own land. Of the remaining 215, 92 questionnaires were completed and returned which represents a response rate of 43 percent. Because only very minor wording changes were made after the pretest, responses from the pretest were included so that a total of 97 cases were analysed. The 97 responses represented 81 companies--nine companies responded more than once from different states so that those nine companies accounted for 25 responses.

While 43 percent is very reasonable for a mail survey, any nonresponse should raise concerns about potential response bias. To test for response bias, the mean score for the first half of the respondents on the integrated forest management (IFM) index (mean = 7.57, standard deviation = 6.11) was compared to that of the second half (mean = 7.11, standard deviation = 4.77). Student's t-test analysis showed no significant difference between these means (at a 95 percent confidence level).

The response rate varied regionally (Figure 4.1) but yielded a good distribution of companies from states with a range of forest management policies, private forest land and PIF land tenure patterns as well as public recreation land per capita. Table 4.1 presents the number of responses from each state.

The responses also provided a good range in company size with 29 cases having sales less than $1 million and 28 cases (17 different companies) with sales of over $1 billion. All of these very large companies were pulp and paper companies. Questionnaires from large companies were usually completed by the senior executive in charge of woodlands for the region. Responses from small companies were frequently completed by the company owner.

This distribution of companies provided enough diversity to analyse the hypothesized influences on IFM. Although the influence of corporate policies could not be examined statistically, a qualitative study of this influence was possible through review of annual reports sent from eleven companies, questionnaires from nine companies who responded from more than one state (six of whom also sent annual reports) and articles which discussed corporate policies of six additional companies. In total, corporate policy information was available on 20 companies.

4.1.2 Companies Operating in Ontario

Questionnaires were mailed to 13 timber harvesting companies that owned land in Ontario. The companies that responded owned between 2800 and 850,000 acres but the average was 284,810 acres. Only two of the companies owned land in one continuous block; three companies owned three parcels, one company owned two parcels and one owned 13 parcels. Six of the seven companies were either subsidiaries or regional offices of very large companies (with sales over $1 billion) but at least two of those four actually had very few employees working in the region.

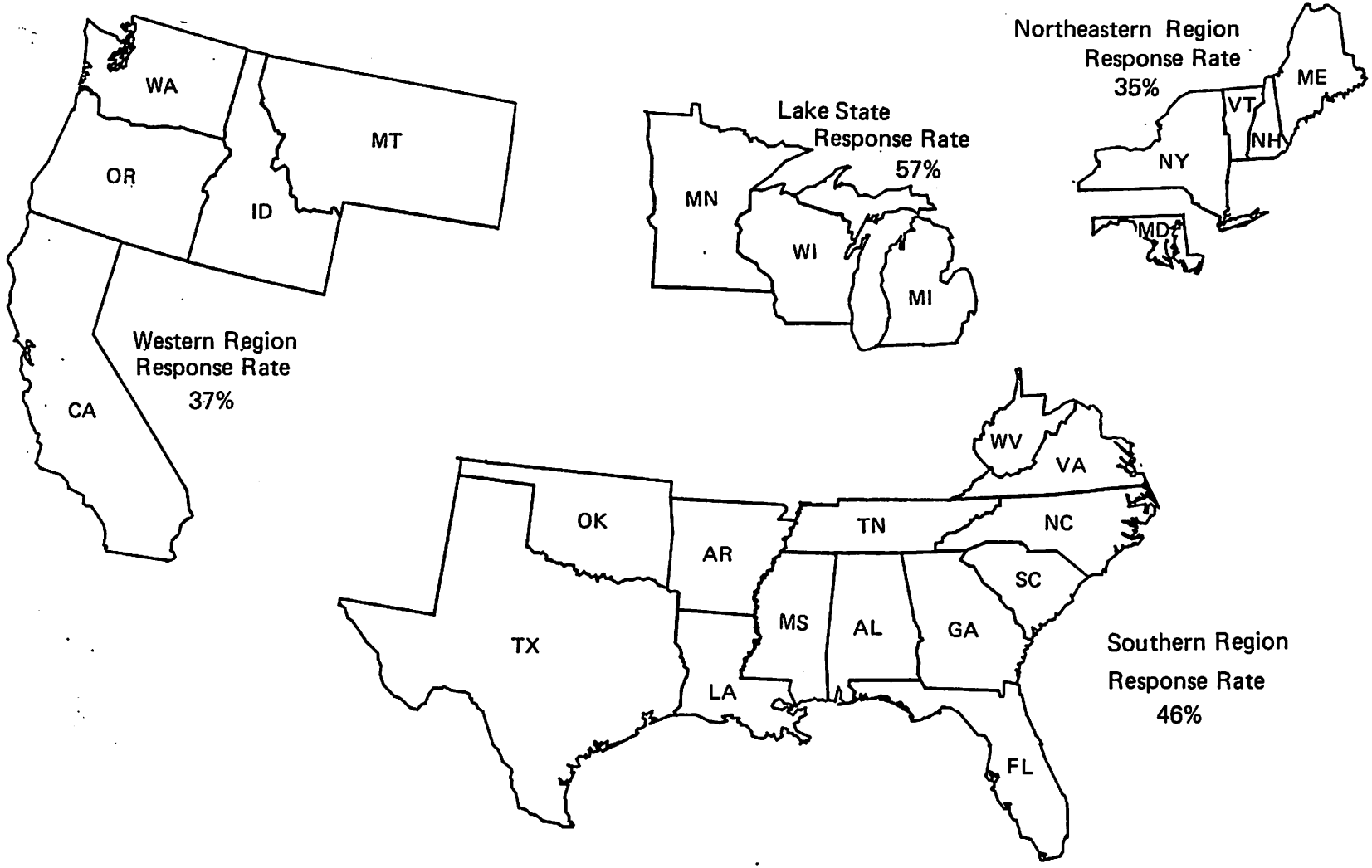

Figure 4.1. Regional response rate for States included in research.

TABLE 4.1. Response Rate by State[1]

State	Questionnaires Sent[2]	Questionnaires Returned	Response Rate (%)
Alabama	4	2	50
Arkansas	8	2	25
California	20	9	45
Florida	8	6	75
Georgia	11	6	55
Idaho	9	1	11
Louisiana	3	2	67
Maine	8	5	63
Maryland	2	1	50
Michigan	19	10	53
Minnesota	3	3	100
Mississippi	3	2	67
Montana	1	1	100
New Hampshire	19	6	32
New York	13	2	15
North Carolina	3	1	33
Oklahoma	1	0	0
Oregon	17	6	35
South Carolina	10	5	50
Tennessee	3	0	0
Texas	4	3	75
Vermont	7	3	43
Virginia	13	5	38
Washington	15	6	40
West Virginia	8	2	25
Wisconsin	15	8	53
26 States	227	97	43

[1]includes pretest returns

[2]Excludes questionnaires returned as undeliverable or by companies not owning forest land

All but one of the respondents owned land in northern Ontario where the total private forest land is only 7.5 percent of all forest land and private industrial land is 3.4 percent. One company operates in southern Ontario where 66.7 percent of the production forest is privately owned but only 1.9 percent is PIF land (Fullerton, pers. comm.).

The data from Ontario companies were insufficient for statistical analysis. A summary of the forest management practices of these companies is presented is Section 4.2.2 and results of the index scores are given in Section 4.3.1. The results of the hypothesis testing are based on data from American companies only but provide useful information for recommendations to encourage IFM in Ontario.

4.2 Summary of Forest Management Practices

4.2.1 Companies Operating in the United States

The questionnaire provided general information on the forest management practices of responding companies which are summarized in Table 4.2. Not surprisingly, the type of species cultivated directed many of the timber practices. Selection cutting was largely associated with hardwood species and clearcutting (and other even-age cutting techniques) with softwoods. Other practices also appeared to be associated with timber species; for example fertilization was more commonly associated with softwoods but thinning was more prevalent with hardwood production.

The questionnaire did not specifically ask respondents to distinguish insecticide use from herbicides but a small sample (ten) of those who stated that they use chemicals were contacted to determine the level of herbicide compared to insecticide use. Nine of the ten were using mainly herbicides and all but two of those nine were practising even-age management. Insecticide use appeared to be low and usually applied to less than two percent of a landholding.

Fifty-two companies participated in wildlife management programs. Most often (67 percent) this was with a state agency but a number indicated that they initiated programs on their own and 19 percent continued to manage these alone. Wildlife management usually involved approximately 25 percent of a company's land and six years was the average age of programs. Deer were by far the most commonly managed species although there were species of regional interest such as wild turkey, particularly in the South, and elk in the West. Game species such as deer, game birds, fish and waterfowl were usually the object of wildlife management but 12 percent of the programs included management for non-game bird species such as eagle and heron. In addition to specific management programs, over 70 percent of the respondents indicated that at some time their company had planted noncommercial vegetation when reclaiming roads or landings. Although erosion control was the usual rationale for this, many cited benefits for wildlife as well.

As Table 4.2 shows, most companies at least permitted public access but many also actively managed recreation on their land. Companies in the southern states were the most involved in recreation management of their land; for example eight of the eleven companies that set aside land for recreation were in the South.

These timber management and other land use practices indicated that most companies were managing their land in a manner that protected at least some nontimber values. Many companies appeared to be making substantial efforts to enhance nontimber values, particularly wildlife and watershed protection. Efforts to integrate nontimber values seemed to be greatest in cutting practices. This is perhaps not surprising given

TABLE 4.2. Summary of Forest Management – US Respondents

ACRES OWNED	243,898 a. av.
ACREAGE OF LARGEST PARCEL OF LAND	72,575 a. av.
VOLUME OF HARDWOOD CUT	24,392 Mft^3
VOLUME OF SOFTWOOD CUT	43,974 Mft^3
EVEN-AGED CUTTING	52%
UNEVEN-AGED CUTTING	48%
CUTBLOCK SIZE	
–≤100a	68%
–>200a	12%
CUTBLOCK SHAPE	70% irregular
CUTTING BY WATER	
–modify	70% (buffer - 53 yd. av.)
–no-cut buffer	18% (buffer - 55 yd. av.)
–cut to edge	11%
CUTTING BY PUBLIC ROADS	
–modify	39% (buffer - 50 yd. av.)
–no-cut buffer	2% (buffer - 20 yd. av.)
–cut to edge	59%
SITE PREPARATION	
–after even-aged cutting	70% burn slash
–after uneven-aged cutting	58% leave debris
REGENERATION	
–after even-aged cutting	96% artificial (on av. of 70% of area cut)
–after uneven-aged cutting	74% natural
FERTILIZATION	24% (on av. of 10% of land owned)
THINNING	
–precommercial	39%
–commercial	78%
PEST CONTROL	
–chemical	45% (mostly herbicides)
–mechanical (cut, burn)	45%
–biological	8%
ROAD CONSTRUCTION	
–bridge only	49%
–bridge & buffer between water	33% (buffer - 60 yd. av.)
ROAD ABANDONMENT	
–usually maintain	53%
–some erosion control	80%
WILDLIFE MANAGEMENT	54%
RECREATION MANAGEMENT	
–no access allowed	3%
–access with restrictions	53%
–provide facilities	13%
–lease land	38%
–levy fees	18%
–set aside land for recreation	11%
RESEARCH (NONTIMBER)	
–staff involved	39%
–fund others	36%
–permit outside researchers access	60%
OTHER FOREST LAND USES	
–none	75%
–minerals, gravel	10%
–grazing	8%
–petroleum, natural gas	2%

the potential magnitude of impact that cutting can have on nontimber values and given that mitigating these impacts has been the focus of copious research and management effort.

Fifty-one percent of all respondents indicated that their company's revenue from nontimber forest uses did not exceed costs associated with those uses. Furthermore, for most companies (77 percent), less than five percent of gross income was derived from nontimber uses of their forest land. Only one company earned as much as between 26 and 50 percent of its gross income from nontimber forest land uses.

4.2.2 Companies Operating in Ontario

Table 4.3 summarizes the forest management practices of the seven Ontario respondents. There were many similarities between the United States and Ontario companies but also some differences. Like the United States respondents, Ontario companies tended to protect water courses in both cutting and road construction.

One striking difference was the frequency of large cutblocks in Ontario. This could reflect the desire for larger openings for moose habitat in northern Ontario. There have been examples in the literature of companies using harvesting to improve moose habitat (Innes 1985; OMNR 1982b). None of the Ontario respondents, however, indicated any involvement in moose habitat improvement. Some were involved in fish habitat improvement and one company had transferred faunal rights to the Province.

Recreation use of corporate land was prevalent and all of the companies allowed public access, generally with seasonal or locational restrictions. One company employed a recreation manager and actively managed all of its land (located in southern Ontario) for a variety of recreational uses including camping and snowmobiling. Two others leased small amounts of their land for cottages and another two levied fees for hunting.

Although none of the companies indicated that they used their forest land for any uses other than the activities that the questionnaire dealt with, three indicated that their company earned greater than 25 percent of their income from nontimber uses of their land (a much higher proportion than the United States results).

4.3 Application of the Integrated Forest Management Index

4.3.1 Index Scores

The scores measured by the IFM index for companies in the United States reflected that most of those companies protected nontimber values to an extent. Figure 4.2 presents the distribution of scores and shows that the observed range of scores, -5.50 to 20.25, was much smaller than, and at the high end of, the possible range of -18.50 to 24.50. The mean score was 7.32 (standard deviation = 5.46).

The index scores for Ontario companies tended to be somewhat lower and ranged from -3.00 to 8.50. The mean score was 4.63 and the standard deviation was 4.68.

