Pine Mushrooms and Timber Production in the Cranberry Timber Supply Area

Prince Rupert Forest Region

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Executive Summary

This report investigates the synergies and tradeoffs between forest management for timber, compared with forest management for both pine mushrooms and timber.

Significant rates of timber harvest are necessary to maximize pine mushroom production. Mushrooms thrive in younger mature forest, and harvesting of older forest creates a stream of young maturing stands. With continued timber harvesting, the long-term pine mushroom production potential in the Cranberry TSA is 2–3 times current production levels.

An economic assessment finds that the total economic yield from the forest is maximized at a rotation age of approximately 145 years. This rotation age extends the period of mushroom productivity, and the development of valuable timber piece sizes. Shorter rotations lose more mushroom value than the gain in wood fibre. Longer rotations lose more timber increment than the gain in mushroom yield.

The report identifies further information requirements for mushroom and timber management, and concludes with a comprehensive list of activities that would improve understanding of the subject.

Acknowledgements

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Many mushroom people have helped educate the author, including: Shannon Berch, mycologist with the B.C. Forest Service, Randy Marchand and Stephen Mills, commercial pine mushroom exporters, Shirley Pietila, and Jennifer Lawlor. Julian Grzybowski, Small Business forester in the Squamish Forest District, arranged an earlier opportunity to investigate pine mushroom habitat and growing conditions. Ros Penty edited the report.

The author thanks all these individuals and other contributors.

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Introduction

Commercial mushroom picking is an important economic activity in the forests of British Columbia, with revenues on the order of $10–20 million annually (Wills 1998). The pine mushroom (*Tricholoma magnivelare*, or Canadian *matsutake*) is the most economically significant mushroom species in B.C., and the Cranberry Timber Supply Area naturally produces large annual crops of pine mushrooms.

The pine mushroom is an ectomycorrhizal species that exists in a symbiotic relationship with living forest trees. The fungal hyphae absorb nutrients from the soil, which are passed to the tree's roots in return for photosynthate sugars. The pine mushroom is not known to produce fruiting bodies without an associated tree host. The clearcut method of timber harvesting removes all forest trees, and thereby extinguishes pine mushroom production. The regenerating forest may re-establish the ectomycorrhizal association, and when trees are large enough may again start producing pine mushrooms.

With funding from Forest Renewal BC, the Northwest Institute for Bioregional Research has initiated a project to build a foundation for sustainable pine mushroom harvesting in the Prince Rupert Forest Region. The project components include a problem analysis (Gamiet et al. 1998), an ecological description and site classification of pine mushroom habitat (Trowbridge et al. 1999), a comparison of the location of present mushroom-producing stands against 5-year development plans (SWAT, in preparation), and a mushroom and timber yield analysis (this report).

This report models production of pine mushrooms and timber within a sample forest, the Cranberry Timber Supply Area (CTSA). Appendix 1 shows the location of the CTSA. Sources of information used in the analysis include published references, and anecdotal and observed characteristics of the fungi. The report highlights further information requirements to successfully integrate timber and mushroom management strategies.

Methods

A forest estate model assembles a description of the forested land base, and assumptions about growth and productivity of organisms on that land base. Within the model, time is projected forward, and changes to habitats and organism responses are monitored. Time increments used in this analysis are 10-year periods.

Each decade, forests grow 10 years older, and some forest stands are harvested and replaced with regenerating stands. The state of the forest in each period determines its ability to produce timber, mushrooms, and other values.

Forest areas and volumes

Figure 1 illustrates the present forest age class distribution on the timber harvesting land base (THLB) in the CTSA. The THLB is a subset of the total forested area, after deducting streamside buffers, other environmentally sensitive areas, low-producing sites and protected areas. The total area of the CTSA is 77 000 ha, the forested area is 60 000 ha, and the THLB is 32 832 ha, or 55% of the total forested area. Within the THLB, most of the forest is presently mature (greater than 120 years old), and 23% is presently less than 30 years old.

