

The Healthy Forest

Just what is a healthy forest? Two descriptions come to mind: firstly, a utilitarian description emphasizes forest conditions that directly satisfy human needs; secondly, an ecosystem description emphasizes the maintenance of sustainable ecosystems over the landscape. Most often we lean towards the utilitarian perspective, where a forest is considered to be healthy if our management objectives are satisfied, and unhealthy if they are not. The two descriptions can be combined into a single, inclusive definition of a healthy forest as being one where the forest ecosystems sustain their complexity while providing for human needs.

Often we can become focused on the health of individual trees in the forest and project that individual tree health to the forest level. Thus, a tree that has been attacked by a forest pest, rendering it "unhealthy", will make the entire forest unhealthy. Not so! The health of a stand is complex and must consider many more dimensions than the health of an individual tree. The health of a forest relates to the management objectives for that forest and to the long-term functioning of the organisms that constitute the forest. Individual tree mortality in a forest does not indicate an unhealthy forest, as long as the rate of mortality is not greater than the capacity for replacement.

This is where you, as forest health professionals, play a critical role. You must make that important determination regarding stand health and recommend appropriate actions to maintain a healthy forest. Of equal importance, you must continue to communicate the forest health message to your colleagues. Keep up the great work!!

- R. Cozens, Forest Practices Branch, Victoria.

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FOREST HEALTH PROGRESS

EDITORIAL AND COORDINATING STAFF

Editor:	T. Ebata	Forest Practices Branch
Production:	S. F. Turcotte	Forest Practices Branch

ADVISORS

Entomology:	P. M. Hall	Forest Practices Branch
Forestry:	R. Winter	Forest Practices Branch
Pathology:	J. A. Muir	Forest Practices Branch
Forest Health:	J. F. Henigman	Forest Practices Branch
Research:	G. Krumlik	Research Branch

Address all correspondence to:

Ministry of Forests
Forest Practices Branch
P.O. Box 9518 Stn Prov Govt
Victoria, British Columbia
V8W 9C2

Attention: Shirley Turcotte

EDITOR'S NOTE

Forest Health Progress is a bi-annual report to the Forest Health Committee of British Columbia on issues, proposals, projects and results by Ministry of Forests staff. Brief, informal and informative articles are welcome from all staff.

Contributions labelled with an appropriate subject heading should be submitted via electronic mail to S. Turcotte, Forest Practices Branch for the spring (May) and winter (December) meetings of the Forest Health Committee.

Authors of individual articles should be contacted for any clarification, as the contents do not necessarily constitute official statements of the Ministry of Forests.

- T. Ebata, Forest Practices Branch, Victoria.

FOREST HEALTH - GENERAL

Thoughts on a Strategic Plan for Forest Health in British Columbia. Periodically, a call arises to develop a strategic plan for forest health in the B.C. Forest Service. This was one of the first exercises that R Sutton undertook in the major forest resources review in 1979-80 that accompanied a major re-organization of the Forest Service, and eventual implementation of pest management as an expanded, substantial activity within the ministry. Subsequently, we have developed several more strategic plans, usually at five to ten year intervals.

Essentially, the task entails questions such as, "Where should we go, what should we do, and how do we get there?" The basis for formulating, articulating and evaluating these questions changes with time and new directions of the ministry.

Generally, the person(s) assigned to the task quickly discover that definitions of a "strategic plan", views and opinions abound. To keep the task within reasonable bounds, one person (preferably the forest health section leader!) should exercise an autocratic, consultative approach.

A major limitation of a strategic plan (in addition to its short shelf-life) is that the purpose of such a plan is generally unknown or only sketchily described within an organization such as the B.C. Ministry of Forests. Often, the purpose or major direction of the organization has not been articulated, or is so complex that it is essentially indescribable. However, the basic purpose of forest health as a ministry activity must be grounded within the overall purpose or direction of the organization. One value of a forest health strategic plan would be to confirm the basic purpose of a forest health activity within the ministry, based on executive review and approval.

If the basic purposes of a forest health program, for example, are to:

- a) help preserve timber supplies from mortality and degrade agents such as bark beetles; and
- b) enhance productivity and value of young forests by preventing or reducing damage from chronic or episodic damage by agents such as root diseases, dwarf mistletoes, stem rusts and terminal leader weevils,

then one major aspect of a forest health program is to establish targets with measures that are needed to achieve and report actual accomplishments.

Strategically, one could envision several approaches to formulate these goals:

- a) establish measurable goals based on currently available resources (people, locations, funding)
- b) establish goals based on timber supply projections, TSA-level objectives and ecological hazard or risk ratings for damage
- c) rationalize current efforts based on limitations (or cutbacks) to resources in a) to give maximum returns for b).

- d) re-analyze what we could do in terms of treatments or management strategies to give maximum returns for the broadest land base. Currently, our major expenditures in the forest health program are for bark beetle management based on our belief or results of limited analyses that protection of mature timber supplies confers maximum benefit.

The major challenge after almost 20 years of expanded forest health management activities within the forest service still is to articulate and measure goals, and structure our activities accordingly.

I believe that forest health as a ministry activity also should advocate and try to take advantage of new treatment opportunities, especially as new funding programs are developed. These new opportunities are recurrent. We often appear to be reluctant to support program proposals based on good but often limited data. Instead, we argue amongst ourselves that we need more research data, or that we do not know enough. It appears to me that it is much easier to determine needed research or survey data from a well-funded treatment program, rather than trying to get funding for research or developmental surveys. We need to take some risks, not be too critical of new ideas and proposals, and have confidence in what we could accomplish. We have to develop goals for our treatments based on funding program goals, such as creating new employment opportunities.

A major part of forest health activities within the ministry has been our role in providing extension services, advice, training, and problem-solving (consultations) with licensees and ministry staff. These have been major demands, strengths and pre-occupations. Our culminating achievement was to develop or incorporate best-available information into the Forest Practices Code forest health guidebooks. Many see the code-related activities, including enforcement, maintenance or improvement of information in the code guidebook recommendations, as the predominant future activity of forest health. No doubt these activities will continue to be a major concern. We all are concerned about implementing reasonable and effective management practices. However, this aspect of forest health requires very little strategic planning other than prioritizing available resources (or developing budget requests) for supporting activities such as training development and programs; research in applications and especially trials; and operational surveys and monitoring. All of these are important activities.

A more immediate and urgent extension issue is to provide enhanced training, support and access to data for professional foresters to fulfill their expanded role of developing and approving development plans and prescriptions. We need to clearly state where we see problems with forest health arising. We need to provide better access to actual trial or experimental results, not just our conclusions and recommendations. Foresters need better means of determining the risk or probabilities of potential impacts (extent and severity) in particular areas or cut blocks, based on local data or ecological information. Some type of quantitative projection appears to be the only rational means of resolving what future impacts are either acceptable or not, given local conflicting resource management objectives and/or differing views.

Finally, my advice on developing a strategic plan is “KISS” and “quick”. Don’t put a lot of time or work into it. Tim Ebata’s “1-hour plan” was about the optimum, but most of us would need about a week to do one. Develop a strategic plan for the purpose at hand, and then send it out for comment. You will get lots! Revisit and revise it frequently, based on input received and changing needs. Strategic plans are something good to think about over a period of several years.

- J. Muir, Forest Practices Branch, Victoria.

Photo Images Needed of Broadleaf Tree Pests. As reported in the December 1997 (page 11) edition of Forest Health Progress, a deciduous addendum to the *Field Guide of Pests of Managed Forests in British Columbia* is slated for publication. A total of 15 diseases, 19 insects, 6 abiotic injuries, and 8 animals were selected as economic pests to commercial broadleaf trees. Summaries for each of these pests have been reviewed by 22 researchers and operational foresters.

As pests of deciduous trees are a relatively recent concern, there are few photographs from which to choose. The field guide is not expected to be available until this autumn in order to give field workers the opportunity to photograph the pests and their damage.

The pests that will appear in the field guide are listed in the following table. We are looking for photographs of the pest or its damage, with a deciduous host, and preferably in British Columbia. Slides or photographs can be mailed to the contacts listed below by October 1998. Slides will be reproduced and the originals returned to the owner. Credit will be given in the publication for each photo.

Final list of economic pests for the field guide.

Diseases	Insects	Abiotics	Animals
Armillaria root rot <i>Armillaria ostoyae</i> , <i>A. sinapina</i>	Bronze birch borer <i>Agrilus anxius</i>	Strong wind	Moose
Sooty bark canker <i>Encoelia pruinosa</i> (<i>Cenangium singulare</i>)	Large aspen tortrix <i>Choristoneura conflictana</i>	Scars: mechanical	Deer
White spongy trunk rot <i>Fomes fomentarius</i>	Cottonwood leafbeetle <i>Chrysomela scripta</i>	Scars: sunscald	Elk
White mottled rot <i>Ganoderma applanatum</i>	Poplar and willow borer <i>Cryptorhynchus lapathi</i>	Scars: fire	Cattle
Sterile conk trunk rot of birch <i>Innotus obliquus</i>	Maple looper <i>Eranis vancouverensis</i>	Frost	Voles
Linospora leaf blotch <i>Linospora tetraspora</i>	Red alder woolly sawfly <i>Eriocampa ovata</i>	Heavy snow	Beavers
Marssonina leaf blight <i>Marssonina</i> spp., <i>M. populi</i> , <i>M. brunnea</i>	Birch leafminer <i>Femisa pusilla</i>	Ice storms	Hares, rabbits
Aspen rust <i>Melampsora medusae</i> f. sp. <i>deltoidae</i>	Striped red alder sawfly <i>Hemichroa crocea</i>	Redheart	
Cottonwood rust <i>Melampsora occidentalis</i>	Fall webworm <i>Hyphantria cunea</i>		
Hardwood trunk rot <i>Phellinus igniarius</i>	Satin moth <i>Leucoma salicis</i>		
Aspen trunk rot <i>Phellinus tremulae</i>	Tarnished plant bug <i>Lygus lineolaris</i>		
Brown cubical rot of birch <i>Piptoporus betulinus</i>	Northern tent caterpillar <i>Malacosoma californicum pluviale</i>		
Septoria leaf spot <i>Septoria populicola</i>	Forest tent caterpillar <i>Malacosoma disstria</i>		
Cytospora canker <i>Valsa sordida</i> (<i>Cytospora chrysosperma</i>)	Cottonwood sawfly <i>Nematus currani</i>		
Aspen and Poplar leaf and twig blight <i>Venturia populina</i>	Bruce spanworm <i>Operophtera bruceata</i>		
	Winter moth <i>Operophtera brumata</i>		
	Aspen skeletonizer <i>Phratora purpurea purpurea</i>		
	Ambermarked leafminer <i>Profenusa thomsoni</i>		
	Poplar borer <i>Saperda calcarata</i>		

Further details as to the exact photographs that we are seeking can be obtained by contacting:

- Adriane Pollard, Pollard Ecological Consulting, 815 Elrick Place, Victoria, B.C. V9A 4T2 Phone (250) 380-7108, or
- Teresa White, Cedrus Consulting, P.O. Box 20275, Smithers, B.C. V0J 3P0 Phone (250) 847-2289.

Meanwhile, the second phase of this FRBC project, to complete deciduous components to Forest Practices Code management guidebooks for the above pests, is underway with a search for information. A draft review exercise will take place in February 1999.

- A. Pollard, Pollard Ecological Consulting, and
J. Henigman, Forest Practices Branch, Victoria.

Proposed Revisions to Ministry (Silviculture) Damage Agent and Condition Codes (May 12, 1998). A uniform, corporate set of damage agent and condition codes is required for ministry resource inventories, growth and yield data, surveys, prescriptions and reports to record significant damage to forest trees by agents such as insects, fungal and plant pathogens, certain animals, and non-living elements such as frost. An official set of damage codes (maintained on the ministry corporate code list table) is used in the silviculture Integrated Silviculture Information System (ISIS), the Major Licence Silviculture Information System (MLSIS), the General Appraisals System (GAS), the Cone and Seed Management System (CONSEP), and other systems. Similar but slightly differing sets of damage agent codes and other related codes such as disturbance codes are used or maintained in several business areas. Recently, several proposals and differing business needs have resulted in adoption of new codes or changes. These differences in definitions or uses were substantial, and have justified efforts to reconcile or harmonize them, to ensure data integrity and compatibility between corporate business areas.

The objectives of the current proposal were to:

- 1) Establish and maintain a standard set of damage agent codes¹ that will be used consistently by all business areas that are concerned with recording data on damage to forest trees;
- 2) Develop revisions and/or additions to the corporate damage agent codes that reconcile differences between current extant sets of damage agent codes;
- 3) Propose procedures for damage code revisions and updating that will facilitate needed future changes; and
- 4) If and when agreement on revisions is reached, notify business areas to arrange for necessary changes to data, reports and training that are consistent with change procedures in effect in each business area or information system.

