Growth and Yield Program
Steering Committee,

Ministry of Forests

A Growth and Yield Modelling Strategy for British Columbia – Summary Report

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DRAFT

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Prepared by:

FORUM Consulting Group
Management and Research
Consultants, Victoria, BC

In association with:

D.R. Systems Inc.,
Nanaimo, BC

Introduction

External strategic pressures over the past few years have significantly increased the importance of growth and yield (GY) information to the continued development of the forest resource. Accordingly, the reliance placed on GY modelling in forest planning and management has increased. Although great strides have been made in the past few years. the Ministry of Forests and cooperating agencies are not yet in a position to adequately serve the current and emerging needs of GY model users without significant changes being made.

This report constitutes the first step in what will doubtless prove to be a long and sometimes arduous process to satisfy the current and emerging needs of GY model users while at the same time coping with reduced financial resources. The strategic recommendations made in this report will be challenging to implement and, we expect, will generate a certain degree of controversy. Nevertheless their development and implementation will be essential if future forest management needs are to be properly addressed.

Our recommendations are relatively broad-ranging and deal with a wide spectrum of nine issue groupings which confront the GY model user in the field – from Ministry GY organisation through data issues, modelling, extension and training. But they fairly reflect what we found and what GY model users told us they were concerned about.

We caution the reader not to view this report as the final, or even the draft, "implementation plan." There are many key players and organizations involved in GY modelling throughout the province and it will be important to gain the confidence of the majority of them, if not all of them, before embarking on the implementation of any of the strategic recommendations. Consequently, these recommendations may require additional refinement before they can be implemented.

Growth & Yield Modelling

The central importance of GY to forest management was summed up by the Forest Productivity Council in 1991.

> *Growth and yield, coupled with forest inventory, provides the information base upon which forest planning and investment strategy rests. Forest inventories provide data on the land base area and the volume of timber on it. A coordinated growth and yield program provides estimates of the rate of forest growth for those stands that have received silvicultural treatments and those untreated stands of natural origin. These necessary measures provide the means to estimate the future yield and quality of the forest under any resources management regime.*[1]

To manage GY issues, both the Forest Productivity Council and the Ministry of Forests have established GY Programs. The objective of both programs is to provide the growth and yield tools and information needed by forest managers to manage forest lands.

GY models are one of the essential tools used in predicting forest growth. These tools have become operational only in the last decade and most advancements have occurred within the last five years or so.

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[1] Secretariat, Forest Productivity Councils of British Columbia (March 1991), *Growth and Yield Program Plan 1991–1995,* Victoria: Inventory Branch, Ministry of Forests.

In this time, GY models have quickly been delivered to the operational levels and are now used by silviculture planners, timber supply planners and inventory specialists.[2]

Growth models are presently used to support several kinds of decisions including:

- timber supply or allowable harvest decisions – how does growth and yield affect timber supply through time?
- silviculture planning – how will specific treatments affect forest growth?
- program monitoring – which silviculture treatments are effective?
- inventory – what is the current and projected forest inventory?

Changing Social Expectations and New Demands on Forest Management

There are an array of constraints, opportunities and threats which affect the GY program and the course of GY modelling. Some of these factors may be found within the GY program while others are external to it.

At the operational level, new provincial initiatives such as the Timber Supply Review (TSR), Forest Practices Code, strategic level land use planning and the Protected Areas Strategy, new forest management approaches and the trend toward collaborative ventures and joint program delivery[3] have each placed new demands on models and vastly increased interest in, and the importance of, GY activities throughout the province.

Additional factors important to GY include market trends, the need to maintain or increase levels of forest-related employment. As well, the protection of biodiversity, wildlife habitat and other values related to the forest have become a greater concern in forest planning, and tree species sites which have been of little commercial value historically are now growing in importance.

As industry and government manage new constraints on the existing fibre supply, they have paid increased attention to growth and yield. As a result, there has been an increased demand for modelling approaches that can handle these additional factors. At the same time, the MOF (which is responsible for much of the GY modelling effort and expenditures) and many of the other cooperating agencies have entered a period of fiscal restraint. This pushes the MOF and others to work more efficiently, seek new mechanisms to fund GY initiatives and explore partnerships and other arrangements which would encourage industry to take on an increased responsibility for GY.

Organizations Involved in GY Modelling

There are several organizations involved in GY modelling including the Ministry of Forests, industry, academia, the Forest Productivity Council, Forest Renewal BC, emerging Growth and Yield Co-operatives and forestry consultants. The activities of each of these groups have or will have some impact on the other. For example, the Ministry of Forest's GY program is guided by the Forest Productivity Council's GY Strategy and FRBC has adopted the strategic priorities of the Forest Productivity Council and the Ministry of Forests programs.

