

REPORT OF THE TASK FORCE ON A
FOREST PEST MANAGEMENT INFORMATION
SYSTEM FOR BRITISH COLUMBIA

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FOREWORD

It has been said that management decisions are only as good as the information upon which they are based. This implies not only a need for "sound" information but also its "ready availability" and its "comparability." The lack of any one can defeat the usefulness of the others.

This report deals with a specific deficiency in the B.C. Forest Service -- the lack of useful information on forest pests and their impact, and the absence of a system to make such information readily available to the personnel who require it to more effectively meet Ministry of Forests objectives.

A management information system (MIS) can be perceived as being a combination of people; data collection and processing equipment and systems; input/output devices; and communications functions acting in concert to supply timely information to both management and non-management people for planning and operations. A management information system can be a total "by hand" system, a completely automated system, or any combination of the two. Whichever is chosen, it must be affordable and capable of being managed.

Throughout its deliberations, the Task Force placed its priority on a Pest MIS which would serve field practitioners and operational managers. It also recognized that "change" must be managed. Businesses can decide to evolve at faster or slower speeds but their success in this is always limited by the funds, staff, and dedication they direct to the change. The Task Force tried to recognize this and offers options so that either gradual or rapid shifts from less sophisticated to more sophisticated systems can be implemented.

There is no magical, all-encompassing "thing" called a Pest MIS. There is, rather, a collection of subsystems which, each by itself, makes peoples' jobs easier and more productive. Collectively, they add up to a larger Pest MIS which will, and should, evolve over time.

Our task was complex, not only because of the variety of pests and their diverse implications, but because of the changes taking place both in forest protection and other programs such as forest inventory, silviculture, and forest planning and yield analysis. Much of our time was spent reviewing the other programs and systems that have strong links with forest protection so as to avoid duplication of efforts in data collection and output systems.

To address all of the above in a practical and realistic manner became the mission of the Task Force.

April 1, 1985

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In addition, groups of specialists willingly gave of their time to describe their own systems and specialties, their perceived linkages with a Pest MIS, and their enlightened thoughts toward a solution to our many problems. In this category are Peter Hall, John Muir, Stu Taylor, Dave Gilbert, and Peter Fuglem of the Forest Protection Branch; Robin Quenet, Imre Spandli, and Lois Pelchat of the Forest Planning and Inventory Branch; Mike Wyeth and Insha Khan of Silviculture Branch; Don Hunt and Fred Beinhauer of Systems Services Branch; Darrell Errico of Research Branch; Gary Sutherland and Don Doidge of the Vancouver and Cariboo Forest Regions; Al Thomson of the Canadian Forestry Service; and Pam Sallaway and Vern Klassen of PAMAP, a computer consulting firm in Victoria.

Two subcommittees were temporarily formed to cover some specific problem areas in detail. They did this exceedingly well and on very short notice: Al Gorley of the Prince Rupert Forest Region and his subcommittee members Peter Hall (Protection Branch), Eric Jeklin (Duncan), Roger Wiltsie (McBride), Tom Lacey (Merritt), Dennis Asher (Quesnel), and Steve Byford (Cranbrook); and Peter Fuglem and his subcommittee members Pat Humphreys and John Henigman, all of Protection Branch.

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REPORT OF THE TASK FORCE ON A FOREST PEST MANAGEMENT
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I. INTRODUCTION AND BACKGROUND

In 1980, the first Five-Year Forest and Range Resource Program report was presented to the Government as required by the new Ministry of Forests Act. This report recommended a significant increase in the pest management program of the B.C. Forest Service in light of the wood losses being sustained and the opportunities for reducing them. These recommendations were acted upon and that same year the nucleus of a pest management organization was formally established in the B.C. Forest Service. This nucleus consisted of a manager and entomologist at the Forest Protection Branch in Victoria, and a pest management coordinator at each of the six forest regions. Prior to this, involvement of personnel in pest activities had been by secondment from other programs, often by fire protection personnel.

By 1984, approved pest management staff in the B.C. Forest Service included a manager, entomologist, pathologist, pesticide specialist, and two technicians at Protection Branch; two entomologists and a vegetation specialist at Silviculture Branch; a coordinator, entomologist and pathologist at each forest region; and pest specialists and crews at many of the 46 forest districts.

After some 70 years, the B.C. Forest Service had finally and formally established a pest management organization within its ranks. It also recognized that pest management was not to be considered a stand-alone function but was rather another facet of forest management with a strong supportive role, especially to forest planning, timber harvesting, and silviculture. Effectively determining and filling this new role is now the major goal of pest managers.

1. Pest Losses, Significance, and Challenges

Wood losses to insect and disease pests, excluding the effects of brush, are estimated to be over 27 million m³ per year. This is equivalent to 44% of the wood volumes harvested in 1982-83 and represents some \$48 million of lost stumpage and over \$2 billion in product export value.

While the magnitude of such losses is staggering, they are only crude provincial estimates. Forest management is not carried out on a provincial basis but at the managed unit level -- the TSA's and TFL's -- where pest loss estimates are either unknown or inadequate. Thus, existing pest and pest loss data are almost useless to forest managers at the management level.

Since the release of the Resource Analysis and Five-Year Program reports in 1980, it has become more and more evident to forest managers that quantification of information is vital to planning and managing the forest resource. This demand for reliable data is nowhere more in need of development than in pest management.

This lack of reliable pest-related data is significant for two reasons. First, the magnitude of some pest losses is often not apparent. While managers are readily aware of "dramatic" pest problems when whole drainages suddenly turn red from defoliator or bark beetle attacks, the losses caused by insidious pests such as dwarf mistletoes and root diseases are largely unknown and can be easily ignored. Yet these "invisible" pests often create greater damage and may offer more prescription opportunities for maintaining or enhancing wood volumes than the "dramatic" pests.

The second reason for quantification is economic analysis. TSA wood production targets can be realized, or even enhanced, by different combinations of practices and prescriptions. The challenge is to optimize the array of forest management options to meet goals at least cost. The yield analysis process will eventually be able to do this using computer models providing the required data is available.

Someday, the impact of pest losses and the benefits of pest management prescriptions will be able to be compared on a quantitative basis, using robust data, against other forest management options. Pest specialists must be able to demonstrate their cost-effectiveness in order to be effective. They intuitively recognize that for some pests and for certain forest conditions, they could provide greater wood production gains than can be obtained from other forms of forest management practices, including juvenile spacing and fertilization operations.

Also, trees killed!
Not only can wood volumes be saved, the actual productivity of many stands can be enhanced. This opens up a whole new dimension in forest management practices -- it is possible to grow more wood on some given land areas than our records indicate can be grown. This is due to the fact that volume tables contain the net results after non-tree killing pests have taken their share. A key requirement is obtaining reliable information which economically justifies the changing of some entrenched practices. Providing this knowledge and then modifying some practices for real gain is the principal challenge facing pest managers today.

2. Opportunities in Pest Management

The basic role of pest management is to provide specialized support to the planning, inventory, timber harvesting, and silviculture programs of the Ministry of Forests. This role is fulfilled by:

- (1) identifying which organisms cause damage,
- (2) collecting and assessing the significance of current and predicted damage,
- (3) determining which pest or forest prescription options are cost-effective,
- (4) integrating this knowledge into both forest planning and operations,
- (5) carrying out or assisting in the chosen prescriptions, and
- (6) appraising the results of prescriptions in order to be able to repeat, improve, or modify them in the future.

The common thread through each of these basic functions is the collection of sound, timely, and comparable pest-host data and its understanding. This thread does not exist in the Ministry of Forests. Thus it follows that if pest managers are to fulfill their supportive role they must have, as a basic tool, a management information system from which to draw the historical, current, and predictive inferences required by forest managers. Such requirements are exceedingly complex because of the variety of pests; their differing interactions with their tree hosts over long time spans and over large and small geographic areas; the limited knowledge existing on some pests; survey techniques and standards which are sometimes demanding; and the overall ability of any organization to meet such demands.

3. Current Status of Pest Management Information Systems

A great deal of pest-related information is being collected in the B.C. Forest Service by some branches, all regions, and most districts. However, the various systems are neither standardized nor compatible (often not even between districts in the same region) and are usually designed and applicable only to a particular pest. Standards of data collection vary considerably and this significantly affects data accuracy. In sum, they are ad hoc systems developed for local purposes in the absence of an acceptable provincial system. The data systems used by Inventory Branch and by Silviculture Branch have not fulfilled these B.C. Forest Service requirements.

The Canadian Forestry Service's Forest Insect and Disease Survey unit collects and maintains a national pest database of current and historical value. It is mainly a record of pest incidences and provides general pest distributions by specific pests over time. While this is useful for some B.C. Forest Service overview purposes, it does not provide the detailed information required for forest management purposes. At the same time, it should be noted that the pest expertise available at the Pacific Forest Research Centre is a most valuable asset available to managers.

Other agencies in North America do not appear to have anything to offer. Forest agencies in Canada are no further ahead than B.C. In the U.S., there are many useful systems in operation for agricultural crop management but these do not lend themselves to forestry use. One forestry system that appears to be at the leading edge of development is the Integrated Pest Impact Assessment System of the Methods Application Group of the U.S. Forest Service at Fort Collins, Colorado. However, they are no further advanced than this Task Force. The B.C. Forest Service should maintain contact with that Group.

In conclusion, there are no existing systems that can be easily adapted and this Task Force must develop its own pest-forest management information systems.

II. THE PEST MANAGEMENT INFORMATION SYSTEM TASK FORCE AND ITS TERMS OF REFERENCE

The lack of a pest management information system in the B.C. Forest Service has been a topic of discussion in many meetings. This demand for a system grew steadily from 1980 and on July 17, 1984 a Task Force was struck to tackle the problem.

Essentially the goals given the Task Force were twofold:

- (1) to conceive and develop the framework of a pest management data collection, storage, and retrieval system for B.C. that would be useful to forest managers, and
- (2) to provide an implementation plan.

The Task Force commenced in September of 1984 with a goal to submit its report to the Chief Forester by April 1, 1985. A major constraint was that its members were able to meet only five days each month.

The full Terms of Reference of the Task Force are shown in Appendix II.

III. TASK FORCE PROCEDURES

The first efforts of the Task Force determined if there were any forestry or agricultural agencies in North America who had systems in place which offered a useful starting point. Long-distance telephone calls and discussions led to a flow of literature. Standard literature searches were also conducted using library computer facilities.

Two conceptual flow charts were then developed. The first clarified the management information systems within the B.C. Forest Service and their potential interactions, and the second outlined the functional processes of a pest management program (see Appendix II).

The Task Force would have wished to hold face to face discussions with a wide range of people throughout the province. Unfortunately this was not possible because of severe time constraints. Therefore, a questionnaire was developed and mailed to a carefully selected list of specialists, managers and practitioners who could provide a balanced range of opinion. In all, 130 questionnaires were mailed. A copy of the questionnaire is provided in Appendix I.

