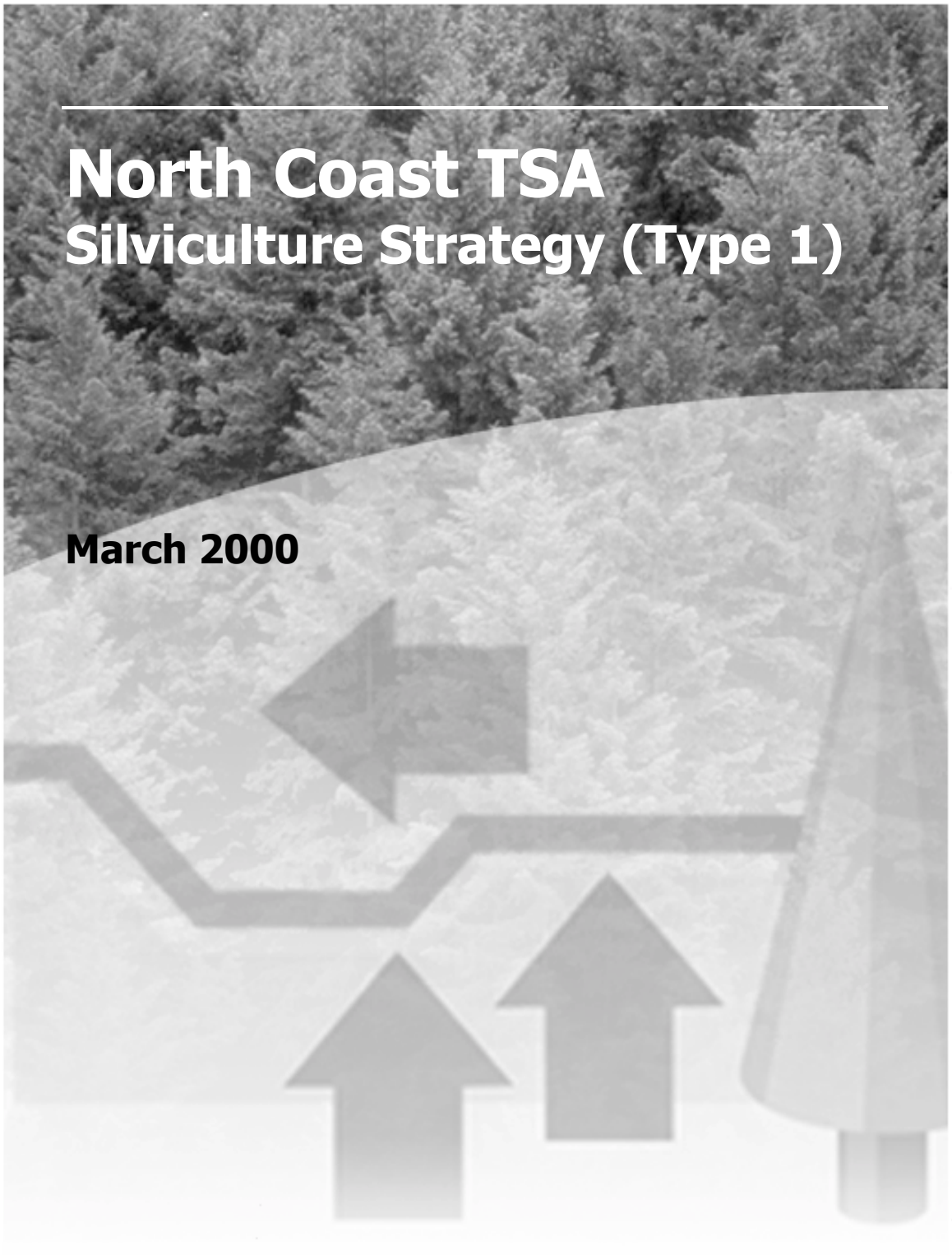
North Coast TSA
Silviculture Strategy (Type 1)

March 2000



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North Coast TSA Silviculture Strategy (Type 1)

Acknowledgements

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Preface

The development of silviculture strategies for TSAs and TFLs is motivated by the desire to clarify the relationship between investments in silviculture and the critical forest-level issues specific to the management unit.

The Type 1 analysis is workshop-based. It draws on the expert knowledge of the participants to identify the critical issues, derive objectives with respect to those issues, specify regimes to meet those issues, and identify the regime activities that can be implemented in the next five years. After consideration of the benefits and costs of each of the activities on each of the forest-level objectives, the participants rank the silviculture activities by priority. The result is a prioritized list of silviculture activities that are explicitly linked to the critical issues of the management unit.

Type 2 analyses are model-based, but the analysis process is fundamentally identical to the Type 1 analysis. A forest-level model is used to evaluate the impacts of regimes on the forest-level objectives, to identify the silviculture activities constituting the "preferred management scenario", and to rank those activities.

The Type 2 (model-based) analysis will result in a silviculture strategy that is considerably more appropriate and robust than the Type 1 approach, but it is more expensive and demanding of scarce modeling expertise. Hence the Type 1 (workshop-based) approach has been designed to produce an interim silviculture strategy that will serve until a Type 2 analysis can be completed.

In the absence of a silviculture strategy for a management unit, the Ministry of Forests' provincial level strategy *Incremental Silviculture Strategy For British Columbia (Interim)* has provided interim guidance. A summary of this document is included as an appendix to this report.

Strategy Summary

Issues Addressed by the Strategy

While many issues were proposed and discussed in the workshop, the participants developed a silviculture strategy that addressed three key issues: protecting seedlings and young trees from damage by porcupine and deer; delaying the falldown projected for decade 3, and investigating items causing uncertainty about site productivity and the size of the timber harvesting land base (THLB).

Elements of the Strategy

Thinning to reduce minimum harvest age

TSR sensitivity analyses indicated strongly that treatments aimed at increasing average piece size (i.e. PCT) would delay initiation of the step-down to LTHL. A program of 200 ha/yr was suggested by the workshop, concentrating in areas with a low hazard for porcupine damage. Recommended target densities were 700 to 1400 trees/ha.

Increasing growth of regenerated stands

Accelerating the growth of regenerated stands both reduces the time to achieve minimum harvest age, and increases the volumes available for harvest in those stands. Proposed treatment regimes included:

- time-of-planting fertilization, which has the potential to shorten time to free growing by 1-3 years. Approximately 800 ha/yr could be treated in this manner. Trials of this technique have been included in the accompanying "To-Do" list.
- pre-commercial thinning and repeated fertilizer treatments (every 15 years). Approximately 500 ha/yr could be treated in this manner. Fertilization trials to help provide this information have been included in the "To-Do" list.