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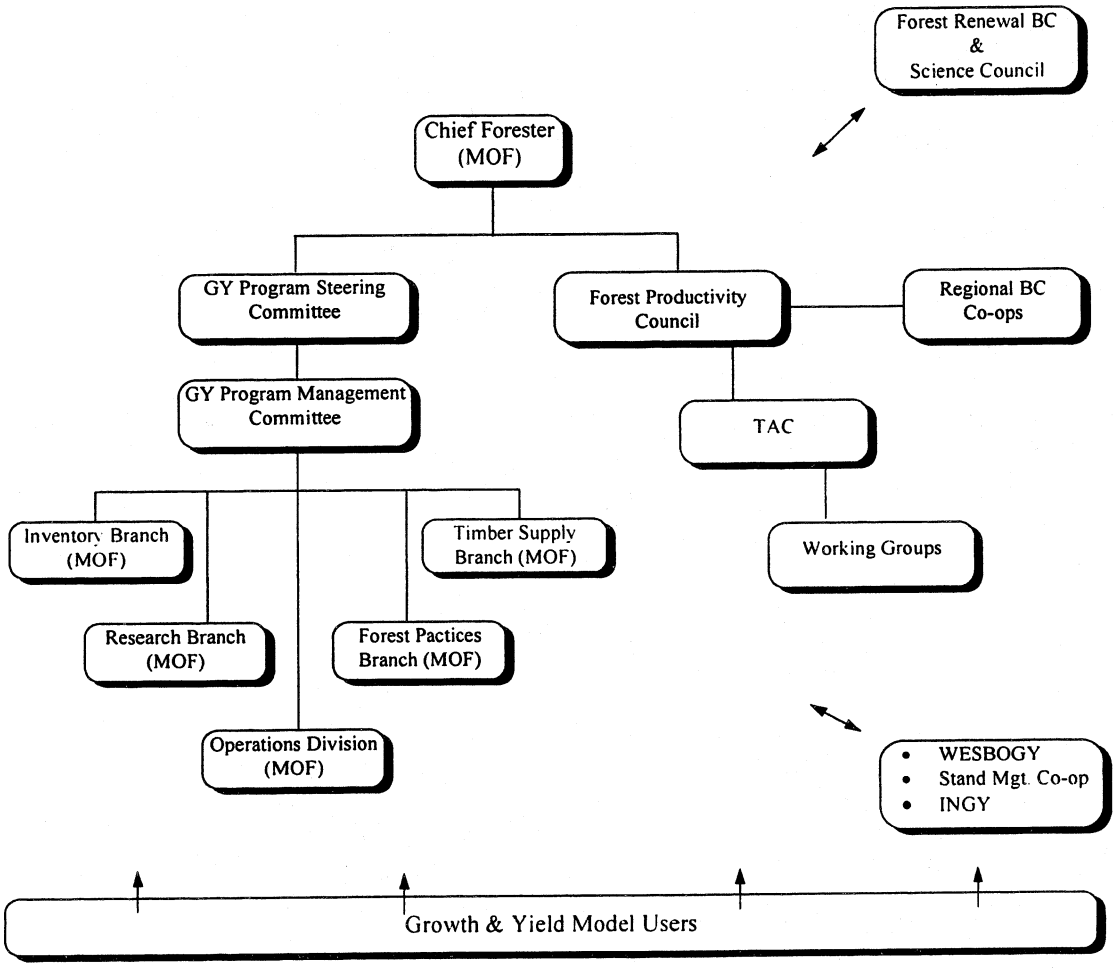
[2] Initially, models were developed for research purposes. In BC, the most significant research model is TASS (Tree and Stand Simulator) which was developed by the Forest Productivity Decision Support Section of the Research Branch (MOF).

[3] Strategic level land use planning includes Land and Resource Management Planning (LRMP) and the CORE initiated regional planning initiatives that continue to unfold.

Principle Groups Involved in GY Modelling



The Ministry of Forests Growth and Yield Program is a coordinated, inter-branch program consistent with the Forest Productivity Council's current Growth and Yield Program. The MOF's program guides GY activities in the Resources Inventory Branch. Research Branch and the Forest Practices Branch. The Timber Supply Branch is also an important participant but primarily as a user of systems developed and implemented in the other branches. These four branches are part of the Forestry Division for which the Chief Forester is responsible and their GY activities are coordinated through a GY Program Steering Committee (GYPSC). The Forestry Division, in turn, is one of the four divisions into which the Ministry of Forests is divided. The Operations Division is the operating arm of the ministry and is responsible for implementing ministry policy. They use systems and tools developed through the GY program and play a leading role in data collection. In sum, activities pursued through the GY Program are expected to contribute to the achievement of branch, division and ministry wide objectives.

