Abstract

The Stand Management Co-operative (SMC), of which the BC Ministry of Forests is a member, is a multi-agency growth and yield cooperative established in 1985. Its mission is to provide a continuing source of high quality information on the long-term effects of silviculture treatments and treatment regimes on stand and tree growth and development and on wood and product quality and recovery. The main objective is to design, establish and maintain a regional program of integrated research on various aspects of intensive stand management to provide a continuing source of consistent, high-quality data on the effects of stand management practices on several aspects of wood production: stand growth and yield, tree growth and yield, wood quality and product recovery. Of particular interest are stands that have been under stocking control from an early age, and that include a wide range of initial spacing. The data are used to assess both the short- and long-term effects of certain silvicultural treatments and management regimes on stand and individual tree responses and to provide better estimates of the biological and economic consequences of alternative management regimes. This year, FIA funding contributed to meeting the SMC objectives by allowing for the full remeasurement of 3 BC installations (21 plots), partial remeasurement at 4 installations (8 plots) and as part of scheduled treatment and maintenance, 5 plots were thinned and 3 plots were pruned. The SMC produced a number of extension products including an annual report, 4 quarterly reports and 9 working papers. In addition, 8 peer-reviewed manuscripts have or soon will be published.

Introduction

The Stand Management Co-operative (SMC), of which the BC Ministry of Forests is a member, is a multi-agency growth and yield cooperative established in 1985. Its mission is to provide a continuing source of high quality information on the long-term effects of silviculture treatments and treatment regimes on stand and tree growth and development and on wood and product quality and recovery. The main objective is to design, establish and maintain a regional program of integrated research on various aspects of intensive stand management. Central to this objective is the need to provide a continuing source of consistent, high-quality data on the effects of stand management practices on several aspects of wood production: stand growth and yield, tree growth and yield, wood quality and product recovery. Of particular interest are stands that have been under stocking control from an early age, and that include a
wide range of initial spacing. The data are used to assess both the short- and long-term effects of certain silvicultural treatments and management regimes on stand and individual tree responses and to provide better estimates of the biological and economic consequences of alternative management regimes.

Since 1985, the SMC has been very successful in achieving its goal of establishing a large number of well designed installations that provide a continuing source of consistent, high-quality data on the effects of stand management practices on tree and stand growth and yield, wood quality and product recovery. The SMC maintains a database on 441 installations located throughout coastal British Columbia, Washington, and Oregon, primarily in Douglas-fir and western hemlock. These installations contain 4,566 plots with a variety of silviculture treatments. This represents a total of 258,057 individual trees which, in aggregate have been measured a total of 1,337,964 times. In addition there are soil survey data, vegetation surveys, and stem section information.

The BC Ministry of Forests, as part of their commitment for membership in the SMC, contributes in-kind services for the measurement and maintenance of 22 SMC installations located throughout coastal BC. Funding for 2004/05 covered costs of planned pruning, thinning, remeasurement and maintenance of 7 of the 22 installations and participation in Policy and TAC meetings where research priorities were voted on.

The SMC is now in the enviable position of using its links with research organizations and universities to use the data for analysis and reporting on a wide range of forest management issues. Recently completed examples include a large study on the processing of plantation Douglas-fir into lumber and veneer that established important linkages between silviculture, log quality, and value; studies on modelling branch and crown structure and occlusion after pruning in young Douglas-fir; and a growth & yield model for Douglas-fir stands.

The following is a list of Contributing Members of the SMC. Industrial partners are dues-paying members, and institutional partners contribute grants or in-kind services.


**Institutional Members:** BC Ministry of Forests, Oregon State University, University of Washington, US Forest Service Pacific Northwest Research Station
Methodology

Although there have been a considerable number of studies on the effects on initial spacing, pre-commercial thinning and commercial thinning, a number of problems with these studies limit their usefulness (SMC, 1985). These studies generally do not have a wide range of tree spacing, have had density control treatments after prolonged competition and resulting crown reduction, and effects have not been followed over the life of the stand. Measurements are often inconsistent among studies, and there are few sets of comparable data that span a wide range of sites, geographical areas, and density control treatments. Studies have rarely included any examination of the effects of silvicultural treatment regimes on wood properties and value.

Based on these observations, the SMC developed their experimental design to permit effective and operationally practical answers to stand management issues. The basic design considerations were:

- The data was to be applicable for inferring and predicting treatment response over the entire coastal Douglas-fir region, rather than to an individual location;
- Installations were designed for long-term monitoring over a complete rotation;
- Plot sizes had to be large enough so that over the entire period of observation, the number of trees was sufficient to provide reasonable estimates of diameter distributions, to allow a range of wide range of thinning treatments, and to allow mortality of individual or small groups of trees without greatly influencing plot values;
- Plots were surrounded with adequate size, similarly treated buffers to avoid influence of adjacent stands and treatments;
- The resulting plot values could be considered a reasonable approximation to results obtainable on an area of operationally treatable sizes.