Protecting young stands from porcupine damage

Porcupine affect young stands by feeding on the bark, often girdling trees. Some proposed strategies to deal with porcupine damage include:

- Altering species composition to create mixed stands by planting stands with 20-30% components of species that are less attractive to the porcupine (i.e. western redcedar, cypress and balsam; retain some alder).
- Create dispersed patterns of small cutblocks (porcupine populations are believed to be positively affected by opening size; larger disturbed areas are believed to stimulate population growth).
- Increase post-thin densities by leaving extra trees after thinning.
- Thin stands later to reduce the susceptibility of stands to porcupine damage.
- Reduce den habitat (see also "To-Do" list) with various practices, including burning or re-distributing slash piles, and avoiding creation of slash piles.
- Direct population control.

Protecting young stands from deer browsing

Maintaining the desired composition of cedar on the landbase after harvesting is dramatically affected by deer browsing on young seedlings. The following strategies have been proposed to help maintain a cedar component on the landscape in the presence of deer:

- Use seedling protection such as mesh tubes and cones; utilize existing obstacles (slash/stumps) to inhibit access to individual trees.
- Alter species composition/distribution by concentrating planting of cedar in distinct areas to reduce costs of applying and maintaining sheltering structures; target areas where other species such as hemlock do poorly.
- Create dispersed patterns of small cutblocks (deer populations are believed to be positively affected by opening size; within limits, larger disturbed areas are believed to stimulate population growth).
- Direct population control by increasing bag limit for hunters.

Tactical Priorities

The tactical priorities set by the participants represent a balance between the participant's strategic objectives for the management unit and the silvicultural opportunities available on the TSA in the next 5 years. Table S-1 lists activities identified by the participants and the rank (priority) assigned to each activity.

Table S-1. Silviculture activities and areas selected by the workshop participants

Activities	Target	Opportunity Area	Rank
Porcupine damage prevention			
Plant species mixtures with species that are less attractive to porcupine	All harvested stands in areas in Baker Inlet and north (less problem in outer coastal areas)	500 ha/yr	1
Burn slash piles, or distribute slash piles throughout block	Regenerating stands in porcupine-susceptible part of district	400 ha/yr	nr[1]
Change yarding practices to avoid creating large slash piles	Areas being logged in porcupine-susceptible part of district	(part of above)	nr
Post bounty for killing porcupines	Existing regenerated and backlog areas in porcupine-susceptible part of district	(part of above)	nr
Deer browse damage prevention			
Concentrate cedar planting where most needed to reduce protection costs	80% of blocks, 30% of block area	200 ha/yr	2
Use tubes or netting	80% of blocks, 30% of block area		3
Obstacle protection, e.g., slash	80% of blocks, 30% of block area		3
Increase bag limit for deer hunters	everywhere in TSA ?		nr
Spacing and thinning			
Space to 700 - 1400 sph	High site index 2nd growth stands, 15-25 yr old with easy access, in areas not prone to porcupine damage	200 ha/yr	nr
Commercial thinning			nr
Fertilization			
Fertilize with tea bags at planting	All sites	800 ha/yr	nr
Fertilize at planting; space to 1200 sph; fertilize again every 15 yr	Medium and good sites	500 ha/yr	nr

[1]not ranked

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1. Issues and Strategies

The strategies developed in the North Coast TSA workshop addressed two key issues: mitigating the falldown projected to begin in decade 3, and protecting young trees from damage by porcupine and deer.

One of the challenges of developing the strategy for the North Coast TSA was the workshop participants' concern that the timber supply forecast was sensitive to a number of factors about which information was uncertain or incomplete. The main factors of concern were estimates of site productivity, and the size of the timber harvesting land base (because of coarse mapping of visually sensitive areas, economic operability, and area reductions for riparian areas). In consideration of this uncertainty, workshop participants were reluctant to rank activities, and did not rank the entire list. In addition, the ranking of the To-Do list somewhat contradicts the activity ranking. For example, activities related to the porcupine and deer damage issues were ranked highest, but there was only one item related to them on the To-Do list, and it was ranked near the bottom of the list.

1.1 Strategies to mitigate the falldown projected to begin in decade 3

Strategies to address the projected falldown (TSR II base case) focus either on increasing growth rates of regenerated stands, or achieving a minimum harvestable average piece size at an earlier age. TSR sensitivity analysis indicates that both of these strategies can have a significant impact on the timber supply forecast. Note that uncertainty over issues around site productivity may overshadow these strategies, as the projected falldown may be an artifact of having poor site index information. A thorough analysis of actual site indices and their impact on the timber supply picture is required before an extensive program of intensive silviculture activities is carried out.

1.1.1 Thinning to reduce minimum harvest age

Without treatment, most regenerated stands are projected to take a very long time to reach what is considered a minimally operable average piece size, and this contributes dramatically to the onset timing of the falldown. TSR sensitivity analyses indicated strongly that treatments aimed at increasing the average piece size (i.e. PCT) would dramatically lengthen the time before initiation of the step-down to LTHL.

A feasible program of 200 ha/yr was suggested by the workshop, concentrating in areas with a low hazard for porcupine damage. Recommended target densities were in the range of 700 to 1400 trees/ha, although at the low end of this range there may be sacrifices in volume (depending on species and site quality). Secondary benefits of this program may be the increase in future opportunities for commercial thinning, particularly in areas with good access and low operating costs.

1.1.2 Increasing growth of regenerated stands

Accelerating the growth of regenerated stands both reduces the time to achieve minimum harvest age, and increases the volumes available for harvest in those stands. Proposed treatment regimes included:

- time-of-planting fertilizer, which has the potential to shorten time to free growing by 1-3 years. Approximately 800 ha/yr could be treated in this manner. It is important to note that there is a great amount of uncertainty around the application of this treatment, and trials of this technique have been included in the accompanying "To-Do" list. It should also be noted that early fertilizer treatments typically work best when applied in conjunction with control of non-crop vegetation.
- pre-commercial thinning and repeated fertilizer treatments (every 15 years). Approximately 500 ha/yr could be treated in this manner. Note that the PCT treatments alone would accelerate development of a minimally operable crop, and that the fertilizer treatments would mainly increase volumes. Each fertilizer application could be expected to increase stand volumes by 15-20 m3/ha, assuming that sufficient knowledge exists to select the most suitable stands. Fertilization trials to help provide this information have been included in the "To-Do" list.

1.2 Strategies to protect forest health

Forest health concerns focused mainly on two mammalian pests: porcupine and deer. Both animals threaten stocking on young plantation, although at different stages and focusing on different species. The following strategies have no timber supply impacts per se; they are merely helping to maintain previously assumed productivity.