Two dimensions of the index contributed to the total score: the score on each component of the index and the weight assigned to that component (refer to Table 2.2). While an attempt was made to be consistent in the range used for each component, it was not always appropriate to do so. Therefore the range of scores, more than the weight, had an important influence on the contribution each component made to the

TABLE 4.3. Summary of Forest Management – Ontario Respondents

ACRES OWNED	284,810 a. av.
ACREAGE OF LARGEST PARCEL OF LAND	170,418 a. av.
VOLUME OF HARDWOOD CUT	385 Mft^3
VOLUME OF SOFTWOOD CUT	1,271 Mft^3
EVEN-AGED CUTTING	57%
UNEVEN-AGED CUTTING	43%
CUTBLOCK SIZE	
–≤100a	33%
–≥200a	50%
CUTBLOCK SHAPE	100% irregular
CUTTING BY WATER	
–modify	43% (buffer -87yd. av.)
–no-cut buffer	57% (buffer -135yd.av.)
–cut to edge	0
CUTTING BY PUBLIC ROADS	
–modify	57%
–no-cut buffer	0
–cut to edge	43%
SITE PREPARATION	
–after even-aged cutting	scarify, windrow or whole tree harvest
–after uneven-aged cutting	100% leave debris
REGENERATION	
–after even-aged cutting	28% artificial (on av. of 16% of land cut)
–after uneven-aged cutting	100% natural
FERTILIZATION	0
THINNING	
–precommercial	14%
–commercial	29%
PEST CONTROL	
–chemical	43%(all herbicides)
–mechanical (cut, burn)	0
–biological	14%
ROAD CONSTRUCTION	
–bridge only	43%
–bridge & buffer between water	43% (130 yd. av.)
ROAD ABANDONMENT	
–usually maintain	57%
–some erosion control	43%
WILDLIFE MANAGEMENT	33%
RECREATION MANAGEMENT	
–no access allowed	0
–access with restrictions	43%
–provide facilities	14%
–lease land	28%
–levy fees	28%
–set aside land for recreation	14%
RESEARCH (NONTIMBER)	
–staff involved	14%
–fund others	0
–permit outside researchers access	28%
OTHER FOREST LAND USES	
–none	100%
–minerals, gravel	0
–grazing	0
–petroleum, natural gas	0

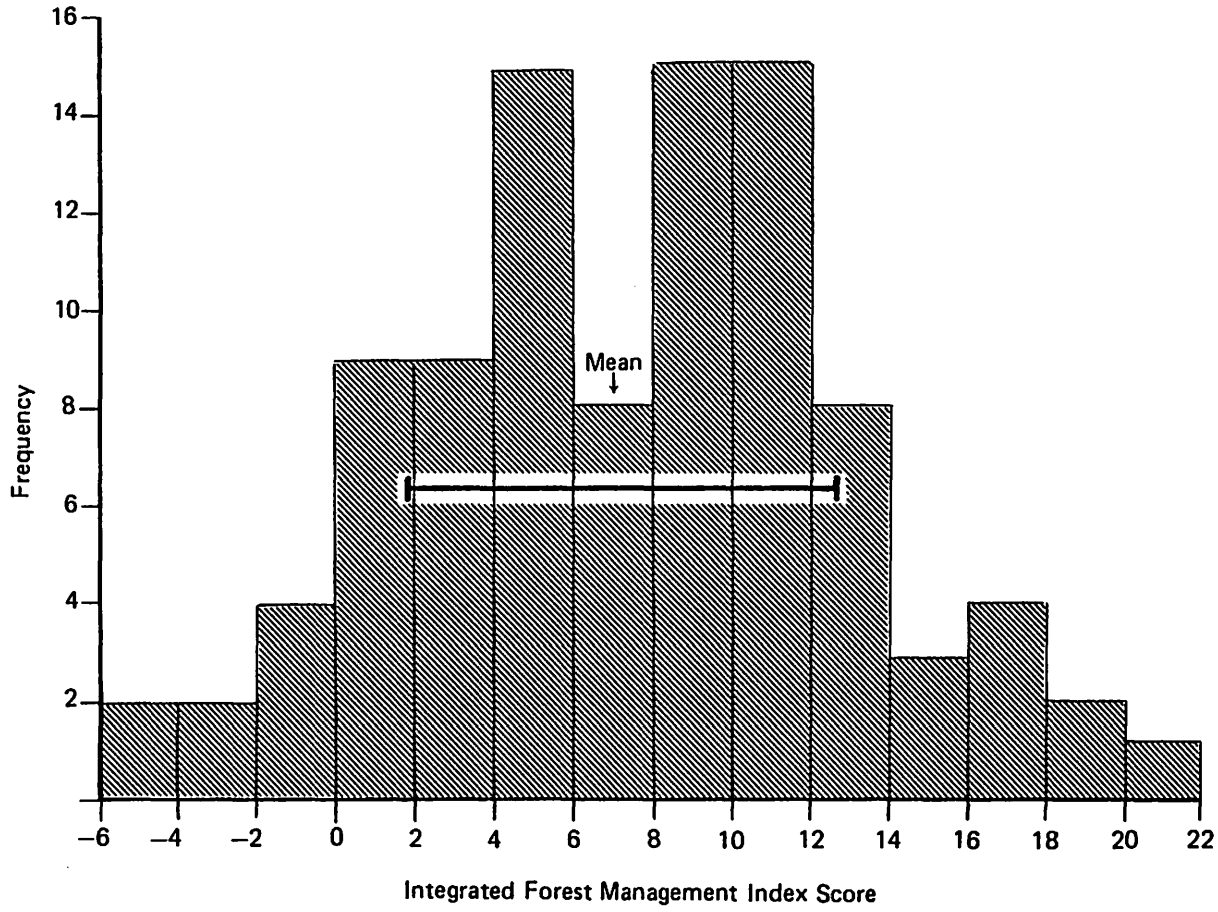

Figure 4.2. Frequency distribution of index scores for companies in the United States. Mean = 7.32 and standard deviation = 5.46 (represented by horizontal bar).

overall score. The road construction, road abandonment, recreation and research components contributed most to discriminating levels of IFM. Weighting reduced the effect of preharvest, and to a lesser extent, post-harvest management, and resulted in minor increases to the influence of scores on road construction, road abandonment, recreation and research.

4.3.2 Validity of Index Scores

There are several indications that the index performed adequately. First, although the results did not include the full possible range of the index, there was quite a wide distribution of results so the index did provide some discrimination of IFM. Although Figure 4.2 shows a bimodal distribution of scores, it did approximate a normal distribution; the two peaks were close to the mean and 46 observations fell below the mean while 51 observations were above the mean. The bimodal distribution could be a result of the index scoring or some characteristic of the sample. However, there were no obvious sample characteristics that would have caused this and analysis of the index (including alternative scoring and weighting) did not show any apparent reason for the bimodal distribution. There is no reason to expect that the apparent bimodal distribution was due to anything other than the relatively small size of the sample.

The second indication that the index performed satisfactorily was that companies that were described in the literature as giving consideration to nontimber values in their timber management practices tended to score high on the index. For example, two companies that have received the American Paper Institute and National Forest Products Association Environmental and Energy Achievement Awards for forest land management both scored over 11 on the index. Five other companies that have been cited in the literature for their progressive IFM techniques also scored well above average. There was one exception. One company that was identified in the literature as a diversified firm making use of nontimber resources scored less than the mean and indicated that farming was the only nontimber use of their land. It is interesting to note that the respondent from this company stated that he saw no benefits that his company could derive from managing forest land for uses other than timber production.

The fact that index scores were usually low where respondents saw no benefits to managing for nontimber land uses was another reflection of the satisfactory performance of the index. Ten respondents stated that they saw no benefits and their mean score was 5.30 (standard deviation = 4.04). Another eight failed to respond to the question and their mean score was 3.38 (standard deviation = 1.24).

There was little evidence on which to judge the validity of Ontario scores which were generally lower than American scores, except that one industry forester from Ontario has said that there has been no integration in Ontario but only some examples of cooperative projects (Innes 1985).

4.4 Factors Influencing Integrated Forest Management

4.4.1 External Factors

The regional distribution of IFM index scores (Figure 4.3) suggests that there may indeed be external influences on corporate IFM practices as proposed in Chapter 3. The analysis investigated the influence of state forest practice policy and land tenure patterns which vary across the United States. Two dimensions of land tenure were examined, the proportion of forest land that is privately owned and the amount of public recreation land per capita.

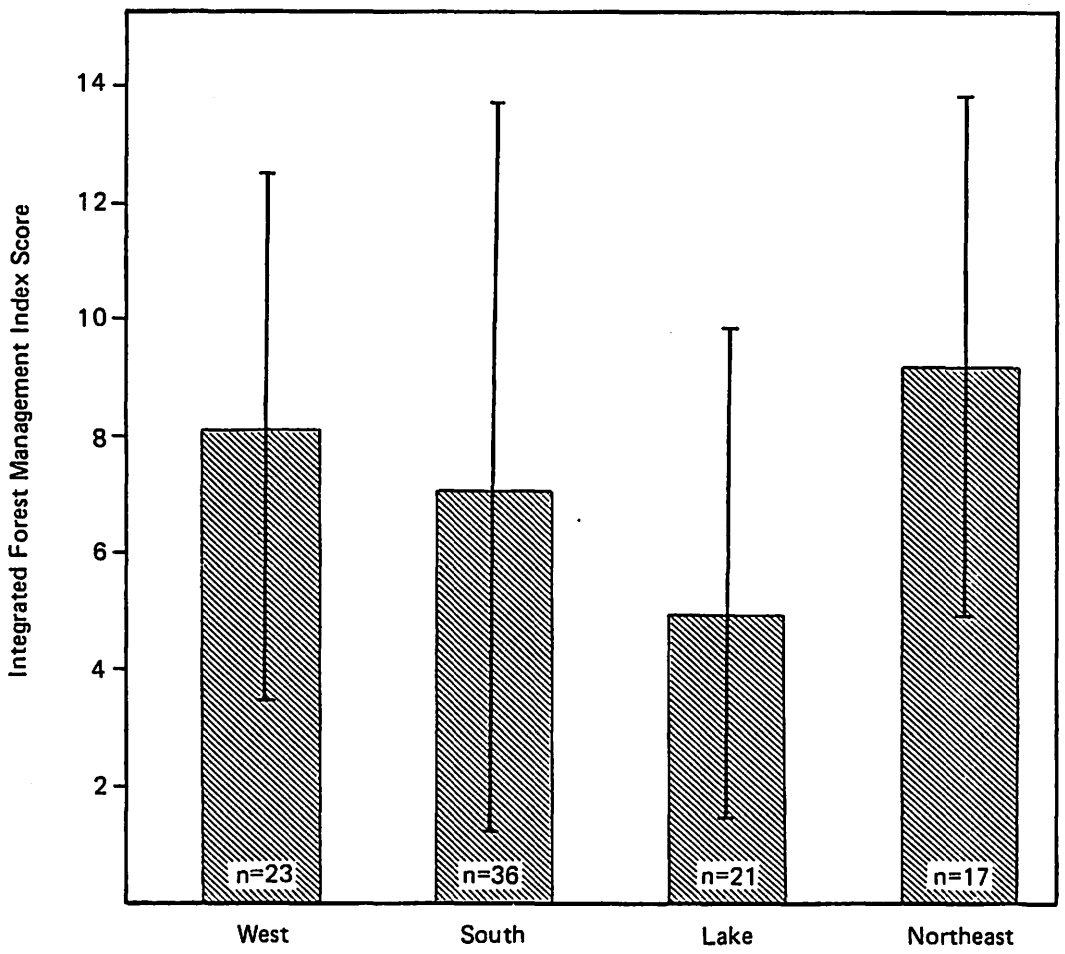

Figure 4.3. Difference in mean integrated forest management scores for regions is statistically significant ($p \leq 0.1$, $F = 2.17$). Verical lines represent the standard deviations.

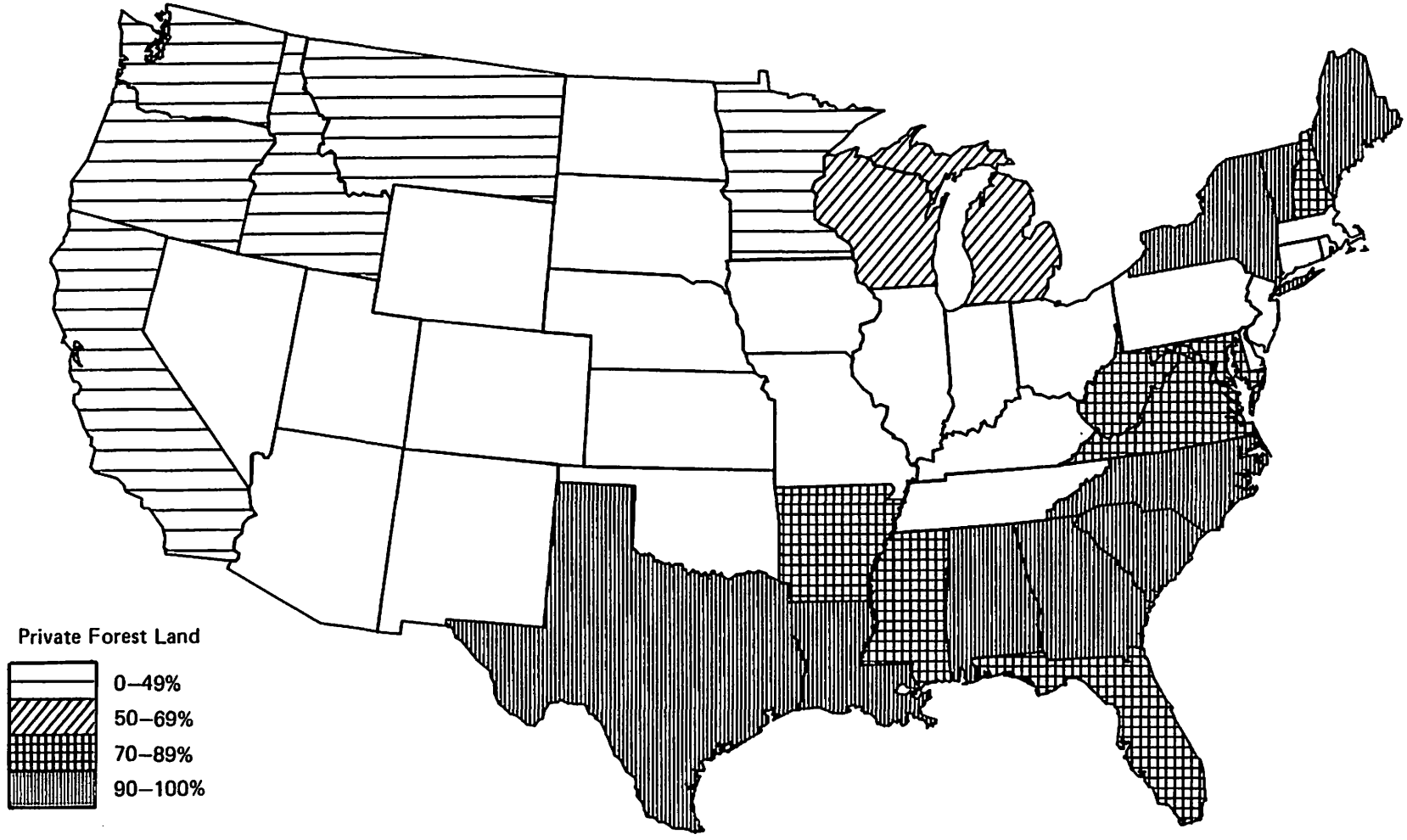

Figure 4.4. Private forest land for States included in research.