GY Modelling Applications

Growth and Yield models are typically used for three key applications, namely:

- Silviculture planning
- Inventory; and
- Timber supply planning (e.g. the determination of AACs)

Silviculture Planning: Foresters demand models to predict stand growth. These predictions are required to conduct economic assessments of treatment alternatives, help in selecting appropriate silviculture treatment programs, select the individual sites for treatment. and on individual sites, prescribe the right treatment.[4] In the Ministry of Forests, attention has been focused on TIPSY and Prognosis predominantly in the Forest Practices Branch and TASS in the Research Branch.

Inventory: The Resources Inventory Branch has typically used GY models to update and project the inventory of standing timber volumes. VDYP is the primary tool used in this regard.

Timber Supply Planning: GY models provide outputs which in turn constitute one of the inputs for strategic level planning at the TSA and TFL levels. The Growth and Yield models typically used in this regard have been VDYP and TASS/TIPSY.

Outputs of GY modelling have also been used in economic modelling, forest health and the modelling of non-timber resources or biological modelling.

Most modelling effort occurs in the Ministry of Forests at the branch level (Research Branch, Forest Practices Branch, Resources Inventory Branch, and Timber Supply Branch) and operations throughout the Forest Regions and Forest Districts. Modelling is undertaken by major licensees including MacMillan Bloedel, Western Forest Products, for example, and in the forestry consulting community and by the various universities involved in forestry (predominantly UNBC and UBC). The models of greatest use in BC are briefly introduced below.

TASS (Tree and Stand Simulator)

The first substantial outputs of the TASS model were managed stand yield tables for coastal Douglas-fir in *1985.* Throughout the 1980's and early 1990's work continued on TASS, calibrating it for more species. The system continues to be maintained by the Research Branch and has been used intensively in the Timber Supply Analysis conducted for both Timber Supply Areas and Tree Farm Licences. These analyses in turn have been a key input into the decision making process for determining AACs.

TIPSY (Table Interpolation Program for Stand Yields)

Following the publication of yield tables for Douglas-fir (Mitchell and Cameron, 1985). Ministry planners requested the development of software that would give them electronic access to yield table information.[5] TASS generates the metric yield tables contained in WinTIPSY's database. WinTIPSY retrieves appropriate yield tables from its database, customizes the information, and displays the yield summaries. Yield tables are available for various even-aged coniferous species of commercial importance growing on the coast and in the interior of BC. TIPSY is used extensively in timber supply and silviculture planning.

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[4] Patrick Martin (January 1997), *Support Centre for Stand Growth models, (FRBC Operations Framework Proposal).*

[5] This section from: J.K. Mitchell, SE. Grout, and R.N. MacDonald (Dec. 1995), *User's Guide for Producing Managed Stand Yield Tables with WinTIPSY Version 1.3 under Microsoft Windows,* Victoria, Research Branch, Forest Productivity and Decision Support Section (FPDS), Ministry of Forests, p. 1.

VDYP (Variable Density Yield Prediction)

VDYP was calibrated for coastal and interior species in 1990/91, tested in 1991 and then validated. VDYP has been used extensively in the Timber Supply Review process initiated in 1992 and the most recent version was released in 1994 (version 6.2b). The recent completion of the Vegetation Inventory will likely lead to a major overhaul of the model in the coming years. VDYP was developed for use as an inventory model but has been pressed into service to project future volumes as well

Prognosis

In the late 1980's the Chief Forester endorsed a proposal to support the implementation of the Prognosis model for BC. Prognosis was developed in Northern Idaho to model complex stands. The feasibility of using the model in BC was explored in the early 1990's and, by 1995, the Forest Practices Branch was actively lobbying for Prognosis. They viewed it as the most viable tool available to project complex stands and their future stand structure. Prognosis was released for limited use in BC in 1996, and it is expected that Prognosis will be calibrated with BC data for the Southern Interior Region by the fall of 1997.

STIM & WinSTIM (Stand and Tree Integrated Model)

STIM was developed through the Canadian Forest Service. Although not designed as a silviculture tool, STIM can be used to make projections of treated stands.[6] STIM was developed for both natural and thinned stands of western hemlock. There were plans to calibrate the model for other commercial species such as aspen and white spruce. However, following the termination of CFS' modelling program, development of STIM has all but ceased.

MGM (Mixed Wood Growth Model)

More recently, the Ministry of Forests has been supporting the development of MGM through the WESBOGY Co-operative. The model is expected to meet emerging demands for mixed wood growth models in BC. The primary focus of the model is on white spruce and aspen. When operational, the application of MGM will initially be limited to the northeastern portion of BC.

