Forest Sciences

Prince Rupert Forest Region

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The Oona River Operational Research Trial

Research Issue Groups:

Forest Biology

Forest Growth

Soils

Wildlife Habitat

Silviculture

Timber Harvesting

Ecosystem Inventory and Classification

Biodiversity

Ecosystem Management

Hydrology

Geomorphology

Forest Engineering

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Introduction

The HyP[3] Project (Pattern, Process, and Productivity in Hypermaritime Forests – see Banner and Shaw 1999) is a multidisciplinary project concerned with the ecology of lower productivity forests on the outer north coast of British Columbia and their potential for sustainable forest management. As part of the HyP[3] Project, the Oona River Operational Research Trial was established with the overall objective of examining the ecological and economic feasibility of harvesting and regenerating these lower productivity forests. The specific objectives of the operational trial are to:

- ❖ Assess the feasibility of harvesting lower productivity redcedar – hemlock stands.
- ❖ Test the efficacy of fertilization and mechanical site preparation treatments for promoting the establishment and growth of natural and planted conifers.
- ❖ Compare the factors affecting establishment and growth of redcedar and yellow-cedar following harvesting.
- ❖ Assess and compare the growth performance of planted and natural redcedar and yellow-cedar.
- ❖ Assess the nutritional status of seedlings established on a variety of microsites with and without the application of fertilizer.
- ❖ Document the growth history and productivity in lower productivity old-growth redcedar – hemlock stands and compare this with second growth productivity on similar sites.
- ❖ Assess the quality of wood harvested from these lower productivity stands.
- ❖ Document end-product recovery and utilization rates.

Location and Site Description

The Oona River trial is located near the community of Oona River on Porcher Island, 40 km south of Prince Rupert, B.C. (Figure 1). The operational area consists of two adjacent blocks that cover a total of 17.6 ha. The trial is situated within the central variant of the very wet, hypermaritime subzone of the Coastal Western Hemlock

Figure 1. Location map of Oona River Operatioanal Trial.

Biogeoclimatic Zone (CWHvh2) (Banner et al. 1993), and includes three site series: 01 (Western Redcedar – Western Hemlock – Salal) covers approximately 84% of the harvested area; 11 (Western Redcedar – Yellow-cedar – Goldthread) covers 10%; and 04 (Western Hemlock – Sitka Spruce – Lanky moss) covers 6%. Both blocks occur on gentle slopes (5 – 25%) with a southerly aspect. Soils are imperfectly to poorly drained and consist primarily of organic (LFH and/or peat) veneers over saprolitic veneers (decomposed schistose bedrock). Soil depth varies from 20 to over 100 cm. Stands in the area are dominated by redcedar (*Thuja plicata*), which accounts for about 50% of the volume, and western hemlock (*Tsuga heterophylla*), with lesser amounts of yellow-cedar (*Chamaecyparis nootkatensis*), Sitka spruce (*Picea sitchensis*), and shore pine (*Pinus contorta* spp. *contorta*). Based on a pre-harvest timber cruise, gross and merchantable volumes within the 01 site series were determined to be 333 m^3/ha and 235 m^3/ha, respectively.

Mapping and Layout

In 1998, timber cruising and ecosystem sampling were carried out within a 50 ha candidate area to identify sites dominated by the 01 site series. Using the ecosystem sampling data, together with field notes and air photo interpretation, an ecosystem map was produced for the study area. Preliminary block boundaries were then laid out to include mainly the 01 site series (Figure 2). Additional cruise plots were then established within both blocks to obtain more detailed information on species distribution, stand structure and wood quality. Detailed soil depth and ecosystem mapping was also conducted on a 50 m grid within each block. A 1:3000 scale ecosystem/soil depth map was produced for both blocks in order to refine the original block boundaries, identify wetter leave patches (mostly site series 13: Western Redcedar-skunk cabbage and 11: Western Redcedar- Yellow-cedar-goldthread), and plan harvesting and silvicultural treatments.