In addition to the advice solicited by questionnaire, the Task Force deemed it vital that consultations be held with specialist groups. Accordingly, one-half to two day sessions were arranged and held with the following:

- (1) Pest Specialists -- to determine which pest-related data are generally being collected now, and which data need to be collected from a biological pest-host context in order to understand current pest dynamics and forest impact, and the prediction of future trends.
- (2) Forest Insect and Disease Survey (FIDS) of the Canadian Forestry Service -- the Task Force had, as one of its members, a specialist in the FIDS organization and thus obtained an update and appreciation of the present and planned procedures and systems of collection, storage, and use of pest information as carried out in the province by this federal agency.

- (3) Inventory Branch -- to improve understanding of the provincial forest inventory system; how data are collected, stored, and used; what standards must be met in order for pest-related data to be acceptable for inventory updates; the current and potential capabilities of the Interactive Graphics Design System (IGDS); and what options are available for integrating pest management and inventory information systems.
- (4) Silviculture Branch -- to understand the workings of the History of Crop Establishing and Tending (History Record) System; how data is collected, stored, and used; and the potential for improved integration of pest and silviculture information systems.
- (5) Resource Planning Section -- to clarify TSA planning procedures and the process of yield analysis and annual allowable cut (AAC) determination; and the type and format of pest-related information that would be most useful in upgrading these planning and analysis procedures.
- (6) Protection Branch -- to obtain a systems perspective on potentially feasible pest management information systems; their configuration in hardware, software, and communications methods; costs; and implementation recommendations.
- (7) PAMAP Graphics Ltd. - a computer graphics consulting firm -- to see demonstrations of their product GEOMAP, which is a computer system for manipulating forest inventory data on a geographic basis for both updating and planning purposes.
- (8) Multi-Disciplinary Systems Specialists -- a workshop was held with 10 systems specialists from various branches of the B.C. Forest Service and from the Canadian Forestry Service wherein the Task Force provided them with its essential findings to date, and in return received their advice and recommendations in resolving some of the complex problems, and clarifying concepts and options.

The information obtained from these eight specialist groups gave the Task Force a fundamental understanding of the environment within which any Pest MIS would have to function. The findings have been recorded in some detail, in Appendix III, as they are deemed to be vital to the full appreciation of the complexities and interrelationships involved. The Task Force strongly recommends that these be read and understood.

In its later deliberations, the Task Force recognized that there were two systems being used in some parts of the province which could be adapted to satisfy two specific requirements identified by many of the respondents to the

questionnaire. Thus, the chairman appointed two subchairmen to investigate these for the Task Force. These were designated:

- (1) A Pest Management Tracking System -- Al Gorley of the Prince Rupert Forest Region accepted the task of converting a project tracking system, used in that region for managing bark beetle projects, into a standardized provincial system suitable for all major pests. To ensure provincial acceptance, a district representative from each of the other forest regions formed his subcommittee.
- (2) A Pesticide Use Recording System -- Peter Fuglem of Protection Branch similarly accepted the challenge of investigating a system, recently developed by the Pesticide Control Branch of the B.C. Ministry of Environment, so that it could be readily accessed by B.C. Forest Service personnel. Two members from the Protection Branch completed his subcommittee.

The final stages of the project involved analyzing, understanding, and synthesizing the vast amounts of information collected from the questionnaire, the two subcommittees, and the eight specialist groups and then determining the possible options that could be implemented and which would satisfy the wide range of needs and opinions that were now perceived. The last steps involved choosing those options which could be realistically implemented.

IV. DISCUSSION

This chapter synthesizes all Task Force findings, identifies the basic needs for pest-related information, and recommends how this information should be integrated into the overall functions of the B.C. Forest Service. Included are recommendations for the development of new systems.

1. The Important Distinction Between Tree Mortality and Growth Reductions Caused by Pests

Pest losses must be categorized into two types: mortality losses and growth reductions (or incremental losses). Each must be treated differently.

Mortality Losses

Mortality losses are easily visible and tangible (dead trees), they are directly measurable (volumes or proportions of stands), and they can be easily identified by their time of occurrence (the tree died in 1981, etc.). These easily identified characteristics make mortality loss information useful for operational planning where salvage opportunities can be identified, and timber inventories reduced by their measurable amounts. These types of losses are best exemplified by the attacks of bark beetles and some defoliators.

Short term estimates of annual tree mortality can be reasonably extrapolated from existing known losses and are useful for adjusting short term harvesting levels and for making operational decisions. However, the information required to satisfy long term planning and yield predictions lie in the ability to predict pest losses in following rotations. This information does not usefully exist. Such predictions may eventually become practical from the modelling work of Errico and Reed in B.C., presently being applied to the prediction of future expected wildfire risks and their impacts on timber supplies.

Therefore, until a useful prediction methodology is developed for long term mortality losses caused by pests, the best method continues to be the "guesstimates" of local managers assisted by specialists.

Growth Reductions (Incremental Losses)

Incremental losses are generally invisible and not directly measurable, they cannot be easily determined at any point in the life of a forest stand, and they are difficult to quantify for forestry purposes. Incremental losses, if they are prevented, become potential wood volume gains.

The major pests that cause this type of damage are the mistletoes, root diseases, leader weevils, and most defoliators. While some of these pests may kill individual trees, their impact at the stand level is to erode the productivity of the stand. This is the basic distinction between mortality losses and incremental losses. ? Mortality losses in overstocked P1 may have impact of increasing productivity.

Determining the magnitude of incremental wood losses (or the potential gains) is exceedingly complex. This is because the only measurable item is the tree or stand as it exists at the time of measurement, i.e. the losses are never known accurately, only the net effect of the losses as exhibited by the tree or stand. An example will clarify the issue: a stand at maturity may only have 60% of the volume it is capable of growing on that site because of the growth rate impediments caused by a mistletoe. The 40% loss through the life of the stand may not be recognized and may be considered the norm for the species on that site. Thus, pest prevention measures could have offered this 40% volume benefit at harvest if this had been known. What is productivity of ecosystem in m^3 for a specific species

Incremental loss estimates require a unique approach for each pest category involving the integration of four complex factors:

- (1) Incidence - the proportion of the susceptible host trees in stands that are infested.
- (2) Intensity - the severity of infestation.
- (3) Rate of Growth Impediment - the reduction in stand growth for each level of infestation intensity.
- (4) Yield Curves - yield curves with and without the impact of incremental pest losses. The former are provided by existing VAC's, the latter constitute the knowledge gap.

The "Black Book" is Protection's present method for establishing crude loss estimates by pest categories. Both research efforts and standard data collection systems are required to overcome the lack of pest loss information needed for forestry applications.

2. The Role of Pest Management

The interdisciplinary role of pest management in the B.C. Forest Service is not adequately recognized. Pest impacts and the management of pests can play a major role in almost every phase of forest management. This includes forest inventory processes, forest planning, yield calculations, and AAC determinations, as well as the operational activities of timber management, harvesting, and silviculture. Consequently, the pest management specialists, despite their being housed mostly in the protection discipline, have far-reaching responsibilities that affect almost every other discipline within the Forest Service. This has two important implications:

- (1) In order to effectively function, pest managers must have ready access to the information of other disciplines, especially inventory, silviculture, and planning.
- (2) Conversely, other disciplines (inventory, planning, silviculture, timber management) must have access to pest-related information to be fully effective. Yet it is in trying to provide this that pest managers have major difficulties. Appropriate pest-related information is either not available or is of limited accessibility because of the lack of a useful information system.

3. Major Functions That Should be Served by a Pest MIS

There are two major functions to be satisfied by a Pest MIS -- planning and operations.

(1) The Planning Function

The Planning and Inventory functions at branch, region, and district require pest-related information to properly calculate yield and Annual Allowable Cut, to establish the objectives for managed units (i.e. the TSA's and TFL's), and to optimize harvesting, silviculture, protection, and other programs to meet these objectives.

(2) The Operations Function

Forest management operations implement plans. Timber management personnel require pest-related information to prioritize and schedule timber harvesting operations and to coordinate salvage of damaged trees. Silviculture personnel need such information to apply appropriate regeneration prescriptions, and subsequent treatment on young stands. Forest protection personnel use pest information in order to evaluate and implement preventative and control measures. Coordination among these disciplines offers the most cost-effective response to pest problems.

4. Ministry of Forests Programs and Their Pest-Related Information Needs

There are basic pest-related data requirements necessary to improve the performance of some major Ministry of Forests programs. These information requirements are outlined in the following.

Planning and Inventory Program

- (1) annual depletion updates on stand level inventory data as significantly affected by pests
- (2) data that provide information on the estimated changes to present forest productivity due to pests
- (3) information on the estimated changes to future forest productivity due to pests

Current status:

None of these requirements are currently met by B.C. Forest Service systems although the reinventory process may eventually capture most depletions.

Most Regions must have

Timber Management Program

- (1) location and stand components of merchantable timber undergoing or predicted to be significantly affected by pests
- (2) merchantable wood volume losses that are occurring where harvesting or rescheduling could reduce or minimize losses
- (3) merchantable wood volume losses that have occurred which will require salvage

Current status:

None of these are provided in a standard and consistent manner on a province-wide basis. There are local systems which are based on local knowledge and educated guesses.

Silviculture Program

- (1) past, present, and expected future pest problems which may affect silvicultural prescriptions for a site
- (2) cost effective treatment prescriptions to minimize specific pests in specific stand types
- (3) pesticide use records

Current status:

The History Record System provides some information on locations of some past and present damage but this is not maintained over time (i.e. only the most recent status is maintained) and future "hazard" is not provided.

Requirements (2) and (3) are not adequately met by any B.C. Forest Service systems.

Forest Protection Program

- (1) all of the information requirements in the above programs for prevention and control recommendations/operations
- (2) tracking systems for pest occurrences and management activities
- (3) pesticide use administration and management
- (4) areas at risk to damage by specific pests
- (5) economic evaluation of actual and predicted pest occurrences

Current status:

Requirements in (1) are the same as per other systems as noted above.

Requirements (2) - (5) are not presently supplied by any B.C. Forest Service systems.

5. A Proposed Partnership of Ministry of Forests Information Systems

Forest management will be well served by the Inventory and History Record systems when their planned enhancements are completed and operating. However, there are knowledge gaps that neither of these systems are properly addressing and these gaps are primarily pest-related. Useful information must not only be collected, but it must also be stored in a manner readily available to users.

The History Record System is limited because it only collects and stores information on "openings." The Inventory systems are limited because they are not designed to efficiently track the historical detail necessary for pest management usage.

Therefore, it is apparent that in order to optimize forest management requirements, additional capability to manage pest-related information is needed. A partnership of Inventory, History Record, and yet-to-be developed pest information systems is proposed.

