Reports on several forestry/wildlife research projects are included in this issue.

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Solutions

Editor: Tim Mock

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SUPPORT AND COMMITMENT:

KEYS TO PROGRAM SUCCESS

Over 5 years the Extension, Demonstration, Research & Development sub-program has generated thousands of pages of reports, books, memos, topic summaries, and newsletter articles along with hundreds of hours of video presentations, training sessions, field tours, workshop presentations, and large and small group discussions. This work brought researchers together with field foresters—in the laboratories and out on the backlog sites.

The EDR & D sub-program, as with the rest of FRDA, was a great success. The sub-program set a new standard for operational problem evaluation and ranking, research program development and implementation, and solution packaging and delivery. The three regional technical advisory committees brought researchers from many agencies and the private sector together with Forest Service and company operations staff. Each of the committees developed a local agenda and program of extension, demonstration, research, and development to address their needs.

Program implementation was aided by contracted administrators. Extension specialists directed surveys and ongoing feedback from district and company operations staff that helped to guide their extension and demonstration programs. Coordination between the three committees during program development and implementation was provided by Forest Service and Forestry Canada Victoria-based members and a committee coordinator. Some components were provincial in scope while others served a local need.

Clients in the operations areas of the Forest Service and industry have recognized and appreciated many of the research projects and numerous educational and informational products that have come from the program. Several of these are discussed in this issue’s feature on page six.

The program has demonstrated the feasibility of developing and delivering solutions to operational problems in shorter times than previously thought possible, but with room for further improvements. It has relied heavily on the time, energy and commitment of many staff and contract researchers, research assistants, administrators, and support workers. The infrastructure is in place and program momentum continues, and with many new and remaining problems to be addressed, there is ample reason to continue this work.

With ongoing support we can continue the applied research with its focus on solutions, we can continue to develop user-friendly products, we can continue operational testing of research results, and we can continue to receive direction for new work and evaluation of past work from operational clients in industry, the contract forestry companies and the Forest Service. Besides continuing backlog reforestation research, many existing and new challenges lie ahead—silvicultural systems, old growth and biological diversity, soil management, growth and yield, hardwood and mixed wood silviculture and vegetation management. Resolving these and other issues will require a solid and continuing research and extension program.

Henry J. Benskin
Manager, Forest Renewal
Research Branch
B.C. Forest Service
Scheduling: A key to cost-effective treatments

Timing of silviculture treatments is critical to the successful establishment and growth of forest crops. Throughout the province studies have shown that inappropriate timing has been the cause of treatment and regeneration failures. The cost of treatment failures can be very high. They include the cost of the lost treatment, the often higher cost of retreatment, and the cost of a longer period to harvest.

Treatment windows are usually narrow and many factors, administrative and otherwise, influence the chance of completing treatments during those periods. The Northern FRDA research committee hired Laing and McCulloch Forest Management Services of Smithers to prepare a Synopsis on the topic. Leisbet Beaudry authored the review, now available as FRDA Memo No. 125.

The Synopsis identifies the factors that restrict the scheduling of each phase of basic silviculture. It also includes a list of points on how to improve treatment timing and graphically presents the timing and associated costs for optimum versus delayed scheduling on dry, mesic, and wet sites. This is a timely summary of an important topic. To obtain a copy, contact the Research Branch in Victoria.

Overcoming subalpine fir supply problems

Increased demand for subalpine fir seedlings (Abies lasiocarpa) to reforest ESSF and high snowpack ICH sites has pushed growers to find answers to the poor germination and poor early growth problems associated with this species. Demand for height growth response to short days in container-grown spruce.

Andrea notes that use of blackout in conifer seedling production is new to northern British Columbia. However, it appears to be better for inducing height control and winterization when compared to the alternatives of nutrient or drought stressing. The use of blackout is on the increase worldwide as new applications and benefits are discovered.

Project: 1.22
Contact: Dave Wilford
NITAC Chairperson
Forest Service
Smithers 847-7428

Overcoming subalpine fir supply problems

Increased demand for subalpine fir seedlings (Abies lasiocarpa) to reforest ESSF and high snowpack ICH sites has pushed growers to find answers to the poor germination and poor early growth problems associated with this species. Demand for

Project: 1.36
Contact: Andrea Eastham
Forest Science
Red Rock Research Station
Prince George 963-9651
subalpine fir has risen from a few hundred thousand to more than 3 million annually. In addition to nursery problems, seed supplies for the species are low, the seeds do not store well, and cone crops can be infrequent.