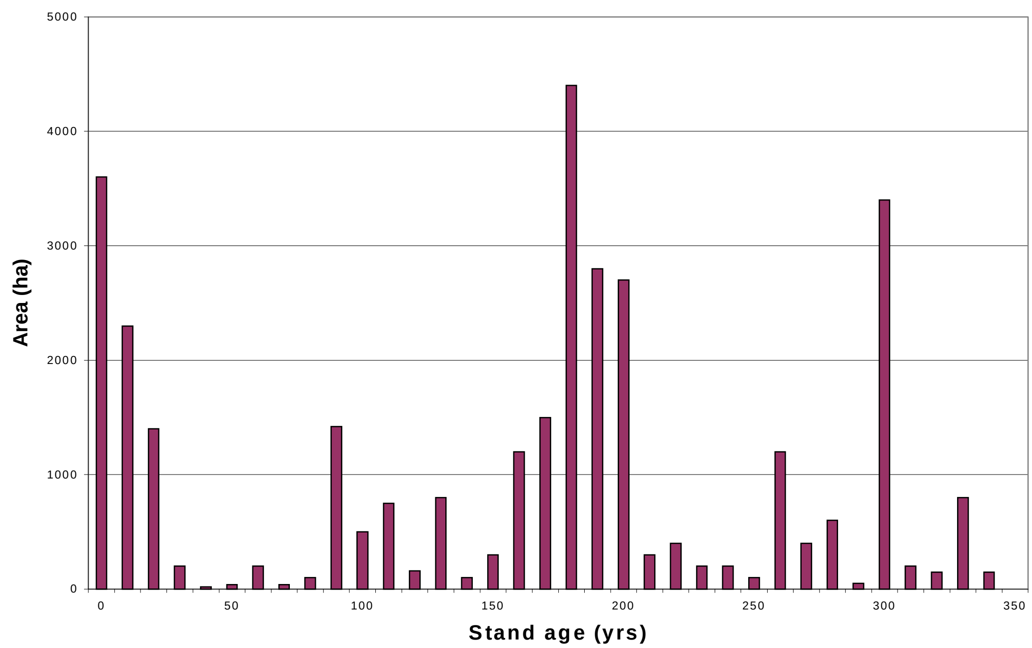

FIGURE 1. Age-class distribution on the timber harvesting land base, Cranberry TSA.

The rates of timber growth and yield on this area are estimated using the Table Interpolation Program for Stand Yields (TIPSY), with a site index of 14.0 and operational adjustment factors (OAF 1 and 2) of 15 and 15, respectively. Trowbridge et al. (1999) sampled 21 highly productive pine mushroom sites near the CTSA during an earlier phase of this integrated project. They found site index ranging from 10.3 to 15.5 m at 50 years breast height age in the sample plots, and standing volumes ranging from 317 to 475 m^3/ha. The *Cranberry TSA Timber Supply Analysis* (B.C. Ministry of Forests 1997) estimated present average harvested yields at 440 m^3/ha. Figure 2 illustrates the TIPSY yield curve used in this model.

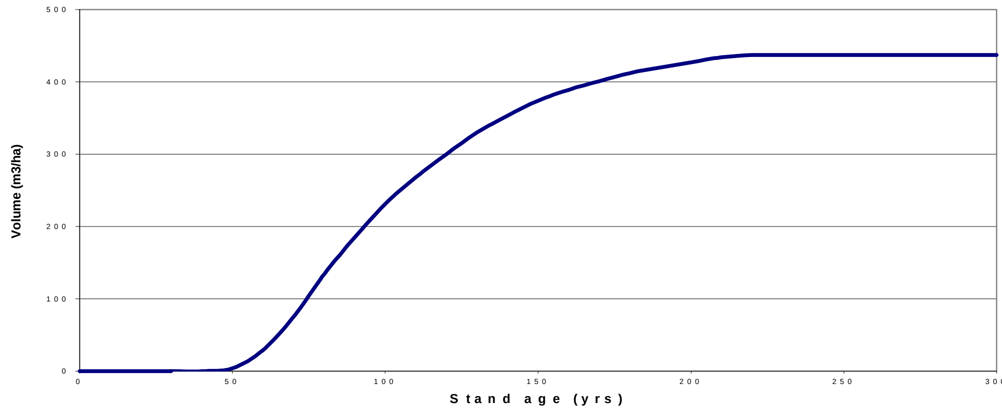

FIGURE 2. Stand volume development, Cranberry TSA.

The economic module of the TIPSY program was used to estimate timber values over time. Larger trees, produced later in stand development, have higher grade value. Assumptions input to TIPSY include default harvesting, hauling and milling costs for the Kispiox Forest District, and lumber values of $450 per thousand board feet (Madison's Online 1999). Figure 3 illustrates the economic value of standing timber over time.