6. Additional Systems Required for Immediate and Future Implementation

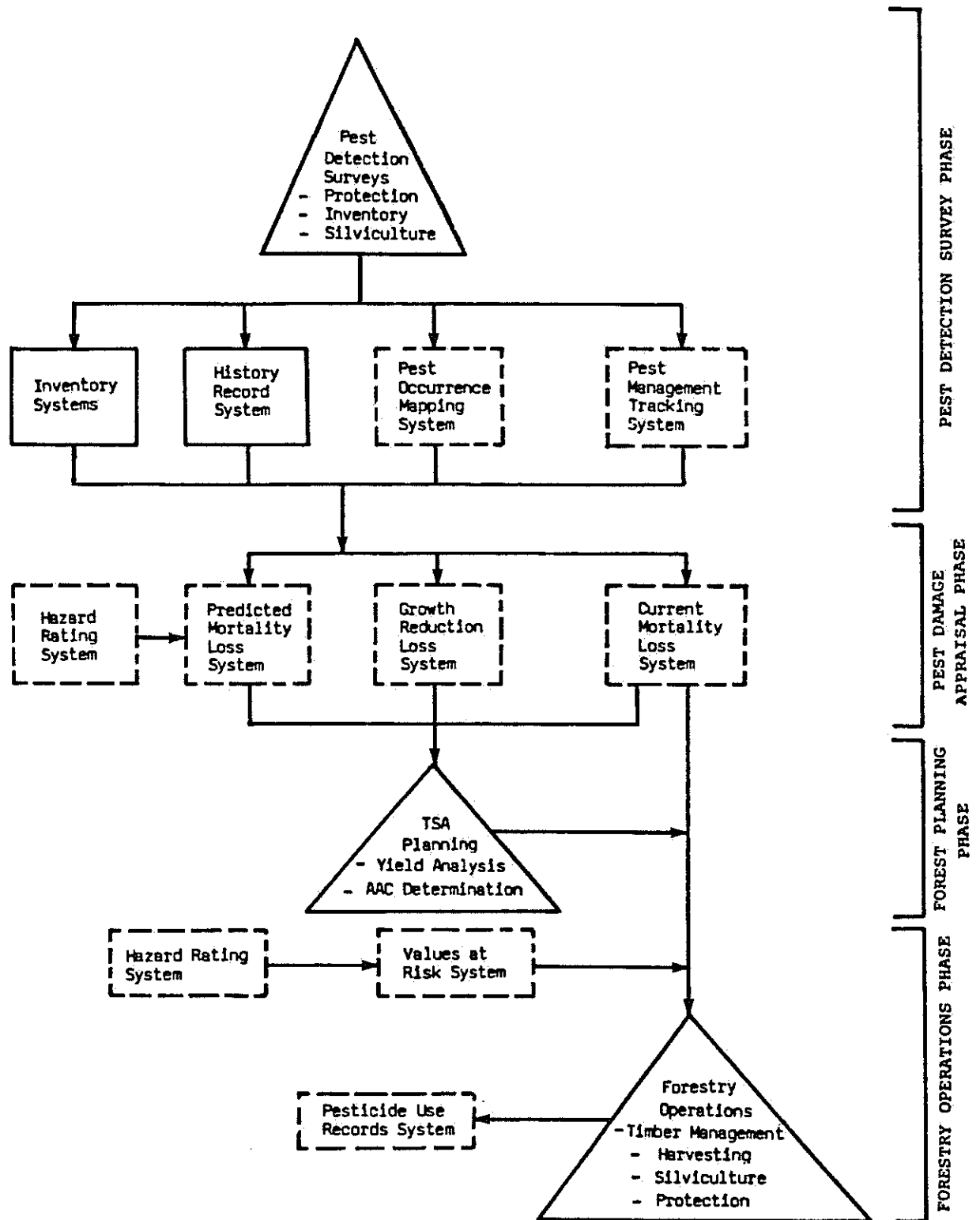
While some of the pest management needs of the B.C. Forest Service can be fulfilled by existing systems, new Pest MIS systems are required to satisfy the needs of Ministry of Forests programs. Eight systems are recommended for province-wide implementation:

- (1) A Pest Occurrence Mapping System - to record the current and historical location of significant pests, their damage, and pest management projects.
- (2) A Pest Management Tracking System - to record current and historical data on pest occurrences, their impacts, and pest management operations.
- (3) A Damage Appraisal System for Current Mortality - to provide a standardized method for the calculation of annual stand level mortality losses due to pests.

- (4) A Damage Appraisal System for Growth Reduction - to provide a standardized method for the calculation of stand level growth losses due to pests.
- (5) A Damage Appraisal System for the Prediction of Mortality - to provide a standardized method for the estimation of future stand level mortality losses due to pests.
- (6) A Hazard Rating System for Pests - to provide a method for identifying and ranking forest stands susceptible to specific pests.
- (7) A Values System for Pest Management - to provide a method for determining the values actually or potentially at risk to specific pests.
- (8) A Pesticide Use Recording System - to record current and historical data on the progress of permit applications and their specifics once approved.

These eight recommended systems are designed to work in concert with the existing geodatabase systems in the B.C. Forest Service. In combination, they should reasonably fulfill pest management information requirements. The inter-relationships between these systems are schematically represented in Figure 1.

**Fig. 1 INTERRELATIONSHIP OF FOREST MANAGEMENT
INFORMATION SYSTEMS**



The systems outlined in dashes constitute the proposed Pest MIS.

The "Mapping", "Tracking," and "Pesticide Use" systems in combination with Silviculture Branch's History Record System and the Inventory systems, should satisfy short-term requirements. These can be developed in 1985 and implemented in 1986 or 1987.

The remaining five systems will facilitate the determination of pest-related wood volume losses (or potential gains), the assessment of impact, and the planning and conduct of forestry activities. These systems will be more difficult to implement.

All eight proposed systems are described with suggested implementation plans in the next chapter.

V. PEST MANAGEMENT INFORMATION SYSTEMS RECOMMENDED TO BE IMPLEMENTED

There are eight information systems which, in the opinion of the Task Force, require development to significantly upgrade pest and forest management in B.C.

Three systems can be implemented soon and relatively easily, using existing technologies. These are:

System #1, A Pest Occurrence Mapping System, and System #2, A Pest Management Tracking System, are companion pieces which should be implemented together. In combination they would form an initial and basic Pest MIS to be implemented in a standard fashion throughout the B.C. Forest Service. Later, when more advanced computer systems are available in an integrated network, including a province-wide geodatabase system, these two systems can be upgraded and integrated in a more automated mode.

System #8, A Pesticide Use Recording System, was found in another Ministry to be readily adaptable to provide some administrative benefits. While not of great importance, it can easily be put into effect.

The remaining five systems cannot be implemented without some further study by dedicated development - implementation groups. These are:

System #3, A Damage Appraisal System for Current Mortality, System #4, A Damage Appraisal System for Growth Reduction, and System #5, A Damage Appraisal System for the Prediction of Mortality which address the very real problem of standardizing the methods for calculating pest losses (or potential wood volume gains).

System #6, A Hazard Rating System for Pests, and System #7, A Values System for Pest Management, address the susceptibility of forest stands to pest attack and the cost-benefit aspects of pest control.

All recommended systems are reported in a standard format, in the following:

1. A Pest Occurrence Mapping System

If a Pest MIS was allowed only one basic function this would have to be one which determined "where pests are doing damage" and, "what their spread is over time." This type of function is best met by a system which maps the occurrence and spread of pests. Thus, a mapping system must be considered the bottom line of any Pest MIS.

Each forest district, if it has any significant pest problems, will usually be maintaining some form of mapping system to follow pest occurrence and spread in order to understand what is happening and to assist in making forest management decisions. Whether maps are kept "by hand," or whether they are put into more sophisticated computer geodatabase mapping systems, the principles remain the same -- first, the pests must be detected, and then the significant ones must be mapped over time, by location, area, and spread.

The Task Force perceives the time when pest-occurrence polygons will be field mapped and then directly entered into computer storage by digitizing, or by page reading facilities located at the district level. However, until such hardware and software are made available, there is a need for a standardized pest mapping system in the B.C. Forest Service which can later be digitized to capture and preserve historical data.

The following provides the framework for a recommended Pest Occurrence Mapping System.

(a) System Objectives

- to provide a current and historical record of location, area, and spread of damaging pests that is compatible with the Inventory and History Record systems, and is useful for planning and management purposes at the district and regional levels
- to provide a location of pest-related probe lines, surveys, and sample plots

- to provide a location of pest prevention/control projects, including treatments and road construction
- to provide an annual update of pest occurrence

(b) System Description

- a TSA/TFL/forest district-oriented base map and plastic overlay mapping system (mylar system)
- Inventory Forest Cover Maps at scales 1:20,000, 1:40,000, or 1:50,000 will constitute the standard and basic system for mapping pest occurrence polygons, pest management projects, and other operational functions. The choice of one of these three map scales should allow integration with the scale already being used in each district for the History Record System.
- topographic maps at scales 1:100,000 or 1:250,000 are to be used for overview and general planning purposes
- map scales 1:5,000 or 1:10,000 may be useful for some specific detailed work at the option of the district, such as root rot locations and permanent sample plot locations

(c) Data Requirements

- pest occurrence polygon mapping should be considered an annual update requirement
- pest occurrence polygons, mapped for the "standard" system (1:20,000; 40,000; or 50,000) must be plotted accurately so they will conform to forest type polygons
- each pest occurrence polygon must be given an ID number, composed of Region No., District No., Managed Unit No., Year, and Sequential Pest Polygon Number for the Year, and identified by the pest species Intensity ?

(Note: data requirements are best described under the "Pest Management Tracking System," in System 2.)

(d) Data Collection System

- mapping of pest polygons and collection of pertinent data is required annually, by aerial mapping, ground probes and surveys, and combinations
- standardized field forms and handling procedures are required to be developed, and printed in Manuals. This is a priority requirement and must be developed immediately.

(e) Data Recording/Storage System

- data from field maps are transferred to the office mylar mapping system

(f) Data Retrieval/Use System

- visual map data would be available on mylar and overview mapping systems, as described above
- other hard data would be available from the Resource Officer Protection, using a standardized program menu via the Wang Professional Computer (see System 2, which follows)

(g) Advantages

- operations and field oriented, designed to serve districts
- uses existing technology (standardizes existing procedures associated with the History Record System for mapping)
- simple to use after Manual instructions are written
- bridges the gap until a computer geodatabase mapping system is developed and available for all users
- offers a standardized "by hand" system which is flexible for users, and makes a beginning toward an eventual distributed computerized geodatabase system

(h) Disadvantages

- the "by hand" mapping of pest occurrences over time is demanding
- linkage to Inventory polygons is inefficient
- duplicates, to some extent, some of the History Record System
- the system does not efficiently satisfy region and branch needs
- the system, while standardizing and filling a basic B.C. Forest Service need, is not very sophisticated

(i) Implementation Plan

(Note: the "Pest Management Tracking System" is a co-system and must be developed with the "Pest Occurrence Mapping System".)

