

**GETTING MORE BENEFITS FROM BC FOREST LANDS:  
THE INTENSIVE ZONING OPTION**

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**NOTE:** This paper is intended for discussion purposes only. The opinion expressed in this paper are those of the authors and do not reflect government policy.

## Getting More Benefits from BC Forest Lands: The Intensive Zoning Option

### Part I: Background

Current forest policies in British Columbia are based on the concept of *integrated resource management*, under which forest land outside parks is managed to simultaneously provide a broad range of benefits, including timber production, ecological services, recreation, and aesthetics.

A difficulty with integrated resource management is that policies must strike a balance, on the same forest land base, among often competing and sometimes mutually exclusive activities such as clearcut logging and preservation of marbled murrelet habitat. So far attempts to balance these objectives have resulted in regulatory costs that have made it difficult for the forest industry to remain competitive, while environmental performance has been insufficient to satisfy environmental interests in BC or abroad.

#### Intensive Zoning

In the context of this paper, *intensive zoning* refers to a combination of concepts. These are:

- ❑ **Greater differentiation** among forest areas, with some areas zoned for intensive timber production and others zoned for environmental benefits.
- ❑ **Reduced regulatory constraints** on forest management practices in intensive timber production zones. This would increase short-term timber supplies available in those areas - allowing reductions elsewhere - and reduce regulatory costs to both industry and government.
- ❑ **Enhanced silviculture**, ranging from prompt restocking and pruning to more complex activities like genetic alteration of species and application of chemicals. These activities would increase future timber supplies.

One possible way around this impasse is to create more diversified zones on public forest land, with some areas reserved mainly for intensive timber production, and other areas reserved mainly for environmental, recreational and aesthetic benefits.<sup>1</sup> A third intermediate area, under integrated resource management, could act as a buffer between the timber and protected areas.

On land zoned for intensive timber production, industry would be freed of much of the expensive regulatory burden imposed by environmental requirements under integrated resource management, and be left to find the best way to produce higher volumes of timber. Greater wood supplies from timber production areas could then be used to offset reduced supplies from areas in which protection of non-timber values is increased. In addition, greater differentiation of forest

zones may have positive effects on biodiversity.

By meeting demands for reduced regulatory costs, maintained timber supplies and expanded protected areas, the *intensive zoning* approach (see box) could increase the total benefits available from our forest land, making it easier to find acceptable balances among competing uses. This paper is intended to stimulate public discussion of intensive zoning by identifying the major issues and obstacles involved, reviewing the relevant literature and posing a series of questions for public consideration.

#### Current Zoning in BC

Zoning on crown land is not a new concept, in BC or elsewhere. We already have a number of existing zoning designations in BC, including provincial parks, crown forests, community watersheds, the Agricultural Land Reserve and the Forest Land Reserve. Land use planning

processes such as the Commission on Resources and Environment (CORE) and the Land and Resource Management Plans (LRMPs) maintained these areas and identified three managed forest land designations in various regions of the province:

- ❑ *special management zones* that allow commercial use but emphasize conservation of unique environmental, cultural and recreational features;
- ❑ *integrated management zones* where timber harvesting and other resource values are closely integrated; and
- ❑ *enhanced resource development zones* where timber harvesting dominates, while still subject to protection of environmental, recreational and aesthetic values under the Forest Practices Code.

Intensive zoning would involve similar categories but provide timber operators in the enhanced resource development zones, or timber production zones, with more relief from Code requirements than is the current practice. Conversely, special management zones would be given greater conservation emphasis.<sup>2</sup>

The CORE and LRMP land use plans are currently connected to forest practices through "higher level planning" under the Forest Practices Code.<sup>3</sup> The Code contains default provisions on regulatory restrictions such as green-up and stream protection that are found in the Operational Planning Regulations and elsewhere, but it permits higher level plans to vary these rules in particular zones.

Despite relatively good overall progress on land use planning, the establishment of higher level plans under the Code has been very slow. To date, no intensive timber zones have been exempted from the default Code regulations, although the emerging Vancouver Island Land Use Plan will likely permit some exemptions. Thus, BC already has the legal framework in place to provide for more intensive zoning, but it has not been utilized to date.

## Part II: Opportunities and Challenges for Intensive Zoning in BC

For intensive zoning to increase the total benefits provided by public forest land in BC, timber supplies from intensive timber production areas will need to increase, through relaxed regulatory requirements in the short term, and enhanced silviculture in the medium and long term. However, intensive zoning faces a number of economic, environmental, and social challenges.

