Abstract
The Stand Management Co-operative (SMC) is a multi-agency growth and yield co-operative established in 1985 to provide a continuing source of consistent, high-quality data on the effects of stand management practices on stand growth and yield, tree growth and yield, wood quality and product recovery. This Regional program of integrated research on various aspects of intensive stand management in Douglas-fir and western hemlock extends from BC to Oregon. There are 22 installations in BC. This project has resulted in substantial additions of data to the GYdatabase. Over the 3 year period of FIA funding, 162 plots were measured and/or treated to SMC and Ministry Standards on 18 installations. The data from these and other long-term Coastal Stand Management Growth and Yield Field Experiments are used to build models and decision-making tools needed for essential tasks such as determining the effects of management practices on forest dynamics, growth and timber yields, continued development of SIBEC and other tools including GY modeling, and ultimately for the AAC determination processes. The data is also important is assessing new and emerging forest practices questions. As well, a variety of technical reports, proceedings publications, and peer-reviewed journal articles are published yearly through SMC members and institutional collaborators. In the 3 year funding period from 2004 to 2006, the SMC has produced 34 publications. Much of the information is placed on the SMC website (www.standmgt.org). SMC information is made available to B.C. audiences through our partnership with FORREX. Continued involvement in the SMC will provide much needed forest management data and information well into the future.

Introduction
The long-term future of the forest industry on the BC coast depends in part on the productivity of the region's forests and on the choice of silviculturally sound and cost-effective management regimes. Intensive silviculture is considered an important part of the Coast Recovery Strategy. Reliable projections of the results of possible alternative combinations of silvicultural practices are essential for realistic evaluation of forestry investments and for intelligent choices among management regimes. Needed are reliable estimates of response to silvicultural treatments and management regimes, understanding of how product quality and value are influenced by these treatments and regimes, and methods for designing regimes that will produce high yields of wood with desirable properties. The cost of establishing and maintaining a long-term research experiment on the scale necessary to build an adequate regional database to achieve this, are beyond the capabilities of any single organization.

To create a pool of funding, scientific talent, and long term continuity needed to assess the effects of intensive silviculture, the Stand Management Co-operative (SMC) was established in 1985 as a multi-agency growth and yield co-operative. The mission is met through a cooperative effort of land owners, processors, research agencies, and universities. The main objective is to provide a continuing source of consistent, high-quality data on the effects of stand management practices on stand growth and yield, tree growth and yield, wood quality and product recovery through the design, establishment and maintenance of a regional program of integrated research on various aspects of intensive stand management.
Although there have been a considerable number of studies on the effects of 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.

SMC currently measures and maintains 92 active research installations that are Type 1 (juvenile spacing), II (commercial thinning), or III (espacement) installations and in cooperation with the Northwest Tree Improvement Cooperative, the Type IV (genetic gain by spacing by vegetation control). The SMC is currently in the enviable position of having a large high quality database that can effectively answer the questions stated above.

The Ministry of Forests and Range has been a member of the SMC since its inception and is responsible for the maintenance and remeasurement of the 22 SMC installations located throughout coastal BC. The information we receive from SMC staff, student and partner's research projects, data and extension products includes the response of stand to treatments, appropriate treatment levels and timing, impacts of treatment on final yield and impact of damaging agents following treatment. SMC information is made available to B.C. audiences through our partnership with FORREX. In addition, the data for these installations and all other SMC installations contribute to the Provincial Growth and Yield Program (GYP), that provides the data, models, and information needed for essential tasks such as inventory projection, planning silvicultural treatments, calculating stumpage revenues and determining allowable annual cuts.

**Methods**

SMC currently measures and maintains 92 active research installations that are Type 1 (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 the experiment types 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 thinnings 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 thinnings to be performed.
4. Delayed thinning – at RD 65, cut to RD 35. No further thinnings 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 spacings 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. In BC there are 21 Type III installations of different species including 2 Douglas-fir, 1 western hemlock, 3 yellow cedar, 2 western reedcedar, 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 6 installations, each containing 22 plots, within a genetic breeding zone. The first set of 6, in the Grays Harbor breeding zone for Douglas-fir, were planted in 2005-6. However, because BC has no plans to establish a Type IV at this time, this design will not be discussed here.