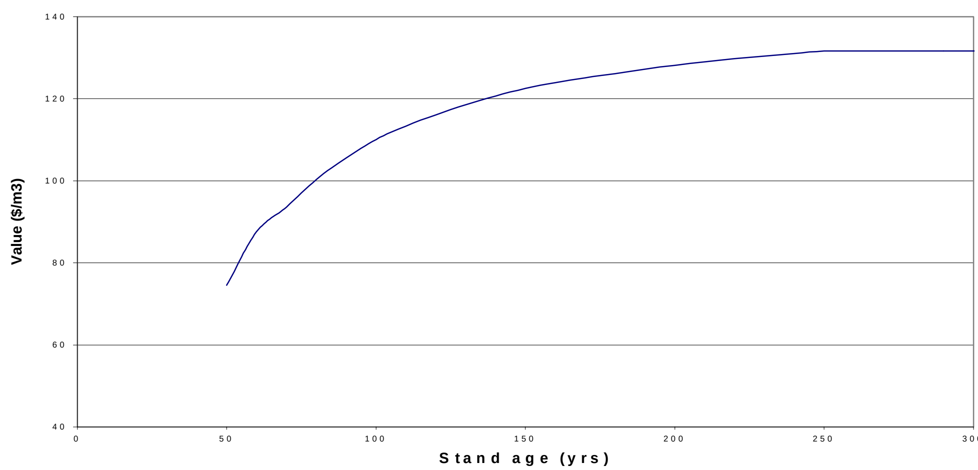

FIGURE 3. Standing timber values as potential economic activity through the complete manufacturing process.

Presently, the CTSA contains a total of 10.2 million m³ of merchantable standing timber, with a potential economic value (i.e., value that could be realized if all the timber was converted to lumber and sold at current market prices) of $1.3 billion.

Pine mushroom yields

Mushroom yields are modelled as a function of stand age. Trowbridge et al. (1999) found that among 21 sample plots visited in the fall of 1998, most producing stands were aged between 81 and 160 years old, although some stands were up to 240 years of age. The sites visited are all known to produce pine mushrooms in commercial quantities. Figure 4 is copied from Trowbridge et al.'s (1999) findings of frequency of highly productive pine mushroom sites across the range of observed age classes.

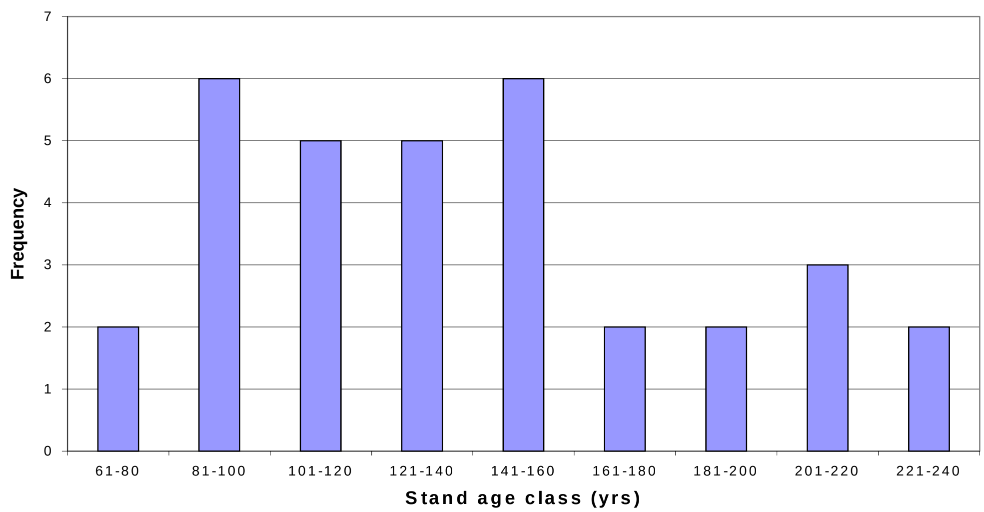

FIGURE 4. Frequency of sampled stands occurring in each age class (Trowbridge et al. 1999).