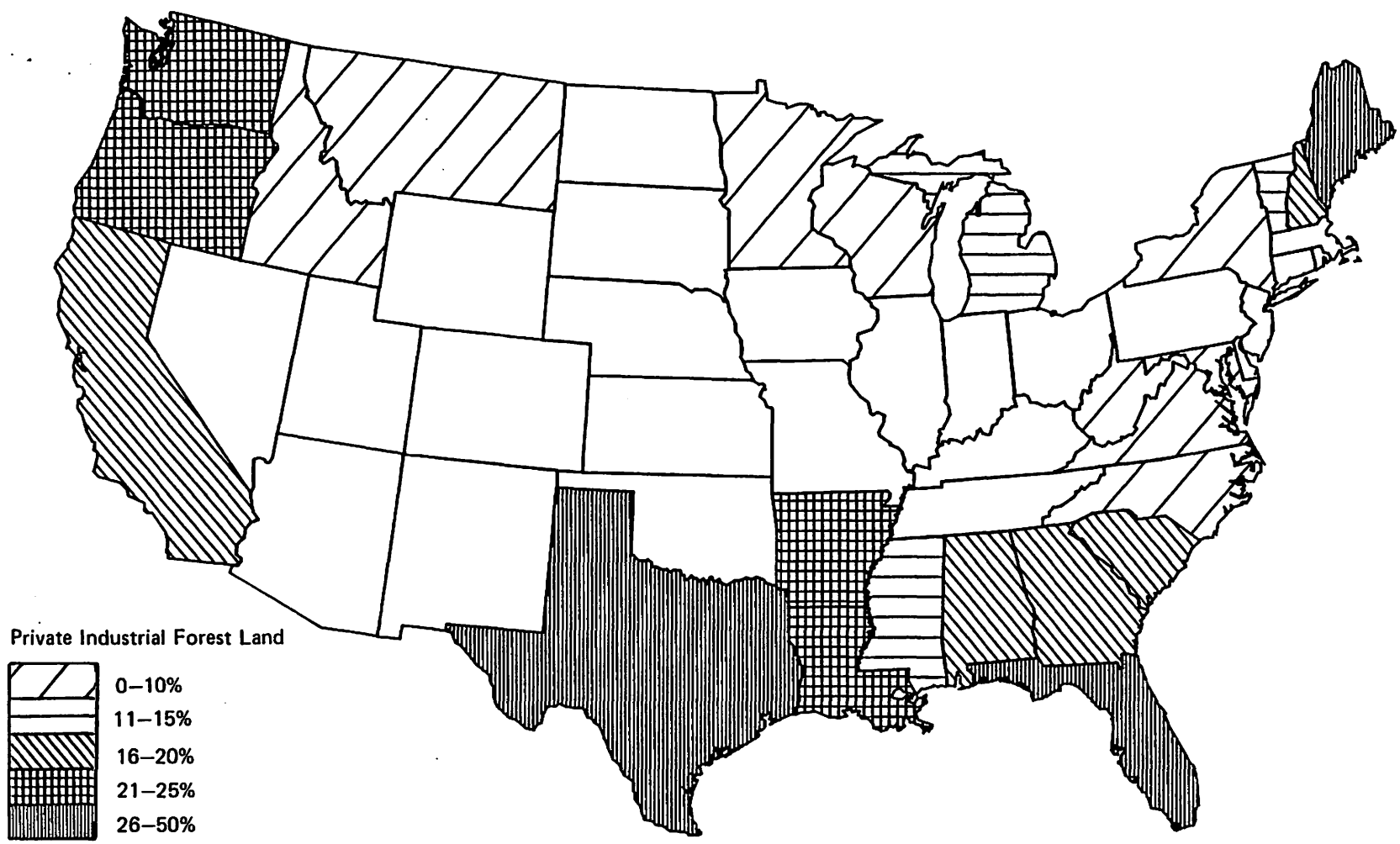

Figure 4.5. Private industrial forest land for States included in research.

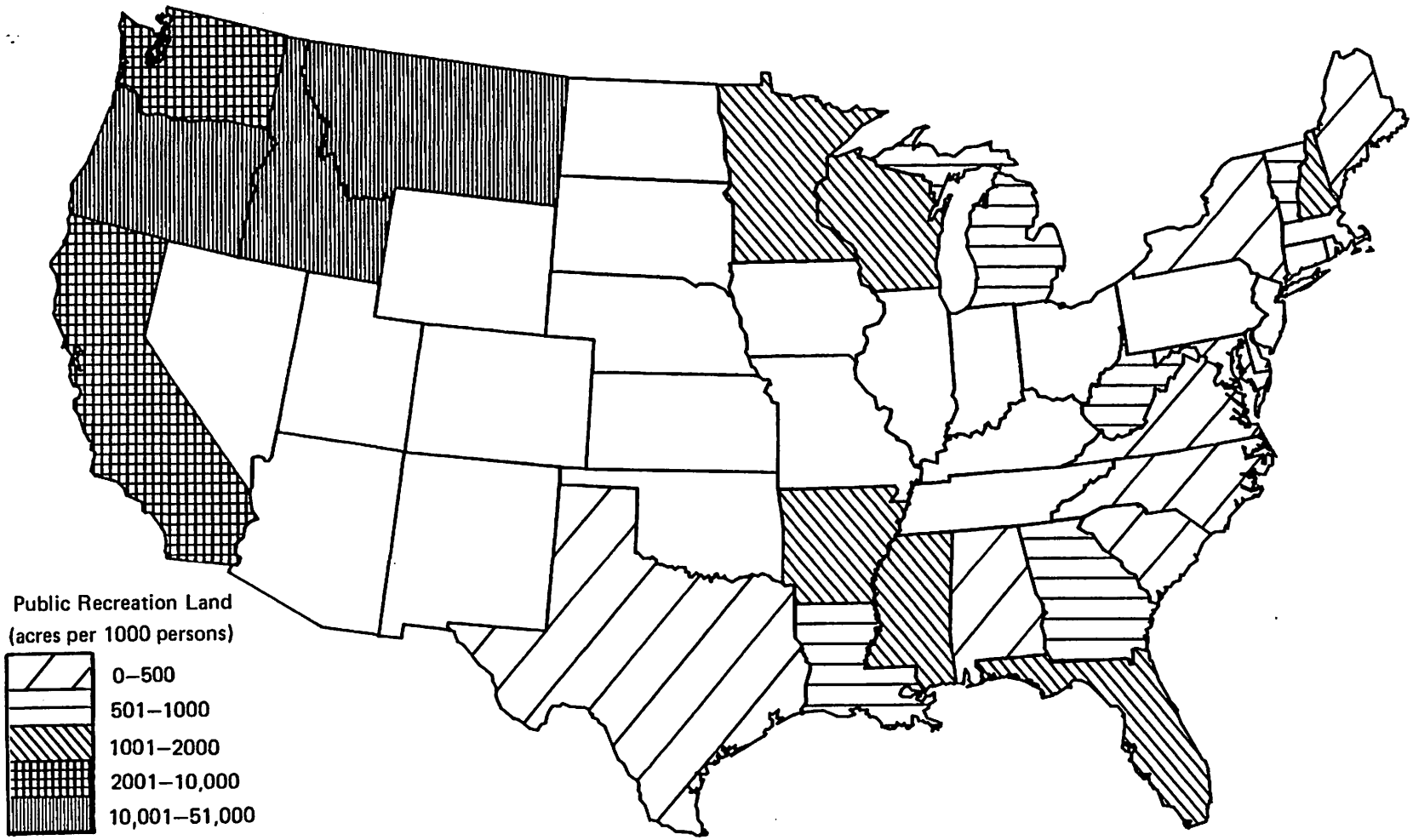

Figure 4.6. Public recreation land for States included in research.

Companies that operated in the northeastern states had the highest mean index score. Land tenure in this part of the United States is dominated by the private sector as shown in Figures 4.4 and 4.5. There is, however, some variation in the amount of PIF land with New York having only eight percent PIF land and Maine at the other extreme with 48 percent PIF land. Similarly, as displayed in Figure 4.6, public recreation land per capita is low with the exception of New Hampshire. Although the northeastern states do not have widely enforced forest management practice acts, they have implemented policies with objectives to protect nontimber values.

Conversely, the Lake states have very little PIF land (but total private forest land is more evenly divided between the public and private sector) and no state forest practice legislation. Mean index scores were lowest for the Lake states. The possible influences of external factors are less clear in the South and West which have similar amounts of PIF land, but very different approaches to government regulation of private forest land management and opposite patterns of total private versus public forest landownership. Yet the mean scores between the West and South differed by only 1.09. Index scores of the South had the largest standard deviation indicating less homogeneity in this region than others.

Each of the external factors, state policy and land tenure, was examined separately to test the hypotheses stated in Chapter 4 by determining the degree of association between each external factor and the index scores.

Policy

The hypothesis relating to policy was that IFM scores will be positively influenced by comprehensive and strictly enforced forest land management policies.

State forest policies were ranked from 1 to 4: no forest practice legislation ranked 1; seed tree legislation ranked 2; less strongly enforced but somewhat comprehensive legislation ranked 3; and the most widely enforced and comprehensive legislation ranked 4. A rank of 3 versus 4 primarily distinguishes how the legislation is applied. Those with a rank of 4 are enforced ubiquitously but those with a rank of 3 are either adopted on a voluntary basis by each landowner or are only applicable to limited geographical regions.

The mean index scores for companies in each policy rank are presented in Figure 4.7. The difference in means is not significant using analysis of variance. Although mean scores were lower in states with no policy and states with seed tree legislation (rank 1 and 2), there were quite large standard deviations for each of these ranks. Nevertheless the mean scores showed an increasing trend as higher policy ranks increased except that the mean rank was highest where policies were ranked 3.

It could be argued that the division of scores emphasizing the stringency with which legislation is applied was misleading and that a focus on comprehensiveness, i.e. the difference between states that have policies related to IFM compared to those that do not, is more appropriate. Seed tree legislation was developed to ensure future timber supplies, with no stated objective to protect nontimber values although this may result. Therefore policies ranked either 1 or 2 do not specifically relate to IFM. Most of the policies that were ranked 3 place an emphasis on nontimber values, particularly watershed protection, aesthetics and to a lesser extent wildlife. Some policies such as those of Maine, New Hampshire and New York have as strong an emphasis on these values in their policy objectives as California which was ranked 4. Other western states with forest practice acts that were ranked 4 also consider nontimber values. Therefore all of the policies that were ranked 3 or 4 to some extent pertain to IFM although the emphases differ from state to state.

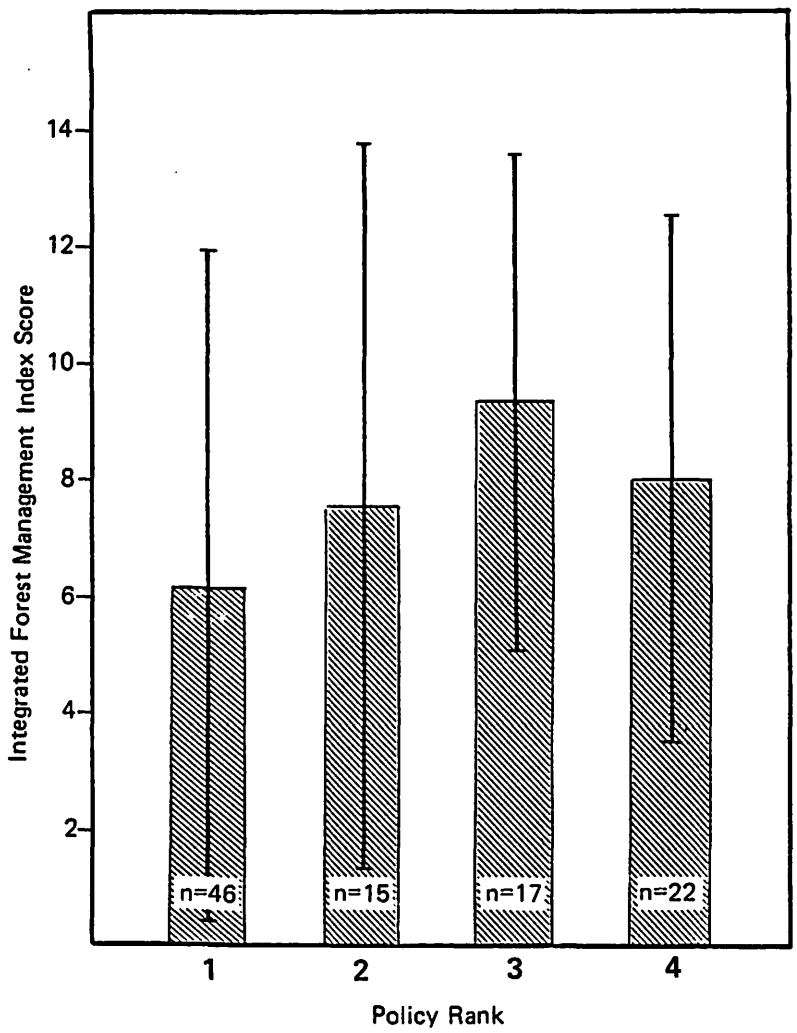

Figure 4.7. Difference in mean index scores for policy ranks is not statistically significant ($p \leq 0.1$) Vertical lines represent standard deviations.

