

The Salal Cedar Hemlock Integrated Research Program (SCHIRP): Management through understanding

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The problem being addressed is the poor growth of regenerating western redcedar, western hemlock, amabilis fir and Sitka spruce on cutovers of coastal old-growth cedar-hemlock (CH) forests invaded by salal. The approach has been dual; a series of field trials was established to determine the best practices for improving the productivity of CH sites, and ecological studies have investigated the underlying causes of the poor regeneration. SCHIRP is based on partnerships among individuals from forest industry, government, and universities. There have been multiple funding sources during the 15-year history of the project, most notably NSERC and Forest Renewal BC. The involvement of forest industry in the research program has helped to ensure funding for research, completion of projects during ebbs of funding, and the extension of findings to forestry practices. The project has a coordinator who is responsible for communicating with funding agencies, synthesising information, producing proposals and reports, carrying out extension activities, and facilitating communication among researchers. Decisions concerning the administration and future directions of SCHIRP are made by a consensus among researchers through e-mail or at annual meetings. The SCHIRP database contains data from the silvicultural trials and consists of plain text data files and programs which perform various functions. SCHIRP results are summarised in two synthesis reports and a field guide, and are available on the SCHIRP website. SCHIRP results have been presented in scientific journals, in pamphlets distributed to the public, at meetings, and through field tours.

Key words: silvicultural trials, cedar, hemlock, salal, fertilization, vegetation control, organic fertilizers, data management, regeneration, extension, project management

Le problème étudié se rapporte à la faible croissance de la régénération du cèdre rouge de l'Ouest, de la pruche de l'Ouest, du sapin gracile et de l'épinette de Sitka sur les parterres de coupe des vieilles forêts de cèdre et de pruche de la Côte envahies par le salal. L'approche suivie est double: une série d'essais sur le terrain a été entreprise pour déterminer les meilleures pratiques permettant d'améliorer la productivité des sites, et des études écologiques ont été entreprises pour étudier les causes sous-jacentes de cette faible régénération. Le projet SCHIRP repose sur le partenariat entre les individus en provenance de l'industrie forestière, du gouvernement, et des universités. Plusieurs sources de financement ont été utilisées au cours des 15 années qu'a duré la projet, surtout en provenance du CRSNG et du Forest Renewal BC. La participation de l'industrie dans le projet de recherche a permis d'obtenir des fonds pour la recherche, pour la finalisation des projets à la fin du financement, et pour le transfert des découvertes au coeur des pratiques forestières. Le projet a été mené par un coordonnateur responsable des communications avec les organismes qui finançaient le projet, de la synthèse de l'information, de la production de propositions et de rapports, du transfert de l'information, et chargé de faciliter les communications entre les chercheurs. Les décisions touchant la gestion et les orientations futures du SCHIRP ont été faites par consensus entre les chercheurs au moyen de courriels ou de rencontres annuelles. La base de données SCHIRP comprend les données sur les essais sylvicoles et consiste en des fichiers de données sur forme de texte simple et des programmes qui exécutent différentes fonctions. Les résultats du SCHIRP sont résumés en deux rapports de synthèse et un guide-terrain, et sont disponibles sur le site Internet du SCHIRP. Les résultats du SCHIRP ont été publiés dans des journaux scientifiques, dans des brochures distribuées au public, lors de réunions, et lors des excursions sur le terrain.

Mots-clés: Essais sylvicoles, cèdre, pruche, salal, fertilisation, contrôle de la végétation, fertilisants organiques, gestion des données, régénération, transfert, gestion de projet

Background

Logging of CH (cedar-hemlock) forests on northern Vancouver Island in British Columbia during the 1960s generated substantial areas of cutovers that regenerated very slowly with cedar and hemlock. To achieve more rapid regeneration, sites were slashburned to reduce slash accumulations and the heavy cover of the ericaceous shrub, salal, and planted with Sitka spruce. The spruce plantations grew well initially, but by age six to eight years, they showed signs of severe nutrient deficiency and growth rates declined markedly. Cedar appeared to be less influenced by the nutritional problems on these sites and, consequently, cedar was planted thereafter. However, growth check and associated chlorosis were apparent in all species five to eight years after clearcutting and slashburning,



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coincident with the expansion of salal on CH sites. The problem did not occur on adjacent sites formerly occupied by second-growth forests of hemlock and amabilis fir (HA). Analogous regeneration problems on *Vaccinium* sites at higher elevations have also been observed.