- obtain approvals for system implementation
- establish an "Implementation Group," with a deadline for the completion of a documented finished product by November 31, 1985
- the "Group" to be composed of one systems specialist from the Planning, Development, and Research Section of the Protection Branch (as chairman), one pest management specialist from Protection Branch, one pest management coordinator from a region, and two district representatives (care must be taken to provide coastal and interior representation)
- by this deadline, the following are to be completed:
 - full development and understanding of the total system as indicated by the framework recommended herein,
 - testing of the system by simulation of all actual practices,
 - documentation of the total system,
 - development and distribution of user manuals, and
 - training of users.
- the system should be operationally implemented by Executive decree in all districts and regions in Spring, 1986. This deadline will require immediate and full dedication of the Implementation Group. If this cannot be guaranteed, then operational implementation will not be possible until Spring, 1987.
- all levels of the B.C. Forest Service should be kept informed of development work and deadline dates so there is widespread understanding of progress, and this should hopefully stop any further proliferation of local systems

2. A Pest Management Tracking System

Each forest district, if it is actively managing pest problems, will want a data system which can track pest occurrence and impacts, pest control projects and related activities, and facilitate the preparation of statistical summaries and reports. Such a system would also support budget requests and

the allocation of resources once operating funds are received, and summarize accomplishments. Regions and branches would also be able to utilize this type of management tool.

Such a management system demands the collection of essential data and its entry into a computer storage system which becomes a giant spread sheet of basic information. Computer menus provide the user with an array of standardized tabular printouts which are useful in managing or understanding any part of the business cycle of an individual project, or the total business. This "Tracking System" is only possible to implement if the "Pest Occurrence Mapping System," recommended above, is in place.

The following provides the framework for a system which can accomplish these tasks. It was derived from the work of a Task Force Subcommittee chaired by Al Gorley, and made up of regional and district practitioners.

(a) System Objectives

At District, to:

- monitor location, size, spread, and impact of pest attacks,
- develop district prevention and control priorities, and strategies,
- establish staff and budget requirements,
- track project completion and costs,
- provide timber volume losses,
- monitor pest management activities and projects, and
- create periodic reports.

At Region, to:

- monitor location, size, spread, and impact of pest attacks,
- develop regional prevention and control strategies,

- rank district prevention and control projects,
- allocate staff and budgets,
- track progress of projects for reallocation purposes, and
- create periodic reports.

At Branch, to:

- summarize staff and budget requirements, and allocations, and
- create periodic reports.

(b) System Description

The Tracking System is a computerized spread sheet which allows a large number of field entries over time, and a list of prepared computer programs with which, by menu selection, a manager can call up standardized management information outputs as required.

(c) Data Requirements

Pest Occurrence Polygon Identification/Location: The basic pest polygon ID number is composed of: Region No., District No., Managed Unit No., Year, and Sequential Pest Polygon Number for the Year. Refining the ID Number are the additional location items of Inventory Region - Compartment Nos., UTM Grid, History Record Opening(s) No., Land Status Category, and General Geographic Description.

Pest: Pest Category and Species.

Detection: Detection Date, Detection Method, and Detection Agency.

Assessment Planning: Assessment Due Date, Assessment Method, and Assessment Completion Date.

Assessment Results: Inventory Polygon Nos. Affected, Major Timber Type, Tree Species Composition, Height, Age, Date of Establishment, Stocking (Inventory and Silviculture), Site Index, Total Areas Attacked, Total Volume Attacked, Attack Intensity, Stand Susceptibility Rating, Short-Term Areas and Volumes at Risk, Long-Term Areas and Volumes at Risk, Secondary Pests by Category and Species, Total Areas Surveyed, Total Man Years in Survey, and Cost of Surveys.

Project Planning: Project Identification/Location, District Control Priority, Regional Ranking, Treatment Method, Area of Treatment, Infected Volume in Treatment Area, Non-Infected Volume Benefiting from Treatment, Total Volume Benefiting from Treatment, Agency Responsible, Estimated Manpower Requirements, Estimated Costs, Estimated Treatment Starting Date, Estimated Treatment Completion Date, Estimated Time to Complete Treatment, New Access Required (km), Volume Benefiting from New Access, Estimated Cost of New Access, Agency Responsible for New Access, Existing Access Requiring Upgrade (km), Volume Benefiting from Upgraded Access, Estimated Cost of Upgrade Access, and Agency Responsible for Upgrade Access.

Project Execution and Results: Project Identification/Location, Treatment Method, Area Treated, Volume Treated, Total Volume Actually Benefiting from Treatment, Agency Conducting Treatment, Manpower to Date, Cost to Date, Final Manpower Employed, Final Costs, Project Start Date, Project Completion Date, Total Time to Complete Project, New Access Built (km), New Access Costs, Agency, Upgrade Access Completed (km), Upgrade Access Costs, Agency, Non-Salvable Volume Losses, Non-Salvable Area, Project Cross-Referenced to Other Systems, and Unfinished Business.

(d) Data Collection System

Standardized field forms require development, and "how to" instructions must be prepared and printed in user manuals. This is a priority requirement and should be addressed immediately.

(e) Data Recording/Storage System

Direct entry by the Resource Officer Protection at the District level as information is collected/collated, into the Wang Professional Computer.

(f) Data Retrieval/Use System

Requests for information to be directed to the Resource Officer Protection, using the standardized computer program menus.

(Note: If and when the Wang network is made province-wide, then management queries can be made at source.)

(g) Advantages

- operations and field oriented, designed to serve the districts
- uses existing technology (the Wang Professional Computer System)
- together with the "Pest Occurrence Mapping System" (also recommended), the system provides a practical, basic, and standardized Pest MIS for the total B.C. Forest Service

- simple to use after Manual instructions are written
- bridges the gap until a B.C. Forest Service-wide computer network system is developed and available for all users
- bridges the gap until IGDS or a similar system is able to serve the whole province on a geodata basis
- offers a standardized "by hand" system which is flexible for users, and makes a beginning toward an eventual distributed computerized geodatabase system
- offers a standardized management tool for project management

(h) Disadvantages

- the "by hand" tracking of pest occurrences over time is demanding
- limited linkage to Inventory polygons, and inventory updating is difficult
- would duplicate some of the History Record System
- the system is not designed to efficiently transfer data to region and branch levels
- the system, while filling a basic need, is not very sophisticated

(i) Implementation Plan

(Note: the "Pest Occurrence Mapping System" is a co-system. They must be developed together.)

- obtain approvals to implement this system
- establish an "Implementation Group," with a deadline for the completion of a documented finished product by November 31, 1985
- the "Group" to be composed of the same individuals as indicated in the Pest Occurrence Mapping System.
- by this deadline, the following are to be completed:
 - full development and understanding of the total system as indicated by the system framework recommended herein,
 - testing of the system by simulation of all actual practices,
 - documentation of the total system,

- development of software programs to take input, and to produce standardized printouts by standardized menus,
- development and distribution of user manuals, and
- training of users.

(Note: the Implementation Group should be aware that the History Record System could be readily modified to accomodate this system on managed stands. Whether a system run by Protection Branch would be more desirable will have to be determined.)

- the system should be operationally implemented by Executive decree in all districts and regions in Spring, 1986. This deadline will require immediate and full dedication of the Implementation Group. If this cannot be guaranteed, then operational implementation will not be possible until Spring, 1987.
- all levels of the B.C. Forest Service should be kept informed of development work and deadline dates so there is widespread understanding of progress, and this should hopefully stop any proliferation of local systems

(Note: the Task Force suspects that the data requirements listed here may be excessive. The recommendations of the subcommittee were accepted and included in this report, but should be carefully reviewed by the Implementation Group.)

3. A Damage Appraisal System for Current Mortality

The Task Force recommends a system which offers a standard means of calculating current mortality losses on a stand-level basis. This system is a combination of "by-hand" and computer technology. Later, when the IGDS, or similar capabilities are made available at all districts, then a completely automated and integrated electronic system can be implemented.

(a) System Objectives

- to determine the annual volume of mortality losses due to pests (generally bark beetles and some defoliators)
- to update the inventory files of significant volume losses annually

(b) System Description

The Task Force recommends a system similar to that used by the Cariboo Forest Region for calculating bark beetle losses. The location and area of mortality is obtained from aerial sketch maps or ground surveys. The area of each pest polygon is matched with inventory polygons. Average volume lines (AVL's or similar) are selected on the basis of inventory labels. The pest-affected portion of each inventory polygon is multiplied by the appropriate AVL to obtain a gross volume, which is finally adjusted by using a percent mortality factor. (This process can be facilitated by a special software program.) Each pest polygon and its amount of depletion is recorded in the Pest Management Tracking System, described in System 2 above.

(Note: Care must be taken to avoid double counting of losses from one year to the next. Because of this problem and others, the Task Force recommends that depletions not be used to adjust the inventory database until a special group determines whether the accuracy of pest surveys are adequate for inventory update purposes.)

(c) Data Requirements

- annual maps of bark beetle- and defoliator-affected polygons (from the "Pest Occurrence Mapping System"), with intensity levels recorded
- inventory forest cover maps
- AVL or VAC volumes for all affected label types
- percentage mortality factors

(d) Data Collection System

- annual aerial sketch mapping and/or ground surveys, combined B.C. Forest Service and Forest Insect and Disease Survey (Canadian Forestry Service) efforts

(e) Data Recording/Storage System

- Pest Occurrence Mapping System, described in System 1 above
- Pest Management Tracking System, described in System 2 above

(f) Data Retrieval/Use System

- see (e) above

(g) Advantages

- uses existing methods and technologies
- operations and field oriented, designed to serve the districts
- simple to use once Manual instructions are written
- bridges the gap until a B.C. Forest Service-wide computer network system, the IGDS, and FIPS files are available to all users

(h) Disadvantages

- the system is not completely automated and is time-consuming
- the losses calculated are subject to inaccuracies, due largely to survey errors and double-counting problems

(i) Implementation Plan

- establish an "Implementation Group" with a deadline for the completion of a documented finished product by November 31, 1985
- by this deadline, the following are to be completed:
 - develop and test of recommended system,
 - development of software programs,
 - development and distribution of user manuals, and
 - training of users.

(Note: The above is an interim system for calculating current mortality losses due to certain pests. It should be replaced by a computer assisted mapping system (CAM) as soon as a B.C. Forest Service-wide computer network is established, and IGDS and FIPS capabilities are available to all districts. Once this CAM damage appraisal system capability is established, then recommended System #1, the Pest Occurrence Mapping System, and recommended System #2, the Pest Management Tracking System, can be combined into a single, powerful, and sophisticated Pest MIS for the pest/host complexes suffering current pest mortality.)