### Forest Yield Terminology

**Wood volume:** measured in cubic metres (m<sup>3</sup>).

**Mean annual increment (MAI):** Average volume of wood grown annually by a hectare of forest, measured in cubic metres/hectare/year, or simply m<sup>3</sup>/ha/yr.

**Annual allowable cut (AAC):** Volume of wood the BC government allows to be cut on public land (and some private land). Currently about 70 million m<sup>3</sup> a year for the entire province.

**Long-term harvest levels (LTHL):** A harvest level that can be maintained in the long term, assuming current land base and management practices. Currently about 60 million m<sup>3</sup> a year for the entire province.\*

\* "Provincial Allowable Annual Cut by Region, In effect as of August 31, 1999," Timber Supply Branch, Ministry of Forests. For more detail on the distinction between AAC and LTHL, see <http://www.for.gov.bc.ca/tsb/back/tsr/tsrbkg.htm>.

### The Possibility of Increased Yields

Timber supply forecasts, among other factors, are used by the Chief Forester to determine allowable annual cuts (AACs). These forecasts require the Ministry of Forests to estimate yields, both of existing stocks in old growth stands and of growing stocks in second-growth stands. Yield estimates used in the first round of the Timber Supply Review (TSR 1)<sup>4</sup> by the Ministry of Forests varied significantly, from below 2 m<sup>3</sup>/ha/yr in less productive areas of the interior to around 8 m<sup>3</sup>/ha/yr in the Vancouver region. The province-wide average was 2.7 m<sup>3</sup>/ha/yr.<sup>5</sup>

There is growing recognition that these growth estimates are too conservative, but there remains a significant amount of disagreement about how much too conservative. The BC government has recently commissioned a re-evaluation of its growth estimates under the Old Growth Site Index project (OGSI). The results indicate that current estimates have systematically underestimated yields, suggesting that even without any changes in management, BC forests are more productive than previously thought. Overall, the Ministry of Forests believes there may be an "OGSI boost" of as much as 18%.<sup>6</sup> However, this boost only applies to existing stands of old growth and will only be realized once these trees are cut and a new rotation of second growth trees matures.

### Impact of reduced regulations

It is also possible to increase sustainable timber production by relaxing some regulatory restrictions in certain zones. A recent study examines the Revelstoke Forest District and concludes that the relaxation of some regulatory restrictions would allow about 40% of the land base to produce the same amount of timber as would 100% of the land base under existing regulatory restrictions. These increases were achieved simply by relaxing regulatory constraints

#### Forest Land in BC

More than half of BC – about 50 million hectares – is considered productive forest, but only about 23 million hectares is considered suitable for harvesting. Areas are considered unsuitable for a variety of reasons:

- Environmentally sensitive areas (soils, avalanche tracts, regeneration, wildlife)
- Operation constraints
- Unmerchantable timber
- Riparian areas
- Wildlife tree patches
- Recreational areas
- Roads, trails and landings
- Cultural heritage
- Visual quality objectives

Source: Timber Supply Branch, MoF

on adjacency, visual quality, and wildlife habitat in intensively zoned areas. Riparian leave strips were maintained and no additional silviculture was assumed.

Another recent study that addresses the issues of zoning and intensive management in BC looks at the timber supply and economic impacts associated with management zone recommendations in the Vancouver Island Land Use Plan. The project looks at two landscape units on the Island's west coast, divided into enhanced development, general management and special management areas, with each area managed according to objectives defined in the land use plan.

The project concludes that, for the two units studied, the zoning approach increases short-term timber availability by 62%, in comparison to landscape units uniformly managed under the Forest Practices Code. This increase is mainly due to removal of adjacency and green-up constraints in enhanced management areas, which more than offsets increased harvesting constraints in special management areas. Overall operating costs declined by 16%.<sup>7</sup>

Not all such studies suggest that zoning can increase yields. In a study done of the Nelson area, a move to a more intensive zoning approach is projected to *decrease* timber availability. However, road-building and related costs are also projected to decrease substantially.<sup>8</sup>

The key issue is what constrains timber availability. When regulatory constraints are a big factor, more intensive zoning can free up potentially significant amounts of timber volume. In some areas like Nelson, the history of harvesting in the area is more important than current regulatory constraints, and zoning doesn't help timber flows per se, but it can still reduce costs.