When responses from states with no IFM policy (those ranked 1 and 2) were combined, the mean index score was 6.47 (standard deviation = 5.96). This is significantly different from responses in states with IFM policy (those ranked 3 and 4) which had a mean of 8.58 (standard deviation = 4.40) (Student's t value = -1.89).

Influence of Specific State Regulations

A closer look at the influence of specific state regulations on forestry practices provides more insight into the effectiveness of legislation.

Table 4.4 shows the distribution of companies using various cutting and road construction practices where there is relevant state legislation compared to where there is no legislation. It illustrates that there is no significant difference between states with specific legislation covering cutting adjacent to water compared to those without such legislation. It appears that regardless of whether or not states make a deliberate attempt to modify cutting adjacent to water, few companies cut to the edges of water bodies. All of the states with forest practice acts, with the exception of Maryland, have some objective to modify cutting adjacent to water bodies (Ellefson and Cubbage 1980a).

Only two states, Oregon and New Hampshire have legislation that addresses cutting practices along public roads (Ellefson and Cubbage 1980a). Table 4.4 shows that companies that operated in these states tended to modify cutting practices along public roads. Seventy-five percent of the companies in these states either modified practices or left a no-cut buffer adjacent to public roads whereas only 36 percent of companies in other states did this. There is some indication that even state forestry policies that are less prescriptive in this regard may encourage modified cutting practices along public roads. Where states have no IFM policies, the majority of companies (68 percent) cut to the edge of public roads but where there are IFM policies, only 46 percent of the companies cut to the edge of public roads.

Improved road construction is also a frequent objective of state forest practice legislation and appeared to be encouraged by legislation. Only one company used unimproved stream crossings where there is relevant legislation but almost 21 percent did where there is no legislation.

There were other indications that state forest practice legislation may have influenced corporate forest practices. Nine companies (six from the West and three from the Northeast) added special notes to their responses that state regulations influenced their cutting practices adjacent to water or roads or their road construction practices. Three companies from states with IFM policies cited that a benefit of managing for nontimber uses is avoidance of regulatory reprisals. Fifty-one percent of the companies which operated in states with IFM policies ranked government regulations as an influence on cutting methods but only 28 percent cited regulations as an influence where there are no state policies. However, those 28 percent would not be expected to consider government regulations as an influence on their cutting practices considering the lack of forest practice legislation in those states.

There were other examples of respondents that cited the influence of legislation on corporate forest practices in numbers that were inconsistent with the distribution of companies operating in states with relevant forest practice legislation. State forest practice legislation was cited as an influence on streamside cutting by 56 respondents, 17 more than the number of cases from states with IFM legislation. State legislation was identified as an influence on roadside cutting by 21 respondents yet only 12 companies operated in states with legislation dealing with roadside cutting. Thirty-seven respondents felt that state legislation influenced their road construction practices but only 32 companies operated in states with

TABLE 4.4. Influence of Policy on Specific Timber Management Practices[1]

Policy	Cutting Adjacent to Water[2]			Cutting Adjacent to Public Roads[2]		Road Construction[3]		
	Cut to Water's Edge	Modify Cutting	Leave No-Cut Buffer	Cut to Edge of Road	Modify Cutting or No-Cut Buffer	Ford	Bridge	Bridge & Buffer
Where Specific State Legislation	6 (16%)	26 (68%)	6 (16%)	3 (25%)	9 (75%)	1 (3%)	15 (48%)	15 (48%)
No Specific Legislation	5 (9%)	41 (71%)	12 (21%)	54 (64%)	30 (36%)	13 (21%)	33 (52%)	17 (27%)
Chi² Results	$\chi^2 = 2.15$			$\chi^2 = 5.19^*$		$\chi^2 = 7.09^*$		
General Integrated Forest Management Policy	6 (15%)	27 (69%)	6 (15%)	18 (46%)	21 (54%)	1 (3%)	18 (47%)	19 (50%)
No Integrated Forest Management Policy	5 (9%)	40 (70%)	12 (21%)	39 (68%)	18 (32%)	13 (23%)	30 (54%)	13 (23%)
Chi² Results	$\chi^2 = 1.28$			$\chi^2 = 3.89^*$		$\chi^2 = 11.38^*$		

[1] Number of respondents following practice (percentages may not equal 100 due to rounding).

[2] 1 missing case

[3] 3 missing cases

*Significant at $p \leq 0.1$

legislation that directly affects road construction. Companies from seven different states cited legislation as an influence on regeneration but only one of the states with seed tree legislation was in this group.

There are several possible reasons for the discrepancies between the number of companies that might be expected to cite the influences of government regulation, on the basis of their land being in a state with forest practice legislation, compared to the number that actually cited it as an influence. One reason, that would result in a higher number identifying state regulations as an influence, may be a lack of distinction made by respondents between forest practice regulations and other government policies or programs. This research focused on the influence of forest practice acts but other policies, such as tax incentive programs, may be implemented by governments to manipulate forest practices. Very little information was available from secondary sources on these types of policies but one example is Minnesota's Tree Growth Tax Law that was cited as an influence by a respondent who stated that "one of the criteria of this law is that in exchange for land and timber tax [reductions], the land must be open to the public." Tax incentives were identified as the sole influence on public access or other recreation concerns three times and, in combination with other factors, as an influence on other forest practices 37 times.

Other government programs such as wildlife management programs may also have some influence over forest management practices. The mean index score for the 52 companies that have specific wildlife management programs was 9.25 (standard deviation = 5.06) which is significantly higher than the mean of 5.09 (standard deviation = 5.09) for companies that had no programs (Student's t value = 4.02). Thirty-five of the 52 companies participated in wildlife programs managed by state agencies and another six cooperated with other government organizations.

Lack of enforcement of state regulations may have influenced fewer respondents to identify the effect of forest practice regulation. For example, Crichton and Kreutzwiser (1985) found that Virginia is the state which most actively enforces their seed tree legislation. It is interesting to observe that this was the only state with seed tree legislation from which respondents cited state regulations as an influence on regeneration.

Another possible reason for the discrepancy between the number citing state regulation as an influence compared to the number expected to is that it was possible that a few respondents were referring to the potential for legislation rather than to existing regulation. Although the questionnaire addressed the influence of existing legislation, some respondents, (particularly those from companies operating nationally) being cognizant of state policies elsewhere, could have been considering the possibility of those policies being adopted by other states. In Chapter 3 it was noted that the threat of legislation can influence forest management practices.

In summary, policy did appear to have some influence on IFM. The difference between mandatory legislation compared to less broadly enforced legislation did not seem as important as the difference between legislation with IFM objectives compared to that without regard for IFM. Specific policies to improve road construction and cutting along roads and waterways apparently were associated with improved practices although respondents did not always acknowledge the influence of these policies. There was also some indication that other government programs, particularly cooperative wildlife management programs, improved IFM practices.

Land Tenure

Regional land tenure patterns were expected to influence IFM scores in several ways. A land tenure pattern dominated by the private sector may foster private land stewardship and provide more opportunities

for economic gain from wildlife and recreation management where there is less competition from the public sector. There were two specific hypotheses: 1) IFM scores will be higher in states where a greater percentage of forest land is privately owned (both total private forest land and PIF land were considered); and 2) IFM scores will be higher in states which have low levels of publicly owned recreation land per capita.

There is no significant correlation between either private forest land or public recreation land and the index scores (Pearson's r = .02 and -.02 respectively). A breakdown of index scores by classes of private forest land and public recreation land (Figures 4.8 and 4.9) provides more information. A positive relationship was expected between private forest land and index scores and a negative relationship between public recreation land and scores. Figure 4.8 shows that in fact the highest mean scores were recorded where private forest land is low. The relationship between public recreation land per capita and the index scores was almost the reverse of what was expected. Controlling for the effects of policy had no effect on these results.

The relationship between PIF land and index scores was closer to that which was expected and there is a significant, positive correlation (Pearson's r = .23). Figure 4.10 shows the variation in index scores by categories of PIF land.

The influence of competition with the public sector was explicitly acknowledged by one respondent from Michigan where public recreation land is over 900 acres per thousand capita, private forest land is 65 percent and PIF land is 12 percent. This person saw no benefits to managing for nontimber forest land uses and stated that "large public ownership in our area...eliminates other income producing opportunities." Economic benefits to nontimber forest land use management were identified by 42 respondents. Although index scores were higher where respondents identified economic benefits compared to those who saw no economic benefits (8.55 versus 6.77), Student's t-test analysis indicated that the difference is not significant. There is a relatively large variation in scores where no economic benefits were identified (standard deviation = 6.15 compared to 4.95 where economic benefits were identified).

There are, however, statistically significant relationships between the perception of economic benefits and land tenure. Sixty eight percent identified economic benefits where private forest land is greater than 70 percent compared to only 40 percent where private forest land is less than 70 percent which is significantly different (Chi^2 = 7.03). A similar, but not significant, relationship is true for PIF land and economic benefits--almost 70 percent of those who cited economic benefits were from states where PIF land exceeds 15 percent. There was, however, no pattern among those who did not cite economic benefits who were just as likely to be from states with greater than 15 percent PIF land as less than 15 percent.

There is a significant trend in the relationship between reported economic benefits and public recreation land per capita (Chi^2 = 10.20) Where public recreation land is less than 500 acres per thousand persons, over 70 percent cited economic benefits but only 45 percent did where there is greater than 2000 acres of public recreation land per thousand persons. Furthermore, almost all of the companies that set aside land exclusively for recreation were in states where public recreation land is less than 1000 acres per thousand persons.

In total, 44 respondents saw improved public relations as a benefit to managing nontimber forest land uses; however, the mean index scores of this group are not significantly different from those that did not cite public relations benefits. Although the mean score was higher (8.40 compared to 6.86) when public relations benefits were cited, there was a large variance in scores (standard deviation of 6.18 compared to 4.56).

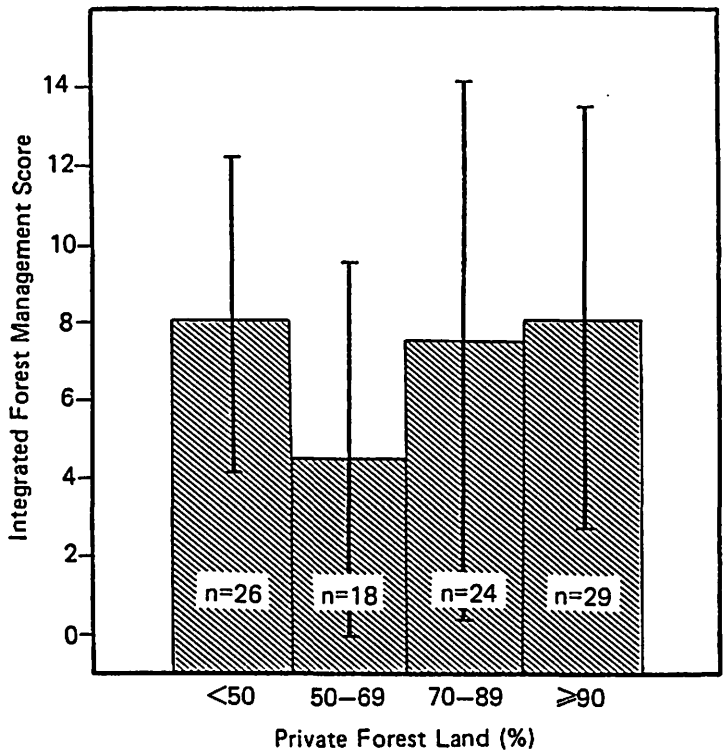

Figure 4.8. Mean integrated forest management scores for classes of private forest land. Vertical lines represent standard deviations.