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Table 1. SCHIRP silvicultural trials established to test the efficacy of silvicultural treatments for improving conifer growth on CH sites on northern Vancouver Island

Silvicultural trial
Single Tree Screening: diagnose nutrient deficiencies in Ss, Cw, Pl, Fd, Hw (Weetman <i>et al.</i> 1989a,b)
Conventional Plot: determine optimal rates of fertilization of Ss, Hw, Cw, Pl (Weetman <i>et al.</i> 1990)
Salal Smothering: response of Ss to salal suppression
Site Preparation: responses of Cw, Hw, Ba to burning, cultivation and weed control
Salal Eradication: responses of Ss, Cw, Hw to manual eradication and fertilization (Weetman <i>et al.</i> 1990)
Operational Fertilization: helicopter application to Ss, Cw
Lime and Starch Amendments: responses of Cw, Hw, and Ss to higher pH and carbon (Prescott and McDonald 1994)
Nurse Species: pines (Pl, Pw) as nurse species to Ss
SCHIRP Installation: responses of Cw and Hw to fertilization, scarification, and planting density
Organic Fertilization: responses of Hw, Cw, and Ba to biosolids, fish silage, compost (Weetman <i>et al.</i> 1993, McDonald <i>et al.</i> 1994, Prescott and Brown 1998)
Nitrogen Fertilization of Salal: high N doses to control salal
SCHIRP Extension: SCHIRP installation on southwestern Vancouver Island
Fertilizer Delivery: responses of Cw, Hw to fertilization at planting treatments
S1^{CH} Ecosystems: responses of Cw and Hw to scarification and species mixtures
Individual Tree Fertilization: responses of Cw and Hw to fertilizer applied at planting
S1^{HA}/S1^{CH} Transitional Ecosystems: responses of Cw and Hw to fertilization, planting density and species mixtures
High Elevation Screening: diagnose nutrient deficiencies in Ba and Hw on <i>Vaccinium</i> sites
Nutrient Loading of Seedlings: test performance of nutrient-loaded Hw seedlings
High Elevation: responses of Hw, Ba, and Cy to fertilization and <i>Vaccinium</i> control

Ss: Sitka spruce, Cw: western redcedar, Pl: lodgepole pine, Fd: Douglas-fir, Hw: western hemlock, Ba: *Abies amabilis*, Pw: western white pine, Cy: yellow cedar

Objectives

The Salal Cedar Hemlock Integrated Research Program (SCHIRP) was initiated in 1983 to establish the best operational means for improving productivity on these cutovers of coastal old-growth CH forests invaded by salal (*Gaultheria shallon* Pursh.) (Table 1). An additional objective was to determine the underlying causes of poor growth of regenerating conifers on these sites (Table 2). Experiments have also been initiated to understand and treat the chlorosis and slow growth observed on high elevation *Vaccinium* sites throughout Vancouver Island. This research is part of a recent effort to determine if the information gained from CH sites can be applied to other ecosystems dominated by ericaceous shrubs.

Overview

SCHIRP studies are situated on both coastal and montane sites throughout Vancouver Island. Descriptions of the soils, climate, and vegetation of this region can be found in the SCHIRP synthesis report (Prescott and Weetman 1994).

The early screening trials demonstrated deficiencies of N (nitrogen) and P (phosphorus) as the cause of poor conifer growth. Silvicultural trials have investigated means of improving productivity on these sites through various types of fertilization, vegetation control, site preparation, tree planting density, mixed species plantings and soil amendments (Table 1). Eco-

Table 2. SCHIRP ecological studies established to examine the nutrient availability on CH cutovers, the extent to which salal contributes to low nutrient supply to crop trees on these sites, and the dynamics of CH ecosystems

Ecological studies
N and P availability on cutovers Messier 1993, Messier <i>et al.</i> 1995, Weetman <i>et al.</i> 1990, Chang <i>et al.</i> 1995, Prescott <i>et al.</i> 1996, Cade-Menum and Lavkulich 1997
Nutrient cycling in CH and HA forests Keenan <i>et al.</i> 1993, 1994, 1995a,b, 1996, Prescott <i>et al.</i> 1993, 1995, Prescott and Preston 1994
Salal competition and allelopathy Messier <i>et al.</i> 1989, Messier and Kimmins 1990, 1991, Messier 1992, Fraser <i>et al.</i> 1993, Fraser <i>et al.</i> 1995
The role of tannins in N supply problems Preston 1999
NMR analysis of litter and humus DeMontigny <i>et al.</i> 1993, Fox <i>et al.</i> 1994, Cade-Menum and Preston 1996
Mycorrhizae of salal, cedar, and hemlock Xiao and Berch 1993
Soil fauna in CH and HA forests Battigelli 1992, Battigelli <i>et al.</i> 1994
N fertilizer efficiency and soil N dynamics Chang <i>et al.</i> 1996, 1999, Chang and Preston 1998
Soil P use by cedar Cade-Menum and Berch 1997
Interactions between Hw genotype and fertilizer treatments
Nitrogen nutrition of salal, cedar, hemlock, Sitka spruce, lodgepole pine
Modelling SCHIRP with FORECAST