¹Tables for Damage Agent and Condition Codes may be found in the Tabulations & Graphics Section, p 42, under Appendix 1

A major objective of the work leading to this proposal was to develop a flexible, ideal set of damage agent codes which could be expanded without the need for major future code conversions. Our review indicated that realization of this objective would require changing most or all of the existing three-letter damage agent codes. The proposed extent of changes was not supported by the majority of the reviewers, and the objective was abandoned. (For details of this objective, and the consequences of not achieving it, see the subsection "Previous Proposal" in "Background" section.)

An overall guiding principle of this exercise was to develop and implement (in a rational and orderly manner) changes of damage codes that support forestry operations. Realistically, potential benefits of proposed changes must be seen to clearly outweigh costs of changes that include not only changes to systems and data, but also costs of implementation, such as for field staff training and ease of use.

Recommendations of the current proposal (in section 3, "Issues and Recommendations") include:

1. Conserve current three-letter damage code structure.
2. Assuming that the largest impacts for proposed changes would be to current users of the ministry corporate code tables, i.e., ISIS (largest number of users, established system, large number of data records), the least disruptive or costly approach for the ministry is to retain current codes "A" and "N" in the current ministry corporate code list, and convert the codes on the systems that have incorporated the Forest Productivity Council codes (new vegetation inventory; inventory and research growth and yield permanent sample plots) back to the corporate damage codes.
3. Do not incorporate Forest Productivity Council code recommendations nor ISIS silviculture damage codes into the forest cover attribute data or inventory maps.
4. Distinguish between damage agent codes (applied to individual trees) and other sets of related or similar codes, such as inventory polygon or silviculture opening disturbance codes. Restrict damage agent codes to those things (mostly insects and fungi) that damage individual forest trees, and exclude other attributes such as symptoms, infection severity, and disturbance to stands, plots and/or forest-level areas, from damage agent codes.
5. Develop definitions, selection criteria and processes to determine and revise damage agent codes.
6. Determine, after consultation with business areas, users in operations and other staff, what insects, fungi, or other entities should be included as damage agents, and how they should be named and coded for use in the ministry set of damage agent codes.
7. Incorporate recommended changes (see Appendix 1, Tabulations & Graphics Section, page 42, this issue), including some proposed by the Forest Productivity Council, in newly revised damage agent codes. Delete "U" unknown damage codes from the corporate damage codes.
8. After damage code changes are approved, develop an implementation plan that dovetails with schedules for changes in the affected business areas.

BACKGROUND

History of Damage Agent Codes

In 1983, protection and silviculture branch staff developed a three-letter set of damage agent codes. The purpose was to enable field staff and silviculture surveyors to record observations of damage to forest trees caused by insects, diseases and other damaging agents. To facilitate field use by personnel with varying ability to identify specific agents, damage codes were developed as a three-level hierarchy based on general type of agent, tree part affected, and species of insect or pathogen. For example, armillaria root disease was coded **DRA**:

D for disease;

R for roots affected; and

A for the specific agent, the fungus *Armillaria ostoyae*.

A three-letter code enabled field crews to record one, two or three letters of a code for each occurrence of damage, depending on their ability or confidence to identify the causal agent. In many instances, where trees are surveyed early spring or late autumn or winter, definitive signs such as fruiting bodies or fungal structures are not yet formed or have disappeared, and only symptoms can be observed to indicate general type of damage.

Subsequently, damage codes have been revised and expanded several times to include damage to cones, seeds and seedlings, and other damage conditions, such as forking or dead tops due to insect attack, and overtopping by competitive vegetation.

Before development of damage agent codes, Resources Inventory Branch developed a set of one-letter or numerical codes to represent either general types of damage or in some instances, specific causal agents, for damage or disturbance to trees occurring at more than a defined level -- usually 15% -- within an inventory map unit ("polygon"). These codes were often displayed as symbols with percentages on forest cover maps.

In 1990-92, the Forest Productivity Council (FPCouncil) developed a minimum set of standards or criteria, including a revised set of damage agent codes, to measure attributes of trees on long-term sample plots. Data from these plots are used for calculations of timber growth and long-term sustained yields of timber under different management regimes. In addition to several new damage codes, codes for two groups were interchanged:

- Non-living (abiotic) agents previously coded as "N" (and still coded as "N" on the corporate code table) were coded as "A" which was previously used to designate animal damage; and
- Animal damage coded as "A" originally (and still coded as "A" on the corporate code table) was renamed as wildlife damage and re-coded as "W" in the FPCouncil proposal.

These changes or new codes proposed by the FPCouncil recently were implemented by inventory and research groups dealing with growth-and-yield plot data, and in a newly developed inventory program (new vegetation inventory).

However, before these proposed changes were incorporated in ISIS, a major objection was raised by other inventory staff. The inventory forest cover attribute program determined that implementation of the proposed changes and using three-letter instead of one-letter codes would result in more complicated mapping standards and higher costs (several million dollars) for inventory updates and map revisions. (Resources Inventory Branch maintains approximately 10 000 map sheets, with each map sheet containing several hundred or thousand polygons, each polygon with one or more coded symbols. Approximately 3000 map sheets are updated each year.) Consequently, proposed changes were put on hold, pending review of codes and recommendations for reconciliation or harmonization of the different sets of damage codes by the different organization sections or business areas. This process has been underway for the past two to three years.

Currently, the official set of damage agent codes is held in the ministry corporate code tables and used in various systems, such as ISIS, MLSIS, GAS, etc. However, some business groups have required and developed slightly different sets of codes to fulfil their business objectives. As a short term agreement until a revised set of codes was developed, several of these groups agreed to maintain and use their current codes, but they would advise their staff and contractors of *potential confusion and errors in moving data between sections such as silviculture and inventory, resulting from using different codes for the same agent, and different meanings for some of the same codes.*

An ad hoc group of specialists and analysts was formed to review business needs and possible options for developing an improved set of damage agent codes. The objectives of the review were to:

1. Establish and maintain a standard set of damage agent codes that will be used consistently by all business areas that are concerned with recording data on damage to forest trees;
2. Develop revisions and/or additions to the corporate damage agent codes that reconcile differences between existing sets of damage agent codes;
3. Establish principles (policy) and procedures for damage code revisions and updating that will facilitate needed future changes; and
4. After agreement on revisions is reached, facilitate changes to data, reports and training that are integrated with change procedures in effect in each business area or information system.

A major goal of this exercise has been to develop and implement (in a rational and orderly manner) changes of damage codes that will support forestry operations. We believed that potential benefits of proposed changes must clearly outweigh costs of changes not only to systems and data, but also for implementation such as for field staff training and ease of use.

Previous Proposal

The previous (June 97) draft proposal, developed in response to a request by the working group, was intended “to create a flexible (ultimate) set of codes which would be expandable without the need for future code conversion”. This proposal examined problems with the current sets of damage agent codes used within the ministry, and suggested possible solutions. This was an attempt to develop a better set of flexible codes that would support divergent business needs, allow expansion, and avoid the need to revise or change damage codes frequently.

The major approach recommended to achieve this objective was to remove the hierarchy of embedded meaning within the damage agent codes, and to separate damage agents, damage types and damage levels into different sets of codes.

Unfortunately, removing the hierarchy and separating damage agent, type, and level would have required changing virtually all of the existing three-letter damage agent codes, and developing four-letter or larger codes to distinguish between organisms with similar names. Response from the user review group indicated that the proposed changes to the current codes required to achieve this degree of flexibility were not acceptable. Thus, we propose conserving the current three-letter code structure.

Conserving three letter codes with an embedded hierarchy has the consequence of also maintaining code inflexibility. Current codes not only identify the damaging agent, but also include a classification category for the damage agent. For example, the code AB for “Animal, Bear” includes the damage agent “Bear”, but also categorizes it as an “Animal”. This categorization was developed to facilitate silviculture surveys, but its inclusion can restrict or confuse the meaning of the code if it is applied to other uses or business areas.

As new agents are identified, the number of available corresponding letters for the first two-character-embedded categories will eventually be used up. New first and second letters will have to be designated for the same group, thus making new codes less meaningful and possibly misleading. For example, almost all of the possible third letters for defoliating insects “ID” are now used, and defoliating insects will have to be identified in future by a second-place letter other than “D”.

This embedding of categories also caused a problem when the Forest Productivity Council proposed that the first character category “A” should be re-defined as abiotic injuries, and the existing “A” for animal codes changed to “W” for wildlife. It is not clear if the council realized this would necessitate extensive data conversion of existing damage agent codes at significant cost, and potentially recurring errors about the definition of “A” codes in different sets of data. If the damage agent codes only identified the damage agent (species) and did not include the embedded category, and if a separate set of codes had been established that categorized the damage or symptoms, then the changes proposed by the Forest Productivity Council would have been feasible.

Unfortunately changing the damage agent codes now to remove the embedded categories would necessitate extensive data conversion at unacceptable cost in both dollars, confusion, and new training needed to apply new damage agent codes. Therefore, our previous proposal to change the codes to be more flexible and expandable was abandoned.

Current Proposal

The current proposal addresses most of the critical areas identified by developers, data managers and users. It differentiates between different sets of codes currently being used for similar purposes, e.g., disturbance codes, and proposes for revisions, including many previously recommended by the Forest Productivity Council, to update the current three-letter codes. This proposal is being circulated to directors (data custodians), managers and other involved staff for final review.

ISSUES AND RECOMMENDATIONS

Several major issues were identified in discussions and reviews of proposed changes to the damage agent codes, and our approach and/or recommendations are outlined in the following sections.

Three-letter or larger Damage Codes

Although several reviewers were supportive of our proposal to develop a new set of six- or eight-letter damage codes, many users expressed concerns about changing current three-letter codes to some other longer, less-intuitive code. Accessibility, use in the field and training were major issues. We have listened to these concerns, and now believe that the costs of conversion to some other code structure would exceed potential benefits.

Future name changes or additions might necessitate development of four-letter or longer codes, but for the foreseeable future, three-letter codes should suffice. As available letters in categories are occupied, new codes will probably not follow existing hierarchy or embedded classification, but instead designate individual organisms or damage agents.

Recommendation: Conserve current three-letter damage code structure.

Confusion between "A" & "N" and "A" & "W" damage codes in existing code sets

As outlined in the Background section, two groups adopted the Forest Productivity Council proposals for changes to damage codes. These groups now use "A" for abiotic (non-living) damage agents (formerly coded as "N") and "W" for wildlife damage (previously designated as "A" for animal damage). Currently ISIS and MLSIS use "N" for abiotic damage and "A" for animal damage.

To resolve these conflicts, we believe that the least severe impact would be for these groups to re-adopt "A" for animal damage and "N" for abiotic damage rather than changing codes in the corporate tables and in ISIS /MLSIS.

Recommendation: Assuming that the largest impacts for proposed changes would be to current users of the ministry corporate code tables, i.e., ISIS (largest number of users, established system, large number of data records), the least disruptive or costly approach for the ministry is to retain current codes "A" and "N" in the current ministry corporate code list, and convert the codes on the systems that have incorporated the Forest Productivity Council codes (new vegetation inventory; inventory and research growth and yield permanent sample plots) to the corporate damage codes. This assumes that it is feasible to convert previously recorded data to the corporate codes without introducing a major source of potential error or uncertainty.

Proposed Use of Damage Codes for Forest Cover Attribute Data and Maps (Resources Inventory).

Following the proposal by the Forest Productivity Council to implement new codes, there was a proposal to use or incorporate the three-letter silviculture damage codes in forest cover attribute data and on inventory forest cover maps. Subsequent reviews and discussions indicated that this would be expensive, confusing, entail much more detail than needed, require more space allocation on maps for symbols, and would be time-consuming for future data processing.

We suspected that it would be very annoying and nonsensical for field staff and map users to have to use a three-letter damage code. For example, the inventory code "L" to indicate logging should not be replaced by the silviculture damage code "TL" that is used to indicate tree damage by logging. Also, proposed changes to inventory forest cover codes probably are not justified in view of imminent change to a new inventory mapping system that probably will include the new damage agent codes.

The proposed use of silviculture damage codes by the inventory group also entailed a much different use than was intended for the silviculture codes. Inventory forest cover data and maps record only substantial and extensive disturbance that affects most trees in a map type or "polygon", whereas silviculture codes were intended to record data on damage to an individual tree. In fact, inventory codes should be regarded as disturbance codes rather than damage agent codes, and the proposed damage agent codes should not be used for forest cover attributes or mapping symbols.

Recommendation: Do not incorporate Forest Productivity Council code recommendations nor ISIS silviculture damage codes into the forest cover attribute data or inventory maps. Instead, update current inventory disturbance codes, where appropriate.

Disturbance codes and other sets of related codes

Several sets of codes are similar to, and may be confused with, damage agent codes. For example, in inventory forest cover attribute data, disturbance codes are used to designate substantial damage to forest trees in a map unit or polygon. ISIS also has a set of disturbance codes, but these codes are used to designate agents that disturbed the previous stand and resulted in an opening that is being surveyed or considered for reforestation, e.g., a bark beetle outbreak that destroyed the previous mature trees. The Forest Productivity Council also recommended sets of damage severity codes now used in the Resources Inventory Branch vegetation inventory to describe damage per tree, such as defoliation or dwarf mistletoe infection ratings. Clearly, it is very important to distinguish between the purpose and meaning of the different sets of codes established in various business areas.