SPS (Stand Projection System)[7]

The Stand Projection System was developed in the US specifically for coastal Douglas-fir and later calibrated for other species. Several pilot projects were initiated by the MOF to operationalize SPS for use in BC. Over the last few years SPS has fallen into disuse in the MOF. However, it continues to be used in the consulting community and industry where it has strong support.

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[6] G.M. Bonnor, R.J. DeJong, P. Boudewyn and I. W. Flewelling (1995). *A Guide to the ST/A! Growth Model,* Victoria: Pacific Forestry Centre, Canadian Forest Service.

[7] Secretariat, Forest Productivity Councils of British Columbia (July 1991) *A Guide to Growth and Yield Models of the Pacific Northwest.* Victoria: Inventory Branch, Ministry of Forests.

Strategic Directions for GY Modelling

Vision and Principles

The FPC is presently revising its vision of GY to better accommodate an ecosystem-based approach to GY. The following vision is suggested in this regard:

> *"To be able to consistently and accurately predict the dynamics of BC's forested ecosystems under any resource management scheme."*

Strategic Goals

There are nine strategic areas around which strategic goals and recommendations have been made. The strategic areas and goals are identified below. Issues and recommendations for each of these nine areas are then discussed and presented.

Strategic Area	Strategic Goals
1. Organization, Administration and Liaison	Ensure that the Organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.
2. Resources to Support the GY Program	Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.
3. Model Applications	Ensure that application related needs are identified and priorized.
4. Model Inputs and Data Requirements	Ensure that model inputs and data requirements are being collected to use GY models.
5. Model Development, Procurement and Operationalization	Provide specific GY models that meet the needs of clients.
6. User/Model Interface	Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.
7. Training	Improve the skills of GY clients to ensure that appropriate and optimal use is made of existing GY models.
8. Extension & User Support	Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.
9. Modelling Standards and Guidelines for Development, Application, maintenance, and Monitoring	Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.

The strategic directions, issues and recommendations are discussed below.

Issues and Recommendations

Organisation, Administration and Liaison

Strategic Goal: ***Ensure that the Organisational framework for GY allows for the development of "corporate" approaches to GY and engenders long-term support for GY modelling activities in BC.***

The MOF and other organizations pursuing GY activities remain committed to steering and managing the GY program through interagency mechanisms. To this end, the FPC has recently been reconstituted, a regional co-op appears to be taking root in the Southern Interior and the GY Steering Committee continues to improve the cohesion and coordination within the MOF's GY Program.

There are both positive and negative features of such an approach. Creative solutions often emerge, GY outputs hold greater legitimacy in the GY community, tensions are more easily resolved and client needs may be more easily communicated. But there are also risks. Initiatives may falter or progress according to the issues driving each of the constituent agencies and the GY organisation is more prone to losing cohesion and breaking down.

The organization of GY remains complex. We identified fourteen separate organisations which have responsibility for some part of the program. As a result, the accountability relationships are not always clear. That GY has made significant progress over the last several years is due more to the dedication of the individuals involved rather than any inherent qualities of the organisation.

Our recommendations center on the need for controls which ensure that the GY functions are clearly identified and purposively steered to improve understanding of the framework for pursuing GY and build commitment to and support for the organisational framework. These controls will assist in maintaining a stable, purposeful and accountable organisational and administrative framework which is an essential foundation for the GY modelling strategy.

Recommendations:

1. Formalize the GY program and design and document it according to accepted program design principles. The program design model should include the following features:
    - Identify the players
    - Specify which stakeholders benefit, and how
    - Evaluate alternative means of program delivery
    - Consider compatibility and linkages with other programs, and any potential for overlap or redundancy
    - Maximize cost-effectiveness and efficiency of delivery method chosen
    - Ensure the program is consistent with accepted government management principles
    - Ensure financial predictability and feasibility
    - Allow for program flexibility if conditions change
    - Examine for potentially unintended consequences
    - Determine implementation feasibility and practicality
    - Build in cessation provisions for specific activities, and
    - Design and implement performance measurement and program evaluation systems which may include:
        - identification of success indicators
        - formative evaluations

  - needs assessments
  - maintaining ongoing monitoring capabilities

  The description presented in Chapters 2 and 3 may be used as the starting point for this activity.
2. Develop a new GY communication strategy (including a GY modelling communication strategy) to convey program and strategy details and current initiatives. This strategy serves a two-fold purpose by raising awareness and managing expectations related to GY modelling.
3. Continue to use working groups, co-ops and TACs which have the support of the provincial GY community to undertake well defined, problem oriented projects or tasks. As such these bodies must be:
   - assigned specific terms of reference which:
     - define the problems,
     - explicitly link projects to problems;
     - identify project terms;
     - are limited as to duration; and
     - identify project deliverables.
   - comprised of members from each of the agencies with an interest in a particular initiative; and
   - guided by formal project plans. (The Prognosis BC approach serves as a model for future working group activities.[8])
4. Operate the GY Program under a 10 to 15 year planning horizon to ensure that plans to meet short and long term goals can be properly developed and implemented and that an appropriate balance is maintained between them.
5. Develop a formal business plan for each one to three year "rolling "planning period.