1.2.1 Strategies to protect young stands from porcupines

Porcupine affect young stands by feeding on the bark, often girdling trees. They frequently feed in concentrated areas, leaving unstocked gaps in stands. Porcupine populations are believed to increase in areas with heavier logging histories, possibly due to habitat enhancement. Porcupine are more of a problem on the inner coast than the outer coast. Some proposed strategies to deal with porcupine damage include:

Alter species composition – create mixed stands

Plant stands with 20-30% components of species that are less attractive to the porcupine (i.e. western redcedar, cypress and balsam; retain some alder)

Create dispersed patterns of small cutblocks

Porcupine populations are believed to be positively affected by opening size; larger disturbed areas are believed to stimulate population growth.

Increase post-thin densities

Leaving extra trees after thinning will help overcome mortality losses, as long as porcupine activity is dispersed throughout the stand. Where mortality occurs in concentrated clumps, extra trees will not help to avoid unstocked gaps.

Treatment timing (PCT)

Thin stands later than would otherwise be considered to reduce the susceptibility of stands to porcupine damage. Drawbacks to this strategy include increased treatment cost and a delay to the thinning-related acceleration of diameter growth for crop trees.

Reduce den habitat (see also "To-Do" list)

At least part of the reason for population growth associated with logging is believed to be tied to the use of slash piles for dens. Various practices might be employed to reduce such habitat creation. These include burning or re-distributing slash piles, or avoiding creation of slash piles by not yarding cull logs or yarding culls back out onto the block. Any re-distribution of slash away from that seen with current practices may, however, have detrimental impacts on plantable spots.

Direct population control

It was suggested that a bounty system may prove beneficial as a population control method.

1.2.2 Strategies to protect young stands from deer

Maintaining the desired composition of cedar on the landbase after harvesting is dramatically affected by browsing by deer on young seedlings. To a lesser degree, cypress is also browsed. On poorer sites where hemlock is not very productive, the inability to plant cedar may result in an inability to produce a merchantable crop in the future. Cedar is also valuable for wildlife habitat and has significant importance to First Nations cultures. The following strategies have been proposed to help maintain a cedar component on the landscape in the presence of deer:

Use seedling protection

Seedling protectors such as mesh tubes and cones may provide effective protection from deer browse, but are expensive to install and maintain. Less effective but cheaper is to utilize existing obstacles (slash/stumps) to inhibit access to individual trees.

Alter species composition/distribution

Concentrate planting of cedar in distinct areas to reduce costs of applying and maintaining sheltering structures; target areas where other species such as hemlock do poorly.

Create dispersed patterns of small cutblocks

Deer populations are believed to be positively affected b opening size; within limits, larger disturbed areas are believed to stimulate population growth.

Direct population control

Increase bag limit for hunters.

2. Silviculture Impacts and Priorities

The following worksheet, defining the elements of the interim strategy, was produced in the workshop in the North Coast Forest District offices.

Table 1. Workshop issues, objectives, strategies, activities, targets, and impacts, North Coast TSA

							Opportunity	Jobs	Cost	
	Issues	Objectives		Strategies	Target	Activities	Area (Ha/Yr)	Days/ha	$/ha	Rank
1	**Deferred harvesting in scenic areas:**									
1a	Viewsheds not accurately defined	Improve mapping and VQ classification of viewsheds		"to do list"						
1b	Heli-logging drop zone sensitivity	Map sensitivity for heli-log drop zones and log dumps (any ocean development facilities)		"to do list"						
2	Forest health—porcupine damage in reforested areas (hemlock, spruce)	Avoid or reduce damage	s1	Alter species composition, create mixed stands	All harvested stands in areas in Baker Inlet and north (outer coastal areas tend to be free of problems)	Plant species-mixtures with 20% to 30% less attractive species, e.g., cedar, cypress, balsam, retain some alder	500 ha/yr		10/ha	1
			s2	Reduce cutblock size and distribution; some retention of older trees					large	
			s4	Population control	Post-logging stands in porcupine-susceptible part of district	Reduce denning habitat (slash piles) by burning or distributing througout block	400 ha/yr		$150 to $200 per ha	
					Areas being logged	Change yarding practices to avoid large piles, leaving culls in the block rather than yarding to landing, yarding culls back to block	(part of above)			
					Existing regenerated stands and backlog in porcupine-susceptible part of district	Eradication through bounty	(part of above)			
			s5	Alter prescriptions to consider forest health implications when considering treatments	Stands being spaced	Leave higher target stocking level; apply spacing treatments at older age to determine whether porcupines are a problem	200 ha/yr spaced in District		costs +30% because stems are bigger	
3	Forest health—deer browse damage to cedar in reforested areas	Avoid or reduce damage	s6	Alter species composition	About 80% of blocks, 30% of area of block	Concentrate cedar where other spp do poorly to reduce protection costs	200 ha/yr		0	2
			s7	Reduce cutblock size and distribution						
			s8	Protect trees	as with s6	Tubes, netting			$5/tree	3
					as with s6	Obstacle protection e.g. slash			$0.40 /tree	3
			s9	Population control		Increase bag limit for hunters			0	
4	Timber quality in northern part of THLB	Convert old-growth stands in north to make them more productive	s10	Provide economic incentive to harvest and convert stands						
5	Development costs are very high	- more flexibility and cooperation in development planning - encouragement for innovation								
6	basic silviculture costs very high	Reduce costs								
	incremental silviculture costs are very high	Reduce costs								
7	Riparian area management	Improve understanding of impact of riparian areas on THLB		move to "to do" list						
8	Falldown beginning decade 3	Delay falldown	s11	Reduce MHA						
					2nd growth, 15-25 yr, best sites, easiest access	Spacing to 700 - 1400 sph in non-porcupine areas	200 ha/yr		$1900/ha	
						Commercial thinning				
				Reach FG sooner	All sites	Fertilize with tea bags at planting	800 ha/yr		$120/ha	
					Medium and good sites	Space, fertilize at planting, and every 15 yr	500 ha/yr		2550	
			s12	Increase volumes of 2nd growth stands		Space to 1200 sph, fertilize at planting and every 15 yr	500 ha/yr		2550	
			s13	Improve estimates of site index		"To Do" List -- OGSI studies				