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. 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. 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.

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.

**Results**

**1. Measurement and Maintenance of BC Field Installations**

Over the 3 year period of this project, and according to the planned schedule, there were 162 plots measured from 18 installations, 10 plots were re-thinned and 3 plots were pruned. The details are listed in the following table.

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<th>Install #</th>
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The data is stored as individual tree detail and meta-data, 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.

The data from the BC installations is sent to the Stand Management database which is stored in ACCESS 2000 located at the College of Forest Resources, University of Washington. 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. A data dictionary (SMC 2002b) describes in detail the tables in the relational database currently maintained by the SMC.

2. Extension

The extension plan for the SMC requires publication of an annual report and 4 newsletters per year to transfer the latest research results to members. The SMC also works with University of Washington & Oregon State University Extension on their needs and provide support to Rural Technology Initiative Program (www.ruraltech.org), the Focused Science Delivery Program and others per their requests. A variety of technical reports, proceedings publications, and peer-reviewed journal articles are published yearly through SMC members and institutional collaborators. Much of the information is placed on the SMC website (www.standmg.org). The following lists extension activities of the coop from 2004 to 2006.

A. MEETINGS, WORKSHOPS & FIELD TOURS, AND CONFERENCES FOR 2006

1. Meetings

   1) • Silviculture/Nutrition joint TAC Meeting, Oregon State University, Corvallis, OR, January 23.
   2) • Wood Quality TAC Meeting, USFS PNWRS Olympia Lab, Olympia, WA., March 14.
   3) • SMC Strategic Planning Committee, Center for Urban Horticulture, University of Washington. Seattle, WA., March 16.
   4) • SMC Spring Policy Committee Meeting, Hood River Inn, Hood River, OR. April 26-27.
   5) • SMC Fall Policy Committee Meeting, University of British Columbia Research Forest, Haney, BC, September 11-13.
   6) • Silviculture/Nutrition TAC Meeting, Vancouver, WA at Gifford Pinchot NF Headquarters, November 16-17.

2. Workshops & Field Tours

   1) • Database tutorial, Rayonier Forest Resources, July 5.
2) • Washington Society of Professional Soil Scientists. 2006 field tour.

3. Conferences, Presentations and Posters Presentations


Posters


B. PUBLICATIONS and REPORTS 2004-2006

Listed are all fact sheets, reports, proceedings, and journal articles produced over the last 3 years associated with SMC projects and resources (data, plots, wood samples, etc.). Many can be copied from the SMC website; for others contact the authors.

2004


2005


2006


**Accepted**


**In-review**


2) Strahm, B.D., and R.B. Harrison. Electrochemical controls on the biogeochemistry of low molecular weight organic acids in variable-charge soils. (submitted to Soil Biology and Biochemistry)


**SOFTWARE**


3) SMC Organon and associated DLL’s are available on the ORGANON web site: http://www.cof.orst.edu/cof/fr/research/organon/

Staff attended bi-annual meetings for research updates, planning and voting on proposed research and policy issues.

**Discussion**

The huge source of high-quality data provided through the funding of this project will contribute to the knowledge base supporting sustainable forest management through its direct input into the GYdatabase. The data contributes to models and decision-making tools needed by clients including: the Chief Forester and Forest Analysis and Inventory Branch requiring site index and
yield estimates to support TSR and the forest inventory program requiring managed stand yield projections for their system; MOF Executive and other senior management who derive expertise and advice on issues, policy development related to silviculture planning and growth and yield (e.g. Stand Density Management Guidebook, Weyerhaeuser’s variable retention strategy); District and Regional staff requiring data, tools and extension information for planning (e.g. silviculture prescriptions); Industry and consultants who use the growth and yield tools and applications (e.g. site index, growth intercepts, yield models), yield projections for timber supply analysis, silviculture strategies and prescriptions.