Resources to Support the GY Program

Strategic Goal: ***Secure sufficient resources (including funding, skills and personnel) to pursue GY initiatives of strategic importance in a timely manner.***

There are only a small number of GY experts in the province. Many of these people work within the MOF, while the remainder can be found in industry, private consulting practices and academic institutions. GY experts are a precious resource currently stretched thinly over many initiatives. As a result, some organizations are seeing. increased staff burnout, slow progress on some initiatives, the occurrence of too many projects sometimes managed off of a single desk, and initiatives faltering when a project "champion" leaves or retires. The small pool of available qualified GY experts cannot be brought to bear adequately on all GY issues.

In addition, the capacity to achieve long-term GY objectives is being compromised by the absence of a long-term funding commitment. As such, many of the long-term objectives of research and development work in GY and GY modelling are at risk. Further, given the risk posed to long-term objectives, there has been a tendency to focus efforts on short-term objectives and to develop "quick fixes."

Now that FRBC has become the greatest source of funding for GY initiatives, users feel that the capacity to develop a long-term GY modelling program has been further eroded. During the course of our work, conflicts in funding criteria between FRBC and agencies such as the MOF were identified. In some instances this has caused GY projects of relatively little strategic importance to proceed at the expense of GY modelling initiatives of relatively great importance to the MOF.

[8] Ministry of Forests (nd.), *Prognosis BC.*

Given these conditions, two key challenges face the GY community. Firstly, issues of strategic importance must be addressed first. As well, sufficient control over the allocation of funding and security of funding over an adequate planning horizon (say 10 to 15 years) is required to ensure that greater emphasis is placed on identifying and working towards long-term objectives.

Secondly, the pool of available GY expertise should be enhanced. Additional training and teaching could be provided (issues addressed in the "training" section below). In addition, the GY program must be more actively promoted as a "career opportunity." The pool of labour may also be boosted somewhat by extending networks to GY experts abroad.

Other aspects which have affected GY resources include the perceived "black box" nature of GY and consequent perceptions that GY-related decisions are overly subjective and biased towards MOF interests. As a result, some organizations have reduced their effort in GY and in other cases, GY experts have left the pool of GY expertise altogether. Recent developments and our recommendations with respect to organisational, administration and liaison-related issues are intended to make some progress in alleviating this problem. Recommendations with respect to standards and guidelines have also been made which address this problem.

Recommendations:

1. FRBC should commit long-term funding to support the GY program in BC. One suggested funding arrangement is to establish an annuity with a term of ten to fifteen years (which is reviewed every 3 to 5 years). The annuity should ensure that current annual expenditure levels are maintained and, if possible, enhanced However, long-term continuity of funding may be as important as its actual level, since many GY projects are long-term in nature.
2. Partnerships between industry, MOF and academia should be promoted as a means to effectively implement and advance the province's GY program and GY modelling, in this regard, greater consideration should be given to incentives that promote industry participation in GY (Without sufficient incentives, continuing commitment to the newly constituted FPC, and GY generally, cannot be ensured.)
3. Co-ops should be promoted as one of the key mechanisms to pool resources between industry, MOF and academia. (Co-ops may be funded through FRBC and industry contributions.)
4. Long-term funding should be used to attract people with required skill sets, alleviating some pressure to develop skill sets locally through academic institutions, industry and the Ministry.
5. Seek out staff with broader skill sets rather than narrow model-specific GY expertise. Acquisition of a generalized skill set enhances adaptability of staff and promotes a more efficient use of human resources.

Model Applications

Strategic Goal: ***Ensure that application related needs are identified and priorized.***

Clients identified stand types, silvicultural systems and treatments and other conditions which cannot be modelled adequately with the GY tools currently available. These included:

- Forest health impacts on GY (root rot in the Southern Interior was identified most frequently)
- Even-aged single species stands for some individual species
- Uneven-aged stands (a need identified in all regions)
- Mixed species stands (in all regions)
- Mixed-wood stands and deciduous stands (identified in the Northern Interior predominantly)
- Succession
- Deciduous stands

- Non-productive stands
- Young stands
- Silviculture treatments including pruning, thinning, spacing and fertilization
- Partial cutting
- Decay and waste
- Wood value and quality modelling
- Stand modelling which is linked to estate level models

As apparent from this list, there are perceived gaps in many areas and a vast GY program would be required to address them. However, given the current climate it is important that gaps of greatest strategic importance to each of the major client groups are addressed first. Care must be taken to avoid the risk of undertaking a modelling effort which is too broad in scope given anticipated resourcing constraints. There is some evidence that at present the GY modelling effort is too diffuse.