Table 2. Summary of silvicultural activities, North Coast TSA

Strategies	Activities	Target	Opportunity Area	Rank
Reduce Porcupine Damage				
Manage species composition of regenerating stands to reduce vulnerability to porcupine damage	Plant species mixtures with species that are less attractive to porcupine	All harvested stands in areas in Baker Inlet and north (outer coastal areas tend to be free of problems)	500 ha/yr	1
Control porcupine population by reducing amount of denning habitat	Burn slash piles, or distribute slash piles throughout block	Regenerating stands in porcupine-susceptible part of district	400 ha/yr	nr[1]
	Change yarding practices to avoid creating large slash piles	Areas being logged in porcupine-susceptible part of district	(part of above)	nr
Control porcupine population by eradication	Post bounty for killing porcupines	Existing regenerated and backlog areas in porcupine-susceptible part of district	(part of above)	nr
Reduce Deer Damage				
Manage species composition to avoid or reduce deer-browsing damage to cedar seedlings	Concentrate cedar planting where most needed to reduce protection costs	80% of blocks, 30% of block area	200 ha/yr	2
Protect seedlings to reduce deer-browsing damage to cedar seedlings	Use tubes or netting	80% of blocks, 30% of block area		3
	Obstacle protection, e.g., slash	80% of blocks, 30% of block area		3
Control deer population by eradication	Increase bag limit for deer hunters	everywhere in TSA ?		nr
Delay Falldown				
Delay falldown by reducing minimum harvestable age	Space to 700 - 1400 sph	High site index 2nd growth stands, 15-25 yr old with easy access, in areas not prone to porcupine damage	200 ha/yr	nr
	Commercial thinning			nr
Delay falldown by reaching FG earlier and increasing volumes of regenerating stands	Fertilize with tea bags at planting	All sites	800 ha/yr	nr
	Fertilize at planting; space to 1200 sph; fertilize again every 15 yr	Medium and good sites	500 ha/yr	nr

[1] not ranked

3. Silviculture Program

3.1 Tactical Priorities

Tactical priorities for North Coast TSA were defined in the workshop by having participants ranking strategies and activities for implementation in the next five years. Priorities were assigned through discussion and consensus among the participants, and produced a clear sense of the most important activities from the participants' perspectives. In North Coast TSA, workshop participants felt that the most important tasks are to protect seedlings and young trees from damage by porcupine and deer. However, workshop participants were reluctant to rank activities because of uncertainties about, and the sensitivity of the forecast to, changes in expected yields for regenerated stands, and in the size of the timber harvesting land base.

3.2 Program Costs and Benefits

The costs and benefits of the program developed in the workshop are summarized in Tables 3-6 (below). Table 3 shows the assumed unit costs and employment associated with each activity. Employment multipliers were estimated by the consultant and should be verified by the District. Tables 4-6 show the area treated, expenditures, and employment respectively by program year.

Table 3. Unit cost ($/ha) and employment (person-days/ha) assumptions

	Porcupine Damage Prevention		Deer Browse Damage Prevention				Fertilization	
	Plant species less attractive to porcupines	Burn or distribute slash piles [1]	Plant cedar	Use of tubes or netting [2]	Obstacle protection [3]	Space to 700-1400 sph	"Tea bags" at planting	Fertilize and space[4]
$/ha average	10	175	0	6000	480	1900	120	2550
PDs/ha[5]	0	0.1	0	1	1	3	0.1	3

[1] Changing yarding practices contributes to the area for this activity

[2] Assuming planting at 1200 sph and $5/tree

[3] Assuming planting at 1200 sph and $0.40/tree

[4] fertilize at planting, space, repeat fertilization every 15 years

[5] employment multipliers were estimated by the consultant

Table 4. Area (ha) treated by activity and year

	Porcupine Damage Prevention		Deer Browse Damage Prevention				Fertilization		
Year	Plant species less attractive to porcupines	Burn or distribute slash piles	Plant cedar	Use of tubes or netting	Obstacle protection	Space to 700-1400 sph	"Tea bags" at planting	Fertilize and space	Total
1	500	400	200	200	200	200	200	500	2,400
2	500	400	200	200	200	200	200	500	2,400
3	500	400	200	200	200	200	200	500	2,400
4	500	400	200	200	200	200	200	500	2,400
5	500	400	200	200	200	200	200	500	2,400
Subtotal Yr 1-5	2,500	2,000	1,000	1,000	1,000	1,000	1,000	2,500	12,000
6 - 10	2,500	2,000	1,000	1,000	1,000	1,000	1,000	2,500	12,000
Total Yr 1-10	5,000	4,000	2,000	2,000	2,000	2,000	2,000	5,000	24,000

Table 5. Expenditure ($ x 1000) by activity and year

	Porcupine Damage Prevention		Deer Browse Damage Prevention				Fertilization		
Year	Plant species less attractive to porcupines	Burn or distribute slash piles	Plant cedar	Use of tubes or netting	Obstacle protection	Space to 700-1400 sph	"Tea bags" at planting	Fertilize and space	Total
1	5	70	0	1,200	96	380	24	1,275	3,050
2	5	70	0	1,200	96	380	24	1,275	3,050
3	5	70	0	1,200	96	380	24	1,275	3,050
4	5	70	0	1,200	96	380	24	1,275	3,050
5	5	70	0	1,200	96	380	24	1,275	3,050
Subtotal Yr 1-5	25	350	0	6,000	480	1,900	120	6,375	15,250
6 - 10	25	350	0	6,000	480	1,900	120	6,375	15,250
Total Yr 1-10	50	700	0	12,000	960	3,800	240	12,750	30,500

Table 6. Short term employment benefits (person-years[6]), by activity and year

	Porcupine Damage Prevention		Deer Browse Damage Prevention				Fertilization		
Year	Plant species less attractive to porcupines	Burn or distribute slash piles	Plant cedar	Use of tubes or netting	Obstacle protection	Space to 700-1400 sph	"Tea bags" at planting	Fertilize and space	Total
1	0	0.2	0	1	1	3	0	8	13
2	0	0.2	0	1	1	3	0	8	13
3	0	0.2	0	1	1	3	0	8	13
4	0	0.2	0	1	1	3	0	8	13
5	0	0.2	0	1	1	3	0	8	13
Subtotal Yr 1-5	0	1	0	5	5	15	1	38	64
6 - 10	0	1	0	5	5	15	1	38	64
Total Yr 1-10	0	2	0	10	10	30	1	75	128

[6] one person-year of employment is equivalent to 200 person-days of employment

4. Issues Requiring Investigation ("To-Do List")

As various issues, objectives and strategies were discussed in the workshop, there were inevitably some that were clouded by lack of information. Either the lack of information itself was the issue (e.g., uncertainty about site index estimates for existing regenerated stands), or the issue could not be resolved until further investigation provided some clarification (e.g., the impact of silvicultural systems on wildlife habitat). These items were added to a running "To-Do List" throughout the workshop. At the end of the workshop participants ranked these items by urgency (Table 7).

Some of the items in the following list relate to the size of the timber harvesting land base. The current Resource Management Plan (RMP) for the North Coast TSA recognizes this issue, and also identifies several strategies for dealing with it. The two lists contain some overlap, and in some cases approach the same issue from slightly different perspectives.