Recommendation: Distinguish between damage agent codes (applied to individual trees) and other sets of related or similar codes, such as inventory polygon or silviculture opening disturbance codes. Restrict damage agent codes to those things (mostly insects and fungi) that damage individual forest trees, and exclude other attributes such as symptoms, infection severity, and disturbance to stands, plots and/or forest-level areas, from damage agent codes.

Definitions of damage agent and criteria

A restricted definition of “damage agent” and criteria for including or excluding organisms or non-living agents are needed. Potentially thousands of insects, fungi, nematodes, and others are associated with trees. It is often difficult to determine if an agent causes damage, e.g., ivy, or if damage is sufficiently severe or widespread, e.g., pitch nodule moths, to require coding. The data custodian (Director, Forest Practices Branch) will have to decide (following appropriate consultation) whether damage is extensive or severe enough to warrant coding for the purpose of tracking or recording data.

Several insects, diseases, animals and other agents are listed in Forest Practices Code guidebooks as potential risks to certain forest ecosystems. These and other similar agents will receive major emphasis in developing or revising damage agent codes. These insects and diseases must be considered in formulating, approving and reviewing development plans and prescriptions. As well, new insects and disease agents might need to be coded for inventory sampling and other ministry business needs.

Recommendation: Develop definitions, selection criteria and processes to determine and revise damage agent codes. Incorporate or use current ministry policy and/or procedures where possible.

Assigning Damage Codes

One of the central issues in assigning codes is to determine the biological entity that is to be named, and then decide on a relatively durable code name to use.

The role of the data custodian is to consult with ministry staff to determine needs for new codes. Often it will be necessary to determine what new biological entities to recognize, e.g., a current “species” is recognized as one or more new species; a new combination of previous species to constitute only one species; or new subspecies of a current species are designated. Usually this will also entail designation of a preferred or “best” name, whether scientific or common.

As previously mentioned, the data custodian might also have to designate new codes for agents that do not follow the current code structure of embedded features, as available letters are used up.

Recommendation: Determine -- after consultation with business areas, users in operations and other staff -- what insects, fungi, or other entities should be included as damage agents, and how they should be named and coded for use in the ministry set of damage agent codes.

Needed updates/revisions to codes.

Tables of proposed changes/additions/deletions to codes are listed in the Tables and Graphics Section, page 42. Details on why changes are needed are listed for review and comment. These changes include some new codes for additional insects or diseases recommended by Forest Productivity Council.

Current ISIS and FPC proposed codes included an unknown “U” code group. These “U” codes are redundant, because the one or two letter part of the other codes were intended to be used when a specific damage agent could not be identified. Possibly a separate symptom code could be developed to record type of damage, but this is beyond the scope/definition of our current task to revise damage agent codes.

Recommendation: Incorporate recommended changes (see Appendix 1, Tabulations & Graphics Section, page 42, this issue), including some proposed by the Forest Productivity Council, in newly revised damage agent codes. Delete “U” unknown damage codes from the corporate damage codes.

Other code issues

Creating subsets and combinations of codes

In our June 1997 memo we outlined several possible approaches for selecting subsets of damage codes, and setting up combinations of damage codes with other codes such as disturbance codes or symptom codes. These were envisioned as subsets or “super-sets” to facilitate business applications in different sections. Business areas could set these up in corporate code tables in future as need arises. If interested, please contact Tom Fulton, Senior Administration Analyst, Information System Branch for further information.

Data modelling

One reviewer recommended that we consider detailed data modelling, including changing the structure, content, and increasing the scope of damage agent codes, as part of our task to revise/update damage agent codes. As achieving consistent use of damage agent codes across all ministry business areas is a substantial enough task, we have decided not to expand the scope of our proposal beyond damage agent codes.

Implementation plan

Several reviewers expressed concerns about providing adequate notice of any changes to damage agent codes before field work commences in order to make changes to field forms, training packages, informing contractors, and dove-tailing any code revisions to update or change management procedures already in use for systems such as ISIS or the new vegetation inventory. We concur. Changes will be recommended so that they can be incorporated into updating routines or schedules, with sufficient notice to district staff, licensees and contractors.

Recommendation: After damage code changes are approved, develop an implementation plan that dovetails with schedules for changes in the affected business areas.

- J. Muir, Forest Practices Branch, and T. Fulton, Information Systems Branch, Victoria.

FOREST INSECTS

Overview Assessment of Weevil Infested Sitka Spruce Plantations on Vancouver Island. The Vancouver Forest Region, with the assistance of FEN Forest Consulting, has recently completed an assessment study of weevilled Sitka spruce plantations on Vancouver Island. Over 60 plantations that have endured 15 or more years of weevil infestation were assessed to determine the success of Sitka spruce and the estimated impacts of the spruce weevil, *Pissodes strobi*.

Although the impacts of many successive years of weevil attack remain severe in many locations, the results of this study suggest that they may not be quite as severe as was once thought. Sitka spruce that were able to grow within dense, fully stocked patches generally have surprisingly good first logs. Although growth losses are still significant and some trees retain serious stem defects, the majority of these trees have reasonably good form. Most forks sort themselves out and most crooks straighten out as they become buried in the radial growth of wood. Also, the diameters of Sitka spruce are generally larger than adjacent conifer species, though they are often shorter in height. What remains an unknown at this point, is that the deformed cores of these trees may still be significant when it comes to lumber recovery.

The success of planted Sitka spruce in many areas was poor due to brush competition, or offsite planting. On richer sites, competition with salmonberry often resulted in widely spaced stands, often with openings. It sometimes resulted in an almost complete failure of planted Sitka spruce. Widely grown Sitka spruce generally had higher weevil attack rates, more stem defects, retained larger branches and had large ring widths. At rotation, these trees are unlikely to provide much more than utility grade logs.

Branch retention and ring width are two of the most serious concerns when considering log quality in second growth Sitka spruce. Sitka spruce tends to retain its branches for a long time. Weevil attack results in larger branch diameters and more branches per length of log. Pruning has been proposed as a way to potentially recoup some of the losses in wood quality due to weevil attack. However, wide ring widths, that are common in second growth Sitka spruce, will result in the default of the log grade to a lower grade. In other words, pruning will seldom be sufficient to improve the log grade.

Work that has been done at Forintek has shown that wood properties of second growth spruce with wide growth rings are well within acceptable limits. So, even though scaling rules discriminate against wide ring widths, there is not a real problem with wood quality, as far as construction lumber is concerned. Rules for lumber grading do not seem to be as strict and can result in improved values over the log grade. This is where the added value of pruning will show up.

In many of the plantations assessed in this study, much of the Sitka spruce has been cut out during juvenile spacing. Additionally, a number of them have been pruned as well, and, usually the Ss have been left unpruned. This is probably due to concerns about epicormic branching and the belief that the Ss would not amount to much due to weevil attack. One of the primary conclusions of this study is that Sitka spruce in these weevilled

plantations are not “write-offs.” We recommend that Sitka spruce not be “spaced out” unless it is truly deformed, and, if the stand is to be pruned, prune the Sitka spruce as well. Experience to date suggests that epicormic branching is not as big of a concern as was originally thought, especially if tree densities are maintained.

A silviculture regime with which to grow Sitka spruce under a high weevil hazard has started to emerge. Plant Ss densely were ecologically best suited (microsite planting) with other species at ~1600 sph. Maintain high initial densities until the trees are ≥ 25 years of age. This will help ensure good form in the first log. From this point, a few options are available:

- do not space and leave to self-thin and self-prune;
 - space to >1000 sph and leave to self-prune, and consider commercial thinning;
 - space to 700 - 1000 sph and prune (if density is maintained, epicormic branching is not a problem).
- D. Heppner, Vancouver Forest Region, Nanaimo, and
R. Muller, FEN Forest Consulting, Duncan.

Forest Health Management Plan - TFL 15 (Weyerhaeuser, Okanagan Falls Division. This FRBC-funded project involved a number of phases that fed into the final product; a Forest Health Management Plan. Initial phases included historical data compiled from Forest Insect and Disease Surveys (FIDS) of pest occurrence, aerial overview flights and personal knowledge of forest health agents known to be in the area. The TFL was stratified by Biogeoclimatic zone (BEC), Inventory Type Groups (ITG) and ageclass from which surveys for pest incidence (SPI) were conducted. A tracking system in MS® Access was developed so that forest health information regarding a specific type could be queried and plans developed according to the pest involved. This system also allows continued updating as new incidences of pests are found. Additional surveys for pest incidence are planned, subject to funding.

The plan, entitled *Forest Health Management Plan, TFL 15* is a substantial document including history of certain pests, management strategies by pest with consideration to other resource values, hazard and risk maps and a list of references.

This document will provide an excellent template for future Forest Health Management Plans.

We extend our thanks to Weyerhaeuser Canada for conceiving the project, the ministry for supporting it, FRBC for having the insight to fund it and to JCH Forest Pest Management (Janice Hodge) for having the courage to take on a project as comprehensive as a Forest Health Management Plan.

- M. Hollinger, Penticton Forest District, Penticton.

Bark Beetle and Other Insect Attack Levels for 1997. This report contains the results of the bark beetle and other insect aerial surveys conducted in 1997. The aim of this report is to provide forest managers with information that will help them make better strategic decisions on the bark beetle survey results within the region.

Results are often reported by planning cells allocated to licensees, the Ministry of Forests (Table A-1 is shown in the Tabulations Section, page 40 this issue) and forest industry share joint responsibility for the management of beetle problems in these planning cells.

Some differences in survey methodology and reporting are apparent between the districts represented here. Many of these differences will be corrected in future editions of the report.

Regional Profile

Mountain Pine Beetle, *Dendroctonus ponderosae*

Aerial surveys found 42 802 ha of mountain of pine beetle damage in the Fort St. James, Prince George, Mackenzie, Vanderhoof and Robson Valley Forest Districts. This represented the third year of increase by this beetle in a row from 25 367 ha in 1995, 36 884 ha in 1996 and 42 802 ha in 1997. Approximately 25% of this attack occurred in more remote areas managed by the Ministry of Forests, while the remaining 75% occurred in areas where the forest industry of Ministry of Forests had more active operations. While the Fort St. James Forest District had the largest area of damage of about 38 505 ha, this insect also increased dramatically in a remote proposed protected area in the Mackenzie Forest District.

Spruce Beetle, *Dendroctonus rufipennis*

Approximately 47 666 ha of damage was mapped in 1997 in the Prince George, Fort St. James, Mackenzie, Vanderhoof, Dawson Creek and Robson Valley Forest Districts. This was about 8 400 ha more attack than was mapped in 1996. The increase was due to 20 000 ha of new attack in the Prince George Forest District. These attack figures do not include 43 000 ha of old attack from the last outbreak in the Mackenzie Forest District that is still being managed. Approximately 80% of all attacks are located in forest planning cells where licensees have operations, while the remainder occurred on Ministry of Forests lands.

Douglas-fir Beetle, *Dendroctonus pseudotsugae*

Damage by this pest increased from the 7 321 ha in 1996 to the 10 392 ha in 1997 in the Prince George, Robson Valley, Vanderhoof and Fort St. James Forest Districts. Some sanitation harvesting is being used to manage this pest in those districts.

Western Balsam Bark Beetle-Fungus Complex, *Dryocoetes confusus*, *Ceratocystis drycoetidis*

This insect is not normally included in aerial surveys because control treatments are not usually conducted for this pest. However, in 1997, 15 917 ha and 282 090 ha were mapped in the Fort St. James and Mackenzie Forest Districts, respectively. The survey of this pest in the Mackenzie Forest District was very extensive and covered the southern two-thirds of the district.

Two Year Budworm, *Choristoneura biennis*

Increased damage from this insect was noted in 1997 in the Fort St. James and Mackenzie Forest Districts. In Fort St. James Forest District, the damage was severe and this insect was found in association with attacks by the western balsam bark beetle.

A more complete report is available from the Prince George Forest Region by contacting Bob Hodgkinson, 250 565-6122 or Stuart Taylor, 250 565-6774.

- S. Taylor, Prince George Forest Region, Prince George.

Forest Health Content for Bark Beetle Management in Forest Development Plans.

In March 1998, the Prince George Forest Region issued the first in a series of "Forest Practices Code Information Notes". The first one is *Forest Health Content for Bark Beetle Management in Forest Development Plans (FDP's)*. It provides guidance to district managers in the Prince George Forest Region in approving the bark beetle management content in FDP's. Topics addressed are:

- responsibilities for bark beetle management activities
- mapping guidelines
- processing emergency beetle permits
- bark beetle clauses for cutting permit documents
- beetle management in riparian reserve zones
- plans for tracking deployment of trap trees, pheromone baits, hauling restrictions, and milling plans.