A priority! Must utilize some of existing data base by assessing existing natural stand G + Y plots as being substantively with or without

4. A Damage Appraisal System for Growth Reduction

A system is recommended which could, if developed, provide a standardized method for calculating growth reduction (incremental) losses on a stand-level basis, specific for each major pest or pest category. While very difficult and complex to accomplish precisely, this type of system would attempt to improve our ability to determine the volume growth of a stand to culmination age with and without the effects of a pest. This net difference in wood growth would then provide reasonable indications of the impact of major pests on wood production and future timber supplies, the potential wood volume gains possible by preventative treatments, and permit benefit-cost analysis for program allocations. The pests that best portray this type of loss are root diseases, mistletoes, weevils, some defoliators, and most plantation pests.

(a) System Objectives

- to determine the volume of stand-level growth losses
- to estimate the potential volume gains that can be achieved by prevention or control of these type of losses

(b) System Description

The system would determine the net pest impact on forest growth at culmination age for large areas such as TSA's, or subunits of TSA's. A series of yield curves would be derived for the major timber types and groupings of specific pest incidences and intensities. Managers would choose the most applicable yield curves to determine cause and effect of pest losses, compared with the normal yield curves, in order to calculate long-term yield and AAC implications before making the final TSA plan decisions.

"Normal" - realistic way to volume about 60% of growth

(c) Data Requirements

- growth and yield field data to support the development of VAC's with and without pest impact
- average pest incidence, by intensity categories and other relevant stand attributes, for each major pest, over the length of a rotation, for each managed unit

(d) Data Collection System

- to be developed

(e) Data Recording/Storage System

- to be developed

(f) Data Retrieval/Use System

- to be developed

(g) Advantages

- a user will be able to more accurately estimate the long-term impact of pests on wood production and timber supplies, and be able to implement cost-effective programs that will meet TSA/TFL objectives. (This ability has not existed to date.)

(h) Disadvantages

- the cost in manpower, time, and effort in both research and basic field data collection will be large.

(i) Implementation Plan

- that a Research and Development Team, composed of pest, planning, inventory, and mensuration specialists from both the B.C. Forest Service and the Canadian Forestry Service be established to develop a problem analysis, a methodology, and an implementation plan

5. A Damage Appraisal System for the Prediction of Mortality

The Task Force has some doubts that the prediction of mortality in future rotations will prove practical. The reasons for this are that most forest stands will be intensively managed and the agents of mortality losses, primarily bark beetles and some defoliators, may not find future forest conditions suitable for large scale damage. The Task Force also admits that it is not fully versed on this subject.

Short term contagion/mortality models, on the other hand, could prove useful for some operational planning in the present rotation. However, these models may have limited application because the judgement of local managers, supported by pest specialists, will often suffice. In addition, the ability to respond to large scale tree-killing epidemics by providing new access, preventative measures, and salvage operations is often limited.

In view of the above, the Task Force recommends:

- that a team, composed of pest and planning specialists, be formed to investigate the feasibility and merit of developing long term mortality prediction systems or models for the major pests
- that the Errico-Reed fire prediction methodology be particularly investigated as to its applicability for this long term pest management requirement
- that a second team, composed of pest and planning specialists, be established to investigate the potential usefulness of short term contagion/mortality models, especially for the mountain pine beetle and the spruce beetle

(Note: The Hazard Rating System For Pests, recommended in System #6, is required as a companion system in order to be able to effectively predict short and long term mortality losses.)

6. A Hazard Rating System for Pests

In order to predict the trend and potential impact of a pest infestation and to prioritize treatments, it is necessary to understand what constitutes a susceptible host tree and forest stand, and then to rank the host types by their level of susceptibility. There are two major factors affecting susceptibility. One is the physical attributes of the stand (e.g. tree species, age, elevation, vigour, etc.) and the other is the proximity of the stand to an existing pest infestation. The first factor is the stand hazard and the second is the risk of contagion. The following discusses an outline of a stand hazard rating system only.

(a) System Objectives

- to identify stands susceptible to specific pests
- to rank susceptible stands by their likelihood of damage
- to assist in the prediction of short- and long-term stand mortality losses

(b) System Description

There are hazard rating systems and hazard maps available for several pests in B.C. (e.g. McMullen 1976; Safranyik et al. 1974). However, few if any of these are of sufficient detail to be used operationally by pest management personnel.

The obvious foundation for a pest hazard rating system would be the B.C. Forest Service inventory geodatabase because most of the attributes which predispose a stand to a particular pest, such as species, age class, and site quality, are already identified there. Some additional attributes such as elevation and aspect are expected to be incorporated in this database in the future. Whether or not a hazard rating system should physically reside in the inventory geodatabase as a separate layer, or as additional attributes, or reside as a layer on a local GEOMAP is a subject requiring study.

A simple list of characteristics which describe stand susceptibility to each major pest would be a useful starting point. Pest management personnel could then query the inventory system to identify susceptible stands if and when the information is required.

(c) Data Requirements

It will be necessary to examine each major pest individually and, through consultation with pest specialists, identify the tree, stand, and environmental attributes which constitute varying degrees of hazard. It will then be necessary to identify which of these attributes are not on the inventory geodatabase and to determine a method to account for these.

(d) Data Collection System

- to be determined

(e) Data Recording/Storage System

- to be determined

(f) Data Retrieval/Use System

- to be determined

(g) Advantages

- useful for both the pest management contribution to the TSA planning and yield analysis process and for planning and prioritizing pest management programs and activities
- would enable the user to quickly identify susceptible stands or those stands that will become susceptible over the longer term
- combined with a Values System it could be used to determine values at risk which in turn could be used to provide cost/benefit estimates for various forest management strategies

(h) Disadvantages

- requires considerable research and development work for most major pests before implementation can take place

(i) Implementation Plan

- to define those tree, stand, and environmental attributes which comprise a hazard for each major pest (it is likely that our knowledge is presently insufficient to complete this task satisfactorily for some pests)
- identify knowledge gaps for each pest and to develop a plan to obtain this missing information through requests to research organizations
- the Task Force recommends that a Research and Development Team be formed

7. A Values System for Pest Management

Forest managers require a process which gives them a dollar value for the readily quantifiable items at risk to damage caused by the further spread of serious pests. This is necessary for the meaningful use of economic analysis in decision-making. Such valuations, if made readily available to managers, would assist them greatly in justifying whether or not to control an insect or disease infestation.

The need for such a capability has been a priority of every fire control agency across Canada for a number of years. The problem is actively being addressed for wildfire and the Protection Branch of the B.C. Forest Service is taking a lead role in fulfilling this national need.

While not exactly similar to wildfire, and certainly more complex, a values system for pest problems would be useful for some pests to improve their cost-effective management and the interrelations with other forestry functions. It is reasonable to assume that once the values system for fire management has been developed and proven, a values system useful for pest management is a potential spin-off.

The following provides a framework for a recommended pest management values system.

(a) System Objectives

- to provide managers with an easily-used method of determining the value of timber and private lands that are actually or potentially at risk to loss or damage by significant pest infestations

(b) System Description

The Values System would be a software package that utilizes pertinent tree and geographic data from the Forest Inventory database, and land values from the B.C. Assessment Authority database, and then summarizes and displays values-at-risk information within pre-selected map grid cells through a desk-top microcomputer.

A user would be able to call up mosaics of map grids (each grid being approximately 2.3 by 1.4 km) covering areas of his choice and have displayed in each grid, for a specific pest/host combination, the following:

- total grid area (each is approximately 330 ha)
- mature timber \$ value at risk
- immature timber \$ value at risk
- total timber \$ value at risk

- total land \$ value at risk
- species and volume of mature timber at risk
- species and area of immature timber at risk
- area of existing roads
- (it may or may not be feasible to add recreation values)

Having the above, the user could then estimate and plot any infestation boundaries he cared to predict on the map grids, and then easily calculate the basic economic significance of that infestation.

Alternatively, the Values System could be developed to use query language processes instead of the pre-packaged system indicated in the above.

Whichever route is chosen, it should be kept in mind that it need not be "mathematically exquisite." Rather, it should be a readily useful and practical tool which would provide a manager with comparative information. To go beyond this will probably prove to be too complex and expensive.

(c) Data Requirements

No data collection is required. The system would utilize the data already available in Forest Inventory, History Record, B.C. Assessment Authority (and perhaps Lands, Parks, and Housing) databases.

(d) Data Collection System

- see (c) above

(e) Data Recording/Storage System

- see (c) above

(f) Data Retrieval/Use System

- see (b) above

(g) Advantages

- would use existing technology
- would provide a major advance in the ability of managers to assess pest problems using an economic approach in a systematic and consistent manner

- would improve the ability of forest managers to make decisions based on economic reality
- would improve the budgeting and allocation of funds within and between the programs and activities of the B.C. Forest Service

(h) Disadvantages

- considerable time, funds, and commitment will be required to develop the system because of the complexities involved
- it would not be useful for the impact of pests for long-term planning beyond a forest rotation
- it cannot be fully developed until the values system for fire management has been adequately tested and proven
- it must await the implementation of the Forest Inventory Planning System (FIPS) database. However, this will probably be available when needed.

(i) Implementation Plan

- establish the proposal as a research project in the Protection Branch and designate the project leader
- a deadline date for project completion cannot be set as this is dependent upon the funds and staff devoted to the project. However, a 1988 deadline for operational trial in one forest region is feasible

8. A Pesticide Use Recording System

Some respondents to the questionnaire expressed the need for a system which allowed access and easy updates on the progress of pesticide use applications that were submitted to the Pesticide Control Branch of the Ministry of the Environment, and their subsequent approval and permit conditions.

It was determined that the Ministry of Environment had recently implemented a computer system to keep track of permits, as compared to the older ledger system. Consequently, a Task Force Subcommittee was formed from the Protection Branch, to investigate and report to this Task Force. The following was derived from their report.

(a) System Objectives

- to facilitate access to current and historical records and summaries of forest-related pesticides, where and when used, for what purpose, by whom, and method of treatment application. This could include B.C. Forest Service, forest industry, B.C. Hydro, and railroads data.
- to provide the ability to track the progress of an individual pesticide use permit application from the application submission stage to approvals, appeals, and eventual operational use, or completion

(Note: The system would not be designed to capture the efficacy of any individual treatment after pesticides had been applied.)

(b) System Description

The Pesticide Use Recording System would be a computer program whereby a B.C. Forest Service computer could access the Ministry of Environment's database and prepare pertinent management reports and summaries useful to Forest Service staff. It would be programmed so that Protection Branch would initiate access on behalf of a request received from another branch, any region or district, or any other forestry user. At a later date, it may be feasible to set up a system whereby local users could access Ministry of Environment data at that level.

(c) Data Requirements

The collection of data is accomplished by the Pesticide Control Branch's Pesticide Use Permit Application form (ENV. 2112). The data entered in their computer consists of:

Applicant, MOE Region, Active Ingredient of Chemical, Pest Control Products No., Application Rate (kg a.i./ha), Treatment Area, Quantity of Chemical to be Used (kg a.i.), Purpose of Treatment, Location, Application Method, Commencement Date, Completion Date, Aquatic Buffer Zone Requirement, and Appeal Information.