Our recommendations are centred on the lack of systematic and "objective" criteria to identify strategic gaps. Such criteria are essential to focus GY modelling efforts to produce meaningful results, in a timely fashion in areas of greatest need.

Recommendations:

1. Document required outputs for tree and stand simulators for each of the client groups.
2. Develop and implement formal criteria for priorizing modelling needs for each of the major client groups.

Model Inputs and Data Requirements

Strategic Goal: ***Ensure that model inputs and data requirements are being collected to use GY models.***

Modelling gaps are often indicative of data gaps. As such, model inputs and data issues are closely related to the theme of model applications.

Apart from this, there is increased focus on the landscape unit for inventory purposes and this has underscored the need for inventory data of a finer resolution than currently available. Similarly, silvicultural planners are becoming concerned that stand level planning is not adequately linked to forest level objectives. In addition, the uncoordinated data collection and storage of GY data has been identified regularly as an impediment to an integrated, coordinated and responsive GY modelling program.

Recommendations:

1. Model requirements should be identified and documented prior to establishing data requirements.
2. An "end-state "for the database supporting GY modelling must be articulated in order to identify data gaps. These gaps are likely to vary in the short term as compared to the long term.
3. Formal criteria for priorizing data needs should be developed for each of the major client groups.
4. Promote the development of an integrated. coordinated. corporate approach to data collection and storage which maximises the use of existing data first.
5. Encourage the GY Co-ops as essential players in the continued development of the province's corporate data system.

Model Development, Procurement and Operationalization

Strategic Goal: ***To provide specific GY models that meet the needs of clients.***

There is currently no formal means of planning the acquisition of a model and approving its fitness for purpose. Nor is there a certification process which enables a user to know that the model he/she is using fits the data; does what he/she expects it to; has been subjected to a rigorous peer review process; and works according to a set of pre-determined standards. These are essential features which users have every right to expect.

Several initiatives are underway which will make some progress in satisfying the unmet client needs which were described to us. Work continues on Prognosis, TASS and MGM, for example. However, many clients believe that efforts to procure, develop and operationalize models have been inadequate and interview evidence suggests that efforts have not always been sufficiently well co-ordinated. Many have felt that the development of Prognosis BC has progressed too slowly while other models such as SPS have lost MOF support altogether (although still available for use in some districts) or shelved (WinSTIM). Efforts to identify other GY models which may meet particular user needs have been viewed as inadequate by some clients.

Recommendations:

1. Formalize the development/procurement process by including the following explicit functions:
    - Identify the business gaps (what we need versus what we have);
    - Articulate the business need;
    - Scan for existing models (BC and elsewhere) which will meet the business need:
    - Build only if there is no appropriate model to buy;
    - Address data issues refit and validation.
    - Address data issues re model operation; and
    - Develop and articulate strategies for
        - procurement versus building models,
        - data, and
        - operationalization.
2. Conduct an ongoing scan of models used and identify models which could be used in BC. Review should be undertaken by the FPC through an appointed TAC.
3. Models selected for use in BC should be approved and certified for use by the FPC.
4. Licensing/liability issues for GY models must be identified clarified and addressed as part of the model development, procurement and operationalizing process.
5. Criteria for investment in GY models should be established and should include costs, business plan, technical requirements, risk management issues and data availability.
6. Prognosis, MGM SPS, TASS, TIPSY Y-Xeno etc. must be accommodated in an FPC approved strategy.

User/Model Interface

Strategic Goal: ***Develop and maintain a user/model interface that is menu-driven, user friendly and easy to understand.***

GY clients identified the need for a user-friendly interface. Clients noted that some models were very difficult to use and that a Windows environment or simplified front-end would improve accessibility. Others noted that, at times, they found themselves jumping from one model to the other and that a common interface for all models currently in use would be helpful. Finally, some found that the inaccessibility of TASS is adversely affecting their approach to modelling. Although, the support staff for TASS has been quick to respond to client requests for special runs, clients note that this relationship is cumbersome.

Recommendations:

1. A common architecture should be developed for GY models used currently. This architecture would be corporate in nature, housing inventory, silviculture and timber supply models.
2. Prior to developing this architecture there is a need to conceptualize a modelling system with a decision key that allows identification of model(s) appropriate to specific needs.
3. Simplify interface for specific models. When feasible, a Windows format should be developed with sufficient depth to allow users to understand implications of approaches.

Training

Strategic Goal: ***Improve the skills of GY clients to ensure that appropriate and optimal use is made of existing GY models.***

The need for more training in GY modelling was identified frequently by model users. A lack of training has contributed to misapplications in modelling, and an unnecessary limit on the diversity of GY tools employed.