### **Yields through enhanced silviculture**

In addition to zoning for regulatory relief, yields and timber quality can also be increased by investing in more enhanced silviculture, including genetic modification of tree species, site preparation, early planting, weeding and brush control, fertilization, pruning and thinning.

The effects of silvicultural treatments vary dramatically by species and site, and are difficult to summarize. One study done by Weyerhaeuser researchers in the United States examined the impact of various enhanced silviculture practices in Douglas fir plantations in the Pacific Northwest. The cumulative effect of site preparation, tending of young stands, fertilization, and improved tree seedlings produced yields 70% higher than in unfertilized natural stands.<sup>9</sup>

Enhanced silviculture is expensive and requires considerable investment early in the tree rotation. While there are no systematic studies available, there is broad agreement that not many types of intensive forestry investments are likely to be economical here in BC. The three investments that do seem to pay off consistently are prompt restocking, genetic selection of faster growing trees, and fertilization.<sup>10</sup>

### **Tenure and enhanced silviculture**

It is difficult to separate the issue of zoning forest land for intensive timber production from the issue of forest land tenure. One of the anticipated benefits of zoning some forest land for intensive timber production is that forest companies will increase their investment in silviculture, thus increasing future timber supplies. However, research indicates that greater investment is linked to security of tenure, and the right to reap future benefits of silvicultural investments.\*

Outright privatization of public land is one way to provide tenure security, and increase silvicultural investment, but this approach faces strong public opposition and may complicate future land claims. Another option is to offer long-term leases, guaranteeing the lease-holder at least one complete rotation and including clearly defined buy-out provisions.

In return for increased tenure security and reduced regulatory requirements in timber production zones, forest companies might exchange cutting rights in other areas for alternative uses such as new protected areas, community forests and aboriginal land claims.

Under long-term lease arrangements or even private ownership of land used for intensive forestry, there are no legal impediments to government regulation of riparian areas, water quality, soil conservation or other requirements.\*\*

\* One study shows that the level of silvicultural investment under the most secure form of tenure (private land) is 67% greater than under the least secure form (forest licences). Daowei Zhang and Peter Pearce, "Differences in Silvicultural Investment Under Various Types of Forest Tenure in British Columbia," *Forest Science* 42 (1996): 442-9.

\*\* David Haley and Martin Luckert, "Property Rights and the Management of Forest Resources: The Canadian Experience," *Commonwealth Forestry Review* 71 (1992): 9-12.

If it is indeed technically and economically feasible to increase yields in BC, a move to more intensive zoning would still face environmental and social challenges.

### **Environmental challenges**

Enhanced silviculture and reduced regulatory requirements will almost certainly have greater local impacts than integrated forest management. Research is needed to find out more about these impacts, but some areas of concern can be identified.

Perhaps the greatest impact of more differentiation of forest use areas is the loss of biodiversity in areas where intensive forest management is practiced, but the impact could be offset by increased protection of biodiversity in newly protected areas. Other possible impacts are less readily apparent. These include the following concerns:

- ❑ relaxation of regulatory requirements would place a larger proportion of watersheds in a recently disturbed condition, creating the potential for hydrological problems that change the nature of flows, contribute to soil erosion and increase sedimentation that can affect riparian habitat;
- ❑ soil erosion might occur if pre-planting site preparations (soil tillage) associated with enhanced silviculture are undertaken in unsuitable areas;
- ❑ successive crop rotations could deplete soil nutrients and the complex soil systems that are sustained in natural forests, as well as weaken root structures that hold soils in place;
- ❑ repeated cropping of a limited variety of tree species may cause the buildup of “pathogens” such as disease and pest infestation; and,
- ❑ herbicides used for brush control, pesticides used to control insects and disease, and excessive or improperly applied fertilizers, especially nitrogen and phosphorous, can affect water quality and surrounding areas.

### **Mitigating environmental impacts**

The possible local impacts of intensive timber production zones can be mitigated to some degree through appropriate location of timber production zones. Ideal locations would be in areas with minimal interactions with streams, lakes and wetlands. While it is true that no ecosystem exists in isolation, some areas are more isolated than others. Timber production areas should also be assessed for soil stability, slope and precipitation patterns.