(Note: A B.C. Forest Service ID/Location System is required to enable a tie in.)

In addition to the basic permit application data, annual information is also collected on what actually was treated in the year, for each application. This includes:

Permit No., Active Ingredient Used (kg), Area Treated, Forest Stand Information (Stand Type Label), Height of Target Species, and Reasons If There Was No Treatment Applied.

(Note: A B.C. Forest Service ID/Location System is required here also.)

(d) Data Collection System

Original data is collected through permit and other administrative systems of the Pesticide Control Branch of the Ministry of Environment.

(e) Data Recording/Storage System

The Ministry of Environment computer system is responsible for this.

(f) Data Retrieval/Use System

District, region, or branch personnel, who require information, would advise the Pest Management Section of the Protection Branch of their needs. Protection Branch would access the Ministry of Environment computer from their terminal, retrieve the required information, and pass it back to the initiator. Either query language or standardized program menus need to be developed in order to be able to do this.

(g) Advantages

- uses existing paper and computer systems of another Ministry to fulfill Forest Service needs
- uses computerization, thus improving methods of tracking pesticide application permits and summarizing current and historical data, and replaces inefficient ledger recording systems

(h) Disadvantages

- data is limited to the system needs of another Ministry
- access to data by a user must be directed to and from the Protection Branch
- data available on the new computer system dates only to 1984. If historical data is desired earlier than 1984, either the Ministry of Environment or B.C. Forest Service would have to undertake entry of the older data from the paper ledgers.
- there will be costs for terminals, communications links, and access

(i) Implementation Plan

- establish an "Implementation Group," with a deadline for completion by spring of 1986

- the "Group" to be composed of one systems specialist from the Planning, Development, and Research Section, and one pest management specialist from the Pest Management Section, both from the Protection Branch
- by the above deadline, the following are to be completed:
 - understand the total system and its potential,
 - establish the required ID/Location requirements of the Forest Service and have it accepted and inserted in the Ministry of Environment "permit application form" system and the "annual pesticides actually used" forms. (The requirement involves Forest Region, District, TSA, TFL, History Record Opening No., Stand Tending Report Admin. No., Site Preparation Project No., -- these latter link to Silviculture ID systems.),
 - obtain cooperative agreement from the Ministry of Environment,
 - develop the B.C. Forest Service hardware and software requirements,
 - test the system,
 - develop and distribute user manuals, and
 - train users.

VI. CONCLUSIONS AND RECOMMENDATIONS

1. There appears to be no B.C. Forest Service-wide "systems vision" towards which it is striving for its total organizational management system needs. Instead, many programs are heading in directions where there is duplication of effort in data collection, gaps in data which should be collected, and incompatibility of hardware and software, all of which inhibit the ability to communicate, share, and utilize each other's data and information.
2. As a general rule, the Task Force has come to believe that the concept of a service-wide management information system should be based on the districts being responsible for collecting and managing data, regions providing training and support, and branches setting the standards, guidelines, and managing the technology.
3. The B.C. Forest Service's Forest Inventory database and the applications systems planned to serve other Ministry of Forests programs is basic to forest management in the province. The Task Force strongly recommends a rapid acceleration in the implementation of Inventory Branch's IGDS, the FIPS files, and other service/support applications.
4. Conceptually, the IGDS and the other Inventory Branch systems, as well as the History Record System, when enhanced, should be capable of accomodating most of the geodata requirements of the Forest Service. These capabilities, or their equivalent, are necessary for any advancement to the next generation of sophisticated forest management techniques.
5. There were some discrepancies noted between Inventory's update of forest polygon information and that of Silviculture's History Record System. This will create future confusion to forestry managers and is considered a serious weakness. This difference in designating label information on some polygons must be resolved by standardizing the procedures for both these branches.

6. Pest management is not an isolated discipline concerned only with direct control of pest outbreaks. On the contrary, the greatest contributions pest management can make to forestry lie in the careful incorporation of its philosophies, knowledge, techniques, and data into the planning and operations functions of other programs especially in planning, timber management, and silviculture. This support role is difficult to conceive and effectively implement because it requires the subtle modification of plans and practices, when and where needed, through the full period of each forest rotation by disciplines other than pest management.
7. The quantification of information is vital for effectively planning and managing the forest resources.
8. The need for reliable and standardized data/information is nowhere greater than in pest management.
9. Neither the Forest Inventory System nor the History Record System are adequately capturing and storing the data required for the management of pests.
10. The History Record System, in particular, should be expanded to adequately accomodate pest management surveys and treatments. This remains valid whether or not any Pest Management information systems are established.
11. Any Pest MIS must be developed to manage pests, and their damage, and not to inventory pests. Information is costly to acquire.
12. Any Pest MIS must operate at the TSA - TFL levels, and be structured primarily to serve practitioners.
13. Any Pest MIS must be operationally linked to both the Forest Inventory System and the History Record System at the polygon level. This is basic to its success.

14. Any Pest MIS must avoid duplication by utilizing the mapping and data capturing capabilities of the Inventory and History Record systems whenever this is feasible.
15. Any Pest MIS must use the same standards and format for determining actual or potential pest losses as are used by the Planning and Inventory Branch in calculating volumes, yields, and Annual Allowable Cuts. This will probably be the most useful product of a Pest MIS. In particular, any Pest MIS must be able to distinguish between, and calculate pest losses and potential gains in terms of stand level mortality and stand level growth reductions. Most bark beetles and some defoliators fall into the mortality category, all other pests belong in the growth reduction category.
16. The greatest benefits to the Ministry of Forests could accrue from a cooperative "partnership" among Inventory, Silviculture, and Protection branches through the development of an enhanced forest management database having improved usefulness to the planning and operations functions of all programs. This would require some minor modifications to the Inventory and History Record systems data capture and storage procedures, and the development and implementation of a Pest MIS.
17. In view of the above, the Task Force sees the eventual need for eight systems which would form an overall Pest MIS and, in time, significantly improve both pest and forest management practices in the province. Three systems are recommended for immediate development and implementation, and five for later development as dictated by existing priorities and the availability of funds and development personnel.

The systems recommended for immediate development and implementation are:

- A Pest Occurrence Mapping System
- A Pest Management Tracking System
- A Pesticide Use Recording System

The systems recommended for further study and future implementation are:

- A Damage Appraisal System for Current Mortality
- A Damage Appraisal System for Growth Reduction
- A Damage Appraisal System for the Prediction of Mortality
- A Hazard Rating System for Pests
- A Values System for Pest Management

18. The implementation of any systems should not be done until user manuals have been prepared and the users trained.
19. The Canadian Forestry Service - Forest Insect and Disease Survey should be allowed access to any B.C. Forest Service-developed Pest MIS. Further, the databases of both agencies should be viewed as common property with each agency having a sincere desire to optimize data collection, storage, and use for the greater good.

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APPENDIX I

Questionnaire to Assist in the Development of a
Pest Management Information System

Please complete and return to:

Bob Sutton, RPF
Chairman, PMIS Task Force
c/o Protection Branch
Ministry of Forests
Parliament Buildings
Victoria, B.C. V8W 3E7

Deadline: December 3, 1984

- (1) Who do you perceive are the real users or user groups of a Pest Management Information System (PMIS)? Place in order of priority with the first having the highest priority.

- (2) List the basic needs that users or user groups will want fulfilled by a PMIS.

- (3) List the specific data that must be collected in order to satisfy future information needs. (If you perceive major differences between bark beetles, defoliators, dwarf mistletoes, root rots, and terminal weevils then please be specific in your treatment of each of these pest groups).

[illegible]

(5) What specific pest-related yearly summary tables will be required by managers at the following levels? (Be specific on the items of information needed. Respondents outside the Ministry of Forests please find the equivalent levels and respond as applicable)

(a) Executive level:

(b) Branch level:

(c) Regional level:

(d) District level:

(8) Once data has been collected it must be stored in a system that will serve any user at any level.

(a) Who should be responsible for managing the data storage and retrieval system?

District level	Yes _____	No _____
Regional level	Yes _____	No _____
Branch level	Yes _____	No _____
Other (please specify)	_____	

(b) Summarize your opinions on and the requirements of the data storage and retrieval phase of the PMIS.

(9) We think a PMIS should be interactive with the Ministry's forest inventory; silviculture history record and crop establishment and tending; fire weather index; and district map mylar systems as well as with the CFS Forest Insect and Disease Survey system.
(a) Please comment on the need for these linkages.

(b) Do you perceive linkages to other systems not mentioned? Name them and explain these linkages.

(10) What specific pest-related information must the TSA planning function use in order to properly take pests into consideration when conducting yield analyses and when calculating Allowable Annual Cuts?

(11) It is possible to design a Pest MIS ranging from a "Cadillac" to a "VW" system. However, the odds of implementing a "Cadillac" system are decidedly dismal. Provide us with your vision of a PMIS which satisfies minimum requirements.

[illegible]

(12) Provide any other comments, observations, and words of wisdom here.

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Name _____ Affiliation _____ Date _____

(please print).

LIST OF RESPONDENTS TO THE QUESTIONNAIRE:

Peter Ackhurst, BCFS, Vancouver
Arnold Amonson, BCFS, Houston
Les Anderson, BCFS, Chilliwack
Ken Belik, BCFS, Prince George
Bill Bloomberg, CFS, Victoria
John Borden, Simon Fraser University, Burnaby
Ken Braithwaite, BCFS, Nelson
Robin Brown, BCFS, Victoria
Steve Byford, BCFS, Cranbrook
Randy Chan, Balco Industries Ltd., Kamloops (with Trevor Jeanes)
Ken Collingwood, BCFS, Merritt
Mike Connor, BCFS, Prince George
Jim Dangerfield, BCFS, Victoria
Bob DeBoo, BCFS, Victoria
Paul Diggle, BCFS, Victoria
Ron Diprose, BCFS, Powell River
Bruce Doerksen, BCFS, Prince George West
Hank Doerksen, BCFS, Victoria
Don Doidge, BCFS, Cariboo
Ron Edward, BCFS, Kamloops
Darrell Errico, BCFS, Victoria
Robin Fennell, BCFS, Clinton
Dene Ferguson, BCFS, Kamloops
Peter Fuglem, BCFS, Victoria
Dave Gilbert, BCFS, Victoria
Orval Gorley, BCFS, Prince George
Don Grant, BCFS, Vancouver
Peter Hall, BCFS, Victoria
Dave Hames, BCFS, Chilliwack
Dave Handley, MacMillan Bloedel Ltd., Nanaimo
Eric Haupt, BCFS, Vernon
Dick Heath, CIP Forest Products, Saanichton (with Bruce Devitt)
Rich Hodson, Weyerhaeuser Ltd., Kamloops
B. Horning, BCFS, Powell River
Russ Hughes, BCFS, Vancouver
Don Hunt, BCFS, Victoria
Dennis Hutcheson, BCFS, Kamloops
Julius Juhasz, BCFS, Victoria (with Frank Renshaw)
Kathy Kassay, BCFS, Vancouver