Some also identified the need to provide training in models such as WinSTIM and SPS. In the case of the latter we were told by one interviewee that SPS, although once used in the District, had fallen into disuse because the person conversant with the model had left, despite considerable effort and expense made to calibrate it for the district. An obvious result is that models which may be available for use are not being used as widely as they could be.

GY training provided through degree granting institutions was also identified as inadequate;

Recommendations:

1. A concerted effort should be made in the shorter term to increase the level of user training for GY users in the field.
2. A training needs study should be implemented to identify the specific training requirements.
3. A “stand alone” GY training module for foresters should be developed to meet the needs, based on the current SIBC Module 3 curriculum, and offered independently of other SIBC courses.
4. The module should be delivered through SIBC. using private sector trainers where possible and/or the facilities of the Forests Continuing Studies Network

5. MOF should reduce its direct involvement in the delivery of GY training courses.[9]
6. In the longer term, the FPC should promote additional GY knowledge transfer through degree granting institutions. This might include:
   - Establishment of GY training as a mandatory component in a B.Sc. degree in forestry;
   - The attraction of graduates in quantitatively oriented degree courses such as computer science and engineering to work in the forest GY field; and
   - Providing strong support for financial resources needed to implement GY training where there is a need.

Extension & User Support

Strategic Goal: ***Improve GY clients' level of awareness of GY program and initiatives and provide user support at levels which ensure that optimal use is made of existing GY models.***

Model users identified that the quality of extension efforts and user support has improved significantly in the last few years. However, several outstanding concerns were identified. Model users need information about all of the tools available currently whether they are (or are expected) to be in use predominantly in industry or the MOF. For example, although SPS and Y-XENO tend to be used predominantly in industry and the consulting community, there is still a need to provide MOF personnel with background information on each of these models. In some cases this information is required because MOF personnel may be faced with the task of approving plans or outputs which were developed using these models.

Modellers also noted that they were not always sure when to use a particular model. They noted that more effort was needed to communicate model parameters to GY clients and to provide a decision key that allows them to identify models that are appropriate to their needs.

Users identified the need for demonstrations of real life scenarios interpreted for specific models. This was identified as an important extension activity that could aid in promoting a common core approach to modelling and interpreting real conditions in terms of particular models.

Finally, clients reported some confusion with respect to which models have been approved for use (especially with respect to silviculture). In part this perception is due to the lack of user support for some models (e.g., WinSTIM) and the consequent perception that these models were not endorsed by the MOF.

To date, extension and user support efforts have been focused on WinTIPSY and VDYP. Interview evidence suggests that these efforts have been well received by GY clients, but, a greater commitment to extension is needed.

Recommendations:

1. A user support function should be established to provide assistance to GY users in the field. The service should include quick advice on the GY models approved for use, including the advantages and disadvantages of the use of specific models in the circumstances identified by the user.
2. GY users in the field should be kept up to date on GY developments taking place in the MOE head office, or in other areas, which affect them directly or indirectly. The best way to do this would be through the MOE internet service.

[9] During the course of the study, it was argued that in the ministry, GY experts' time was better spent in research and model development rather than in the delivery of training. This recommendation is therefore intended to ensure that GY experts are used as effectively as possible. It is also recognized that the ministry's GY experts have a much valued ministry context when teaching. As such, some training courses, whose success is dependent on effectively communicating this unique experience, must continue to be delivered by the MOF.

3. MOE should investigate the option of contracting out the user support function to a private sector agency, which might also offer similar services to industry.
4. A multi-year training and extension plan should direct extension activities.
5. Greater efforts are required to make GY clients aware of GY initiatives and current research.

Modelling Standards and Guidelines for Development, Application, Maintenance and Monitoring

Strategic goal: ***Ensure that accepted standards and guidelines for the development, application, maintenance and monitoring of GY models are developed and communicated to GY clients.***

GY activity is characterized by an absence of explicit and recognizable standards and guidelines. Yet there is considerable uncertainty regarding the role and practicality of developing such standards and guidelines. Some strongly oppose the development of guidelines arguing that further abuses and misapplications of GY modelling are likely. Additionally, many argued that GY modelling remains a very subjective exercise and that guidelines will not change this condition. In opposition, others argued that guidelines are essential to move beyond the "black box" view of GY modelling and to develop approaches that command the legitimacy of MOF and industry alike. We support the latter view because misapplications of the technology, while not immediately apparent, can have significant long term consequences.

Some of the areas and functions where standards and guidelines do not exist are as follows:

- The recertification of specific GY models to be used under particular circumstances such as location and areas, species, silviculture applications, age, etc.
- The process of approving and certifying models for particular usage;
- The process of maintaining the certification, or recertification, of models and applications;
- "Use policies" or "practice codes" governing the use of GY models;
- Performance monitoring processes used to ensure what models, and the data used in them, continue to be relevant; and
- The acceptance and approval of specific yield curves.

