Management of Species Composition in Cutblocks in Beetle-impacted TSAs

October 27, 2005

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Message from the Chief Forester

When reforesting harvested areas, there are few things more important than ensuring that the areas are renewed with desirable tree species. The species composition re-established on harvested areas is a key determinant of the future productivity, biodiversity, health, and economic value of these areas. The benefits that the future forest will provide to British Columbians depend, in part, on the skilful management of species composition today.

The time is right to review the management of species composition on harvested areas in management units heavily damaged by the mountain pine beetle (MPB). Timber harvest rates have been increased in many of these areas and the government is committed to attempting to mitigate future wood supply shortages. There is a general awareness of the need, and opportunity, to create a future forest that is at lower risk to catastrophic damage. And, there is widespread recognition of the need to improve the linkages between stand level actions and forest level goals.

In April 2005, a small team of Forest Service staff was given four months to prepare a preliminary assessment of the management of species composition in harvested areas in beetle-impacted Timber Supply Areas (TSAs). Their report, *Management of Species Composition in Cutblocks Beetle-impacted TSAs*, provides a useful review of many of the underlying issues and includes some management recommendations.

Clearly, the topic is an important one that has many significant implications for the health and vitality of the future forests in MPB affected areas. I am grateful to the team for their efforts, and at this time, I feel that their work is best utilised as a basis for eliciting discussion and feedback with the many individuals and groups that are interested in this topic – outside the Forest Service as well as in-house staff.

In the interim, a few recommendations may be implemented that will help us better understand the implications of species selection changes. However, in general, I look forward to first seeing the results of internal and external discussions, as well as the findings of upcoming special events (e.g., the Future Forest Ecosystems of B.C. symposium at UNBC, Dec. 6–7, 2005). With the benefit of these inputs, the Forest Service will then consider the merits of policy and procedure changes where necessary and appropriate.

I invite your comments on the report and the issues identified in it. Please direct your comments to Mr. Patrick Martin, Forest Practices Branch, BC Ministry of Forests and Range, PO Box 9513 Stn. Prov., Victoria, BC, V8W 9C2. E-mail: Pat.Martin@gov.bc.ca.

Jim Snetsinger
Chief Forester

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Summary and Recommendations

In response to a request from the Chief Forester, a committee was formed to advise on questions pertaining to the management of species composition in cutblocks in beetle-impacted Timber Supply Areas (TSAs):

- Are harvested areas being reforested to desirable species composition?
- Are species management practices and outcomes adequately monitored and controlled?
- What actions are recommended to improve the management of species composition?

Evidence was gathered from interviews with Forest Service staff and others (consultants, academics, and industry staff), reports generated from the provincial silviculture records database (RESULTS), and other sources. Numerous issues emerged, including concerns over:

- the amount of lodgepole pine that is being planted,
- the appropriate use of hardwoods and non-native (exotic) tree species,
- the lack of a reforestation requirement for tree species diversity,
- the degree of green-tree retention at harvest,
- the current capability to monitor and control species management practices and outcomes, and
- whether current species management practices will produce a resilient future forest.

The current situation was assessed, response options available to the Forest Service were identified, and conclusions were drawn.

Based on our assessment of the evidence, we offer the following recommendations:

1. **Over-planting pine – Encourage mixed species planting where appropriate**
   There is general agreement among Forest Service staff interviewed that lodgepole pine has been over-planted in some locations in the past. In 2003, 60% of seedlings planted in the study area were lodgepole pine and reports generated from RESULTS suggest that some viable opportunities to establish other species are not being utilized. Nevertheless, it is appropriate for lodgepole pine to continue to be widely used in the reforestation of harvested sites in the BC interior. Overall, we conclude that i) lodgepole pine has been over-planted in some areas, ii) over-reliance on any single species is undesirable, especially in landscapes where natural forest species composition is diverse, and iii) efforts should be made to increase species diversity at planting, as per the set of recommendations below.
2. **Species diversity – New tools, and possibly new rules, required**
   The risk of future losses can be reduced, and ecological benefits gained, by re-establishing on harvested areas diverse tree species compositions. However, higher-level (strategic) targets for species composition and diversity on harvested areas generally do not exist. The Forest Service cannot easily produce reports that characterize species diversity and lacks a regulatory requirement for species diversity. We recommend that Forest Service executive direct:
   - Forest Practices Branch to work with the Ministry of Environment and the Ministry of Agriculture and Lands to i) evaluate alternative methods for

establishing targets for species composition and diversity, and ii) design and evaluate alternative formulations for a landscape-level (or multi-block) regulatory requirement for species diversity, and

- Forest Practices and Information Management Branches to develop in RESULTS new reports that characterize species diversity at the stand, multi-block, and landscape scales.

3. **Exotics – Maintain current restrictions**
Non-native tree species (exotics), such as Siberian larch, have achieved greater growth at young ages than native conifers in some test locations. However, the exotics that have been suggested for the BC interior have not been adequately tested and may pose a threat to native biodiversity. We recommend no increase in the operational planting of exotic tree species and no change to the current restrictions on the use of exotics. If additional action is desired on this issue, we recommend that existing outplantings (trials) be catalogued and assessed.

4. **Hardwoods – No change to current restrictions unless justified by detailed, local planning**
Forest Service staff have varying opinions on easing the current restrictions on broadleaf tree species. We recognize the potential benefits of greater use of hardwoods in specific circumstances. However, we do not recommend a global change to current procedures (e.g., increasing the amount of hardwoods accepted in stocking standards or changing the current free-growing criteria). In those TSAs with the greatest potential use for hardwoods, we recommend that Forest Service executive direct the Forests For Tomorrow (FFT) program and Forest Analysis and Inventory Branch to complete forest-level (Type II silviculture strategy) assessments of the consequences of expanded hardwood management. These assessments should determine the degree to which an increase in hardwoods will increase wood supply during future periods of severe shortage and the associated reduction in future conifer harvest. Further, we recommend that Forest Practices Branch prepare for the Chief Forester a hardwood management guidance memo that will replace the Chief Forester's "Broadleaf memo" in select districts. This memo should update the conditions under which Districts should approve an increase in hardwoods. To provide environmental benefits, the current practices of retention of low levels of mature hardwoods and acceptance of low levels of hardwoods at free-growing should be continued.

5. **Retention – Strike a committee to address**
Retaining, and not harvesting, non-pine merchantable trees within cutblocks, when they provide a future economic harvest opportunity, should be adopted as a key management strategy in beetle-impacted units facing severe mid-term timber supply deficits. Forest Service executive should question whether enough is being done to avoid harvesting non-pine trees within cutblocks. In 2004 in the Prince George TSA, for example, 4.6 million cubic metres, one-third of the total harvest, was species other than lodgepole pine. We recommend that Forest Service executive strike a committee to evaluate this issue, determine whether all reasonable retention opportunities are being captured, identify possible policy responses, and recommend action.

6. **Forest Service programs – Lead by example with good species management**
The Forest Service should lead by example and ensure that programs managed by the Forest Service (e.g., BCTS, FFT, and NRFLs with Forest Service silviculture obligation) employ best practices in their management of species composition. Forest Service executive should direct BC Timber Sales (BCTS) to lead the

development of a Best Management Practices (BMP) statement to guide the management of species composition. This BMP statement should be signed off by, and binding on, all Forest Service silviculture programs. In addition, the FFT program should be used to restore species diversity to landscapes with reduced diversity due to past management practices.

7. **MSSp – Maintain high standards**
   Although no longer specifically required under the Forest and Range Practices Act (FRPA), in stocking standards we recommend that foresters i) maintain the current practice of distinguishing preferred from acceptable species, ii) continue to limit preferred species to those that are truly most desirable, and iii) maintain the current practice of a minimum required stocking by preferred species (MSSp). In addition, we recommend that the Forest Service i) periodically revise and re-issue the provincial species selection guidelines, and ii) evaluate the stocking standards in Forest Stewardship Plans to assess their implications for the management of species composition in beetle-impacted TSAs.
8. **Performance reports – Identify and challenge those with the greatest room to improve**
   Records of silviculture activities and outcomes, and other information, can identify license-holders who appear to have opportunities to increase species diversity that they are not utilizing. Forest Practices Branch should identify these cases and prepare brief performance reports. A performance report should contain a few key graphs and tables that compare practices and outcomes to relevant benchmarks, including the practices used by others, outcomes achieved by others, and other substantive information. Performance reports should be sent to these licensees from the Chief Forester with the request that licensees i) examine their practices, ii) identify opportunities for – and impediments to – increasing the mixture of economically valuable, ecologically suitable species, and iii) reply to the Chief Forester. Responses should be used to identify additional government actions that can facilitate improved management.
9. **Climate change – Prepare to act on recommendations of Climate Change Task Team**
   It appears likely that the Climate Change Task Team will recommend a review of the provincial species selection guidelines in light of potential climate change. The issue is complicated and quick resolution should not be expected. Forest Service executive should support this initiative and prepare to act on the other recommendations that the Climate Change Task Team may make regarding species and seed selection.
10. **Knowledge – Fill critical gaps in knowledge**
   To provide the foundation for continuous improvement of the management of species composition, Forest Service executive should identify to the Forest Service Research Program the following critical knowledge gaps: (i) the long-term performance and optimal management of species mixtures, (ii) the impact of climate change on tree species selection, and (iii) comparative hardwood, mixedwood, and softwood yields over the site series where hardwoods and mixedwoods may offer a viable alternative to conifers. Forest Service executive should identify to Forest Analysis and Inventory Branch the need for analyses of the long-term, forest- and landscape-level consequences of species selection and management alternatives.

11. **Managing the issue – Develop and communicate a plan**
    Forest Service staff and others have many concerns about the management of species composition in cutblocks in management units impacted by the mountain pine beetle. The Forest Service should develop an overall plan for the management of this issue and communicate the plan to all interested parties. The following elements should be considered for the plan:
    - Adopt diversity of desirable tree species as a key strategy to create a resilient, productive, valuable forest most likely to continue into the future providing the goods and services desired by society.
    - Communicate to licensees the government's desire for a diversity of desirable tree species and ask licensees to make reasonable efforts to achieve this at free-growing.
    - Consult widely while developing the plan, utilizing opportunities such as the Chief Forester's Future Forests initiative.
    - Employ a variety of tools to achieve plan objectives, possibly including communication, direct government action, regulation, economic incentives, and the provision of tools, analyses, and information.
    - Engage the issue of diversity in terms of diversity of desirable species and diversity at multiple scales.
    - Prioritize issues to address, take action, and monitor the effectiveness of actions.
    - Provide tools, analyses, and information to better specify objectives, craft strategies, select practices, and evaluate outcomes.
    - As Forest Stewardship Plans are submitted, evaluate the stocking standards in them to assess the implications for the management of species composition in beetle-impacted TSAs. Use this evaluation to adapt and refine the plan.

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1. Introduction

Concerns have been expressed about the management of species composition in cutblocks in the portion of the province most heavily impacted by the mountain pine beetle. Forest Service executive have been asked whether too much lodgepole pine is being planted and whether fast-growing hardwoods and exotics could help offset expected mid-term timber supply shortfalls. In May 2005, the Chief Forester requested an assessment of the problem and recommendations on whether any interim guidance or changes to policy are warranted. A committee was struck to assess the situation and make preliminary recommendations by August 2005 (Appendix 1). The scope of the review was limited to 11 beetle-impacted TSAs in the BC interior.[1]

The specific concerns raised by Forest Service executive were generalised to three broad questions:

- Are harvested areas being reforested to desirable species compositions?
- Does the current policy framework allow for adequate monitoring and control of species composition on harvested areas?
- What should be done to influence practices, facilitate good species management, and align species composition at free-growing with policy goals?

This report is organized as follows. Following the introduction, the methods are described, including the criteria used to judge the desirability of species composition. Next, a summary of findings is provided. Then, policy response options are reviewed, followed by our conclusions. A variety of supporting materials are organized in the appendices. A brief summary and the main recommendations are located at the front of this report.

2. Methods

From the various questions raised by Forest Service executive, we synthesized the central questions (see 1. Introduction). Then, we adopted criteria for assessing the desirability of cutblock species composition and identified species management strategies that might satisfy these criteria. Next, we gathered evidence on the current state-of-affairs through interviews with Forest Service staff and other experts (Appendix 2), RESULTS reports, and other sources. We identified possible policy response options. Last, we formed conclusions and recommendations based on the evidence available to us.

We adopted the following criteria to assess the "desirability" of species composition following the reforestation of harvested areas. Any particular species composition can be considered desirable if it provides a short-, mid-, or long-term supply of economically valuable timber, and/or an appropriate level of ecological benefits.

For each criterion, key methods to satisfy the criterion were identified. These methods, species management strategies that could be used, include:

- Plant fast-growing exotics to mitigate projected mid-term fibre shortfalls.
- Promote hardwoods to mitigate projected mid-term fibre shortfalls.
- Ensure that the seedlings established on harvested areas are of productive, economically valuable species.
- Achieve a level of tree species diversity, both at the stand and landscape scales, adequate to reduce risks of future losses.
- Retain tree species at harvest that provide the desired level of ecological benefits.
- Achieve the degree of diversity of species composition (both within stands and among stands) that provides the desired level of ecological benefits.
- Retain economically valuable merchantable trees at harvest that provide harvesting opportunity in the short- and mid-term.

3. Assessment of the Current Situation

For each species management strategy, the current situation was assessed – including current practices, outcomes, monitoring procedures, and controls. Table 1 summarizes the assessment of the current situation.

Table 1. Summary assessment of the current situation

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
I. Trees provide a mid-term supply of economically valuable timber.	**1.** Plant fast-growing exotics to mitigate projected mid-term fibre shortfalls.[2]	**Status:** The most widely discussed exotic in the central interior is Siberian larch. There are a small number of test plantings in BC and early growth is very good in some locations. With only a short period of observation on a few sites, the health and productivity of exotics over a full rotation is not known. Exotics are often viewed as posing a threat to the native ecosystem.[3] BC foresters have divergent views on their acceptability and little operational experience managing them. The introduction of lodgepole pine to Sweden provides an instructive example of a well-managed program to introduce an exotic species, significant growth gains, and, today, mounting concern over negative ecological impacts.[4] For exotics, a complete catalogue of existing out-plantings is not available, growth performance to-date has not been summarised, and there is no well-designed network of long-term growth trials. **Monitoring:** Seed use is monitored through SPAR (Seed Planning and Registry System) and the tree species planted is monitored through mandatory RESULTS reporting. **Controls:** The planting of exotics on crown land is strictly limited by regulation. Currently, under the Chief Forester' Standards for Seed Use, blister-rust resistant white pine is the only seed from outside of BC that can be registered for use in the interior of BC. If a person wanted to register an exotic species from another location (e.g., Siberian larch) that person would have to apply to the Chief Forester for an alternative to the standards under section 43 of the Forest Planning and Practices Regulation. The use of exotics is often discouraged (and sometimes prohibited) by SFM-certifying bodies.[5]
	2. Promote hardwoods to mitigate projected mid-term fibre shortfalls.	**Status:** In many management units, broadleaf tree species (hardwoods) are common and, on the right sites, somewhat faster growing than conifers. Opportunities exist to increase the amount of hardwoods, though this will reduce future conifer yields and delivered volume to existing conifer-based sawmills. RESULTS reports show variation in hardwood amounts over time and among TSAs, with averages typically 5–10% of stand composition.[6] Because current controls and practices reduce but do not eliminate hardwoods, the overall result is low levels of hardwoods in most current blocks at free-growing. Forest Service staff hold varying views on the issue of promoting hardwoods. Opinions are influenced by one common means of hardwood control – herbicide application. The ability to selectively harvest small hardwood patches or dispersed hardwood trees in a conifer stand is also of concern. Assessments of the forest-level consequences of promoting hardwoods have not been done. In some management units, there is little area suitable for hardwoods. In others, there is considerable suitable area and hardwood volume on the landbase, especially in

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
		pre-87 blocks. Relative to conifers, hardwood yield has lower value per unit of yield. For use in the interior, hybrid poplars typically require intensive site preparation and management. They are unlikely to thrive in relatively untended wild plantations. They are best suited for agricultural use or use on abandoned agricultural lands. Their potential use on crown forest land in beetle-impacted areas is therefore quite limited. **Monitoring:** On cutblocks, key characteristics of the hardwood component (e.g., species, size, density, etc.) are monitored through mandatory forest cover reporting into RESULTS, immediately after harvest, at regeneration delay, and at free-growing. **Controls:** Hardwood abundance is limited by the free-growing criteria and limits on the inclusion of hardwoods as preferred and acceptable species in stocking standards.[7] The Chief Forester's "Broadleaf memo" of August, 2000 is influential.[8] In the most recent revision of the provincial species selection guidelines, site series that can produce productive, commercial hardwoods in a reasonable timeframe were identified.
II. Trees provide a long-term supply of economically valuable timber.	**1.** Ensure that the seedlings established on harvested areas are of productive, economically valuable species.	**Status:** A recent province-wide review by the Forest Practices Board confirms a very high success rate re-establishing desirable species on harvested sites.[9] A tendency to add species to both preferred and acceptable species lists in stocking standards has been identified.[10] Climate change may impact which species are most productive and healthy on which sites.[11] The Forest Service Climate Change Task Team will likely recommend a review of species selection in the face of changing climate. Depending on their recommendations, it may be necessary to update the species selection guidelines, provide guidance to districts on the approval of new stocking standards, and/or revise currently approved stocking standards. Appropriate species choices at planting are premised on having an available supply of quality tree seed to grow the requisite number of seedlings.[12] Analyses to date indicate that there is sufficient lodgepole pine seed in inventory to meet short-term needs for the MPB area. Advanced generation lodgepole pine seed orchards have also been established for the central interior, but these will not produce substantial amounts of seed for 5–7 years. In the interim, and if additional lodgepole pine seed is required, collections from superior provenance (B+) sources and natural stand (B) sources could be undertaken. Studies undertaken at the Tree Seed Centre indicate that viable seed still can be extracted from cones collected from stands killed by the MPB several years earlier. There is plenty of spruce seed in storage and available from existing orchards. Further analysis is required to determine the status of seed from other species. Although stand density is outside of the scope of this review, several interviewees expressed the view that when established at low density, lodgepole pine was a less desirable tree species than when established at higher densities. In making species choices, silviculturists rarely have access to analyses that quantify the long-term forest- and landscape-level consequences of

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
		species management alternatives. For the next revision of the provincial species selection guidelines, interviewees identified the following areas of concern: sites on either side of the 01 on transitional ecosystems, balsam on sites in the Bulkley TSA, balsam in subzones where it is common, and cedar and lodgepole pine in the ICH. Findings related to the over-use of lodgepole pine are provided in the species diversity section (II(2) of Table 1) that follows. **Monitoring:** Seedling species composition is monitored through mandatory RESULTS reporting. **Controls:** Species selection guides, stocking standards and district policy ensure that productive, valuable species are re-established on harvested areas. Conventional stocking standards discriminate between preferred and acceptable species and contain a minimum stocking requirement for both stocking by preferred species (MSSp) and overall stocking (MSS). However, FRPA does not refer to both MSS and MSSp. Under section 169 of FRPA, the Chief Forester may establish standards for forest practices that, presumably, could include standards respecting species management, composition, and diversity. In addition, FRPA requires approval of stocking standards that match TSR assumptions, though some of these management practices were condemned by some interviewees (e.g., repeatedly planting ICH cutblocks to spruce).
	2. Achieve a level of tree species diversity, both at the stand and landscape scales, adequate to reduce risks of future losses.[13]	**Status:** Young stands in MPB-impacted TSAs tend to be dominated by a single species. On average, the leading species accounts for 60–70% of young stand composition in the study area.[14] Many young stands lack a significant secondary species in their composition.[15] This cannot be attributed to single-species planting as RESULTS records clearly show a significant reduction since the 1980s in the frequency of single-species plantings.[16] The vast majority of harvested areas are planted.[17] In most cases, where more than one species is listed as preferred in the stocking standard, more than one species has been planted.[18] Thus, the issue of species diversity is not primarily about pure species deployments (monocultures). It is about the degree of leading species dominance, the infrequency of significant secondary components in stands, and the level of diversity among stands.[19] Compared to managing relatively pure stands, less is known about the optimal management of species mixtures, though the regional Site Identification and Interpretation handbooks (and other sources) provide considerable information. Forest Service staff interviewed often felt that lodgepole pine had been over-planted in some locations and that opportunities to increase species diversity through planting were missed in the past. RESULTS reports and other evidence support this view.[20] Past over-use is attributed to the fact that lodgepole pine was often viewed as lower-cost, more reliable, and faster to free-growing. However, many district staff reported increases in mixed species planting in recent years (a trend confirmed

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
		by RESULTS reports). The pure, single-species planting of lodgepole pine occurs in only 20% of the area planted annually.[21] Several interviewees reported recent shifts away from lodgepole pine due to damage to lodgepole pine before free-growing from various agents (including rusts and root collar weevils), and the lower free-growing height, rapid initial height growth, and low costs of class A spruce seed. The extent of mixed planting varies over the province.[22] It is difficult to estimate the magnitude of the opportunities to increase diversity that remain.[23] Lodgepole pine is the best, and sometimes the only, species option in many locations. Dry climate, summer frosts and drought limit the use of other species in many areas. However, with site preparation, vegetation management, and other practices, non-pine species (e.g., Douglas-fir and spruce) can be successfully established on some of these sites, though with an increase in reforestation cost. In some areas, Forest Service staff viewed the high percentage of lodgepole pine planted as appropriate given the stand and site types that are being harvested.[24] Forest Service forest health specialists predict increasing pest and disease problems with lodgepole pine, especially in wetter environments.[25] In many stands, natural regeneration, released advance regeneration, and retained mature trees add to the species mix at free-growing, lessening the concern over planting too much lodgepole pine. Lodgepole pine amounts to 40–50% of the species composition of young stands in the study area.[26] A shift from pine to spruce may reduce harvestable volume in 60 years – as lodgepole pine culminates sooner. Landscape-level planning of reforestation is rare.[27] **Monitoring:** Landscape-level monitoring of species diversity is not developed. RESULTS currently lacks the ability – but has the potential – to produce reports on species diversity at the multi-block or landscape scale. **Controls:** The current policy framework does not provide the ability to set standards for diversity within a single block or over multiple cutblocks. Within a Standards Unit, any single one or any combination of preferred species is equally acceptable. Over multiple blocks, no species diversity control mechanism exists. In terms of the regulation of species composition within cutblocks, there is little (if any) strategic planning and specific targets for composition and diversity at spatial scales above that of the individual Standards Unit.

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
III. Trees provide the desired level of ecological benefits.	**1.** Achieve the species composition of retention at harvest that provides the desired level of ecological benefits.[28]	**Status, monitoring, and controls:** Little information was obtained on this issue. One recent evaluation of wildlife tree retention found species composition of retention in the SBS differed from pre-harvest species composition. However, the ecological implications of the shift in composition are unclear.[29] For large-scale salvage logging in beetle-impacted areas, Bunnell recommends: "Reserve riparian and upland hardwoods from harvest."[30] A Chief Forester guidance letter on retention in large beetle-salvage blocks is being prepared.[31] Aspects of Wildlife Tree Patch retention are controlled in both the transition Code and FRPA. Mature tree retention is required by most SFM-certifying bodies, a commitment in most SFM plans, and thus monitored and reported by SFM-certified operations.[32]
	2. Plant (or otherwise promote) ecologically-suitable species.	**Status, monitoring, and controls:** In general, the current status is satisfactory with adequate monitoring and controls. For more detail, refer to the comments in Table 1 sections I(1)-exotics, I(2)-hardwoods, and II(1)-seedlings.
	3. Achieve the degree of diversity of species composition (both within stand and at the landscape-level) that provides the desired level of ecological benefits.	**Status, monitoring, and controls:** Refer to the comments in Table 1 section II(2)-diversity.
	4. Strictly limit the planting of exotics.	**Status, monitoring, controls:** Refer to the comments in Table 1, section I(1)-exotics.
IV. Trees provide a short-term supply of economically valuable timber.	Retain economically valuable merchantable trees at harvest that provide harvesting opportunity in short- and mid-term.[33]	**Status:** It is not clear whether the current level of within-cutblock retention is optimal. In one recent audit, the Forest Practices Board concluded that too much non-infested volume was being harvested and advised the licensee to take additional steps to limit the harvest of non-infested trees.[34] In their projections of the mountain pine beetle outbreak, Marvin Eng and his team assumed that: 'For every cubic metre of non-recovered losses that are saved we also harvest 1.3 cubic metres of non-pine volume as an "incidental by-catch."[35] Reports from the Harvest Billing System show 499 656, 4 581 269, and 655 877 m^3 of non-pine harvest in 2004 in the Lakes, Prince George, and Quesnel TSAs, respectively. These non-pine harvested volumes translate to 27, 33, and 19 percent of the total harvest in 2004 in these three TSAs.[36] Some Forest Service staff interviewed believed that not much more could be done to retain valuable, merchantable non-pine trees at harvest. One factor is that some current mills cannot function exclusively on lodgepole pine. Also, the non-pine trees available for retention are sometimes less desirable species – such as black spruce or balsam. Retention has the potential to reduce harvest revenue and increase harvest cost. On the desirability of retaining advance regeneration balsam, Forest Service staff hold widely varying views.

Tree species composition at free-growing is desirable if it meets these criteria	A species management practice that satisfies the criterion	Assessment of the current situation
		Monitoring: Mandatory RESULTS reporting tracks the character of trees that have been retained. However, we are not aware of any assessment of what *could have been retained* under best management practices. **Controls:** Stocking assessment methods and stocking standards flexible enough to cope with retention are required. A Chief Forester guidance letter is being prepared that deals with retention in large beetle-salvage blocks.[37] Traditionally, restrictions in the cutting permit were often used to control retention. The cut-leave table in the appraisal and the take-or-pay policy are influential.

4. Forest Service Response Options

To monitor, help improve, and control species management practices and outcomes, the Forest Service has a wide range of response options. To ensure a broad consideration of possible responses, the following options were discussed, but not necessarily endorsed.

1. **Forests For Tomorrow (FFT)**
   Use the FFT program to improve species composition on the landbase and provide leadership in good species management.
2. **BCTS, NRFL, SSS**
   Use these programs to improve species composition on the landbase and provide an example of good species management.
3. **Communication, training, and technical assistance**
   Communicate government objectives for the management of species composition and provide the training, tools, and technical assistance that will help licensees to achieve these objectives.
4. **Third parties**
   Raise the awareness of influential third-parties, such as professional associations and SFM certifying bodies, of species management issues. Encourage these third parties to promote best species management practices with licensees.
5. **Cutting Permit (CP)**
   Add restrictions to CPs to increase the retention of desirable non-pine mature trees where appropriate.
6. **Appraisal**
   Increase the silviculture appraisal allowance in return for improved species management. Pair this with a new regulatory requirement to plan for and achieve diverse species compositions at free-growing. More broadly, these changes could be part of a new enhanced management regime in select TSAs that partners an increased silviculture allowance with increased silviculture requirements (e.g., an increased MSS, a new species diversity requirement, etc.).
7. ***Forest and Range Practices Act* – species diversity**
   A wide variety of options were discussed, including the following: i) request (or require) a strategy to address the management of species composition; ii) create a new practice requirement for species diversity; iii) create a new landscape-scale (multi-block) control on species diversity.
8. **Conifer stocking standards**
   Options include i) Act and/or regulation change to allow the Chief Forester to specify stocking standards, over-ride currently approved stocking standards, or compel mandatory amendments to approved standards; ii) to guide the approval of new stocking standards, certain species could be identified as no longer acceptable to contribute to stocking on specified sites; iii) revise the provincial species selection guidelines.
9. **Hardwood stocking standards**
   To allow more hardwoods at free-growing: i) permit/encourage hardwoods as preferred (or acceptable) species in stocking standards; ii) increase the maximum allowable countable broadleaf trees in the free-from-brush assessment; iii) where appropriate, ensure licensees have approved hardwood stocking standards for a

well-defined set of situations and circumstances; iv) update the Chief Forester's "Broadleaf memo."

10. **C&E**
    Intensify the enforcement of existing species composition requirements (such as existing MSSp requirements).
11. **RESULTS**
    Develop in RESULTS the capability to report on the nature of species composition at the landscape (or multi-block) scale.
12. **Performance reports**
    Create reports that portray the species management performance of a licensee or the performance of all licensees operating in a given area. Use these reports to drive improvements.
13. **Research, analysis, and effectiveness evaluation**
    Initiate research, analysis, and effectiveness evaluation on critical species management issues to build the information base to guide change to current policy and practice.

5. Conclusions

From the assessment of the current situation, and possible response options, the following conclusions were drawn.

1. A detailed assessment of opportunities to increase exotics is not warranted. Rather, the current restrictions on operational use should be continued.
2. It is inappropriate to globally either promote or constrain hardwoods. Rather, any change should be adjudicated at the local level on the basis of thorough analysis. In the interim, the current rules should be maintained. Better yield estimates for conifers, deciduous, and mixedwoods by site series would contribute to intelligently evaluating species options. In those management units where interest in increased use of hardwoods is strong, the FFT silviculture strategies should include an investigation of the impact of an increase in hardwoods. This assessment should recognise the level of hardwoods currently on the landbase and the losses to long-term conifer yields associated with increased hardwoods. Low levels of hardwoods adequate to sustain ecological values must be maintained. The FFT program should be discouraged from brushing older hardwoods until impacts are evaluated. The Chief Forester Broadleaf Memo should be revised for those districts with a credible potential for active hardwood management. Increased hardwood management should only be contemplated where hardwoods are ecologically acceptable, silviculturally feasible, and likely to be commercially viable. Under the right circumstances, when there are discrete hardwood patches contained within a block boundary there should be the option to harvest, regenerate, and actively manage these as hardwoods.
3. In management units with severe mid-term timber supply deficits, the retention within cutblocks of operable concentrations of economically valuable, merchantable non-pine trees should be promoted. This issue is sensitive due to its impact on harvest cost and revenue. Control mechanisms include Cutting Permits, the cut/leave tables in appraisals, and restrictions in licenses. Furthermore, this issue is tightly linked to Chief Forester guidance on retention in large beetle salvage blocks. The question of whether retention in large salvage cutblocks should be designed for subsequent harvest should be thoroughly debated. Issues around retention merit examination by a committee reporting back to Forest Service executive.
4. The provincial species selection guidelines should continue to be periodically reviewed and updated. At the next revision, on a few sites, lodgepole pine should likely be demoted from preferred to acceptable (or acceptable to unacceptable) species to reflect recent forest health concerns such as *Dothistroma* foliar disease. The review of the species selection guidelines with potential revisions to accommodate climate change should be managed as a separate initiative.
5. The current procedure of distinguishing preferred from acceptable species, and having a stocking requirement for preferred species, should be maintained. These elements were required under the Forest Practices Code, but they are not specifically required under FRPA. As a result there is some uncertainty around the content and structure of the stocking standards that will be contained in the new Forest Stewardship Plans (FSPs). As FSPs are submitted, their stocking standards should be evaluated to assess changes in i) the nature of the control they exercise over species composition, and ii) the species compositions that are considered acceptable.

6. Given the importance of species diversity to both long-term timber supply and to ecological sustainability, several actions on the issue of species diversity are warranted. The capability should be developed for RESULTS to easily report on species diversity (both within stand and among stands). Those with the room to improve their management of species composition should be identified and then challenged to do so. The Forest Service should communicate its desire for re-establishing on harvested sites a diversity of desirable species. The design of regulatory controls on species diversity should be explored.
7. We must ensure that our own house is in order. It would be useful to create a best practices document that covers species management and applies to all reforestation programs managed by the Forest Service. BCTS should follow best practices for species management. FFT should be used to increase diversity, especially in landscapes where species diversity has been reduced due to past practices. Such efforts are consistent with the objectives of the Mountain Pine Beetle Action Plan.[38]
8. In future stages of this policy analysis, more input should be solicited from First Nations, licensees, NGOs, the academic and research community, and other interested parties. General support for species diversity can be expected from several stakeholder groups.
9. Care should be taken to avoid an excessive backlash against planting lodgepole pine. On many sites, lodgepole pine remains the most valuable, productive, reliable conifer species. And, on many sites, even if only lodgepole pine is planted, retention and natural regeneration add to species diversity at free-growing.
10. Some changes to reforestation practices that will increase species diversity add little to costs and do not increase the risk of regeneration failure. However, others are much more costly and/or add significantly to the risk of regeneration failure. Consideration should be given to alternative methods to pay for the desired species diversification and assume the increased risk.
11. It is important to get right the relationships among current practice, TSR and stocking standards. When new information indicates that current practice is creating undesirable conditions, it is important to revise practice and change standards – not simply continue because this practice and these standards have been modeled in the TSR. More generally, foresters can better manage species composition when they have access to forest- and landscape-level simulations of the long-term consequences of species management alternatives. Stand-level species choices should be informed by higher-level strategic analyses and plans. To conduct these analyses and formulate these plans, up-to-date inventories are important.
12. Opportunities to improve species composition are generally local – not global – opportunities. That is, when feasible improvement opportunities exist, they exist on specific sites in specific locations. In addition, debate on what species management changes are feasible and worthwhile is required. For this type of problem, an appropriate response is an evidence-based approach that identifies specific areas with improvement potential, provides the evidence that supports the preliminary assessment of improvement potential, and challenges local silviculturists to review species management practices in light of the evidence.
13. This analysis of the management of species composition demonstrates the great value of accurate, complete, long-term records of silviculture standards,

activities, and outcomes. Quality data makes possible evidence-based policy analysis and decision-making. To sustain this capability, the Forest Service must maintain its information systems (such as RESULTS) and takes steps to ensure data quality.

14. In summary, we set out to address three very broad questions:
    i) Are harvested areas being reforested to desirable species composition?
    ii) Are species management practices and outcomes adequately monitored and controlled?
    iii) What actions are recommended to improve the management of species composition?

    We considered species composition “desirable” if it provides a short-, mid-, or long-term supply of economically valuable timber, and/or an appropriate level of ecological benefits. By these measures, we conclude that – overall – harvested areas are being reforested to desirable species composition, but improvements can be made in the use of hardwoods, the degree of retention, and the diversity of species composition. While many aspects of species management practices and outcomes have been adequately monitored and controlled, species diversity has not, and more higher-level (forest, landscape, and/or multi-block) strategic planning is needed. We offer 11 specific recommendations to improve the management of species composition (see Summary and Recommendations).

6. Acknowledgments

This report has been enhanced by the contributions of many people. They are listed in Appendix 3 and we are grateful to them all. This report has been reviewed in draft form. We wish to thank the following individuals for their review comments on all – or part – of an earlier version of this report: Lorne Bedford (BC Forest Service), Henry Benskin (BC Forest Service), Bob Clark (BC Forest Service), Dave Coates (BC Forest Service), Nancy Densmore (BC Forest Service), Gord Dow (BC Forest Service), Marg Shamlock (BC Forest Service), Art Shortreid (Canadian Forest Service), Gordon Weetman (University of British Columbia), Roger Whitehead (Canadian Forest Service), Ralph Winter (BC Forest Service), Colene Wood (BC Ministry of Environment), and Alex Woods (BC Forest Service). For extracting and summarising data from the provincial harvest and silviculture databases (HBS and RESULTS), we thank Tony Dellaviola. For managing the data summaries, and producing graphs and tables, we thank Martin Watts.

7. Limitations

The committee faced a daunting task in the preparation of this report: a very short time frame, numerous complex issues, and a vast and variable portion of the province. Additional analysis is recommended in virtually all areas to refine and confirm our preliminary results. The findings, conclusions and recommendations in this report reflect the information available to us at this time. The views expressed in this report are those of the committee and should not be interpreted as the views of the BC Forest Service.

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1 The study area comprises the following TSAs: Williams Lake, Prince George, Quesnel, Lakes, 100 Mile House, Merritt, Kamloops, Mackenzie, Okanagan, Morice, and Cranbrook.

2 This strategy is plausible as there are many examples world-wide where exotics achieve volume production rates that exceed those of native species (for example, Radiata pine in New Zealand, lodgepole pine in Sweden, and Sitka spruce in Great Britain).

3 For a more thorough discussion, refer to Hartley (2002) and Carnus et al. (2003).

4 See volume 141, issues 1-2 of Forest Ecology and Management, especially Elfving et al. (2001) for discussion of Swedish experience with the introduction of lodgepole pine into Sweden.

5 See for example, the FSC boreal forest standard (Forest Stewardship Council 2004).

6 See Appendix 4, Figures A4–1 and A4–2 for the average percent of hardwoods in young stands on harvested areas (from the inventory label) by harvest year by TSA.

7 The harvested area on which deciduous (broadleaf) tree species can contribute to the stocking requirements varies among districts and over time. Where they are included in stocking standards, deciduous are typically acceptable, not preferred, species. Deciduous tree species are included in the stocking standard more commonly in the southern TSA group than in the northern TSA group. See Appendix 4, Figures A4–3 to A4–14 for the percent of harvested area where the stocking standard lists deciduous as preferred or acceptable by TSA by year. Note that the data for 2004 may be incomplete, resulting in an erratic percentage value in 2004 in some TSAs.

8 See Pedersen (2000).

9 In Special Report #16, the BC Forest Practices Board (2003) found excellent results reforesting harvested areas.

10 For example, a review in 2004 found that 35% of FDP stocking standards in southern interior have more species listed as preferred than are listed as preferred in the Forest Service's reference guide (L.P. Atherton and Associates 2004).

11 See Lemmen and Warren (2005) for a recent overview of the possible effects of climate change on forests and the potential forest management options. Woods et al. (2005) examine the link between an increase in *Dothistroma* needle blight on lodgepole pine in northwestern BC and climate change in the form of an increase in summer precipitation. Logan et al. (2003) conclude that climate change may result in an intensification of insect outbreaks.

12 Seed availability is dictated by frequency of natural stand cone crops, establishment and maturity of seed orchards for the area, the quality, amount and ownership of seed stored at the Forest Service's Tree Seed Centre, and the transfer limits for the species and seed origin as prescribed by the *Chief Forester's Standards for Seed Use*. Seed requirements for MPB-impacted areas would be best determined following the selection of appropriate silviculture strategies and reforestation species. Tree Improvement Branch is currently undertaking a preliminary seed needs analysis for MPB-impacted areas. Licensees, regions, and BCTS are also reviewing their seed needs and undertaking collections in some cases.

13 Achieving a diversity of species composition, both within and among stands, is one of several ways to reduce the risk of damage by forest health agents. See, for example, Whitehead et al. (2004). Other strategies include active monitoring and prompt response to emerging pest and disease problems. The importance of the species diversity strategy relative to other strategies is open to debate. Kimmins et al. (2005) discuss the strategy of accepting a higher risk forest and focussing effort on increasing the ability of communities and society to cope and adapt when large-scale disturbances occur. A recent examination of the economics of spruce-beech mixtures illustrates many of the concepts that underpin the use of species mixtures to reduce the probability of, and harm from, future damage (Knoke et al. 2005). The strategy of species diversification to manage risk appears to enjoy popular support (see Parfitt (2005) for a recent example). Although this report is limited to an investigation of tree species issues, several interviewees expressed support for both structural and compositional diversity.

14 See Appendix 4, Figure A4–15 and A4–16 for the average percent of the leading (dominant) species in young stands on harvested areas (from the inventory label) by TSA by year. Compared to more recently harvested areas, the composition on areas harvested more than 20 years ago is more diverse, especially in southern TSAs. In some TSAs, young stands originating in the late 80s and early 90s appear to be the most strongly dominated by a single species, with a trend to increasing diversity in more recent cutblocks.

15 See Appendix 4, Figure A4–17 and A4–18. On average, young stands in the study area have less than two species with percentages > 20% (in the inventory label).

16 See Appendix 4, Figures A4–19, A4–20, and A4–33 to A4–43. The percent of planted area (ATU area) where only one species was planted varies among TSAs and declines strongly from the 1980s to the present.

17 See Appendix 4, Figures A4–21 to A4–32 for the area harvested, area planted, and planted:harvested ratio by year by TSA. Note that the data for 2004 may be incomplete in some TSAs, resulting in erratic planted:harvested ratio values in 2004 in some TSAs. The ratio of area planted to area harvested varies among TSAs and over time. It is generally greater in the northern TSA group than in the southern TSA group, but has increased since the 1980s in both groups.

18 See Appendix 4, Figures A4–33 to A4–43 for the area planted by planting situation by year by TSA. The area planted annually varies among TSAs and over time and has increased substantially since the 1970s. In most planting situations, more than one species is listed as preferred in the associated stocking standard. The frequency of planting events where only one species is planted but the stocking standard lists more than one species as preferred is generally low and has declined to the present.

19 Previous investigations concluded that forest practices were not increasing the amount of monocultures (BC Ministry of Forests 1992, Tsoi 1999). However, a study currently underway finds a slight increase in the ratio of monocultures before harvest to monocultures after harvest (Ralph Winter, BC Ministry of Forests, personal communication, 2005). A recent comparison in New Brunswick of pre-harvest stand to post-harvest plantation species composition found a similar frequency of monocultures. However, species composition before harvest and after reforestation differed in other potentially important ways. Compared to the natural forests that they replace, plantations in New Brunswick's public forest have fewer hardwoods, more jack pine, less red spruce, and less species diversity (Erdle and Pollard 2002).