This *Information Note* will be revised to accommodate upcoming changes to the various Regulations empowering the *Forest Practices Code of British Columbia Act*. Copies of the revised document will be available from the undersigned by late June 1998.

- R. Hodgkinson, Prince George Forest Region, Prince George.

Ground Survey Procedures for Mountain Pine Beetle and Douglas-fir Beetle.

Following a survey of district needs, the Prince George Forest Region issued *Standard Operating Procedure 10.2* in March 1998: "*Ground detection and assessment procedures for mountain pine beetle and Douglas-fir beetle in the Prince George Forest Region*". Distinctions have been made between "walkthroughs for tree marking", "general walkthroughs", and "probing". The document will be revised in August 1998 to reflect the new beetle flight periods. A copy can be obtained from the undersigned.

- R. Hodgkinson, Prince George Forest Region, Prince George.

FOREST DISEASES

A New "Non recoverable Loss". Non recoverable losses (NRL), of the first kind, are well known and defined as unsalvaged catastrophic losses. NRL's of the second kind occur as individual tree mortality during the rotation and are termed endemic losses. These losses are generally accounted for by being built into the inventory sampling method.

NRL's of the fourth kind are OAF 1's, where, say root disease, removes specific areas from production for the foreseeable future. NRL's of the fifth kind, are OAF 2's, where extra growth losses to our second growth (over and above that occurring in unmanaged stands) are attributable to our management activities (e.g., DRA). NRL's losses of the sixth kind are value losses due to pest activities, such as, dead trees from bark beetle attack and blue staining.

Recently, I have noticed a non recoverable loss of the **third kind**. In the Kootenay Lake Forest District, their last inventory occurred in the early 70's, about 70 years after the major fires of 1898 - 1906. Most conifer stands regenerated after those fires and as a result, were young age class 4 stands when inventoried. Very few, if any, stands of age classes 5 & 6 with Pl or Fd leading types would have been available for sampling. Hence when we grew the inventory on computers, additional volume was added as the stands increased in age. F 430 G 7 stands became F530 G 7 or 640 G 7 stands. Through root disease research in both Kamloops and Nelson Forest Regions, Hadrian Merler and I have noticed that late rotation species shifting can occur, resulting in reduction of the effective mean annual increment (MAI). For example, in the Kamloops Forest Region, near the Skimikin Nursery, a 70 year old Fd stand had 350m³/ha, but through the action of *Phellinus*, the volume was reduced to 100 m³/ha by age 100; the volume was in small Cw and Ep stems of barely merch size with a few Fd "vets". Through contact with a local forest worker, I became aware of a stand that was mainly good sized Fd 15-20 years ago, but today was mostly depleted of those Fd. Firewood cutters have removed most stems close to the road, leaving a poor quality Cw, Hw, Bg, Pw stand behind that is not merchantable. A review of the forest cover maps showed that indeed this area was recorded as Fd (Cw Lw) 530 G7. Remnants of the original stand show gross volumes over 450m³/ha, where moderately impacted by root disease, volumes are between 260-360 m³/ha, and in the heavier impacted areas volumes range between 60-120m³/ha. Hence MAI has taken a drop from around 4.5 m³/ha per year to less than 1 m³/ha per year. From viewscapes along the road, this appears to be a common feature. Since these volume or growth losses were very unlikely to have been picked up during the original sampling, these losses would have to be considered as NRL's.

Stands like this would suggest that we need to design and develop a forest health monitoring program to specifically look at age class 4, 5 and 6 stands of susceptible leading species to determine the potential impact on AAC from undetected species stand shifts.

- D. Norris, Nelson Forest Region, Nelson.

Older Juvenile Spacing Retrospective Study (OJSRS). In the fall of 1997, the Stand Tending Forester and the Regional Pathologist, Nelson Forest Region had Sheri Walsh, Heather Pinnell and Maria Grau randomly select and inspect 40 stands that were spaced more than ten years ago. The objectives were to compare pre- and post-stocking levels, detect and determine the causes of any significant mortality, determine incidence and damage from various pests and review diameter growth trends.

Stocking levels of well spaced trees were on average lower after ten years than at the time of spacing, with well spaced tree densities ranging from a low of 270 to 1,150 trees per ha with a median of around 500-600 in the dry zone and 500-700 sph in the moist zone (Note total trees ranged from 782 to 2138 sph). No significant species shifting was detected.

Recent total mortality was between 2 and 5% of total conifers, more so in the crop trees than infill trees mostly caused by wildlife and Armillaria. Mortality did not vary with current stand densities.

Forest health problems were prevalent. The incidence of pest damage and defects was almost double in the dry vs. the moist zones; wildlife and *Atropellis* canker accounted for much of this difference. Armillaria, based on above ground signs, was confirmed in 12 moist sites and 9 dry sites. While most of the Armillaria infection ran around 1-2%, (divide by three for approximate annual rate), at this time in the life of a stand, any presence of Armillaria should be barely visible.

Of the randomly selected stands, 37 of 40 had pest impact III (6) or pest impact IV (31) ratings in a 4 point rating system (III = significant current volume loss and potential long term losses; IV = significant long term volume losses). What the pest impact rating really means in terms of stand and disease development are unclear at this time. However, this result is a red flag that should not be ignored.

The Armillaria Risk Assessment Matrix was tested on these inspections, and the results tracked along very well with both the circular plot and transect sampling techniques.

Analyses of pest and growth responses were limited due to sample size, study timing and the preponderance of PI sites (most older spacing was in PI stands). Further sampling in Fd, S, and CwHw stands is required before differences in trends can be detected. However, it is clear that some form of monitoring plan needs to be developed for our managed stands.

- D. Norris, Nelson Forest Region, Nelson.

Impact of Hard Pine Stem Rusts in the Lakes TSA. The original outline was written up in the December 1997 edition of Forest Health Progress.

Methods

I conducted this study in the Lakes Timber Supply Area (TSA), the eastern most TSA in the Prince Rupert Forest Region. Lodgepole pine is the dominant commercial tree species in the Lakes TSA covering over 490 000 ha, or 77% of the timber harvesting land base (Lakes TSA, Timber Supply Review Discussion Paper, Anon. June 1995. B.C. Min For.). The remainder of this land base is covered in interior spruce and subalpine fir at 21% and 2% respectively. The majority of the lodgepole pine is in the mature (> 100 years) age class with only approximately 77 000 ha of stands < 20 years.

The first requirement of this project was an estimate of the incidence of hard pine rusts throughout the Lakes TSA. I selected a random sample of 67 juvenile lodgepole pine stands out of the population of 339 from the ISIS database (BC Ministry of Forests) for the Lakes TSA. The requirements for the sample stands were as follows; the stands were between the ages of 10-25 years, >80% lodgepole pine and < 5000 stems/ha.

We used a low intensity survey of each of the selected blocks to determine the incidence of rust. Based on the results of the survey, the stands were grouped into three rust incidence classes; Low 0-10 %, Moderate 10-20 % and High >20 %. The rust incidence estimates were based on those rust infections that would deem a tree unacceptable based on the Free Growing Damage Standards (BC Ministry of Forests, 1997). These standards state that a tree is unacceptable if a branch has a comandra or stalactiform infection closer than 60 cm to the stem or a gall rust infection closer than 10 cm to the stem. Stem infections of all three rusts were considered lethal. This portion of the project was completed by Cedrus Consulting, Smithers, British Columbia.

I randomly selected ten sample stands from the Low, Moderate and High rust incidence classes. Silvicon Services, Smithers, British Columbia, located a 100 m x 100 m (1 ha) plot in each of these stands. They recorded the location of each tree greater than 1.5 m in height by taking a minimum 30 second Global Positioning System (GPS) reading using two Trimbol Pro XL GPS units per two person crew. At each tree the plot number, subplot number and tree species was recorded on the GPS recording unit. For lodgepole pine trees they also recorded the following specific tree attributes:

- live pine with no rust
- live pine with stalactiform rust*
- live pine with comandra rust*
- live pine with western gall rust*
- dead pine (due to other causes)

Note: Dead trees where the cause of death was obviously a rust were recorded as rust infected.

Stand Growth Projection Modelling

Albert Nussbaum and Ken Polson, Research Branch, entered the stem mapped stand data and site index for each stand into the Tree and Stand Simulator (TASS) model. They modelled merchantable volume using a 12.5 cm minimum diameter at breast height, and a minimum top diameter of 10.0 cm. In order for us to model the effects of hard pine rusts on the lodgepole pine stands using TASS, we had to provide answers to the following questions:

1. How long do rust infected trees take to die?
2. Which rust infections are lethal?
3. Do the voids created by rust persist?

We compared the mean merchantable volume at culmination age with all rust infected trees considered healthy (control) to the mean volumes under five scenarios:

- 1) Rust trees killed from age 21-50, gall and comandra 100% lethal.
- 2) Rust trees killed from age 21-40, gall and comandra 100% lethal.
- 3) Rust trees killed from age 21-40, gall 50%, comandra 100% lethal.
- 4) Rust trees killed from age 21-40, gall 25%, comandra 100% lethal.
- 5) Rust trees killed from age 21-40, gall 100%, comandra 50% lethal.

I compared the merchantable volume for the rust affected runs at the culmination age of the rust free control run. Culmination age was the age at which merchantable mean annual increment (MAI) was maximized. I determined the percent volume reduction (or addition) by subtracting the merchantable volume for the rust influenced runs from that of the rust free run and dividing that value by the rust free volume.

Results

A total of 3322.2 ha were surveyed. The landscape level rust incidence for the Lakes TSA is significantly higher than two of its neighbouring TSAs (see Figure 1, Tabulations and Graphics Section, page 41 this issue). In 1996, a similar landscape level incidence survey was conducted in the Morice TSA covering 3270 hectares (Alex Woods, unpublished data). In 1992/93, a total of 1803 ha were surveyed in the Vanderhoof Forest District (Richard Reich, unpublished data).

There was no significant difference in the rust incidence between the low and moderate stem mapped stands. Effectively there were only two rust incidence classes for the stem mapped stands; low and high. The correlation between rust incidence and stand density was very poor ($r = 0.102$).

TASS Results

The effect of stem rusts on stand productivity was two fold. First, stem rusts reduced the volume produced at culmination age in the majority of the stands, in the High incidence stands quite significantly. In the Low and Moderate incidence stands, there were some instances where the presence of rusts actually leads to an increase in stand volume. None

of these increases were statistically significant. It is possible that rusts could space the lower incidence stands and have a beneficial effect on volume. The second effect of rusts, particularly in the High incidence stands, was a lengthening of the rotation period.

We found that mean volumes at culmination age differed significantly ($\alpha = 0.05$) among rust incidence classes and mortality scenarios (Table 1, below). There was no significant difference in mean volume between the Low and Moderate rust incidence classes. The ANOVA results also indicated that there was a significant interaction between rust incidence class and rust mortality scenario.

Table 1. The ANOVA results of the comparison of mean volumes at rust free culmination age for all combinations of rust incidence class and rust mortality scenario.

Source	df	F-Value	p of F value
Rust Incidence Class	2	8.39	0.0015
Rust Mortality Scenario	5	21.16	0.0001
Rust Incidence X Mortality Scenario	10	9.35	0.0001

We analysed the affects of rust mortality scenario for each rust incidence class individually (Table 2, below).

Table 2. Difference in mean volume (m^3/ha) at rust free culmination age, with 95% confidence interval, between mean volume of the rust free control, for the High (386.4), Moderate (382.5), and Low (394.9) rust incidence classes, and five rust caused mortality scenarios.

High (> 20 %)

Mortality Scenario	Lower CL	Difference	Upper CL
kill from age 21-50	-96.98	-76.60 a	-56.22
kill from age 21-40	-91.18	-70.80 a	-50.42
Gall rust 50 % lethal	-84.08	-63.70 ab	-43.32
Gall rust 25 % lethal	-65.88	-45.50 bc	-25.12
Comandra rust 50 % lethal	-51.68	-31.30 c	-10.92

Moderate (10 - 20 %)

kill from age 21-50	-0.364	-10.60a	-20.84
kill from age 21-40	-1.764	-12.00a	-22.24
Gall rust 50 % lethal	-0.364	-10.60a	-20.84
Gall rust 25 % lethal	-3.636	+6.60 b*	+16.84
Comandra rust 50 % lethal	-0.164	-10.40a	-20.64

Low (< 10 %)

kill from age 21-50	-3.534	-10.00a	-16.47
kill from age 21-40	-4.834	-11.30a	-17.77
Gall rust 50 % lethal	-3.434	-9.900a	-16.37
Gall rust 25 % lethal	+6.866	+0.400b*	-6.07
Comandra rust 50 % lethal	-0.234	-6.700a	-13.17

Those values followed by the same letter are not significantly different from each other within their respective incidence class ($\alpha = 0.05$). Those values followed by * are not significantly different from the rust free run.