4.1. Estimates of SI for future regenerated stands

Concern was expressed that there is uncertainty around SI values for all stands in the inventory where the existing cover consists of old stands (old growth). Improved estimates of SI are needed to estimate yields for regenerated stands once these areas are harvested. ***There is a need for a localized OGSI study to improve estimates of SI for future regenerated stands.*** The impacts of such a study on yield projections for this TSA are potentially huge, and may have a major impact on decisions regarding silviculture priorities. (see also Strategy #4, section 7.3, North Coast RMP)

4.2. Develop TSA-level product objectives

The lack of TSA-level product objectives makes it difficult to evaluate silvicultural opportunities which affect future production by species, size class and log grade. ***There is a need for a TSA-level decision process by which broad scale priorities can be set for a range of end product mixes.*** Such a process should be sensitive to treatment costs, expected yields and product values.

4.3. Improved mapping of visually sensitive areas

There is a great amount of uncertainty around the size of the THLB in the North Coast TSA. One of many uncertainties in this assessment is access to timber in visually sensitive areas. Current mapping of these areas is very coarse, and includes many areas which would be excluded at a finer scale. ***Improved mapping of visually sensitive areas would improve assessments of the THLB, and would greatly facilitate harvest planning.*** (see also Strategy #9, section 7.3, North Coast RMP)

4.4. Investigate options for operability in northern portions of the TSA

Another source of uncertainty in determining the THLB involves operating costs relative to timber quality in areas north of Kincolith. These areas are currently included in the THLB for TSR, but are being avoided by licensees as they are perceived to be economically inoperable. ***A study is required to investigate issues around economic operability in northern portions of the TSA, and to assess their inclusion in the THLB.*** (see also Strategy #8, section 7.3, North Coast RMP)

4.5. Net-down factors for riparian zones

Concern was expressed that landbase effects resulting from riparian management/reserve zones were not adequately reflected in the current TSR. ***A fish stream inventory is needed, with associated assessments of riparian zone net-downs.*** (see also Strategy #10, section 7.3, North Coast RMP).

4.6. Regenerated stand species targets

Concern was expressed in the workshop that hemlock, which regenerates naturally on most sites at high densities, is frequently not the most productive species. Also of concern was maintaining existing species compositions on the landscape (particularly with respect to cedar). ***A strategy is needed to ensure that volume production and species occurrence for regenerated stands meet public and industrial expectations.*** Such a strategy would likely include planting targets. This item is closely linked to item 1b above.

4.7. Inventory label site index should reflect crop trees

Concern was expressed that inventory labels, which are the primary source of stand data used for generating yield curves for timber supply analysis, may not reflect planted crop trees. Instead they are heavily weighted to the abundant natural regeneration of hemlock that commonly occurs. The perception among workshop participants was that the planted but less abundant species (mainly spruce and cedar) are more productive than the hemlock, and will form the bulk of the future crop despite their lower numbers. ***A method is needed to reconcile inventory and silviculture labels to better reflect expected future crop composition in predicted yield curves for regenerated stands***.

4.8. Investigate achieved regenerated stand structures, and options for modeling

Concern was expressed in the workshop that achieved stand structures in regenerated stand may not be a close match with the assumptions used to generate managed stand yield tables in TIPSY. Specific mention was made with regard to spatial and temporal patterns of natural regeneration, and the resulting effects on density and height distributions. *An investigation is needed to assess currently achieved regeneration patterns, and the requirements to model them appropriately for timber supply purposes.*

4.9. Refine definition of "countable stems"

Concern was expressed in the workshop that methods used to evaluate stand density may result in misleading figures. Total stand density (trees/ha) is a statistic that has important administrative connotations (i.e. maximum density thresholds), as well as impacts on yield prediction as a variable used in selecting appropriate managed stand yield tables. In order to deal with vertical structure in stands, a size cut-off is frequently applied for determining which trees are "countable" in determining stand density. The intent of this cut-off is to avoid inclusion of suppressed trees having little effect on patterns of stand dynamics, and ultimately yield. ***An investigation is needed to evaluate application of "countable stem" rules and their impact on use of the "total stems" statistic.***

4.10. Time-of-planting fertilizer trials

Interest was expressed in the use of time-of-planting fertilizers to speed early growth rates of planted trees. The intended effects include earlier green-up, shorter rotations and reduced brushing costs. Currently there is insufficient information on growth response of different species

under different conditions for reliable application. ***A series of time-of-planting fertilizer response trials is required to help develop application guidelines.***

4.11. Investigate options for reducing slash piles re: porcupine den sites

Concern was expressed in the workshop that forest practices currently in use may be contributing to increases in porcupine populations, and subsequently to increased levels of porcupine feeding damage in plantations. It was also suggested that slash piles left after logging may provide secure den habitat for the porcupines. ***An investigation is needed to explore porcupine population impacts of reducing size and frequency of slash piles, and to evaluate economically feasible options for such practices.***

4.12. Broadcast fertilization screening trials

Interest was expressed by workshop participants in broadcast application of fertilizers, but uncertainty over response has been one of several factors inhibiting its use. For hemlock, response in past trials has been erratic. For other species, response data is very limited. ***A series of fertilizer response trials is needed to help develop guidelines for appropriate fertilizer use.***

Table 7. Issues identified in the workshop that require investigation, North Coast TSA

Rank	Item
1	Estimates of SI for future regenerated stands
1	Develop TSA-level product objectives
2	Improved mapping of visually sensitive areas
3	Investigate options for operability in northern portions of the TSA
4	Net-down factors for riparian zones
5	Regenerated stand species targets
5	Inventory label site index should reflect crop trees
5	Investigate achieved regenerated stand structures, and options for modeling
5	Refine definition of “countable stems”
6	Time-of-planting fertilizer trials
7	Investigate options for reducing slash piles re: porcupine den sites
8	Broadcast fertilization screening trials

Appendix A. Timber Supply Context

Timber supply is the rate at which timber is made available for harvesting, and it is "made available" through natural, administrative, and economic processes. The forest economy draws timber from the land base in response to consumer demand, and this flow of timber is limited by the rate at which the forest can physically grow trees, and by a variety of administrative constraints. The combined effect of these administrative constraints is incorporated in the Allowable Annual Cut (AAC).

The base case of the timber supply review (TSR) forecasts future timber supply subject to current administrative constraints and assuming present market conditions. The purpose of this section is to identify the "pinch points" and constraining mechanisms that shape the timber supply forecast for the unit. Observations drawn from the TSR base case and selected sensitivity analyses are used to describe the timber supply dynamics of the management unit and to suggest how silviculture treatments might enhance timber supply.

Base Case Forecast

This section is based on the 1999 TSR timber supply analysis report. The previous TSR analysis was published in 1994.

The initial harvest level in the base case harvest forecast is 600 000 m^3/yr, the current AAC (Figure A-1). After two decades the harvest must be reduced by about 10% per decade until decade seven, when it reaches the long-term harvest level of 361 000 m^3/yr. In the base case forecast of the previous TSR analysis (1994) the initial harvest level could be maintained for six decades, but the long-term harvest level was 17% lower.