20 The best-documented case of over-planting lodgepole pine is in the ICH zone in north-western BC where mature forests of hemlock, balsam, spruce, pine, cedar, and hardwoods were harvested and then regenerated to stands dominated by only two species: lodgepole pine and interior spruce (Woods 2003, Woods et al. 2005). The resulting young stands are less healthy and resilient than young stands with a more diverse species composition that more closely approximates composition following natural disturbance.

21 See Appendix 4, Figures A4–44 and A4–45 for the average percent of planted area (ATU area) in which only lodgepole pine was planted at the planting event by year by TSA. The frequency of pure pine planting events varies among districts and over time and tends to be more common in southern TSAs than in northern TSAs. In recent years, the Merritt, 100 Mile House, and Williams Lake TSAs show notably higher percentages of areas planted solely to pine.

22 See Appendix 4, Figures A4–19 and A4–20.

23 See Appendix 4, Figures A4–46 to A4–57, where the number of preferred species listed in the approved stocking standard is used to compute the percent lodgepole pine in young stands under a theoretical scenario of high within-stand diversity. The average amount (percent) of lodgepole pine in young stands varies among TSAs and over time, but generally exceeds the amount expected under a hypothetical scenario of high within-stand species diversity. This difference suggests that there may be room to reduce the amount of lodgepole pine, increase the amount of other preferred species, and thus increase the diversity of desirable species in young stand composition. By this measure, older regenerated stands (e.g., those harvested before 1990) are more diverse than younger stands.

24 See Appendix 4, Figure A4–58 to A4–75 for the number of seedlings planted by species by year by TSA. The number of trees planted varies among districts and over time, with the total number planted strongly increasing from the 1970s to the present. Lodgepole pine and members of the spruce genus have been planted in the greatest numbers. Since the early 1990s, spruce planting has declined compared to the amount of pine planted. As a percent of trees planted, lodgepole pine has generally increased from 1980 to the present, except in the Morice and Lakes TSAs. Among BEC zones, the percent of lodgepole pine planted varies as follows: MS>SBS>ICH and ESSF. Since the 1980s, the percent of planted seedlings that are lodgepole pine has increased over time in these four BEC zones. However, since about 1995 the percent of lodgepole pine planted in the ICH has strongly declined. These general trends vary substantially among subzones.

25 For an example, see Woods et al. (2005).

26 See Appendix 4, Figure A4–76 and A4–77 for the average percent lodgepole pine in young stands (from the inventory label) by disturbance year by TSA. The amount of lodgepole pine in young stands varies among TSAs and over time with higher levels in 1980s origin stands in the Lakes TSA and in 1990s origin stands in the Lakes, Morice, Quesnel, Merritt, and Williams Lake TSAs.

27 As part of a review of mountain pine beetle management in BC, the Forest Practices Board examined two landscape units in the Nadina Forest District (BC Forest Practices Board 2004a). In these areas, in response to the question "Are silviculture opportunities planned at the landscape-level to address the risk of future MPB outbreaks?" the Forest Practices Board concluded: "At the time of the assessment there was no mention of reforestation plans being planned at the landscape-level to address the risk of future outbreaks."

28 Broadleaf tree species are often identified as particularly important (see Bunnell et al. (2004) for example).

29 See Bradford et al. (2003).

30 See Bunnell et al. (2004) page 16.

31 For more detail, contact Nancy Densmore, Forest Practices Branch, BC Ministry of Forests and Range, Victoria, BC.

32 For an example, see the TFL 30 SFM plan (Canadian Forest Products Ltd. 2003).

33 This is a corollary to the oft-repeated injunction to avoid harvest of areas with lower amounts (<40%) of lodgepole pine (Bunnell et al. 2004, Eng 2004). However, we emphasise the value of this retention for short- and mid-term harvest. The dual economic and ecological benefit of retention is noted by Bunnell et al. (2004).

34 The Forest Practices Board has encouraged licensees to avoid harvesting non-infested trees. For example, in its audit of a West Fraser licence near 100 Mile House (BC Forest Practices Board 2004b), the Board concluded: "As a result, the percentage of incidental non-infested timber harvested by West Fraser may not have been minimized. This practice requires improvement."

35 See Eng et al. (2005).

36 See Appendix 4, Figures A4–78 to A4–91 for the harvested volume by species by year by TSA. The timber volume harvested varies among TSAs and over time. The majority of the timber harvest in the study area is lodgepole pine. The percent of the annual harvest that is lodgepole pine varies among TSAs and has been steadily increasing since 1995 in all TSAs in the study area.

37 See end note #31.

38 Objective six of the action plan is to “restore the forest resources in areas affected by the epidemic” (Province of BC 2005).

Appendix 1: Committee terms of reference (June 8, 2005)

Committee Name: Management of post-harvest species composition in beetle blocks

Type: ____ Standing ____ Ad Hoc _X_ Advisory

Chairperson: Patrick Martin, Stand Development Specialist, Forest Practices Branch

Members: title or qualifications (individual)

Brian Barber, Technical Advisor, Tree Improvement Branch

Craig Delong, Landscape Ecologist, Northern Interior Region

Del Meidinger, Research Ecologist, Research Branch

Mike Pelchat, Stewardship Officer, Quesnel Forest District

Responsible to: Manager, Harvesting and Silviculture Practices Section (Lorne Bedford)

Purpose:

The purpose of this committee is to advise ministry executive on issues pertaining to the management of post-harvest species composition in cutblocks in that portion of the province under mountain pine beetle (MPB) attack. The specific questions to be addressed are:

1. Will the tree species composition – after harvest and reforestation – be optimal, desirable, and consistent with the broad, public policy goal of sustainable forest management? The assessment will consider the extent to which current practices will result in:
    a. a high level of economically valuable timber supply in the short-, mid-, and long-term, and
    b. the conservation of biodiversity, ecological resilience, and other resource values.
2. Does the current policy framework allow for adequate monitoring and control of species composition on harvested areas?
3. If changes are required, what should be done to align post-harvest species composition with the policy goal?

Background:

Concerns have been expressed as to whether areas harvested in the MPB-attack region are being reforested to the optimal species composition. Specific concerns have been raised about the possible excessive planting of lodgepole pine and the potential use of fast-growing hardwoods to offset mid-term timber supply shortfalls. Forest Practices Branch has committed to two relevant initiatives: 1) a RESULTS report prepared by Ralph Winter that will characterize current trends in reforestation and 2) an update to the species selection guide by Research Branch with FFT funding. In addition, the Forest Practices Board is conducting a review of planting species selection in MPB harvested areas. WLAP may have a related initiative.

In May 2005, the Chief Forester requested an assessment of the problem and recommendations on whether any interim guidance or change to policy is warranted. In addition, a detailed proposal, a communication plan, timelines, and a partnership with Ops to Div to develop a strategy and guide implementation of recommendations was requested. This effort must recognize the potential for climate change and link to the work of the ministry's Climate Change Review Committee.

Deliverables:

1. Terms of Reference and Work Plan.
2. Brief, preliminary, draft document:
   a. assessing the trends and implications in species composition resulting from current practice;
   b. assessing current monitoring and control mechanisms;
   c. if problems are evident, identifying and evaluating alternatives to rectify the problems;
   d. recommending actions to rectify identified problems; and
   e. identifying knowledge gaps critical to the assessment, monitoring, and control of species composition.
3. A presentation to MoF executive and a field review.

Following the review of the initial document, the committee may be asked to continue with further development of an implementation strategy.

Authority: Advisory

Timeframes, reporting and deadlines:
(schedule of meetings or important timelines)

Terms of reference and work plan by May 27, 2005

Draft document by August 31, 2005

Field review and presentation to MoF executive in September, 2005

Support, Resources or Budget:
A budget is available for contractor support, travel, and administrative assistance.

Additional Notes:
The project scope is limited to the 13 highly impacted management units. The scope of this committee is not limited to FFT projects. However, the FFT provides a convenient means of organization and administrative support.

Chair: ____

TOR Approval/Revision Date: _______________________

Work Plan

This is the plan of work for the committee from mid-May to mid-September, 2005.

Task	Responsibility	Will be completed by
1. Host a series of conference calls with ministry district and regional staff and other key parties (e.g., academics and industry staff) to explore issues and response options	Organized by Pat Martin with participation of Committee members as their schedules permit	August 31, 2005
2. Conduct field reviews	Pat Martin with participation of Committee members as their schedules permit	August 31, 2005
3. Quantify issues with custom RESULTS reports	Organized by Pat Martin with participation of Committee members as their schedules permit	August 31, 2005
4. Plan a field tour for interested MoF executive	Pat Martin with participation of Committee members as their schedules permit	August 31, 2005
5. Prepare a brief, preliminary report assessing issues, evaluating options, and making recommendations	Pat Martin with contributions of committee members	August 31, 2005
6. Presentation to executive and/or field review with interested MoF executive	Pat Martin with participation of Committee members as their schedules permit	mid-September, 2005

A communication strategy will not be developed until executive provides direction following the mid-September presentation of results.

The partnership approach that will be employed with Ops Div includes ensuring Ops Div members are on the committee and that Ops Div staff participate in describing the issue, and identifying and evaluating possible responses.

Appendix 2: Questions for districts and regions Management of species composition in beetle blocks

The purpose of this conference call is to get the opinions of district and regional MoF staff on the management of species composition in beetle blocks, including:

1. whether current practices (retention, planting, etc) are creating desirable species compositions,
2. whether current policies are adequate to monitor and control species composition, and
3. what could be done to improve species composition at free-growing in beetle blocks.

On the conference call, district and regional staff will be asked to address the following questions:

1. **Retention of non-pine species at harvest**
    a. What species are typically retained? In what amounts? Under what conditions?
    b. Will these species provide an economically valuable future timber supply?
    c. Are these species providing the desirable levels of environmental values (e.g., biodiversity)?
    d. Are the current RESULTS procedures adequate to monitor the species, amount, and quality of retention? Should something more be done? What?
    e. Should more be done to influence or control species retained at harvest? What?
2. **Planting**
    a. Is too much lodgepole pine being planted? Where? Under what conditions? Why?
    b. What opportunities to increase species diversity by planting are being missed?
    c. Are the current RESULTS procedures adequate to monitor the species planted? Should something more be done? What?
    d. Should more be done to influence or control species planted? What?
3. **Increase aspen to mitigate mid-term timber supply**
    a. Should more aspen be allowed in the hope that it will be available for harvest sooner and thus mitigate mid-term timber supply deficits?
4. **Economically valuable timber supply:**
    a. Where/when are current species management practices harming:
        - short-term timber supply
        - mid-term timber supply
        - long-term timber supply
5. **Ecological values (biodiversity, ecological resilience)**
    a. Where/when are current species management practices harming ecological values (biodiversity, ecological resilience, etc.)?

6. **If current practices (retention, planting, etc) are not creating desirable species compositions, what are the pros and cons of the following possible policy responses:**
   a. Educational initiatives to clarify government objectives and encourage better practices (e.g., CF letter, regional letter, training sessions, discussion at conferences, etc.).
   b. Economic incentives (e.g., a change to the silviculture allowance to increase mixed species planting where practical).
   c. Government programs: compensate though BCTS or FFT activities.
   d. Regulation: retention requirements in cutting permits, create a new requirement to diversify species compositions, etc.
   e. Information: Effective evaluations and RESULTS reports – widely disseminated – that document trends in practices and outcomes.

Appendix 3: Individuals consulted

Consultation with policy specialists on response options, June 27, 2005, Victoria
- Lorne Bedford
- Ralph Winter
- Marg Shamlock

Discussions in field near Prince George, June 1, 2005
- Gord Dow
- Craig Farnden

Discussion with Roger Whitehead, June 9, 2005

Conference call with northern districts June 9, 2005
- Ray Leduc
- John DeGagne
- Guy Newsome
- Gord Dow
- Carolyn Stevens
- John Paul Wenger
- Megan Williams
- Russ MacDonald

Discussions with John Przeczek, June 21, 2005

Conference call with south districts, June 28, 2005
- Bernie Kaplun
- Ted McRae
- Brent Olsen (by e-mail)
- Don Parno
- George Williamson

Conference call with MoF geneticists, June 29, 2005
- Brian Barber
- Mike Carlson
- Barry Jaquish
- Greg O'Neil
- Alex Woods
- Alvin Yanchuck

Meeting with Prince George industry silviculture staff July 11, 2005
- Vince Day
- Peter Forsythe
- Doug Perdue

Meeting with Prince George academics, researchers and educators July 12, 2005
- Phil Burton
- Andrea Eastham
- Steve Kiiskila
- Ed Morice
- Chris Hawkins
- Roger Whitehead
- Alan Wiensczyk
- Colene Wood

Appendix 4: Data

Data Set #1: Tree species planted and species composition on planted cutblocks in Vanderhoof district. Data provided by John DeGagne.

-----Original Message-----

From: DeGagne, John M FOR:EX

Sent: Thursday, June 02, 2005 10:34 AM

To: Martin, Pat J FOR:EX

Subject: RE: Conf call to discuss species composition June 9 1:30-3 PM

Some preliminary numbers for you from RESULTS.

- The number of tree planted in the District, as indicated in the Activity Report, since 1994 is PLI 143,575,010 (82%); Sx 28,398,215 (16%); Sw 1,789,155 (1%); FDI 1,399,256 (0.8%)
- From the Forest Cover Report and filtering by stands stocked artificially we have Pl 88,144 ha(83%); S 13,893ha (13%); Fd 584ha (0.5%); and deciduous 3024ha (3%, not likely planted but a part of the forest cover).

Numbers are close enough in each example to show a trend. Numbers probably accurate but will put more thought into the questions you raise below for the call.

John

-----Original Message-----

From: DeGagne, John M FOR:EX

Sent: Thursday, June 02, 2005 11:36 AM

To: Martin, Pat J FOR:EX

Subject: RE: Conf call to discuss species composition June 9 1:30-3 PM

One other set of number for you based on last years planting percentages. Numbers similar to those I've already provided but based on last year only.

<< File: 2004 SILV ACTIVITY NUMBERS.xls >>

Table A4-1. Silviculture activities and tree species planted by licensee in Vanderhoof district. Data provided by John DeGagne.

Silviculture Activities 2004:		Licensee (# Units – Hectares or # trees)								
Activity	**Funding**	**L&M**	**PL**	**CF**	**WF**	**LK**	**BCTS**	**District Total**		
Site Preparation	IA	16	301	0	280	0	770	1,367	ha	
Total Brushing	IA	170	464	48	333	40	34	1,089	ha	
Manual Brushing	IA	53						53	ha	
Chemical Brushing	IA	115				40		155	ha	
Juvenile Spacing	–	0	194	54	0	0	0	248	ha	
Pruning	–	0	0	0	0	0	0	0	ha	
Fertilization	–	0	0	0	0	0	0	0	ha	
Mistletoe Control		0	97	700	181	0	0	978	ha	
Total Planted	IA	773,530	2,100,000	4,200,000	2,379,551	421,560	1,600,000	11,474,641	trees	
Planted (Pine)	IA	759,695	1,785,000	3,360,000	1,665,686	421,560	1,300,000	9,291,941	trees	81.0%
Planted (Spruce)	IA	13,835	315,000	756,000	713,865	0	300,000	2,098,700	trees	18.3%
Planted (Douglas-fir)		0	0	84,000	0	0	0	84,000	trees	0.7%

Data Set #2: Tree species planted by year by license type in Lakes and Morice districts. Data provided by Carolyn Stevens.

Table A4-2. Tree species planted by year by license type in Lakes and Morice districts. Data provided by Carolyn Stevens

									SPECIES TRENDS								
YEAR	SBF	M/L	PLI	SX	BL	FDI	AT	LW	PLI	SX	BL	FDI	AT	LW	TOTAL	DND	HA's
1998	DLA		957489	411324					70	30.0	0.0	0.0	0.0	0.0	1,368,813		
1998	DMO		375870	124710					75	24.9	0.0	0.0	0.0	0.0	500,580	1,869,393	1290.2
1998		DLA	2943720	1061295					74	26.5	0.0	0.0	0.0	0.0	4,005,015		
1998		DMO	4179946	3049673	374840			15900	55	40.0	4.9	0.0	0.0	0.2	7,620,359	11,625,374	8488.6
1999	DLA		1065107	375099					74	26.0	0.0	0.0	0.0	0.0	1,440,206		
1999	DMO		204880	112935	13100				62	34.1	4.0	0.0	0.0	0.0	330,915	1,771,121	1161.5
1999		DLA	3364417	764570	5190				81	18.5	0.1	0.0	0.0	0.0	4,134,177		
1999		DMO	4597564	3151257	265544			7266	57	39.3	3.3	0.0	0.0	0.1	8,021,631	12,155,808	8365.9
2000	DLA		1003500	372060					73	27.0	0.0	0.0	0.0	0.0	1,375,560		
2000	DMO		362665	128845					74	26.2	0.0	0.0	0.0	0.0	491,510	1,867,070	1288.6
2000		DLA	2740285	1120250			3995		71	29.0	0.0	0.0	0.1	0.0	3,864,530		
2000		DMO	4788693	2758682	137641				62	35.9	1.8	0.0	0.0	0.0	7,685,016	11,549,546	9232.3
2001	DLA		912579	377223	27342				69	28.6	2.1	0.0	0.0	0.0	1,317,144		
2001	DMO		370405	338670					52	47.8	0.0	0.0	0.0	0.0	709,075	2,026,219	1587.2
2001		DLA	3075505	1864652					62	37.7	0.0	0.0	0.0	0.0	4,940,157		
2001		DMO	4210084	2586709	313381				59	36.4	4.4	0.0	0.0	0.0	7,110,174	12,050,331	8569.2
2002	DLA		1049865	470235	72220				66	29.5	4.5	0.0	0.0	0.0	1,592,320		
2002	DMO		291875	267082					52	47.8	0.0	0.0	0.0	0.0	558,957	2,151,277	1599.4
2002		DLA	2925791	1874315	38540	35100			60	38.5	0.8	0.7	0.0	0.0	4,873,746		
2002		DMO	3610070	2822340	134715				55	43.0	2.1	0.0	0.0	0.0	6,567,125	11,440,871	7611.9
2003	DLA		1340577	1182317	99869	15552			51	44.8	3.8	0.6	0.0	0.0	2,638,315		
2003	DMO		54514	93138					37	63.1	0.0	0.0	0.0	0.0	147,652	2,785,967	1905.1

					SPECIES TRENDS												
YEAR	SBF	M/L	PLI	SX	BL	FDI	AT	LW	PLI	SX	BL	FDI	AT	LW	TOTAL	DND	HA's
2003		DLA	4126302	2691246	29175				60	39.3	0.4	0.0	0.0	0.0	6,846,723		
2003		DMO	3697739	2869040	96095				55	43.1	1.4	0.0	0.0	0.0	6,662,874	13,509,597	9900.6
2004	DLA		1402388	1145490	110055	21120			52	42.8	4.1	0.8	0.0	0.0	2,679,053		
2004	DMO		370155	485028					43	56.7	0.0	0.0	0.0	0.0	855,183	3,534,236	2954.4
2004		DLA	1408776	1428676	3010				50	50.3	0.1	0.0	0.0	0.0	2,840,462		
2004		DMO	2438205	2367181	114815				50	48.1	2.3	0.0	0.0	0.0	4,920,201	7,760,663	6055.1

	Ha's planted		
	ML	SBF	DND
1998	8488.6	1290.2	9778.8
1999	8365.9	1161.5	9527.4
2000	9232.3	1288.6	10520.9
2001	8569.2	1587.2	10156.4
2002	7611.9	1599.4	9211.3
2003	9900.6	1905.1	11805.7
2004	6055.1	2954.4	9009.5

Data Set #3: Tree species harvested, planted, and at free-growing in Canfor Prince George operations. Data provided by Vince Day, Canfor, Prince George.

Table A4-3: Volume delivered to Canfor Prince George mills by species by year

Species Breakdown by M^3 Delivered to Canfor PG Mills

Year	Aspen	Balsam	Birch	Cedar	Fir	Hemlock	Larch	Pine	Spruce	Total
2003	28	331,782		329	10,918	14,688		2,996,834	1,272,659	4,627,238
2004	–	204,905	10	–	101,723	8	–	2,921,606	988,827	4,217,079
Total	**28**	**536,687**	**10**	**329**	**112,641**	**14,696**	**–**	**5,918,440**	**2,261,486**	**8,844,317**
2003	0.0%	7.2%	0.0%	0.0%	0.2%	0.3%	0.0%	64.8%	27.5%	100.0%
2004	0.0%	4.9%	0.0%	0.0%	2.4%	0.0%	0.0%	69.3%	23.4%	100.0%
Total	**0.0%**	**6.1%**	**0.0%**	**0.0%**	**1.3%**	**0.2%**	**0.0%**	**66.9%**	**25.6%**	**100.0%**

Table A4-4: Number of trees planted by species by supply block by year in Canfor Prince George operations

Trees Planted by Supply Block

Canfor PG Woodlands (includes TFMI planting)

		Sum of # Trees by Year							
SBLK	**SPP**	**2003**	**2004**	**2005**	**Grand Total**	**2003**	**2004**	**2005**	**Total**
A	Pli	721,330	1,071,220	981,240	2,773,790	94%	94%	80%	88%
	Sx	49,505	66,215	247,680	363,400	6%	6%	20%	12%
B	Pli	2,119,910	1,349,300	404,030	3,873,240	67%	69%	58%	66%
	Sx	1,060,835	611,710	295,929	1,968,474	33%	31%	42%	34%
C1	Fdi	540	2,970		3,510	0%	1%	0%	0%
	Pli	474,270	179,470	631,080	1,284,820	66%	56%	60%	61%
	Sx	244,237	140,150	425,790	810,177	34%	43%	40%	39%
E	Fdi			53,280	53,280	0%	0%	3%	1%
	Pli	1,477,850	949,363	877,230	3,304,443	39%	33%	50%	39%
	Sx	2,357,307	1,967,025	821,490	5,145,822	61%	67%	47%	61%
F	Fdi	551,990	809,455	664,074	2,025,519	10%	13%	11%	11%
	Pli	3,752,251	4,327,472	4,430,000	12,509,723	69%	69%	70%	69%
	Sx	1,115,802	1,173,155	1,228,060	3,517,017	21%	19%	19%	19%

		Sum of # Trees by Year							
SBLK	**SPP**	**2003**	**2004**	**2005**	**Grand Total**	**2003**	**2004**	**2005**	**Total**
G	Bl	65,100			65,100	4%	0%	0%	2%
	Fdi	58,590	36,720	21,600	116,910	4%	5%	2%	3%
	Pli	647,210	272,365	278,480	1,198,055	44%	38%	23%	35%
	Sx	698,770	412,215	899,783	2,010,768	48%	57%	75%	59%
H	Sx	410,452	546,875	326,182	1,283,509	100%	100%	100%	100%
Q	Pli	376,324	63,140	549,405	988,869	66%	89%	80%	75%
	Sx	189,865	7,950	136,805	334,620	34%	11%	20%	25%
T	Fdi	810			810	0%	0%	0%	0%
	Pli	86,110	133,695	25,000	244,805	5%	9%	2%	6%
	Sx	1,524,779	1,295,520	1,162,994	3,983,293	95%	91%	98%	94%
Grand Total		**17,983,837**	**15,415,985**	**14,460,132**	**47,859,954**				
	Bl	65,100	0	0	65,100	0%	0%	0%	0%
	Fdi	611,930	849,145	738,954	2,200,029	3%	6%	5%	5%
	Pli	9,655,255	8,346,025	8,176,465	26,177,745	54%	54%	57%	55%
	Sx	7,651,552	6,220,815	5,544,713	19,417,080	43%	40%	38%	41%

Table A4-5: Area-weighted average species composition on free-growing strata by BEC unit for Canfor Prince George operations

Species Breakdown on Free-growing Strata (Inventory Layer) for Blocks with FG Surveys Completed for Canfor PG

Zone	Subzone	Aspen	Balsam	Cedar	Birch	Douglas-fir	Hemlock	Pine	Spruce	Grand Total
ESSF	h	8.4	236.4	0.0	0.0	0.0	0.0	0.0	586.3	831.1
	mv	27.2	202.4	0.0	4.8	0.0	0.0	217.0	172.7	624.0
	wk	138.5	1,089.6	0.0	9.7	0.0	0.0	255.2	3,964.1	5,457.1
ESSF Total		174.1	1,528.4	0.0	14.4	0.0	0.0	472.2	4,723.1	6,912.2
ICH	f	0.0	32.9	16.8	20.2	2.5	9.8	4.8	208.1	295.1
	vk	31.0	112.7	64.1	78.2	75.0	52.2	166.6	723.9	1,303.7
	wk	84.8	73.3	51.8	400.5	9.0	55.4	316.7	900.8	1,892.2
ICH Total		115.7	218.8	132.7	498.9	86.5	117.3	488.1	1,832.8	3,490.9
SBPS	dc	1.9	11.7	0.0	0.0	0.0	0.0	53.7	16.4	83.7
SBPS Total		1.9	11.7	0.0	0.0	0.0	0.0	53.7	16.4	83.7
SBS	dw	429.1	363.9	0.0	402.8	380.7	0.0	5,128.9	905.7	7,611.1
	e	174.6	180.3	0.0	62.3	0.0	0.0	545.1	786.9	1,749.1
	f	29.6	623.7	3.1	302.0	79.6	0.0	147.2	5,634.7	6,819.7
	j	57.0	595.3	28.9	532.0	19.9	32.2	509.1	1,913.9	3,688.2
	k	19.5	2.5	0.0	10.9	0.0	0.0	230.7	57.0	320.6

Zone	Subzone	Aspen	Balsam	Cedar	Birch	Douglas-fir	Hemlock	Pine	Spruce	Grand Total
	mc	107.0	116.3	0.0	0.0	0.0	0.0	871.6	514.1	1,609.1
	mk	1,155.6	1,163.7	0.0	552.6	149.2	0.0	6,217.5	4,616.9	13,855.4
	mw	10.9	16.7	0.0	15.8	0.3	0.0	27.0	54.0	124.6
	vk	223.0	1,099.6	54.2	727.4	62.8	59.0	444.5	8,116.0	10,786.4
	wk	1,236.0	1,215.8	12.2	1,181.8	277.7	46.2	5,058.0	5,459.0	14,486.7
SBS Total		3,442.2	5,377.8	98.4	3,787.5	970.1	137.4	19,179.6	28,058.0	61,050.9
Grand Total		**3,734.0**	**7,136.7**	**231.1**	**4,300.8**	**1,056.6**	**254.7**	**20,193.6**	**34,630.3**	**71,537.8**

Zone	Subzone	Aspen	Balsam	Cedar	Birch	Douglas-fir	Hemlock	Pine	Spruce	Grand Total
ESSF	h	1.0%	28.4%	0.0%	0.0%	0.0%	0.0%	0.0%	70.5%	100.0%
	mv	4.4%	32.4%	0.0%	0.8%	0.0%	0.0%	34.8%	27.7%	100.0%
	wk	2.5%	20.0%	0.0%	0.2%	0.0%	0.0%	4.7%	72.6%	100.0%
ESSF Total		2.5%	22.1%	0.0%	0.2%	0.0%	0.0%	6.8%	68.3%	100.0%
ICH	f	0.0%	11.1%	5.7%	6.8%	0.8%	3.3%	1.6%	70.5%	100.0%
	vk	2.4%	8.6%	4.9%	6.0%	5.8%	4.0%	12.8%	55.5%	100.0%
	wk	4.5%	3.9%	2.7%	21.2%	0.5%	2.9%	16.7%	47.6%	100.0%
ICH Total		3.3%	6.3%	3.8%	14.3%	2.5%	3.4%	14.0%	52.5%	100.0%
SBPS	dc	2.3%	14.0%	0.0%	0.0%	0.0%	0.0%	64.2%	19.5%	100.0%
SBPS Total		2.3%	14.0%	0.0%	0.0%	0.0%	0.0%	64.2%	19.5%	100.0%
SBS	dw	5.6%	4.8%	0.0%	5.3%	5.0%	0.0%	67.4%	11.9%	100.0%
	e	10.0%	10.3%	0.0%	3.6%	0.0%	0.0%	31.2%	45.0%	100.0%
	f	0.4%	9.1%	0.0%	4.4%	1.2%	0.0%	2.2%	82.6%	100.0%
	j	1.5%	16.1%	0.8%	14.4%	0.5%	0.9%	13.8%	51.9%	100.0%
	k	6.1%	0.8%	0.0%	3.4%	0.0%	0.0%	72.0%	17.8%	100.0%
	mc	6.7%	7.2%	0.0%	0.0%	0.0%	0.0%	54.2%	31.9%	100.0%
	mk	8.3%	8.4%	0.0%	4.0%	1.1%	0.0%	44.9%	33.3%	100.0%
	mw	8.7%	13.4%	0.0%	12.7%	0.2%	0.0%	21.7%	43.3%	100.0%
	vk	2.1%	10.2%	0.5%	6.7%	0.6%	0.5%	4.1%	75.2%	100.0%
	wk	8.5%	8.4%	0.1%	8.2%	1.9%	0.3%	34.9%	37.7%	100.0%
SBS Total		5.6%	8.8%	0.2%	6.2%	1.6%	0.2%	31.4%	46.0%	100.0%
Grand Total		**5.2%**	**10.0%**	**0.3%**	**6.0%**	**1.5%**	**0.4%**	**28.2%**	**48.4%**	**100.0%**

Notes:

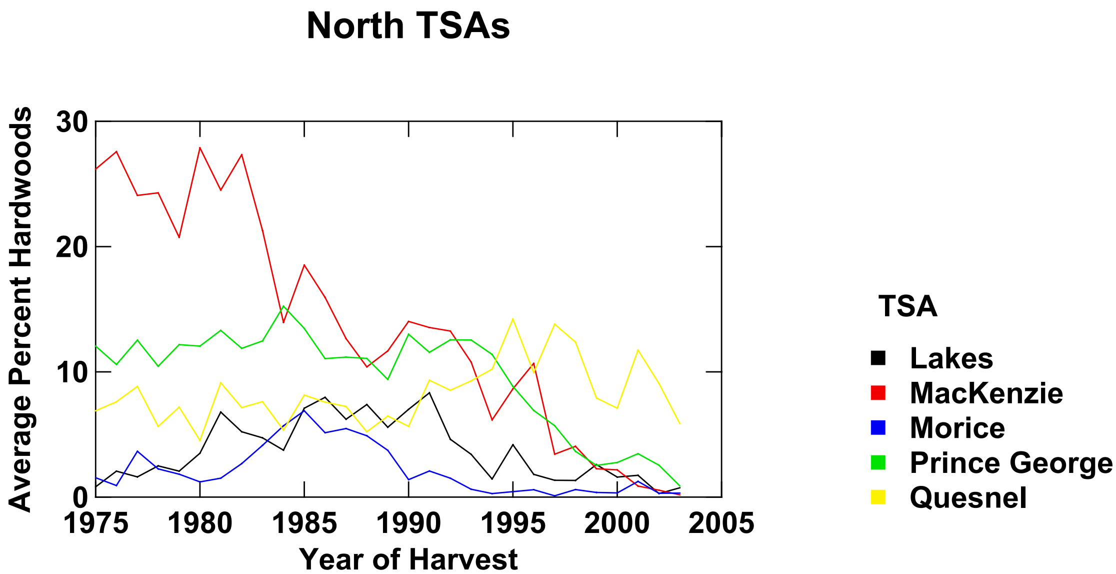
1. Areas of species taken from inventory label and was calculated by taking the product of the % of that species and the area of the stratum (10% Aspen in the inventory layer on a 10 hectare stratum shown as 1.0 of Aspen).

2. Only species which made the inventory label are represented and only the top 4 species in each inventory label were used for the table.

Data Set #4: Tree species harvested and planted in Dunkley's TFL 53. Data provided by Doug Perdue, Dunkley Lumber Ltd.

Table A4-6: Number (and %) of trees planted and volume billed (%) by species by year in TFL 53

Species Mix Planting Year	Pine	Spruce	Balsam	Douglas-fir	Total
2003	795,500 (50.5%)	749,060 (47.6%)	5,340 (0.4%)	24,210 (1.5%)	1,574,110
2004	750,960 (59%)	504,420 (40%)	0 (0%)	17,440 (1%)	1,272,820
2005	1,742,140 (54.5%)	1,317,690 (41.3%)	0 (0%)	134,190 (4.2%)	3,194,020
Scaled Volume % Species **Year**	**Pine**	**Spruce**	**Balsam**	**Douglas-fir**	**Deciduous**
2002	38	48	9	4	1
2003	59	35	3	2	1
2004	49	31	9	7	2



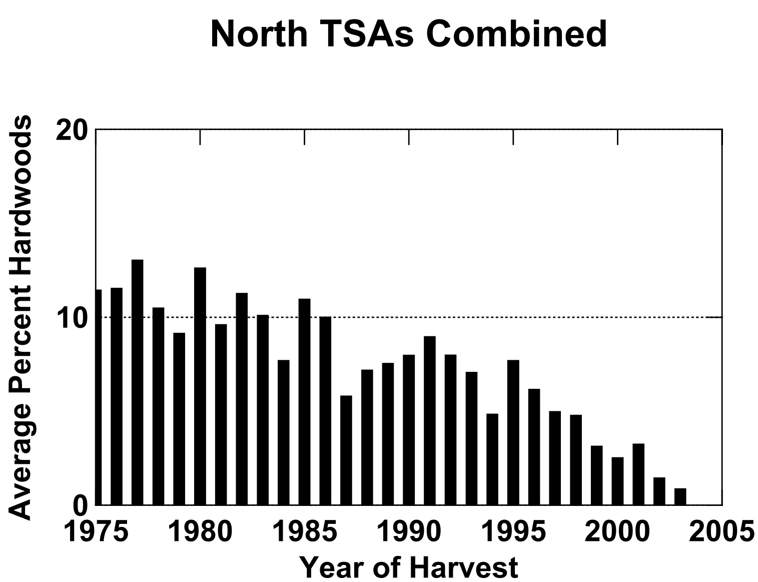
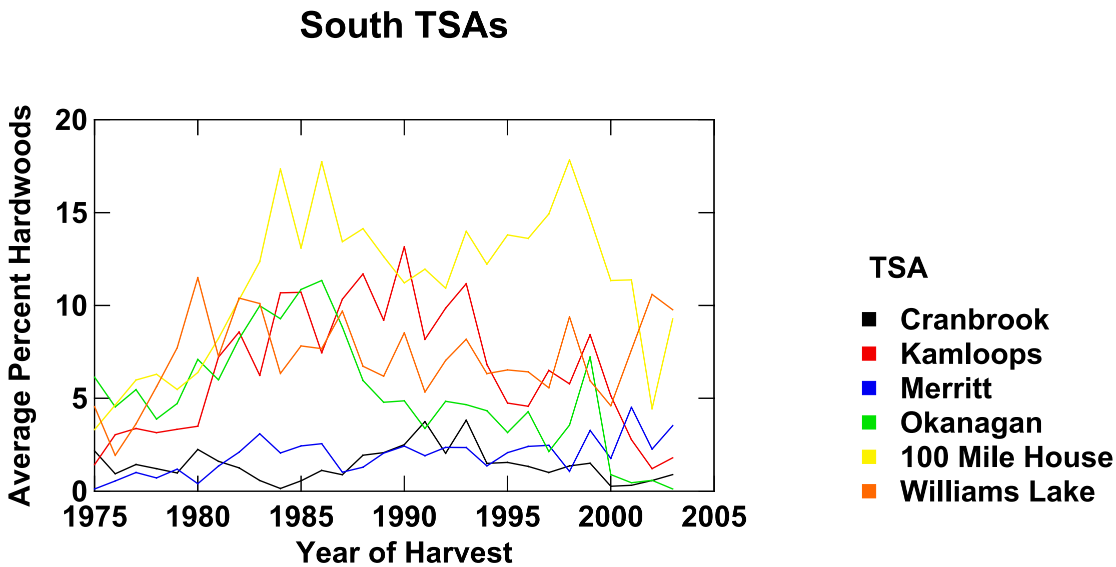


Figure A4–1. Average percent of hardwoods in young stands on harvested sites (from the inventory label) by harvest year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



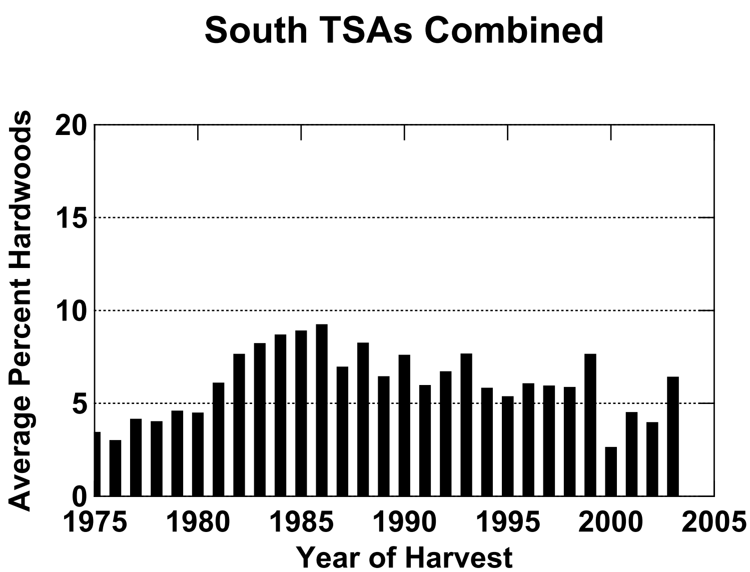


Figure A4–2. Average percent of hardwoods in young stands on harvested sites (from the inventory label) by harvest year by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

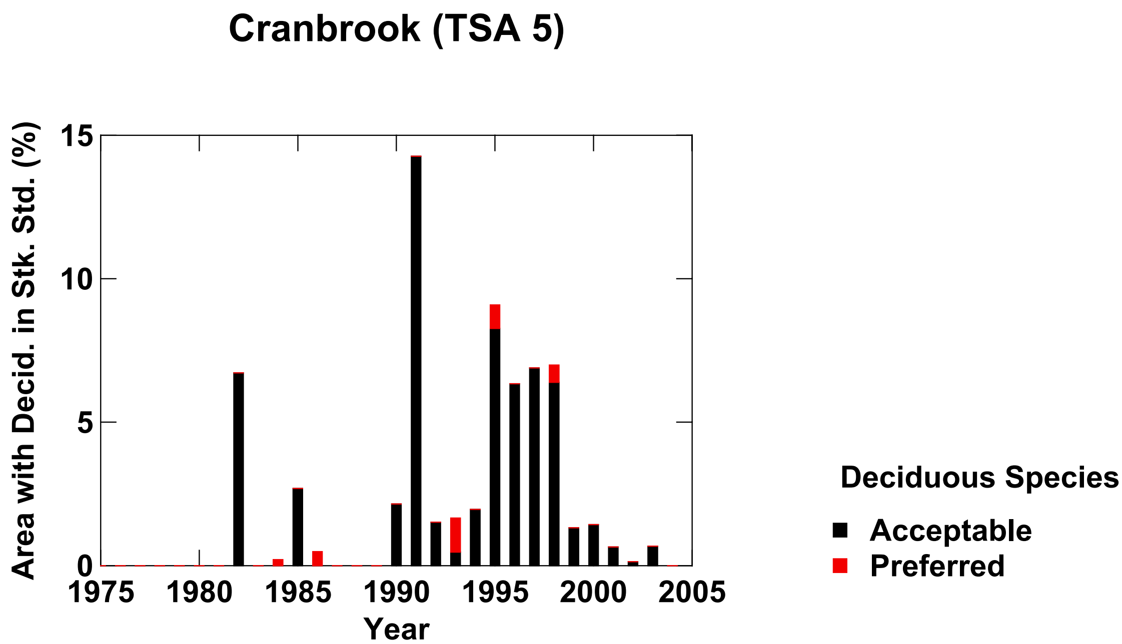


Figure A4–3. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Cranbrook TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