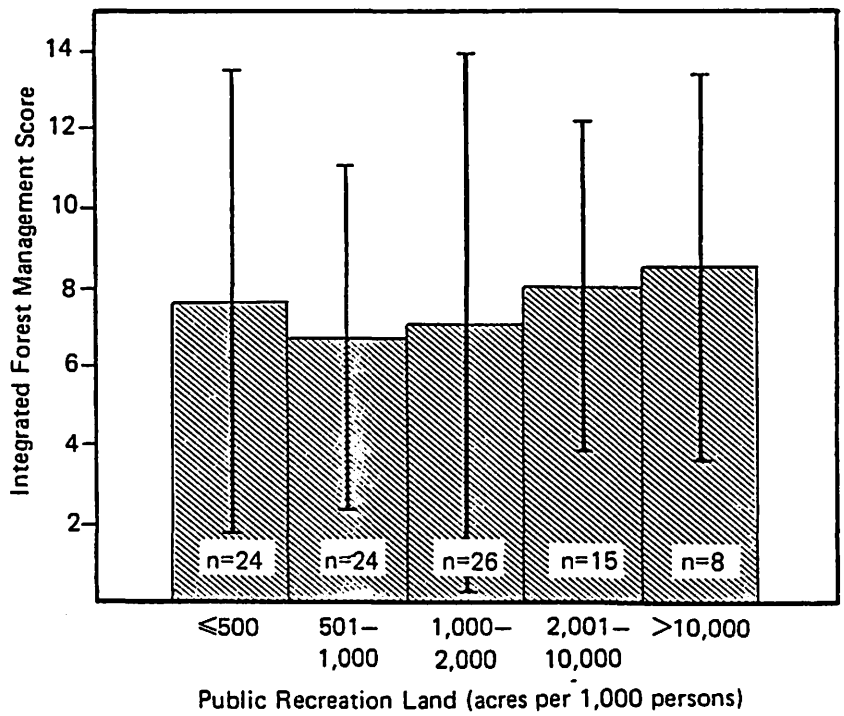

Figure 4.9. Mean integrated forest management scores for classes of public recreation land. Vertical lines represent standard deviations.

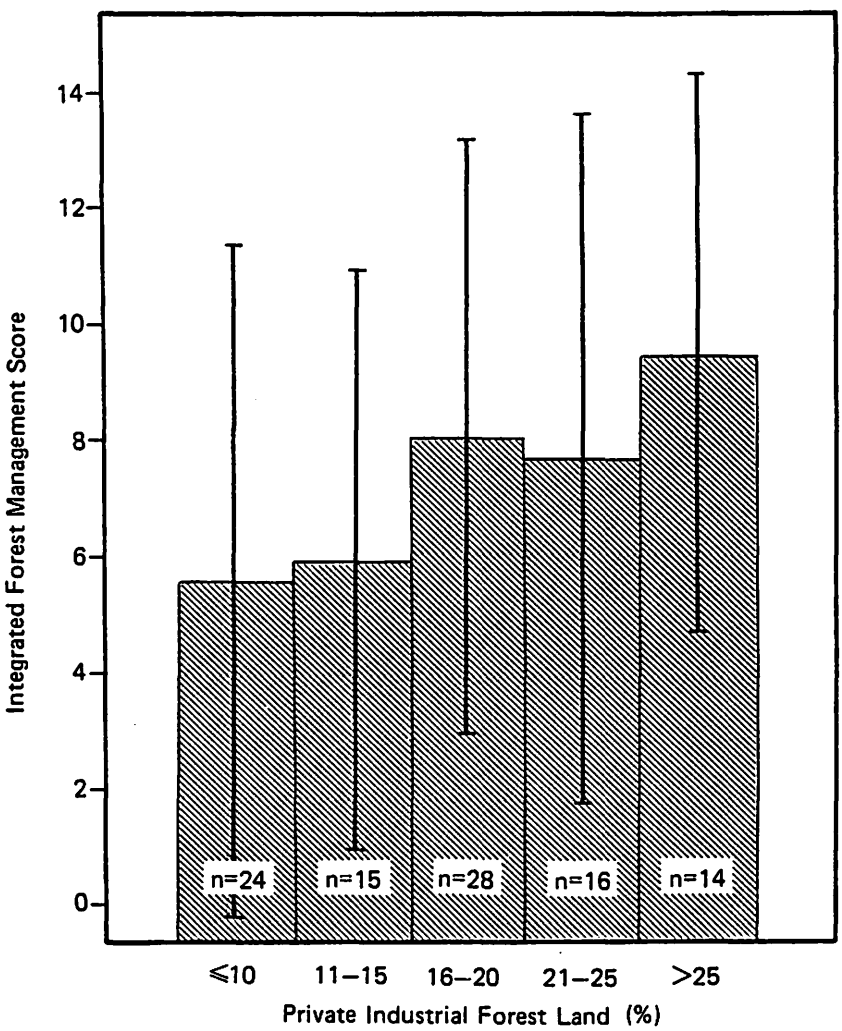

Figure 4.10. Mean integrated forest management scores for classes of private industrial forest land. Vertical lines represent standard deviations.

Land tenure patterns appeared to have less influence on respondents' perception of public relations benefits of nontimber forest land management although it was expected that a high proportion of private land might evoke a desire to practise IFM in the interests of being a "good neighbour". Where private forest land is less than 70 percent, companies were just as likely to cite benefits as not, although where it is over 70 percent, public relations benefits were perceived by 65 percent of respondents. Respondents mentioning public relations benefits came equally from states with less than 15 percent PIF land and states with greater than 15 percent PIF land. If the remarks of one respondent are an indication, the proximity to both nonindustrial private forest land and public forest land are considered in IFM decisions. This respondent, from a large company in Minnesota said "since most of our lands are intermixed with other private and public lands, this policy of multiple use management creates good will both with the general public and neighboring landowners." Nevertheless, a remarkable 84 percent of respondents perceived public relations benefits where public recreation land is less than 500 acres per thousand persons. Beyond that level only about 50 percent identified public relations benefits.

These results indicated that land tenure had some influence on IFM. There is a significant relationship only between only PIF land and index scores. However, private forest land and public recreation land have a significant influence on perceptions of economic benefits of nontimber production land use management. There are some trends in the relationships between land tenure patterns and of public relations benefits but these are not significant.

4.4.2 Internal Factors

In addition to the external factors which were expected to affect the environment in which companies operate, three factors descriptive of companies were expected to influence corporate IFM decision making: size of landholding; size of company; and corporate policies.

Size of Landholding

It was hypothesized that companies with larger landholdings within a state, in predominately contiguous parcels, would have higher IFM scores. Larger parcels might provide more flexibility in land management and perhaps a feeling of greater social responsibility or land stewardship. The correlation between the total amount of land owned within a state and the index score was the strongest of all of the expected influences (Pearson's r = .28). Both this relationship and the relationship between the size of the largest landholding and scores (Pearson's r = .21) are significant. There were eight missing cases for size of largest landholding because of the difficulty some companies had in measuring this where land was in a checkerboard ownership pattern.

The amount of land owned in a contiguous parcel did not have a stronger relationship to scores than the total amount of land owned in a state as had been predicted. In fact, using the coefficients of determination (r^2 values), the total amount of land owned explained eight percent (r^2 = .08) of the variation in index scores compared to only four percent (r^2 =.04) explained by the size of the largest land parcel owned.

The distribution of index scores for categories of total amount of land owned within a state and the size of the largest land parcel are presented in Figures 4.11 and 4.12. As with external factors, the relationship between land owned and index scores was not entirely as predicted; scores were higher than expected for very small landholdings. Scores were much lower in the second category (10,000 to 50,000 acres) and

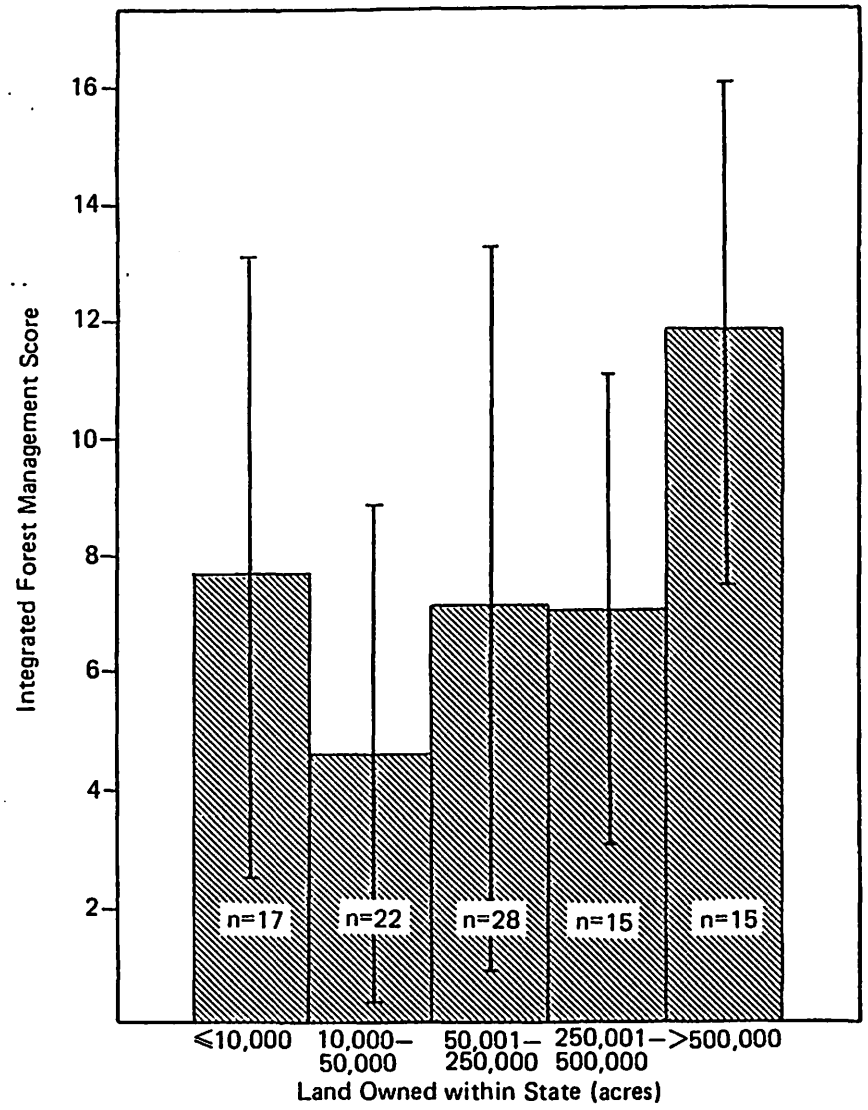

Figure 4.11. Mean integrated forest management scores shown for a breakdown of the amount of land owned within a State
Vertical lines represent standard deviations.

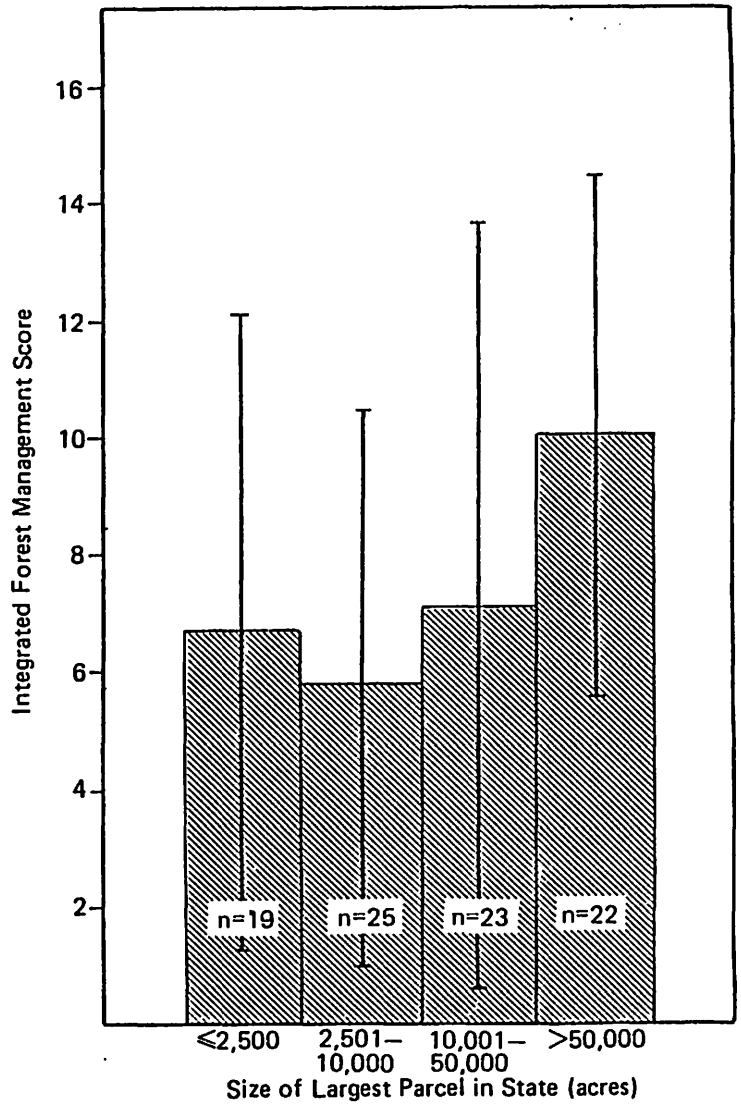

Figure 4.12. Mean integrated forest management scores shown for a breakdown of the size of the largest land parcel owned within a State.
Vertical lines represent standard deviations.

this combined with the very high scores associated with the 15 companies with over 500,000 acres appeared to drive the relationship between the amount of land owned and index scores.

Companies that owned more land tended to more frequently see economic and public relations benefits to managing their land for uses other than timber production. Figure 4.13 shows an increase in the percentage of companies citing economic benefits as the amount of land owned increased. On average those that identified economic benefits owned 327,000 acres whereas those that did not cite economic benefits owned 141,000 acres, which is a significant difference (Student's t value = 2.31). The frequency of companies that mentioned public relations benefits, however, peaked in the midsize class of land owned. This may have some relationship to the remark made earlier that when lands are intermingled with nonindustrial private land and public forest land, such as smaller landholdings in a checkerboard pattern, there may be greater perception of public relations benefits. Nevertheless companies that saw public relations benefits to IFM on average owned 315,000 acres which is significantly more (Student's t value = 2.08) than the average holding of 146,000 for those that did not perceive public relations benefits.