The losses suffered in the High rust incidence class were at least six times those suffered in the Moderate and Low incidence classes for every mortality scenario except 50% lethal comandra. In that scenario, the losses were still approximately three times those suffered in any scenario in the Low and Moderate incidence classes. Every mortality scenario except that in which gall rust was 25% lethal, resulted in significantly reduced mean volumes in the Low and Moderate incidence classes. The magnitude of these losses, though statistically significant, only account for a reduction of at worst 3% in the mean volume at rust free culmination age for the Low and Moderate incidence classes. In the worst case scenario, in which both rusts are 100% lethal and take 50 years to kill, the losses range from 14.5 to 25.1% in merchantable volume for the lower and upper 95% confidence limits with a mean loss of 19.8% in the high incidence class.

Discussion

Volume loss due to rusts throughout British Columbia were estimated by van der Kamp at 5.5%. (van der Kamp, B.J. 1981. The incidence and impact of western gall rust, stalactiform and atropellis canker in managed stands of interior lodgepole pine. 56p. B.C. Min For.). In our study, the mean percent volume loss in the high incidence stand was 18.32% when both rusts were 100% lethal and the trees died over 40 years. The high incidence stands accounted for 26.57% of the population of juvenile lodgepole pine stands in the Lakes TSA. The two combined then result in a 4.87% reduction in volume for the entire TSA. Rusts in the Low and Moderate incidence stands account for a 2.18% reduction in volume using the same calculations. The total losses due to rusts in this scenario account for a reduction of 7.05% in volume at rotation over the entire TSA. If we consider that the Lakes TSA has a higher rust incidence than neighbouring TSAs, our results do not refute those of van der Kamp (1981).

We found no difference in rust incidence between the mapped Low and Moderate rust incidence classes. The incidence survey used to classify stands by incidence class was not robust enough to identify the differences between the low and moderate incidence stands. This stand level survey was more or less typical of those used operationally to identify forest health concerns prior to spacing. The survey methods required to place stands into three individual incidence classes may be too onerous to be conducted operationally. Perhaps it would be more appropriate to have only two incidence classes for stand management decision making purposes.

We chose to use the Free Growing Damage Standards (BC Ministry of Forests 1995) to define lethally infected trees. This was perhaps an overly pessimistic choice. Since the data collectors did not differentiate between stem and branch infections, we cannot completely remove this uncertainty from our study. The range of mortality scenarios we used did indirectly address this uncertainty. The TASS volume predictions were more sensitive to changes in comandra rust lethality than to changes in gall rust lethality. This sensitivity in the model could be due to the tendency of comandra infected trees to be clustered together to a greater extent than western gall rust infected trees. If this is the case, then reducing the lethality by 50% would be similar to reducing the size of the voids created by groups of comandra infected trees. It is the large voids that have the greatest negative influence on volume.

van der Kamp and Spence predicted that juvenile lodgepole pine trees with comandra stem infections would die within one or at most two decades, and that many of the trees with branch infections would also succumb before maturity. (van der Kamp, B. J., and Spence, M. 1987. Stem diseases of lodgepole pine in the British Columbia interior following juvenile spacing. For. Chron. 64: 334-339.) They also stated that all trees with western gall rust stem infections would die before harvest. We used their prediction along with my own experience in these stands in our modelled mortality scenarios. Our comparison of time to death mortality scenarios indicated that there was no significant difference in volume loss between killing the rust infected trees from age 21-40 or 21-50 years. After the initial analysis, we also ran TASS using a model in which the rust infected trees were killed from age 21-30. The mean volume reduction in this run was not significantly different from either the 21-40 or the 21-50 runs.

The high proportion of stands in the high rust incidence class coupled with the impacts suffered in that incidence class result in significantly less productive young forests. There are approximately 77 000 ha of juvenile lodgepole pine stands in the Lakes TSA, of which, 26.6% or 20 790 ha are in the high incidence class. Using the mortality scenario in which both rusts are 100% lethal and rust infected trees die from age 21-40, the losses over the rotation range from 1.05 million m³ to 1.90 million m³ (95% confidence limits) with a mean of 1.45 million m³.

The Lakes Timber Supply analysis report (1995) estimates that in the next 50 years there will be an increase of close to 25% in the proportion of the harvesting land base in the most susceptible age class of 0-20 years. A corresponding increase in rust impacts could be circumvented if steps are taken to improve the genetic resistance of lodgepole pine planting stock and if stand management treatments are conducted in a manner that addresses rusts. The three greatest individual stand volume reductions due to rusts were suffered in those high incidence stands that had been spaced to 1300 stems or less. Rust incidence alone, regardless of stem density, is responsible for a great deal of the variation in loss values. However, the combination of low density (< 1300 stems/ha) and high rust incidence is devastating. It is clear that rust incidence must be accurately assessed prior to any density management treatment. It is also clear that hard pine stem rusts must be given due consideration at the landscape level in current Timber Supply Reviews and at the stand level in treatment prescriptions.

- A. Woods, Regional Pathologist, Prince Rupert Forest Region.

Determination of the Impact of Tomentosus Root Disease in the Bulkley TSA. (The original outline was written up in the December 1997 edition of Forest Health Progress.)

Methods

Briefly in review, we randomly selected 50 spruce leading polygons of all age classes from the data base for the Bulkley TSA. David Rusch of Rot Rooters then established a 11.28 m radius plot in each of the 50 polygons. Within each plot every spruce and lodgepole pine tree was measured for height and dbh. All live spruce and lodgepole pine

within the plots were also examined at the root collar and on 3 main roots within 1 m of the root collar, using a gas powered drill and a ship auger to determine if they were infected with *Tomentosus*. David determined the volume of live infected trees using height and diameter measurements and the Schumacher volume equations for each species.

All standing dead spruce and lodgepole pine trees were closely examined to determine that *Tomentosus* was the cause of mortality. Positive identification of *Tomentosus* caused mortality was based on the presence of characteristic pitted decay in the roots or at the root collar. If pitted decay was present, it was assumed that *Tomentosus* root disease was responsible for the death of the tree. The time of tree death was estimated based on the amount of bark and branches that were still on the tree.

For those dead trees that had fallen, the species, cause of mortality, height (length of the bole) to the nearest meter, and the diameter to the nearest centimetre were recorded. The length of time that the tree has been on the ground was also estimated. It is accepted that these estimates are rough, thus, age estimates were made to the nearest 10 years.

The volume lost due to the death of infected trees consists of two components. The first is simply the volume of dead wood that is no longer harvestable. The second loss component is the increment growth that the infected tree would have put on, had the tree continued to live. In order to determine this estimate, first, the approximate time of death must be established. Then, the average radial increment of the healthy trees in the plot over the period of time since the time of tree death must be added to the diameter of the dead tree. The sum of the growth loss and the current dead tree volume is the total volume loss. This volume loss was reported as being over the past 10 or 20 year period.

The projected impacts for the next 20 years were made using the volume estimates of the infected live trees. It was assumed that these infected trees will die within the next 20 years.

Results

In mature stands (>30 years), 37 plots were located and in immature stands (<30 years), 13 plots were located. All of the plots were located in polygons of age class 3 or greater. The average age class was around seven.

Tomentosus Incidence

The average *Tomentosus* incidence was 8.8 ± 4.7 % (Table 1, below) for mature plots. The infected basal area per hectare for mature plots was 6.4 ± 2.9 m²/ha. The average incidence of *Tomentosus* in spruce leading stands was high in the Interior Cedar Hemlock (ICH) zone and moderate in the Sub Boreal Spruce (SBS) zone. No *Tomentosus* root rot was found in the ESSF.

Table 1. Average incidence of Tomentosus root rot and average Tomentosus infected basal area by biogeoclimatic (sub)zone in the Bulkley TSA.

Biogeoclimatic (sub)zone	# of Plots	% Incidence (Sx)	% Incidence (Pl)	% Incidence (Total)	Infected Basal Area(m ² /ha)
ICH	5	37.2	17.5	16.3	11.0
SBS dk	4	15.0	0.0	7.5	4.9
SBS mc2	26	15.3	1.5	8.2	6.3
ESSF	2	0	0	0	0
All	37	17.4 ± 8.7	3.4 ± 3.4	8.8 ± 4.7	6.4 ± 2.9

The estimates of volume losses due to Tomentosus are shown in Table 2, below. The “lost growth” portion of the Tomentosus impact estimate for the last twenty years accounted for about 11.2% of the volume reduction.

Table 2 Mean and 95% confidence intervals for Tomentosus infected volume losses by species and mean and 95% confidence intervals for total volume by species in the Bulkley TSA.

Species	Volume loss for trees killed 11-20 years ago (m ³ /ha)	Volume loss for trees killed 1-10 years ago (m ³ /ha)	Projected volume loss next 20 years (m ³ /ha)	Total volume loss (m ³ /ha)	Total living conifer volume (m ³ /ha)
Sx	5.3 ± 6.5 (2.9 %)	13.3 ± 10.3 (7.2 %)	32.6 ± 20.2 (17.7 %)	51.2 ± 29.0 (27.8 %)	184.0 ± 45.5
Pl	0.8 ± 1.7 (1.6 %)	3.2 ± 3.0 (6.2 %)	3.0 ± 3.2 (5.8 %)	7.0 ± 6.3 (13.6 %)	51.6 ± 34.4
Bl & Hw	0.0	0.9 ± 1.8	0.06 ± 0.1	1.0 ± 1.8	107.7 ± 37.7
All	6.2 ± 6.8 (1.8 %)	17.4 ± 11.2 (5.07 %)	35.6 ± 21.6 (10.4 %)	59.2 ± 32.7 (17.2 %)	343.2 ± 51.5

Comparison Between Inventory Branch PSPs and Spruce Leading Polygon Plots.

We compared the results of this study with those of an earlier study (Table 3, below) that used Inventory Branch PSPs to determine impact estimates (White, 1997). This earlier study was written up in the May 1997 edition of Forest Health Progress. The data is presented in the same format as the earlier report. The impacts estimated from PSPs with a spruce component were considerably less than those estimated from randomly selected spruce leading polygons. The total impact of Tomentosus for the last 20 years and next 20 years in the previous study was only 2.1% of the total spruce volume as opposed to 27.8% in the current study. Spruce accounted for 78% of the combined pine and spruce volume in this study as compared to only 44% in the earlier study. In the case of immature stands, the percentage of plot area within 3 m of an infected stump was almost the same in both studies (4.2% vs. 4.0%). The occurrence of Tomentosus in this study as measured by the percentage of Tomentosus infected plots was about twice that of the occurrence of Tomentosus in the earlier study.

Table 3. Comparison of Results from Inventory Branch PSPs and Randomly Selected Spruce Leading Polygon Plots in the Bulkley TSA.

Inventory Branch PSPs

Species	Projected volume lost over next 20 years (m ³ /ha)	Total volume lost (m ³ /ha)	Total volume (m ³ /ha)	% of Volume infected with DRT
Sx	0.9664	1.7742	83.8182	2.1
Pl	0	0.9325	105.0648	0.9
Total	0.9664	2.7067	189.4662	1.4

Randomly Selected Spruce Leading Polygons

Sx	32.6213	51.2976	184.0239	27.8
Pl	2.9612	5.5218	51.5533	10.7
Total	35.5826	54.8194	235.5772	23.3

Discussion

There was very little *Tomentosus* found in young stands. Detection of *Tomentosus* in young trees less than 10 years old is often difficult because pitted decay is less common in small roots. Tree less than 5 years old do not produce root rot symptoms (Hunt, R. S. and Unger, L. 1994. *Tomentosus* root disease. Forest Pest Leaflet 77. Natural Resources Canada, Canadian Forest Service). There was no *Tomentosus* found in association with *Tomentosus* decayed stumps except at one site. In some of the youngest stands, the opportunity for root spread was probably limited by the small root systems of the trees. As trees get older the opportunity for root to root and root to stump contact increases, but the time between initial infection and symptom expression also increases. High levels of mortality are not that common in very young stands except where there are very high inoculum levels. Drought years may play a significant role in determining the amount of *Tomentosus* mortality in young stands.

The large difference in the estimated impact for the last 11-20 years compared to the last 1-10 years may be due to a natural increase in disease level over the life of the stand. It could also be a result of a bias in estimating how long the trees had been dead. Some of the trees that died 11-20 years ago could have been recorded as being dead for more than 20 years or less than 11 years.

The two main assumptions used to come up with *Tomentosus* impact estimates involve the calculation of lost growth and the prediction of time to death for infected trees.

The method used to calculate lost growth assumes that the lost growth will not be made up by an increased growth in surrounding trees due to reduced competition. The validity of the assumption that current living Tomentosus infected volume is a good predictor of future loss over the next 20 years is very difficult to assess. Tomentosus infected trees can survive for long periods, however, the presence of Tomentosus at the root collar is a good indication of advanced Tomentosus root rot. The only way to assess whether or not this is a valid assumption of future loss would be to re-measure the plots in the future.

The large difference in the volume impact estimates between this study and the earlier study are probably a result of two things: 1) The tendency to avoid placing permanent sample plots in openings or areas with very much blowdown or dead standing trees probably precluded plots from being located in heavily infected Tomentosus areas, and 2) The permanent sample plots were probably not all located in spruce leading polygons.