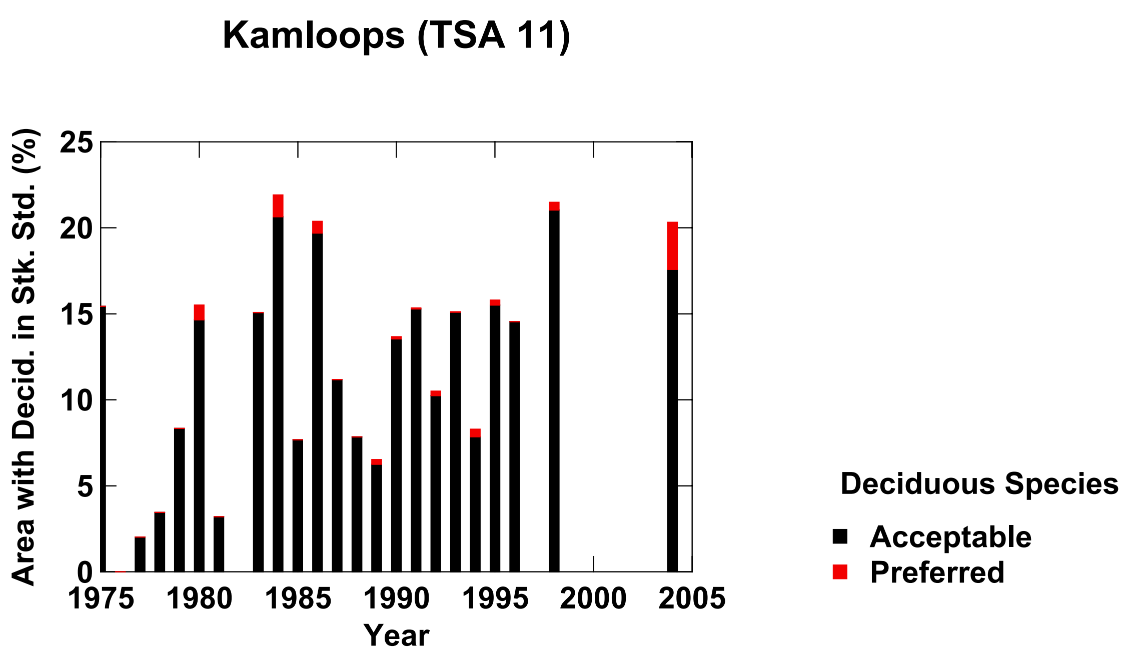


Figure A4–4. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Kamloops TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

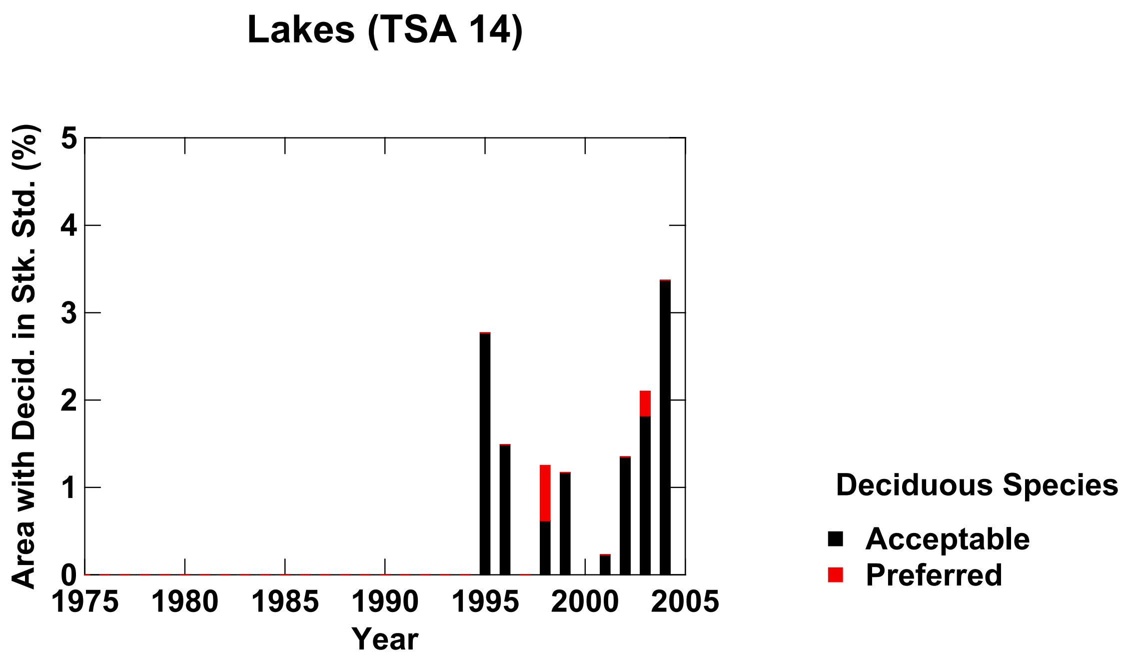


Figure A4–5. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Lakes TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

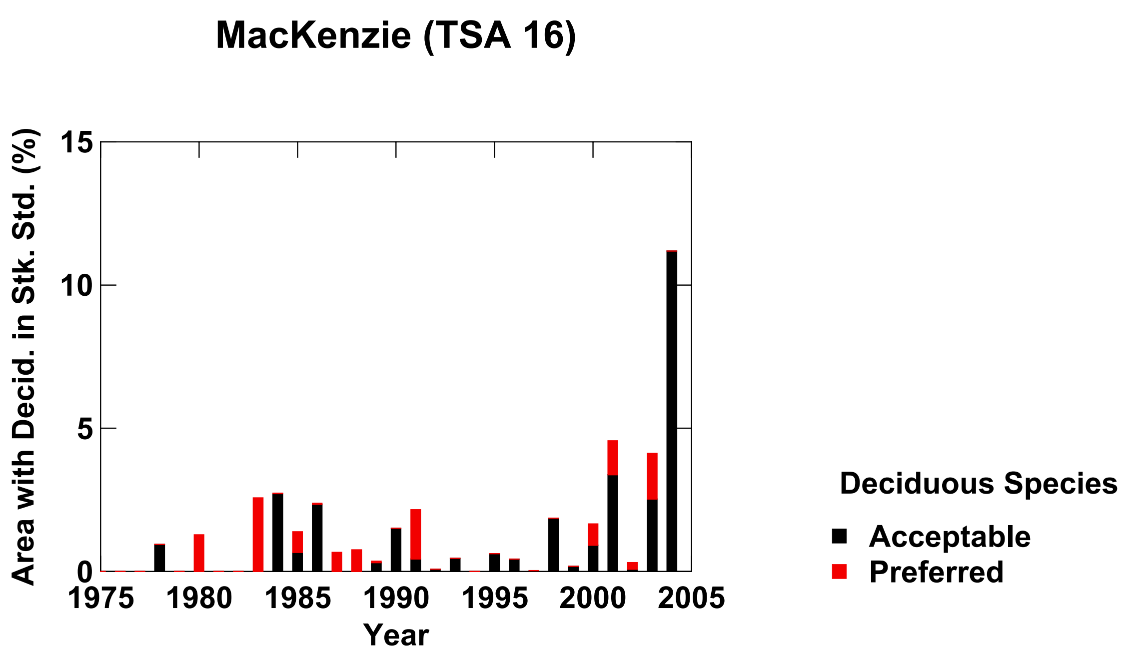


Figure A4–6. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the MacKenzie TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

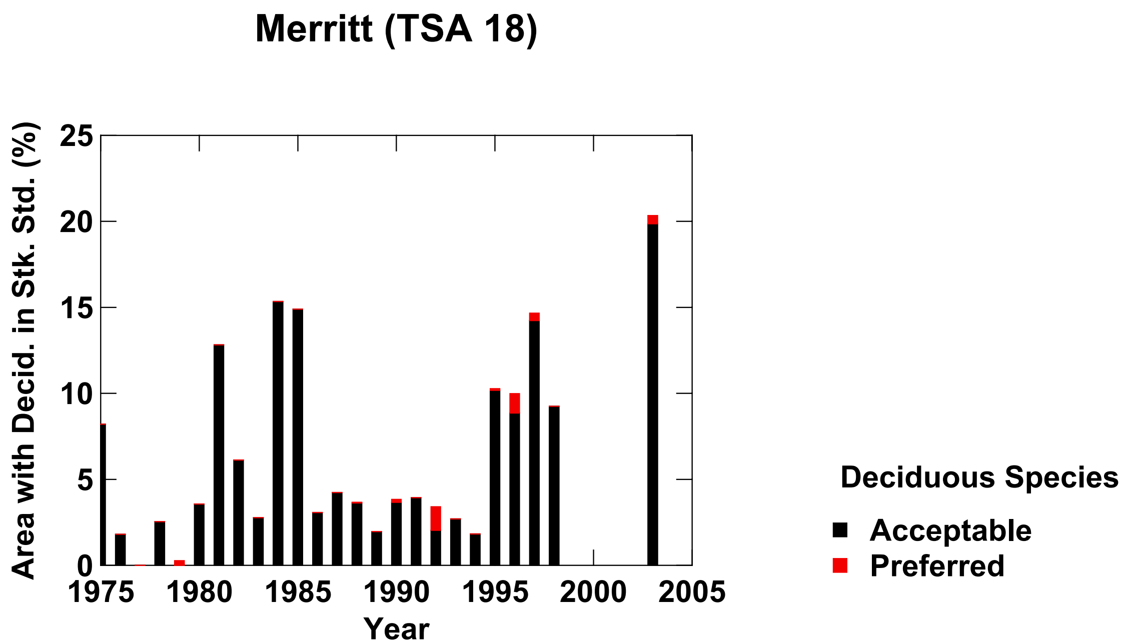


Figure A4–7. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Merritt TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

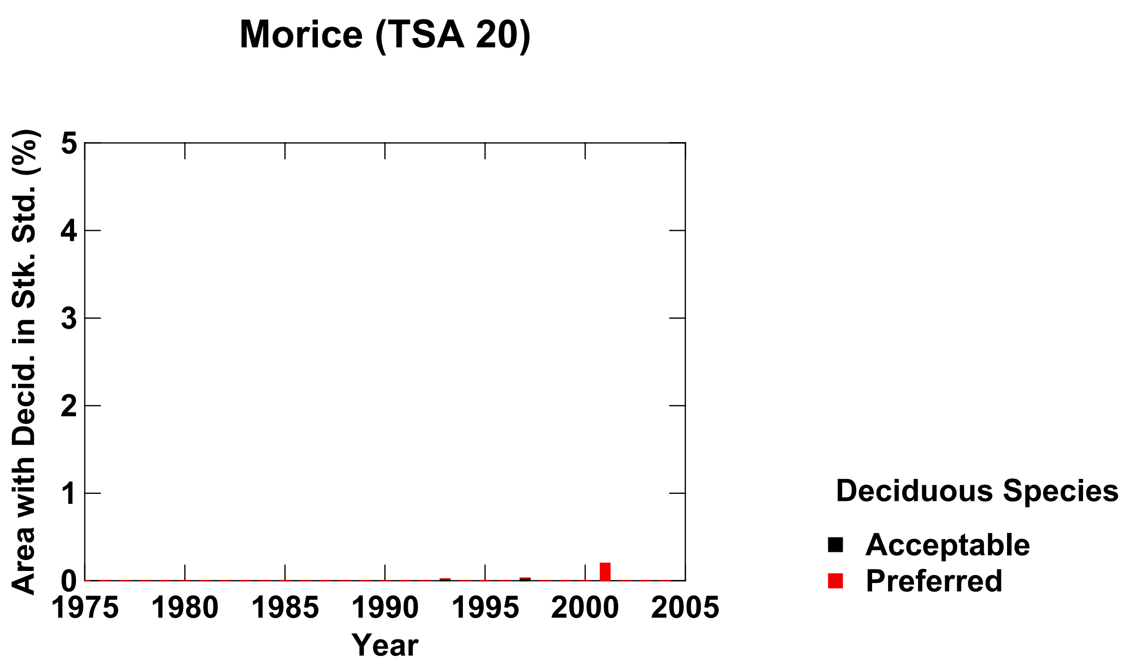


Figure A4–8. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Morice TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

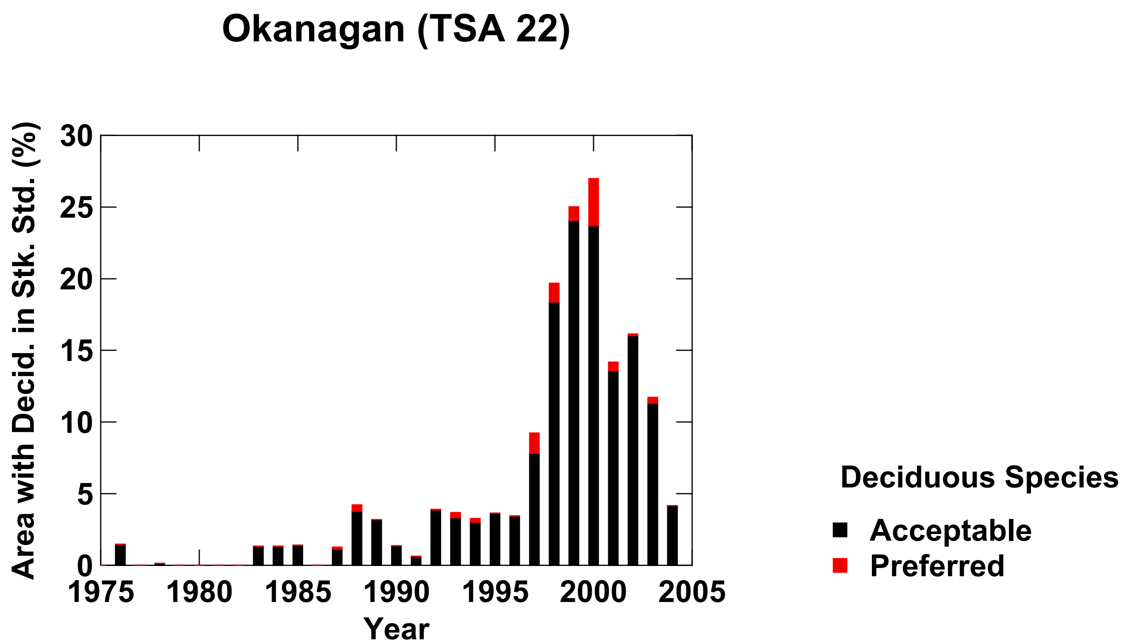


Figure A4–9. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Okanagan TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

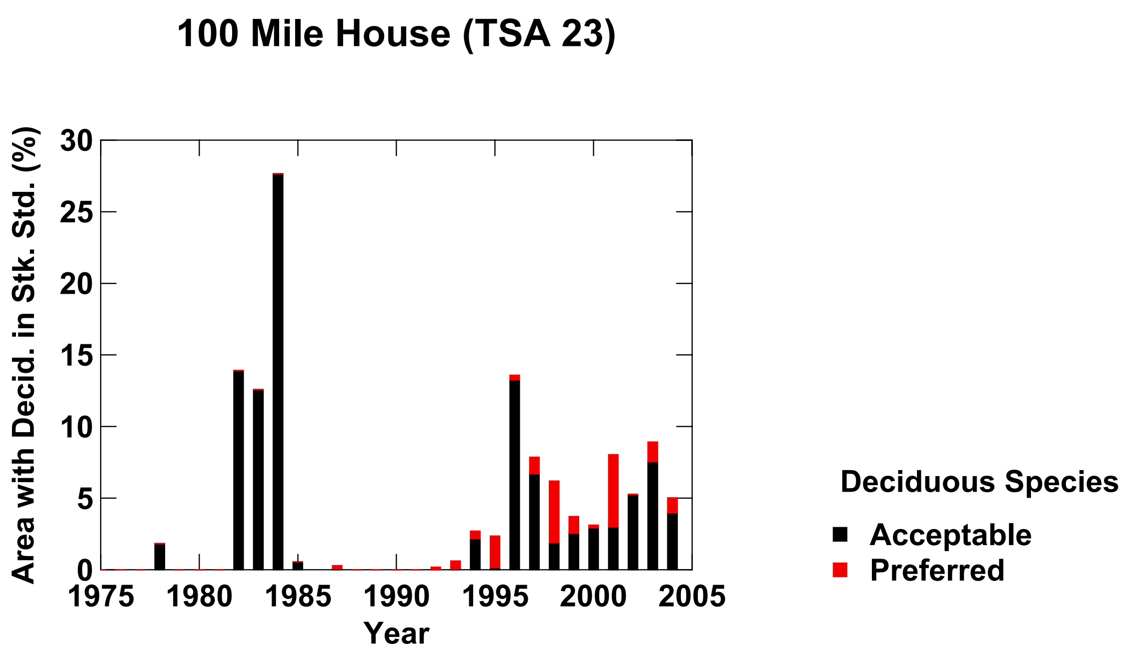


Figure A4–10. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the 100 Mile House TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

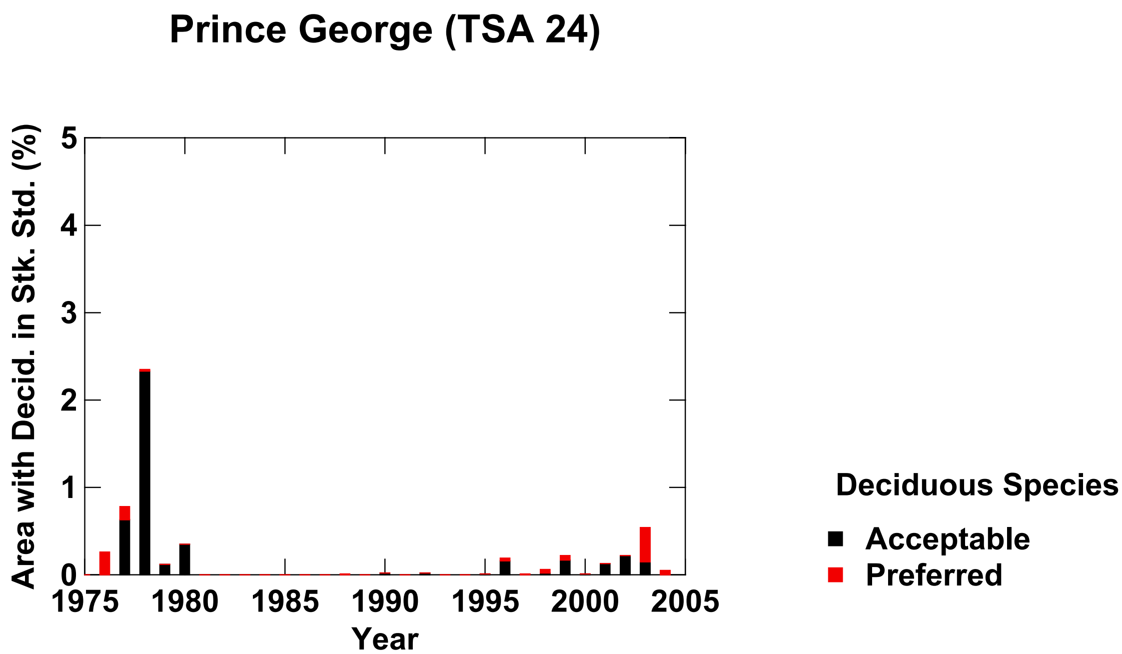


Figure A4–11. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Prince George TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

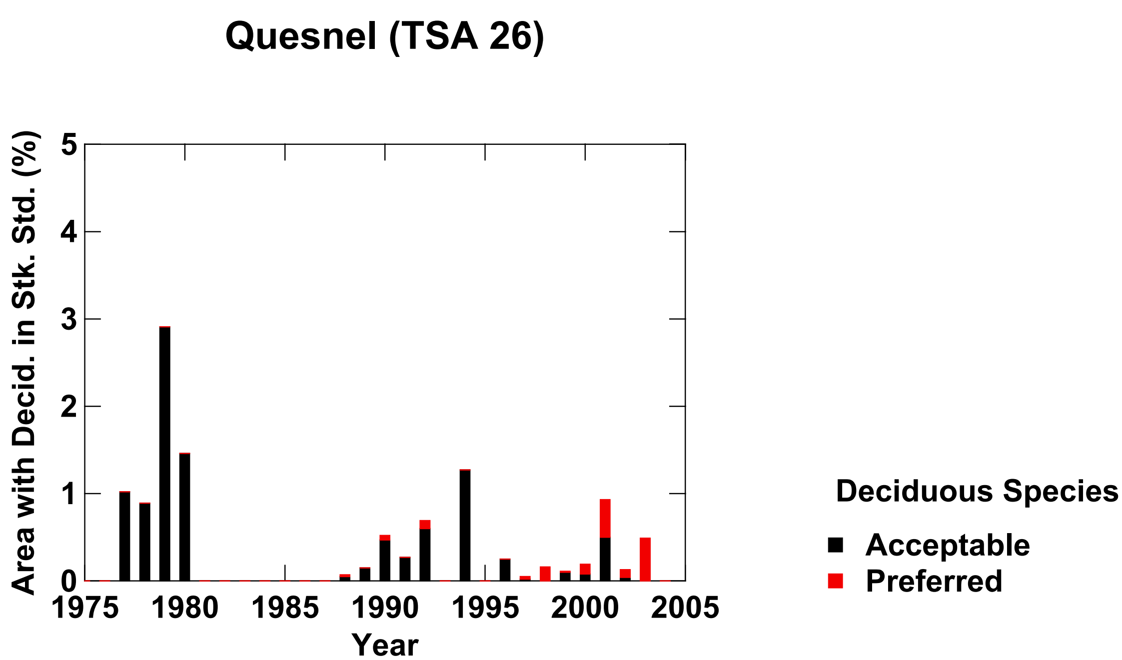


Figure A4–12. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Quesnel TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

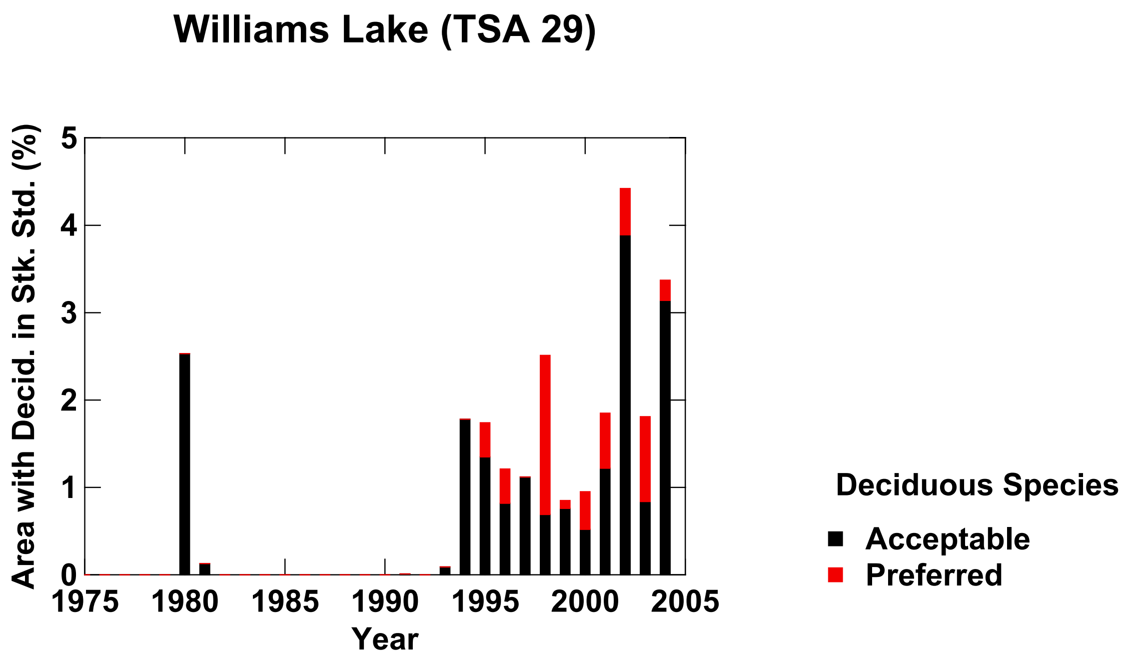
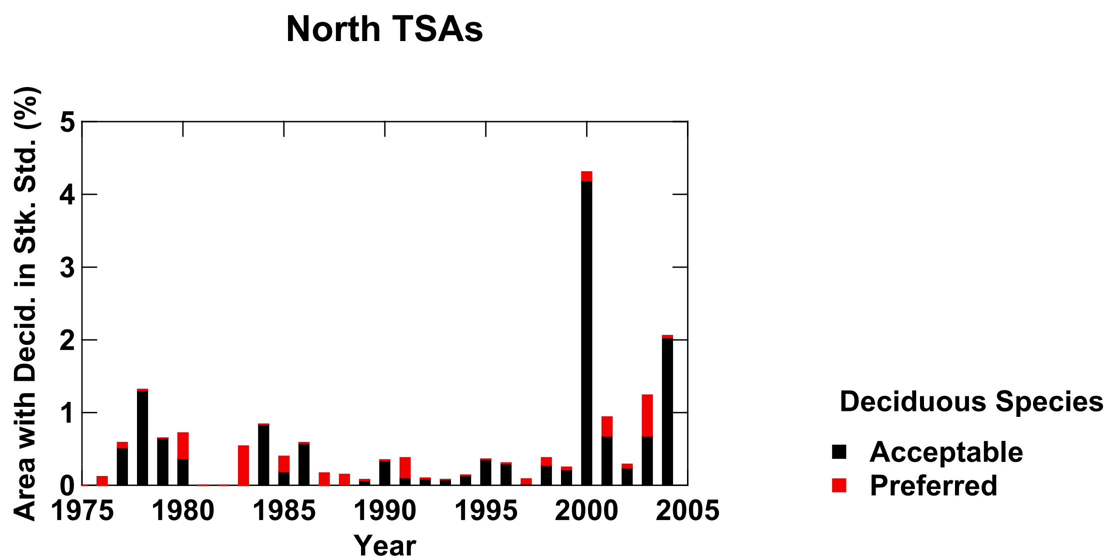


Figure A4–13. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable in the Williams Lake TSA by disturbance year. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



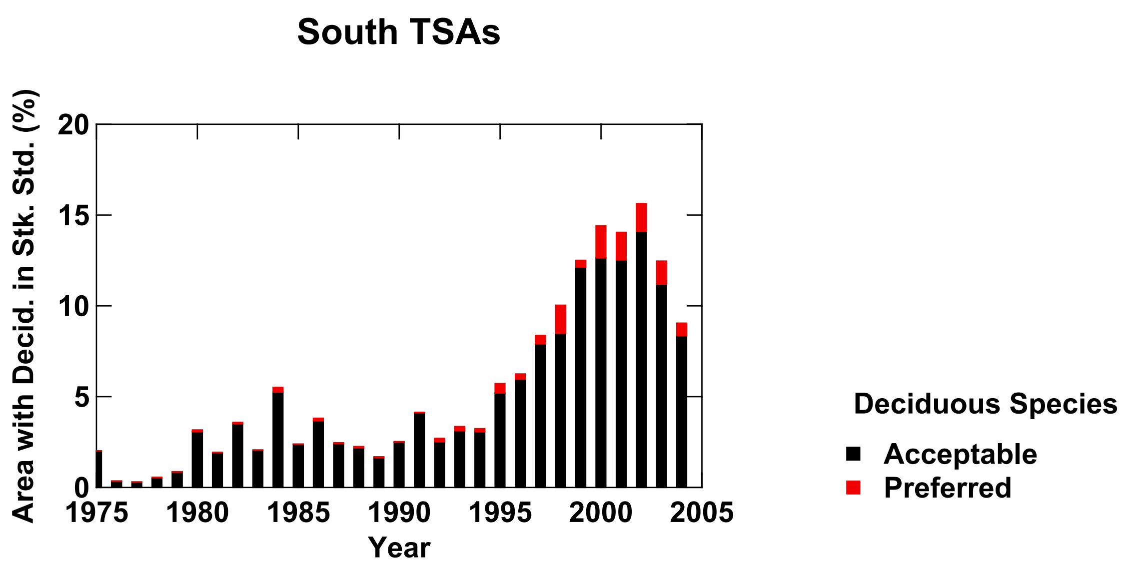
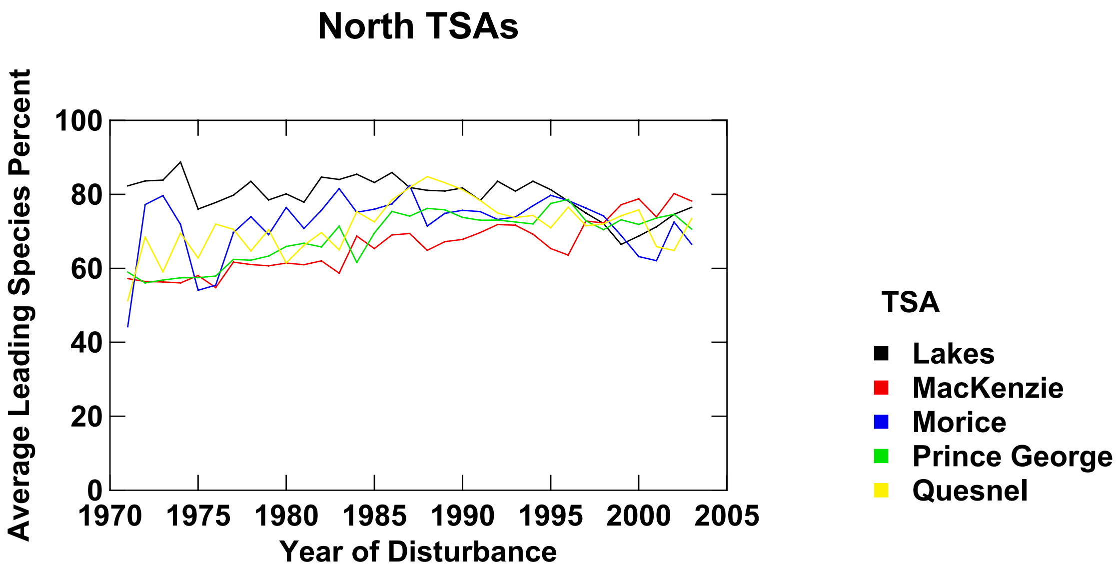


Figure A4–14. Percent of harvested area (standards unit area) where the stocking standard lists deciduous as preferred or acceptable, by disturbance year, in the northern (upper graph) and southern (lower graph) TSA group. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



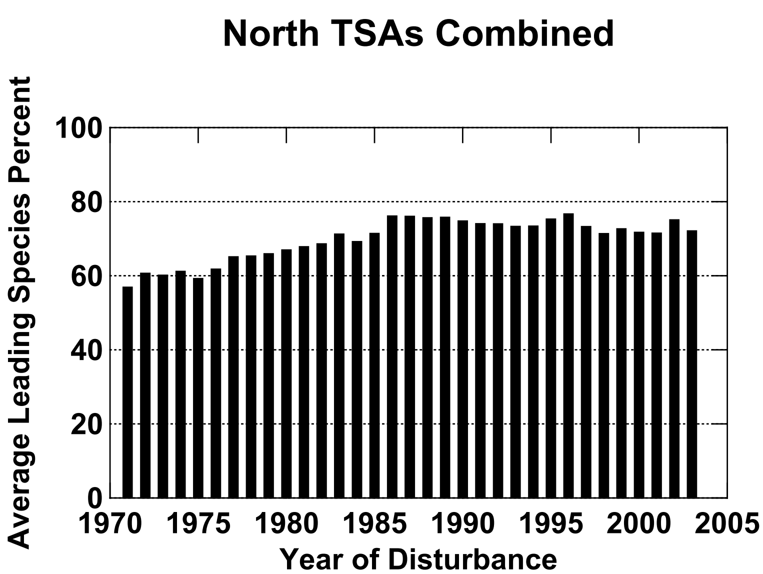
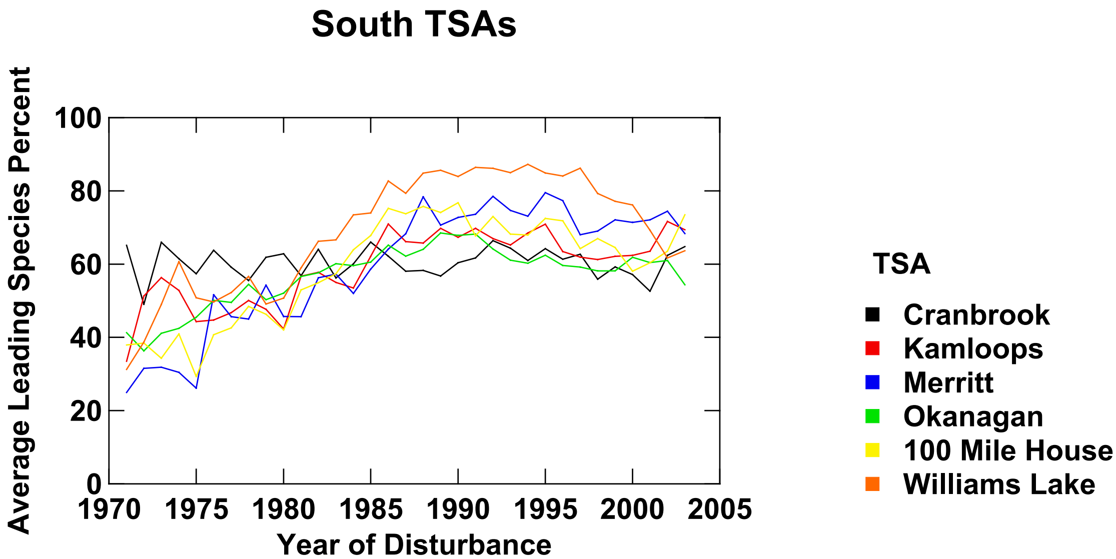


Figure A4–15. Average percent of the leading (dominant) species in young stands on harvested areas (from the inventory label) by disturbance year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



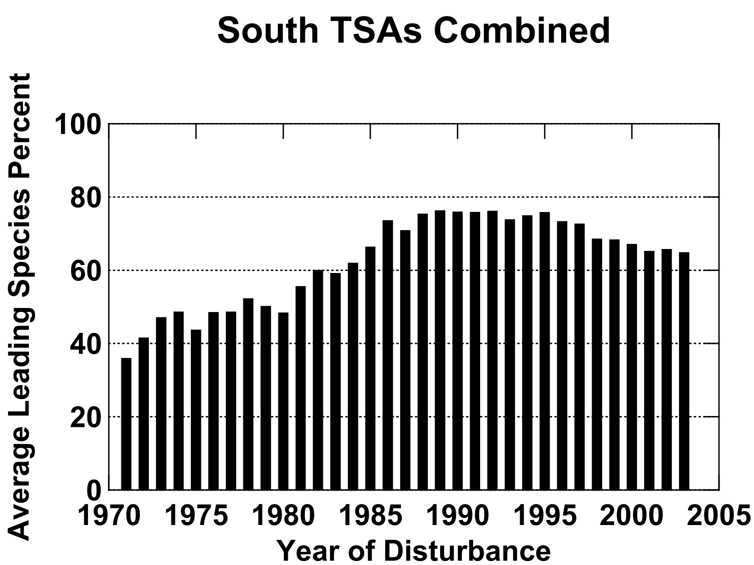
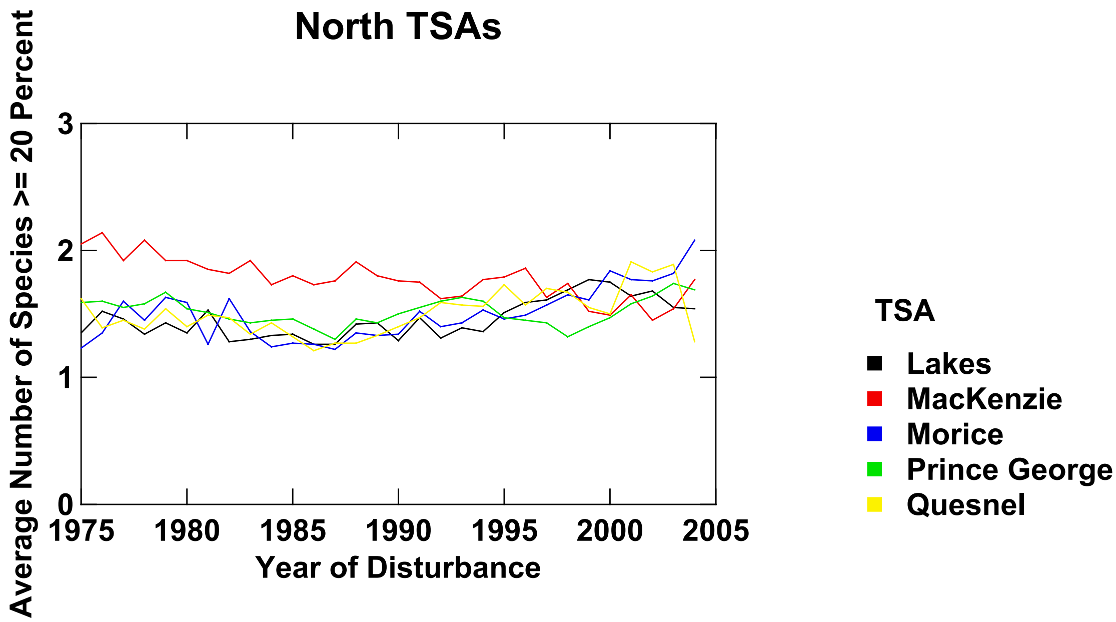


Figure A4–16. Average percent of the leading (dominant) species in young stands on harvested areas (from the inventory label) by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



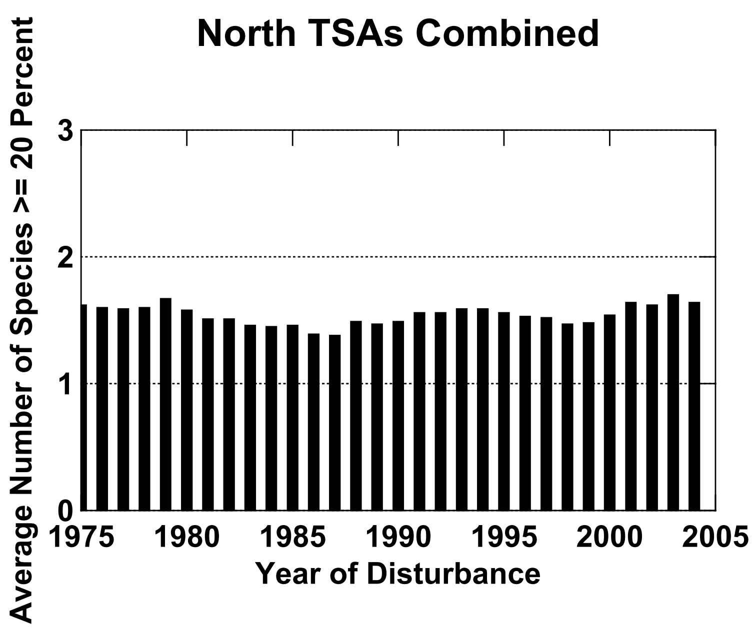
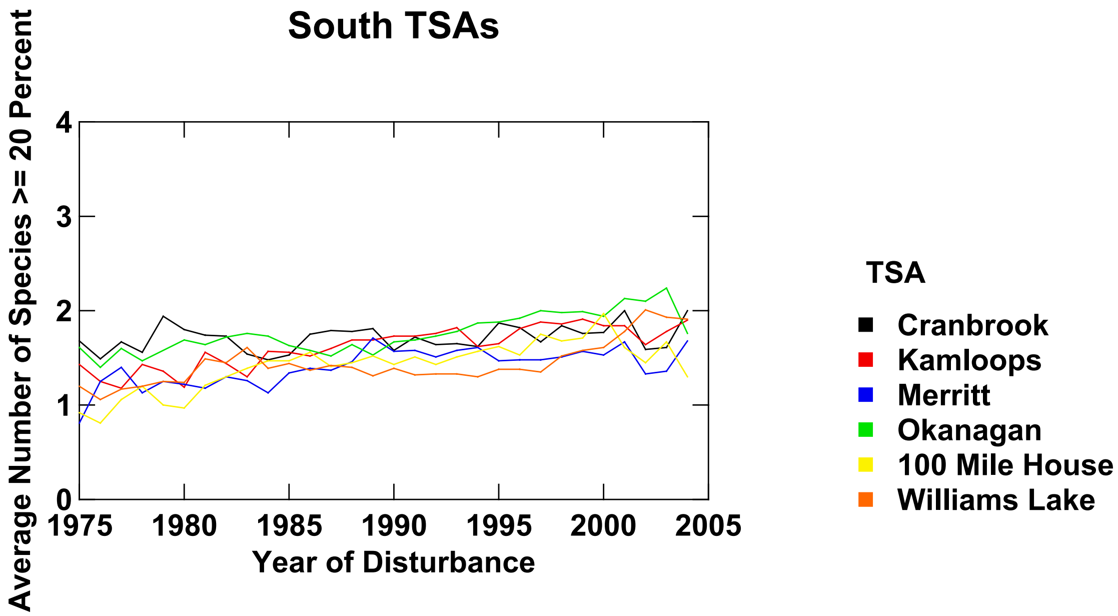


Figure A4–17. Average number of species with percentages ≥ 20 in the inventory label by disturbance year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