Size of Company

Larger companies were expected to have higher IFM scores because of potentially greater financial flexibility and staff expertise and also perhaps larger companies with national or international reputations might feel greater public pressure to consider nontimber values.

The sources available for company size included only those companies with sales greater than $1 million and therefore the 27 missing cases for sales and 22 missing cases for employees were assumed to be small companies. Consequently, correlation analysis was inappropriate to test this hypothesis. Instead, data for sales and employees were categorized, with missing cases included in the lowest categories of each variable, and the difference in mean index scores was compared using analysis of variance. Figures 4.14 and 4.15 show the differences in mean scores which were not significant (for sales, F = .132; for employees F = .346).

The number of employees was not always indicative of the availability of staff expertise to implement IFM practices because employee figures included mill workers and other secondary manufacturing employees. Only 15 companies indicated that they had staff working specifically in wildlife, fisheries, watershed or recreation management. Personnel in these 15 companies included nine wildlife biologists, five recreation managers, four watershed managers and two fisheries biologists. These companies scored much higher, on average, on the index than companies without staff in nontimber management positions (a mean of 10.68 compared to 6.70). The regional distribution of companies with IFM staff resembled the pattern found by Yoho (1980). There were eight from the South, four from the Northeast, three from the West and none from the Lake states. Yoho reported that the forest industry employed 21 wildlife biologists in the South, four in the Pacific Northwest, one in the Northeast, one in the Lake states and one in the Intermountain states. In addition to the relationship between IFM staff and scores found through the questionnaire, six companies that had staff speak on IFM at conferences (found in the literature) also scored above 10 on the index.

Larger companies tended to more frequently identify economic and public relations benefits to managing their land for nontimber uses. Figure 4.16 shows a very similar increase in perception of both public relations and economic benefits as sales increase. Chi^2 analysis demonstrated that the increasing frequency of either type of benefits with sales is significant.

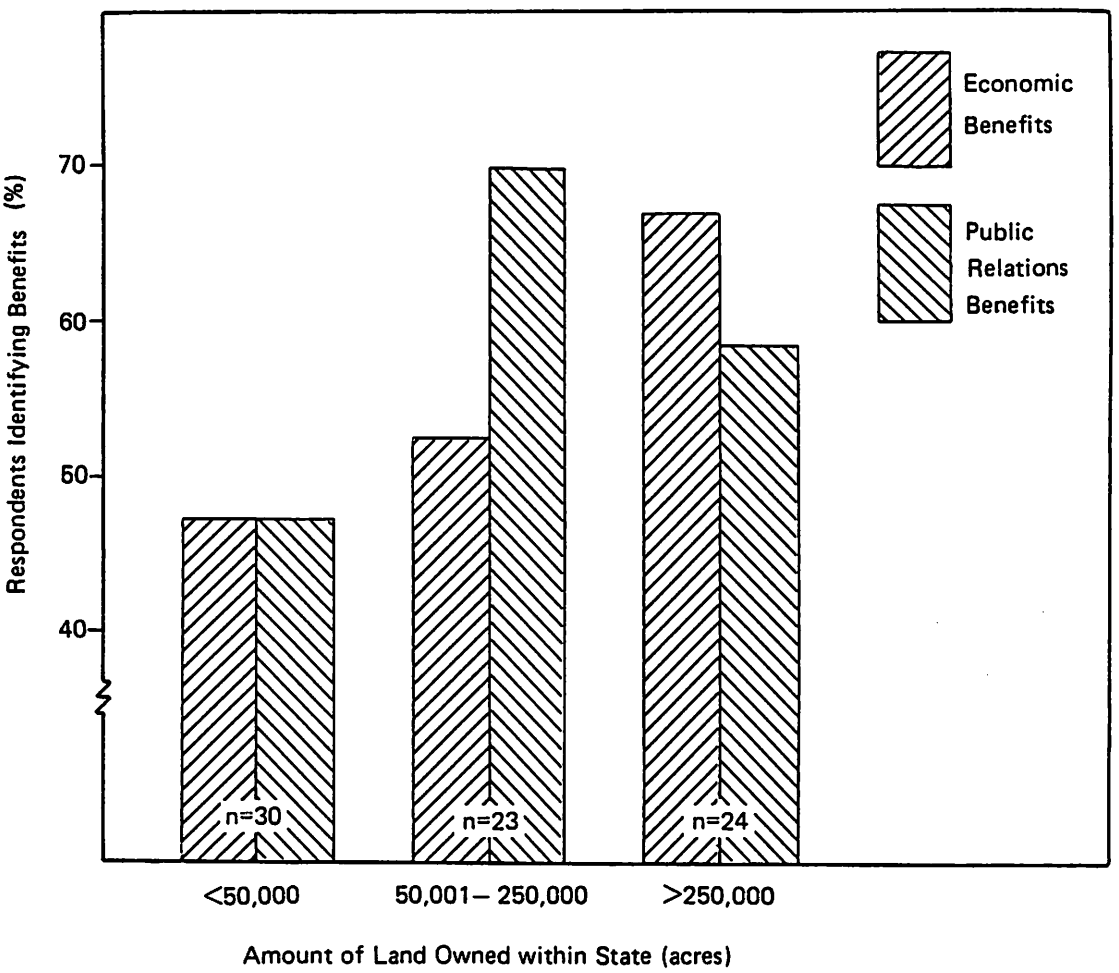

Figure 4.13. Respondents identifying economic and public relations benefits by amount of land owned within a State.

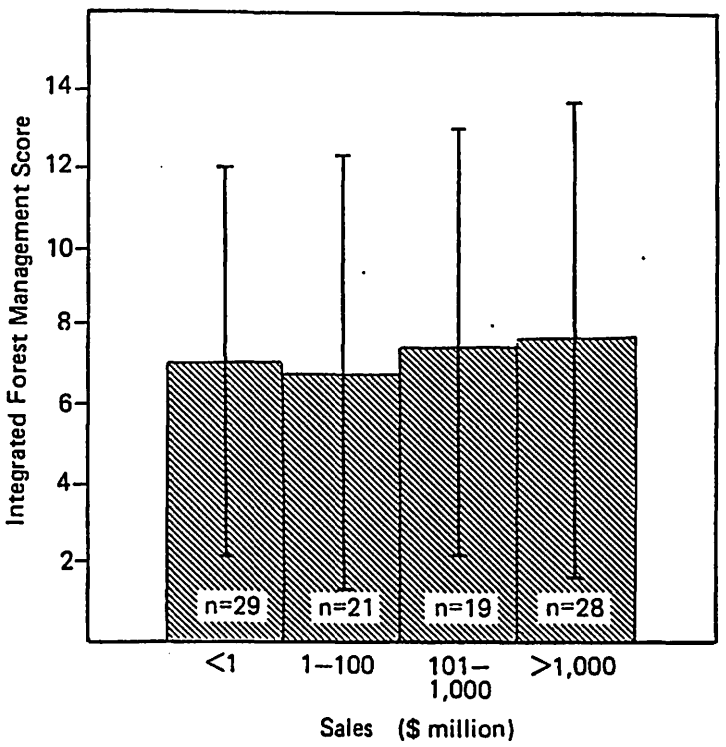

Figure 4.14. Mean integrated forest management scores for a breakdown of classes of sales. Vertical lines represent standard deviations.

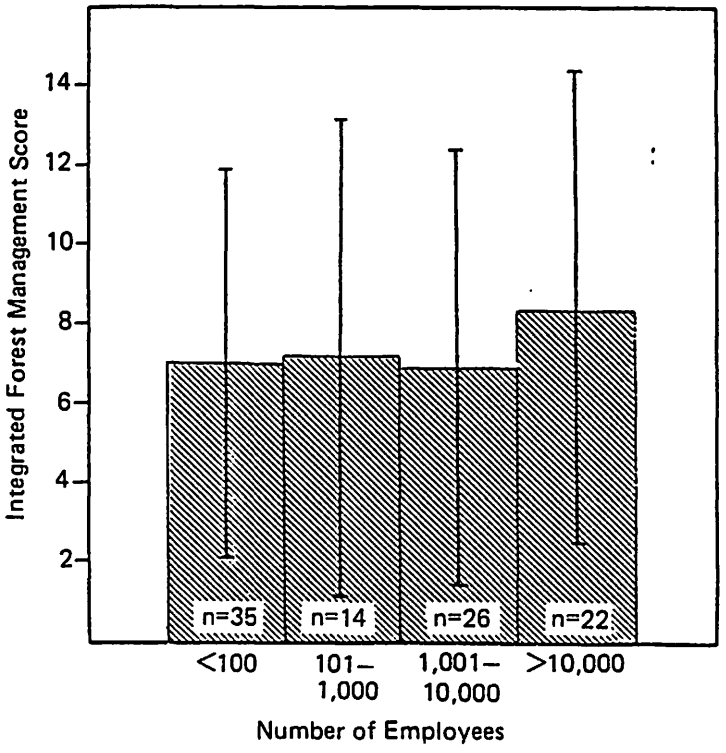

Figure 4.15. Mean integrated forest management scores for a breakdown of classes of employees. Vertical lines represent standard deviations.

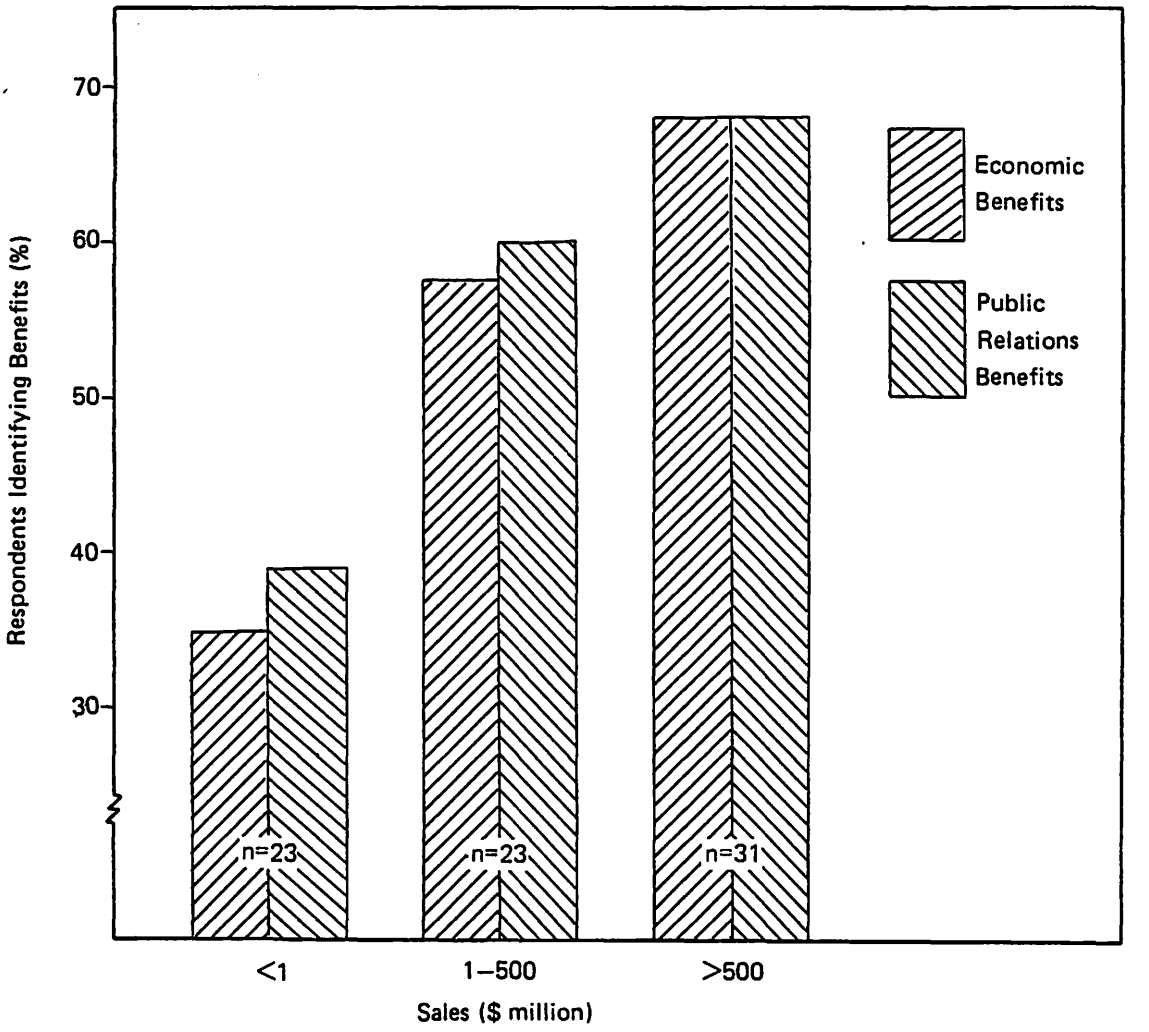

Figure 4.16. Respondents identifying economic and public relations benefits by sales.

Corporate Policies

Corporate land management policies were not directly solicited through the questionnaire but it was felt that staff opinions on the benefits that could be derived from managing land for nontimber uses might be reflective of corporate policies. It was hypothesized that IFM scores would be higher for companies that espouse a policy of land conservation or stewardship.