The difference between these two impact estimates has significant implications on timber supply projections and the estimates of unsalvageable losses due to disease. It has been argued by timber supply analysts that losses to diseases such as Tomentosus are already accounted for in timber supply predictions. Their argument is that the Temporary Sample Plots (TSPs) account for any disease caused losses that are systematically avoided in Inventory PSPs, since they are randomly located and not moved to avoid patches of blowdown, etc. Timber supply projections are then based on the combined PSP and TSP data. These TSPs provide a “snapshot” view of the stand in which all live trees are tallied. These tallied trees are assumed to be healthy and are assumed to remain that way into the future. Our results indicate that 17.7 % (Table 2, above) of this volume of live trees is, in fact, infected and therefore their projected longevity is in question. The TSP “snapshot” similarly does not account for those trees that have recently been killed. In many mature stands in the Prince Rupert Region, particularly in the ICH, interior spruce is the largest, most productive tree until age 120-150, at which time Tomentosus root disease effectively removes them from the stand. The volume estimates derived from TSPs in these stands depends to a great extent on how close these stands are to the Tomentosus driven pathological rotation. The inventory species classification would similarly depend on how close the stand is to this pathological rotation.

Some of the infected stands will be harvested prior to suffering substantial volume reductions due to Tomentosus. However, it is not possible, nor necessarily desirable, to access all of these spruce leading stands in time to capture this volume. It is clear that the current estimates of disease-caused unsalvageable losses in the Bulkley TSA are not *negligible* as they are currently defined in this TSA’s Timber Supply Review.

- A. Woods, Regional Pathologist, Prince Rupert Forest Region.

Decay in Advance Subalpine Fir Regeneration in the Bulkley TSA. The background for this project is found in the December 1997 edition of Forest Health Progress.

Subalpine fir is an important commercial tree species and a major component of forests in the Bulkley TSA. Continued harvest and regeneration of this species are important to the economy and ecology of the area. An increased use of partial cut silviculture systems and heavier reliance on natural regeneration has resulted in increased interest in advance regeneration. This increased interest has raised concerns over the quality of understorey subalpine fir with respect to scarring, stem form, vigour, and potential decay pathogens.

A key objective of this study was to determine the incidence of decay fungi in subalpine fir advance regeneration. Secondary objectives included examination of the relationship between decay and age, size, BEC variant, and tree acceptability. The Biogeoclimatic Ecological Classification (BEC) variants studied included the ESSFmc, SBSmc2 and ICHmc2. A contract was awarded to Laing and McCulloch, Smithers, British Columbia to try to answer these questions regarding decay in advance subalpine fir regeneration.

Methods

Five stands were selected from each of the three biogeoclimatic variants. Stands were selected using 1:20 000 scale forest cover maps and regional biogeoclimatic maps, and evaluated for suitability in the field. Criteria for selection required that: subalpine fir was a major regeneration component, stands were not located in transitional areas between variants, there was no evidence of past logging, and stands were spatially separated as much as possible.

Survey lines were systematically located prior to sampling, and plots were located 100 m apart along the survey lines. Sampled trees were selected from three regeneration layers (Layer 2: 7.6cm to 12.5cm dbh, Layer 3: 1.3m tall to 7.5cm dbh, and Layer 4: < 1.3m tall). The 3 trees closest to the plot centre from each layer were sampled, for a total of 9 trees at every plot. A total of 7 plots were established in each stand, and 5 stands were sampled in each BEC variant, making a total sampling intensity of 945 trees, with 315 trees sampled in each BEC variant. Sample trees were cut at 0.3 m and 1.3 m and the percent of cross sectional area with stain and decay was estimated. A cross section was taken in layer 4 trees at 0.3 m only, since they are less than 1.3 m tall. Infection courts such as scars, forks, branch die-back, and stem defects were noted for each tree, as well as the position of the infection court on the tree. The tree age at 0.3 m was also recorded for each tree.

Trees were also recorded as either acceptable or unacceptable. Tree acceptability was based on the free growing damage criteria for silviculture surveys¹ and Regional Operating Standards #1². The Regional Operating Standards #1 define further acceptability criteria for subalpine fir (Bl) advance regeneration. Under these criteria, Bl is required to have a

¹ Forest Practices Code of British Columbia Establishment to Free Growing Guidebook:
Prince Rupert Forest Region, 1995, Ministry of Forests.

² Regional Operating Standards # 1, Prince Rupert Forest Region, 1997, Ministry of Forests.

functional live crown of at least 24%. Functional live crown is a product of the percent of stem height with live crown and crown occupancy, which is a measure of crown “fullness”. The acceptability of scars is also defined in the operating standards. Unacceptable scars are listed as follows: wounds > 25% of stem circumference or 10% of height (layer 2, 3 and 4 trees), or > 33% of stem circumference or 400cm² (layer 1 trees).

Twenty seven samples of stained and decayed trees were cultured and analyzed by Applied Forest Science Limited, Victoria, British Columbia, to determine the presence and species of fungal pathogens.

Results

Identification of fungal presence and species was not always possible. Some samples with physical signs of decay did not culture any decay pathogens, whereas one sample with stain and no decay did produce a decay pathogen (*Stereum sanguinolentum*). The majority of samples with stain alone did not culture any decay pathogens. We confirmed the presence of at least four species of decay pathogens. Of the species identified in the lab, seven were determined (with 99% certainty) to be *Stereum sanguinolentum*, and one was identified as *Phellinus pini*. *Echinodontium tinctorium* and *Perenniporia subacida* were not cultured in the lab, but were identified in the field.

Variation in Stain and Decay Between Stands

There was considerable variability in the incidence of stain and decay between stands. This was likely due to factors which were not studied during this project such as fire history and wind-throw. Evidence of fire and wind-throw was more common in some stands, particularly in the ICHmc2. These events may have contributed to additional scarring, leading to more decay.

Relationships Between Age, Size, and Stain and Decay

Trees were divided into three groups: those affected by stain and/or decay, those affected by decay alone, and those unaffected by either. Average ages and diameters of affected and unaffected trees were compared and found to be significantly different ($\alpha = 0.05$). The average age of trees affected by stain and/or decay was 92 years, while the average of trees affected by decay was 103 years. The average age of trees unaffected by stain and/or decay was 56 years. The average diameter of trees affected by stain and/or decay, decay alone, and unaffected trees was 7.9 cm, 8.7 cm, and 4.8 cm, respectively.

Of all the trees sampled, 78% were not affected by stain or decay. Of the trees less than 60 years old, 94% were unaffected by stain or decay. Trees with a dbh less than 7.5 cm (Layer 3) were 88% unaffected, and trees less than 1.3 m tall (layer 4) are 95% unaffected.

At least one infection court was found in 47.7% of unaffected trees, in 58.5% of trees affected with stain and/or decay, and in 64.4 % of trees with decay. The high incidence of infection courts in unaffected trees suggests a relatively poor relationship between infection courts and the occurrence of decay pathogens.

The average age and diameter was determined for each advance regeneration tree layer (Table 1, below).

Table 1. Average age and diameter of layers, measured at 0.3 m height.

	Layer 2 (7.6 cm to 12.5 cm dbh)	Layer 3 (1.3 m tall to 7.5 cm dbh)	Layer 4 (< 1.3 m tall)
Average Age (years)/	95	64	33
Standard Deviation	35	21	12
Average Diameter (cm)/	9.8	4.8	1.8
Standard Deviation	1.4	1.2	0.6

There was no significant difference in cross sectional area of decay at 0.3 m between any of the layers for both the ESSF and the SBS. In the ICH the difference between layers were as follows: layer 2 = layer 3 > layer 4. The maximum amount of cross sectional area with decay was less than 3% of total basal area, and was usually less than 1%.

Variation in Stain and Decay Between Acceptable and Unacceptable Trees

Of all the trees sampled, 36% were evaluated as acceptable based on the damage standards and acceptability criteria (see Figure 1, Tabulations and Graphics Section, page 41 this issue). Significantly less stain and decay was found in acceptable trees than in unacceptable trees. Although there is approximately half as much decay in acceptable trees than unacceptable trees, it is incorrect to assume that all healthy, vigorous trees are free of decay pathogens. Of the acceptable trees, approximately 97% were free of decay, contrasted with 94% of unacceptable trees. At least one infection court was found in 29.8% of acceptable trees, but in 60.4% of unacceptable trees. Forks and scars were the predominant infection court type in each acceptability class. (Please refer to Figure 2, Acceptable and Unacceptable Stems Affected by Stain and Decay, page 41 of the Graphics and Tabulation section of this issue of Forest Health Progress.)

Discussion:

The fungal species found causing decay in subalpine fir in the Bulkley TSA include: *Stereum sanguinolentum*, *Echinodontium tinctorium*, *Perenniporia subacida* and *Phellinus pini*. There was a considerable amount of variation between stands with respect to the incidence of decay. This high variability in the incidence of stain and decay within similar populations (i.e. the same layer and same BEC variant) precludes applying generalized results regarding incidence to all stands. Further work is required to characterize stands where the risk of decay pathogens is high. In such cases, advance regeneration should not be considered for the purposes of regenerating the stand.

In general there is more stain and decay in older, larger trees, however, there is not a strong relationship between age and size. If trees are suppressed under a canopy for a long period, there is an increased probability of developing an infection court, which may lead to decay.

The environment in the ICH is more conducive to decay, probably because it is moist and mild in comparison to the other two variants. The ICH has also had relatively high occurrences of fires and selective logging, due to the history of settlement, which are factors contributing to decay.

There was significantly more decay in the unacceptable trees than in the acceptable ones on a statistical basis. One would hope this to be the case. In practical terms, there was very little difference in decay incidence between the two classes; both had relatively low levels of infection. The use of current acceptability and damage criteria does not exclude decayed trees, but can reduce the number of decayed trees chosen for regeneration.

Favouring trees in regeneration layer 4 over trees in layers 2 and 3 will reduce the risk of decay. In general, trees in layer 4 are the least likely to host decay pathogens. However, retaining trees from layers 2 and 3 is important for silvicultural purposes and for structural diversity.

The risk of volume losses due to decay in advance regeneration has probably been over-estimated in the past. The amount of cross sectional area with decay is quite small, and if compartmentalized by the trees' own defence mechanisms, it may not amount to much by harvest. Relying on current acceptability criteria, and choosing acceptable stems from the youngest regeneration layers, can reduce the overall risk of decay even further.

- A. Woods, Regional Pathologist, Prince Rupert Forest Region.

PERSONNEL

FOREST PRACTICES BRANCH

Russ Cozens	Forest Health Officer	Victoria	387-8737
Peter Hall	Forest Entomologist	Victoria	387-3842
Val Fletcher	Forest Health Sampling/Surveys Specialist	Victoria	356-8763
Tim Ebata	Forest Health Project Specialist	Victoria	387-8739
John Henigman	Forest Health Forester	Victoria	356-5886
Shirley Turcotte	Forest Site Management Secretary	Victoria	953-3582
Dwayne Brooke	Noxious Weed Control Officer	Kamloops	319-4074 (Cell Ph.)
Marsha De Wolf	Biocontrol Technician	Kamloops	319-4250 (Cell Ph.)
Susan Turner	Noxious Weed Control Specialist	Kamloops	319-4240 (Cell Ph.)
	Noxious Weed Office Phone	Kamloops	376-3973

TREE IMPROVEMENT PROGRAM

Robb Bennett	Seed Pest Management Officer	Victoria	652-6593
Michelle Hall	Seed Pest Management Biologist	Victoria	652-7613
Ron Planden	Seed Planning Forester	Victoria	652-8303
Ward Strong	Seed Pest Management Biologist,	Kalamalka	549-5696

NURSERY AND SEED OPERATIONS BRANCH

Don Summers	Manager, Nursery Extension Services	Surrey	930-3301
Dave Trotter	Nursery Pest Mgmt. Specialist	Surrey	930-3302
Diane Gertzen	Special Proj./Christmas Tree Specialist	Surrey	930-3309

CARIBOO FOREST REGION

Regional Staff

Al Randall	Forest Resources Manager	Williams Lk.	398-4395
Leo Rankin	Forest Entomologist	Williams Lk.	398-4439
Bill Chapman	Research Soil Scientist	Williams Lk.	398-4718

District Staff

Bob Mitchell	Forest Health Officer	Chilcotin	394-4700
Grant Johannesen	Forest Health Officer	Quesnel	992-4400
Von Vickers	Forest Health Officer	Williams Lk.	398-4341
Don Wright	Forest Health Officer	100 Mile Hse	395-7800
Ron Godlonton	Silviculture Specialist	Horsefly	620-3220
Dave Greenley	Forestry Operations Manager	Horsefly	620-3206

KAMLOOPS FOREST REGION

Region Staff

Lorraine Maclauchlan	Forest Health/Research	Kamloops	828-4177
Hadrian Merler	Research Associate	Kamloops	828-4176