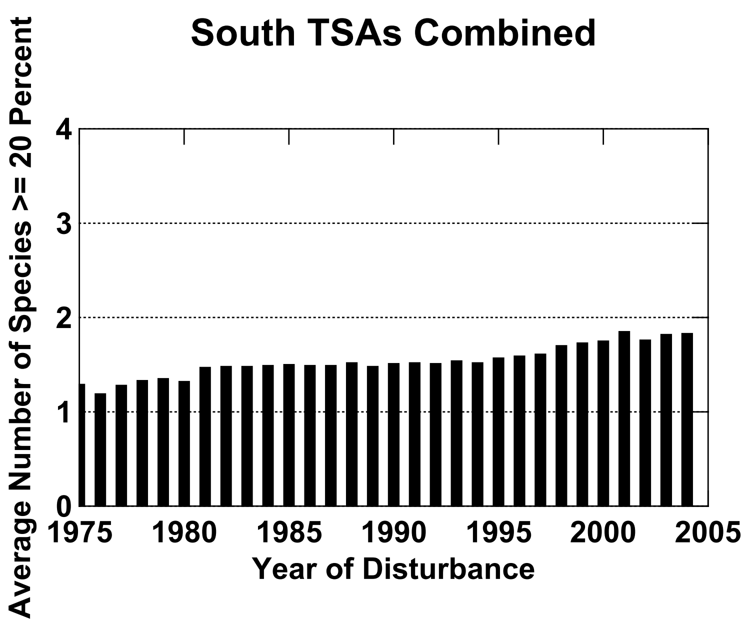
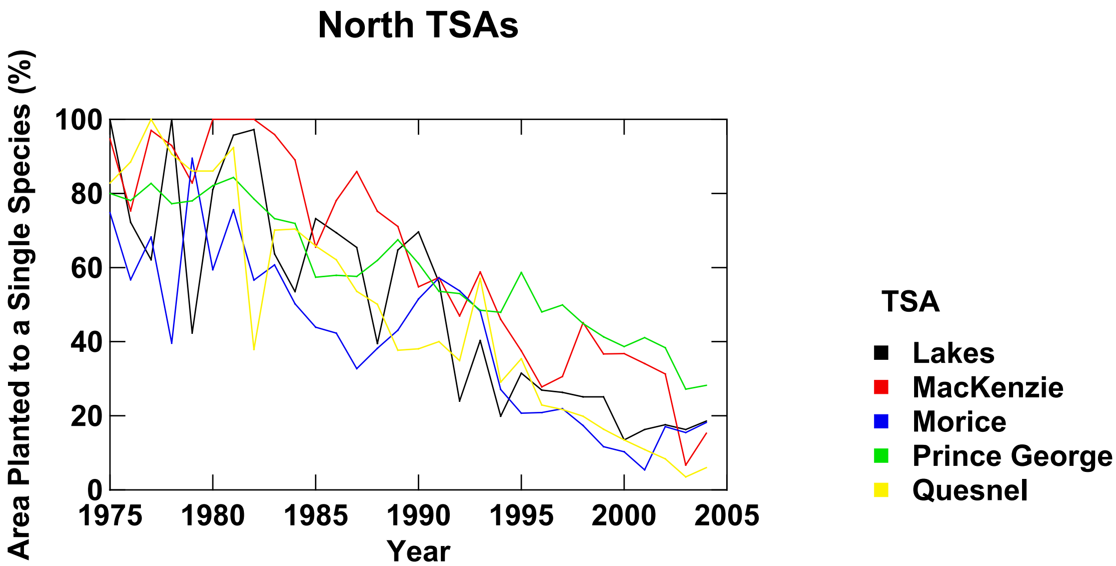


Figure A4–18. Average number of species with percentages ≥ 20 in the inventory label by disturbance year by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



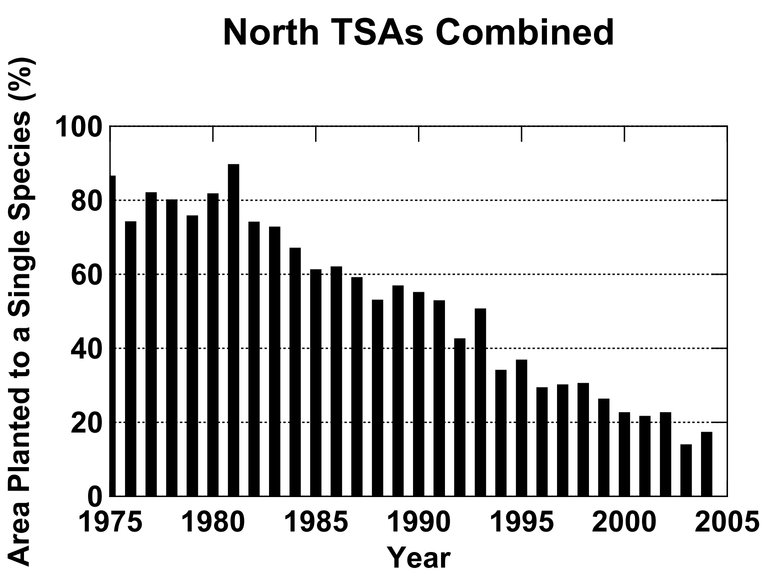
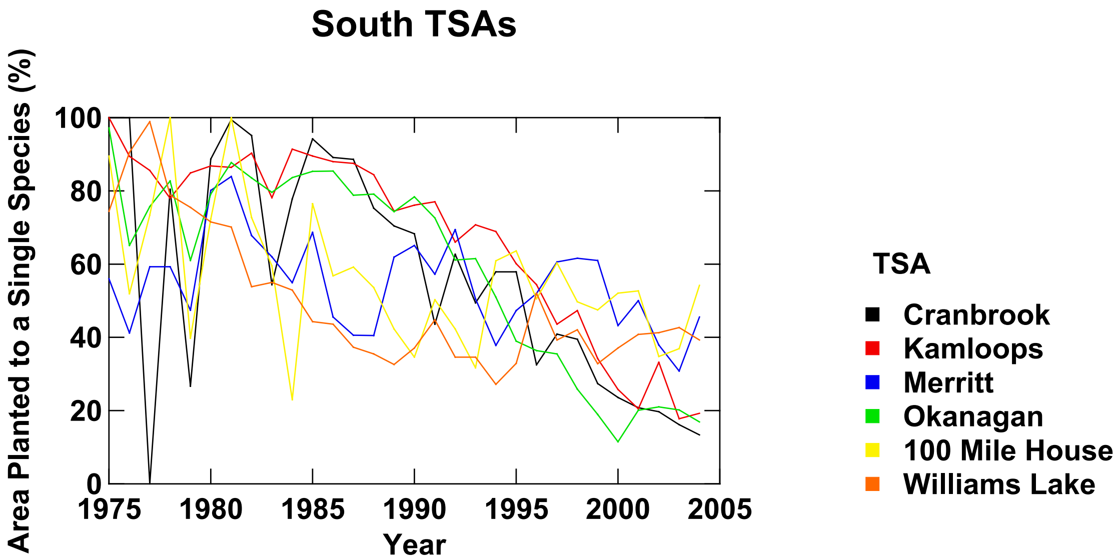


Figure A4–19. Percent of planted area (ATU area) where only one species was planted, by year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



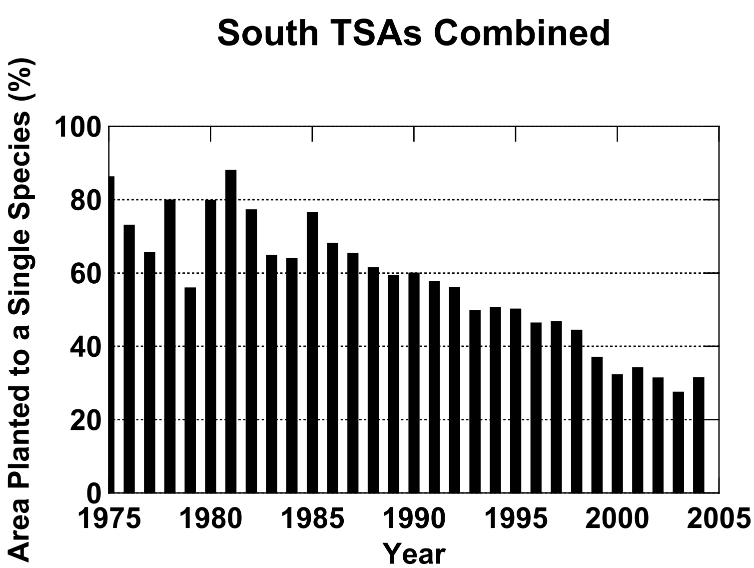


Figure A4–20. Percent of planted area (ATU area) where only one species was planted, by year by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

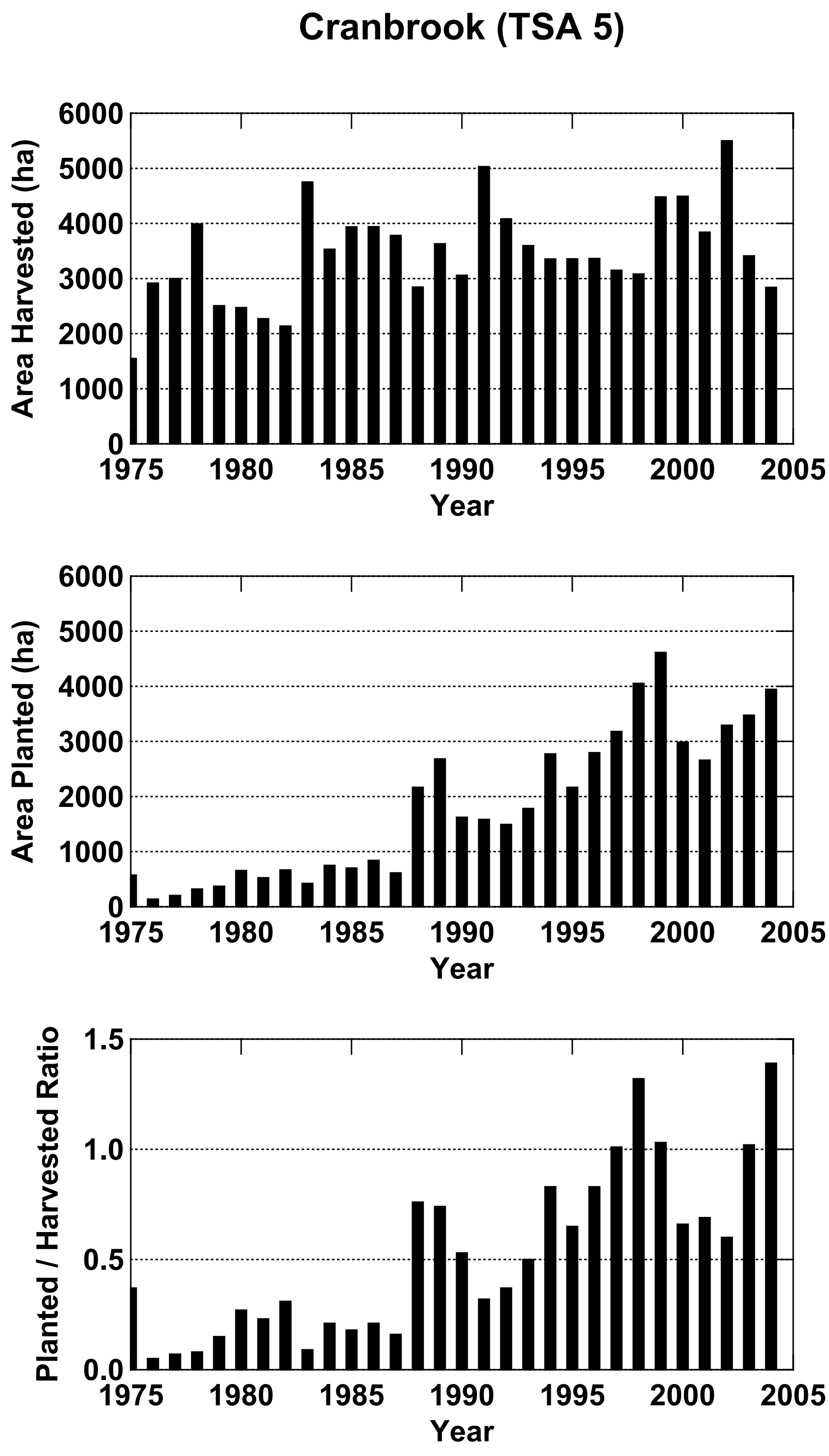


Figure A4–21. Area harvested, area planted, and planted:harvested ratio by year in the Cranbrook TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

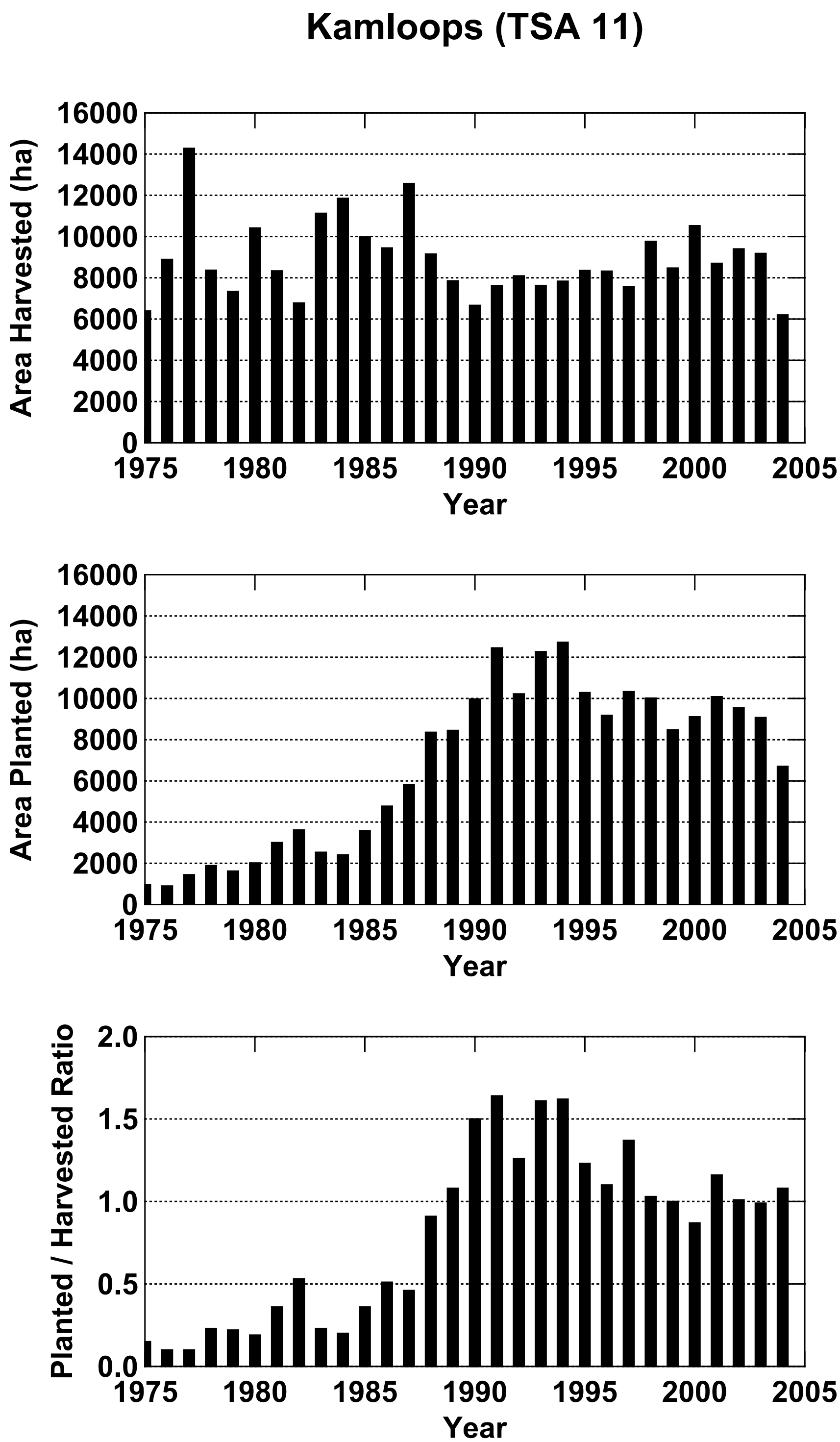


Figure A4–22. Area harvested, area planted, and planted:harvested ratio by year in the Kamloops TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

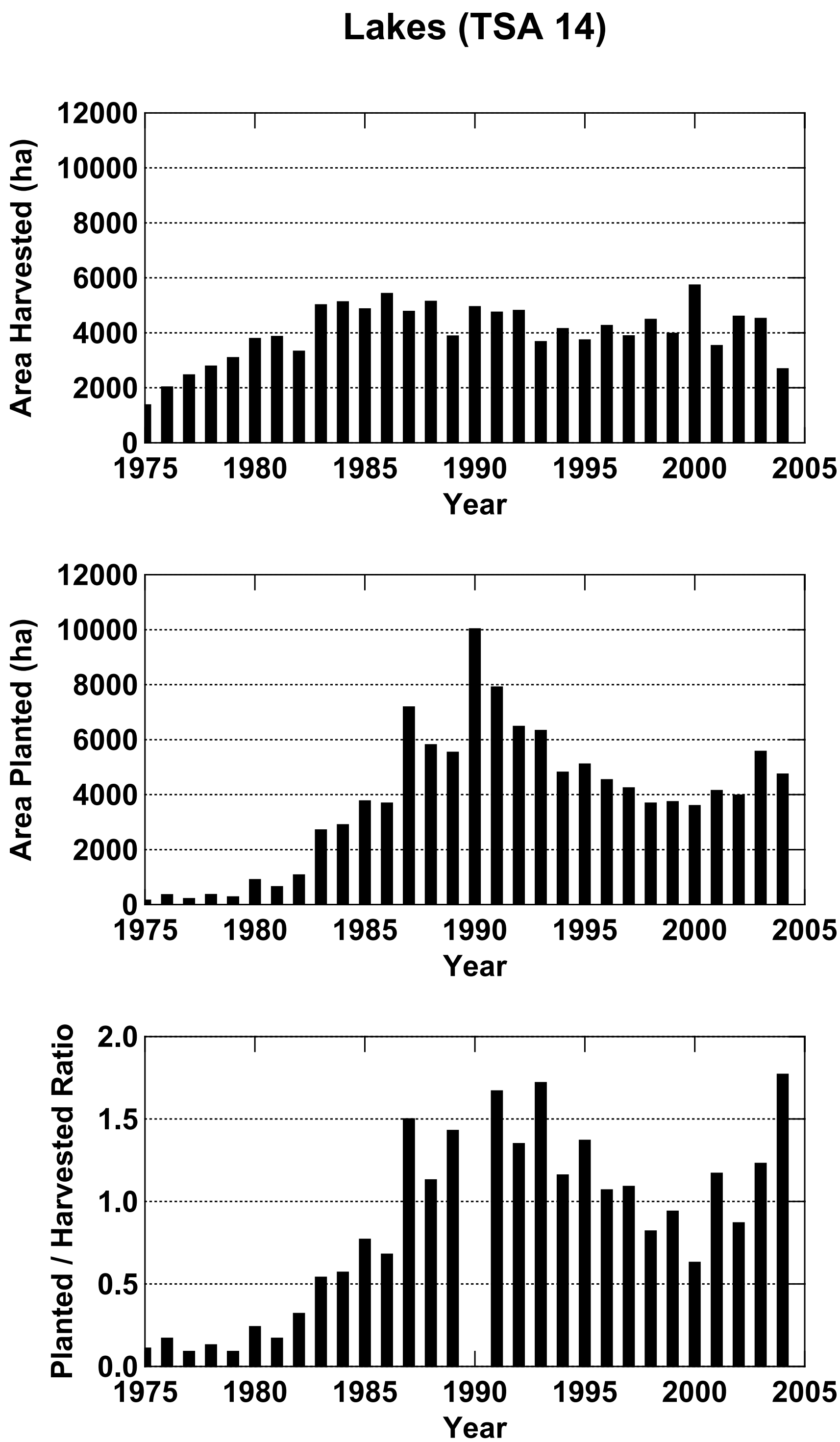


Figure A4–23. Area harvested, area planted, and planted:harvested ratio by year in the Lakes TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

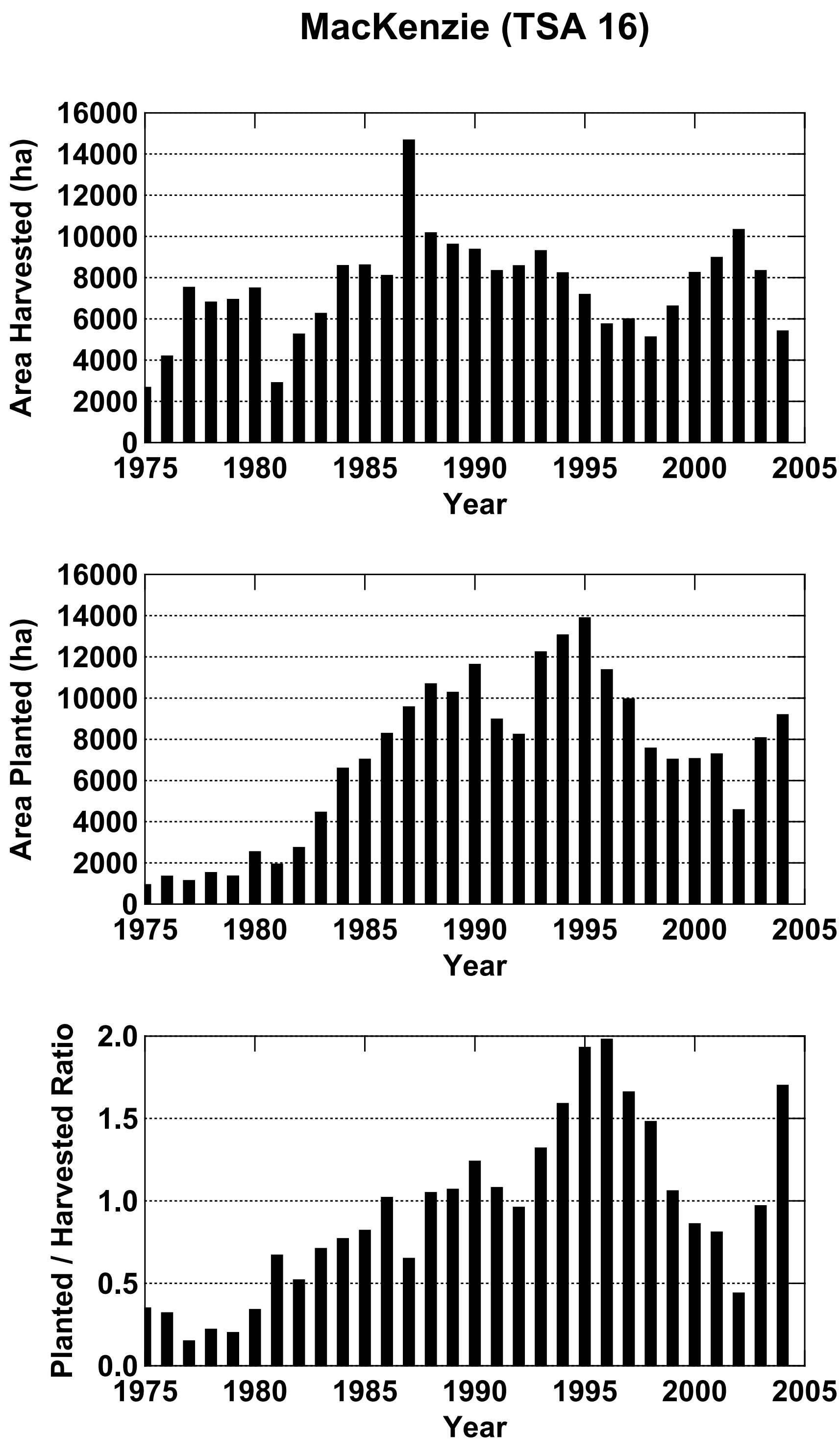


Figure A4–24. Area harvested, area planted, and planted:harvested ratio by year in the MacKenzie TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

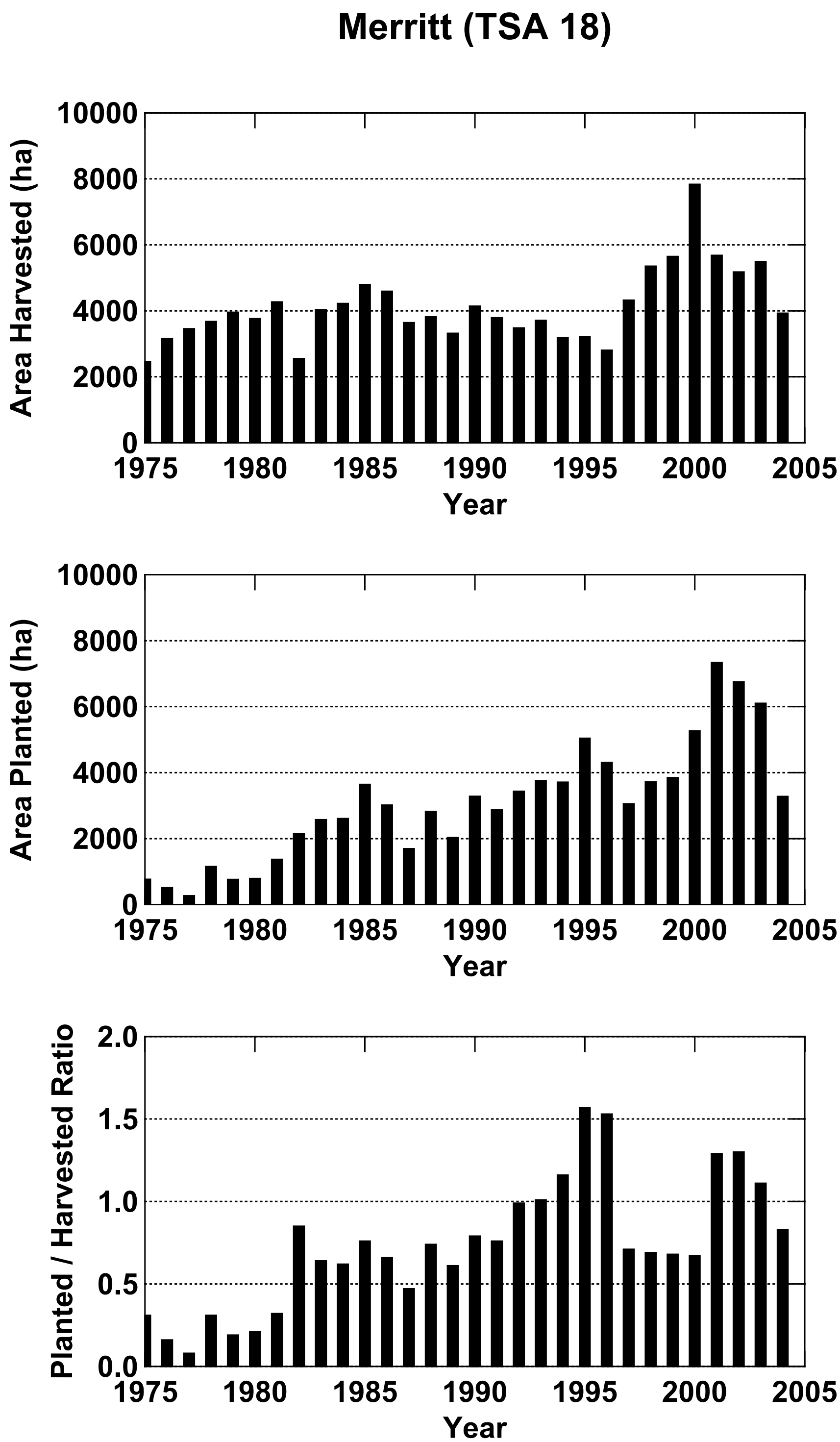


Figure A4–25. Area harvested, area planted, and planted:harvested ratio by year in the Merritt TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

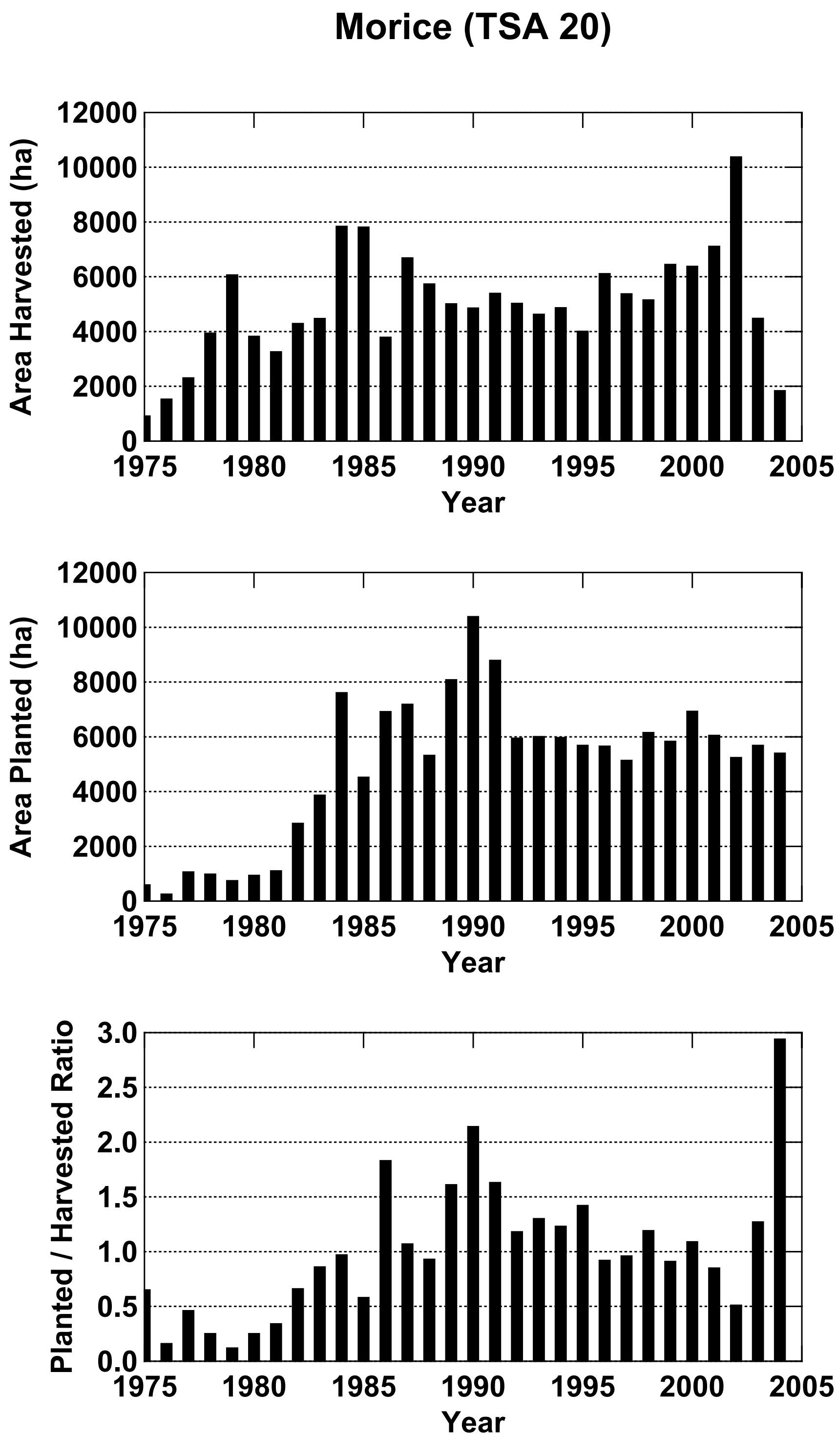


Figure A4–26. Area harvested, area planted, and planted:harvested ratio by year in the Morice TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

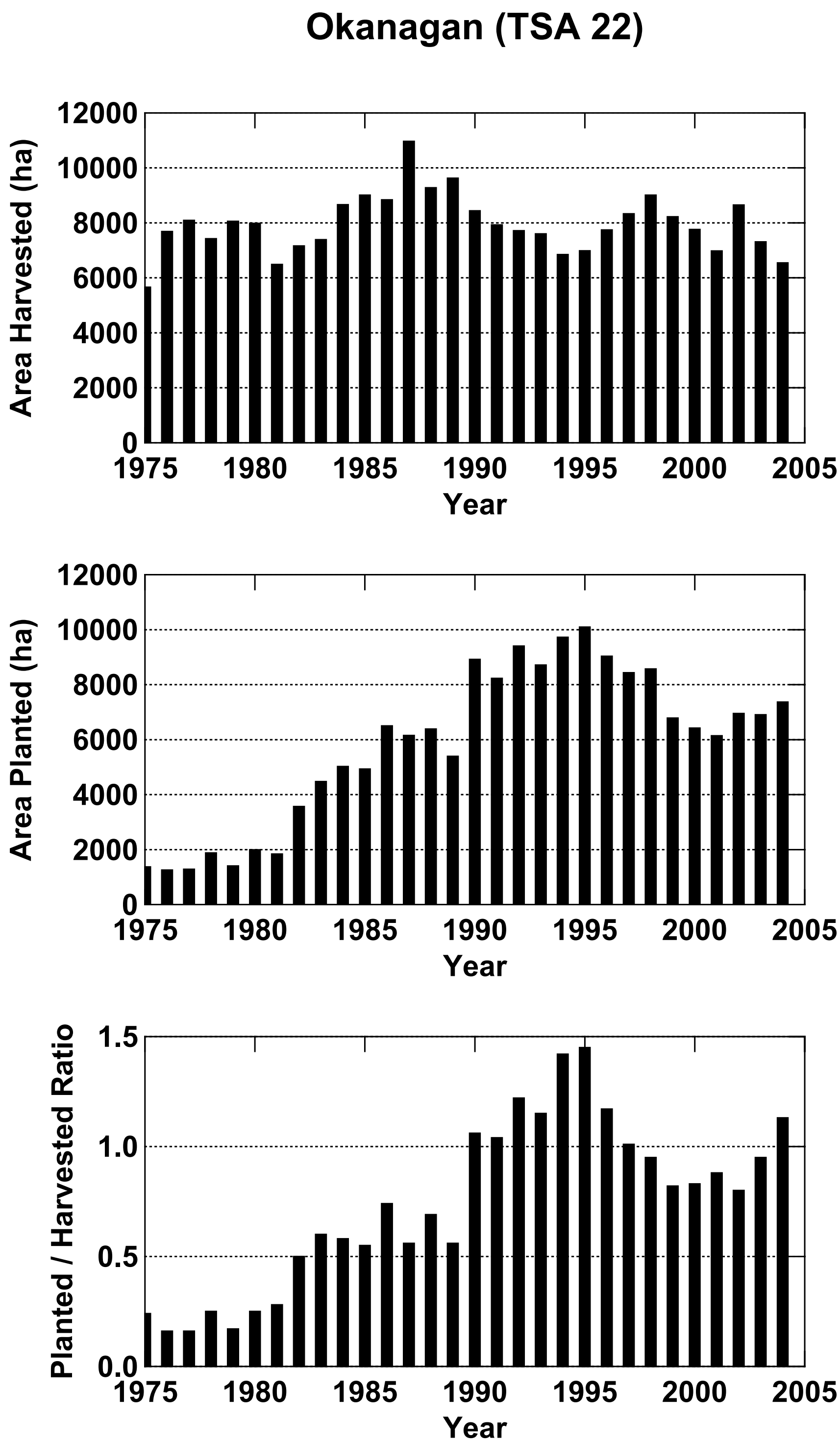


Figure A4–27. Area harvested, area planted, and planted:harvested ratio by year in the Okanagan TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

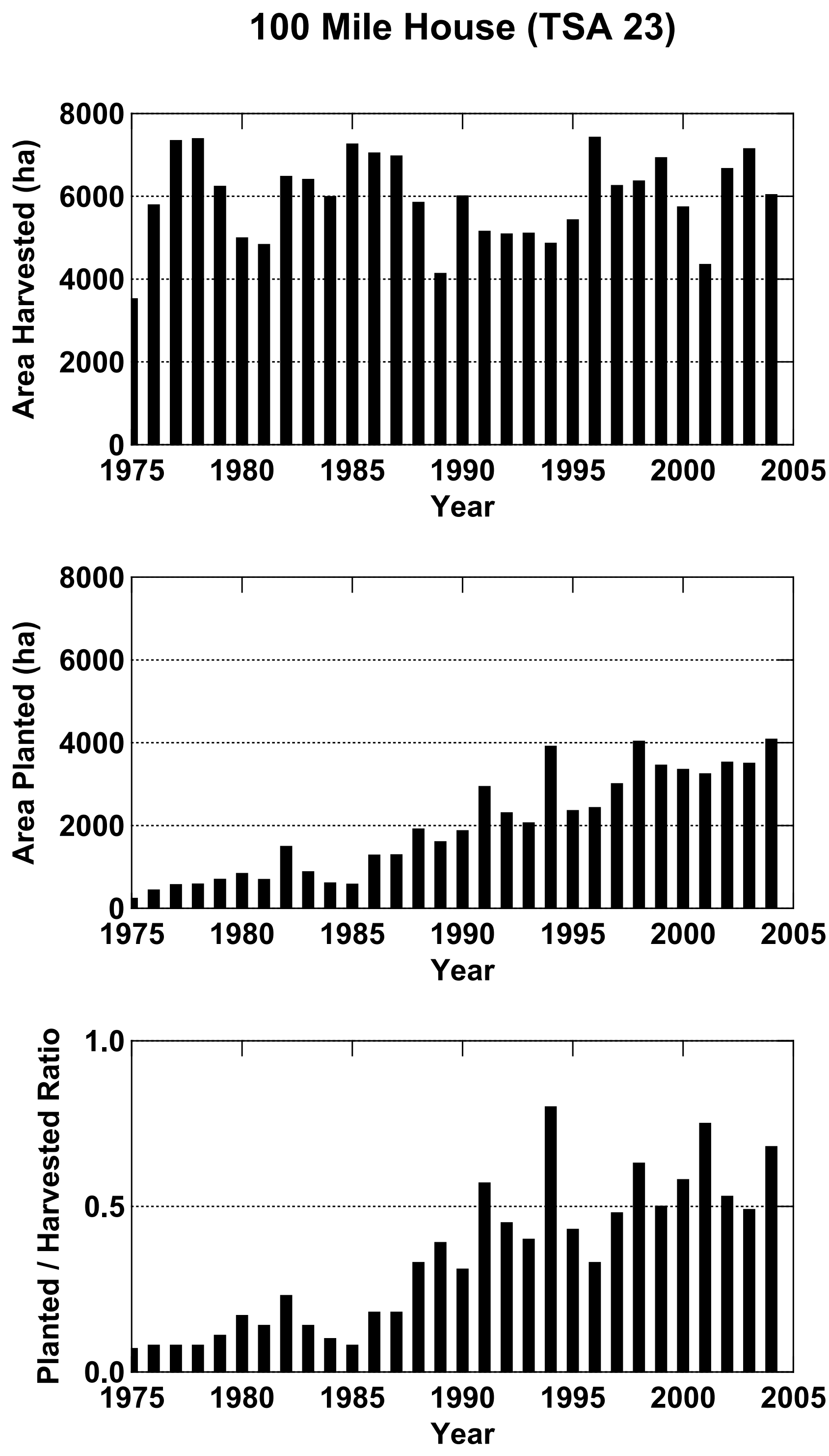


Figure A4–28. Area harvested, area planted, and planted:harvested ratio by year in the 100 Mile House TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

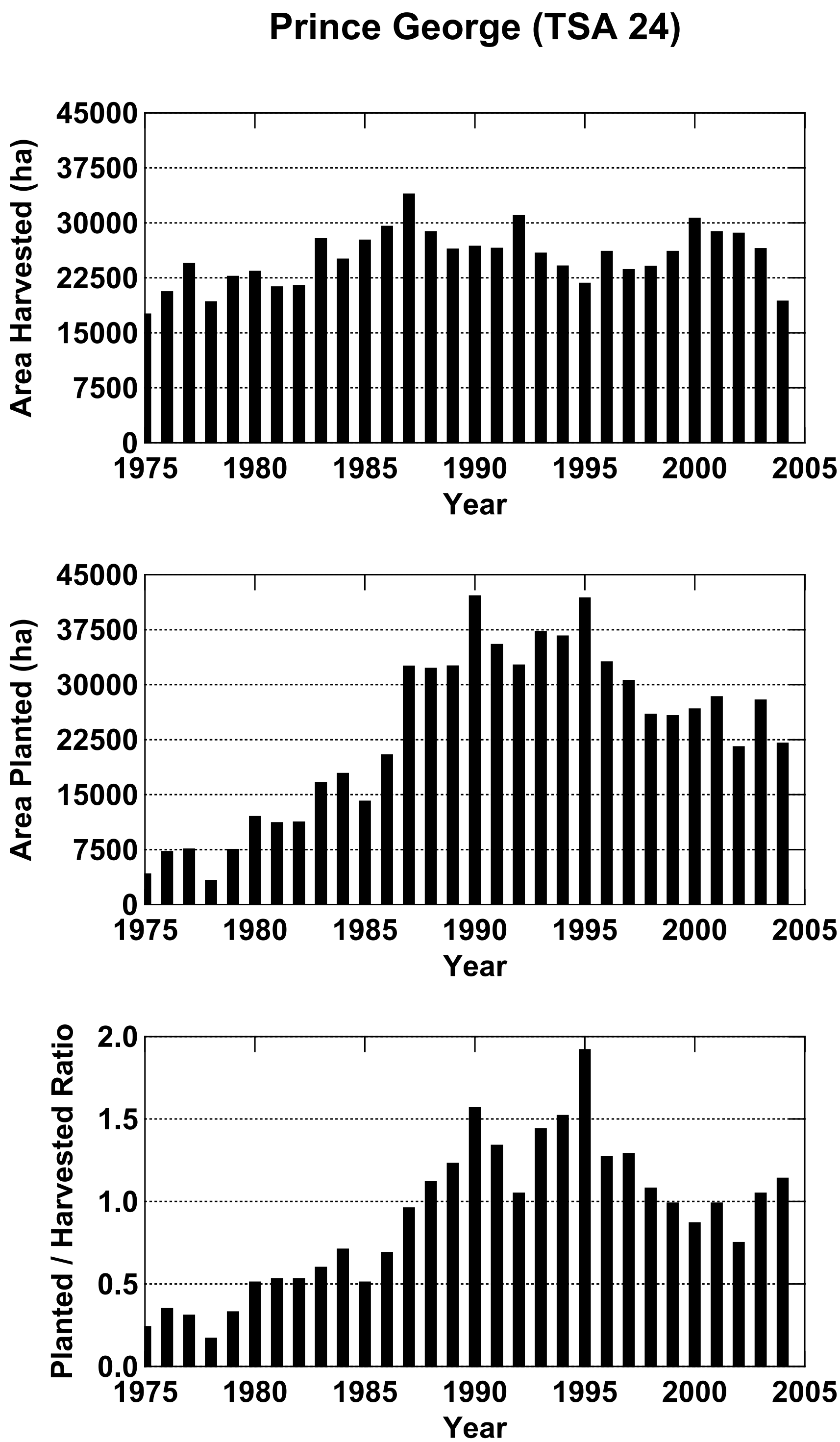


Figure A4–29. Area harvested, area planted, and planted:harvested ratio by year in the Prince George TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