Stands that produce pine mushrooms in the CTSA are generally greater than 60 years old. After that age, production rises rapidly, and continues at a high rate until approximately 160 years of age, after which production declines. Comparing Figure 4 with Figure 1, one may conclude that production declines to a very low level by 200 years of age. Stands older than 160 years are well represented in the inventory, but occur infrequently in the samples. The information in Figure 4 was scaled to the existing age-class distribution (frequency of occurrence is divided by the existing area, by age class, and scaled so maximum yields are 100%) and smoothed to a continuous curve. Figure 5 illustrates the scaling and smoothing steps in developing a *relative* yield curve for pine mushrooms in the CTSA.

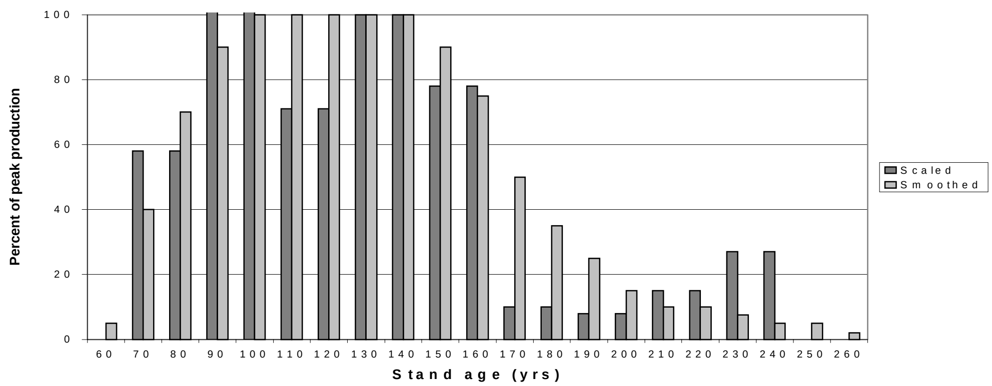

FIGURE 5. Frequency data (Trowbridge et al. 1999) scaled to the land base, and smoothed to a gentle curve

The smoothed shape in Figure 5 illustrates a first approximation of the shape of a pine mushroom yield curve for the CTSA. However, it does not indicate the magnitude of expected yields. Trowbridge et al. did not measure pine mushroom yields in their plots. Yields for this analysis are estimated using the following observations. Mushroom buying camps operate in the CTSA each year during September and October. The main camp is at Cranberry Junction, and two other buying camps are usually located north of Borden Mountain. Some of the crop delivered to Cranberry Junction originates outside the CTSA, particularly mushrooms picked farther north. In an average year 4000 pounds per day for 50 days (Tsunami Mushroom Co., pers. comm.) are brought to Cranberry Junction.

Judging by the map in Appendix 1, the forest area from which mushrooms are picked and delivered to Cranberry Junction is approximately twice the area of the CTSA. An estimate of annual production from the CTSA would therefore be half the total delivered product, or 100 000 pounds (45 000 kg). The THLB covers 55% of the forested area so an unbiased estimate would be that 25 000 kg/yr of pine mushrooms are harvested from the timber harvesting land base.

Figure 5 illustrated productive forest ages. Cross-multiplying the present age class distribution (Figure 1) by the relative production (Figure 5), and solving for a total yield of 25 000 kg, indicates that natural yields through the peak productivity age range presently average 3.5 kg/(ha·yr). This yield figure assumes that pine mushrooms are produced in all forest stands. An alternative assumption, that the mushrooms come from concentrated patches, would indicate yields of 25 kg/(ha·yr), and is tested later in the report. The derived “average” yield curve for pine mushrooms in the CTSA is illustrated in Figure 6.