Germination Improved

Growers were experiencing very low germination rates with subalpine fir seeds. This prompted the Coastal FRDA research committee to fund a project to have Seed Physiologist Carole Leadem investigate the problem. Carole tested a treatment procedure that involved stratifying the seeds at a lower moisture content (30-35%) and incubating the seeds at a lower temperature (25°C/15°C).

Carole’s stratification/redry process produced, under lab conditions, germination rates up to 85%—almost one-third higher than alternative stratification. “The stratification-redry technique enhances the ability of subalpine fir seeds to germinate well under a range of nursery temperatures,” says Leadem.

Early Growth Investigated

Northern nurseries were growing subalpine fir as a 2+0 seedling but overwinter losses and high costs were unfavourable. The Northern FRDA Research Committee funded a project in which Andrea Eastham, a nursery culture scientist at the Red Rock Research Station investigated the feasibility of growing a plantable 1+0 container-grown subalpine fir seedling.

Andrea tested three treatments, individually and in combination with each other. The treatments were shade versus no shade and growth hormones—gibberellin A₄ (GA₄), and benzyladenine (BA). Andrea found no differences between seedlings grown with or without shade or between seedlings receiving 0, 5, or 10 ppm BA. However, weekly applications of GA₄, commencing 11 weeks after sowing, significantly increased root collar diameter over those not receiving GA, and also decreased the number of times seedlings set bud. Andrea noted a trend where GA-treated seedlings increased height with increasing concentrations of gibberellin from 0 to 80 ppm.

Andrea concludes, “these results and those from other studies indicate that subalpine fir can be grown as a plantable 1+0 container seedling under conditions of decreased temperature, increased humidity, and a wide range in light intensity.” She adds, “the usefulness of GA and BA to improve seedling growth may be limited in a commercial setting.”

Controlling vole damage

Plantation failures in the Prince Rupert Forest Region from vole damage prompted the development of a FRDA research project on the topic. Tom Sullivan of UBC Forest Sciences was hired to identify how to avoid this problem; specifically, to investigate population cycles and forestry practices.

Tom surveyed 58 plantations between 1-5 years and 21 between 6-16 years old for survival and stocking. He found 24 of the 58 young plantations to be NSR due to vole damage. Tom noted that planted trees were attacked significantly more than natural regeneration. The NSR plantations tended to occur in spruce/subalpine forest types above 800 metres elevation and on north to northeasterly aspects. Also, the sites worst hit generally had mechanical or no site preparation and a large amount and/or variety of logging debris with limited vegetation cover. Older plantations with serious damage had complex vegetation communities. Tom suspects that manipulation of the nursery fertilizer regime may help to alleviate feeding damage from voles.

Intensive sampling and monitoring is underway in forest, clearcut, and clearcut-burned habitats in cooperation with Northwood Pulp and Timber Ltd. in the Morice Forest District. Although Tom noted low vole populations over the summer, the long-tailed and red-backed voles are increasing on an annual basis. Tom also noted that the meadow vole is appearing on some sites. This is the vole that caused extensive plantation damage during the 1986/87 outbreak.

Impact of glyphosate use on grizzly forage

The Coastal FRDA research committee supported a project to evaluate and make recommendations about the impact of glyphosate on the availability of grizzly bear forage. Tony Hamilton of the Ministry of Environment’s Wildlife
Branch has conducted the study and will soon publish his findings.

Tony and contractors Colleen Bryden and Chris Clement looked at the impacts of glyphosate treatment, mostly on floodplain ecosystems, from regional (grizzly occupied areas in the CWH zone), local (four watersheds typical of operational use), and site-specific (22 cutblocks) perspectives. They measured changes in percent cover and fruit production of forage species following foliar (aerial and ground spray) and individual stem treatments.

Habitat mapping carried out in two watersheds suggests that most glyphosate use is on medium and high value bear forage sites. Study results also indicate that foliar treatments reduce the amount of forage available for at least two years after treatment. The most serious impact is the acceleration of succession on the treatment sites towards closed canopy conifer dominated second growth. If regional stocking targets are achieved on rich and moist sites in the CWH, there will likely be limited forage available through the majority of the rotation.