Two changes in the information used for the timber supply analysis caused these differences. First, a re-inventory of 60% of the TSA led to a 17% reduction in the estimated total growing stock inventory. Second, in the 1999 analysis the volume tables representing yields from managed stands have higher volumes and higher minimum harvestable ages than do those used in the previous analysis. The lower volume of existing inventory reduces the volume available for harvesting in the short term. Using higher minimum harvestable ages delays the transition to harvesting managed stands. Together, these changes make it necessary to begin the reduction from the initial harvest level to the LTHL earlier. The higher volume estimates for managed stands increase the long-term harvest level.

Currently most of the inventory on the timber harvesting land base is older than minimum harvest age. As the stock of existing timber is drawn down in periods one through six, the proportion of inventory that is younger than minimum harvest age increases (Figure A-2). The volume of inventory on the timber harvesting landbase stabilizes at around 30 million m^3 by about the eighth decade. The total inventory volume is much higher than that of the timber harvesting land base, with about 300 million m^3 in the first decade, and increasing slightly over the planning horizon.

Figure A-1. Base case harvest forecast, North Coast TSA

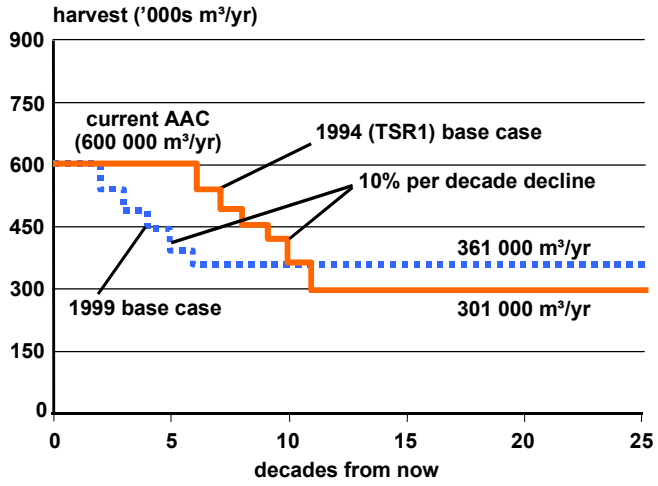
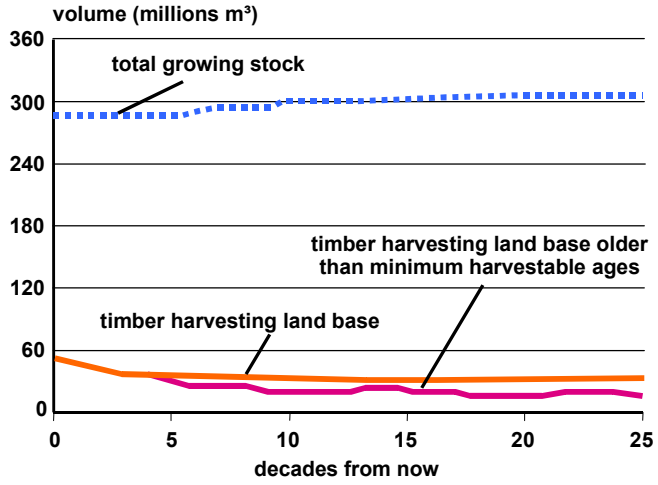


Figure A-2. Total and harvestable growing stock, base case forecast, North Coast TSA



During the first 13 decades the harvest is almost entirely from existing stands. The average age of harvested stands drops rapidly near the completion of the transition to harvesting managed stands, and stabilizes at an average of about 170 years (Figure A-3).

Over the planning horizon the average area harvested annually ranges from about 850 ha/yr in the first two decades to about 600 ha/yr at the long-term harvest level (Figure A-4), reflecting the lower harvest level in the long run. The area harvested annually is more variable during the first 15 decades than it is after decade 15, reflecting the variability of the existing inventory and the changing harvest rate in the first six decades.

Figure A-3. Average age of harvested stands, base case forecast, North Coast TSA

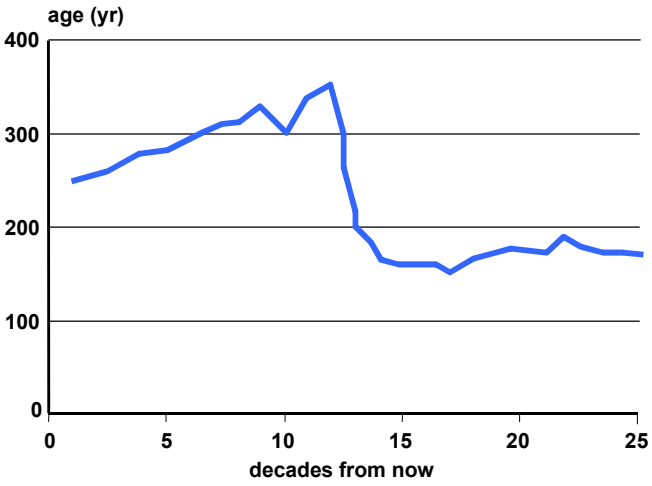
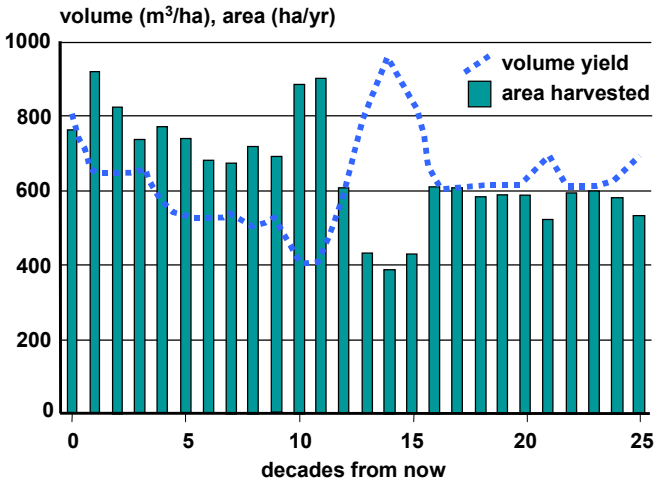
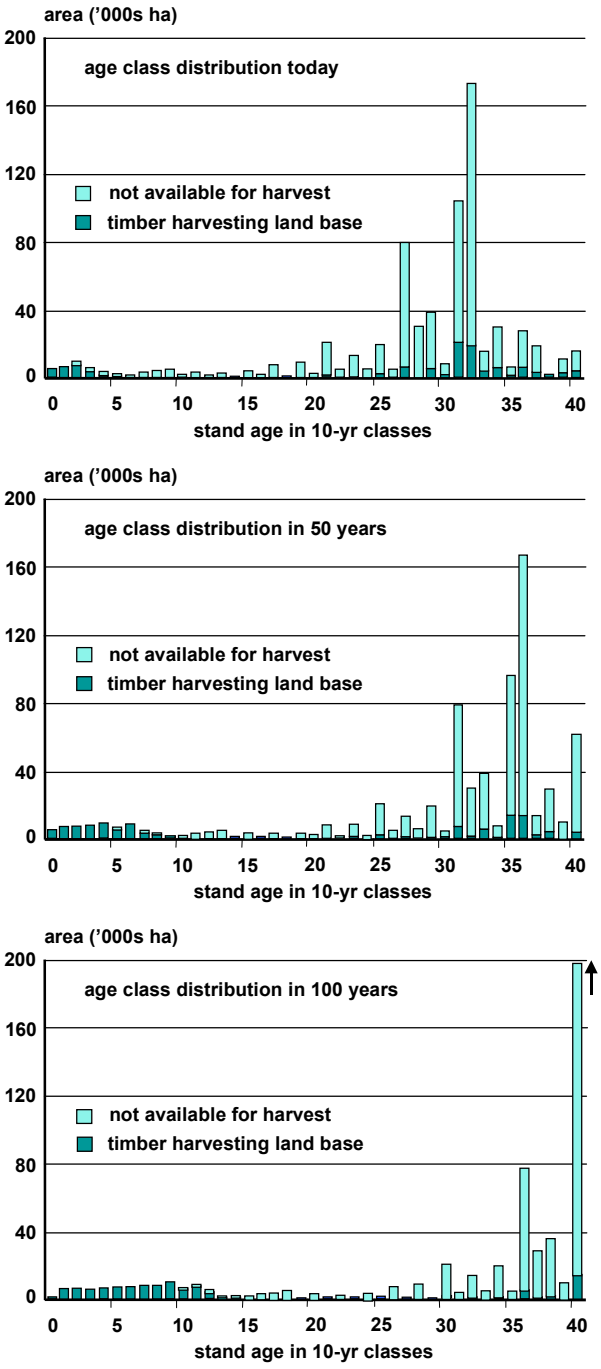