Certainly where respondents said they had no corporate policy towards managing their land for forest uses other than timber production or saw no benefits to this, index scores were substantially lower. The mean score of this group (of ten) was 5.30 but when combined with those that did not respond to the question (eight), the mean was 4.44 (standard deviation = 3.20). This is significantly different from the mean of 8.10 (standard deviation = 5.69) for companies that saw some benefits (U = 324.0; Mann-Whitney U test was used because of the small sample size). Only 12 respondents specifically indicated that managing for nontimber production forest uses satisfied an objective to act as land stewards or conservationists (often in combination with other benefits, but six saw this as the only benefit). These 12 companies on average actually scored slightly lower (mean = 6.38; standard deviation = 5.11) than those who did not mention stewardship benefits but the difference is not significant. Interestingly, these were generally small companies (both on the basis of land owned and sales) and mainly located where land tenure is dominated by the public sector. Possibly the low mean associated with the companies that identified stewardship benefits represented a higher mean than would otherwise be expected for these companies given the effects of external influences. In contrast, three large companies that operated nationally and proclaim a role as environmental land managers in their advertizing (Schoenfeld et al. 1980) all scored above 10.

While it appeared that few companies saw a conservationist role, there were indications that companies more often acknowledge their land management policies in annual reports. O'Laughlin and Ellefson (1982) observed that few companies identified land management policies in their annual reports but ten of the eleven annual reports provided by respondents made reference to corporate land policies. Six of the eleven made specific reference to corporate IFM policies. A typical statement from an annual report is "our corps of foresters and woodlands personnel demonstrate a high regard for the environment. Company-owned forests are managed for multiple use, including wildlife propagation, watershed protection and public uses such as fishing, hunting, backpacking and sightseeing." Four other reports described their land as an important source of raw material and indicated that the company practises intensive forest management. One of these companies stated that their policy is "to enhance the value of timberland assets into the future." The report did not mention, however, any nontimber values as part of the assets of their land.

There was a substantial range in index scores for companies that provided annual reports. The six companies whose reports included IFM statements account for 11 responses (some responded from more than one region). Their scores ranged from 3.50 to 18.25 with a mean of 8.87. The mean score of the other companies (which included 12 responses) was lower at 6.83 and the range was larger, from .25 to 20.25. The highest score, 20.25 was for the company that expressed a policy to enhance the value of timberland assets.

The literature review on corporate organizational theory had suggested that staff expertise may be reflective of corporate policies (March and Simon 1958). Only three of the companies whose annual reports espoused IFM policies had staff working in nontimber production research areas. On the other hand, two companies whose annual reports did not mention IFM also had staff in similar research areas. Only one of the eleven companies, however, had any specific IFM staff positions (again the company with the policy to enhance timberland assets).

From this analysis it is difficult to conclude what effect corporate policies have on IFM. Conservation or land stewardship did not appear to be a pervasive policy. However, scores tended to be slightly higher with a smaller range where there was an indication, from annual reports, of corporate policies to manage nontimber uses. This sample was too small to draw firm conclusions but it may suggest that corporate policies can modify somewhat the influences of regional variances.

The amount of land owned by a company and the size of the largest parcel of land owned are the only internal influences that have a significant association with index scores. Nevertheless larger companies, as measured by sales, did have a greater propensity to identify economic and public relations benefits of IFM.

4.4.3 Combined Influences

When all of the independent variables were considered (i.e. PIF land, private forest land, public recreation land, policy in two groups, total amount of land owned in a state and company size as measured by sales), the multiple coefficient of determination (R^2) was .124. In other words 12.4 percent of the variance in index scores was explained by these factors. The interdependence, or multicollinearity, among the independent variables meant that most of the independent variables added little to the explanation of variance in scores. Student's t-tests identified significant relationships between policy and all of the measures of land tenure (private industrial forest land, private forest land and public recreation land). Furthermore, companies tended to own more land in states with higher percentages of PIF land (Pearson's $r = .581$). Companies with high sales owned more land; the difference was greatest where sales were over $100 million and the average amount of land owned in a state was 378,236 acres compared to 112,225 acres for companies with sales less than $100 million. There was, however, no statistically significant relationship between the amount of land owned in states with policy (mean of 261,874 acres) compared to states without policies (mean of 227,160 acres).

Therefore, although the hypothesis testing identified significant relationships between index scores and policy, PIF land and amount of land owned, only policy and amount of land owned were independent of each other. Consequently, when the effects of policy and land owned were controlled in analysis of variance, PIF land (divided into states with less than 15 percent and those with greater than 15 percent) had no relationship with index scores.

Policy and the amount of land owned together explained 11.7 percent of the variance in index scores ($R^2 = .117$) This implies that IFM scores tended to be higher where there are IFM policies and where companies owned large amounts of land. Earlier analysis on the correlation between the amount of land owned and index scores showed that the amount of land owned alone explained 8 percent of the variance. This indicated that policy alone had only a minor influence which would tend to substantiate Enk's findings. Enk (1975) found that timber companies did not feel that forest practice legislation had a major effect on their land use strategies. Yet, where there are state policies, correlation analysis indicated that the amount of land owned no longer explained a significant proportion of the variance in index scores ($R^2 = .013$). On the other hand where there are no policies, the amount of land owned explained 20 percent of the variance in scores.

Enk's information was collected in 1969 prior to the development of any of the comprehensive forest practice legislation in the western United States and included only very large (on the basis of sales) companies. It is important then to examine more closely the influence of policy and land owned on large companies compared to small companies. The difference between large and small companies on the basis of sales was set at $500 million per year. This is a somewhat arbitrary figure but it separates the

companies that operate nationally (and internationally) from regionally-based companies and classes most of the firms studied by Enk into one group.

For the total sample, the difference in index scores between companies operating where there are state policies (ranks 3 and 4) and those without the influence of state policy (ranks 1 and 2) was 2.11 (from 8.58 to 6.47). The difference for small companies (sales less than $500 million) was 2.52 (from 8.42 to 5.90). These differences are significant using Student's t-test. In contrast, for large companies, although scores increased by 1.91 where there is policy (from 7.09 to 9.03), that increase is not significant. Figure 4.17 shows that where there are policies the scores of small companies came closer to those of larger companies. It is interesting to note that regardless of the size of companies, not only did scores increase where there are policies, but the variances in scores (standard deviations) decreased.

For small companies, the amount of land owned only explained a significant proportion in the variance of index scores where there are no policies (R^2 = .17). For large companies, on the other hand, the amount of land explained 16 percent of the variance regardless of policies and 22 percent where there are no policies. Yet where there are policies, land owned did not explain a significant proportion of the variance for large companies. This may be partly due to the small sample of only 10 large companies where there are policies (compared to 28 large companies where there is no policy).

The results indicated that for the total sample, the amount of land owned had a strong association with index scores but that state IFM policies reduced that association and promoted greater IFM practices particularly amongst companies with lower sales. The practices of very large companies (with sales over $500 million) were, as Enk (1975) found, not as strongly influenced by state forest practice legislation. This group, with the advantage afforded by large landholdings and greater consideration for public relations, practised quite high levels of IFM regardless of government policy.

Regional differences in IFM scores (discussed in Section 4.4.1 and presented in Figure 4.3) can now be explained by several factors. The highest scores were recorded in the Northeast which had many quite small (in terms of sales) companies, but companies in this region tended to have large landholdings. There are also state policies which generally have comprehensive objectives to protect nontimber values. Landholdings were also large in the South and as well, most of the companies there were very large. This group frequently perceived both economic and public relations benefits to IFM and was less influenced by state policy which is lacking in the South.

Both the West and Lake states had a somewhat even mix of large and small companies but average landholdings were much larger in the West compared to the Lake states. Small landholdings and lack of state policy explain the low scores in the Lake states. In contrast, the quite large landholdings and comprehensive state policy in the West were factors which contributed to that region having the second highest scores.

4.5 Summary

The factors studied in this research accounted for only a small percentage of the variation in IFM scores (12.4 percent overall but up to 22 percent for a subgroup). A number of constraints on the study no doubt contributed to the small explanation of the factors examined. For example, in order to examine the behaviour of a large number of companies in very diverse regions, only a general indicator of opportunities for economic gain and public pressure (land tenure pattern) was used and the more specific influences of individual corporate decision makers were ignored. Therefore to complement the information

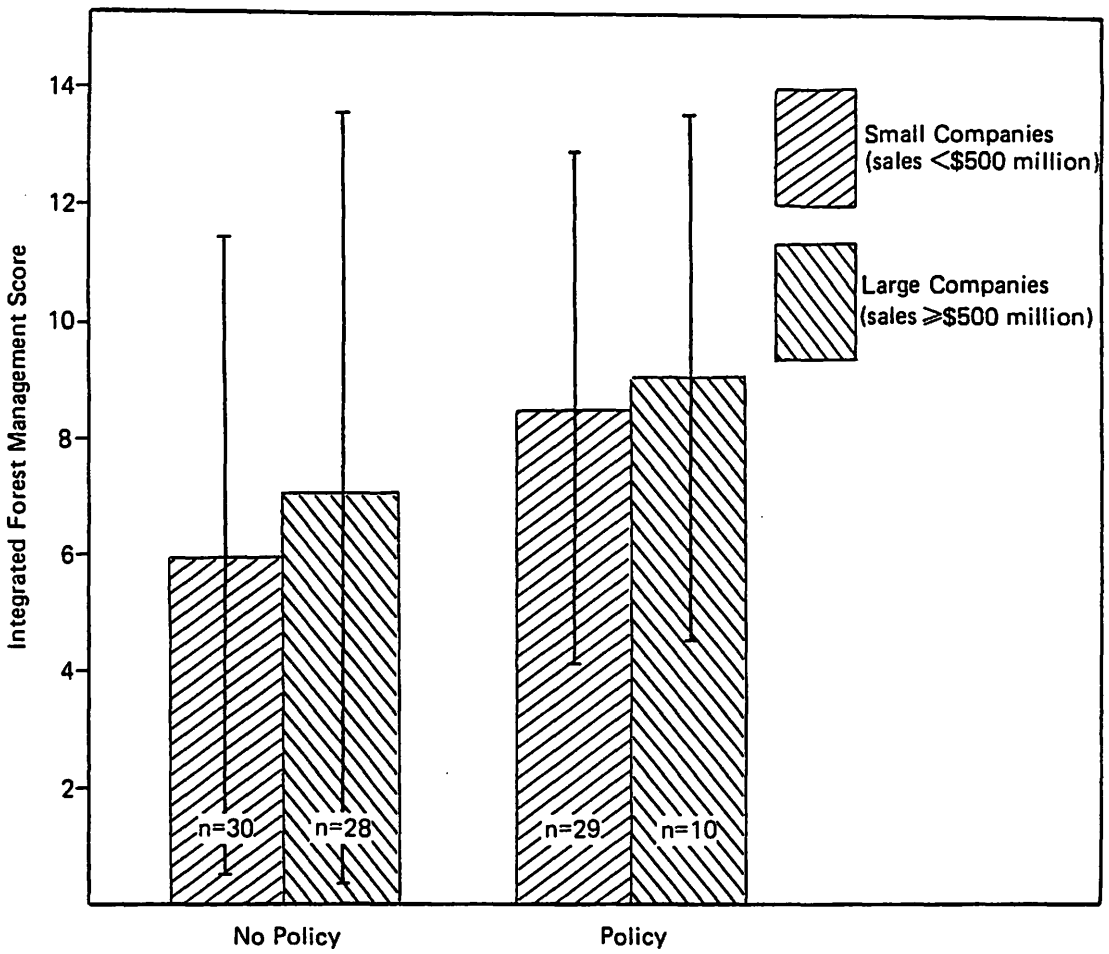

Figure 4.17. Mean integrated forest management scores increased where policies are in effect regardless of company size although the increase is only significant for small companies (Student's t = −1.95) Vertical lines represent standard deviations.

TABLE 4.5. Respondents' Perception of Factors Influencing Company Forest Practices

Forest Practice	Number of Respondents Citing Influence					
	Potential for Economic Gain	Public Relations	State Forest Practice Legislation	Zoning Laws	Tax Incentives	Trespass/Liability Laws
Roadside Cutting	40	45	21	5	0	4
Streamside Cutting	18	45	56	7	2	2
Cutting Method	76	16	19	7	6	2
Regeneration	73	18	24	0	12	0
Road & Landing Construction	58	15	37	3	3	8
Reclamation	40	17	21	6	0	4
Public Access	12	66	4	2	11	34
Recreation Management (facilities etc.)	27	42	1	4	2	24
Wildlife Management	25	53	11	6	2	2
TOTAL	369	317	194	40	38	80

provided by testing hypotheses, respondents were asked to identify factors that their company considered in various forest management policy areas.

Potential for economic gain, public relations and state forest practice legislation were, in that order, the factors most frequently by respondents as influences on corporate forest management practices. Table 4.5 summarizes the factors that respondents felt influence their forestry practices. Although the potential for economic gain was the most frequently cited influence, public relations was more often cited as an influence on streamside cutting, wildlife management, public access and other recreation concerns and to a lesser extent, roadside cutting. State forest practice legislation was a strong influence on streamside cutting and road and land construction. Other state policy initiatives appeared to have less influence but trespass and liability laws were a frequent consideration in recreation management.

This suggests that, while economic gain from land use was important (or essential) to timber companies, many of their forest land management practices were altered either because of regulations or more frequently because they perceive it is what society prefers them to do. The companies that actually said they profited from managing nontimber uses did not have significantly higher IFM scores than those who said costs of providing nontimber uses exceeded associated revenues (7.66 compared to 7.09; nine missing cases). So although companies would undoubtedly prefer to profit from nontimber production uses of their land, economic motives did not appear to be the single most important influence on levels of IFM.

The combination of economic and public relations benefits, however, provided incentives to practise IFM. These benefits were most frequently perceived by companies with high sales and large landholdings. Land tenure patterns also appeared to have some influence on perceptions of economic and public relations benefits which were more often perceived in states with high levels of private land and particularly where there are low levels of public recreation land per capita.