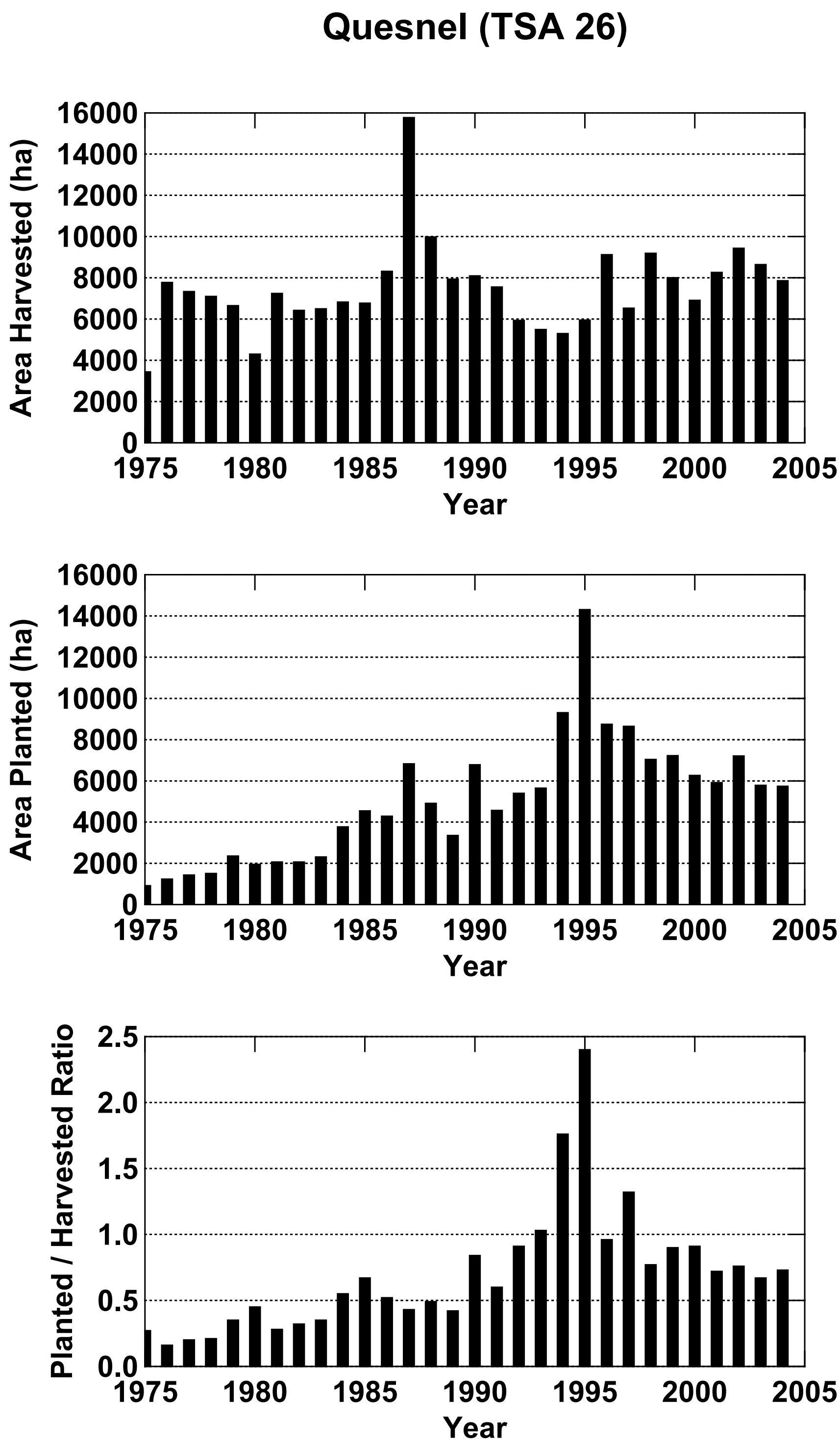


Figure A4–30. Area harvested, area planted, and planted:harvested ratio by year in the Quesnel TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

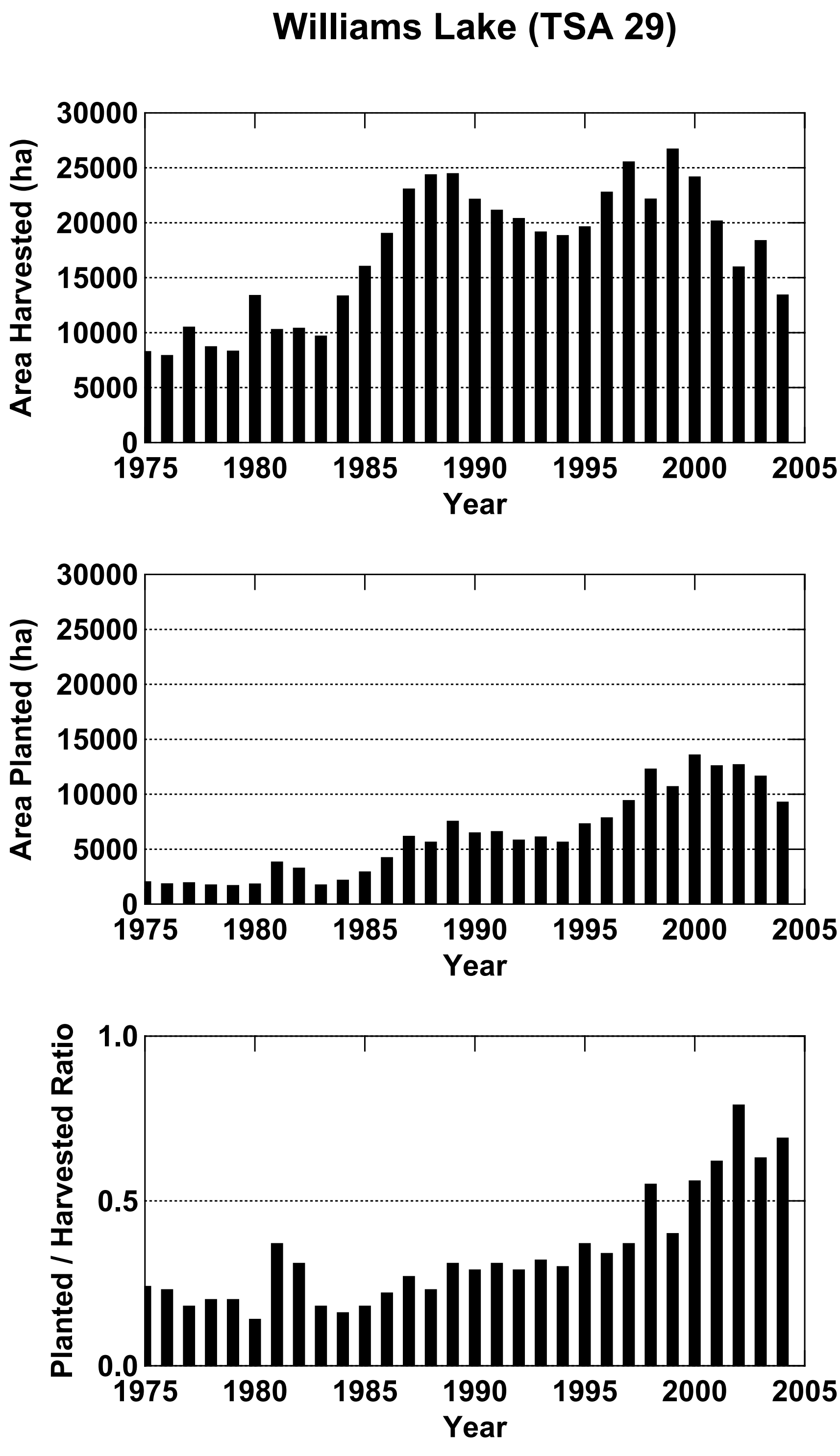


Figure A4–31. Area harvested, area planted, and planted:harvested ratio by year in the Williams Lake TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

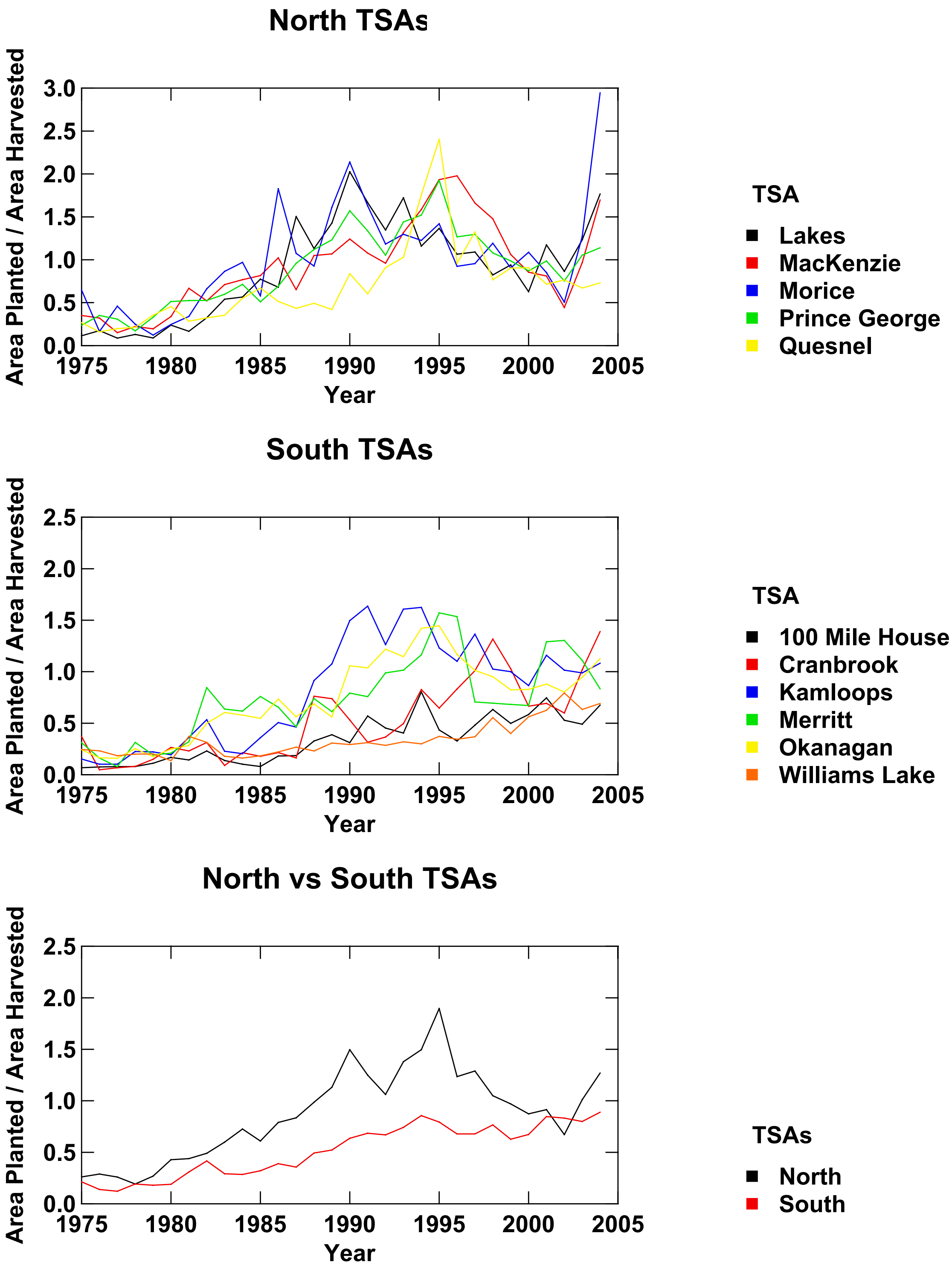


Figure A4–32. Ratio of area planted to area harvested by year for the northern TSAs (top) and the southern TSAs (middle), with averages for the northern and southern TSA groups (bottom). Source: Data extracted from RESULTS by Syntax Designs September 2005 and graphed by Martin Watts.

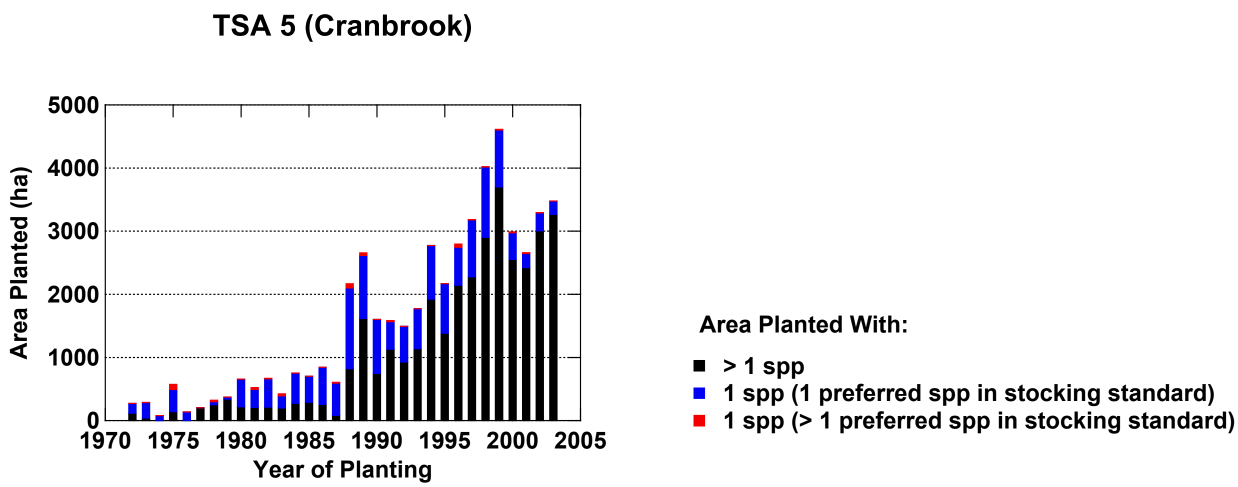


Figure A4–33. For the Cranbrook TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

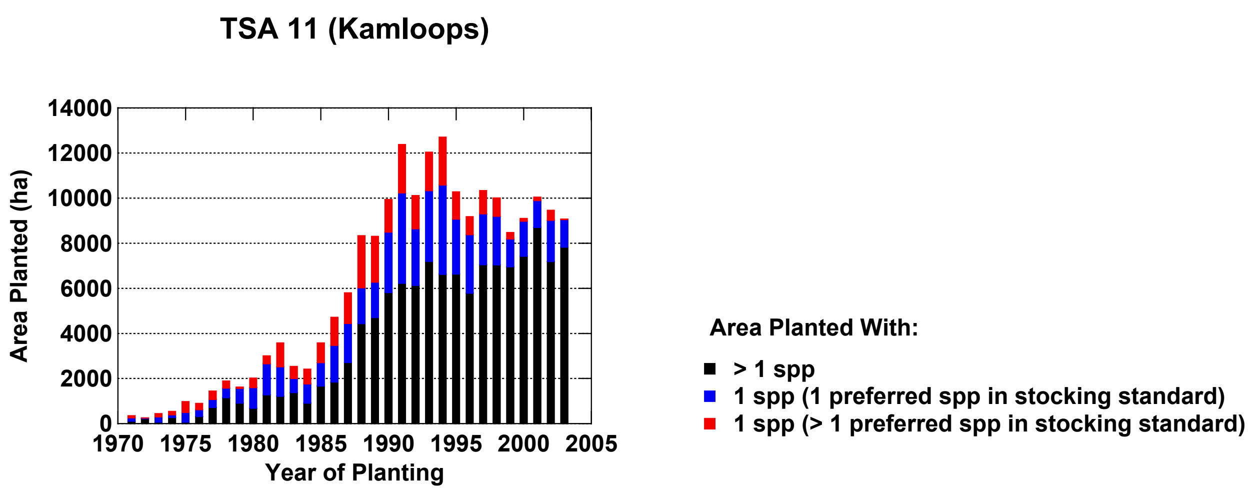


Figure A4–34. For the Kamloops TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

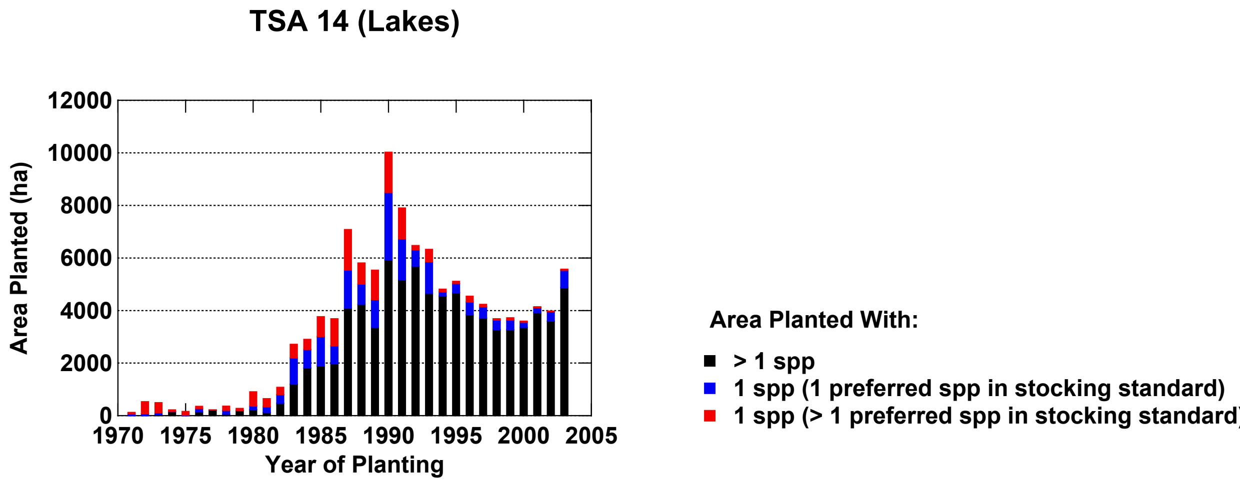


Figure A4–35. For the Lakes TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

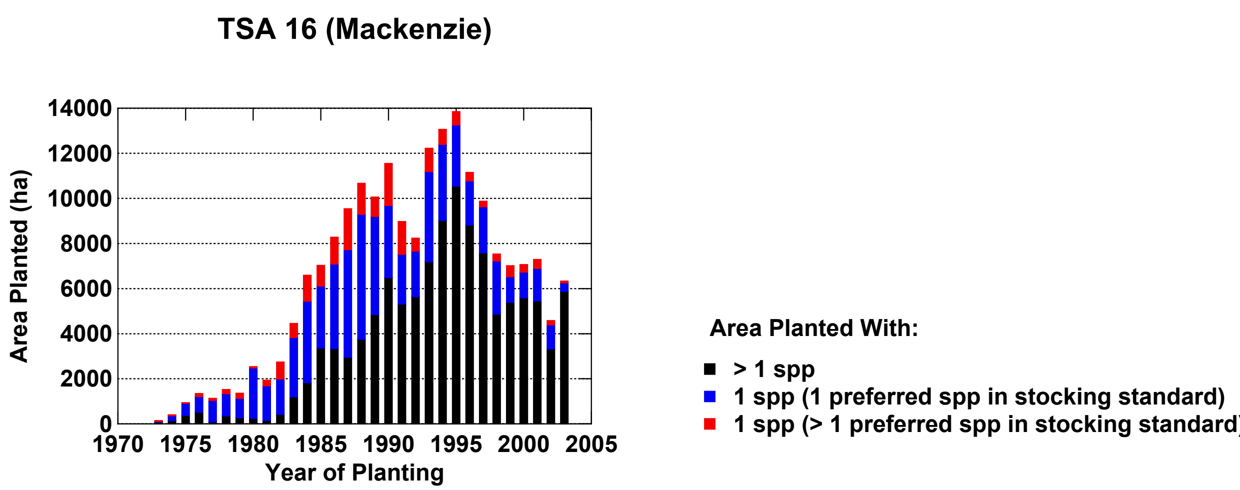


Figure A4–36. For the Mackenzie TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

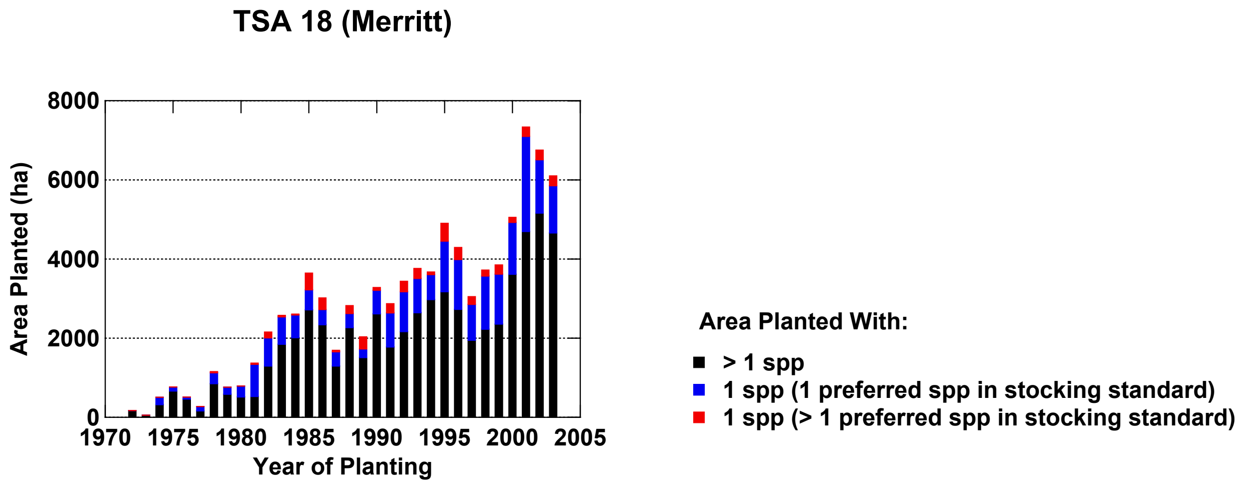


Figure A4–37. For the Merritt TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

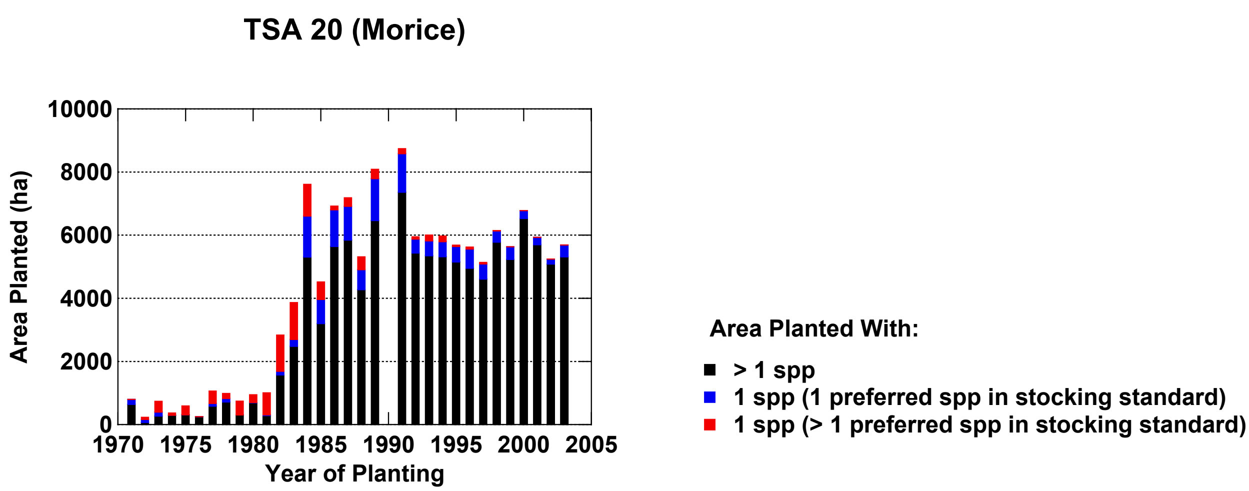


Figure A4–38. For the Morice TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

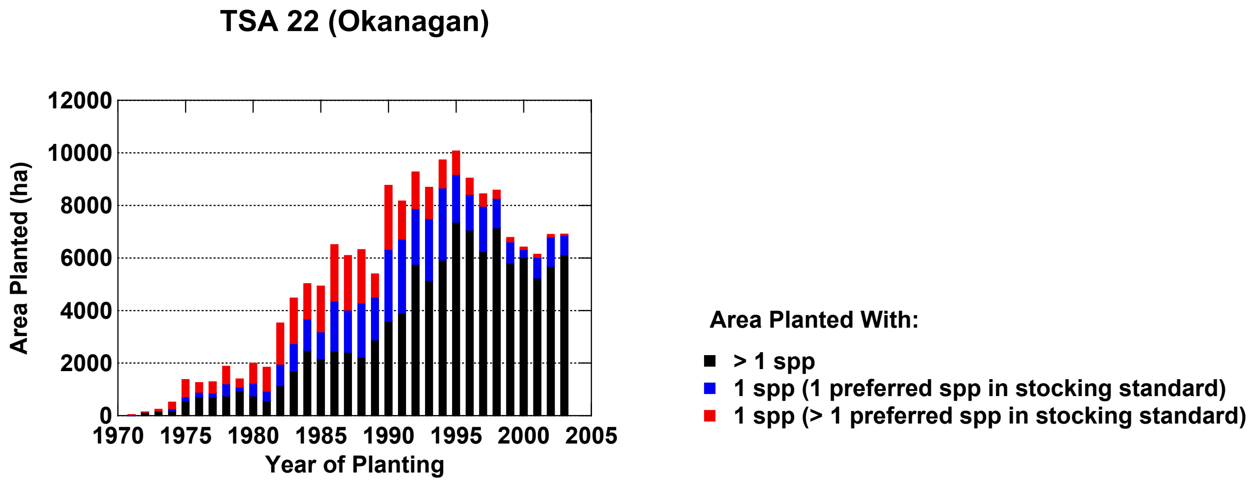


Figure A4–39. For the Okanagan TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

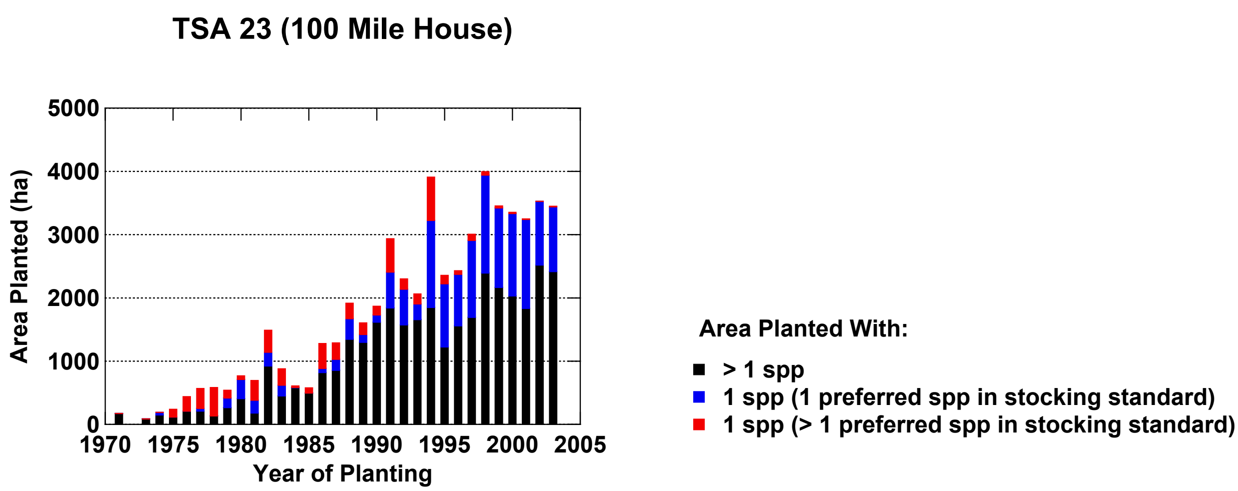


Figure A4–40. For the 100 Mile House TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

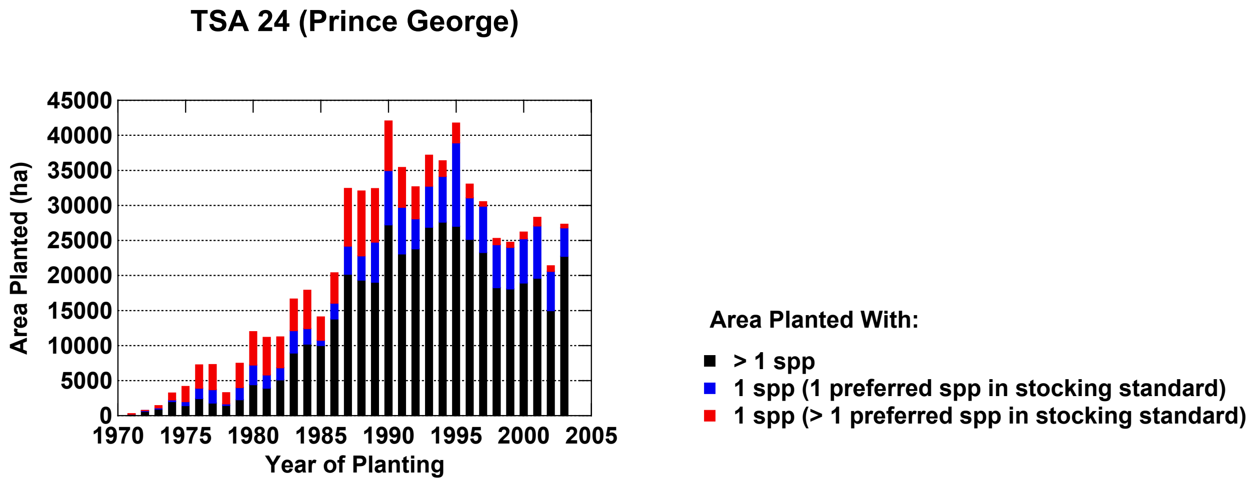


Figure A4–41. For the Prince George TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

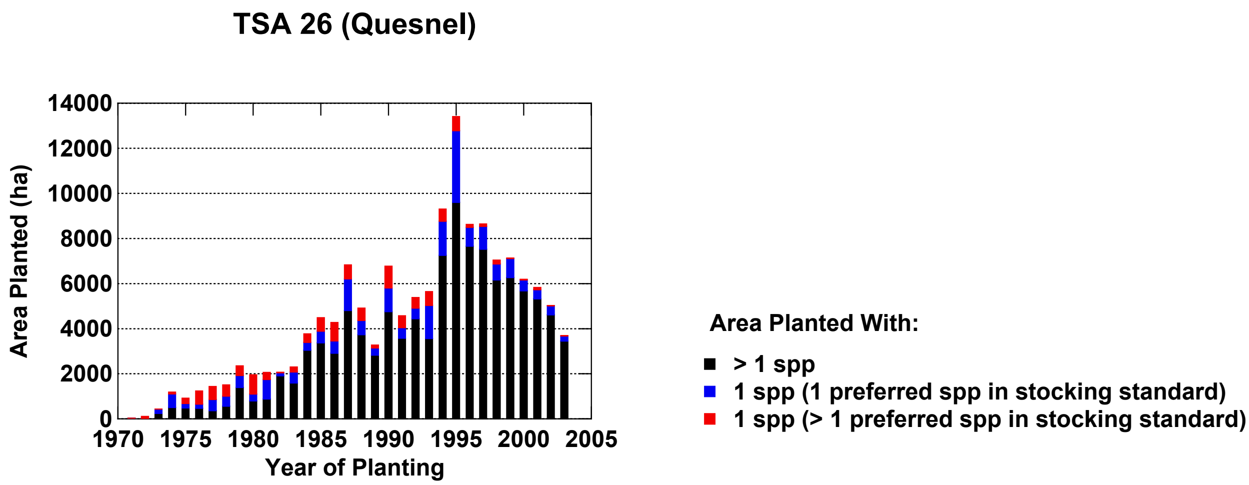


Figure A4–42. For the Quesnel TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

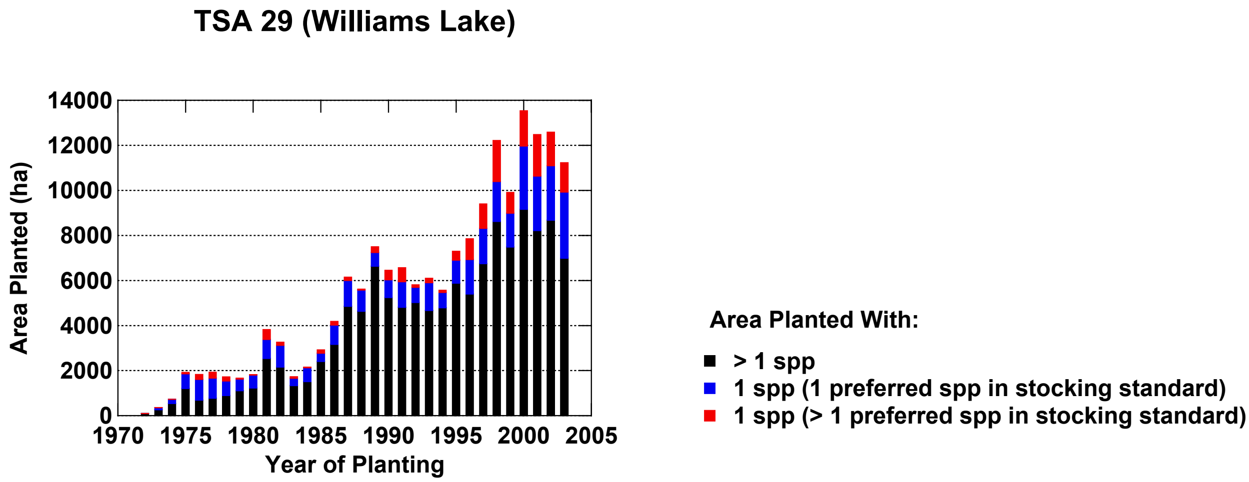
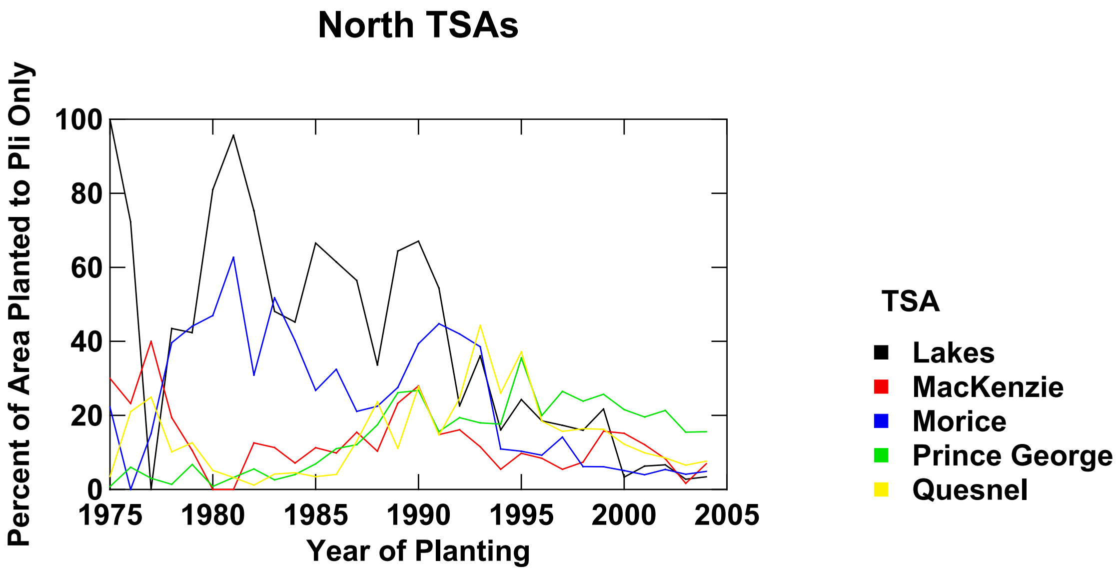


Figure A4–43. For the Williams Lake TSA, area planted by year by planting situation: i) area planted with more than one species, ii) area planted with one species and only one species listed as preferred in the stocking standard, and iii) area planted with one species while more than one species is listed as preferred in the stocking standard. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



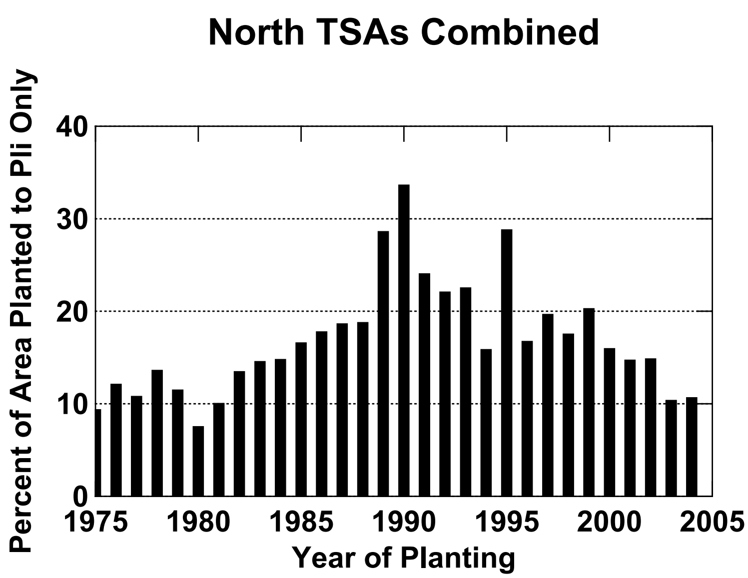
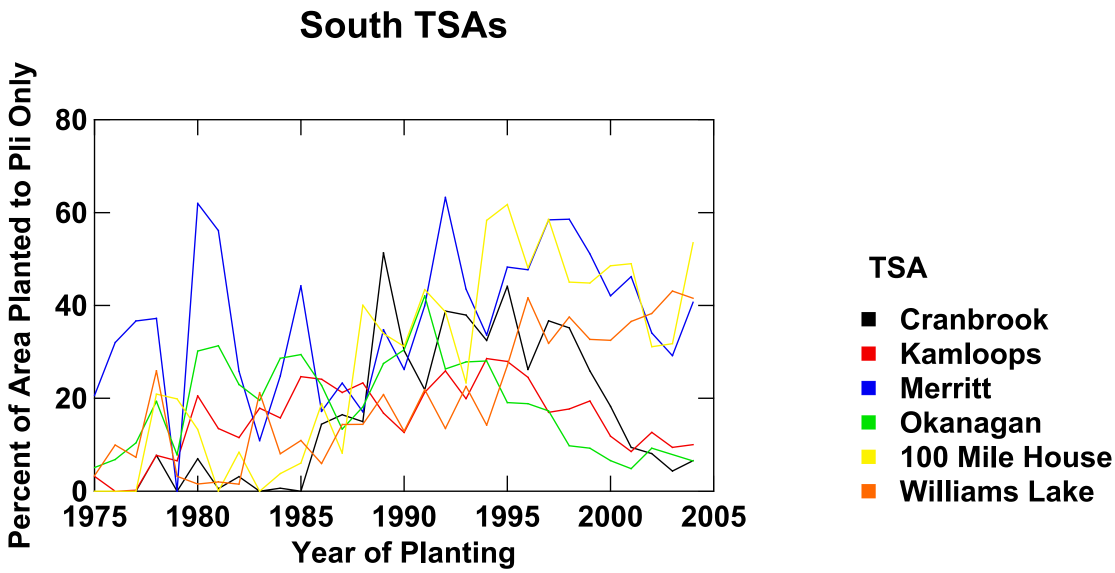