Figure A-4. Average volume yield and area harvested annually, base case forecast, North Coast TSA



Changes in the age class structure of the forest over the first 100 years of the base case forecast show the large proportion of area not included in the timber harvesting land base (Figure A-5). The area in each age class of the timber harvesting land base becomes reasonably balanced by the tenth decade, reflecting that much of the existing timber has been harvested. By year 150 (not shown) the area in the timber harvesting land base has stabilized with a balanced age structure spreading over 17 age classes, and very little area older than 200 years. By this time the inoperable parts of the land base have become very old (Figure A-5).

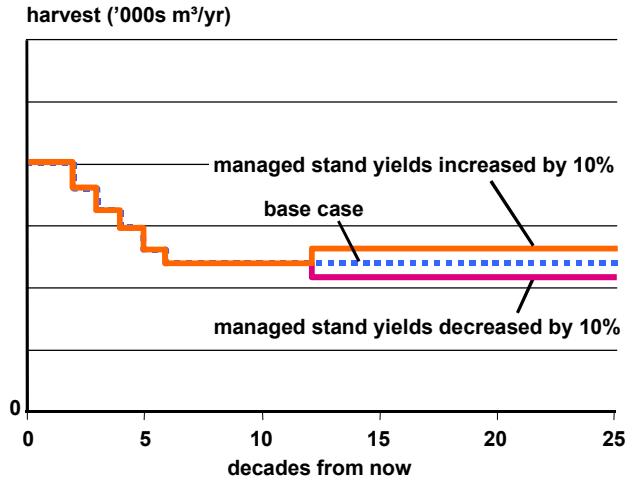
Figure A-5. Changes in age class structure over time, base case forecast, North Coast TSA



Stand Yields

Figure A-6 shows that the projected long-term harvest level is sensitive to increasing or decreasing regenerated stand volume estimates, with the forecast changing after the transition to managed stands, from year 130 onward.

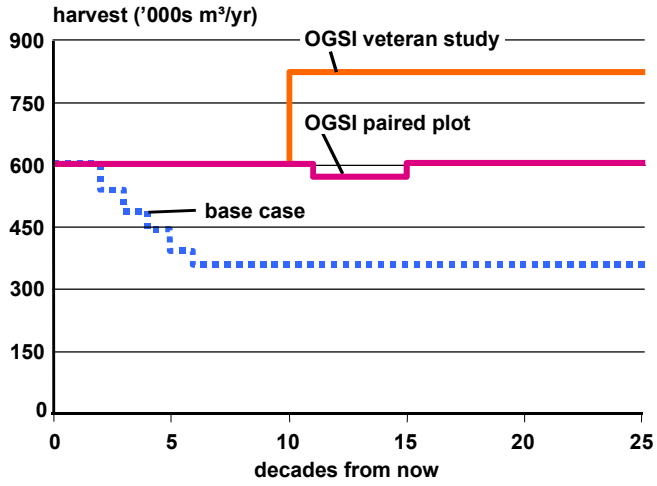
Figure A-6. Harvest forecasts with changes in yields for managed stands, North Coast TSA



Site Productivity

There is some uncertainty about the estimates of site index on older stands, which determine the site productivity estimates for regenerated stands after harvest. Sensitivity analysis tested two approaches for improving the estimates of old-growth site index. The first approach, known as the *OGSI veteran* study, compared site indices derived using growth intercepts on young stands with those derived conventionally for old-growth stands on adjacent ecologically similar sites. The second study used a different measurement approach in what are termed *paired plots*. The base case forecast is very sensitive to adjusting site indices according to the information produced in either of these two studies (Figure A-7). Sensitivity analysis showed that long-term harvest levels could be raised by 67% and 38% for the *OGSI veteran* study and OGSI paired-plot study respectively.

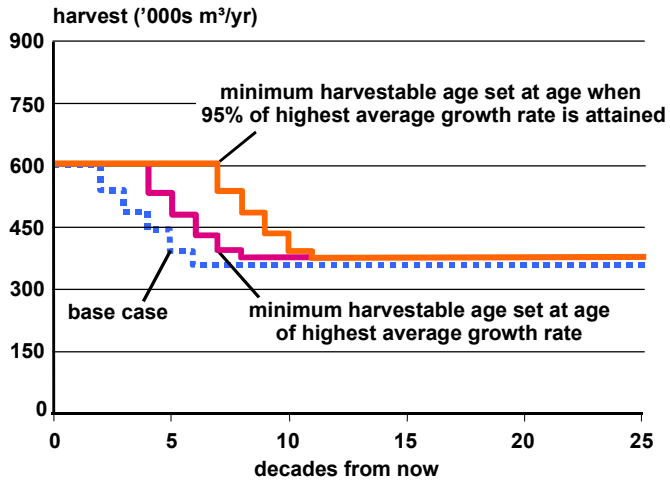
Figure A-7. Harvest forecasts with increased estimates of site productivity on older stands, North Coast TSA



Timber Rationing, Minimum Harvestable Age, and Density Control

The number of periods in which the initial harvest-level can be maintained in the North Coast base case forecast is largely dependent on when regenerating stands reach minimum harvestable age. Evidence of this was shown by testing an alternative harvest forecast (not shown) in which the initial harvest level was maintained for three decades (rather than two, as in the base case), after which harvest levels dropped to 5% below the long-term harvest level until decade 13. Decade 13 is an important point in the forecast, indicating the time when the availability of timber older than minimum harvestable age constrains the rate at which the existing stock of mature timber can be rationed out. Sensitivity analysis testing showed that the short-term and medium-term harvest levels are very sensitive to changes in minimum harvestable age (Figure A-8).