District Staff

Rob Martin	Forest Health Spec./Woodlot For.	Clearwater	587-6700
Dave Piggin	Forest Health Forester	Kamloops	371-6534
Ed Senger	Forest Health Specialist	Lillooet	256-1277
Pat Byrne	Forest Health Specialist	Merritt	378-8449
Margot Hollinger	Forest Health Specialist	Penticton	490-2242
Jim Wright	Zone Forester, Silviculture	Salmon Arm	832-1424
Wayne Anshelm	Forest Health Specialist	Salmon Arm	832-1428
Rick Specht	Forest Health Specialist	Vernon	558-1784

NELSON FOREST REGION

Region Staff

Art Stock	Forest Entomologist	Nelson	354-6633
Don Norris	Forest Pathologist	Nelson	354-6143

District Staff

Dan Reibin	Forest Health Officer	Arrow	365-8600
Ross Elliott	Forest Health Officer	Boundary	442-5411
Liz Goyette	Forest Health Officer	Cranbrook	426-3391
Bernie Hagemann	Forest Renewal Coordinator	Golden	344-7500
Emile Begin	Forest Health Officer	Invermere	342-4200
Julie Castonguay	Forest Health Officer	Kootenay Lk	825-1142
Barb Wadey	Silviculture Specialist	Revelstoke	837-7611

PRINCE GEORGE FOREST REGION

Region Staff

Robert Hodgkinson	Forest Entomologist	Pr. George	565-6122
Richard Reich	Forest Pathologist	Pr. George	565-6143
Stuart Taylor	A/Forest Resources Team Leader	Pr. George	565-6207

District Staff

Bruce Doerksen	Forest Health Technician	Pr. George	565-7100
Sharron Schiefelbein	Forest Health Technician	McBride	569-3748
Nathan Voth	Forest Health Technician	Vanderhoof	567-6363
Barb Harrison	Forest Health Technician	Ft. St. James	997-5276
Steve Bower	Forest Health Technician	Mackenzie	997-2200
Sherilyn Smith	Resource Assist. - Silviculture	Dawson Creek	784-2350
Janice Edwards	Planning Forester	Ft. St. John	787-5616
Steve Lindsay	Resource Officer - Silviculture	Ft. Nelson	774-3936

PRINCE RUPERT FOREST REGION

Region Staff

Neil Endacott	Silviculture Officer	Smithers	847-7513
Alex Woods	Forest Pathologist	Smithers	847-7478
Ken White	Forest Entomologist	Smithers	847-7479
Lou Tromp	Stand Tending Forester	Smithers	847-7514
Don Russell	Range Officer	Smithers	847-7443
Gerry Pinkerton	Reforestation Forester	Smithers	847-7512

District Staff

Tracy Cooms	Resource Assistant	Bulkley	847-6328
Bill Camenzind	Silviculture Specialist	Bulkley	847-6310
Bob Wilson	Silviculture Officer	Kalum	638-5138
Doug Davies	Zone Forester	Kalum	638-3290
Bruce La Haie	District Planning Forester	Kispiox	842-7613
Todd Bresser	Forest Health Technician	Morice	845-6224
Fiore Milinazzo	Forest Health Technician	Lakes	692-7515
Mike Grainger	Silviculture Specialist	North Coast	624-7460
Mark Vieweg	Resource Officer-Silviculture	Lakes	692-7515

VANCOUVER FOREST REGION

Region Staff

Don Heppner	Forest Entomologist	Nanaimo	751-7107
Stefan Zeglen	Forest Pathologist	Nanaimo	751-7108

District Staff

John Ingram	Resource Officer - Silviculture	Campbell Rv.	286-9300
Buck Tanner	Timber Specialist	Campbell Rv.	286-9300
Jeff Fournier	Silviculture Officer	Chilliwack	794-2225
Kelly Schellenberg	Small Business Forester	Duncan	746-2768
Steven Payne	Compliance and Enforcement Technician	Mid Coast	982-2000
Mark Palmer	District Silviculturist	Pt. Alberni	724-9205
Karl Branch	A/District Silviculturist	Pt. McNeill	956-5034
Ron Diprose	Forest Health Technician	Sunshine C.	485-0730
Mark Salzl	Silviculture Officer	Qn. Char. Is.	559-6222
Doug Bacala	Basic Silviculture Officer	Squamish	898-2134

MEETINGS

Western International Forest Disease Work Conference. The annual meeting will be held in Reno, Nevada, September 28-October 2, 1998, on the University of Nevada campus. Lodging is available on campus at the University Inn (702 323-0321), and is situated only six blocks from all the major hotels and casinos in downtown Reno. A block of 80 rooms has been reserved at the Inn, and a special rate is being negotiated for under \$50.00 per night, single occupancy, if booked under the WIFDWC name before August 27, 1998, and reserved with a major credit card.

A poster session is planned for the duration of the conference. Those interested in displaying a poster should contact Greg Filip, Program Chair, before July 31, 1998, at the Department of Forest Science, Forestry Sciences Laboratory 020, Oregon State University, Corvallis, Oregon, 97331-7501, Telephone 541 737-6567, e-mail: filipgr@ccmail.orst.edu for further information or a copy of the proposed program.

- J. Muir, Forest Practices Branch, Victoria.

2-Year Budworm Field Trip and Seminar. A field trip and seminar on the 2-year budworm, *Choristoneura biennis* and associated species was held in Ft. St. James on April 28-29, 1998. Forty-six attendees included staff from Ministry of Forests Districts, Regions, and Branch, Forestry Canada, licensees, consultants, and the University of Northern British Columbia. The field trip on April 28th allowed Forestry Canada research scientists to view heavy defoliation of 2-year budworm on subalpine fir and spruce at Kloch Lake and Tchentlo Lake 70-90 km north of Ft. St. James.

Agenda topics at the seminar on April 29th included:

- biology and potential impact
- incidence and intensity of damage
- possible relationship between 2-year budworm and western balsam bark beetle
- previous impact work on defoliators - what we could apply here
- FRBC-funded work

An afternoon workshop defined priorities for answering both short- and long-term questions on 2-year budworm biology and impact. A summary of the seminar will be available from the undersigned within a few weeks.

- R. Hodgkinson, Prince George Forest Region, Prince George.

TABULATIONS AND GRAPHICS

**Table A-1. Areas of Damage for the Prince George Forest Region
for 1997 as mapped from aerial surveys**

Forest District & Beetle Type	Areas of Infestation Class (ha)				
	Light	Moderate	Severe	Old	Total
Mountain Pine Beetle					
Fort St. James	12,710	16,933	8,240	622	38,505
Prince George	n/a	n/a	n/a	n/a	3,784
Mackenzie	n/a	n/a	n/a	n/a	460
Vanderhoof	n/a	n/a	n/a	n/a	53
Total					42,802
Spruce Beetle					
Fort St. James	1,327	385	12	316	2,040
Prince George	n/a	n/a	n/a	n/a	47,564
Mackenzie	n/a	n/a	n/a	n/a	300
Vanderhoof	n/a	n/a	n/a	n/a	1
Dawson Creek	473	217	50	2,021	2,761
Total					47,666
Douglas-fir Beetle					
Fort St. James	1,506	826	181	312	2,825
Prince George	n/a	n/a	n/a	n/a	7,566
Vanderhoof	-	-	-	-	1
Total					10,392
Western-fir Beetle					
-fungus complex					
Fort St. James	11,167	2,181	2,217	352	15,917
Mackenzie	-	-	-	-	282,090
Total					298,007
Western Hemlock Looper					
Robson Valley	4,828	973	816		6,617
Prince George	12,478	8,088	7,765		28,331
Total					34,948
Two year cycle Budworm					
Fort St. James	-	-	-		252,533

¹Please refer to article Bark Beetle and Other Insect Attack Levels for 1997 by S. Taylor on p. 18

Proportion of juvenile lodgepole pine stands in High (>20 %), Moderate(10-20 %) and Low (<10 %) rust incidence classes for the Morice, Lakes and Vanderhoof Forest Districts

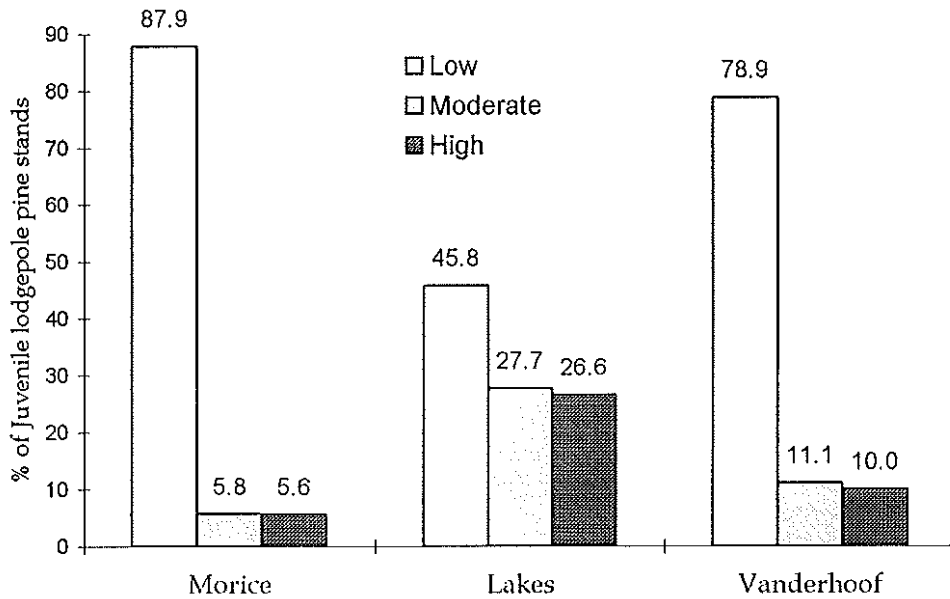


Figure 1. Hard pine stem rust incidence class breakdown for juvenile lodgepole pine stands in the Morice, Lakes and Vanderhoof Forest Districts.

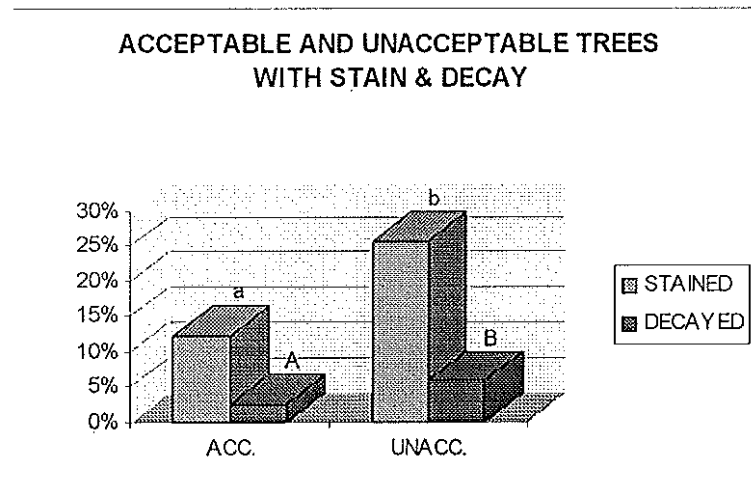


Figure 2. Acceptable and Unacceptable Stems Affected by Stain and Decay. Tree acceptability and stain and decay are significantly different where populations are represented by different letters ($\alpha = 0.05$).

¹Please refer to articles *Impact of Hard Pine Stem Rusts in the Lakes TSA*, p. 22 and *Decay in Advance Subalpine Fir Regeneration in the Bulkley TSA*, p. 31. A. Woods, Prince Rupert Forest Region. , this issue.

Appendix 1. Proposed Changes and Retentions of Forest Practices (Silviculture) Damage Agent (Pest) and Condition Codes (May 12, 1998)

The attached tables are proposed changes to silviculture (pest) damage agent codes. Essentially, this option retains most of the current three-letter codes on the corporate code table, e.g., those used in the integrated silviculture information system (ISIS). We proposed adopting many of the codes proposed by the Forest Productivity Council with two exceptions: code letters A for animal damage (A codes) and N for non-living (abiotic) damage agents, such as frost, are retained.

The following tables show current codes that are to be changed (Table 1), deleted (Table 2), retained (Table 3), and new codes to be added (Table 4).

NOTE: These damage agent codes are not intended to replace or incorporate DISTURBANCE CODES currently in use. Inventory and silviculture disturbance codes, e.g., L for logging, are used to indicate stand-level disturbances, not damage to individual trees.

Further Note: Most of the "C" and "P" codes listed for damage to cones, seeds, seedlings, and seed orchard trees are anomalous or inconsistent with the current code structure. However, these codes are used only in a few business areas not involved with most field surveys or inventory sampling, and we propose to retain them as is, without changes.