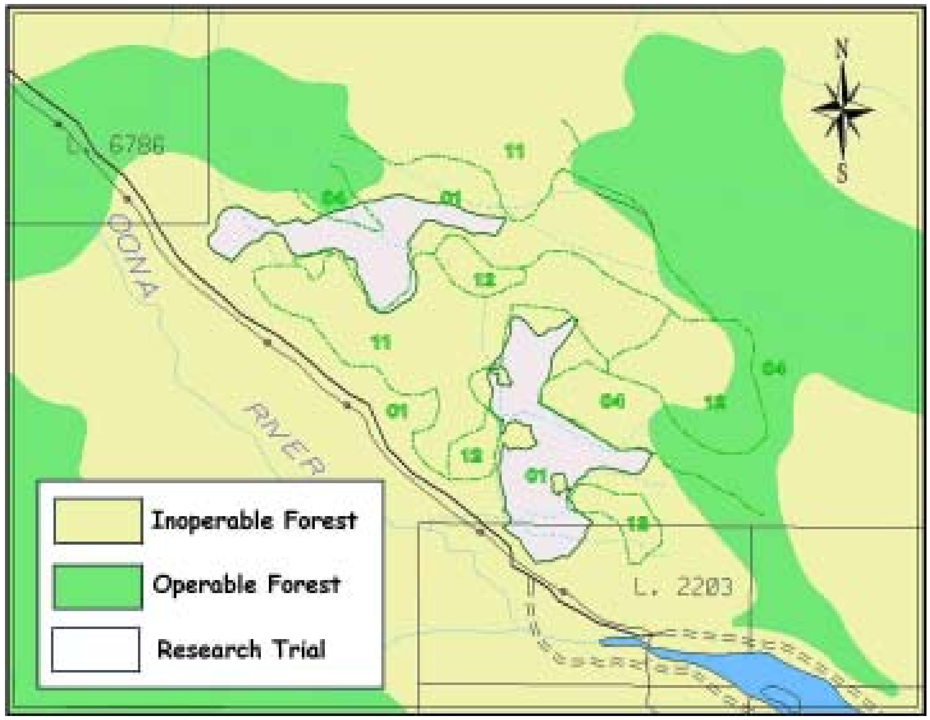

Figure 2. Ecosystem map of study site showing preliminary block boundaries that encompass mainly the Western Redcedar-Western Hemlock-Salal (01) site series.

Harvest Methods

Harvesting of the blocks began in June 2000. Following a diameter limit approach, all western redcedar and yellow-cedar between 17.5 cm and 150 cm DBH (diameter at breast height) were felled. Redcedar and yellow-cedar less than 17.5 cm DBH were retained for crop trees in the next rotation and those greater than 150 cm DBH were retained as seed and wildlife trees. The majority of hemlock and shore pine greater than 2 m in height were also felled; neither species was being considered as a crop tree for the next rotation, so leave tree specifications were not required. Hand felling was completed over a period of several weeks. The main skid roads were constructed by an excavator using non-merchantable wood (rotten logs, snags, undersized hemlock) as corduroy material. One main skid road was constructed through the centre of each block with short spurs constructed to access block extremities (Figure 3). Logs were "hoe-chucked" to the main skid roads

Figure 3. Main corduroy skid road built through block 1.

Figure 4. Excavator 'hoe-chucking' logs to main skid trail.

Figure 5. FMC tracked skidder moving logs to the landing.

using a CAT 320L, wide-tracked (32 inches) excavator (Figure 4) and moved to the haul road by a low ground pressure (< 6.0 psi) FMC tracked skidder equipped with chokers (Figure 5).

Site Treatments

Following harvest, twelve 0.1 ha treatment plots were laid out across the two blocks. Each plot was selected to be as uniform as possible in slope, soil moisture and soil depth. Areas dominated by peaty soils (mainly site series 11) were not included in the plots. The site treatments selected for the operational trial were based on existing knowledge of ecosystem processes and the results of a research trial established on similar sites near Port Simpson (Shaw and Banner 2001a & b). The Port Simpson trial indicated that planted seedlings generally performed better on mounds that consisted of a mixture of organic and mineral soil horizons. Experience on northern Vancouver Island (Prescott and Weetman 1994) has shown good tree growth response to fertilization with Nitrogen (N) and Phosphorus (P) and we hypothesize that the addition of P alone will enhance N availability by stimulating the nitrogen cycle (Cole and Heil 1981, White and Reddy 2000).

The lower productivity sites contain a huge amount of organic material in the form of dead and down trees, humus layers, moss and vegetation. Disturbance of the surface organic soil layers and the removal / mixing of excess organic material will result in soil warming, increased soil aeration and subsequent impovements to nutrient availablity. Surface scarification is expected to help to create better seedbeds for natural regeneration of redcedar. Based on the above rationale, the following three site treatments were randomly assigned to the plots (4 replications of each):

1) Light surface scarification and raking/piling of slash;
2) Scarification and raking (as above) combined with phosphorus fertilization (application rate of 75 kg/ha);
3) Spot raking followed by mixing of the organic and mineral soil horizons to form shallow mounds.