Hamilton developed several recommendations for integrated management of grizzly bears and forestry-related glyphosate use:

1. assess proposed treatments in the context of available grizzly bear habitat within the watershed;
2. minimize glyphosate use to that required to meet silvicultural obligations;
3. avoid treating bear forage species not competing directly with crop trees;
4. relax regional stocking standards on some floodplain sites;
5. use the biogeochmical ecosystem classification to structure integrated management prescriptions;
6. better integrate silviculture and timber harvest planning;
7. improve timber resource, site and wildlife inventories;

Tony notes that resource planning on these floodplain sites should consider the likelihood of silvicultural success and the economics of harvest and reforestation, in addition to their value over time as bear and other wildlife and salmon habitat.

Project: 2.55
Contact: Tony Hamilton
Wildlife Branch
B.C. Ministry of Environment
Victoria 387-9761

Tour sites to demonstrate forestry/wildlife management

Many backlog areas on Vancouver Island and the lower mainland provide important habitat for deer and elk. Open clearcuts are used by both species for spring forage and deciduous stands provide year-round forage for elk. Conversion of backlog sites into dense coniferous stands decreases the forage value of these areas making them less productive for deer and elk. However, with appropriate stand tending, backlog areas can remain productive for wildlife while gaining value as a timber resource.

The Coastal FRDA research committee has funded a project to install two self-guided demonstration sites that will show foresters and students examples of cooperative wildlife/forestry silviculture management. The sites will be located on Vancouver Island, in the Nanaimo Lakes area, and on the lower mainland, north of Mission.

At each site, tour stops are located along logging access roads and each stop is marked by a numbered sign corresponding to descriptions in an interpretive brochure.

Salmonberry, a preferred grizzly forage, one year after glyphosate treatment.

Visitors will see the effects of silviculture treatments on wildlife habitat and examples of treatments that maintain or enhance the habitat.

Project: 2.68
Contact: Robin Hoffos
Forest Service Research Branch
Victoria 387-3474

SOUTHERN

Survey confirms threat of root disease

Results of a survey conducted on 27 backlog sites in the Kamloops Forest Region have underscored the role of root disease in plantation failure. Forest Service Regional Pathologist, Hadrian Merler said that Armillaria obscura was identified in the majority of surveyed plantations and adjacent stands. Phellinus weirii, although present in one plantation and five adjacent stands, was not considered a threat in plantations of the age studied.

Douglas-fir, lodgepole pine, and white pine are each highly susceptible to attack by A. obscura, both as young regeneration and as mature trees. Western larch, western red cedar, and western hemlock are also somewhat susceptible.

continued on page 8...
From 1985 to March 1990, the FRDA agreement provided funding for a wide range of forestry activities. Within the Backlog Reforestation Program of FRDA, the Extension, Demonstration, Research and Development sub-program (EDR & D), implemented technology transfer activities. These activities included making available and demonstrating to practicing foresters and field staff new information resulting from research, and existing information gathered regionally, provincially, or from other parts of the world. The EDR & D sub-program also funded research studies to investigate backlog problems and filled in the missing pieces in backlog reforestation puzzles.

One extension product, originally developed under the Northern EDR & D sub-program was the Reforestation Information Bank (RIB). RIB provided a way for people to organize and access the high volume of new information made available through FRDA. Also, the developers of RIB recognized that many research and operational trials were in place across the north and in other regions and that the system would be more comprehensive if it included the Forest Service Sx trials. For information and results to be useful to others, it had to be accessible.

Version 2.0 of RIB is now available and includes an expanded program with summaries for approximately 550 projects province-wide. The program has received strong endorsements from its users. For more information on RIB, contact Brenda Hopkin in Victoria at 383-5280 or see the Solutions article “Computerized Data Base Available” page 6, Vol. 3 No. 2.

Field trials have been accepted as the proving grounds for new ideas and a method of pilot testing the feasibility for operational-scale use what has worked well in research plots. Field trials are also beneficial in extension programs, putting into practise the adage “tell me and I will forget, but show me and I will understand.” Numerous research plots, operational-scale trials and demonstration sites were established throughout the province during FRDA. Included in these were many large-scale, long-term research installations. (See side bar page 7.) Each of the projects allowed comparisons to be made between a variety of treatment types, equipment alternatives and species choices.