Other local environmental effects can be mitigated through management techniques. For example, riparian buffer zones can filter some sediment and chemicals, with effectiveness depending largely on structure and extent. Disturbance of sensitive soils can also be controlled to reduce sedimentation and nutrient loss.

More information is needed on local environmental impacts, especially on the dimensions and structure of riparian buffer zones. In particular, we have only a limited understanding of small streams, which are crucial to some fish species and may require specific types of buffers. Ideally, timber production areas would avoid these small streams.

### **Possible environmental benefits**

On a large scale, dedicating a percentage of forest land specifically to intensive forest management zones, with fewer regulatory requirements, should allow a greater percentage of forest land to be set aside in protected areas or community forests. This would help satisfy public demands for larger protected areas and allow government agencies to focus their attention on

protecting fewer non-timber values on a smaller land base. It would also eliminate some of the complexity (and cost) associated with trying to balance timber production, ecological services, recreational opportunities and aesthetics, objectives that are often competitive or even mutually exclusive.

Greater differentiation of forest use zones could have other ecological benefits. One UBC study points out that different types of forest-dependent species rely on different types of forest structures. Some species, such as cavity-nesters ranging from woodpeckers to black bears, benefit from having large, contiguous areas of old growth habitat. Other species, such as shrub nesters, do better in larger openings.

The study author argues that biodiversity in BC would be best promoted by the creation of at least two major types of zones within unprotected areas, one with an emphasis on old growth conservation, and another with a timber production emphasis. The timber production emphasis areas would be further divided to create different types of habitat suitable for different types of species: aggregated retention (for cavity nesters and others), individual tree retention (for owls and other aerial predators), and enlarged openings (for shrub nesters). The study concludes that "we are better off ecologically and better off economically if we make our biodiversity emphasis zones less similar."<sup>11</sup>

Another aspect of the paper needs to be considered. The Forest Practices Code is said to increase habitat fragmentation, with likely detrimental impacts on biodiversity. But it appears it is the absolute area of habitat that is the main determinant of biodiversity, rather than the degree of fragmentation. In fact, the issue of fragmentation is most significant when the areas between the habitat fragments – the “matrix” – is hostile territory such as cities or areas under intensive agricultural cultivation.<sup>12</sup> Research is needed to ascertain to what degree forestry plantations constitute a hostile matrix, relative to cities, cultivated fields or areas harvested under the provisions of the Forest Practices Code.

Zoning the forest into different use areas may result in environmental improvements by reducing the impact of roads, which can affect drainage and sedimentation, especially if structural failures occur, and can cause damage by providing public access to remote areas. Permanent roads used in plantation forests are likely engineered to higher standards than temporary roads in integrated resource management areas that are de-activated after harvest. Road networks may be more dense in timber production areas, but this could be more than offset by much smaller road networks in areas subject to greater protection of non-timber values, so the total road network would be reduced. One study shows the length of road required under single use is 35% less than under integrated resource management.<sup>13</sup>

### **Social Challenges**

In addition to environmental concerns, there are also significant social challenges to adopting more intensive zoning.

- ❑ *short term timber supply.* Many of the benefits of intensive zoning will only occur over the long term, as second growth matures to harvestable age. If there are still significant shortfalls in timber supply over several decades, the strategy of using zoning to increase benefits from the forest over the long term may be very disruptive in the short term.
- ❑ *aboriginal land claims.* Any major change in the allocation of land use in the province will be affected by ongoing aboriginal land claims negotiations. This issue could potentially be addressed in part by using long-term leases instead of outright privatization for intensive

timber production areas,<sup>14</sup> as well as offering First Nations an opportunity to select intensively managed lands as part of their claims.

- *community stability*: The geographical structure of many forest dependent communities is based upon a particular allocation of cutting rights and the establishment of processing facilities. If a move to more intensive zoning were to create a significant geographical reallocation of harvesting or processing, the implications for some communities would be significant. Losses might include reduced value of homes and businesses, as well as relocation and retraining costs. In addition to communities, many forest-oriented businesses might experience lost value of tenures and productive capital. Current labour arrangements would also be affected. For a discussion of possible mitigation strategies, see the “Communities, Jobs, and the Forest Sector” paper.