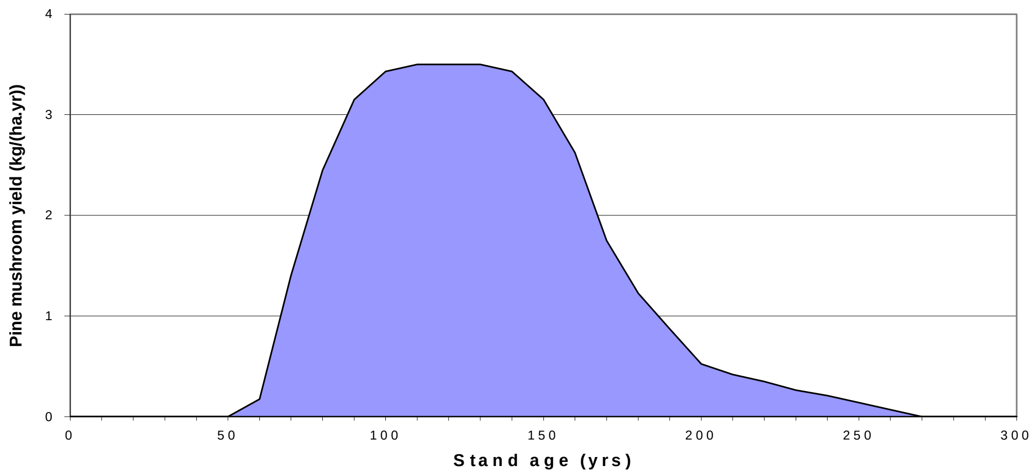

FIGURE 6. Estimated average yield curve for pine mushrooms in the Cranberry TSA.

For this analysis, pine mushrooms are assumed to have an average field price of $15/lb, or $38/kg. Prices in the 1998 picking season ranged from $5/lb to $75/lb, and were between $12 and $20/lb for most of the season. When prices fell below $10/lb, pickers were leaving the area, and prices rose to ensure a labour supply. The total revenue for pine mushroom pickers from the CTSA is estimated to be $950 000/yr.

Results

The 1997 TSR analysis of the CTSA found that a timber harvest rate of 110 000 m^3/yr would be sustainable for 9 decades, declining afterwards to a long-term sustainable harvest level of 87 000 m^3/yr. Harvesting at those rates produces a forest evenly distributed across age classes from 0 to 120 years, with a small amount of area in older age classes due to reduced harvest rates in visually sensitive areas. The 45% of the forest outside the THLB was assumed in the TSR analysis to age indefinitely, and meet biodiversity requirements. Based on that analysis, and other considerations, the present allowable annual cut in the CTSA is 110 000 m^3/yr.

Alternative harvest rates

This analysis varies the rate of timber harvesting, and reports expected pine mushroom yields over the next 200 years. Minimum harvest ages are set at 120 years, and an oldest-first harvest priority rule is used. A key assumption is that stands regenerating after timber harvest will experience a rate of colonization by the pine mushroom fungus equal to the colonization rate in existing natural-origin stands.

Figure 7 illustrates expected pine mushroom production from the CTSA under these assumptions, and even-flow harvest projections. To achieve the target harvest levels over the 200-year horizon, minimum harvest ages must be reduced to 110 years for a harvest level of 100 000 m³/yr, and to 60 years for a harvest level of 105 000 m³/yr.

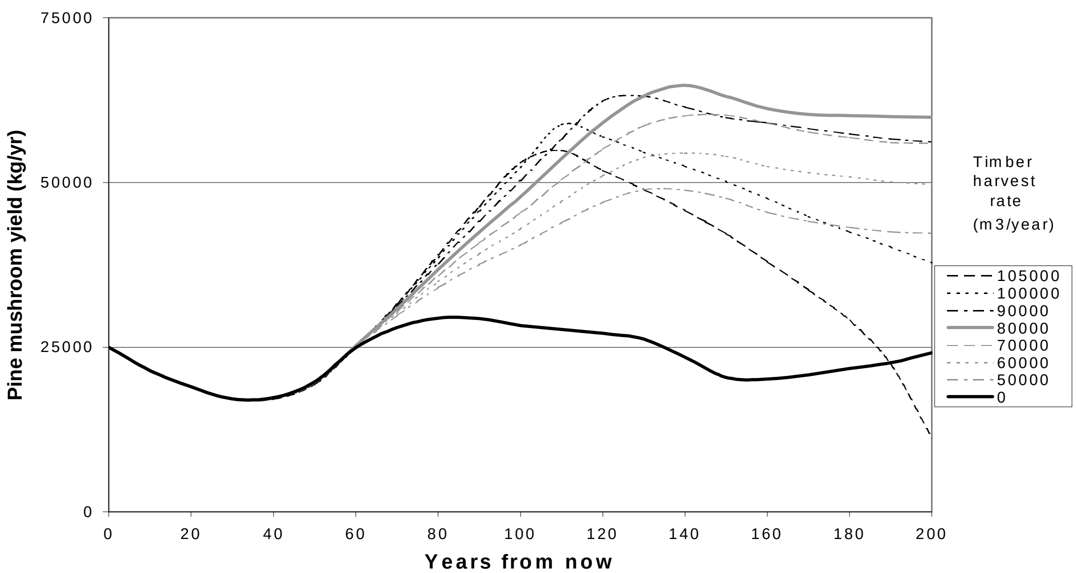

FIGURE 7. Long-term pine mushroom yields with alternative rates of timber harvesting.