Table 1. Damage Agent (Pest) Codes to be changed

CODE	DEFINITION	JUSTIFICATION/REASON
DA	foliage disease	change to DF
DAF	Broom Rusts	change to DB
DB	broom rusts	replaces DAF

¹ See *Proposed Revisions to Ministry (Silviculture) Damage Agent and Condition Codes (May 12, 1998)*, J. Muir, Forest Practices Branch, Victoria., p. 6, this issue

Table 2. Deletions of current codes

CODE	DEFINITION
DA	foliage disease. Change to DF
DAF	broom rust changed to DB
DDA	Armillaria stem rot. u.c. DRA
DDC	Laminated Root Rot (cedar strain). Use DRC
DDI	Tomentosus. Use DRT
DDL	Laminated. Use DRL
DDN	Annosus. Use DRN
DLB	Branch Dieback. Use DL
DLL	Leader Dieback. Use DL
DP	Bark Disease (bark only). Use DS
DSN	Aspen cankers, Use DS or three letter codes for specific diseases, e.g. DSY proposed for cytospora canker
U	Damage - Cause Unknown, Redundant. Use two letter codes, e.g. DS for unknown stem damage.
UA	Galls. Damage symptom
UB	Dead or Broken Top. Damage type
UC	Chlorotic. Symptom only
UF	Fork or Pronounced Crook. Damage type
UG	Lammas growth. Stem defect
UL	Leaning. Damage?
UM	Multiple Leaders. Stem deformation
UR	Brooming. Stem damage
US	Basal Sweep. Stem deformation

Table 3. Codes to be Retained.

CODE	DEFINITION
A	Animal Damage
AB	Bear
AC	Cattle
AD	Deer
AE	Elk
AH	Hare or Rabbit
AM	Moose
AP	Porcupine
AS	Squirrel
AV	Vole
AX	Birds
AZ	Beaver
CAH	Cone Resin Midge (<i>Asynapta hopkinsi</i>)
CBC	FD Cone Moth (<i>Barbara colfaxiana</i>)
CBX	Fir Cone Moth (<i>Barbara</i> sp.)
CCP	(<i>Camptomyia pseudotsugae</i>)
CDC	SX Cone Gall Midge (<i>Dasineura canadensis</i>)
CDD	Fir Seed Midge (<i>Dasineura abiesemia</i>)
CDR	SX Cone Axis Midge (<i>Dasineura rachiphaga</i>)
CDX	Dasineura Midges (<i>Dasineura</i> spp.)
CEA	Fir Cone Maggot (<i>Earomyia abietum</i>)
CEB	(<i>Earomyia barbara</i>)
CEQ	(<i>Earomyia aquilonia</i>)
CEX	Earomyia Maggots (<i>Earomyia</i> spp.)
CFP	FD Cone Beetle (<i>Ernobius punctulatus</i>)
CHX	Budworms (<i>Choristoneura</i> spp.)
CIA	Fir Coneworm (<i>Dioryctria abietivorella</i>)
CIP	FD Coneworm (<i>Dioryctria psuedotsugella</i>)
CIR	SX Coneworm (<i>Dioryctria reniculelloides</i>)
CIX	Coneworms (<i>Dioryctria</i> spp.)
CLO	Western Conifer Seed Bug (<i>Leptoglossus occidentalis</i>)
CMA	PY Seed Chalcid (<i>Megastigmus albifrons</i>)
CMC	SX Seed Chalcid (<i>Megastigmus piceae</i>)
CML	BL Seed Chalcid (<i>Megastigmus lasiocarpae</i>)
CMS	FD Seed Chalcid (<i>Megastigmus spermotrophus</i>)
CMT	HW Seed Chalcid (<i>Megastigmus tsugae</i>)
CMX	Seed Chalcids (<i>Megastigmus</i> spp.)

Table 3. Codes to be Retained (Continued)

CODE	DEFINITION
CPS	(Pineus similis)
CRX	Cone Scale Midges (Resseliella spp.)
CSN	Spiral Spruce Cone Borer (Strobilomyia neanthracina)
CIS	Pine Coneworm (Dioryctria rossi)
CIV	PY Coneworm (Dioryctria auranticella)
CMP	Fir Seed Chalcid (Megastigmus pinus)
CMR	(Megastigmus rafni)
CNP	Pine Cone Beetle (Conophthorus ponderosae)
CTO	FD Cone Gall Midge (Contarinia oregonensis)
CTW	FD Cone Scale Midge (Contarinia washintonensis)
CVP	PW Cone Borer (Eucosma ponderosa)
CVR	PL Cone Borer (Eucosma recissoriana)
CYC	SX Seed Midge (Mayetiola carpophaga)
CYP	PY Seedworm (Cydia piperana)
CYS	SX Seedworm (Cydia strobilella)
CYT	CW Cone Midge (Mayetiola thujae)
CYX	Seedworms (Cydia spp.)
D	Disease
DD	stem rot
DDE	Rust Red Stringy Rot (Echindontium tinctorium)
DDP	Red Ring Rot (Phellinus pini)
DDS	Schweinitzii Butt Rot (Phaedus schweinitzii)
DDT	Aspen Trunk Rot (Phellinus tremulae)
DFL	Pine Needle cast (Lophodermella concolor)
DL	Disease Caused Dieback of leader
DM	Dwarf Mistletoe
DMF	Douglas-fir Dwarf Mistletoe
DMH	Hemlock Dwarf Mistletoe
DML	Larch Dwarf Mistletoe
DMP	Lodgepole Pine Dwarf Mistletoe
DR	Root Disease
DRA	Armillaria Root Disease
DRB	Black Stain Root Disease
DRC	Laminated Root Rot (cedar strain)
DRL	Laminated Root Rot
DRN	Annosus Root Disease
DRR	Rhizina Root Disease
DRT	Tomentosus Root Rot

Table 3. Codes to be Retained (Continued)

CODE	DEFINITION
DS	Stem Disease (Canker or Rust)
DSA	Atropellis Canker (Lodgepole Pine)
DSB	White Pine Blister Rust
DSC	Comandra Blister Rust (<i>Ponderosa</i>)
DSG	Western Gall Rust
DSS	Stalactiform Blister Rust
I	Insects
IA	Aphids
IAB	Balsam Woolly Adelgid
IAC	Giant Conifer Aphid (<i>Cinara</i> species)
IAG	Cooley Spruce Gall Adelgid
IAL	Western Larch Cone Woolly Aphid (<i>Adelges lariciatus</i>)
IAS	Spruce Aphid (<i>Elatobium abietinum</i>)
IAX	Gall Aphids or Woolly Aphids (<i>Adelges</i> spp.)
IB	Bark Beetles
IBB	Western Balsam Bark Beetle
IBD	Douglas-fir Beetle
IBI	Engraver Beetles (<i>Ips</i> species)
IBM	Mountain Pine Beetle
IBS	Spruce Beetle
ID	Defoliators
IDA	Black Army Cutworm
IDB	Two-Year Budworm (<i>biennis</i>)
IDC	Larch Casebearer
IDE	Spruce Budworm (<i>fumiferana</i>)
IDF	Forest Tent Caterpillar
IDG	Greenstriped Forest Looper
IDH	Western Blackheaded Budworm
IDL	Western Hemlock Looper
IDM	Gypsy Moth
IDS	Conifer Sawflies
IDT	Douglas-fir Tussock Moth
IDV	Variegated Cutworm
IDW	Western Spruce Budworm (<i>occidentalis</i>)
IDZ	Western False Hemlock Looper

Table 3. Codes to be Retained (Continued)

CODE	DEFINITION
IS	Shoot Insects
ISB	Western Cedar Borer
ISE	European Pine Shoot Moth
ISP	Pitch Nodule Moths (Petrova species)
IW	Weevils
IWC	Conifer Seedling Weevil
IWM	Magdalis Species
IWP	Lodgepole Terminal Weevil
IWS	White Pine Weevil (on spruce)
IWW	Warren's Root Collar Weevil
M	Mite Damage
N	Non-Biological (Abiotic) Injuries
NB	Fire
ND	Drought
NF	Flooding
NG	Frost
NS	Slide
NW	Windthrow
NGH	Frost Heaved
NGK	Shoot/Bud Frost Kill
NH	Hail
NK	Fumekill
NN	Road Salt
NR	Redbelt
NY	Snow or Ice (includes snow press)
NZ	Sunscald
PAX	(<i>Alternaria</i> spp.)
PBC	Gray Mould (<i>Botrytris cinerea</i>)
PCD	(<i>Cylindrocarpon destructans</i>)
PCF	Seed or Cold Fungus (<i>Caloscypha fulgens</i>)
PCP	Inland Spruce Cone Rust (<i>Chrysomyxa pirolata</i>)
PDT	Cedar Leaf Blight (<i>Didymascella thujina</i>)
PFX	(<i>Fusarium</i> spp.)
PPG	Damping-Off Disease (<i>Phoma glomerata</i>)
PPX	(<i>Penicillium</i> spp.)
PSS	Sirococcus Blight (<i>Sirococcus strobilinus</i>)
PTX	(<i>Trichothecium</i> spp.)

Table 3. Codes to be Retained (Continued)

CODE	DEFINITION
T	treatment injury
TC	chemical
TL	logging
TP	planting
TPM	poor planting microsite
TR	pruning
TT	thinning or spacing
V	problem vegetation
VH	herbaceous competition
VP	vegetation press
VS	shrub competition
VT	tree competition

Table 4 New Proposed Codes to be Added:

CODE	DEFINITION
DB	broom rust
DF	foliage disease
DFM	larch needle blight (<i>Meria laricis</i>)
DFR	Douglas-fir needle cast (<i>Rhabdocline pseudotsugae</i>)
DFE	elytroderma needle cast (<i>Elytroderma deformans</i>)
DFH	larch needle cast (<i>Hypodermella laricis</i>)
DFP	fir fireweed rust (<i>Pucciniastrum epilobi</i>)
DFS	redband needle blight (<i>Mycosphaerella</i> [<i>Schirria</i>] <i>pini</i>)
DFA	western pine aster rust (<i>Coleosporium asterum</i>)
DFC	large-spored spruce-labrador tea rust (<i>Chrysomyxa ledicola</i>)
DFD	spruce needle cast (<i>Lirula macrospora</i>)
DFU	cedar leaf blight (<i>Didymascella thujina</i>)
DFT	sirococcus tip blight (<i>Sirococcus strobilinus</i>)
DBF	fir broom rust (<i>Melampsorella caryophyllacearum</i>)
DBS	spruce broom rust (<i>Chrysomyxa arctostaphyli</i>)
DDF	brown crumbly rot (<i>Fomitopsis pinicola</i>)
DDD	sulfur fungus (<i>Laetiporus sulphureus</i>)
DDB	birch trunk rot (<i>Fomes fomentarius</i>)
DDH	hardwood trunk rot (<i>Phellinus ignarius</i>)
DDQ	quinine conk rot (<i>Fomitopsis officinalis</i>)
DDO	cedar brown pocket rot (<i>Poria sericeomollis</i>)
DLD	dermea canker (<i>Dermea pseudotsugae</i>)
DLP	phomopsis canker (<i>Phomopsis lokoyae</i>)

New proposed codes (cont'd)

DLS	sydowia (<i>Sclerophoma</i>) tip dieback (<i>Sclerophoma pithyophila</i>)
DLV	aspen-poplar twig blight (<i>Venturia</i> spp.)
DLF	red flag disease (<i>Potebniamyces balsamicola</i>)
DSY	cytospora canker (<i>Cytospora chrysosperma</i>)
DSH	hypoxylon canker (<i>Hypoxylon mammatum</i>)
DSP	cryptosphaeria canker (<i>Cryptosphaeria populina</i>)
DST	target canker (<i>Nectria galligena</i>)
DSR	ceratocystis canker (<i>Ceratocystis fimbriata</i>)
DSE	sooty bark canker (<i>Encoelia pruinosa</i>)
IBP	twig beetles (<i>Pityogenes</i> , <i>Pityophthorus</i> spp)
IBT	red turpentine beetle (<i>Dendroctonus valens</i>)
IBW	western pine beetle (<i>Dendroctonus brevicomis</i>)
IDD	western winter moth (<i>Erranis tiliaria vancouverensis</i>)
IDI	pine needle sheath miner (<i>Zellaria haimbachii</i>)
IDN	birch leaf miner (<i>Fenusa pusilla</i>)
IDP	larch sawfly (<i>Pristiphora erichsoni</i>)
IDR	alder sawfly (<i>Eriocampa ovata</i>)
IDU	satin moth (<i>Leucoma salicis</i>)
IDX	large aspen tortrix (<i>Choristoneura conflictana</i>)
ISG	gouty pitch midge (<i>Cecidomyia piniinopsis</i>)
ISQ	sequoia pitch moth (<i>Vespa mima sequoiae</i>)
ISS	western pine shoot borer (<i>Eucosma sonomana</i>)
IWY	cylindrocopturus weevil (<i>Cylindrocopturus</i> spp.)
IWZ	Yosemite bark weevil (<i>Pissodes schwartzii</i>)
NGC	frost crack
NL	lightning
NWS	windthrow - soil failure
NWT	windthrow - treatment or harvest related
TM	other mechanical damage (non-logging)

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