All mechanical treatments were carried out using a wide-tracked excavator equipped with either a five-fingered brush rake or a bucket. Disturbance in the remaining area of the blocks (excluding treatment plots and trails) resulted only from logging activities (felling, forwarding, and excavator travel). These areas will be planted and used as untreated controls for monitoring tree growth and natural regeneration.

Regeneration

To determine optimal regeneration methods for these lower productivity sites, we will examine the factors affecting the establishment and growth of both natural and planted redcedar and yellow-cedar seedlings. The factors include: substrate composition, degree of soil disturbance, proximity to seed trees/stand edges, vegetation competition and deer browsing. The nutritional status of planted and naturally regenerated trees, with and without the application of fertilizer, will also be assessed. Natural regeneration of all coniferous species (redcedar, yellow-cedar, western hemlock, shore pine, Sitka spruce, and amabilis fir (*Abies amabilis*)) will be monitored within the blocks. Survival rates and growth patterns of natural red and yellow-cedar will be compared to planted stock. Planting took place in April, 2002.

Browsing of seedlings by high numbers of deer has been a considerable impediment to successful artificial regeneration of redcedar on operational sites. All seedlings planted within the treatment plots were protected using 4 foot long VEXAR Rigid Tubes, double anchored with a cedar and a bamboo stake. VEXAR was also used throughout the remaining area within the blocks. Three other seedling protector designs (Cotter-Sinclair tubes, Sinocast Cones, and Free-Grow shelters) were installed on a small trial basis in order to do a preliminary assessment of their overall efficacy on these sites with respect to susceptibility to wind and snow damage as well as seedling survival and growth (Figure 6).

Figure 6. Free-Grow (left), Sinocast (front right) and Cotter-Sinclair (back right) seedling protectors.

Growth History, Productivity, and Log Quality

Thirty-seven dominant and co-dominant sample trees were identified prior to harvest to be used for stem analysis (Figure 7). The sample trees will provide growth history and old-growth site productivity information to refine existing site index and rotation length estimates for these lower productivity sites. Growth history data from the operational trial is being compared with data gathered from the Smith Island and Diana Lake old-growth study sites and with ongoing growth studies in second growth stands. The stem analysis trees will also be used to assess the physical and chemical wood properties that relate to strength and rot resistance of western redcedar. Since most of the lower productivity sites on the north coast are currently considered inoperable, there is very little information available on the properties of the wood from these sites. The wood properties and chemical analysis work is being done by Forintek at UBC, and will compare levels of rot resistant chemicals from these stands with those from other areas.

Figure 7. Redcedar sample tree marked for stem analysis cutting.

In order to improve our knowledge base, a detailed field assessment of log quality was completed. This assessment compared timber cruise grades to grades obtained from call-grading. Results of this assessment will help refine protocols for determining log quality while cruising in lower productivity stands where existing cruise compilation programs do not accurately portray the relationship between pathological indicators and log quality.

End Product Recovery

End-product recovery of redcedar was determined in order to compare utilization rates from these lower productivity stands to those from more productive, operable redcedar forests. Recovery volumes were obtained by relating the volume of dimensional lumber produced at the Group Mills sawmill at Oona River to the scaled volume of logs entering the mill.

Preliminary Findings and Issues

Block Layout and Harvesting

Pre-harvest ecosystem mapping was an effective tool used to help delineate block boundaries. The irregularly shaped, relatively small blocks that resulted from following the boundaries of the 01 site series, will not only help to promote the natural regeneration of redcedar with seeds coming from adjacent stands, but also, from a visual perspective, blend well into the blanket bog – upland forest landscape pattern (Figure 8).

The wet soil conditions typically found on lower productivity sites,

Figure 8. Aerial view of Block 1 showing the irregular ecosystem-based boundaries and leave trees (individuals and patches).

combined with the perceived positive benefits of logging and site preparation disturbance on second growth tree productivity, presents some significant operational challenges. While there is a need for some site disturbance, there are also site–specific and weather–specific limitations that must be recognized by operators in order to avoid site degradation and off-site (stream) impacts. The Oona River blocks consist primarily of the 01 site series, but typically vary in slope and soil characteristics throughout the blocks. Variation in slope and depth of organic and mineral soil horizons presented conditions that responded quite differently to machine traffic, especially during wet periods. Flat and gently sloping areas with deeper organic soils, as well as areas that were shallow to bedrock had much greater potential for soil puddling and surface water ponding, especially if operations were not suspended during wet periods. Changes to the current operational shutdown guidelines may be required to ensure these sites are not degraded. The use of low ground pressure tracked machinery that is capable of performing multiple functions, such as trail construction, log forwarding, slash piling, and site preparation, shows considerable potential for minimizing the negative impacts of machine traffic on these sites while providing desirable levels of surface soil disturbance. Using the logging slash and dead and down woody material to build corduroy roads for skidding also proved to be effective in minimizing site disturbance associated with the main skid roads, as well as aiding in slash management.