Each of the SMC installations is a group of permanent sample plots, forming part of the designed experiment, which is established based on statistical principles to determine and compare the effects of stand management treatments on tree and stand growth and yield. Plots are grouped within a designed experiment according to ecosystem, geographic location, species, treatment, etc.

SMC currently measures and maintains 92 active research installations that are Type I (juvenile spacing), II (commercial thinning), or III (espacement) installations of Douglas-fir, western hemlock or mixed plantations. All procedures for the establishment, measurement and maintenance of each of these experimental designs are documented in Field Procedures Manuals (SMC, 1995).

The Type I installations are established in existing young Douglas-fir and western hemlock plantations that have uniform stocking and before the onset of substantial
inter-tree competition. Each installation consists of 7 treatments based on the initial stems per acre or hectare (ISPA) of the stand and Curtis’ Relative Density Index (RD). At establishment four plots remain at the ISPA, two plots are thinned down to half (ISPA/2) and one plot is thinned down to one-quarter (ISPA/4) of the initial density. Except for one control plot, all plots then follow a prescribed thinning regime. One of the ISPA and ISPA/2 treatments are given a minimal thinning regime consisting of reducing the RD from 55 to 35 with no further thinning. One each of the ISPA plots are given a repeated thinning regime (RD 55 to 35, RD 55 to 40 and subsequent thinnings RD60 to 40) or a heavy thinning regime (RD45 to 30; RD50 to 35 and subsequent thinnings RD55 to 40). At some installations, additional plots are treated to implement pruning and/or fertilization treatments. There is a total of 30 Douglas-fir (4 in BC) and 8 western hemlock Type I installations (4 in BC).

The Type II installations are established in existing older Douglas-fir plantations approaching a commercial thinning stage and considered to approximate the expected future condition of the Type I installations. Each installation consists of 5 plots with density control treatments described as follows:

1. Repeated thinning, high density regime – first thinning at RD 55, cut to RD 35; second thinning at RD 55, cut to RD 40; subsequent thinnings at RD 60, cut to RD40. The number of thinnings depends on site class and rotation age.

2. Repeated thinning, low density regime – first thinning at RD 55, cut to RD 30, subsequent thinning at RD 50, cut to RD 30. The number of thinnings depends on site class and rotation age.

3. Minimal thinning – at RD 55, cut to RD 30. No further thinning to be performed.

4. Delayed thinning – at RD 65, cut to RD 35. No further thinning to be performed.

5. Control – no thinning performed.

There are 12 Type II installations (3 in BC).

Type III experiments are areas operationally planted at a wide range of spacing from 100, 200, 300, 440, 680 and 1210 stems per acre (250, 490, 740, 1090, 1680 and 2990 stems per hectare respectively) to provide experimental material for future research uses. At least 3 contiguous acres (1.1 ha) were planted using the best current regeneration practices at each spacing. After planting, permanent tree and vegetation measurement plots (Type IIIp) are established at each density to monitor early stand development. Depending on the initial spacing, additional plots are established to evaluate the effects of very early thinning or pruning on growth and development. In the three widest spacings a matrix of pruning density, (100 or 200 stems per acre pruned with unpruned “followers”) and levels of pruning (50% of live crown removed or pruned to 2.5 inch top) is prescribed. In the three dense spacings a matrix of thinning regimes is scheduled. Thinning treatments include: early/light, early/heavy, late/light, late/heavy, and a late one time. There are 38 Douglas-fir, 6 western hemlock and 3 mixed Type III installations. BC installations include 2
Douglas-fir, 1 western hemlock and 8 other species including 3 yellow cedar, 2 western redcedar, 2 amabilis fir and 1 Sitka spruce.

And, in collaboration with the Northwest Tree Improvement Cooperative, a new Type IV experimental design will examine genetic gains at 3 levels of spacing, with and without vegetation control. This design creates a set of installations, each containing 22 plots, within a genetic breeding zone. The first set, in the Grays Harbor breeding zone for Douglas-fir, will be planted in 2005-6.

The primary aim for the data is for fitting “regionalized” response surfaces, rather than to test “significance” of differences at individual locations. The installations have been established such that there is a balanced distribution of installations across sites and physiographic regions. The information resulting from the experiments include the response of stand to treatments, appropriate treatment levels and timing, impacts of treatment on final yield and impact of damaging agents following treatment. The statistical approach ensures that objective and meaningful conclusions can be drawn from the data collected from experimental plots.