The success of these installations lay partially in the care that was taken to construct the sites as demonstration areas; layout allowed treatment effects to be easily compared and signage and supplementary materials explained what visitors saw.

Extension efforts were also focussed on producing “products” for extension. Coastal committee support went toward the publication of two major books Indicator Plants of Coastal British Columbia and Regenerating British Columbia’s Forests, and several other important publications, Nutrient Deficiency Symptoms in Container-Grown Douglas-fir and White Spruce Seedlings, the revision of A guide to Collecting Cones of British Columbia Conifers and the update of Diseases and Insects in British Columbia Forest Seedling Nurseries. Other landmark publications are the revision of Guide to the Uses of Mechanical Site Preparation Equipment and the translation of Site Preparation: A Swedish Overview. The sub-program has supported development of videos; Nursery to Forest Site, a Team Effort about handling nursery stock and maintaining their health and vigor during transportation, on-site storage, and handling; More than Trees, about integrating wildlife and other resource concerns into forest management decisions; several videos on mechanical site preparation; and, a video currently underway covering the Carnation Creek integrated management study.

Regional committees showed strong leadership in developing integrated resource studies; the coast led with watershed projects at Carnation Creek and on the Skeena River. Wildlife investigations included a study of the impact on wildlife and wildlife habitat...
R & D Sub-program

Long-term Field Installations

Cariboo Region
- Treatment development for rehabilitating ESSF backlog brushfields. (1.17)

Kamloops Region
- Site preparation and planting procedures to minimize seedling water and temperature stress in backlog areas. (3.02)
- Effects of mechanical and chemical site preparation treatments on vegetation succession and growth on survival of planted Pl and Sx in a Rhododendron brushfield. (3.40)
- Screening trials to assess crop tree and vegetation response to chemical and non-chemical weeding treatments for major competition complexes. (3.41)
- The effects of cattle grazing, forage seeding rates, basal scarring and shoot damage on forest regeneration. (3.55)

Nelson Region
- A comparison of site preparation options for reforesting backlog sites in the ICH subzones. (3.21)

Prince George Region
- Site stress x stock type stress resistance interactions on SBS NSR backlog sites. (1.01)
- Assessment of treatment options for backlog hardwood stands in the BWBS. (1.02)
- Appraisal and development of backlog reforestation mechanical site preparation systems. (1.10)
- Prescribed fire effects and efficacy in the treatment of backlog NSR land. (1.20)

Prince Rupert Region
- Assessment of treatment options and effects in rehabilitating dense, suppressed lodgepole pine stands. (1.13)
- The conversion of multistoried brushfields to coniferous plantations. (2.06)
WHAT CLIENTS ARE SAYING...

Although research has been underway for many years, during FRDA the operations forestry staff have taken some big steps toward understanding the processes at work on our forest sites, including the biology of weed species and the impact of microclimate on seeding survival and early growth. Since research projects and research teams worked with clients in operations, all of their work had an applied focus. We got the answers we needed.

Forestry research, like the practice itself, is long term. FRDA funds started and completed many good projects, however, we need a commitment to continue this calibre of work over a longer term.

Shane Brown-Clayton, Administrative Forester
Fletcher Challenge Canada, Kelowna

Through FRDA, numerous studies and trials were initiated that are beginning to bear answers. As more results become available, field forestry staff are going to benefit and be able to improve their day-to-day decision-making. We must keep up the momentum!

Laird Pitman
Evan’s Forest Products, Golden

Through the FRDA program, information has been made available to the small forest products companies that was otherwise unavailable. At Riverside, this information has formed a tremendous resource library in reports, memos, and topic summaries. The training courses and field tours provided my field staff with a first-time opportunity to get answers to long-standing operational problems, to tour field sites with the experts, and to quiz them on their research findings.

Don Couch, Silviculture Forester
Riverside Forest Products, Vernon

The FRDA training sessions, workshops and research demonstrations have been a tremendous education vehicle for forestry personnel.

John Clarke, Administrative Forester
Terminal Forest Products Ltd., Richmond

Growing quality forest seedlings is a continual learning process. Information is constantly needed to assist in making decisions about capital investments or to improve cultural regimes. In 1990, Woodmere Nursery installed five photo period control (blackout) systems. This investment decision was largely based on the results of research funded by FRDA and carried out at the Red Rock Research Station. Also during the past year, Woodmere has improved its irrigation scheduling largely as a result of FRDA-funded research carried out by Pacific Phytometric Consultants of Surrey. FRDA has funded quality applied research. Let’s keep this work going!