GY modelling efforts have survived in the absence of such standards and guidelines processes. However, its increasing importance to the forest managers of the 21st century will require that these critical processes be documented in a formal way.

Recommendations:

1. Establish certification processes for GY models and development of yield curves.
2. Develop standards and guidelines to address species, geographic limits, treatments, and resolution (age classes, individual stand densities etc.)
3. Develop "use policies" for current GY model to ensure that models are wisely/appropriately used (Prognosis "use policy" can serve as an instructive model).
4. Establish monitoring procedures to ensure that GY tools are periodically evaluated and "recertified."

Priorising and Scheduling the Strategic Directions

The elements of the entire strategy have been priorised over a five year period, shown in chart form on the next page. It is anticipated that these priorities will be confirmed and refined over the coming months.

GY Modelling Strategy
Proposed Priorities and Implementation Schedule

	Ranking	1997/98	1998/99	1999/00	2000/01	2001/02
ORGANIZATION, ADMINISTRATION, LIAISON						
1. Formalize GY Program	B					
2. GY Communication Strategy	B					
3. Define Role of Working Groups	C					
4. Extend Planning Horizon (10 - 15 years)	C					
5. Develop Formal Business Plan	D					
RESOURCES						
1. Secure Long-term Funding	A					
2. Promote/Develop Partnerships	B					
3. Promote Coops as Means to Pool Resources	C					
4. Attract Required Skill Sets	C					
5. Seek out Broader Skill Sets	D					
MODEL APPLICATIONS						
1. Document Required Outputs for GY Models	C					
2. Develop & Implement Criteria for Priorizing Needs	C					
MODEL INPUTS AND DATA REQUIREMENTS						
1. Identify Model Requirements	C					
2. Identify "end-state" for Data Base	C					
3. Develop Criteria for Priorizing Data Needs	B					
4. Corporate Approach to Data Collection & Storage	C					
MODEL DEVELOPMENT, PROCUREMENT AND OPERATIONALIZATION						
1. Formalize Development/Procurement Process	D					
2. Environmental Scan - For Models	D					
3. Certification Process and Role of FPC	D					
4. Address Licensing/Liability Issues	D					
5. Investment Criteria	D					
6. Ensure FPC Accomodates Major Models	B					
USER/MODEL INTERFACE						
1. Develop Common Architecture for GY Models	D					
2. Conceptualize Modelling System	D					
3. Simplify Interface for Specific Models	C					
TRAINING						
1. Increase Level of User Training in the Field	A					
2. Identify Training Needs	C					
3. Develop Stand Alone GY Training Module	C					
4. MOF Reduce Level of Direct Involvement in Training	D					
5. Promote Knowledge Transfer	A					
EXTENSION AND USER SUPPORT						
1. Establish User Support Function	B					
2. Keep Operations Informed on GY Developments	A					
3. Investigate Option of Contracting Out	D					
4. Develop Multi-year Training and Extension Plan	A					
STANDARDS AND GUIDELINES						
1. Certification for GY Models & Yield Curves	C					
2. Species, Geographic Limits, Treatments, Resolution	B					
3. Use Policies	B					
4. Monitoring	A					

Key	Ranking			D	C	B	A
	colour code						
	amount of program emphasis		none	low	med.	high	max.

Next Steps

Growth and Yield is at a threshold in BC. The GY community has been quick to take up many of the merging challenges already but cannot yet ensure strong program coordination, responsiveness and effectiveness in this climate of shifting responsibilities, interests, and needs. We believe the GY modelling Strategy presented represents a departure from, and an improvement in, the way things get done.

The strategy presented here represents one of the first of many steps in the implementation of change. The real effort is yet to come, but come it must if the GY program and related activities are to meet the rapidly emerging needs of the managers of the forest resource throughout the province.

For the immediate future, the following steps are recommended for implementation over the coming months:

1. General acceptance by the GY Steering Committee of the recommendations comprising the GY modelling strategy and the preliminary estimates of timing;
2. Summarization and presentation to the Chief Forester and the FPC, together with preliminary estimates of timing and resources;
3. General approval of the FPC and the Chief Forester;
4. Development of a detailed implementation plan, overseen by the FPC on behalf of the Chief Forester;
5. Establishment of a GY Modelling Group to assist in developing an implementation plan;
6. Publication and distribution of the implementation plan; and
7. Implementation of the plan over a five year period.

* * * * *

We appreciate the opportunity to conduct this work on behalf of the Ministry and look forward to providing further assistance during the implementation of the strategic recommendations.

FORUM Consulting Group
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