logical studies have examined the decline in N and P availability following clearcutting and burning, and the role of salal and humus chemistry in contributing to poor conifer growth. The roles of mycorrhizae and soil fauna in tree nutrition have also been studied. Comparisons of nutrient cycling in old-growth CH forests with second-growth forests of HA which do not have low nutrient supply after clearcutting, and studies of the successional dynamics of CH and HA forests have also been undertaken. The findings of these studies are being incorporated into the ecosystem model FORECAST to improve the representation of these ecosystems in the model and facilitate its use as a decision support tool for managing CH sites.

Coordination

The breadth of research conducted within SCHIRP has been facilitated through the cooperation of several agencies and many individual researchers. SCHIRP is a three-way partnership between universities, government and industry. Individuals involved include people from Western Forest Products Ltd., MacMillan Bloedel Ltd., TimberWest Ltd., Canadian Forest Service, BC Ministry of Forests, University of Victoria, and UBC Departments of Botany, Soil Science and Forest Sciences. The research was initiated and has been spearheaded by John Barker of Western Forest Products through collaboration with Gordon Weetman of UBC. The primary disciplines involved are silviculture, forest nutrition, forest ecology, soil chemistry, soil ecology, and mycorrhizal genetics.

Communications among this diverse group of researchers are primarily through annual workshops where individuals provide updates and research findings. Questions concerning

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* DATASET FILE NAME SCHTRE.DAT
* SALAL CEDAR HEMLOCK INTEGRATED RESEARCH PROGRAM
* VANCOUVER ISLAND, BRITISH COLUMBIA
* SILVICULTURAL TRIAL - TREE MEASUREMENT DATA
  TOTAL NUMBER OF OBSERVATIONS: 41161
*
* DATA FORMAT AND VARIABLE DEFINITIONS
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* VARIABLE COLUMN DEFINITION
* YEAR 1-4 YEAR OF MEASUREMENT (YEAR)
* SITE 6 SITE TYPE CODE
* SPECIES 7 SPECIES PLANTED CODE
* BLOCK 8 BLOCK NUMBER
* SCARIFY 9 SCARIFICATION CODE
* FERT 10 FERTILIZATION CODE
* DENSITY 11 PLANTING DENSITY CODE
* TREE 13-14 TREE NUMBER
* RCD 16-21 ROOT COLLAR DIAMETER (cm)
* HT 23-27 HEIGHT (m)
*
* VALUE DEFINITIONS
-----
* SITE TYPE: 1=CH (WESTERN RED CEDAR-WESTERN HEMLOCK)
  2=HA (WESTERN HEMLOCK-AMABILIS FIR)
* SPECIES PLANTED:
  1=WESTERN RED CEDAR
  2=WESTERN HEMLOCK
* FERTILIZATION: 1=NOT FERTILIZED 2=FERTILIZED
* SCARIFICATION: 1=NOT SCARIFIED 2=SCARIFIED
* DENSITY: 1=500 trees/ha 2=1500 trees/ha
  3=2500 trees/ha
*
* SAS INPUT STATEMENT
-----
* INFILE 'SCHTRE.DAT';
* INPUT TEST $ @; IF TEST='*' THEN DELETE;
* INPUT YEAR 1-4 SITE 6 SPECIES 7 BLOCK 8 SCARIFY 9
* FERT 10 DENSITY 11 TREE 13-14 RCD 16-21 HT 23-27;
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Fig. 1. Example header from SCHIRP tree measurement data set.

project funding, coordination, and future direction are discussed among all researchers either at the annual meetings or through e-mail, and decisions are made by consensus. The program is coordinated by C. Prescott, whose responsibilities include acting as a liaison with funding agencies, synthesizing and producing proposals and reports, carrying out extension activities, and facilitating communication among researchers. Western Forest Products Ltd. and MacMillan Bloedel Ltd. actively coordinate the activities of researchers on site and coordinate research activities with forestry operations. Western Forest Products Ltd. also provides accommodations and logistical support to researchers at the field sites.