Joe Wong
Woodmere Nursery, Telkwa

“FRDA gave us the opportunity for more one-on-one time with the researchers - a chance to discuss local problems and scope out potential solutions. Through this process, Les Herring and other researchers helped us to increase our summer planting. We moved from a spring/summer planting ratio of 90/10 to approximately 50/50. It’s now easier to schedule the work and survival is higher too.”

Cal Wilson, R.O. Silviculture
B.C.F.S., Dawson Creek Forest District, Dawson Creek

Survey findings indicated that seedlings and small hardwoods were often “flash-killed”, being killed rapidly without early symptoms or prior indication of infection. In young plantations, losses to A. obscura ranged from 0-15%. Surveyors estimate that although root disease had not caused understocking, a loss of 1% per year could pose an enormous threat before the stands reach rotation age.

In plantations older than 10 years, incidence ranged up to 60% with a mean level of 16.6%. Rapid mortality in infected trees on these sites had resulted in understocking and, in some cases, imminent plantation failure.

Several indicators of the root disease were identified. On the cutblocks, symptoms were visible on infected regeneration, residuals, and hardwood species, especially falsebox Paxistima myrsinites. In the adjacent stand, infected trees were the most reliable indirect indicators. These indicators could be used in a hazard rating index (high-medium-low) which was developed to assess the risk of root disease.

Projects: 3.08/3.35
Contact: Hadrian Merler
Forest Service
Kamloops 828-4176

From brushfields to forests — converting high site ICH

Many moist NSR sites in the southern ICH zone are overgrown with shrub and herb species such as Sitka alder, birch, thimbleberry, fireweed, and bracken. Foresters questioned what long- or short-term effects on site productivity and seedling survival and growth this competing vegetation may produce. Chris Thompson of the Forest Service in Nelson set up three demonstration sites in 1987 under FRDA project 3.21 to identify the range of effects brought on by four site preparation options. Project 3.21 also examined the performance of different species.
planted in each of these treatments and studied how each treatment altered soil and site properties and influenced post-treatment revegetation.

The three sites chosen were representative of ICHa sites: Murphy Creek, a mid-slope site north of Rossland; Begbie Creek, a lower slope site south of Revelstoke; and Blackwater Ridge, a mid-slope bench site north of Golden.

Each site included an untreated control area, a herbicide treatment (Roundup® 5L/ha), and a mechanically scarified treatment (rough bunching and random trail construction). At Murphy Creek a prescribed burn was carried out and the other two sites included a manual brush removal treatment.

Treated areas were planted in spring, 1988 with Douglas-fir and lodgepole pine at Blackwater Ridge, Douglas-fir and Engelmann spruce at Begbie Creek, and Douglas-fir, larch, and white pine at Murphy Creek. One-half of the 300 seedlings of each species planted on each site were fertilized with Osmocote® 18-6-12.

After two growing seasons the survival in all locations for all species was good, except for white pine at Murphy Creek. Here, mortality approached 40 percent on the herbicide treatment. RGC was lower in this species before planting and Chris suggests there is much to learn about its culture and handling.

The herbicide treatments provided good, but not exceptional performance at all locations in the first year. However, the performance deteriorated in the second year, with the exception of Blackwater Ridge, where the high proportion of woody target species took longer to return to their dominant position.

The burn treatment at Murphy Creek provided the best two-year performance for all species at that site.

Manual treatment for vegetation removal only provided average results while the no-treatment control was one of the least effective at all locations.

Species Performance

- Larch preferred the burn and MSP treatments.
- Spruce suffered from heavy browsing but showed good response to fertilization.
- Lodgepole pine was outperformed by Douglas-fir in the first year at Blackwater Ridge, but improved in the second year. It responded well to fertilizer only in the second year.
- Douglas-fir was prone to browsing, had a moderate first year and excellent second-year response to fertilizer, especially on the MSP treatment.
- White pine did the least well of the species tested with mortality approaching 40 percent.