Figure A-8. Harvest forecast with different minimum harvestable ages, North Coast TSA



If all stands were treated with pre-commercial thinning to 700 sph, the initial harvest level could be sustained for two decades longer than in the base case (Figure A-9) because of the effect initial spacing has on piece size, and thus on minimum harvestable age. In effect, changing either minimum harvestable age or the amount of pre-commercial thinning affects the forecast through the same mechanism, i.e., the decade when regenerated stands first become harvestable.

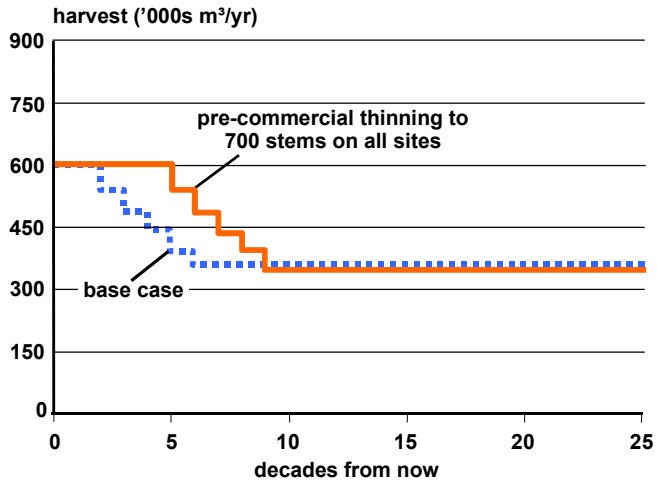
Green-up Period

The base case forecast was not sensitive to changes in green-up period (figure not shown).

Visual Quality Objective Forest Cover Requirements

The base case forecast was slightly sensitive to changes in forest cover requirements for visual quality management areas (figure not shown). When the maximum visible disturbance in each visual quality class was reduced to the middle of the permissible range for that class the initial harvest level could be maintained for only one decade.

Figure A-9. Harvest forecast with density control on the entire timber harvesting land base, North Coast TSA



Timber supply Dynamics—Summary

The base case harvest forecast is sensitive in the short-term and medium-term to changing the time at which regenerating stands first become available for harvesting, as shown by the sensitivity of the forecast to changes in minimum harvestable ages and the amount of density control of regenerating stands.

In the long term the forecast is sensitive to changes in yield estimates for regenerating stands, with the effects first apparent around decade 13.

The forecast is very sensitive in the medium-term and long-term to changes in estimates of site index.

This timber supply forecast is very robust with respect to management parameters such as green-up age and adjacency.

Appendix B. Executive Summary, Incremental Silviculture Strategy for BC

Purpose

This strategy provides guidance to the application of available funds for incremental silviculture activities. It is not tied to a specified funding level.

Government's Goals

- Sustainable Use
- Community Stability
- A Strong Forest Sector

Key Principles

1 Because the distant future cannot be foretold, the best and only course of action in managing the timber resource is that which minimizes risk and maintains options.

2 British Columbia's forests are import locally, provincially, nationally and globally and should be managed in this context.

3 Each generation of British Columbians becomes the steward of the province's forest resources and has a moral obligation to preserve this heritage for future generations.

Working Targets

Within the context of the guiding principles:

1 Minimize the anticipated interim reduction in timber supply so that provincial annual harvests of at least 65 million m^3 can be achieved.

2 Create a long-term timber supply capable of supporting a steady long-term provincial harvest level of at least 75 million m^3.

3 Over the long term, maintain the production of premium quality logs at or above 10% of total harvest.

Major Silvicultural Strategies

- Increase the use of alternative silvicultural systems and commercial thinning.
- Achieve earlier green-up of harvested areas.
- Increase regenerated stand volumes 20%.
- Eliminate all pre-1982 good and medium site backlog NSR and all 1982 to 1987 backlog NSR.
- Initiate a long-rotation quality management program for stands where harvesting must be delayed.

Other silvicultural and non-silvicultural strategies must also be implemented to achieve the working targets.

Strategy Implementation

Regional and management unit strategies must be developed, followed by programs and plans to implement them

Appendix C. Workshop evaluation summary

Workshop Evaluation —North Coast TSA (27-28 Jan 2000)

Please circle the number that best represents your view.

	5	4	3	2	1
1 Length of session	too long	(1)	just right (6)		too short
2 Level of detail of content	too much	(1)	just right (6)		not enough
3 Instructional method (style, interaction, clarity)	excellent (1)	(4)	adequate (2)		poor
4 Relevance to your interests/needs	extremely (1)	(3)	average (3)		not at all
5 Extent to which your needs were met	entirely	(4)	average (2)	(1)	not at all
6 Usefulness of the handout graphics and texts	very	(5)	adequate (2)	2	useless

What were the strengths of this workshop?

- Good communication with participants
- Assimilation of thoughts/ideas from different users/licencees helps to broaden my own "relatively narrow" point of view".
- Well structured.
- Sought participants' input/involvement. Good level of interaction.
- Well facilitated, interactive, flexible and casual.
- Identifies long term issues. District"to do" list (planning and inventory).

What were the weaknesses of this workshop?

- None.
- Lack of target objectives for forest end use products makes it difficult to know how to give "best" recommendations. Emphasis seemed to be on maximizing volume, which doesn't necessarily mean maximum value.
- Should have enlisted other gov't. agency participation, such as MoE and other MoF.
- Other forestry communities should be included in this process.
- Computer/slide glitch cost ½ hour.

- Ensure larger range of people – experience i.e. managers, biologists. Lack of specialists.

How could this workshop be improved?

- Good job, no need to improve.
- Perhaps, planning and engineering should be included in this type of exercise.
- Perhaps did not need the sample TSR slides, could have just used the NC TSR graphs, charts, etc.

Other comments? (use back if necessary)

- There should be strong emphasis in the resulting report on the highly ranked "things to do" issues. These are fundamental to a TSA/District level silvicultural strategy.
- It would be more beneficial if the general forest production goals were known.
- Donuts!