SCHIRP research is highly interdisciplinary and has attracted researchers interested in either the silvicultural problems or the ecological questions associated with CH sites. The consensus approach on which SCHIRP operates fosters a collaborative atmosphere among researchers. The success of the research program results from the partnership between companies supportive of research and researchers dedicated to producing both operationally applicable information and scientific advances. Investigators are given the intellectual freedom to pursue questions of interest as long as the research is relevant to the broad goals of SCHIRP.

Funding

SCHIRP has been supported by a variety of funding agencies, including Forest Renewal BC, NSERC, South Moresby

Replacement Fund, Forest Resource Development Agreements I and II, and industrial support from Western Forest Products Ltd., MacMillan Bloedel Ltd., and Fletcher Challenge Canada. Although public funding has been substantial, it has been pulsed. Strong industrial support has helped secure funding from other agencies and allowed continuation of projects during ebbs of funding. The current phase of the program is funded by Forest Renewal BC until March 2001.

Data

Because SCHIRP is funded largely through the public funding agencies listed above, there are no constraints on the release of data. A database containing all data from the SCHIRP trials has been established and is managed by L. Blevins.

Data Files

Data are stored in plain text format (ASCII text) to minimize file size. This type of storage also makes file transfer easier, uses fewer computer resources, and is readable by most software programs. For each study, a single file containing all data of one type is saved. From these large files, data to suit the needs of each user can be extracted.

Data are stored in files that contain headers (Fig. 1), containing the study name and the type of data contained in the file. The number of observations is also helpful in ensuring that files created from this data set are complete. The headers clearly define all variables, provide units, and define any coding included in the data set. Finally, the header contains the statement that allows the data to be read into SAS (Statistical Analysis Software) properly.

Data files are organized in directories and carry unique, systematic names. Because many programs are still limited to names of eight characters or less the first part of the data file names are coded. The first part of this name consists of three letter codes denoting the study to which the data belongs, followed by the sub-study where applicable and then by the type of data contained in the file.

Program Files

A number of SAS programs have been created. The function of these programs is to append existing data sets with new data, extract data needed for a particular user, create new data sets which can be easily transformed into spreadsheet format, produce summary statistics, produce values for graphical presentation, and perform statistical analyses. As with the data files, there is identifying information at the top of each file. This information describes the function of the program and the data set to which it applies.

Deliverables

There are two major target audiences for SCHIRP results: scientists and foresters. Results of all the ecological studies and many of the silvicultural trials have been published in scientific journals and presented at scientific meetings. SCHIRP research has been the basis of six Ph.D. theses, five M.Sc. theses, and there are currently seven graduate students working on SCHIRP projects. SCHIRP results are also presented in periodic updates (Prescott and Weetman 1994, Prescott 1996a) that are published and distributed to foresters and scientists and are also available on the SCHIRP website (<http://www.forestry.ubc.ca/schirp/homepage.html>).

SCHIRP results have been presented to foresters through the production of a silvicultural field guide (Prescott 1996b), participation in Coastal Silviculture Committee Meetings, field tours, and articles in *The Forestry Chronicle*. Pamphlets, a poster, a slide show, and the SCHIRP website were developed to assist in extension of SCHIRP results. Efforts to communicate with the public have included signs at the study area and pamphlets that are distributed free of charge at local offices of companies and government agencies and at the North Island Forestry Tours Center near Port McNeill. Because SCHIRP research is largely publicly funded, results are made known to all interested persons.

Due to cooperation from forest industry and extension efforts by researchers, SCHIRP has successfully made the link from research to practice. Results form the basis for operational fertilization programs on salal-cedar sites; by the end of 1998, Western Forest Products had fertilized over 7000 ha on Tree Farm License 6 on northern Vancouver Island. Site preparation and planting CH sites have also been influenced by SCHIRP results. Findings of high retention of fertilizer P altered the fertilizer practice of repeated P additions, and individual tree fertilizer briquettes have been developed based on SCHIRP results ("SCHIRP-PAK," Reforestation Technologies International). The B.C. Ministry of Forests has used SCHIRP as an example of adaptive management (Bouris 1998). The primary challenge facing the SCHIRP project is ensuring continuity of funding to continue monitoring the many long-term experiments through crown closure, and thereby be able to recommend the optimal silvicultural practices for CH sites.

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