Peer reviewed manuals outline the standarized procedures for establishment of SMC field installations (SMC 1995). Data quality assurance standards are applied to ensure data accuracy. Conformity with establishment procedures, measurement standards, and treatment specifications ensure a reliably consistent, high quality database that is a prerequisite to evaluating alternative management regimes.

Results

Full remeasurements were done at 3 BC installations (21 plots), partial remeasurement at 4 installations (8 plots). In addition to remeasurement, and as part of scheduled treatment and maintenance, 5 plots were thinned and 3 plots were pruned. The data were collected by qualified contractors using an Invitation to Quote solicitation process. All data were field and office checked for quality assurance.

Part of the membership dues is used to support a number of yearly research projects conducted by universities and other research organizations. An annual research planning process identified high priority research needs, developed requests for proposals from the scientific research community, and selected the best of these proposals for funding. BC provided strategic direction for research projects by participating at both the spring and fall policy meetings.

As part of the extension plan, the SMC published an annual report and 4 newsletters to transfer the latest research results to members. A variety of technical reports, proceedings publications, and peer-reviewed journal articles are published through SMC members and institutional collaborators including: presentations or participation at meetings, workshops and conferences; fact sheets, reports, proceedings, theses and journal articles produced in association with SMC resources. The information is placed on the SMC website (www.standmgt.org).
Working papers produced and available on the SMC Website for the 2004 fiscal year include:

- Time and Size for Young, Coastal Douglas-fir to Occlude After Pruning, By David Briggs, Professor Forest Resources, SMC Director
- Juvenile Plantations Exhibit the “Crossover” Effect, By Eric Turnblom, Assistant Professor Forest Management and Engineering
- Pruning, Spacing and Site Quality Affect Branch Size and Stem Form, By Eric Turnblom, Assistant Professor Forest Management and Engineering
- Evaluating the Growth Response of a Forest Stand to Fertilization in the Absence of Replication, By Randol Collier, Data Base Manager SMC, and Eric Turnblom, Assistant Professor, Forest Management and Engineering
- Height-Age Curves for Planted Stands of Douglas Fir, with Adjustments for Density, By James Flewelling, Randy Collier, Bob Gonyea, David Marshall, and Eric Turnblom
- When does Competition Begin and the “Crossover” Effect End? By Sam Pittman, Graduate Student, University of Washington and Eric Turnblom, Assistant Professor Forest Management and Engineering
- Effects of N-Fertilization on Instantaneous Carbon Fixation Ability of Douglas-Fir Foliage: Relative Importance of Leaf Area and Photosynthetic Rate, BY Thomas M. Hinckley, Professor, ES, College of Forest Resources, University of Washington Zuo Shen and Holly Barnard, Graduate Students College of Forest Resources, University of Washington
- Growth of Immature, Spaced and Fertilized Douglas-Fir Stands: Second Measurement Results, Eric Turnblom, Assistant Professor, M&E, Forest Biometry, Rob Harrison, Associate Professor, ES, Forest Soils, College of Forest Resources, University of Washington

As SMC members, the Ministry of Forests have access to these extension products and in partnership with FORREX, information related to SMC reports, publications, events and website updates are made available to forest management professionals and practitioners in British Columbia through announcements posted on the FORREX Forest Resources Dynamics Listserv. Currently this listserv has a distribution of 330 people and is continuing to grow on a regular basis.

In addition, the following papers were published or are soon to be.

MS Thesis. College of Forest Resources, University of Washington, Seattle, WA. 82 pp


For clarity, the following is the SMC policy for distribution and use of publications, software, models and other works taken from ANNEX C of the most recent draft of By-Laws of the Stand Management Cooperative (Sept. 11, 2003). The BC Ministry of Forests is considered a member. Other organizations in BC, unless dues-paying members, would be considered non-members.

SMC Policy for Distribution and use of Publications, Software, Models and Other Works

1. SMC members are encouraged to share results from their analyses involving use of SMC data.
2. Results of analyses, software, or models based on the SMC database in peer-reviewed journals, theses, symposium proceedings, and other media by UW faculty, staff, students, and designated analysts (on data from Cooperative installations and on shared data) are owned by the University of Washington and administered by the Cooperative Director. The Cooperative will publish results in scientific journals and other media. SMC members will receive copies of these works. These works may be copyrighted by the UW, the authors, or the publishing entity.

3. Non-UW members may also develop and publish analyses, software, or models based on the SMC database. Copyright, if any, established on any such works remains under the ownership and control of their respective authors (or assignees).

4. SMC members and non-members wishing to use or distribute copyrighted materials must obtain appropriate permissions from the copyright owner(s).

5. The SMC data used in the development of any copyrighted or uncopyrighted works remains the property of the University of Washington and subject to the distribution rules in Section I (Listed below in Section 4.3).