Timber harvesting modifies the age-class structure in a forest by replacing old stands with regenerating stands. The rate of harvest controls the rate of regeneration, and the maximum age to which stands are permitted to grow. In the long term, at a harvest rate of 80 000 m³/yr in the CTSA, stands are harvested when they reach approximately 165 years old. This permits the stands to mature through the age range when pine mushrooms are produced, and results in the highest long-term levels of pine mushroom productivity. In a 500-year projection at a timber harvest rate of 80 000 m³/yr, pine mushroom production in the CTSA remains between 60 000 and 62 000 kg/yr.

At harvest rates higher than 80 000 m³/yr, forest rotations are shortened and stands are harvested while still producing mushrooms. At lower harvest rates, less area is being regenerated annually, and therefore less area grows through the pine mushroom productivity phase. The lowest long-term pine mushroom productivity occurs at a timber harvest rate of zero.

Long-term economic values

The economic yield from the forest in this two-product model would be the sum of timber and mushroom values. Figure 8 illustrates the long-term (year 200) combined values that would be achieved from the CTSA under the rates of harvest described in the preceding section. Timber value is expressed as the total value of potential lumber yield, and includes stumpage, and economic activity from logging and manufacturing. Mushroom value is the field price paid to the pickers. A more complete estimate would value mushrooms at market prices, once data are available for the valued-added activities of sorting and grading, transportation, and merchandising.

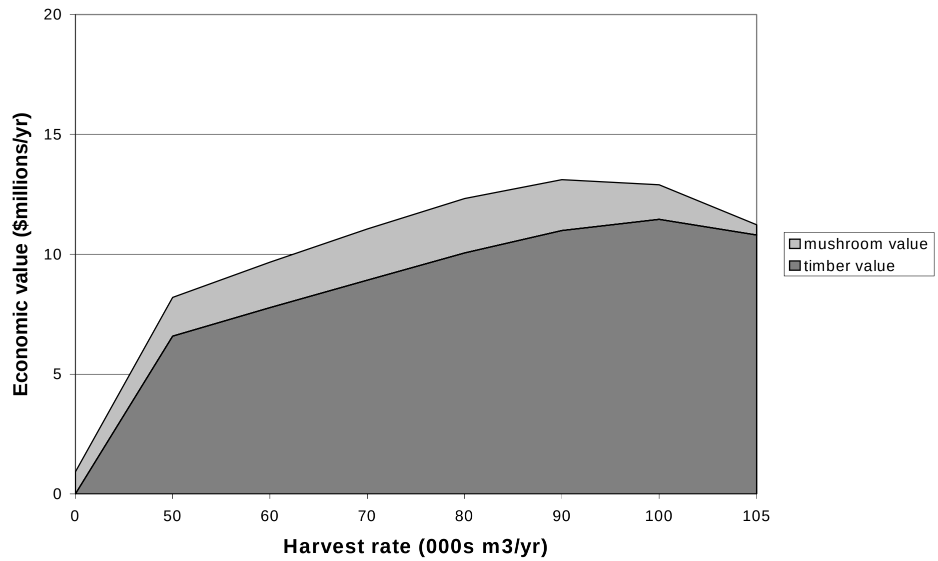

FIGURE 8. Economic yields at year 200 with alternative rates of timber harvesting.

Figure 8 suggests that total forest economic yield would be maximized at a harvest rate of 90 000 m^3/yr. In the long term, at this harvest rate, total annual economic yields would be $10.98 million for timber, and $2.13 million for mushrooms. Rotation ages at this harvest rate are approximately 145 years. Higher rates of harvest reduce value in two ways—by reducing mushroom yields, and by reducing the age at which stands are harvested. Values per cubic metre are less at younger ages (refer to Figure 3).

Note that in Figure 8, both timber and mushroom economic yields rise across the range of harvest levels from 50 000 to 90 000 m^3/yr. Conflicts (higher timber harvest, lower mushroom harvest, and a net loss) only arise at the high-end margin, when timber harvesting is pushing the limits of biological productivity on the land base.