Lower productivity coastal forests have a high degree of structural diversity with many veteran trees and snags. The felling of these non-merchantable trees during harvesting operations can lead to very large accumulations of woody slash on sites that already have excessively deep surface organic horizons. In order to reduce the amount of organic material (decaying wood) added to the forest floor, it is preferable to leave these trees standing if possible (see Figure 8). The retained stems can also serve other purposes such as seed trees and wildlife trees that contribute to habitat diversity goals. While the diameter limit approach used in this trial proved to be effective in meeting slash management as well as seed and wildlife tree objectives, it required a liberal interpretation of existing wildlife/danger tree assessment guidelines. This will continue to be a challenge in developing harvesting guidelines for lower productivity sites, where the desire to leave as many veteran green trees and snags as possible must be tempered with the need for safety.

Site preparation treatments

There are three phases of the 01 site series recognized: 01a – mineral, 01b – lithic and 01c – peaty. The mineral phase is the most suitable for the mounding/mixing treatment because on these sites there are greater opportunities to mix surface organic layers with subsurface mineral horizons (Figure 9). The lithic phase consists of forest floor (LFH) horizons (sometimes over 40 cm in depth) occurring directly over bedrock and the peaty phase is comprised of sphagnum moss–derived organic soils that are generally deeper than 40 cm. Mounding of the pure organic material on either of these phases is not expected to improve productivity except, perhaps through some marginal improvement of surface soil aeration. Excessive machine traffic and site preparation on these phases is just as likely to lead to soil puddling and a decrease in the number of plantable spots and long – term productivity. The best strategy on the lithic and peaty phases is to make use of natural elevated microsites when choosing plantable spots. Surface disturbance on these sites should be restricted to that resulting from the harvesting activities alone and these activities should be curtailed during the wettest periods. Raking treatments to reduce the accumulated organic matter and slash can be applied to all phases of the 01 site series as well as the 04 sites (Figure 10). Initial results of this trial indicate that sites series 11 (occurring mainly on peaty soils) should be avoided if at all possible (flag as a leave patch if area exceeds 0.1 ha in size).

Figure 9. Mixed mineral and organic mound on a CWHvh2/01a site.

From the above discussion, it is apparent that machine operators must receive a basic level of training on recognizing soil conditions that are appropriate for applying site treatments. From an operational perspective (based on feedback from the machine operators) it makes sense to combine logging and hoe-chucking activities with the site preparation activities in order to minimize the number of entries into the block. After assessing soil conditions by test probing with the excavator bucket or rake, operators can apply the appropriate raking and/or mounding treatments opportunistically as they retreat from that area of the block. Planters will then be instructed to utilize the natural, as well as artificially created raised microsites in order to achieve the optimum planting density.

Figure 10. Excavator raking and piling slash on Oona River trial block.

Table 1. Comparison of old growth and second growth productivity for western redcedar on CWHvh2/01 sites (Site index is at 50 years).

	Old Growth	Second Growth
Average Site index (range)	3.9 (1.9 - 10.5)	17.7 (13.5 - 22.3)
Average years to 1.3 m (range)	50 (15 - 124)	7 (3 - 11)

Site Productivity

Current site index estimates produced in the first forest cover database are based primarily on measurements from old-growth stands. Detailed stem analysis of old-growth redcedar growing on CWHvh2/01 sites confirms that the existing forests are indeed poor in terms of conifer growth. Limited site index data from second growth stands on the same site series, however, suggest that second growth productivity, while still low, is significantly higher than current forest cover estimates indicate (Table 1). Additional stem analysis field sampling of old logging sites and continued monitoring of the new operational trials at Oona River and Port Simpson will provide information to more accurately

Table 2. Cruised and Call graded merchantable volumes (m^3/ha), by log grade and species, from the Oona River operational research trial.