Three-year results from Redfish Creek

David Crampton, now with the Forest Service in Prince George, established a trial in 1986 in the ICHA 25 km east of Nelson to test the effects of burning and vegetation removal on seedling physiology and growth (see also FRDA Memo 119). The Redfish Creek site was located on a southern exposed 20 percent slope at 1050 m elevation. David tested Douglas-fir, western larch, lodgepole pine, and Engelmann spruce on burned plots, burned with manual vegetation removal, manual vegetation removal only, and control plots.

By the end of three growing seasons vegetation cover was back to between 3 and 30 percent on unburned plots, and 40 to 90 percent on burned plots. Lack of water limited growth on the burned blocks during the first year, however, it did not limit growth on the unburned plots.

Although height differed little by species within treatments, total biomass (root and shoot dry weight) indicated that all species responded favourably to vegetation removal. Vegetation removal and burning prompted the best growth response, with western larch and lodgepole pine displaying the best short-term growth on this treatment.

David concludes “the shoot:root ratios measured in this study showed the lodgepole pine was the only species to respond consistently to reduced competition by increasing its allocation of resources to root biomass and thereby producing a more balanced seedling. We also found that height alone was a poor indicator of seedling performance and diameter measurements more closely paralleled the seedling dry weight findings”.

Accepting hemlock in the ICH

Managers with NSR land in the ICH zone may be in for some relief. A Southern Interior FRDA research project is suggesting that young hemlock stems should be considered acceptable when conducting stocking surveys.

The studies, conducted by Maureen and John Schulting, under the direction of Forest Service Pathologist, Hadrian Merler, surveyed western hemlock on a variety of site types in the ICH zone. The studies examined the species productivity and the incidence of heartrot. Traditionally, hemlock has been considered unacceptable in the ICH by regeneration foresters.
because of their low productivity and tendency for heartrot. More than 100 stands were sampled representing eight subzones, from very wet to dry.

The study reports that the productivity of western hemlock was greatest in the wet subzones, and it was not significantly different from Douglas-fir in any subzone. In addition, heartrot incidence (due mainly to Echinodontium tinctorium) was less than 7 percent in stands 90 years old. Maureen and John noted that the incidence of the fungus was substantially higher in stands more than 90 years old.

Acceptable height and age characteristics for young Hw naturals on mesic sites in the ICH.

Hadrian says “the results suggest that hemlock is an acceptable species for regeneration on mesic sites in the ICH zone. And provided the stems are not taller than 0.5 metres or more than 20 years old at the time of harvest, western hemlock naturals should be accepted for restocking sites.” Hadrian adds, “it is not clear at this time what impact this change will have on the stocking status of NSR sites in the ICH zone, but it is feasible that it could result in numerous NSR-rated sites becoming SR.”

Competitors: Paper birch and planted Douglas-fir in the Southern Interior

Suzanne Simard of Kamloops recently completed an investigation of competition between paper birch and planted Douglas-fir on medium and good sites in the ICH zone. Suzanne studied five Douglas-fir plantations that ranged in age from 7-11 years. The growth of individual Douglas-fir saplings was related to the density, percent cover, size and spatial arrangement of neighbouring paper birch.

Results show that as the density of birch increased, Douglas-fir growth declined. A threshold was eventually reached where Douglas-fir growth was no longer affected by increasing birch density. The threshold was lower on good (10-20 000 sph) than medium sites (35-40 000 sph) because each individual birch grew faster and larger in response to greater resource availability, and hence had a greater competitive effect on Douglas-fir.

Suzanne suggests that treatments to decrease birch density below these thresholds will result in dramatic increases in Douglas-fir growth.

FRDA Direct delivery

MOF FUNDED

Pruning costs identified

A time study conducted in the Cowichan Valley early in 1989 compared the time required for one-pass and two-pass pruning, and one-lift and two-lift pruning. Lift refers to the raising of a tree’s live crown, in this case artificially by pruning; pass refers to the total number of times an operator goes through the stand to accomplish a lift.

Two stands of Douglas-fir, aged 14 and 18 years from seed, and thinned previously to 900-1100 stems/ha were chosen for the study. The study was designed to compare 5 pruning methods and 5 pruning operators. Time to prune one tree, including travel time between trees, was the prime variable of interest.