Short-term harvest profile

The pine mushroom yield forecasts illustrated in Figure 7 for the first 50 years are identical at all harvest levels. This is due to the oldest-first harvest priority rule in the model. Considerable area in the CTSA is presently greater than 175 years old. All rates of harvest are satisfied from this older forest, which does not produce significant quantities of pine mushrooms. Therefore, in the first 50 years, harvesting does not negatively impact mushroom yields in the model. The downward slope of the mushroom yield curve over the first 30 years is due to stands that presently produce mushrooms maturing to ages with lower levels of mushroom productivity. If the oldest-first harvest priority rule were an accurate representation of current harvest practices, no conflict would occur between loggers and mushroom pickers.

However, older hemlock stands in the CTSA characteristically have high incidence of conk, and heart and butt rots. Many of the older stands are unsuitable for lumber manufacturing, and are harvested primarily for pulp fibre, if at all. The present age-class distribution in the CTSA (Figure 1) suggests that harvesting has concentrated in younger mature stands. Currently mature stands originated mainly from natural disturbance events and smaller area representation would be expected in older stands, due to the increased likelihood of natural disturbance having occurred sometime during the stand development. Instead, representation is relatively low between 100–170 years.

Present harvest priorities may focus on stands most suited to wood manufacturing. Figure 9 illustrates expected short-term pine mushroom yields in the CTSA if harvest priority is placed on stands aged between 120 and 175 years old. The harvest rate is 80 000 m³/yr, and a minimum harvest age of 120 years is maintained for both scenarios.

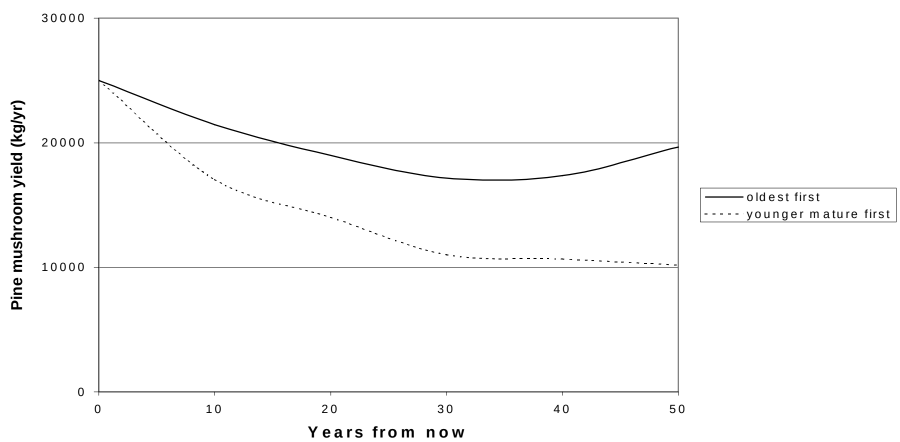

FIGURE 9. Short-term pine mushroom yields with alternative harvest profile assumptions

It is difficult to assess the economic tradeoffs implicit in Figure 9, since the timber valuation curve (Figure 3) does not recognize the deteriorating quality of very old forest in the CTSA. However, it may be assumed that 50 years from now those older stands will be more decadent than at present, and will not be producing pine mushrooms.

Preferred habitat versus extensive coverage

This analysis modelled mushroom productivity from suitable age classes across the entire forested land base. In fact, mushroom occurrence is concentrated in certain areas. Trowbridge et al. (1999) found that where pine mushrooms are found, sites are consistently nutrient poor and drier than typical (zonal) sites. The best habitat is found on the 3B site series, which features coarse-textured, well-drained soils. Within this habitat, pine mushroom occurrence is patchy because of the 50-odd other mycorrhizal species competing for space on the tree root systems. Earlier work by the author (Olivotto Timber 1998) suggested that 15% of natural-origin forest in suitable age classes is colonized by the pine mushroom fungus.

This assumption provides tremendous potential to enhance economic yields from the forest. A majority (85%) of the forest area might be managed to optimize timber production, without consideration of the longer rotation ages needed to enhance pine mushroom production. Rather than the 10% timber harvest rate reduction suggested in Figure 8 (from 100 000 m^3/yr to 90 000 m^3/yr, maximizing timber versus maximizing the combination), timber supply reductions of 1.5% would be adequate to ensure a viable pine mushroom industry.