### **Part III: The Intensive Zoning Option**

The intensive zoning option would involve the following key features:

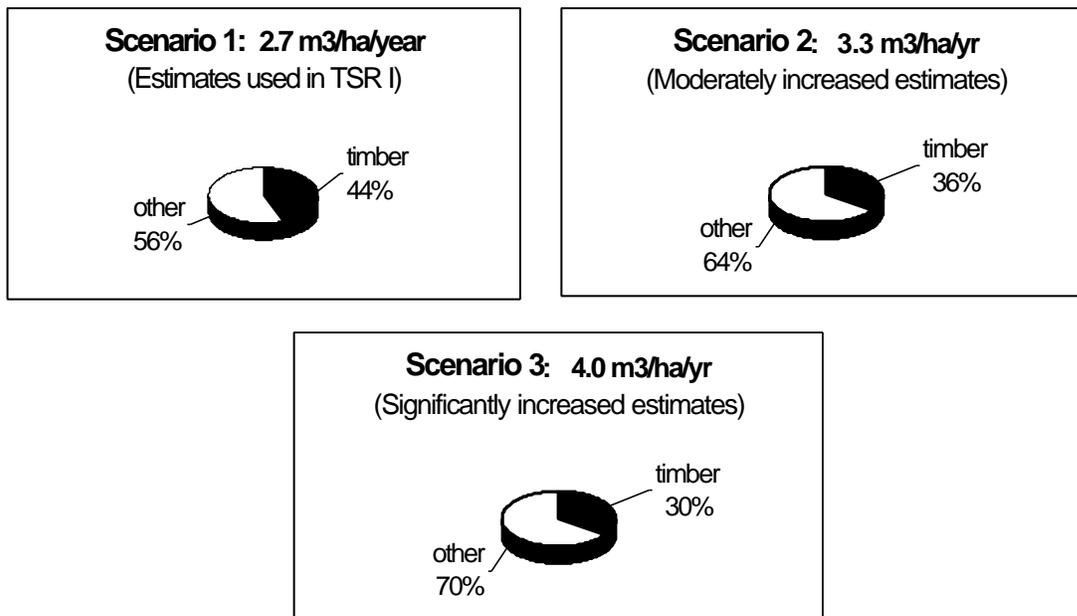
- Designating certain areas of the provincial forest land base in which greater emphasis would be placed on timber volumes;
- Some non-timber values would be sacrificed in the designated areas;
- Higher productivity from intensive timber production areas could free up other lands for conservation and other purposes; and
- Adequate security of tenure so that forest companies can benefit from the right kinds of investments.

If it is indeed technically, economically, and environmentally feasible to use intensive zoning to increase the total benefits available from our forests, it won't necessarily end conflict over the allocation of those benefits. Depending on values and interests, some people might prefer to maximize allowable annual cut, others to maximize protected areas. Intensive zoning is intended to create a bigger pie, but it won't tell us how to cut the pie.

While there is a great deal of uncertainty about potential yields, it is possible to construct various scenarios to project what different forest futures might look like under different yield assumptions. *Figure 1* assumes a harvest level of 60 million cubic meters, currently estimated to be the long term harvest level by the Ministry of Forests, and examines the allocation of productive forest into intensively managed zones and all other uses, including protected areas. The first chart shows the allocation under the yield assumptions (2.7 m<sup>3</sup>/ha/yr) that were used in the first round of the Timber Supply Review process. Under this scenario, 44% of productive land needs to be allocated to forestry, leaving 56% available for other uses. The most optimistic scenario assumes a yield of 4.0 m<sup>3</sup>/ha/yr. In this case, only 30% of the province's productive forest land would need to be allocated to industrial forestry.

Of course, we need not be fixated on a particular harvest level. Some may want lower harvest levels and even more conservation, while others may want higher harvest levels. The important point about the intensive zoning option is that it holds the promise of increasing the amount of conservation (or other non-timber benefits) for any given level of timber harvest, or alternatively, increasing the amount of harvest from any given land base allocated to forestry.

**Figure 1: Percentage of productive land used for timber production under three different yield assumption scenarios (assuming harvest level of 60 million m<sup>3</sup> per year)**



The geographic location and distribution of timber-emphasis zones will be a tough question to resolve, judging by the considerable debate during past CORE and ongoing LRMP processes over the creation of different zones.

One issue is the *scale* that should be used for dividing up zones. They could be developed at a fine scale such as a watershed, or a coarser scale such as a forest district or region, or even provincially. Different scales have different operational and ecological implications. For example, it might be more difficult to preserve large, contiguous blocks of old growth ecosystems if zoning is done at a finer scale.