Pruning methods were defined by a combination of height of pruning, number of pruning passes, and type of pruning tools. Two pruning tools were used: 1) a D-handled saw along with a one-piece, 2- to 3-m ladder, with foam rubber wrapped around its uprights and rope looped around its top rungs, to access branches; and 2) a snap-cut pruner with ratchet style pinions.

Operators were assigned 30 trees on each of 5 sites in the 14- and 18-year-old stands. The times recorded were: pruning time (time taken to prune a tree to a specified height); travel time (time taken to move from one tree to the next); and idle time (time for activities other than pruning or moving from tree to tree).

The mean pruning time and pruning-plus-travel time for one lift at 14 years were 9.0 and 9.5 min/tree, respectively. Assuming a contract wage rate of $13/h, the
The cost of pruning, including travel time between trees, would be $2.09/tree. This cost excludes fixed costs, such as cost of travelling to the pruning site and equipment purchase and maintenance, which could be an additional $2.09/tree.

The two most efficient operators in the study attained an average pruning-plus-travel time of about 6 min./tree. Thus, by using efficient operators and pruning tools, a production pruning crew could probably reduce the pruning-plus-travel time in this study by about one-third.

Differences in mean pruning-plus-travel time between one lift at age 14 years and two lifts at ages 14 and 18 years could not be detected. The practical implication is that forest managers are free to choose between one-lift and two-lift pruning. Differences may arise when fixed costs and compound interest on costs incurred on the first of two lifts, are taken into account. Practice in other countries such as New Zealand favours two- or even three-lift pruning.

The pruning-plus-travel time using a pruner was about 34% greater than that using the saw, in the 14-year-old stand. Differences between the two tools were less pronounced in the 18-year-old stand. Most operators preferred the D-handled saw because the saw was easier to handle and was less strenuous.

**New FRDA Releases**

**Regenerating B.C.'s Forests Released**

More than 60 authors and editors worked together in preparing this landmark text on the theory and practice of forest renewal in British Columbia. The book organizes the experience gained from silviculture operations and research and presents it as a guide for students or practising regeneration foresters and silviculturists. It is designed as a reference that both identifies possible problems and suggests potential solutions.

The 22 chapters in *Regenerating British Columbia's Forests* are organized into five sections. The book contains dozens of graphs, illustrations, and photographs. It is 384 pages in length and contains a comprehensive index and list of references.

This book is a must for anyone involved in reforestation in British Columbia or neighbouring regions. Copies are available at a cost of $25.95 plus shipping and handling from UBC Press.

**Video Focuses on Integrating Silviculture Activities**

The Coastal TAC has funded the production of a video entitled *More than Trees*. The video and accompanying presentation guide, cover the following topics – Considering the whole forest ecosystem when choosing silvicultural practices, Setting objectives and planning, and integrating silviculture activities.

The professionally-prepared video also covers a four-step procedure for developing and implementing integrated silvicultural activities. In addition, four examples of innovation in integrated management are presented. These include a forest-range study in the Nicola Valley, an Integrated Wildlife, Intensive Forestry Research study in the Nimkish, the Coastal Fisheries-Forestry Guidelines used for coastal watershed plans, and streamside management for a valley north of Revelstoke.

Teamwork among interdiscipli­nary resource managers is highlighted as the essential ingredient in achieving integrated resource management objectives. The video suggests that resource managers must be willing to discuss and assess alternative ideas and be unafraid of developing innovative solutions.

*More than Trees* was prepared for operational forestry staff who must integrate silviculture activities with other forest resource uses. The video is suited for viewing by operations staff in government resource management agencies, forest industry, and silviculture contractors.

**Integrated Forest/Range Research Five-year Plan, FRDA Report 074**

This report presents the 5-year plan for research aimed at clarifying the biological interactions among grass, trees, and cattle. The research program is also expected to provide reliable information to assist resource managers with integrated forest management on forest land in the Cariboo, Kamloops, and Nelson Forest Regions.

**Using Data Loggers in the Field, FRDA Report 086**

This report is a guide to the use of electronic data loggers in an environmental monitoring program and is oriented to those used in the field. Although this manual focuses on the Campbell Scientific Inc. CR21, CR10 and 21X data loggers, the basic principles for the careful operation of the other data loggers are the same.