Gerry Kennah, BCFS, Vancouver
Tom Lacey, BCFS, Merritt
Bruce Lawson, CFS, Victoria
Ken Magee, BCFS, Prince George West
Tom Maher, Northwood Pulp & Timber, Prince George
Dave Mayer, Northwood Pulp & Timber, Houston
John McLean, University of British Columbia, Vancouver
Don McMullan, British Columbia Forest Products Ltd., Crofton
Ken Milner, BCFS, Nelson
Ken Mitchell, BCFS, Victoria
Mel Monteith, BCFS, Clearwater
Ernie Morris, BCFS, Nelson
Barry Mountain, BCFS, Powell River
John Muir, BCFS, Victoria
Tom Niemann, BCFS, Victoria (with Bill Howard)
Brian Nordman, British Columbia Forest Products Ltd., Mackenzie
Dave Oswald, BCFS, Nelson
Paul Pashnik, BCFS, Smithers
Lois Pelchat, BCFS, Victoria (with Jim Bullen and Tom Hall)
Robin Quenet, BCFS, Victoria (with Imre Spandli)
Tony Robinson, BCFS, Kamloops
Bob Rualt, Crestbrook Forest Industries, Cranbrook
John Sedlack, BCFS, Nelson
Roy Shepherd, CFS, Victoria
Dick Smith, CFS, Victoria
Guenter Stahl, BCFS, Houston
Verne Strain, BCFS, Smithers
Don Summers, BCFS, Victoria
Gary Sutherland, BCFS, Vancouver
Al Thomson, CFS, Victoria
Russ Trenamen, BCFS, Prince George East
Phil Van Mol, BCFS, Kamloops
Alan Van Sickle, CFS, Victoria (with Doug Lacate, Tom Sterner,
and Bob Dobbs)
Hans Waelti, BCFS, Victoria
Gordon Weetman, University of British Columbia, Vancouver
Howard Willis, BCFS, Prince George (with Ken Walker)
Roger Wiltsie, BCFS, McBride
Mike Wyeth, BCFS, Victoria
Bill Young, Canadian Forestry Association, Vancouver

SUMMARY OF QUESTIONNAIRE RESPONSES:

Question # 1 - Who do you perceive are the real users of a Pest Management Information System, in order of priority?

Group response: All groups basically concur as follows:

The priority users are:

- Districts (Protection, Inventory, Silviculture, Timber, plus the District Manager and Operations Superintendents)
- Industry (Chief Foresters, Woods Managers, Area Foresters, Silviculturists, and Engineers)
- Regions (Protection, Inventory, Silviculture, Timber, Planning, Engineering, Research, plus the Regional Manager)
- TSA Steering Committees
- Branches (Protection, Inventory, Planning, Silviculture, Timber, Research, Range, and Strategic Studies)
- B.C. Forest Service Executive
- Canadian Forestry Service (Forest Insect & Disease Survey and researchers)
- Other government agencies (Parks, Regional Districts, Municipalities, Ministry of the Environment)
- Politicians
- General Public
- Researchers and Academics

Question # 2 - List the basic needs that users will want fulfilled by a Pest MIS?

Group response: All groups basically see a need for a Pest MIS capable of the following:

- effective monitoring of significant pests; appraising pest damage and their impact on TSA's and TFL's; contributing to forest management planning and option decisions; and monitoring the effects of operations
- identifying type and species of pests causing "significant" damage
- recording geographic location and area of "significant" pest problems, both historical and update

- providing present and predicted pest population spread rates, their duration, and severity of attack
- displaying wood volumes and other values at risk by their susceptibility to damage (a values hazard rating system)
- determining present and predicted impact on values (priority must be given to quantifying mature and immature wood losses and their economic implications in TSA's and TFL's)
- tracking past prevention and control treatments, their costs, and effectiveness
- managing and scheduling timber harvests
- recording the location and area of salvage operations and wood volumes recovered, costs and effectiveness; and extent of areas not salvaged and volumes lost
- determining the implications of different pest treatments or non-treatment by TSA and TFL on both short and long term production goals
- determining "allowable" insect and disease losses for TSA's and TFL's
- indicating the wood harvesting accessibility rating of areas under attack
- when to monitor, when to carry out routine maintenance, when to initiate control
- presenting forest management options, including pest prevention and control treatments and costs
- a Pest MIS should facilitate "early detection and initial attack," similar to fire management, for cost-effectiveness
- recording historical and fiscal year pest detection, survey, and assessment statistics, including costs
- determining meaningful pest population thresholds
- providing quality information to update Inventory data files and mapping systems
- providing quality information to update Silviculture History Record System
- providing quality information that can be used by Planning in yield analysis projections and AAC calculations
- providing information that satisfies the "recoverable" and "non-recoverable" losses required by the Resource Planning Section

- providing an efficient catalogue of approved pesticides
- recording annual pesticide usage, both historical and update
- justifying and securing pest control funding via the budget process
- providing basic data in order to develop realistic models such as contagion models, susceptibility models, spread models, etc.
- keep the Pest MIS simple and complete unto itself with no complications with other systems

Question # 3 - List the specific data that must be collected in order to satisfy future information needs.

Group response: All groups were consolidated for this question. Total data requirements are:

- method of data collection used (type of survey, aerial or ground, annual or periodic, standards of intensity)
- date of survey
- pest type and species
- location and extent of area of attack, by year
- all data should be capable of being segregated by "gross land base" and "net land base"
- attack areas "contribute" or "non-contribute" to forest land base
- location and extent of areas susceptible to attack, and "contributing" or "non-contributing" to the forest land base
- tenure descriptions (TSA, TFL, Parks, etc. & Region, Compartment, etc.)
- Forest Cover Map No., Air Photo No., Inventory Polygon No., type label, history record label, (update stand data if labels incorrect)
- ecological classification (site description)
- specific tree and stand data (to be determined for each pest)
- percent of trees attacked
- tree mortality rating

- wood volume affected (mortality)
- wood increment and growth affected
- pest population density and yearly spread
- intensity of attack and trend (population dynamics)
- potential for spread to adjacent stands
- years of attack (past and current history)
- stage of insect life cycle and its density and health
- presence/absence, and type of pest parasites, predators, disease, etc.
- accessibility rating (terrain, slope, rocks, distance from roads, etc.)
- special environmental concerns
- soil type
- treatment recommendations
- salvage opportunities (volumes, area, access, operability, priority)
- cost data (survey, detection, treatment, etc.) i.e. set up a system that facilitates business ledgers for costs of all pest management activities and accomplishments
- special areas of disturbance, or decked material that breed bark beetles (windfall, slash, etc.)
- weather trends
- records of permanent sample plot locations

Question # 4 - What importance do you place on the standards of data collection (strict procedures versus a looser subjective system)?

Group response: All groups were consolidated for this question.

The consensus of all groups (79% of all respondents) is that data collection systems should be based on a mix of "loose" and "strict" sampling systems. The following points are pertinent to this opinion:

- two levels of detection/survey are required:
 - (a) overview sampling for general understanding and planning
 - (b) detailed sampling for forest management purposes such as existing loss estimates, future pest potentials and impact, and control planning
- data should only be collected to the level which meets survey objectives, and rarely beyond
- intensive data collection should be restricted to pests that are important in terms of both damage and treatment opportunities in order to keep surveys cost-effective
- data collection systems are costly in time, effort, and dollars and therefore must be made cost-effective
- data collection systems must be standardized throughout the province but there must be different levels. Guidelines are required to direct users to the cost-effective choice based on management objectives
- minimum data collection standards must be established and followed. These will vary depending on the pest, the degree of damage, and the purpose of the survey
- once data collection standards have been established, the training of personnel must be an on-going commitment
- monitoring will be required to ensure that established data collection standards are being met
- permanent sample plots have been overlooked as a source of pest management data. These could offer great opportunities for increasing the level of pest management understanding

A minority of respondents (13%) were of the opinion that sampling systems should be "strict." The following points are pertinent to this opinion:

- ground sampling procedures are the only reliable means to obtain accurate data
- "strict" sampling systems are required as "subjective" systems often lead to emotionalism, overestimation of damage, and mismanagement of funds
- sampling systems should follow the style and quality of the existing Inventory Branch systems

Another minority opinion (8%) was that sampling systems should be "loose." The following points are pertinent to this opinion:

- loose and more subjective data collection systems are suitable when pest populations and/or their resulting damage are low or insignificant
- data collection systems should be initially "loose" and subjective, with the standards being tightened up over time

Question # 5 - What specific pest-related yearly summary tables will be required by managers at the executive, branch, regional, and district level?

Group response: Opinions from groups closest to the administrative levels were used to determine the needs for the level.

I. District Level

Pest Category and Pest Species by subject District, TSA and Supply Blocks, TFL, Private and Other Lands

- overview map of significant areas being damaged by pests
- area of infestation and damage (wood volume, wood value, impact on AAC & LRSY) by both gross and net land base
- wood volume losses by tree species, by both gross and net land base
- wood volumes salvaged and non-recoverable volumes, by tree species, by both gross and net land base
- pest management activities (detection, surveys, assessment and evaluation, prevention, control treatments, including pesticide use, monitoring, training, administration, special projects)
- predictions or pest trends, their impacts and implications on forest management objectives, by both gross and net land base
- required treatments, their priorities, location, and costs, by both gross and net land base

II. Regional Level

Pest Category and Pest Species by all Districts, with a Regional Total

(as above)

III. Branch Level

Pest Category and Pest Species by all Regions, with a Provincial Total
(as above)

IV. Executive Level

Pest Category and Pest Species by all Regions, with a Provincial Total
(as for the branch level)

Question # 6 - How often should pest information be collected/updated?

Group response: All groups were consolidated for this question, but emphasis was given to the replies of pest specialists and those closely associated with pests and their cause/effects.

Bark beetles and Defoliators	95% of respondents recommend annual updates, and more frequently if problems are severe and operations are intended or underway
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Mistletoes and Root rots	87% of respondents recommend that <u>initial</u> mistletoe information should be collected by <u>specific</u> surveys or other special investigations. Thereafter, updates would only be required every 5 - 10 years
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Terminal weevils	71% of respondents recommend surveys each year once a weevil problem has been discovered in a stand
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Question # 7 - How should pest data be collected by (a) pest specialists, (b) other forest management specialists, (c) generalists; and (d) summarize your requirements for data collection.

Group response: Question 7 (a) was segregated by analysis group, whereas (b), (c), and (d) were summarized by all groups.