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 (SMC, 2007). The BC Ministry of Forests is considered a member. Other organizations in BC that are not dues-paying members are considered non-members.

I. Data & Database

A. Definition

Data are defined as any measurements of stands, trees, or products (a) developed by the SMC research program or (b) shared with the SMC and another organization and for which the SMC has direct responsibility. The Database is defined as all data resulting from efforts of the integrated program, the Regional Forest Nutrition Research Project (RFNRP), and the Stand Management Cooperative; for policy matters no distinction will be made among these three sources of data.

B. Data & Database Rules

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. Costs of special requests to SMC staff for retrieving, analyzing, reporting, and/or transmitting data will be borne by the Cooperator requesting the data.

3. SMC members have access to all data collected from SMC-supported studies under the condition that the data will not be released to non-member organizations with the exception that a member may temporarily share data with confidentially bound assigns for the sole purpose of having analyses performed for the benefit of the SMC member with the assign allowed to make no further use of the data or analyses.

4. It is recognized that certain individuals and organizations who are not SMC members may desire access to the SMC database for research or other purposes without joining. 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.

5. Data shared with the SMC by other organizations 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.

6. Requests for data by Institutional Members are made only through the Institution’s representative on the Policy Committee. This same representative is responsible for making sure that all users within the Institution: (1) are aware of the proprietary nature of the SMC Database; (2) obtain the data directly from the Institutional representative; (3) do not pass any part of the database to any other party within or outside of the Institution; and (4) secure written permission from the SMC Director to proceed with any analyses. Requests for permission include specific objectives, data required, analysis approach, and intended authors of all planned reports and manuscripts.

II. Publications, Software, Models and Other Works

7. Final reports and manuscripts, software, and presentations based partly or entirely on the SMC Database are submitted for approval to the SMC Director before authors submit them to journals or other outlets, in order to check for the following items: (1) acknowledgement of the SMC; (2) co-authorship acceptable to the SMC, including associated UW staff and faculty; and (3) absence of excessive overlap with publications planned by other parties.

8. SMC members are encouraged to share results from their analyses involving use of SMC data. Any publications or products resulting from the use of SMC data must credit that fact.

9. Analyses and software derived in whole or in part on SMC data may not be shared with non-SMC members except when placed in the public domain.

10. Results of analyses, software, or models based on the SMC database produced by UW faculty, staff, students, and designated analysts appearing in peer-reviewed journals, theses, symposium proceedings, and other media are owned by the University of Washington and administered by the Cooperative Director. SMC members will receive copies of these works. These works may be copyrighted by the UW, the authors, or the publishing entity.

11. 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).

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

13. The SMC data used in the development of any copyrighted or un-copyrighted works remains the property of the University of Washington and subject to the distribution rules in Section I.

Conclusion and Management Implications

This project has resulted in substantial additions of data to the GYdatabase. Over the 3 year period of FIA funding, 162 plots were measured and/or treated to SMC and Ministry Standards on 18 installations. The data from these and other long-term Coastal Stand Management Growth and Yield Field Experiments are used to build models and decision-making tools needed for essential tasks such as determining the effects of management practices on forest dynamics, growth and timber yields, continued development of SIBEC and other tools including GY modeling, and ultimately for the AAC determination processes. The data is also important in assessing new and emerging forest practices questions.
A large number of technical reports, proceedings publications, and peer-reviewed journal articles are published yearly through SMC members and institutional collaborators. In the 3 year funding period from 2004 to 2006, the SMC has produced 34 publications. In 2006 alone, there were 6 meetings, 7 workshops and 7 posters presented. Much of the information is placed on the SMC website (www.standmgmt.org). Access to data, models and software and unpublished reports are subject to the SMC Policy for distribution and use of publications, software, models and other works. SMC information is made available to B.C. audiences through our partnership with FORREX.

Continued involvement with the SMC by the Ministry of Forests and Lands will provide much needed information on forest management practices well into the future.

**Literature Cited**