Pine mushroom occurrence in patches will also influence calculations of the area requiring special management. Rather than 3.5 kg/(ha·yr) across the landscape, mushrooms are produced at a rate of 25 kg/(ha·yr) in the patches, and not at all in other areas. Rather than 8000 ha of producing area, the 32 832 ha timber harvesting land base in the CTSA currently has some 1200 ha of productive pine mushroom patches.

Within the patches, mushroom values (picker revenues) are $950/(ha·yr). Timber management on a 120-year rotation would produce a total economic value of $45 000/ha at the first entry, and $35 000/ha at subsequent entries, or $290–375/(ha·yr). Measured on a sustained yield basis, mushroom values within the patches are triple the value of timber harvesting. However, timber harvesting would still occur, though at a later age.

Further Information Requirements

This project assembled the most basic information required for forest estate modelling of integrated timber and mushroom yield impacts. The discussion highlighted where assumptions were made—readers may have different assumptions. Certain aspects of the model would benefit from more rigorous data inputs. The following steps would improve the analysis of timber/mushroom management:

1. Work to predict site series from other mapped inventory attributes is progressing. Site series 3B is highly correlated with known pine mushroom patches. Predictive maps of pine mushroom patches would enable refinement of the 15% productive area estimate in the report.
2. Better information could be collected about actual pine mushroom volumes and grades harvested from within a catchment area, to refine both the estimates of 3.5 kg/(ha·yr) or 25 kg/(ha·yr), and the estimate of 25 000 kg/yr.
3. Trowbridge et al. (1999) recorded frequency of plots by age class. More stand age/mushroom productivity data would refine the estimated shape of the pine mushroom yield curve. Work might also characterize yields as a function of tree species and growing site quality.
4. This analysis assumed that harvested stands would produce pine mushrooms at a rate comparable with present natural stands. Researchers have noted that most producing stands indicate fire origin, or volcanic ash deposits. A site may need rough disturbance, and exposure of mineral soil, as a precursor to eventual mushroom productivity. Better understanding of pine mushroom establishment could facilitate increases in production well above current natural levels.
5. This report did not discuss the ancillary benefits of longer forest rotations, including meeting wildlife habitat objectives. A future mushroom and timber supply analysis would incorporate a more detailed breakdown of the forest inventory to use knowledge from points 1 and 3 above, and include the benefits of maintaining increased forest cover.
6. This analysis only considered clearcut harvesting. Preliminary results from partial harvesting trials in British Columbia suggest that considerable timber volume may be removed from a forest with minimal negative impact on mushroom production.
7. Better information should be available about the quality and value of timber in old stands, and the present timber age profile being harvested.
8. This project compared values using total economic return for timber, but only picker revenue for pine mushrooms. A more fair comparison would include the sorting, grading, repackaging, shipping and merchandising economic activity that the mushroom harvest creates.
9. This analysis stopped short of providing an estimate of the “fungage” rate that the government would charge to replace stumpage values potentially foregone by managing forests for both timber and mushrooms. Using the assumptions in the analysis, the fungage rate would be $2/kg, but a subsequent analysis with more refined input data would be needed to accurately develop this value.
10. Accessibility is steadily increasing as remote forest areas are developed. This easier access may increase apparent harvested mushroom volumes over time, until the entire land base is roaded.
11. Other species of wild mushrooms are of increasing commercial value. The economic models used in this project could be adjusted to include yields and returns of species other than the pine mushroom.

References

B.C. Ministry of Forests. 1997. Cranberry TSA timber supply analysis. Victoria, B.C.

Gamiet, S., H. Redenour, and F. Philpot. 1998. An overview of pine mushrooms in the Skeena-Bulkley Region, Northwest Institute for Bioregional Research, Smithers B.C.

Madison's Online. 1999. Madison's Canadian Lumber Reporter, www.madisonsreport.com. [February 1999]

Olivotto Timber. 1998. Timber harvesting plan for the Blackwater pine mushroom management area. B.C. Ministry of Forests, Small Business Program, Squamish, B.C.

Trowbridge, R., A. Macadam, and M. Kranabetter. 1999. Ecological description and classification of highly productive pine mushroom sites in northwestern British Columbia, Northwest Institute for Bioregional Research, Smithers, B.C.

Wills, R. 1998. An economic/technology strategy to develop non-timber forest products and services in British Columbia. Bowen Island, B.C. in progress.

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