Figure A4–44. Average percent of planted area (ATU area) in which only lodgepole pine was planted at the planting event by year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



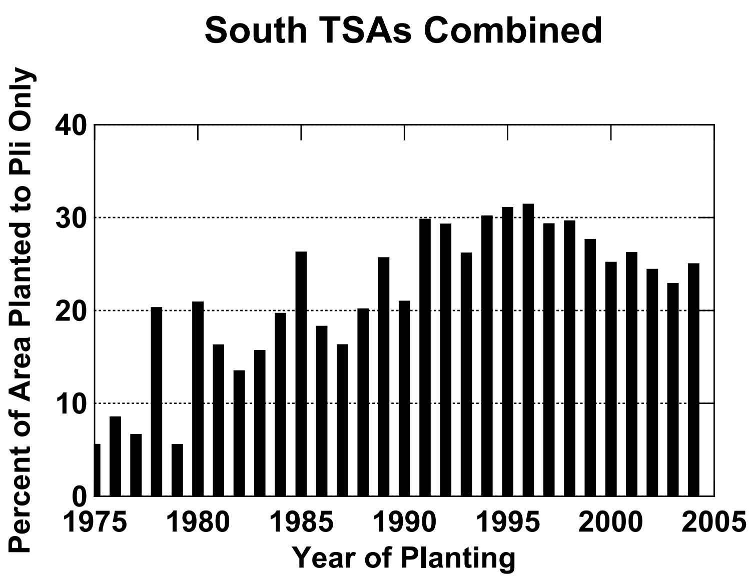


Figure A4–45. Average percent of planted area (ATU area) in which only lodgepole pine was planted at the planting event by year by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

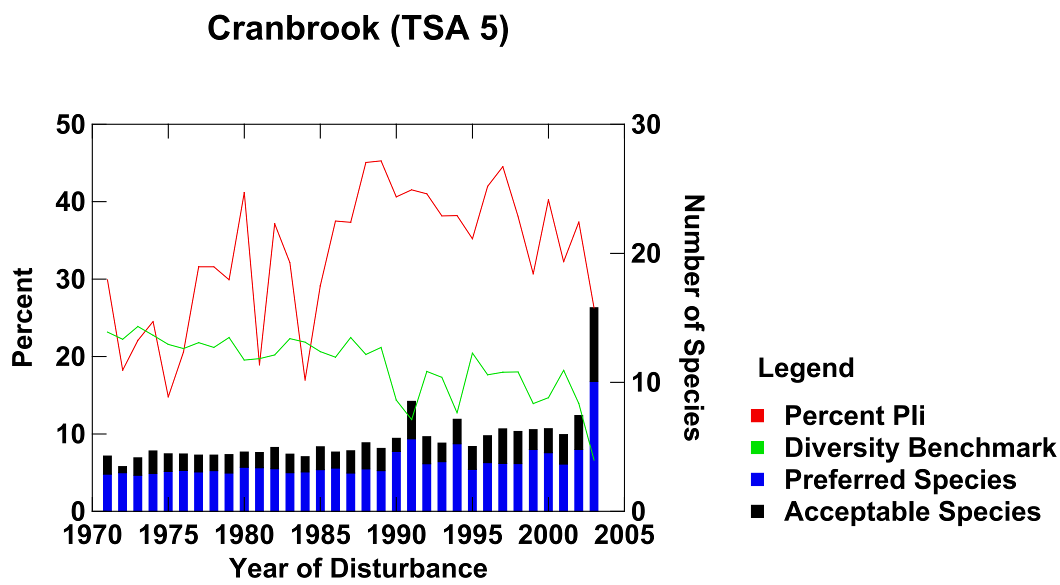


Figure A4–46. For the Cranbrook TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. The diversity benchmark is 2/3/number of preferred species. Thus, it represents the percent lodgepole pine if preferred species equally comprise 2/3 of the stand and acceptable (and unacceptable) species comprise the remaining 1/3. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

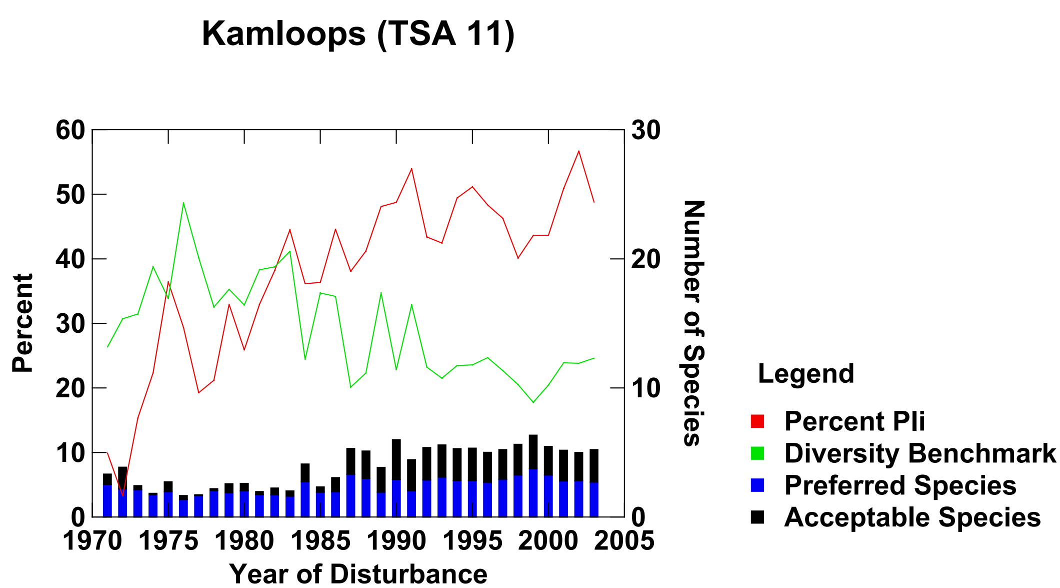


Figure A4–47. For the Kamloops TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

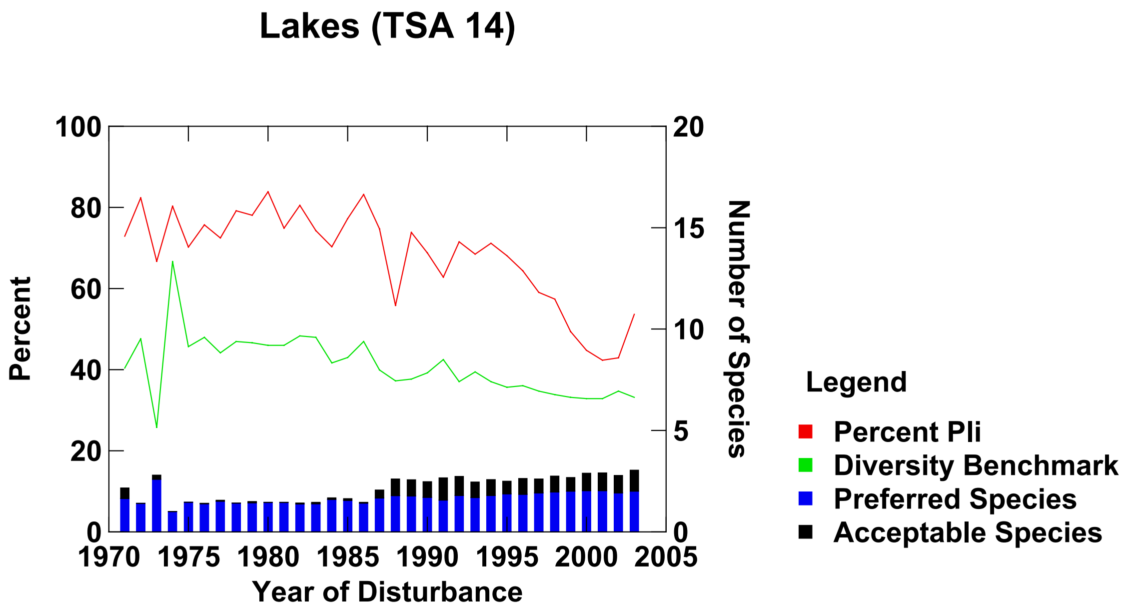


Figure A4–48. For the Lakes TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

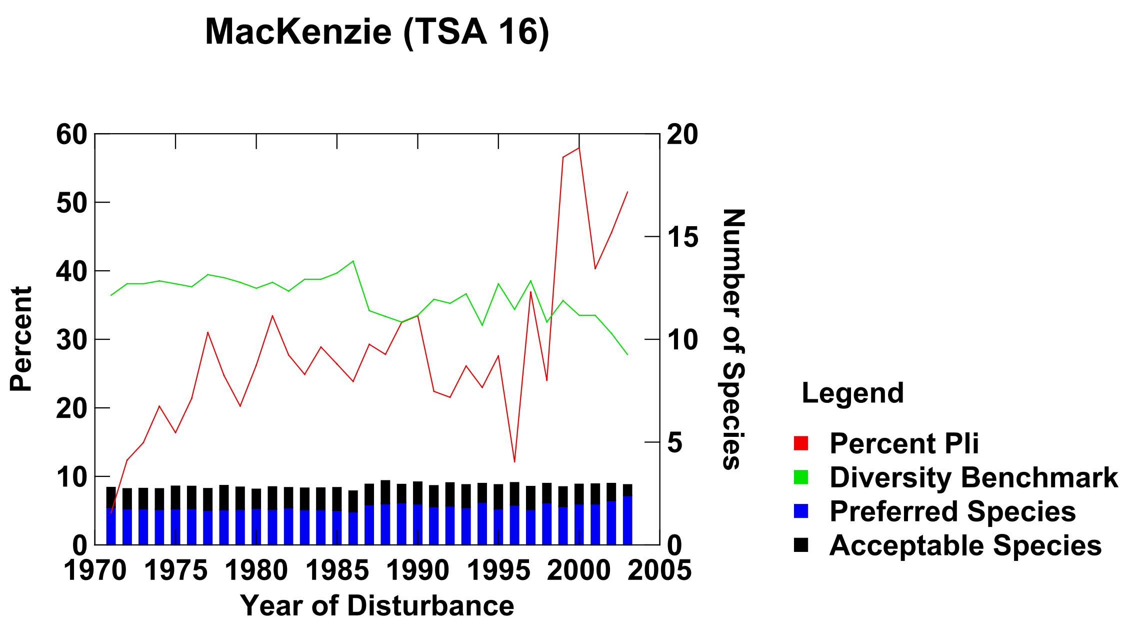


Figure A4–49. For the MacKenzie TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

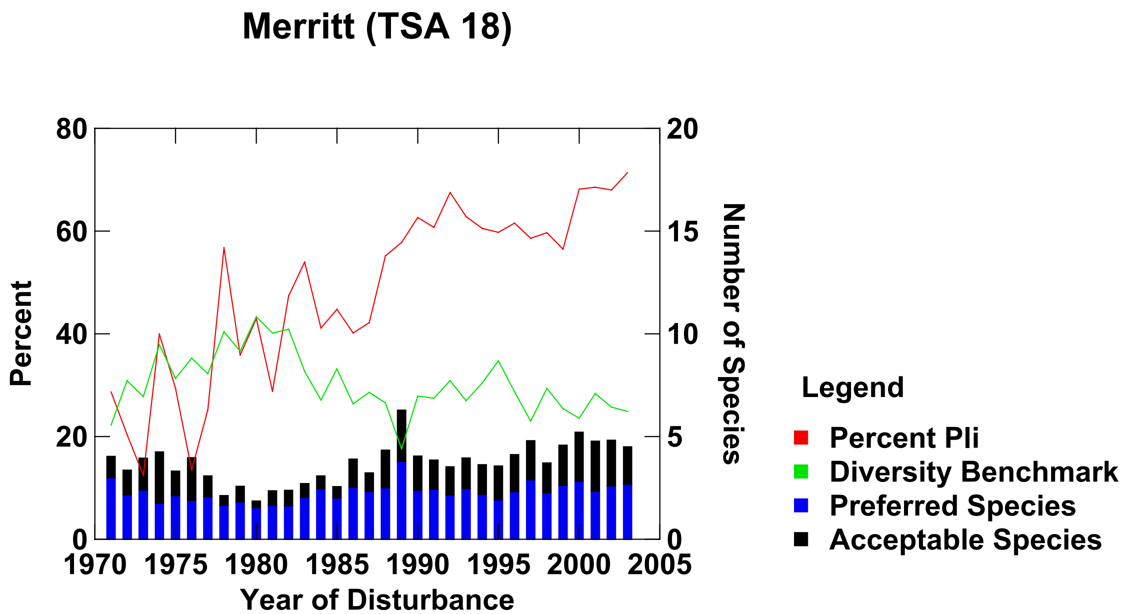


Figure A4–50. For the Merritt TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

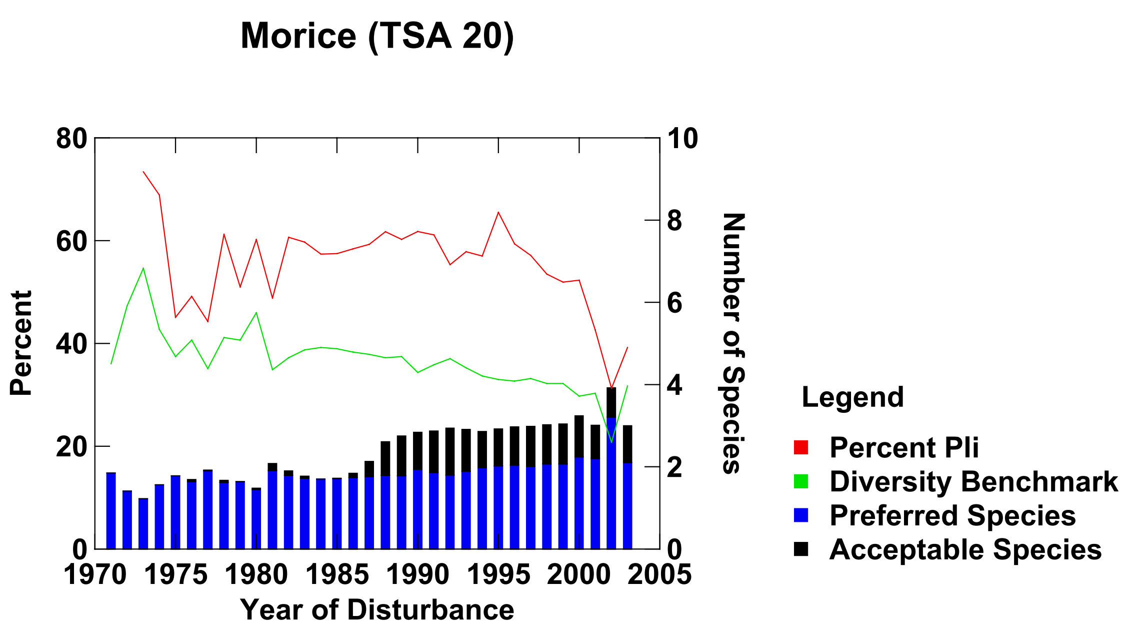


Figure A4–51. For the Morice TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

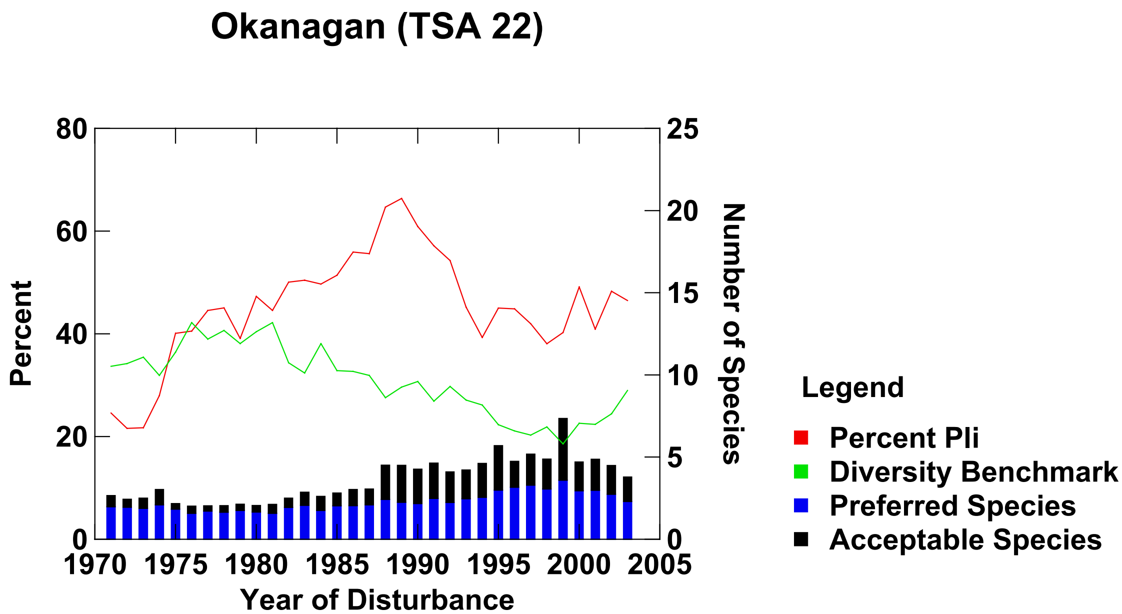


Figure A4–52. For the Okanagan TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

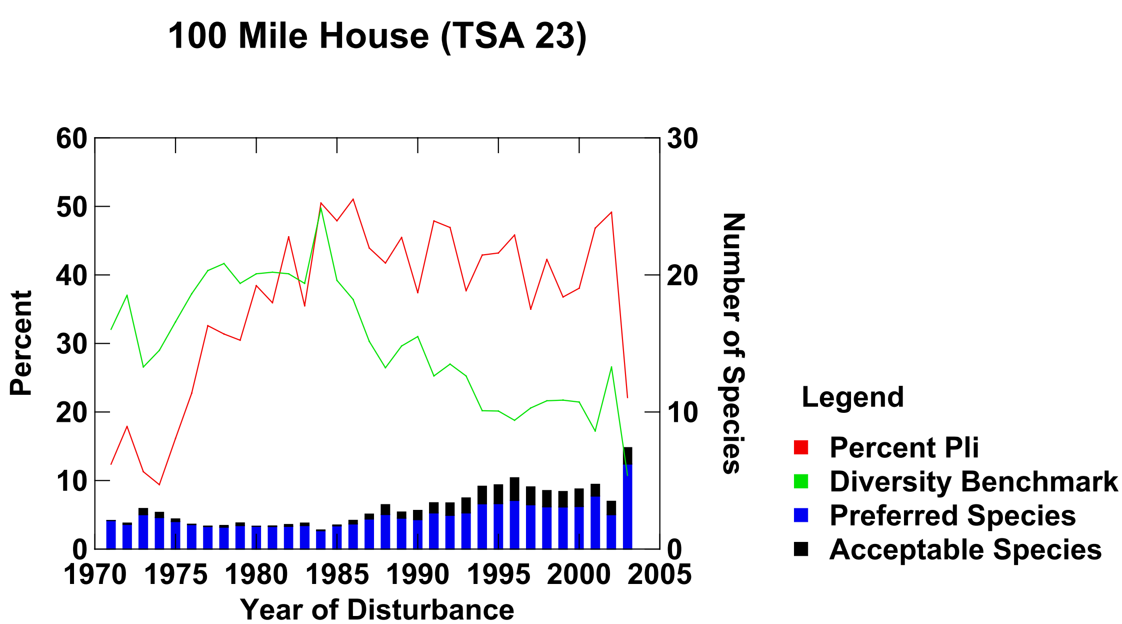


Figure A4–53. For the 100 Mile House TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

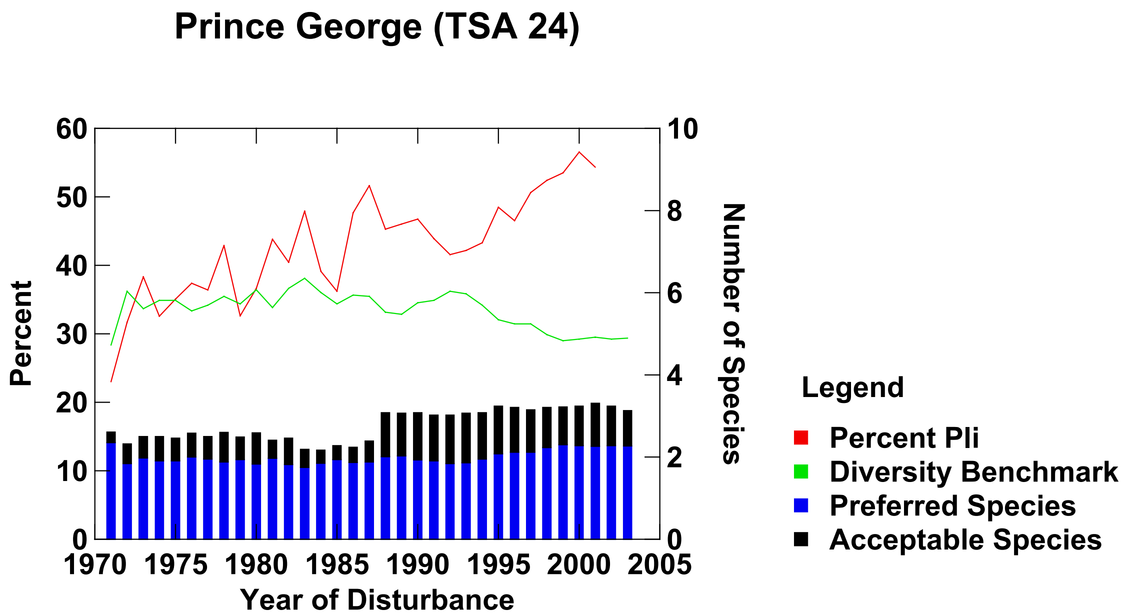


Figure A4–54. For the Prince George TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

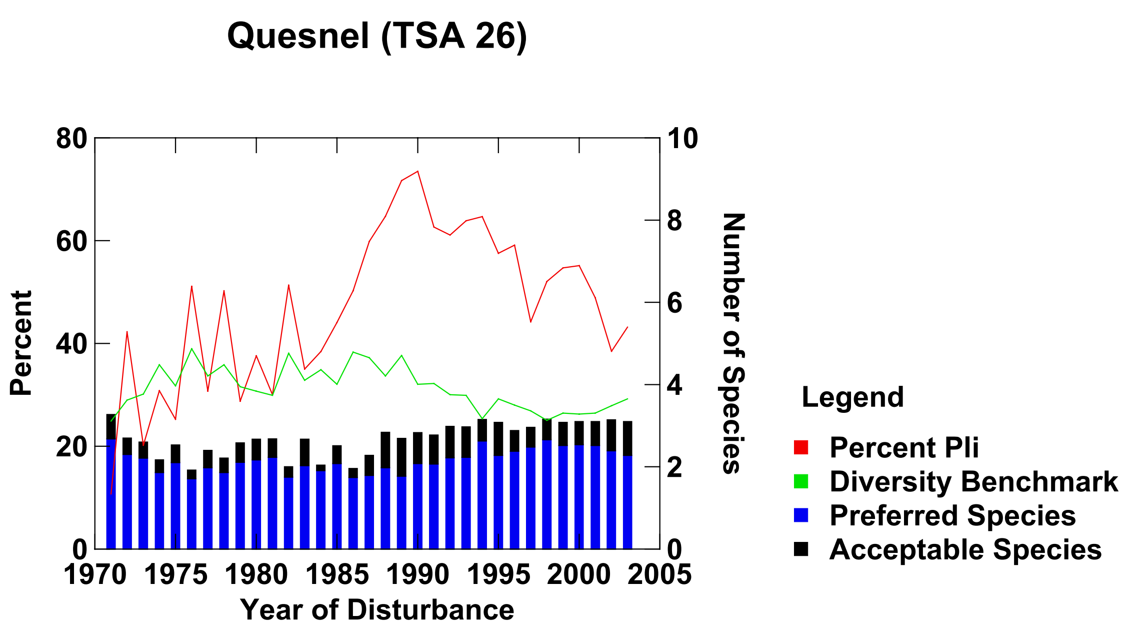


Figure A4–55. For the Quesnel TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.

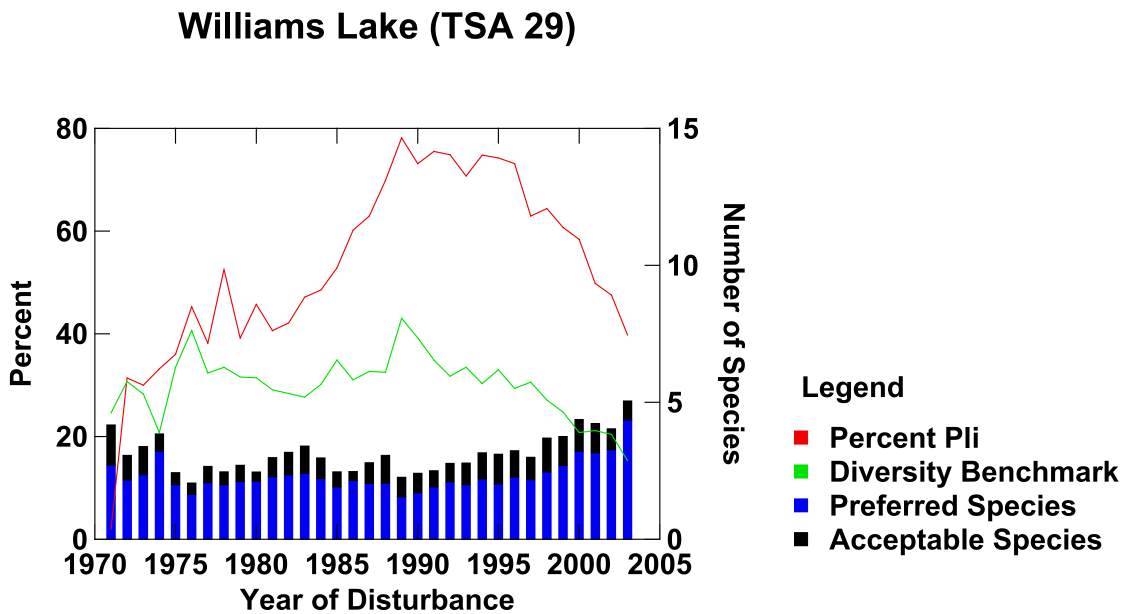
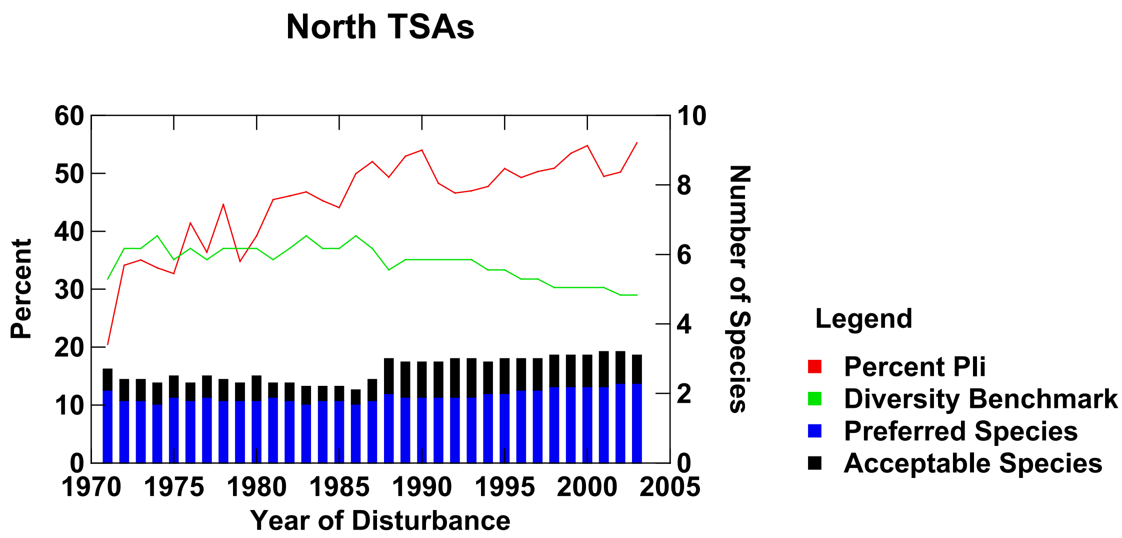


Figure A4–56. For the Williams Lake TSA, for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.



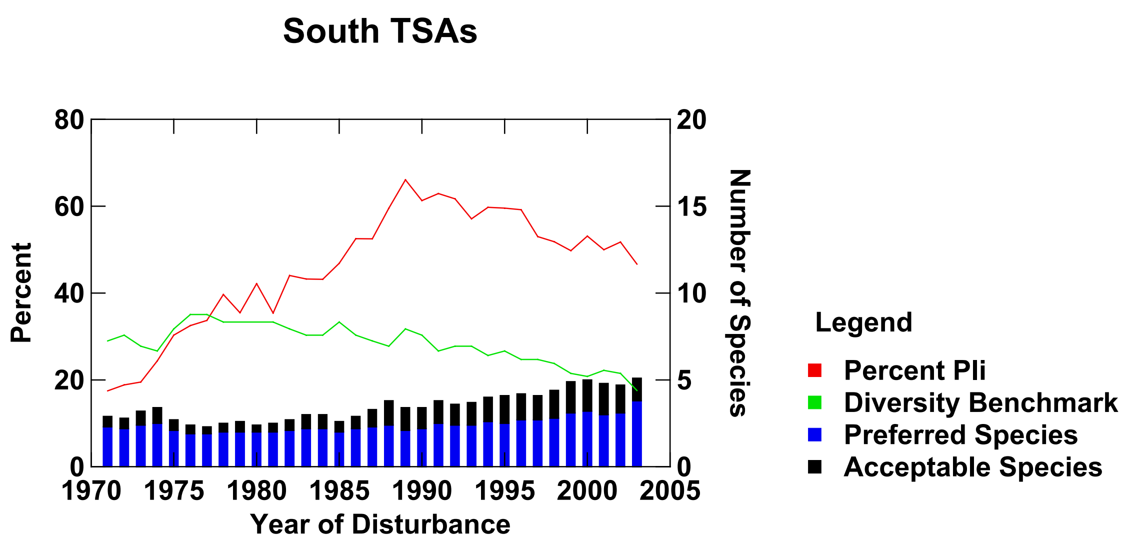
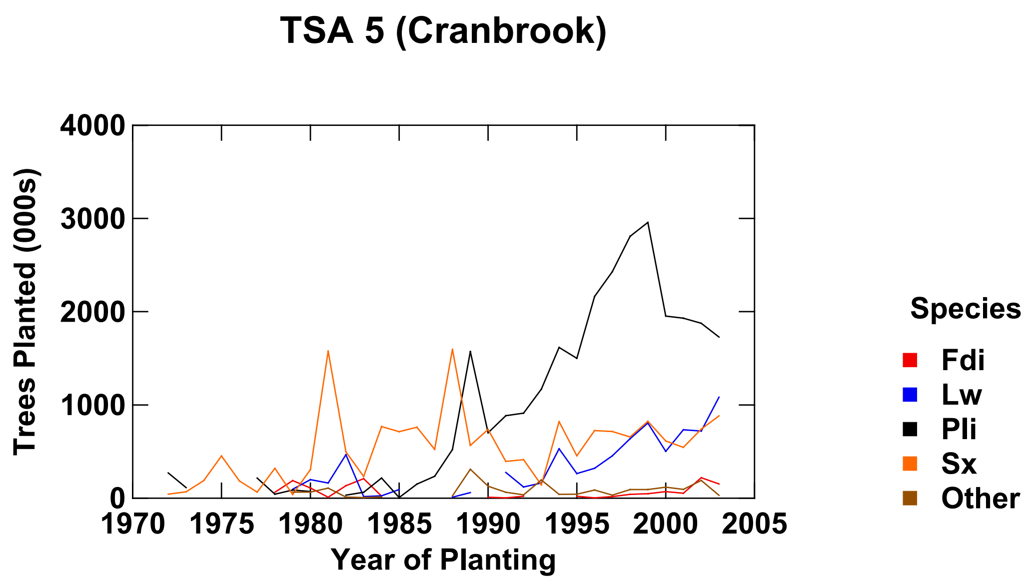
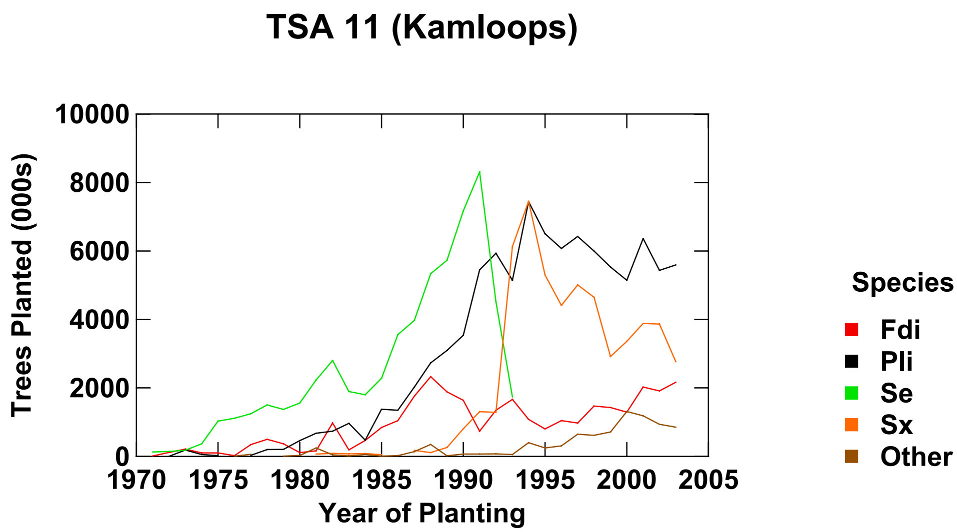


Figure A4–57. For the northern TSA group (upper) and the southern TSA group (lower), for forest cover polygons with lodgepole pine as a preferred species in the associated stocking standard, by disturbance year, the average percent lodgepole pine in the inventory label, the average number of species listed as preferred and acceptable, and the average percent lodgepole pine under a scenario of high species diversity. See Figure A4–46 for detail.



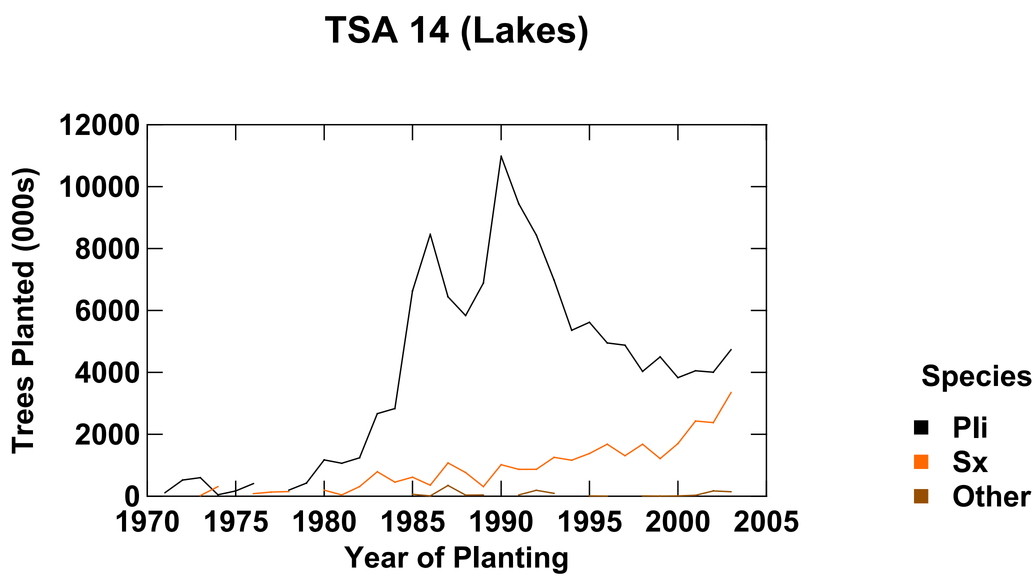
Species	Trees Planted (number)	(%)	(Cum. %)
Pli	30,492,479	48.79	48.79
Sx	18,643,840	29.83	78.62
Lw	9,425,391	15.08	93.70
Fdi	1,809,625	2.90	96.60
Se	1,181,633	1.89	98.49
Py	886,580	1.42	99.91
Pw	30,915	0.05	99.96
Cw	18,582	0.03	99.99
Bl	11,000	0.01	100.00
Ep	900	0.00	100.00
Ss	500	0.00	100.00
Total	**62,501,445**	**100.00**	**100.00**

Figure A4–58. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Cranbrook TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



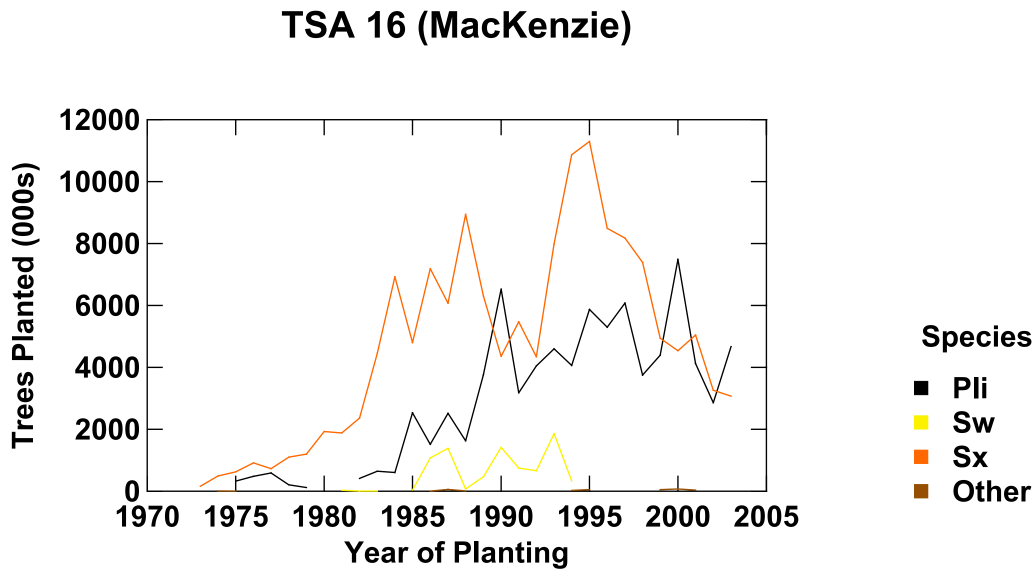
Species	Trees Planted (number)	(%)	(Cum. %)
Pli	100,316,827	38.90	38.90
Se	60,007,808	23.27	62.17
Sx	55,980,885	21.71	83.88
Fdi	32,743,626	12.70	96.58
Cw	4,272,281	1.66	98.24
Lw	1,557,823	0.60	98.84
Py	937,964	0.36	99.20
Pw	698,363	0.27	99.47
Bl	695,180	0.27	99.74
Hw	264,124	0.10	99.84
Fdc	167,680	0.07	99.91
Hm	78,761	0.03	99.94
Ls	50,745	0.02	99.96
Sw	34,000	0.01	99.97
Ba	27,000	0.01	99.98
Act	13,055	0.01	99.99
Sxe	11,000	0.01	100.00
Ac	9,000	0.00	100.00
At	3,000	0.00	100.00
Dr	2,985	0.00	100.00
Ep	1,488	0.00	100.00
Yc	1,000	0.00	100.00
W	80	0.00	100.00
Total	**257,874,675**	**100.00**	**100.00**

Figure A4–59. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Kamloops TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