Criteria will need to be developed for the allocation of land to different zones. In considering the question, we must examine what areas have potential for high forest productivity, the ability to manage environmental impacts of intensive forestry, and the relative merits of competing uses for those areas.

In general, the areas most suitable and desirable for intensive forest management – flat, productive valley bottoms – are also those areas that support the highest level of biodiversity, as well as those with high agricultural potential and suitability for urban development. This sets the stage for a significant land use conflict.

Consideration might be given to areas surrounding existing processing and manufacturing facilities, especially modern plants incorporating the latest technologies. In addition, environmental concerns might dictate that intensive zones be located in areas of low stream density, to reduce impacts and costs and complexities of riparian regulation. Also, the mechanization required to engage in some forms of cost-effective intensive forestry dictates that areas chosen be relatively flat. An obvious place to start would be the “enhanced forestry zones” already identified under land use planning processes and the Forest Practices Code.

Laying out more of the specific consequences of an intensive zoning model is difficult given the significant uncertainties as to how much yield can be increased, and what the economic, environmental, and social consequences might be. What is needed is a strategy to address the uncertainties. Some of these uncertainties can be resolved quickly through analysis of existing data. For example, based on data already gathered as part of the Timber Supply Review, the Ministry of Forests is beginning an analysis on how much more intensive zoning might be able to increase yields and lower costs.

Other data requires experiments and will take a longer period of time. Over the past several years, several programs have been created to conduct operational trials. One project – one of the Innovative Forestry Practices Agreements initiated under the Jobs and Timber Accord – is doing research on growing conditions for trees on specific sites and techniques for estimating how volume of trees growing on those sites can be improved.<sup>15</sup>

Another initiative, known as the Enhanced Forest Management Pilot Project, was begun in September 1995 as a “co-operative effort between industry, the Forest Service, the Environment Ministry, Forest Renewal BC, labour, and the academic community.” Three pilot areas of about 200,000 hectares in the Invermere Forest District and Tree Farm License 39 (north of Campbell River) and a Forest License in Burns Lake have been established. The aim is to measure the effects and viability of silvicultural treatments such as gains from tree breeding, fertilization, brushing and spacing.<sup>16</sup>

These initiatives should provide valuable information about the feasibility of intensive forest management. Whatever trials are developed to increase our understanding about the prospects for productivity gains, it is imperative that appropriate investments be made in monitoring, assessment, and reporting so that we can get the most benefit possible from these experiments.

#### **Part IV: Questions for Discussion**

This paper has argued that we may be able to get more total benefits from our forest land base if we change our land use and management practices. This strategy would involve creating areas where operators are freed from some regulatory constraints, so that they could increase the volume of wood produced on a given land area. We would still be managing for all forest values, but doing so over a larger area may allow us to increase the total amount of values derived from the forest.

There is some evidence that we can significantly increase yields from forest lands, though the exact increase is uncertain. Some of these uncertainties can be resolved quickly through analysis of existing data, but others require experiments and will take a longer period of time.

We are also uncertain about the environmental effects. Relaxing regulatory requirements will increase environmental impacts in intensively managed areas, but this may be more than compensated for the increased land made available for conservation. Implementing such a strategy would involve challenging transitional problems, including the need to address aboriginal land claims and potential effects on jobs and communities.

Before embarking on such a strategy, we will need to address the following questions:

1. Are British Columbians willing to relax some requirements for the protection of non-timber values on some forest lands in order to increase the amount of land available for conservation or other purposes?

2. Should some requirements for the protection of non-timber values – fish, wildlife, soil, water quality and quantity, green-up and adjacency, visual quality – be given more flexibility relative to others? If so, which values?
3. How much can we economically increase yields above levels currently achieved under integrated resource management?
4. How will intensive zoning affect the projected shortfalls in timber supply over the next several decades in areas like the coast and parts of the southern interior?
5. If it is indeed possible to increase the total benefits from our forests through intensive zoning, how should those benefits be allocated? Should harvest levels be increased? Should more areas be conserved? Should some of the increased benefits be allocated to community forests or to First Nations?
6. What scale should be used to divide up zones? Watershed, district, region, province?
7. How should we decide what types of areas should be zoned for more intensive forestry?