A data dictionary (SMC 2002b) describes in detail the tables in the relational database currently maintained by the SMC. The primary entities of this database are Project, Installation, Plot, and Tree. Other data included in the database, such as soil litter and foliage nutrient samples and vegetation and habitat surveys, is an attribute of one of these entities. The Stand Management database is stored in ACCESS 2000 and maintained on a local area network of linked personal computers physically located at the College of Forest Resources, at the University of Washington.

For clarity, the following describes the data and database rules for use of SMC data taken from ANNEX C of the most recent draft of By-Laws of the Stand Management Cooperative (Sept. 11, 2003). The BC Ministry of Forests is considered a member. Other organizations in BC, unless dues-paying members, would be considered non-members.

SMC Metadata and Data Management
1. All organizations, member or non-member, have access to data from installations on their own land at any time.

2. Upon request, each SMC member receives a CD copy of the annually updated database. Updates are generally available at mid-year.

3. SMC members have access to all data collected from SMC-supported studies under the conditions that (a) the data will not be released to non-member organizations and (b) any publications or products resulting from the use of SMC data must credit that fact.

4. Data shared with the SMC by any organization will not be available to any other member or non-member organization without the express permission of the sharing organization. Data shared with the SMC are to be used for accomplishment of SMC goals, and only results and summaries from analyses
are to be published. Shared data will be considered as proprietary information and the designated analyst(s) will take every precaution to ensure confidentiality.

5. An entity that is not a member of the SMC will be granted access to the database and related products only by joining the SMC under one of the membership categories defined in Article V of the By-Laws or via the process indicated in Rule 6. If an SMC member wishes to contract a service provider with the intent that that provider will be granted access to the member’s copy of the SMC database for specific proprietary analyses, that service provider must become an SMC member thereby agreeing to abide by the rules of membership, database use, and publications as stated herein.

6. It is recognized that certain individuals and organizations may desire access to the SMC database for research or other purposes without joining as a member. Requests for data in these situations will be treated on a case-by-case basis. The individual or organization will submit to the SMC Director a written proposal request outlining the analysis planned, plans for use and/or publication of results, and the specific data requested. The proposer must agree to (a) share results of their analyses with the SMC and (b) to provide a review draft of any related publication. The Director will present the request to the Policy Committee for approval. Upon approval, a formal agreement, including a Licensing Agreement and appropriate fees, will be negotiated by the SMC and the proposing entity through the University of Washington Office of Software and Copyright Ventures.

All documents related to the SMC are filed according to Experimental Project number (EP1013). Documents include peer reviewed working plans, establishment reports, interim reports, maps, photographs, correspondence, annual report minutes etc.

Research Branch Growth & Yield data, individual tree detail and meta-data, is being stored in a single database, called Gydatabase. This database is a LAN-based MSAccess application, developed and maintained by the Research branch. The Gydatabase contains current as well as historic data, serving not only as a data archive, but also as a reporting tool. Data quality assurance is obtained by checking all data, prior to loading into the database, for consistency and accuracy. Any research information and data generated by this project is catalogued and linked with existing project data and products in Ministry of Forest’s Forest Science Program (MoFFSP) research database. Metadata tags for these projects and associated products are then be generated and uploaded to the NRIN database on an annual basis. The Research Branch has developed the methods and protocols for an efficient process. This ensures that products resulting from BCFSP investments are made known to as broad an audience as possible. The data management protocol used by the MoF FSP centralises data and information on government servers at all Responsibility Centres (i.e. Regional, Headquarters and Research stations). This data is then backed-up and stored off site at the end of every workday. This will ensure that the BCFSP investment will be protected and will be accessible
following a catastrophic event. In addition, Research Branch geo-references and identifies land-based assets (Research Installations) associated with this project. This demonstrates our long-term commitment to protecting BCFSP investments not only for the current project but also for future projects.

**Conclusion and Management Implications**

The SMC continues to provide a high quality source of data for coastal stand management. This year all scheduled measurement, treatment and maintenance for BC installations were completed. The data are used to assess both the short- and long-term effects of certain silvicultural treatments and management regimes on stand and individual tree responses and to provide better estimates of the biological and economic consequences of alternative management regimes. The information resulting from the experiments include the response of stand to treatments, appropriate treatment levels and timing, impacts of treatment on final yield and impact of damaging agents following treatment. To this end, the SMC produced an annual report, 4 quarterly reports, 9 working papers that are available on the SMC website. In addition, 8 peer reviewed manuscripts were or are soon to be published. Information related to SMC reports, publications, events and website updates are made available to forest management professionals and practitioners in British Columbia through announcements posted on the FORREX Forest Resources Dynamics Listserv. Currently this listserv has a distribution of 330 people and is continuing to grow on a regular basis.

**Literature Cited**