The results indicate that state policies, both mandatory and the less stringent, can encourage IFM in regions here there are fewer opportunities for economic and public relations benefits. Other influences, such as corporate policies that may reflect the opinions of decision makers may be important in particular cases. This appeared to be the case for one small landowner from a Lake state (with a higher than expected score given the results of this research) who stated "I am gratified to have chosen the route of good forest management for multiple purposes rather than the quick dollar that so many people look for in our industry."

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APPENDIX I

FOREST MANAGEMENT ON PRIVATE INDUSTRIAL FOREST LANDS

Dear Respondent

The purpose of this research is to increase our understanding of forest land management on private industrial forest lands throughout the United States and parts of Canada. The study is being conducted by the University of Guelph and is supported by a grant through the Canada-Ontario Forest Resource Development Agreement. The questionnaire is a component of a broader study on industrial forest land management practices.

We are interested only in your Company's forest management practices in the State of and only on the land owned by your Company (not leased land). Answers to most questions require a check in the appropriate box or entering of a number in the appropriate blank. A few questions ask you to write a brief answer in your own words.

The information from this questionnaire will be held confidential and specific companies will not be identified in any publications or reports resulting from this research. The purpose of the study is not to compare companies but rather to identify the range of forest land management practices within the United States and Canada and to develop some understanding for why these variations might occur.

Your cooperation in answering this questionnaire is essential to the success of our study and we greatly appreciate your efforts. A prompt reply will enable us to complete this research efficiently. Please return the completed questionnaire in the enclosed envelope.

If available, we would like to receive a copy of your Company's annual report.

If your Company does not own land in this State, please check here ☐ and return the questionnaire in the envelope provided. Thank you.

Sincerely,

R.D. Kreutzwiser PhD
Associate Professor
Department of Geography
University of Guelph
Guelph, Ontario
Canada
N1G 2W1

Company Name:_____
(Names are needed for initial checking of data because of some complex corporate organizations. Names will be removed after initial processing to ensure confidentiality.)

If this Company is a subsidiary, please give the name of the parent firm._____

The following questions seek information on your Company's land holdings IN THIS STATE ONLY.

1(a) What is the total acreage of forest land owned by your Company? _____acres

(b) How many spatially separate (ie. non-adjoining)land holdings does your Company own?_____

(c) What is the acreage of your largest land holding? _____acres

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The following questions relate to the scale of your Company's timber operations IN THIS STATE ONLY.

1 What volume, approximately, was cut in 1984 on your Company's land?

Hardwood _____ thousand cubic feet
Softwood _____ thousand cubic feet

2 Please list the major (in terms of volume) species harvested?

_____

_____

3(a) How many acres, approximately, of your company's land were cut in 1984? _____acres

(b) How does this compare to your average annual cut?

☐ Above Average
☐ Average
☐ Below Average

The following questions solicit information on cutting practices on your Company's land IN THIS STATE ONLY.

1 How many acres, approximately, were cut in 1984 on your Company's land in the various patterns listed below? (Please refer to the glossary for definitions of the terms used).

- Clearcut:
  - -block (regular or irregular) _____ acres
  - -strip _____ acres
- Shelterwood _____ acres
- Seedtree _____ acres
- Select _____ acres

2 *(If no clearcuts were made in 1984, please omit this question and continue on to Question 3).*

(a) Approximately what percentage of your clearcuts fall within the following size categories (in acres) listed below:

____<50 ____50-100 ____101-200 ____201-300 ____>300

(b) Approximately what percentage of your clearcuts are:

- Regularly shaped blocks ____ %
- Irregularly shaped blocks (such as following contours or timber type boundaries) ____ %

3 Which of the factor(s) below influence decisions on the cutting methods that your Company uses? You may choose more than one factor. If you do, please rank your choices from most important (1) to least important (11).

____ Government regulations(including zoning)
____ Regeneration considerations
____ Soils
____ Tree species
____ Wildlife benefits
____ Accessibility
____ Watershed concerns (such as proximity to water courses)
____ Harvesting costs
____ Slope
____ Recreation or aesthetic concerns
____ Other (please specify)_____

4 Some companies log to the edge of water bodies to prevent overmature timber from falling into and obstructing water courses as well as to make maximum use of timber resources. Other companies leave a buffer along water bodies to reduce sedimentation of streams or for aesthetic reasons. Which of the following best describes your Company's predominant cutting practices along water bodies:

☐ Cut to the edge of all water bodies

☐ Cut to the edge of small water bodies but modify cutting in buffer of approx. _____ yds. along larger water bodies

☐ Modify cutting along all water bodies: e.g. select cut or yard timber from buffer of approx._____ yds.

☐ Cut to the edge of small water bodies; leave a no-cut buffer of approx. _____ yds. along larger water bodies

☐ Leave a no-cut buffer along all water bodies of approx. _____ yds.

☐ Other more common practice—please describe:
_____
_____
_____
_____

5. Similarly, companies vary in the cutting practices that they use along roads used by the general public Some may cut to the edge of all roads opening up views. Others may leave a buffer to screen logging activities from public view. Which of the following describes your Company's most prevalent cutting practices along roads used by the general public:

☐ Cut to the edge of all roads

☐ Modify cutting along roads

☐ Cut to the edge of small roads; modify cutting practices along larger roads

☐ Cut to the edge of small roads; leave a buffer of approx. _____ yds. along larger roads

☐ Leave a buffer of approx. _____ yds. along all roads

☐ Other more common practice—please describe:
_____
_____
_____
_____

The next questions concern regeneration, stand treatment and road contruction on your Company's land **IN THIS STATE ONLY.**

1 Companies differ in their strategies for site preparation for regeneration. Some clear off as much of the logging debris as possible, by burning, crushing and/or scarifying to facilitate replanting. In some cases there is little debris left because of cutting practices (whole tree harvest or select cut). Other companies leave some debris to protect new seedlings and to replace soil nutrients; but debris is scattered, crushed and/or partially burned. Some companies leave all debris untreated to decay naturally and to prevent soil erosion. Which of the following best describes your Company's most frequent site preparation practices on your land? You may choose more than one practice. If you do, please rank your choices from most frequent (1) to least frequent (6).

☐ All debris left; no site treatment

☐ Debris scattered and burned (broadcast burn)

☐ Debris piled and burned

☐ Debris chipped or crushed and spread over site

☐ Debris removed from site

☐ Other practice more common – please describe:
_____
_____
_____
_____

2(a) How many acres of Company owned land, approximately, were artificially regenerated in 1984?
_____ acres

(b) How does this compare to the acreage artificially regenerated in previous years:

- ☐ Above average
- ☐ Average
- ☐ Below average

(c) Were any non-commercial species used? ☐ Yes ☐ No (please go to Question 3)

(d) If yes, why? _____

_____

3 Approximately what percentage of your Company's timber stands would receive, over the life cycle of a stand, any of the following stand or site treatments:

- Fertilizing ____ %
- Thinning (or pruning):
  - prior to a commercial age ____ %
  - at a commercial age ____ %
- Pest control: (insects, disease, weeds)
  - chemical ____ %
  - biological (including bacteriological sprays or predators) ____ %
  - mechanical (including sanitation cutting, prescribed burning) ____ %

4 Requirements for road location and construction vary considerably with expected volume of traffic, season and duration of use, terrain and other environmental considerations. However, which of the following would be most typical of your Company's road construction practices:

- ☐ Ford streams where possible; no specific practice with respect to distance of roads, trails and landings from water bodies
- ☐ Bridge fish-bearing streams; buffer of approx. _____ yds. between roads, trails, landings and water bodies
- ☐ Bridge fish-bearing streams; no specific practice with respect to distance of roads, trails and landings from water bodies
- ☐ Other more common practice – please describe: _____ _____

5(a) After harvesting and when regeneration is established, haul roads, skid trails and landings may be abandoned, reclaimed or maintained for other purposes. Companies vary in their procedures for road and landing abandonment depending on their future uses of the site. Which of the following describes how your Company most often treats haul roads, skid trails and landings after harvest and regeneration:

- ☐ Maintain for other purposes
- ☐ Remove structures (bridges etc.)
- ☐ Remove structures; plow up roads, landings
- ☐ Remove structures; recontour roads, landings
- ☐ Remove structures recontour; reseed or replant roads, landings
- ☐ Other more common practice—please describe: _____ _____ _____

(b) Does your Company ever reseed or replant trails, roads or landings with any non-commercial vegetation:

- For wildlife? ☐ Yes ☐ No
- For erosion control? ☐ Yes ☐ No
- Other reason (please specify)? _____

_____

The following questions relate to other forest land uses that may occur on your Company's holdings **IN THIS STATE ONLY.**

1 In your opinion what benefits might your Company obtain by managing land for other forest uses additional to timber production?

_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

2(a) Does your Company carry out any specific wildlife management programs independently or with a State or other wildlife management group?

☐ Yes ☐ No (please go to Question 3)

(b) If yes, please fill in the following blanks:

- Name of cooperating wildlife management group _____
- Wildlife species the program is designed for _____
- Acres of land involved ____ acres
- Number of years program has been in operation ____ years

(c) What was the motivation for your Company's involvement in the wildlife program(s)? You may choose more than one motivating factor but if you do, please rank from most important (1) to least important (4).

____ To relieve wildlife depredation
____ For public relations
____ To improve hunting
____ Other (please specify) _____

3 Please indicate which of the following relate to your Company's policy with respect to public access and recreation use of your lands (check wherever applicable):

- ☐ No specific policy
- ☐ No access is allowed
- ☐ Seasonal restrictions or some restricted areas (such as where harvesting is occurring
- ☐ Company provides picnic tables, campsites, boat launch or other recreation facilities
- ☐ A fee is charged for the following recreation activities (please list activities; e.g. camping, hunting etc.) _____
- ☐ Land is leased to a recreation group or club (please indicate acreage involved) _____ acres
- ☐ Some land is set aside exclusively for recreation use (please indicate acreage involved) _____ acres

4 If fees and/or lease rents are charged, please indicate why. Identify separately the reasons for fees and lease rents. You may choose more than one reason but if you do please rank from most important (1) to least important (4).

	Fees for recreation activities	Lease rents
To limit the number of people using the area	☐	☐
To recover the costs involved in permitting recreational uses	☐	☐
To add to company profits and returns from land	☐	☐
Other (please specify): _____	☐	☐

The following questions request information on your Company's research and policy making functions IN THIS STATE ONLY.

1 Please indicate (with a check where applicable) if your Company is involved in any of the research fields listed below with the use of Company staff and/or outside researchers.

	Staff involved	Fund other researchers	Have permitted other researchers to use land
Wildlife	☐	☐	☐
Fisheries	☐	☐	☐
Soils	☐	☐	☐
Watershed protection	☐	☐	☐
Outdoor recreation	☐	☐	☐
Pesticides	☐	☐	☐

2 Does your Company have any of the following positions of staff (check where applicable)?

- ☐ Wildlife biologist
- ☐ Fisheries biologist
- ☐ Recreation planner/manager
- ☐ Watershed forester/manager
- ☐ Soil scientist

3 In the chart below, please indicate, by a check in the appropriate column, which (if any) of the factors listed across the top influence the policies related to the activities listed down the left hand side that your Company practices.

	State forest practice legislation	Trespass/ liability laws	Pesticide regulations	Zoning laws	Tax incentives	Public relations	Potential for economic gain
Roadside cutting							
Streamside cutting							
Cutting method							
Regeneration							
Construction of roads and landings							
Reclamation of roads and landings							
Public access							
Other recreation concerns (facilities, leases, etc.)							
Wildlife management							
Research							

4(a) Are there any other land uses to which your Company allocates forest land in this State that have not been previously mentioned in this questionnaire? ☐ Yes ☐ No (please go to Question 5)

(b) If yes, please list the land uses, approximate acreage involved and how these land uses affect your timber management.

_____

_____

_____

_____

_____

_____

_____

5 Approximately what percentage of your Company's gross income in this State is derived from non-timber uses of forest land?

☐ <5% ☐ 6–15% ☐ 16–25% ☐ 26–50% ☐ >50%

6 In an average year, does revenue from non-timber forest uses of your Company's land exceed costs associated with those non-timber uses? ☐ Yes ☐ No

If you would like to be made aware of the results of this survey, please check below and indicate who should be contacted.

☐ Yes, I would like to be informed of the results of this survey.

Please contact:

_____

_____

_____

_____

Thank you for taking the time to complete this questionnaire.

If you would like to make any comments on either the questionnaire or on the subject matter please feel free to do so in the space below or attach an additional sheet.

GLOSSARY

Clearcut – a silvicultural system in which the old crop is cleared over a considerable area at one time.

Fertilizing – the addition of nutrients to the soil (in organic or inorganic form).

Pest control – reduction or elimination of harmful insect or disease populations by chemical, biological or mechanical means.

Policy – a definite course or method of action selected by a governmental agency, organization or individual from among alternatives and, in the light of given conditions, to guide and usually determine present and future decisions.

Prescribed burning – controlled application of fire to wildland fuels in either their natural or modified state, under such conditions of weather fuel moisture, soil moisture etc. as to allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to further certain planned objectives of silviculture, wildlife management, grazing, fire-hazard reduction, etc.

Sanitation cutting – the removal of dead, diseased, infested, damaged or susceptible trees essentially to prevent the spread of pests or pathogens and so promote forest hygiene.

Scarification – loosening the top soil of open areas, or breaking up the forest floor, in preparation for artificial or natural regeneration.

Seed-tree cutting method – removal in one cut of the mature timber from an area, save for a small number of seed bearers left singly or in small groups.

Select cutting – an uneven-aged silvicultural system in which trees are removed individually or in groups, here and there, from a large area each year.

Shelterwood cutting – any regeneration cutting in a more or less regular and mature crop, designed to establish a new crop under protection (overhead or side) of the old.

Thinning – a felling made in an immature crop or stand in order primarily to accelerate diameter increment but also, by suitable selection to improve the average form of the trees that remain.