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### Endnotes:

<sup>1</sup> This strategy has been advocated in the BC context by Clark Binkley, “Preserving nature through intensive plantation forestry: The case for forestland allocation with illustrations from British Columbia,” *Forestry Chronicle* 73 (September/October 1997): 553-559. The same strategy has been advocated at the global level. See Roger Sedjo and Daniel Botkin, “Using Forest Plantations to Spare Natural Forests,” *Environment* 30 (December 1997): 14-20, 30.

<sup>2</sup> Environment organizations have been highly critical of the lack of apparent difference between special management zones established so far and the more timber oriented zoning categories. Jim Cooperman, *Keeping the Special in Special Management Zones*, BC Spaces for Nature, May 1998.

<sup>3</sup> For a clearly written introduction into these relationships, see West Coast Environmental Law Association, *Guide to Forest Land Use Planning*, (Vancouver: West Coast Environmental Law Association, 1999).

<sup>4</sup> For an overview of the government’s Timber Supply Review process, see <http://www.for.gov.bc.ca/tsb/back/tsr/tsrbkg.htm>.

<sup>5</sup> Derived by dividing the long term harvest level by the future timber harvesting land base from “Provincial Allowable Annual Cut by Region, In effect as of August 31, 1999,” Timber Supply Branch, Ministry of Forests.

<sup>6</sup> Personal Communication, Gary Townsend, Timber Supply Branch, March 22, 1999.

<sup>7</sup> “Short term” is described in the study as the first ten years. Over years 11-25, the benefits of zoning are reduced, but compared to the base case, there is still 11% more timber available, and costs are 2% lower. The study does not address the longer term. Olivotto Timber, “Timber Availability and Cost Estimates for the Eliza and Kashutl Landscape Units,” prepared for the Vancouver Forest Region, Ministry of Forests, Nanaimo, BC, February, 1999

<sup>8</sup> Fred Bunnell, Ralph Wells, John Nelson, and Laurie Kremsater, “Patch Sizes, Vertebrates, and Effects of Harvest Policy in Southeastern British Columbia,” in *Forest Fragmentation: Wildlife and Management Implications*, edited by J.A. Rochelle, L.A. Lehmann, and J. Wisniewski, (Brill, Leiden, Netherlands, in press).

<sup>9</sup> P. Farnum, R. Timmis, and J.L. Kulp, “The biotechnology of forest yield,” *Science* 219 (1983): 694-703.

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<sup>10</sup> Eleanor McWilliams and Reid Carter, "Silviculture Investment Opportunities: a Methodology for Identifying Key Decision Variables," FRBC Number HQ96463-RE, September 1998; John Barker, "Intensive Silviculture as a Means of Increasing Forest Productivity," Paper presented to the UBC Workshop on Intensive Zoning, Vancouver, July 26, 1999.

<sup>11</sup> This work focuses only on terrestrial vertebrates. Additional information is needed about the impact of different zoning approaches on non-vertebrate species. For a summary of this work, see Fred Bunnell, "Next Time Try Data: A Plea for Variety in Forest Practices," UBC Centre for Conservation Biology, 1999, and Bunnell, *et al*, "Patch Sizes, Vertebrates, and Effects of Harvest Policy in Southeastern British Columbia," *op cit*. For detailed document and elaboration of these arguments, see Fred Bunnell, Laurie Krensater, and Mark Boyland, *An Ecological Rationale for Changing Forest Management on MacMillan Bloedel's Forest Tenure*, Prepared by the Centre for Applied Conservation Biology, UBC, 1998. Available at <http://www.mbtld.com>.

<sup>12</sup> Bunnell, "Next Time Try Data."

<sup>13</sup> Sahajanathan *et al*, "Planning for Sustainable Forests in BC."

<sup>14</sup> In New Zealand, leases have been structured so that companies reap the benefits of the current rotation before land is transferred to aboriginal owners. This approach may be more difficult in BC because of our longer rotations. O.F. Hall, "New Zealand's Privatization of Forest Lands: Policy Lessons for the United States and Elsewhere?" *Forest Science*, 43 (1997): 181-193

<sup>15</sup> For more information about the Arrow district innovative forestry practices agreement, see the website at <http://www.arrow-ifpa.com>.

<sup>16</sup> For more information, see website at [www.for.gov.bc.ca/PPP/ENHANCED/index.htm](http://www.for.gov.bc.ca/PPP/ENHANCED/index.htm).