Examples of blank and filled-in input and output program forms, computer file record forms, and log sheets are included as appendices.
Stratification and Quality Assessment of Abies lasiocarpa Seeds, FRDA Report 095

In the past several years there has been increased interest in subalpine fir for reforesting northern, wet-belt, and high elevation sites in British Columbia. The superior performance of subalpine fir in cold, moist northern environments underlines the importance of improving knowledge of the cultural requirement of this species. The report deals with the initial part of this cultural process, the problems associated with seed dormancy and vigour.

The experiments demonstrated that germination of Abies lasiocarpa seeds is enhanced under low temperatures if seeds receive appropriate stratification treatment.

Dr. Carole Leadem also reports on work to develop some physiological indicators of seed vigor and seedling performance.

Developing Herbicide Efficacy Tables for the Southern Interior, FRDA Report 096

This project was established to examine the utility of operational herbicide applications as a starting point for creating efficacy tables for the Nelson Forest Region.

The primary objectives of the study were to assess the impact of herbicide treatment on target vegetation species in operational applications and to use these assessments to construct a first approximation efficacy table of chemical treatments versus target species.

Exploratory High Elevation Regeneration Trials in the Vancouver Forest Region: 10-year Species Performance of Planted Stock, FRDA Report 098

In the 1960's and early 1970's silvicultural practice on high elevation sites followed prescriptions derived from low elevation experience. Clearcut logging was frequently followed by slashburning and the planting of bareroot Douglas-fir. These plantations suffered high rates of mortality and trees that survived often had deformed stems and other physical damage. Errors in species prescription, site preparation, and planting time were suspected as the cause of these problems.

With the first cone collection of many subalpine tree species and the advent of large-scale production of container-grown seedlings in the mid-1970's, a wider variety of stocktypes and species became available for regeneration. Exploratory trials using the first stock produced in these different species and stocktypes were established to examine the stock reliability, productivity, and feasibility under high elevation conditions. The trials subsequently influenced various changes made to regeneration practices in the 1970's. This report documents these trials and their results.

Nutrient Deficiency Symptoms in Container-grown Douglas-fir and White Spruce Seedlings, FRDA Report 100

Dr. van den Driessche's study was conducted to illustrate deficiency symptoms in seedlings of two important species, Douglas-fir (Pseudotsuga menziesii) and white spruce (Picea glauca) grown in British Columbia nurseries. Similar studies have been published, but these generally involved trees rather than seedlings.

The report uses tables, graphs and 32 hint plates to illustrate deficiency symptoms clearly in container seedlings under conditions similar to those in operational nurseries. A further objective of the study was to see whether high levels of micronutrients could cause toxicity symptoms and reduce growth. The author did find, in some cases, that the addition of FeSO₄ (a common practice in operational nurseries) led to toxic concentrations of iron, and that the observed benefit from an FeSO₄ treatment resulted from the addition of sulphur.

Performance Evaluation of Powered Scarifiers in North Central British Columbia, FRDA Report 103

Six powered-disc trenchers and cone scarifiers were studied in short-term assessments in the summer of 1987. These implements were used in pairs and monitored on three sites, south of Vanderhoof and one south of Tumbler Ridge. The three sites were very different in characteristics and the implements were all successful in providing acceptable planting spots in all cases. However, the powered-disc trenchers were better able to handle sites with heavy slash and deep LFH horizons.

The report includes detailed descriptions of characteristics of the soils, sites, vegetation cover, equipment productivity and planting sites created by each machine. Illustration is enhanced by 14 photo plates and 3 drawings showing machines and treatments.

Site Preparation: A Swedish Overview, FRDA Report 105

This 60-page richly illustrated report is a translation of a Swedish publication (Orlander and Gemmel 1989) that summarizes state-of-the-art knowledge on site preparation, especially biological questions on seedling establishment and growth. A section has been added to the Swedish introduction to familiarize forest managers in British Columbia with Swedish ecological and silviculture conditions. The report provides basic educational material on stand establishment.

Mechanized and manual site preparation are the main methods dealt with in this report, which is concerned primarily with the biological aspects of site preparation; it examines what seeds and seedlings need in their environment and how favourable environments can be created to meet these requirements.


Proceedings of the November, 1989 Vancouver meeting have been compiled to include more than 127 pages of well-written summaries of the invited papers, posters, and computer-tool presentations. As in previous years, these proceedings will be an important reference for anyone working in vegetation management research or operations – in British Columbia and neighbouring provinces and states.

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