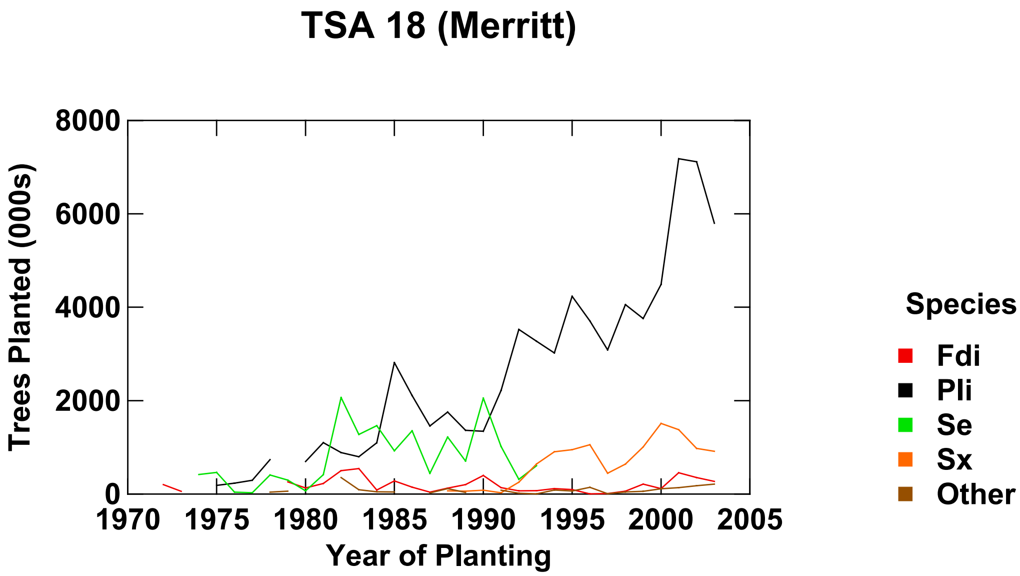
Species	Trees Planted (number)	(%)	(Cum. %)
Pli	131,048,031	79.97	79.97
Sx	31,094,456	18.98	98.95
Sxw	426,100	0.26	99.21
Bl	424,621	0.26	99.47
Fdi	402,662	0.25	99.72
Sw	396,556	0.24	99.96
Sxs	43,600	0.03	99.99
At	26,890	0.01	100.00
Dr	2,160	0.00	100.00
W	1,980	0.00	100.00
Pw	600	0.00	100.00
Lw	0	0.00	100.00
Total	**163,867,656**	**100.00**	**100.00**

Figure A4–60. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Lakes TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



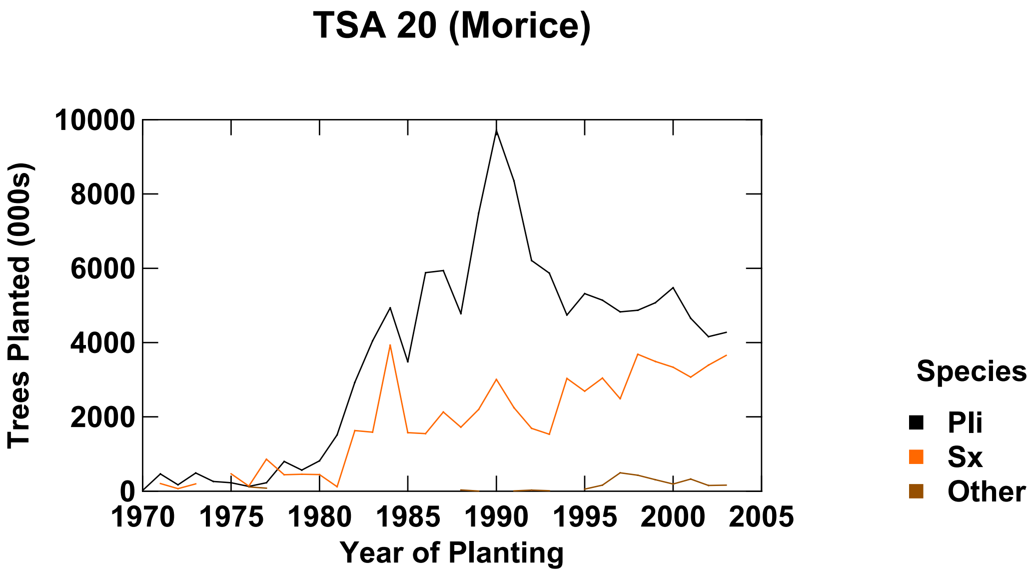
Species	Trees Planted (number)	(%)	(Cum. %)
Sx	150,449,354	60.79	60.79
Pli	88,327,550	35.69	96.48
Sw	8,173,895	3.30	99.78
Bl	408,892	0.17	99.95
Fdi	97,500	0.04	99.99
Lw	19,000	0.01	100.00
Sb	16,822	0.00	100.00
Ls	10,125	0.00	100.00
Act	5,400	0.00	100.00
Total	**247,508,538**	**100.00**	**100.00**

Figure A4–61. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the MacKenzie TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



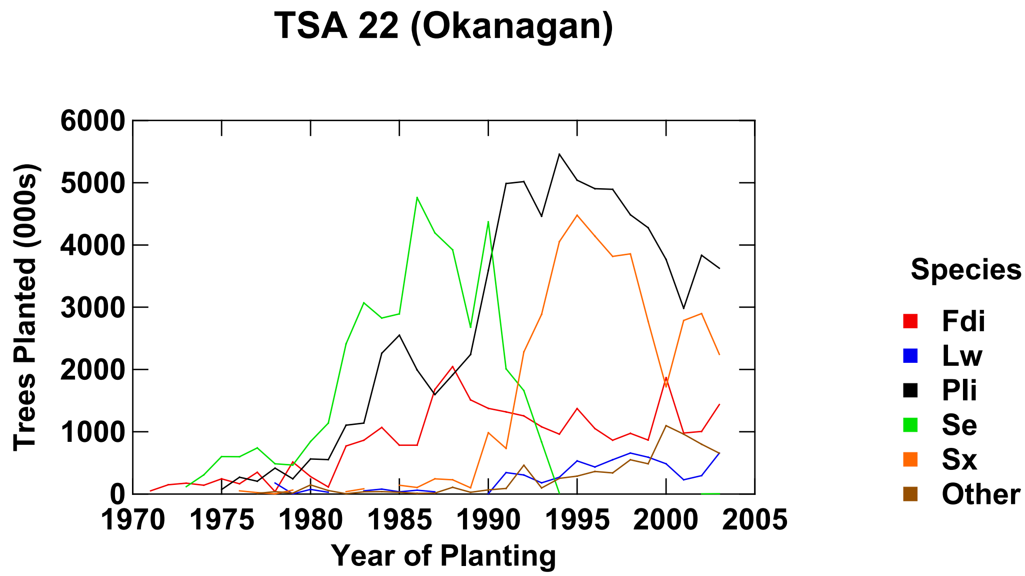
Species	Trees Planted (number)	(%)	(Cum. %)
Pli	77,112,370	68.89	68.89
Se	15,588,239	13.93	82.82
Sx	11,593,720	10.36	93.18
Fdi	5,553,193	4.96	98.14
Py	1,370,682	1.22	99.36
Lw	671,624	0.61	99.97
Ss	16,360	0.01	99.98
Bl	15,596	0.01	99.99
At	7,200	0.01	100.00
Yc	3,890	0.00	100.00
Pw	1,890	0.00	100.00
Act	1,000	0.00	100.00
Total	**111,935,764**	**100.00**	**100.00**

Figure A4–62. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Merritt TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



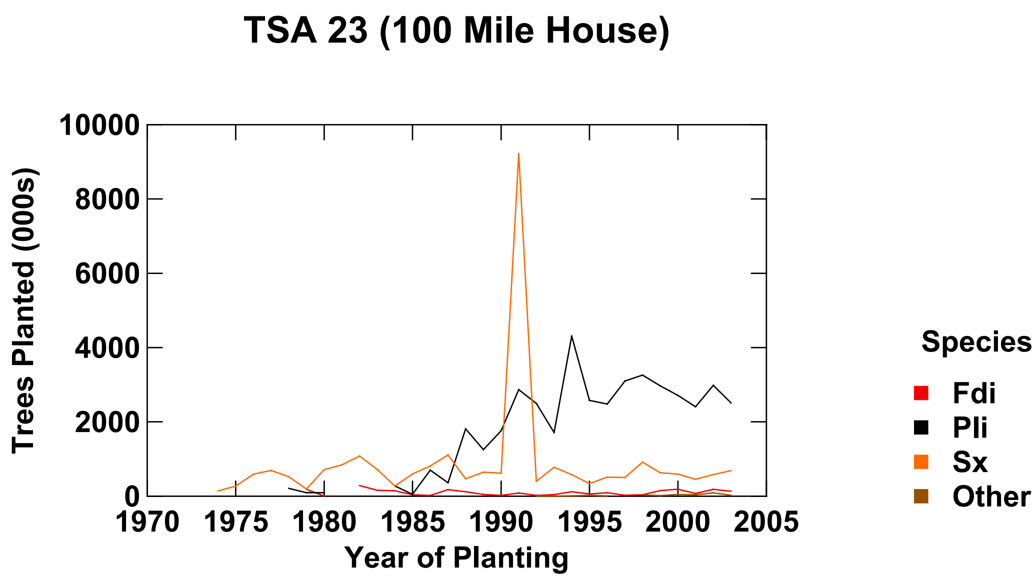
Species	Trees Planted (number)	(%)	(Cum. %)
Pli	127,563,319	65.72	65.72
Sx	63,731,984	32.83	98.55
Bl	2,503,453	1.29	99.84
Sw	233,200	0.12	99.96
Sxw	35,000	0.02	99.98
Lw	17,366	0.01	99.99
Ls	15,300	0.01	100.00
W	1,080	0.00	100.00
Total	**194,100,702**	**100.00**	**100.00**

Figure A4–63. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Morice TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



Species	Trees Planted (number)	(%)	(Cum. %)
Pli	82,604,206	39.18	39.18
Sx	42,984,814	20.39	59.97
Se	40,966,701	19.43	79.00
Fdi	29,960,764	14.21	93.21
Lw	6,513,989	3.09	96.30
Cw	3,898,976	1.85	98.15
Pw	1,512,525	0.72	98.87
Py	1,422,088	0.67	00.54
Bl	626,242	0.30	99.84
Ss	118,460	0.06	99.90
Hw	84,928	0.04	99.94
Sxw	39,270	0.02	99.96
Ep	34,043	0.02	99.98
Fdc	21,780	0.01	99.99
Hm	11,123	0.01	100.00
Sw	3,460	0.00	100.00
Yc	1,720	0.00	100.00
Act	1,500	0.00	100.00
Total	**210,806,589**	**100.00**	**100.00**

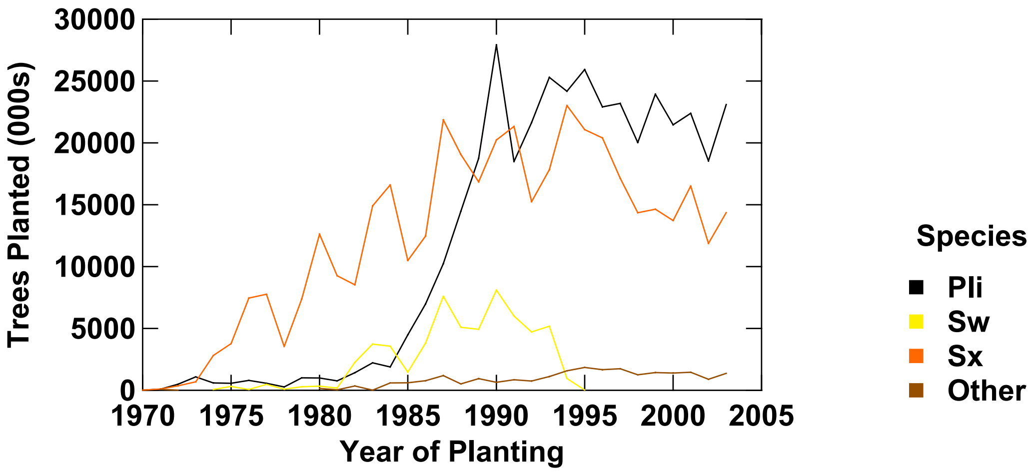
Figure A4–64. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Okanagan TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



Species	Trees Planted (number)	(%)	(Cum. %)
Pli	46,532,878	60.59	60.59
Sx	27,043,279	35.22	95.81
Fdi	2,770,519	3.61	99.42
Lw	148,543	0.19	99.61
Sw	95,000	0.12	99.73
Pw	57,475	0.07	99.80
Ep	56,098	0.07	99.87
Se	53,080	0.07	99.94
Py	18,435	0.02	99.96
Bl	8,241	0.01	99.99
Ls	5,895	0.01	100.00
Ea	3,500	0.00	100.00
Cw	1,000	0.00	100.00
Total	**76,793,943**	**100.00**	**100.00**

Figure A4–65. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the 100 Mile House TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

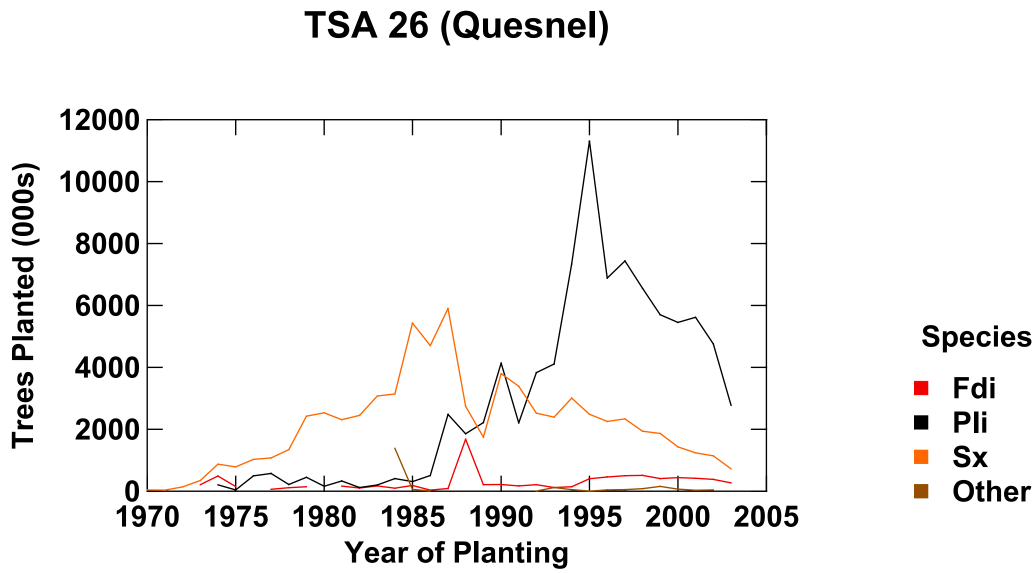
TSA 24 (Prince George)



Species	Trees Planted (number)	(%)	(Cum. %)
Sx	433,543,516	46.45	46.45
Pli	415,601,008	44.53	90.98
Sw	59,208,295	6.34	97.32
Fdi	20,905,322	2.24	99.56
Bl	2,009,988	0.22	99.78
Se	924,060	0.10	99.88
Cw	699,823	0.07	99.95
Sxw	178,000	0.03	99.98
Ss	99,700	0.02	100.00
Lw	33,100	0.00	100.00
At	28,425	0.00	100.00
Sb	19,495	0.00	100.00
Act	12,700	0.00	100.00
Py	11,850	0.00	100.00
Ep	11,470	0.00	100.00
Ac	8,064	0.00	100.00
Pw	8,000	0.00	100.00
W	6,270	0.00	100.00
Ba	6,100	0.00	100.00
Acb	5,005	0.00	100.00
Ax	5,005	0.00	100.00

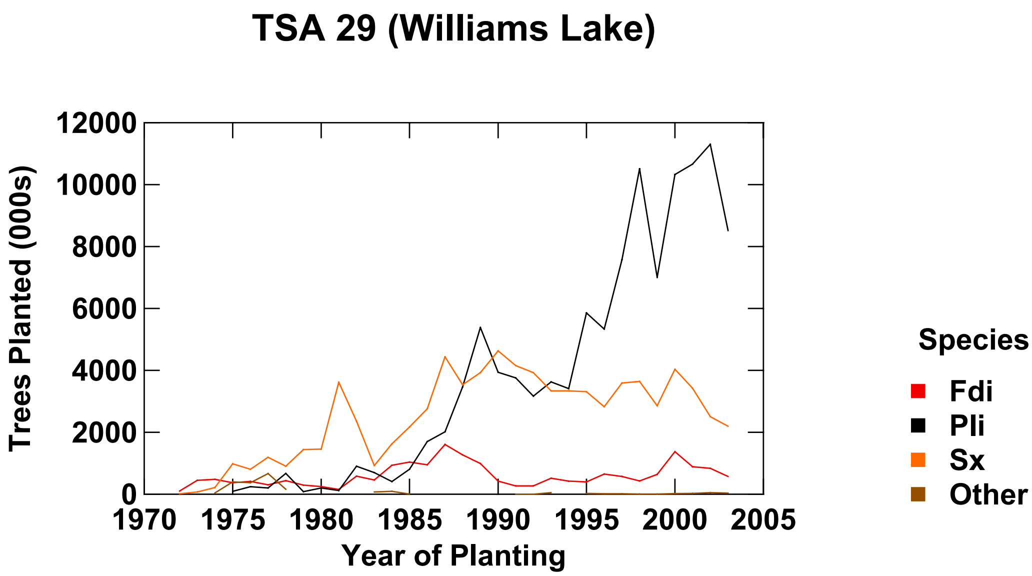
Species	Trees Planted (number)	(%)	(Cum. %)
Dr	3,900	0.00	100.00
Lt	3,000	0.00	100.00
La	1,720	0.00	100.00
Ea	1,700	0.00	100.00
Dm	1,584	0.00	100.00
Bb	300	0.00	100.00
Total	**933,337,400**	**100.00**	**100.00**

Figure A4–66. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Prince George TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



Species	Trees Planted (number)	(%)	(Cum. %)
PLI	93,540,250	52.53	52.53
SX	73,627,695	41.35	93.88
FDI	8,794,162	4.94	98.82
SW	1,541,000	0.87	99.69
BL	531,472	0.30	99.99
SE	27,000	0.01	100.00
LW	440	0.00	100.00
Total	**178,062,019**	**100.00**	**100.00**

Figure A4–67. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Quesnel TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



Species	Trees Planted (number)	(%)	(Cum. %)
Pli	119,202,934	53.12	53.12
Sx	83,336,727	37.14	90.26
Fdi	19,732,512	8.79	99.05
Se	1,680,400	0.75	100.00
Sw	169,000	0.08	100.00
Ls	98,755	0.04	100.00
Bl	88,410	0.04	100.00
Cw	74,120	0.03	100.00
Py	4,695	0.00	100.00
La	4,620	0.00	100.00
Lw	4,480	0.00	100.00
Ep	2,688	0.00	100.00
Total	**224,399,341**	**100.00**	**100.00**

Figure A4–68. Number of trees planted by species by year (upper graph) and cumulative number planted by species (lower table) in the Williams Lake TSA. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

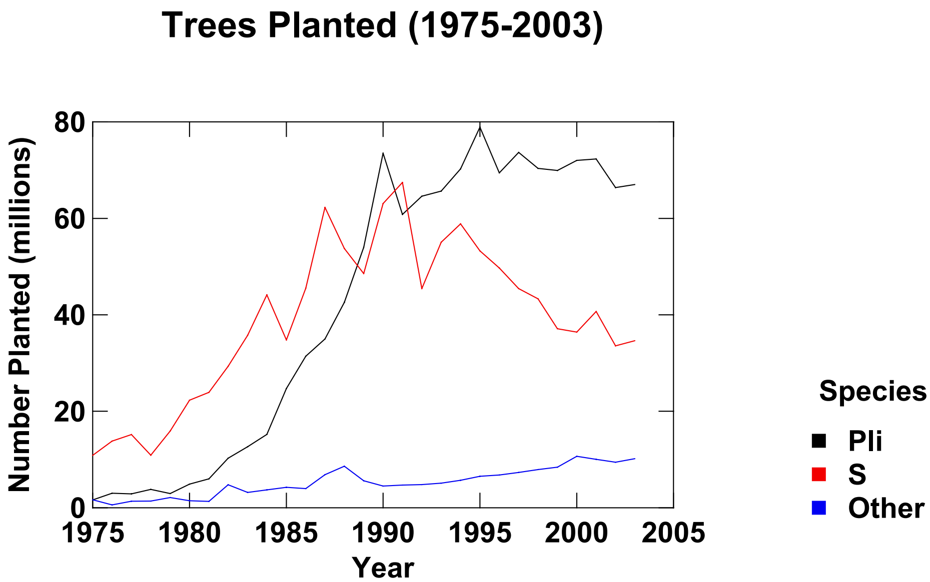


Figure A4–69. Number of trees planted by species group, totalled over all 11 TSAs, by year. Pli is lodgepole pine. S is all spruce species. Other is all other species. Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.

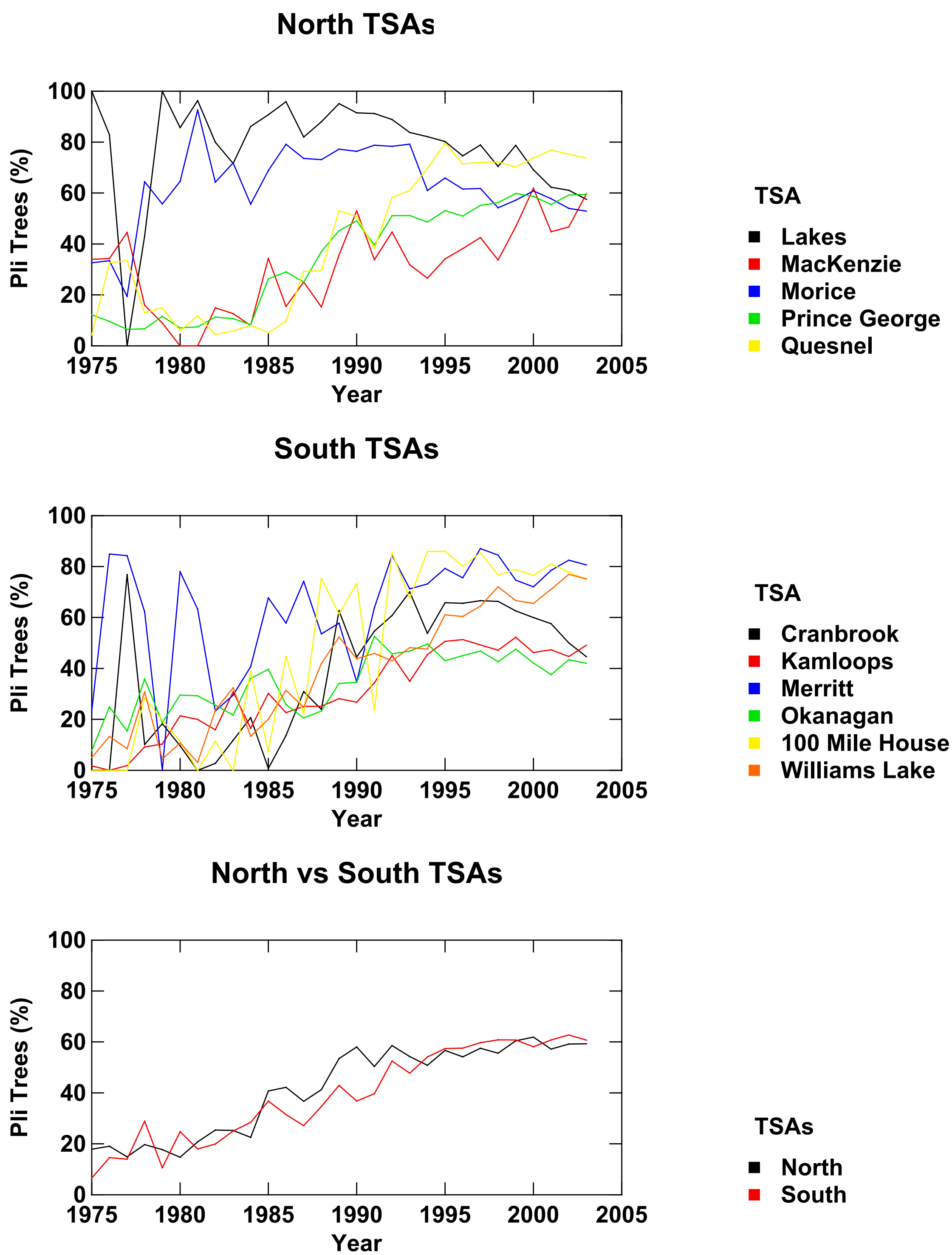
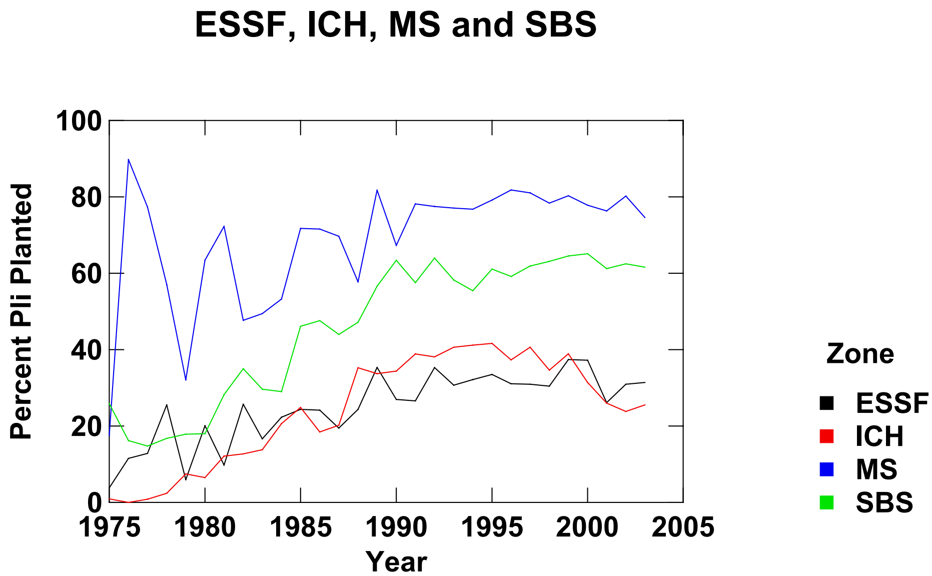
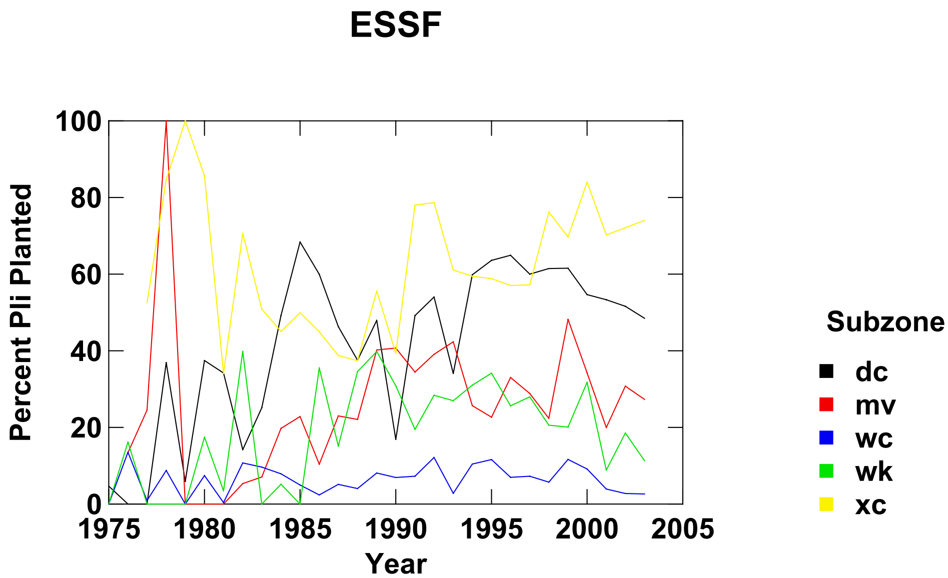


Figure A4–70. Lodgepole pine seedlings planted (expressed as a percent of the total number of seedlings planted) by year i) for TSAs in the northern TSA group (top), ii) for TSAs in the southern TSA group (middle), and iii) comparing averages from the north and south TSA groups (bottom). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



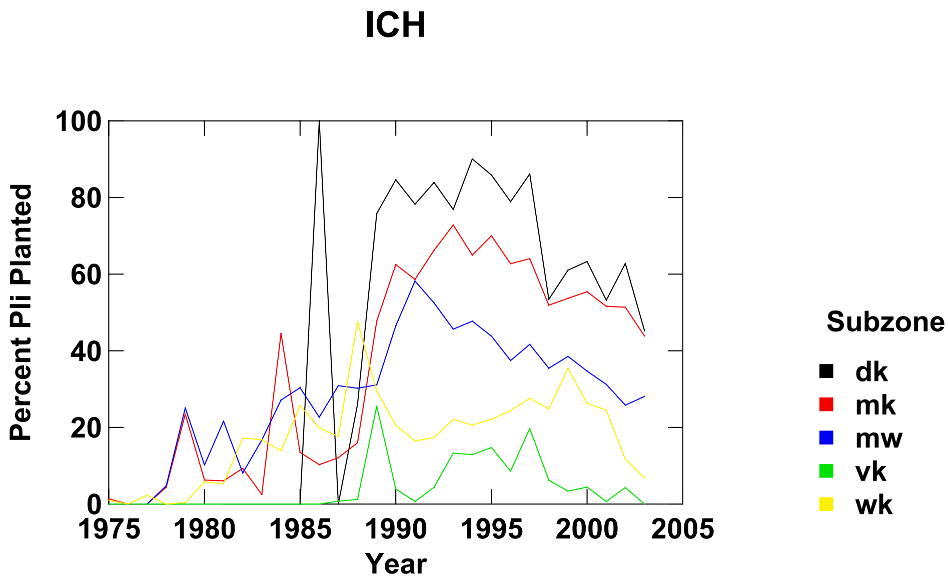
BEC Zone	Trees Planted (1975–2003) All	Trees Planted (1975–2003) Pli	Trees Planted (% of Total)	Pli Planted (% of Total)	Pli Planted (% of BEC)
BWBS	40,063,153	21,983,823	1.7	1.9	54.9
CWH	7,000	0	0.0	0.0	0.0
ESSF	450,487,819	130,783,585	19.1	11.0	29.0
ICH	255,352,418	74,866,701	10.9	6.3	29.3
IDF	110,399,291	80,488,931	4.7	6.7	72.9
MS	170,089,614	128,475,175	7.2	10.8	75.5
PP	114,220	0	0	0.0	0.0
SBPS	81,921,588	68,499,165	3.5	5.8	83.6
SBS	1,243,095,633	682,753,381	52.9	57.5	54.9
Total	**2,351,530,736**	**1,187,850,761**	**100.0**	**100.0**	**50.5**

Figure A4–71. Lodgepole pine seedlings planted (as percent of total seedlings planted) by year by BEC zone in the 11 TSAs (upper graph). The number of seedlings planted by zone, the number of lodgepole pine planted by zone, seedlings planted by zone as a percent of all seedlings planted, lodgepole pine planted by zone as a percent of the total lodgepole pine planted, and lodgepole pine planted as a percent of trees planted in BEC zone (lower table). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



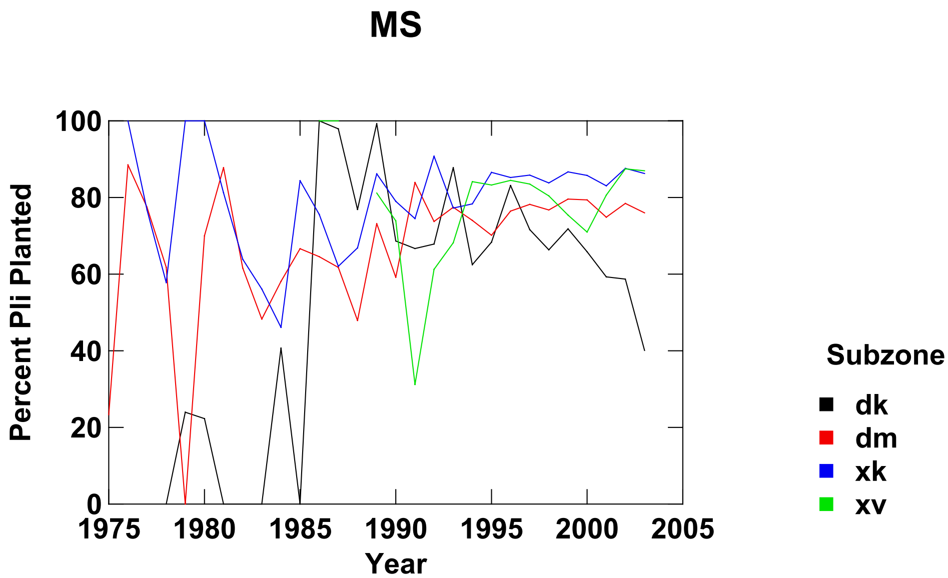
BEC Subzone	Trees Planted (1975–2003)		Trees Planted (% of Total)	Pli Planted	
	All	Pli		(% of Total)	(% of BEC)
dc	47,976,353	23,771,394	10.6	18.2	49.5
dk	20,667,888	10,693,448	4.6	8.2	51.7
dv	108,145	0	0.0	0.0	0.0
mc	19,778,191	10,044,976	4.5	7.7	50.8
mk	473,682	43,005	0.1	0.0	9.1
mm	238,400	0	0.1	0.0	0.0
mv	97,419,126	29,529,041	21.6	22.6	30.4
mw	9,180,590	2,787,825	2.0	2.1	30.4
vc	3,306,488	31,880	0.7	0.0	1.0
vv	8,471,143	743,804	1.9	0.6	8.8
wc	95,117,359	6,513,720	21.1	5.0	6.8
wk	113,238,777	28,408,280	25.1	21.7	25.1
wm	8,681,031	2,975,039	1.9	2.2	34.3
xc	25,058,846	14,726,949	5.6	11.3	58.8
xv	771,800	514,223	0.2	0.4	66.6
Total	**450,487,819**	**130,783,585**	**100.0**	**100.0**	**29.0**

Figure A4–72. Lodgepole pine seedlings planted (as percent of total seedlings planted) by year by subzone in the ESSF in the 11 TSAs (upper graph). The number of seedlings planted by ESSF subzone, the number of lodgepole pine planted by ESSF subzone, seedlings planted by ESSF subzone as a percent of all seedlings planted, lodgepole pine planted by ESSF subzone as a percent of the total lodgepole pine planted, and lodgepole pine planted as a percent of trees planted in ESSF subzone (lower table). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



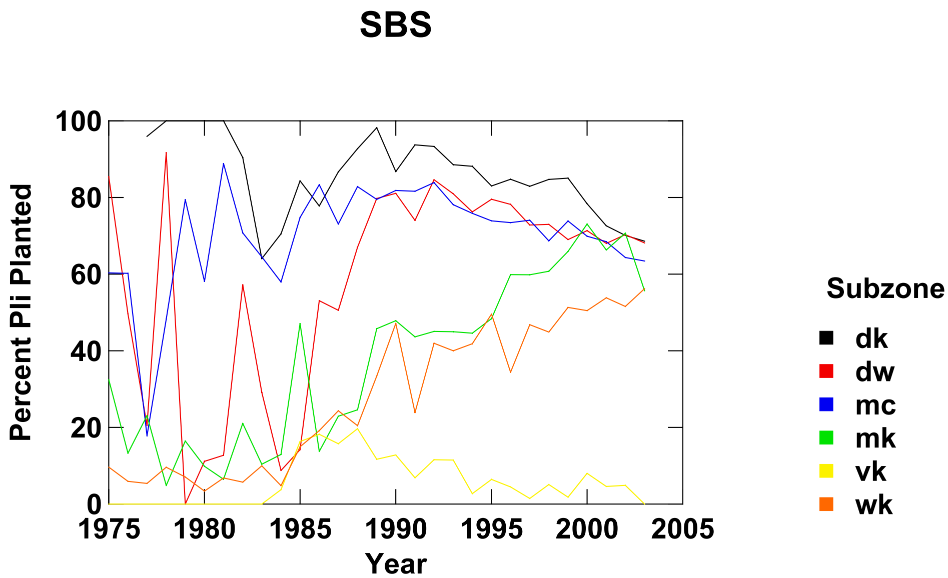
BEC Subzone	Trees Planted (1975–2003)		Trees Planted (% of Total)	Pli Planted	
	All	Pli		(% of Total)	(% of BEC)
dk	5,678,348	3,498,703	2.2	4.7	61.6
dw	22,440	18,580	0.0	0.0	82.8
mc	114,900	31,800	0.0	0.0	27.7
mk	45,197,049	19,903,148	17.7	26.6	44.0
mm	133,950	51,090	0.1	0.1	38.1
mw	83,764,994	29,465,347	32.8	39.4	35.2
vk	23,888,141	1,459,744	9.4	1.9	6.1
wk	96,552,596	20,438,289	37.8	27.3	21.2
Total	**255,352,418**	**74,866,701**	**100.0**	**100.0**	**29.3**

Figure A4–73. Lodgepole pine seedlings planted (as percent of total seedlings planted) by year by subzone in the ICH in the 11 TSAs (upper graph). The number of seedlings planted by ICH subzone, the number of lodgepole pine planted by ICH subzone, seedlings planted by ICH subzone as a percent of all seedlings planted, lodgepole pine planted by ICH subzone as a percent of the total lodgepole pine planted, and lodgepole pine planted as a percent of trees planted in ICH subzone (lower table). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



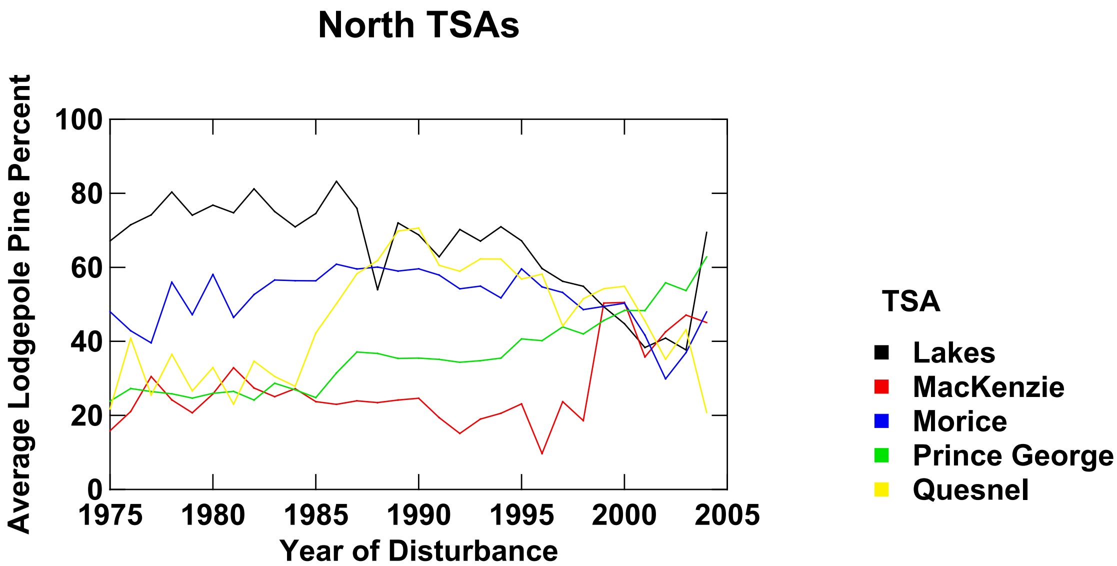
BEC Subzone	Trees Planted (1975–2003)		Trees Planted (% of Total)	Pli Planted	
	All	Pli		(% of Total)	(% of BEC)
dc	17,000	17,000	0.0	0.0	100.0
dk	15,557,000	9,406,881	9.1	7.3	60.5
dm	78,812,395	57,458,801	46.3	44.7	73.0
xk	46,902,513	38,504,302	27.6	30.0	82.1
xv	28,800,706	23,088,191	17.0	18.0	80.2
Total	**170,089,614**	**128,475,175**	**100.0**	**100.0**	**75.5**

Figure A4–74. Lodgepole pine seedlings planted (as percent of total seedlings planted) by year by subzone in the MS in the 11 TSAs (upper graph). The number of seedlings planted by MS subzone, the number of lodgepole pine planted by MS subzone, seedlings planted by MS subzone as a percent of all seedlings planted, lodgepole pine planted by MS subzone as a percent of the total lodgepole pine planted, and lodgepole pine planted as a percent of trees planted in MS subzone (lower table). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



BEC Subzone	Trees Planted (1975–2003)		Trees Planted (% of Total)	Pli Planted	
	All	Pli		(% of Total)	(% of BEC)
dh	66,235	20,600	0.0	0.0	31.1
dk	95,812,885	80,204,114	7.7	11.7	83.7
dw	172,132,671	122,154,369	13.8	17.9	71.0
mc	352,698,215	261,065,950	28.4	38.3	74.0
mh	221,895	57,235	0.0	0.0	25.8
mk	255,398,220	119,976,339	20.5	17.6	47.0
mm	9,522,711	5,052,524	0.8	0.7	53.1
mw	26,959,597	6,642,121	2.2	1.0	24.6
vk	94,140,025	8,806,625	7.6	1.3	9.4
wk	236,143,179	78,773,504	19.0	11.5	33.4
Total	**1,243,095,633**	**682,753,381**	**100.0**	**100.0**	**54.9**

Figure A4–75. Lodgepole pine seedlings planted (as percent of total seedlings planted) by year by subzone in the SBS in the 11 TSAs (upper graph). The number of seedlings planted by SBS subzone, the number of lodgepole pine planted by SBS subzone, seedlings planted by SBS subzone as a percent of all seedlings planted, lodgepole pine planted by SBS subzone as a percent of the total lodgepole pine planted, and lodgepole pine planted as a percent of trees planted in SBS subzone (lower table). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