	<u>Yes</u>	<u>No</u>
a) Pest Specialists	96%	4%
BCFS	93	7
CFS	93	7
Licensees	82	18
Other:		
contractors		6 mentions
consultants		5
all field people		11
industry - only TFL's		3
university		2
general public		1

b) Other forest management specialists	<u>Yes</u> 79%	<u>No</u> 21%
Specifically:		
silviculture	15 mentions	
cruising	9	
inventory	9	
protection	7	
timber management	7	
all forest management functions	7	
range	5	
consultants	4	
scaling	3	
contract aerial detection	1	
colour photography contractors	1	

c) Generalists, while carrying out other duties	<u>Yes</u> 78	<u>No</u> 22
BCFS	<u>Yes</u> 76%	<u>No</u> 24%
Licensees	67	33

- d) What are the requirements of a successful pest data collection system?
- don't reinvent the wheel -- utilize the Inventory System and the History Record System
 - data collection must match the problem, use pest specialists when complex and generalists when simple and straightforward
 - systems must be simple and practical, but also dynamic and capable of being expanded into something more complex
 - a collection system should be incorporated into the 'everyday' activities of the B.C. Forest Service
 - must utilize district, region, and licensee input
 - system must be affordable and be consistently funded
 - prime responsibility for collection must be at the district level
 - provincial standards for detection, survey, and data collection are a prerequisite
 - training of B.C. Forest Service and industry in detection, survey, and data collection to provincial standards is a prerequisite

- anyone can collect and input data, but only if they have been trained
- B.C. Forest Service & Canadian Forestry Service systems must eventually be coordinated to avoid duplication and to optimize efforts
- pest management specialists must not get saddled with basic data collection as this would not be cost-effective
- the establishment of more permanent sample plots and/or transect lines should be carried out by district and regional teams to provide benchmark information
- 'reporting' forms should be established for all collectors of data
- regular and annual aerial surveys and routes should be established. Detailed ground surveys would follow if necessary
- the system must accommodate prompt input once data has been collected, and prompt retrieval by all levels
- at the regional level the Pest Management Coordinator and the Inventory Officer are an important team in managing a Pest MIS
- there is a need for pest management committees (B.C. Forest Service-Licensee) at both the district and regional levels
- full use should be made of consultants and contractors
- Licensees must be funded if they are to be valid contributors

Question # 8 - A pest data system must serve users at all levels. Who should manage the system? Summarize your opinions on the data storage and retrieval phases.

Group response: All groups were consolidated in the following summary

a) Who should manage the data storage and retrieval system?

	Yes	No
District	32%	68%
Region	13	87
Branch	73	27
Other:		
CFS	1 mention	

b) data storage and retrieval phase requirements:

- the system must be simple and inexpensive, at least initially, and be expandable over time without changing the initial system
- the majority favour starting a Pest MIS similar to the Fire Report System initially and later expanding to a district 'managed' system
- the long term view should be one where districts manage the data, regions provide training and special support to districts, and branch manages the technology
- branch must set the standards for the system, provide guidelines, and manage the overall system; region oversees, provides support and expertise, and coordinates collection and interpretation of findings; districts collect and enter data -- and operate
- licensees must have input and output, especially TFL Licensees
- the minimum level for recording data is either the TSA Supply Block or the TSA/Compartment (to be determined). This must also be compatible with management of TFL's
- the Regional Pest Management Coordinator, the Inventory Officer, and the Planning Officer must coordinate efforts and output for a system to be cost-effective, and play a key role in managing the system
- how will TFL lands be managed? Some suggest they should be made to manage their own system
- whatever the final system, very clear and 'user friendly' menu books must be provided to users of the system and its data
- the system must provide both tabular summaries and either maps or graphic displays
- access to data must be quick and efficient for users
- a major decision is whether to have 'direct data entry' at the district level, or to follow the 'Fire' system of reports up the line to branch for entry
- also of importance is the security of data, and who has "change and manipulation" privileges
- some suggest that the Pest MIS should be developed along the lines of the History Record System

Question # 9 - The Pest MIS should be interactive with other Ministry of Forests systems and the Canadian Forestry Service Forest Insect & Disease Survey system. Please (a) comment on the need for these linkages and (b) name and explain linkages which you perceive should be made to other systems.

Group response: All groups were consolidated in the following summary

a) and b) Responses to linkages with other systems

- link to Forest Inventory System
- link to Range Inventory System
- link to History Record System
- link to Planning Yield Analysis, AAC calculations, and timber allocation models
- link to TSA Planning and Harvesting Models
- must be tied to District Mylar Mapping System and be 'updatable'
- link to Canadian Forestry Service - Forest Insect & Disease Survey Pest MIS system
- link to road access systems
- link to Financial MIS
- a Pest MIS must be considered as just another aspect of the total Ministry's information systems, and must be developed in this light
- a Pest MIS must be reactive with and to users. If it is tied intimately with Inventory and History Record Systems it may not be reactive as these other systems are not readily useful to users
- the Pest MIS must be available to Licensees
- the System must incorporate a Geographic System
- the 'Permanent Sample Plots' of Research Branch are sometimes abandoned or moved if there is pest disturbance. This should be stopped as these are valuable for pest information. The Pest MIS should link with Research Branch's database
- linkages with other systems will be expensive
- when systems are 'linked,' you inherit the other fellow's problems, downtimes, etc.
- attempts to form linkages to too many other systems presents too many constraints and problems, and will probably be self-defeating

- a self-contained system will avoid all 'linking' problems and this is how the original Pest MIS should be initiated. Later it should be linked with other systems
- the Pest MIS should not be allowed to enter and alter other systems data, but should be given a map notation only
- the Pest MIS should not reinvent the wheel but should utilize the existing Inventory and History Record System as much as possible
- the Pest MIS should use the same procedures for calculating pest losses or volumes at risk as is used by Planning and Inventory in calculating volumes and yields. To do otherwise would be trying to link 'apples' with 'oranges'
- the Pest MIS should form a layer or layers in IGDS. What are the problems in doing this, and the time period in which all regions could be onstream. The link with Inventory is deemed vital. In essence, a Pest MIS is an inventory update system (or should be)
- a Pest MIS should accommodate TFL's as well as TSA's
- the 'Values System' being developed for Fire Management should eventually be usable for 'values at risk for pests.' Make sure these will be compatible. Thus, systems must be eventually linked with land ownership and tenure data banks.

Question # 10 - What do the TSA Planning function, yield analysis, and AAC calculation systems require of a Pest MIS?

Group response: All groups were summarized but extra weight was given to the replies of the Planning Group

- impact of pest losses (% increase or decrease in volume, annually and by decade) for:
 - Volume Over Age Curves (VAC's)
 - net impacts on mature volumes (average volume lines - AVL's)
 - Managed Stand Yield Tables (MSYT's) for immature types
 - age class distributions
 - species profiles
 - site quality
 - timber quality
- regeneration delay information and linkages and impact on timber types
- rotation or culmination age affected by pest losses (or minimum cutting ages as influenced by pest biology, economics, or timber piece size)

- areas affected by TSA's and TFL's, and further segregated by:
 - TSA Supply Blocks
 - Region/Compartment
 - Map Sheet No., Polygon No.
 - Inventory Type Group
 - Growth Type Group
 - Special Amalgamated Type Groups set for specific TSA's
- land base (net and gross)
- must have a system (perhaps applicable only to pests) which deals with the Net Operable Land Base in terms of how pests are affecting the timber base
- the effect of pest treatment (real or potential) on Section 52 of the Act pertaining to the increased Long Run Sustained Yield (LRSY) because of the treatments
- the effect of pests, losses, and treatments on mill capacities, their species profile requirements, and the economics of the manufacturing business within a TSA/TFL

Question # 11 - What should a minimum Pest MIS do for us? Should it be a 'VW' or a Cadillac?

Group response: All groups were consolidated in the following summary

- keep the Pest MIS simple
- Pest MIS must be a sophisticated computer system with data entry at source if it is to succeed
- data must be readily retrievable by all users and be responsive to user needs
- there must be provincial standards established and these must be managed and met. Data must be reliable
- Pest MIS must be linked with Inventory and the Canadian Forestry Service system
- the bottom line for the Pest MIS must be its usefulness for Yield Analysis and AAC determination
- must project future losses to be useful for Yield Analysis
- must be a computer-based system, useful for all B.C. Forest Service levels, and Licensees
- data entry should be at the district level

- the system should be initially simple and basic (VW), but be expandable over time to the 'Cadillac' without major disruption
- Pest MIS should cover the major or significant pests only, and not try to cover others and become too complex/onerous
- must be capable of quantitatively determining attack intensity categories
- must track historical occurrences and impacts
- must contain a geographic mapping system (manual and/or electronic)
- Pest MIS should form layers in IGDS (it may not have data changing privileges of Inventory data)
- Pest MIS must be 'area/volume' based for the 'TSA net land base'
- the system must also 'flag' potential problems for Silviculture and Timber Management operations
- loss information must be accurate and realistic. 'Inflated' loss and impact information is not acceptable to other disciplines
- should the system be 'grid-based,' 'polygon-based,' 'stand-based,' or 'other?' - this is a key item
- Pest MIS must provide updated (current) information to users
- there must be a 'stand susceptibility rating system' for each pest
- there must be a 'values at risk' rating system for each pest
- must develop 'spread models'
- Pest MIS must provide a 'Project/all pest management activities' tracking sub-system for annual reports, budget preparation, monitoring, etc. uses. (include all use of personnel, harvesting/salvage, pesticides used)
- Pest MIS must be capable of either providing the information, or actually doing the proper analysis for determining optimum program levels and mixes
- must permit benefit/cost analysis of control options and treatments
- Pest MIS should be developed along the lines of the Fire System
- Pest MIS data must be collected by generalists with entry at source (also standards, training, control implied)

- pest specialists should take over after generalists have identified problem areas
- the establishment of standards, and training of all personnel is a must
- permanent sample plots offer great advantages to pest management. This subject requires innovative review

Question # 12 - Final comments, observations, and words of wisdom to the Task Force.

- build a system that is better than minimum and capable of being expanded into a sophisticated system
- start simple, but have a system design that can accomodate future changes and enhancement without having to start fresh
- implement a system that is capable of being consistently funded and staffed (with qualified people)
- start with a prototype and test it in an operational way in a region. When debugged implement it on a provincial scale
- a Pest MIS should be viewed as a sub-part of the provincial Inventory System
- a Pest MIS must be used to manage pests, and not to inventory pests. There is a vital distinction here
- a system has more chance of success if it is evident that there is immediate returns to the 'inputer'
- a tight monitoring and control system will be required to keep the data reliable (and standards & training)
- require the development of basic and easy-to-use survey forms for each significant pest for field entry use
- must establish provincial standards and training
- permanent sample plots require innovative review as a potential benefit to pest management
- look at the Cariboo system for mapping and determining losses by bark beetles. It has some features that are simple and desirable
- the system, while being developed for five pest categories must also be capable of being upgraded to handle other pests, including weeds

- it has to be decided whether the purpose of the Pest MIS is to:
 - (a) be useful for an operational forest management role
 - OR
 - (b) be useful for the Yield Analysis and AAC role
- collect only what is essential and useful data; not that which someone feels is nice to collect and may be of some future use