Log Type	Grade	Western redcedar		Yellow cedar		Western hemlock		Shore pine		Sitka spruce		Total	
		Cruise	Call-grade	Cruise	Call-grade	Cruise	Call-grade	Cruise	Call-grade	Cruise	Call-grade	Cruise	Call-grade
#2 Lumber	F		0.6										0.6
#2 Sawlog	H	12.3	16.5							4.9	3.9	17.2	20.4
#3 Sawlog	I	2.5	9.5			1.7				2.5	3.7	6.6	13.2
#4 Sawlog	J	39.4	40.8	16.1	5.8	22.9	8.5	4.8	1.6	14.5	6.8	97.8	63.5
#2 Shingle	L		4.7										4.7
#5 Utility	U	53.0	16.3	4.0	13.9	24.7	12.0		0.8	4.4	4.8	86.0	47.8
#6 Utility	X	2.5	9.6	1.6	0.5	6.3	22.0		1.8		3.5	10.3	37.3
#7 Chipper	Y	13.6	25.3	0.7	2.2	1.7	14.9		0.7	1.1	4.5	17.0	47.5
Total		123.2	123.2	22.4	22.4	57.3	57.3	4.8	4.8	27.3	27.3	235.1	235.1

classify the productivity of these sites.

Log Quality Comparison

A detailed comparison of the log quality breakdown of the trees harvested from the Oona River operational trial blocks using the cruising and call-grading methods is presented in Table 2. The results indicate that the current cruise compilation programs, designed for productive coastal sites, do not provide an adequate portrayal of the composition of the log quality profile that can be obtained from logging lower productivity redcedar – hemlock stands of the north coast. For redcedar, the biggest difference between the cruised and call graded volumes was the significant decrease in #5 utility logs. Forty-nine percent of this volume was moved into higher quality and more valuable logs (L grade or better). For redcedar, the field-based method of call grading resulted in a 10% increase in sawlogs. For the other harvested species, there were significant decreases in the volume of sawlogs and a corresponding increase in the volume of lower grade utility and chipper logs.

End Product Recovery

The end product recovery portion of this project has yielded some interesting results. The redcedar growing on the imperfectly drained zonal sites on the outer north coast are typically much shorter and have a larger butt flare than those growing on better drained, more productive sites. This type of log profile presents a significant challenge for any lumber processing facility trying to achieve acceptable utilization levels. When sawing these redcedar logs to produce dimensional lumber, the high degree of taper and numerous large branch knots in the top of the tree, in combination with the large butt flare, results in significant waste.

Figure 11. Some of the high quality redcedar siding and dimensional lumber produced at the Group Mills operation at Oona River.

The Oona River milling data indicate that from a typical 16 m tree that produces 3, 5 m logs, the total accumulated waste averages 46% of the scaled log volume entering the mill. On average, 27% comes from the butt log, 14% from the top log and 5% from the centre log. This amount of waste is likely in the high range since the Group Mills facility is a basic operation using a twin bladed circular saw with a ¼ inch kerf for primary breakdown. The amount of waste could likely be reduced if:

1) the shorter pieces of lumber (< 6 ft.) from the butt log were utilized,

2) less one inch material was cut &

3) the primary headrig was a more efficient, narrow kerf bandsaw.

Even more wood could be recovered if the logs were processed in a facility that had taper sawing capabilities. Despite the relatively high amount of waste, the quality of the redcedar dimensional lumber and siding produced from these lower productivity stands was very high (Figure 11).

Summary

The initial results from the Oona River operational trial have provided valuable insight into the management of the lower productivity forests on the outer north coast of British Columbia. This information has lead us to believe that it may be ecologically feasible to conduct sustainable harvesting operations on some of these sites, however, more opeational trials are needed for definitive answers. It is readily apparent that the old-growth site index values currently assigned to these forests are based on the slow growth rates of centuries old stands and do not reflect the growth potential of these sites. The long term lack of significant disturbance (i.e. fire, landslide or windthrow) appears to be the key factor contibuting to the low site productivity. Some level of site disturbance has shown promise towards improving growth rates and additional site treatments may provide further gains. Harvesting activities on these wet sites will, however, present numerous operational challenges. The collection of detailed site information (ecosystem type, soil depth and composition, bedrock type, timber type and diameter distribution, etc.) is required for proper block layout. The use of low ground pressure road building, harvesting and forwarding equipment will help minimize site degradation while allowing sufficient disturbance to occur. Since the soils of these sites are often saturated, it is proposed that the operational shutdown criteria be altered to reduce the risk of off-site hydrological impacts. Planting of the harvested areas with high quality redcedar stock will re-establish a new merchantable crop in the minimum amount of time and natural seed-in of redcedar and other species will help ensure stocking levels are acceptable. The diameter limit approach to harvesting will provide for valuable structural diversity over time. Although there are operational challenges to overcome, both on the block and at the mill, the quality of the redcedar harvested from these lower productivity sites appears to justify the continued pursuit of ecologically and operationally acceptable solutions.

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