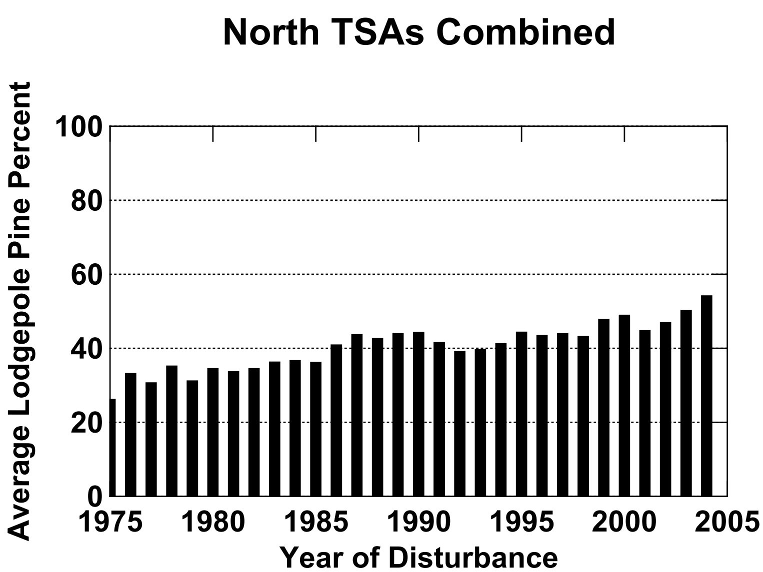
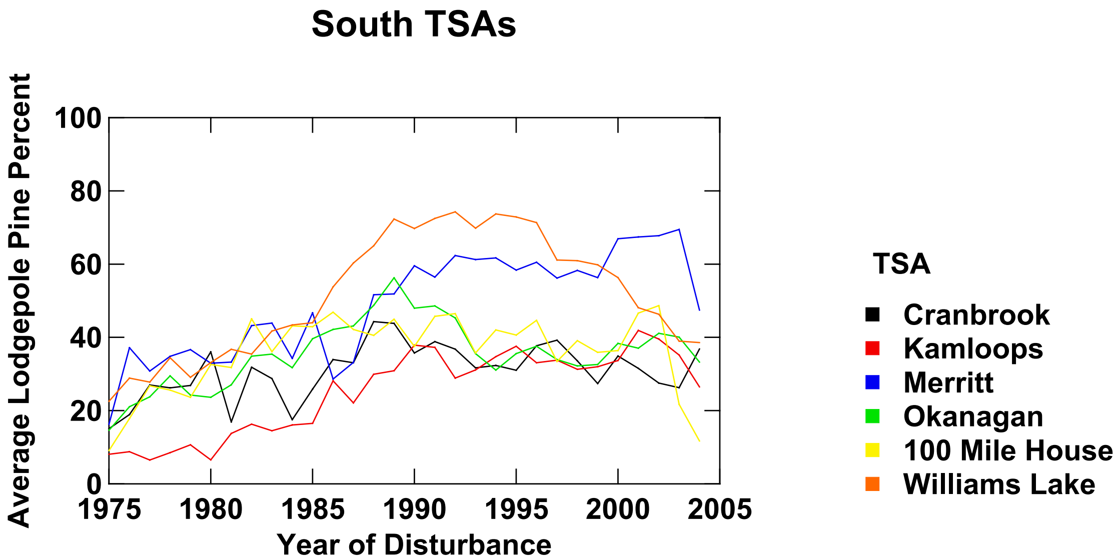


Figure A4–76. Average percent lodgepole pine in young stands (from the inventory label) by disturbance year by TSA (upper graph) and for all northern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



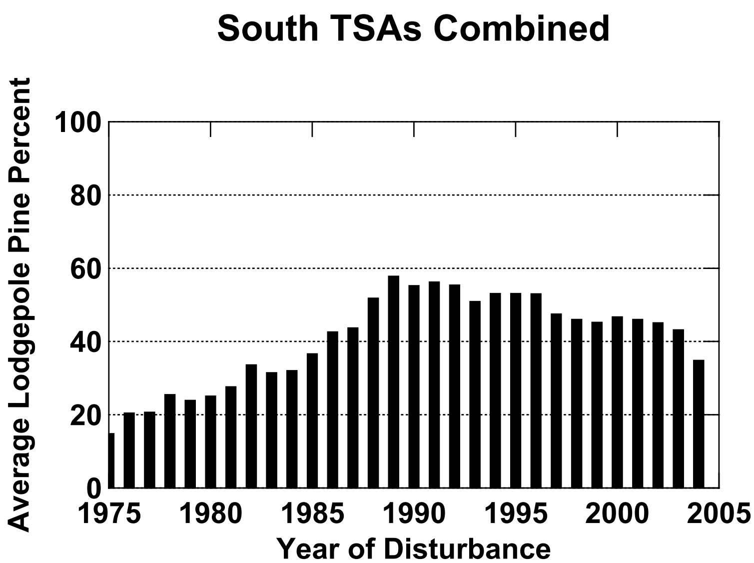
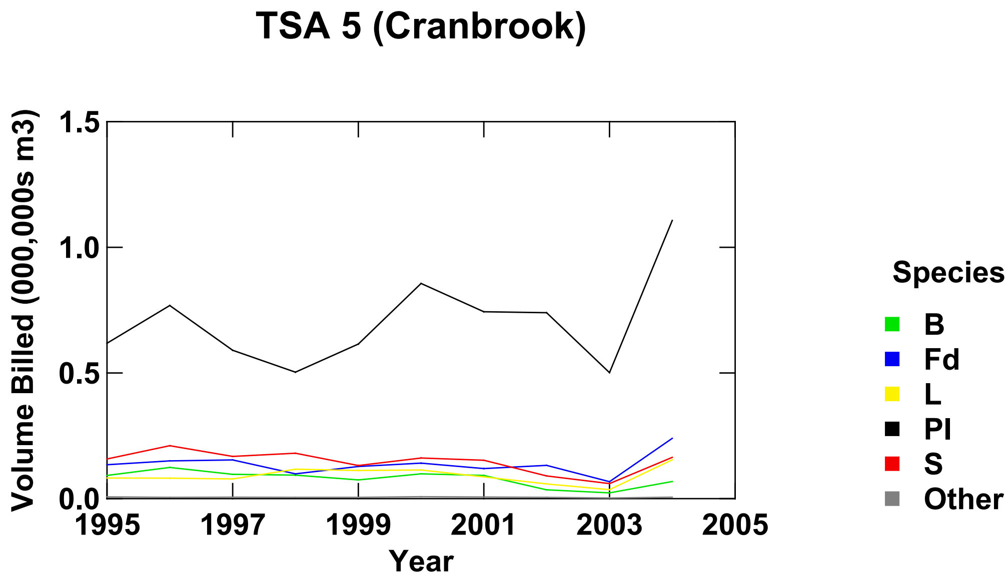
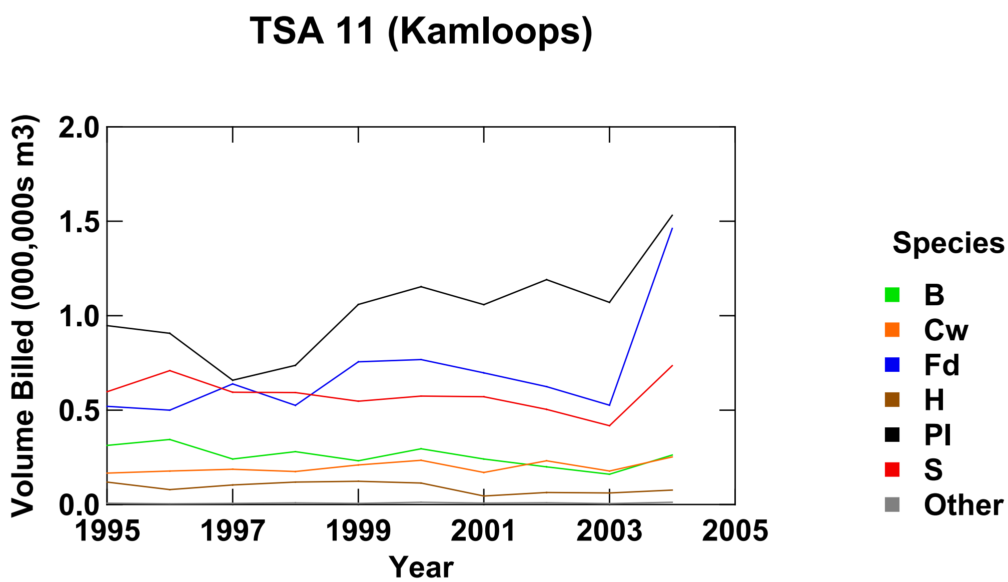


Figure A4–77. Average percent lodgepole pine in young stands (from the inventory label) by disturbance year by TSA (upper graph) and for all southern TSAs combined (lower graph). Source: Data extracted from RESULTS September 2005 by Syntax Designs and graphed by Martin Watts.



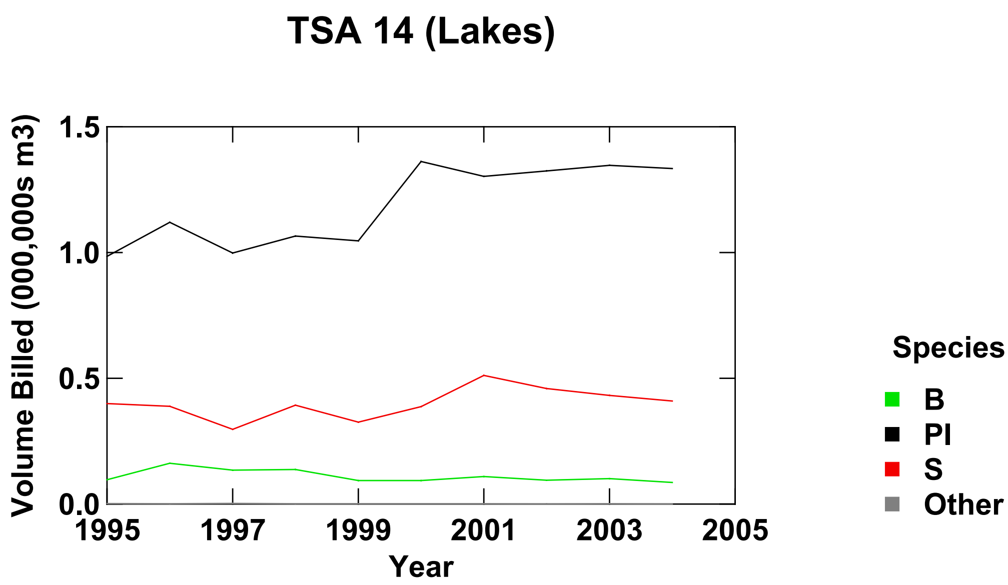
Species	Volume Billed – 1995 to 2004 (m³)	(%)	(Cum. %)
Pl	7,736,896.50	58.99	58.99
S	1,570,502.38	11.98	70.97
Fd	1,437,025.25	10.96	81.93
L	978,962.88	7.46	89.39
B	844,139.00	6.44	95.83
Reject	276,284.50	2.11	97.94
Py	104,541.83	0.80	98.74
Cw	68,441.66	0.52	99.26
H	37,643.52	0.29	99.55
Pa	27,488.70	0.21	99.76
Pw	24,562.12	0.19	99.95
Ac	6,115.65	0.05	100.00
At	1,460.12	0.00	100.00
E	754.58	0.00	100.00
D	8.10	0.00	100.00
Yc	2.83	0.00	100.00
Total	**13,114,831.00**	**100.00**	**100.00**

Figure A4–78. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Cranbrook TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



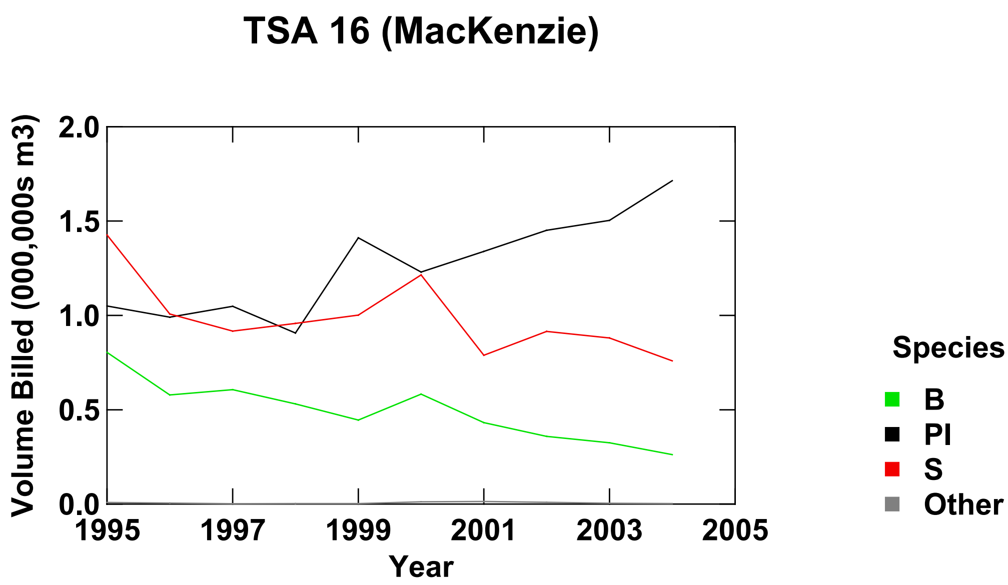
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	11,496,048.00	35.80	35.80
Fd	7,754,092.50	24.15	59.95
S	6,294,810.50	19.60	79.55
B	2,736,360.50	8.52	88.07
Cw	2,114,191.25	6.58	94.65
H	938,489.75	2.92	97.57
At	233,518.61	0.73	98.30
Pw	178,486.91	0.56	98.86
E	106,706.39	0.33	99.19
Reject	102,550.59	0.32	99.51
L	81,227.64	0.25	99.76
Py	41,085.37	0.13	99.89
Ac	33,430.05	0.10	99.99
Pa	395.95	0.01	100.00
D	55.32	0.00	100.00
W	42.90	0.00	100.00
M	13.82	0.00	100.00
Yc	11.70	0.00	100.00
Tw	0.30	0.00	100.00
Total	**32,111,516.00**	**100.00**	**100.00**

Figure A4–79. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Kamloops TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



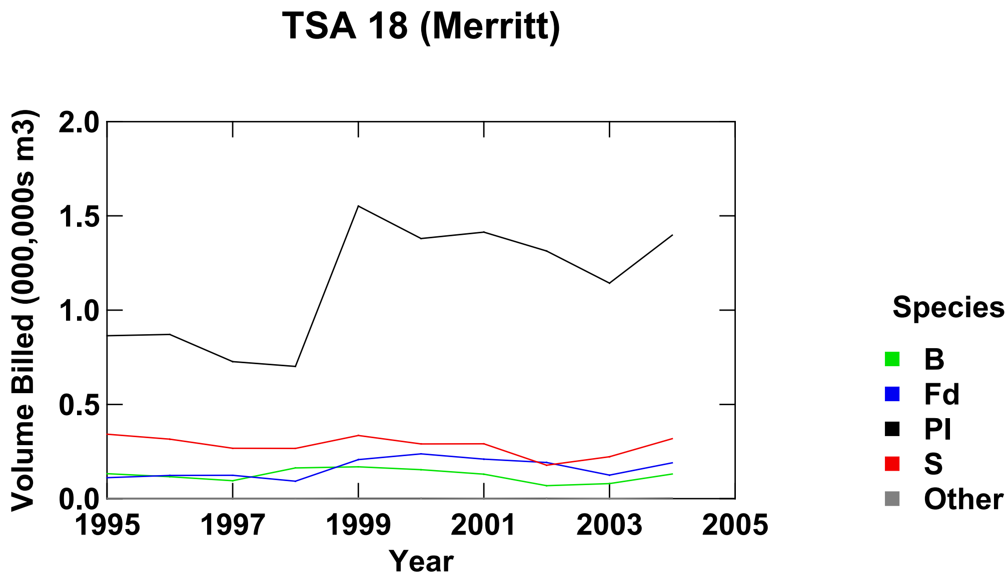
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	13,143,068.00	70.09	70.09
S	4,335,454.50	23.12	93.21
B	1,166,562.12	6.22	99.43
At	45,658.39	0.24	99.67
Reject	42,262.29	0.23	99.90
Ac	7,997.60	0.04	99.94
E	5,094.68	0.03	99.97
H	2,196.66	0.02	99.99
Fd	1,932.70	0.01	100.00
Cw	138.30	0.00	100.00
Yc	19.70	0.00	100.00
D	2.40	0.00	100.00
Pw	1.80	0.00	100.00
L	1.00	0.00	100.00
Py	0.90	0.00	100.00
Total	**18,750,388.00**	**100.00**	**100.00**

Figure A4–80. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Lakes TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



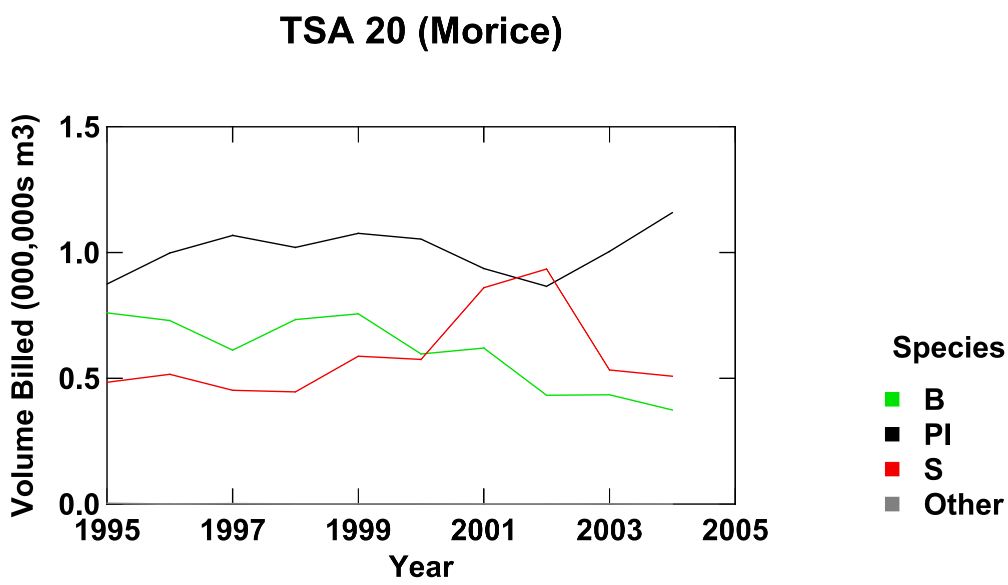
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	14,009,142.00	46.33	46.33
S	10,621,596.00	35.12	81.45
B	5,163,332.50	17.07	98.52
At	252,261.28	0.83	99.35
Reject	135,949.88	0.45	99.80
E	37,754.63	0.12	99.92
Ac	10,092.00	0.04	99.96
Fd	9,509.45	0.04	100.00
L	120.68	0.00	100.00
Pa	8.50	0.00	100.00
D	7.66	0.00	100.00
H	5.10	0.00	100.00
Cw	3.34	0.00	100.00
Total	**30,239,784.00**	**100.00**	**100.00**

Figure A4–81. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the MacKenzie TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



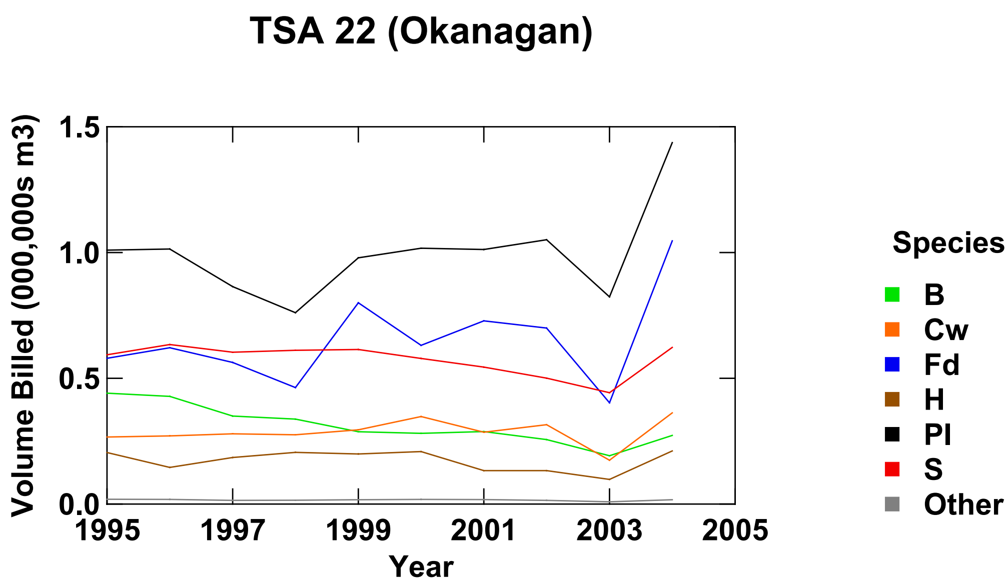
Species	Volume Billed – 1995 to 2004 (m³)	(%)	(Cum. %)
Pl	12,657,223.00	66.54	66.54
S	3,058,454.50	16.08	82.62
Fd	1,747,220.75	9.18	91.80
B	1,317,793.88	6.93	98.73
Reject	98,082.53	0.52	99.25
Py	78,936.39	0.41	99.66
L	32,292.98	0.17	99.83
H	11,312.37	0.06	99.89
Pw	10,011.49	0.05	99.94
Cw	6,376.04	0.03	99.97
Pa	2,093.06	0.02	99.99
At	1,575.65	0.01	100.00
Ac	866.73	0.00	100.00
E	316.91	0.00	100.00
Tw	257.10	0.00	100.00
Yc	134.90	0.00	100.00
D	28.05	0.00	100.00
M	1.00	0.00	100.00
Total	**19,022,976.00**	**100.00**	**100.00**

Figure A4–82. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Merritt TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



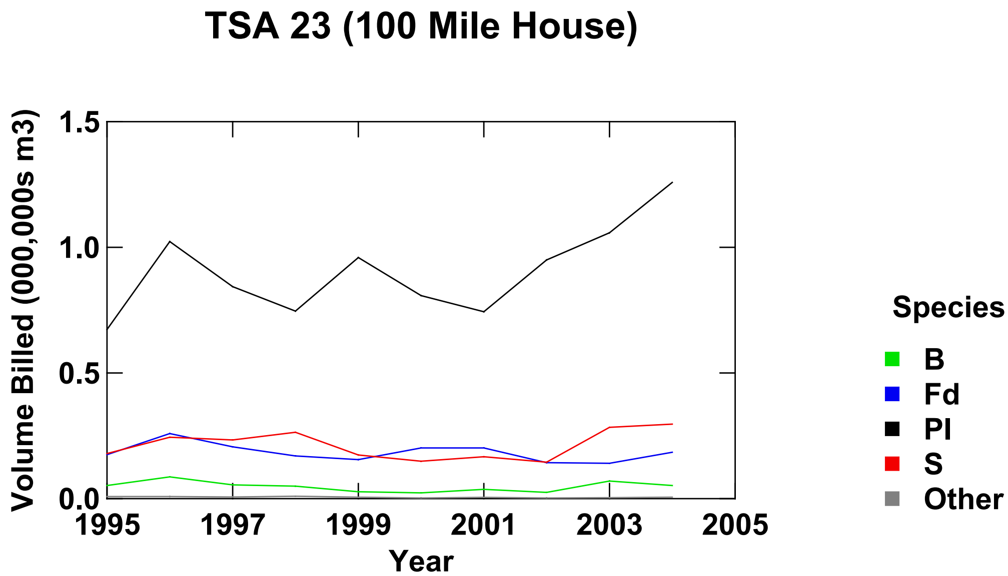
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	10,943,965.00	46.58	46.58
B	6,266,147.00	26.67	73.25
S	6,194,492.50	26.36	99.61
Reject	47,676.65	0.20	99.81
At	16,920.98	0.07	99.88
H	12,089.29	0.05	99.93
Ac	10,473.01	0.05	99.98
E	2,073.08	0.02	100.00
Fd	996.70	0.00	100.00
Cw	205.50	0.00	100.00
D	103.90	0.00	100.00
L	8.70	0.00	100.00
Total	**23,495,152.00**	**100.00**	**100.00**

Figure A4–83. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Morice TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



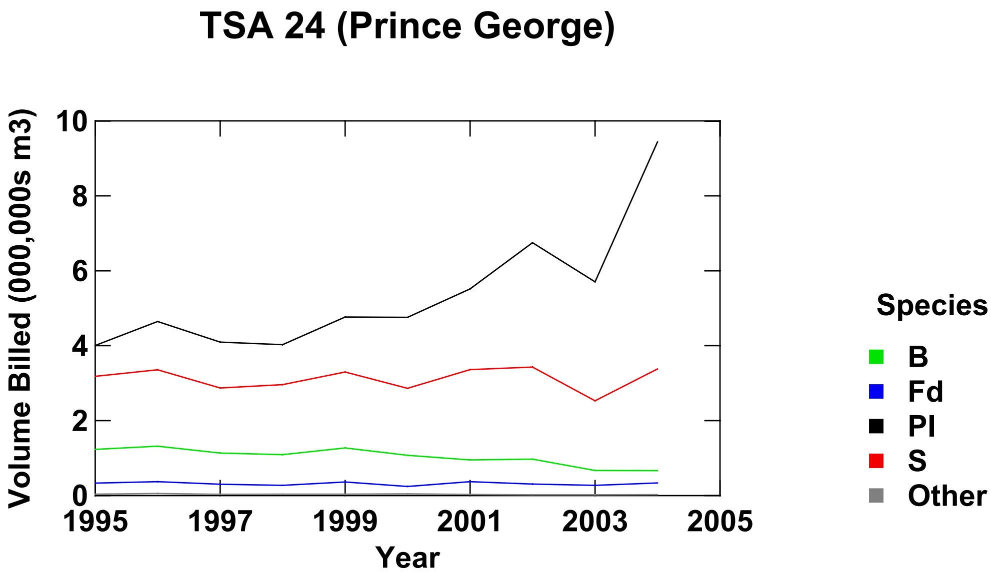
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	11,135,126.00	32.39	32.39
Fd	7,148,967.50	20.79	53.18
S	6,264,981.50	18.22	71.40
B	3,374,308.75	9.81	81.21
Cw	3,065,793.50	8.92	90.13
H	1,809,733.38	5.26	95.39
L	807,136.50	2.35	97.74
Pw	261,661.98	0.76	98.50
Py	175,880.44	0.51	99.01
Reject	132,257.89	0.38	99.39
E	113,143.02	0.33	99.72
At	50,113.30	0.15	99.87
Ac	42,791.42	0.12	99.99
Pa	220.81	0.01	100.00
D	110.30	0.00	100.00
Yc	6.18	0.00	100.00
M	5.20	0.00	100.00
W	4.79	0.00	100.00
Total	**34,382,240.00**	**100.00**	**100.00**

Figure A4–84. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Okanagan TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



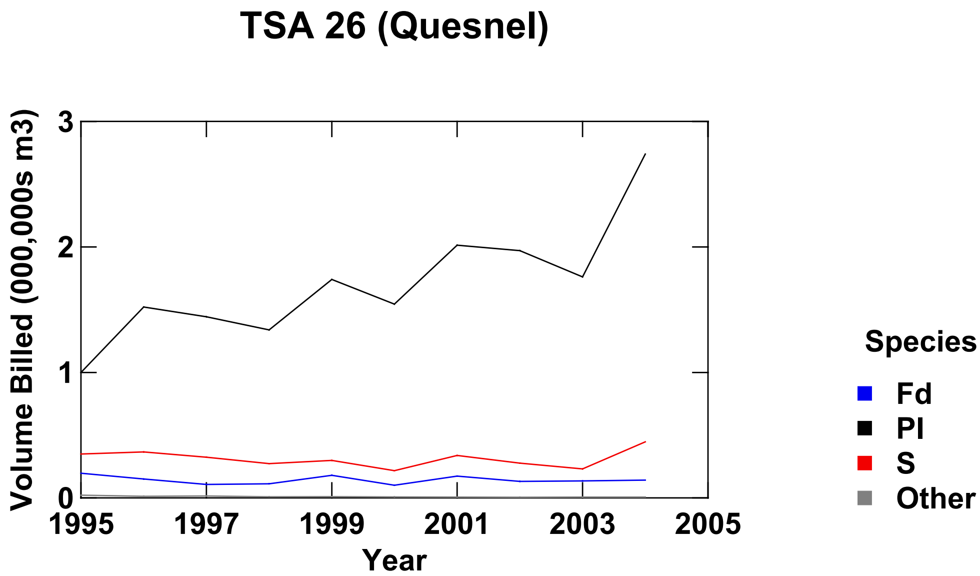
Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	10,242,415.00	64.72	64.72
S	2,379,862.00	15.04	79.76
Fd	1,964,192.75	12.41	92.17
B	521,621.06	3.30	95.47
At	449,830.72	2.84	98.31
Reject	88,650.95	0.56	98.87
Cw	68,165.84	0.43	99.30
E	52,894.66	0.33	99.63
Ac	44,665.82	0.28	99.91
H	4,970.41	0.03	99.94
Pw	3,879.90	0.02	99.96
Py	3,526.26	0.02	99.98
L	1,982.65	0.02	100.00
Pa	117.93	0.00	100.00
D	25.67	0.00	100.00
M	7.54	0.00	100.00
Yc	5.80	0.00	100.00
Total	**15,826,817.00**	**100.00**	**100.00**

Figure A4–85. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the 100 Mile House TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



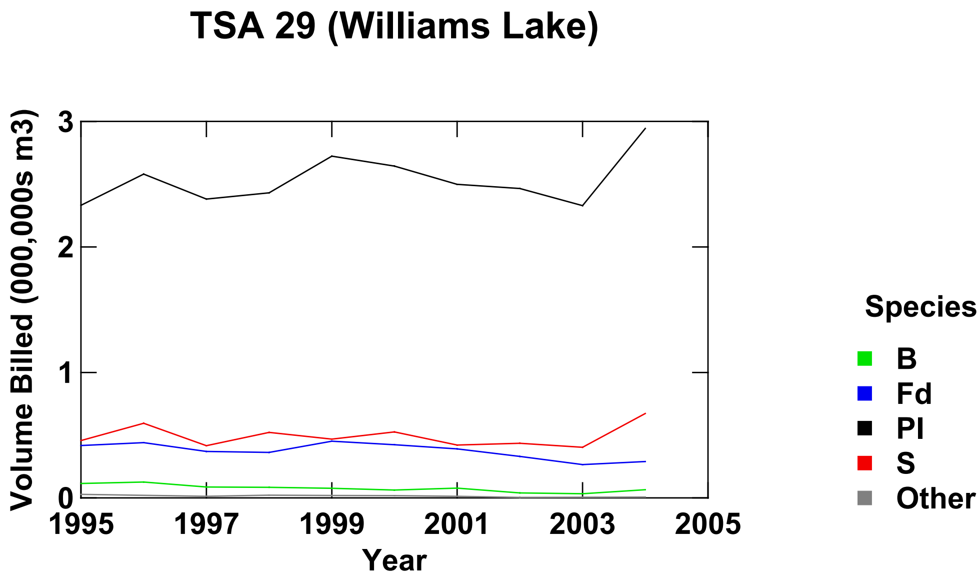
Species	Volume Billed – 1995 to 2004 (m³)	(%)	(Cum. %)
Pl	60,859,840.00	54.34	54.34
S	33,579,444.00	29.98	84.32
B	10,902,332.00	9.74	94.06
Fd	3,449,104.50	3.08	97.14
At	1,253,350.50	1.12	98.26
H	525,541.81	0.47	98.73
Cw	518,782.50	0.46	99.19
Reject	509,093.16	0.45	99.64
E	239,284.94	0.22	99.86
Ac	150,549.25	0.14	100.00
Pw	968.61	0.00	100.00
L	517.78	0.00	100.00
D	153.84	0.00	100.00
Py	22.29	0.00	100.00
Pa	9.40	0.00	100.00
M	3.00	0.00	100.00
Total	**111,989,008.00**	**100.00**	**100.00**

Figure A4–86. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Prince George TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	19,371,492.00	76.39	76.39
S	3,482,092.75	13.73	90.12
Fd	1,524,451.38	6.01	96.13
B	574,565.44	2.27	98.40
At	166,295.31	0.66	99.06
Reject	142,426.83	0.56	99.62
Cw	42,928.33	0.17	99.79
E	30,297.49	0.12	99.91
Ac	13,836.63	0.05	99.96
H	10,929.55	0.04	100.00
Pw	228.97	0.00	100.00
L	205.37	0.00	100.00
Py	33.60	0.00	100.00
D	13.79	0.00	100.00
M	0.50	0.00	100.00
Total	**25,359,798.00**	**100.00**	**100.00**

Figure A4–87. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Quesnel TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.



Species	Volume Billed – 1995 to 2004 (m^3)	(%)	(Cum. %)
Pl	27,730,478.00	70.03	70.03
S	5,400,215.00	13.64	83.67
Fd	3,946,494.50	9.97	93.64
B	817,433.62	2.06	95.70
Cw	505,656.88	1.28	96.98
H	410,280.91	1.04	98.02
Reject	404,722.03	1.02	99.04
At	296,176.97	0.75	99.79
E	55,333.23	0.14	99.93
Ac	24,985.51	0.05	99.98
L	2,328.27	0.01	99.99
Pw	2,128.84	0.01	100.00
Pa	1,913.56	0.00	100.00
Py	466.62	0.00	100.00
D	16.22	0.00	100.00
M	2.14	0.00	100.00
Yc	1.60	0.00	100.00
Total	**39,598,628.00**	**100.00**	**100.00**

Figure A4–88. Volume billed by species by year (upper graph) and cumulative volume billed by species (lower table) in the Williams Lake TSA. Source: Data extracted from HBS by Syntax Designs September 2005 and graphed by Martin Watts.

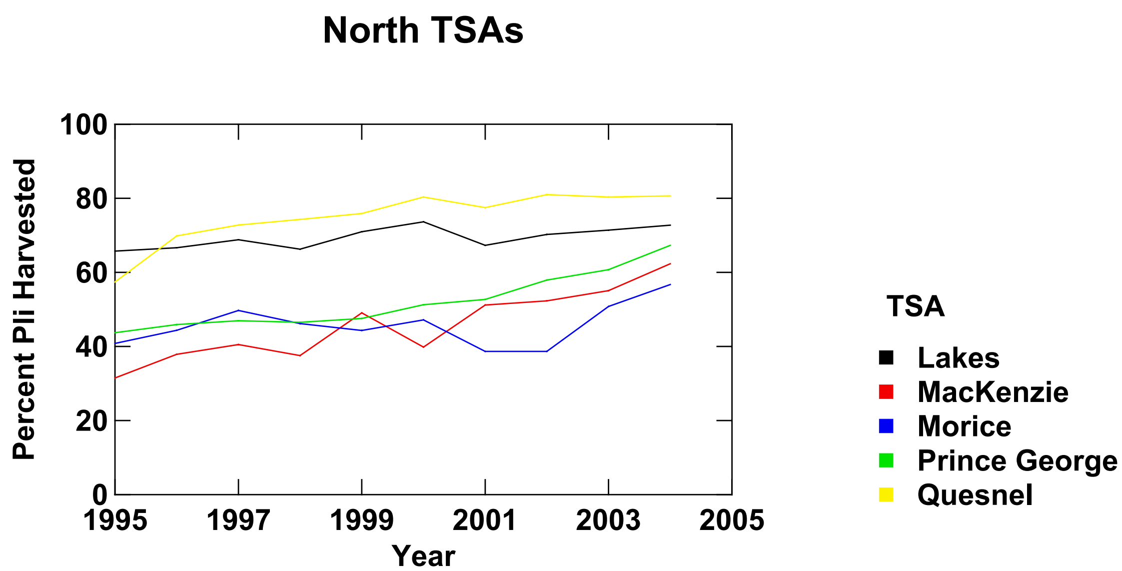


Figure A4–89. For northern TSAs, volume of lodgepole pine (Pli) harvested (volume billed as a percent of total volume billed) by year by TSA. Source: Data extracted from Harvest Billing System by Syntax Designs September, 2005 and graphed by Martin Watts.

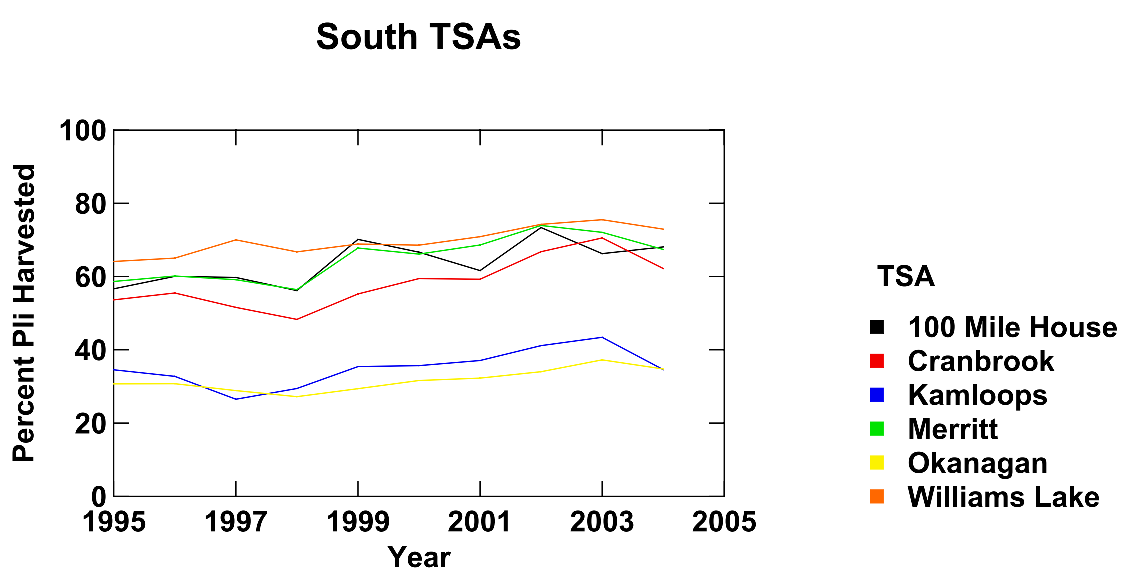


Figure A4–90. For southern TSAs, volume of lodgepole pine (Pli) harvested (volume billed as a percent of total volume billed) by year by TSA. Source: Data extracted from Harvest Billing System by Syntax Designs September, 2005 and graphed by Martin Watts.

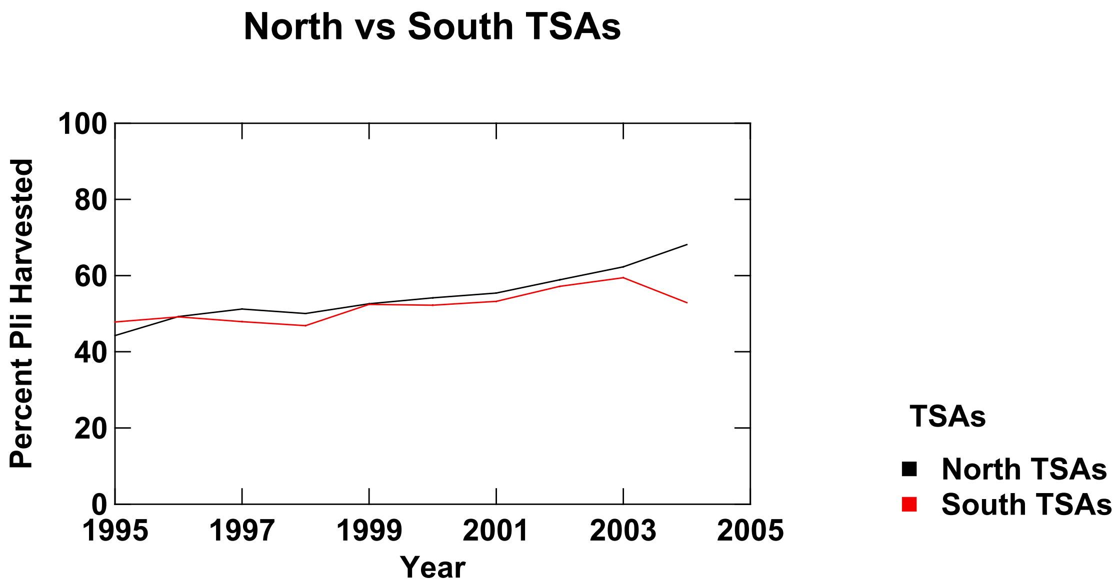


Figure A4–91. Volume of lodgepole pine (Pli1) harvested (volume billed as a percent of total volume billed) by year by TSA group (northern and southern). Source: Data extracted from Harvest Billing System by Syntax Designs September, 2005 and graphed by Martin Watts.