Forest Sciences

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Seedling Browse Guard Trial on the North Coast of British Columbia

Research Issue Groups:

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Introduction

On the coast of British Columbia, western redcedar (*Thuja plicata*) is a very valuable tree species and often the focus of harvesting activities. Redcedar also has very high cultural significance among the First Nations of coastal B.C. Regenerating a new crop of redcedar after harvest has presented many challenges over the years but improvements in seed collection and storage methods and new nursery cultural regimes have resulted in a reliable supply of good quality seedlings being available for planting.

Once a redcedar seedling is planted in the field, it faces a host of biotic and abiotic challenges to successful growth. One of the major factors affecting survival and growth on many coastal sites is browsing by black-tailed deer (*Odocoileus hemionus*). For reasons that are not fully understood, deer find freshly planted redcedar seedlings particularly palatable and they often browse the seedlings beyond the point of recovery. Planting is a time-consuming and expensive operation and browsing can be a serious impediment to the establishment of a viable second growth redcedar crop. One of the most common methods of dealing with this issue is the use of seedling protectors/shelters or browse guards. The guards come in many different styles, sizes, and configurations from a variety of manufacturers. As part of an ongoing operational research trial, we examined five different types of seedling browse guards to determine their effectiveness in establishing a redcedar plantation on the north coast of British Columbia.

Location and Site Description

The browse guard trial was established in an operational trial located near the community of Oona River on Porcher Island, 40 km south of Prince Rupert, B.C. (Figure 1). The trial site is situated within the central variant of the Very Wet, Hypermaritime subzone of the Coastal Western Hemlock biogeoclimatic zone (CWHvh2) (Banner et al. 1993). The trial block includes three site series: Western Redcedar – Western Hemlock – Salal (01); Western Redcedar – Yellow-cedar – Goldthread (11); and Western Hemlock – Sitka Spruce – Lanky moss (04). The trial occurs 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

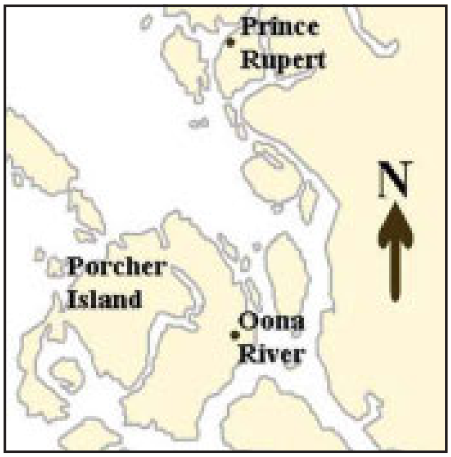

Figure 1. Map of trial location.

varies from 20 to over 100 cm. Mature stands in the area are dominated by redcedar, 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*).

Trial Layout and Measurements

The browse guard trial was laid out in two different areas in a harvested block, one containing a mix of 01 and 11 site series and the other dominated primarily by 01. Five different types of browse guards were tested: 1) Vexar rigid tubes, 2) Freegro Fine (F) and 3) Extra Fine (EF) mesh, 4) Sinocast, and 5) Growcone. Each site had 25 seedlings per guard type for a total of 250 protected trees. In addition, 25 unprotected seedlings were established at each site. The container-grown, one-year-old, redcedar seedlings were planted at Oona River on May 30th and 31st, 2001. Browse guards were put in place the same day planting occurred. A series of sensors were installed inside the solid- or semi-solid walled protectors (Sinocast, Growcone, and Freegro EF) to measure internal air temperature. Sensors were also set up to record external ambient air temperatures. Data were collected from August 1st to September 20th, 2001 using a datalogger that measured temperatures at ten minute intervals and recorded daily average, maximum, and minimum values. After three full growing seasons (Oct. 2003), the survival, condition, and height growth of the planted seedlings was measured as well as the condition of the browse guards. Tree condition was based on an assessment of the foliage and four categories were used: 1) healthy (all foliage appears undamaged); 2) light damage (< 33% of foliage showing evidence of browsing or necrosis); 3) moderate damage (34 - 66% of foliage showing evidence of browsing or necrosis); 4) high damage (>66% of foliage showing evidence of browsing or necrosis). The condition of the browse guards was assessed as either: 1) upright and intact, 2) leaning (> 30°), or 3) over on the ground.

Results

All of the seedling protectors we tested were successful in reducing or eliminating browse damage by the local deer population. Browsing of any unprotected branches, such as those sticking through the Vexar mesh or Sinocast vent holes, was considerable. One hundred percent of the unprotected seedlings were browsed during the first growing season and most had moderate to severe damage (Figure 2, Table 1). After three years, survival of the redcedar seedlings was good to excellent for all protected seedlings and ranged from 80% to 96% (Table 1). The best survival was in the Freegro EF and the Growcone shelters (96%) and the poorest survival was in the Sinocast (80%). The Vexar and the two Freegro seedling protectors had more than 88% of the seedlings with no foliage damage (Table 1). In most cases, the recorded damage was in the light or moderate categories. The Growcone had 73% undamaged seedlings while the Sinocast had 69%. In the Sinocast, almost 50% of seedlings with damaged foliage were in the "high" category (Table 1).

Height growth of the protected seedlings was quite variable and average values ranged from a low of 53 cm in the Sinocast to a high of 75 cm in the Freegro EF (Table 1). The Freegro F and the Growcone had similar height growth response (68 cm and 66 cm, respectively), while trees in the Vexar shelters averaged 60 cm. Microsite conditions had a major impact on growth and there was a significant range in height within each shelter type (Table 1).

The Growcone shelters had the best performance from a durability standpoint with 84% of the guards in the upright and intact category (Table 2). This was followed closely by the Freegro EF, the Freegro F, and the Vexar tubes with 80%, 76%, and 76% intact,

Figure 2. An unprotected redcedar seedling with high deer browse damage.

Table 1. Condition of planted redcedar, by protector type, after three years

Protector Type	Seedling Condition: Survival (%)	Foliage Damage (%)			Average Height (cm) (min - max)
		Light	Mod	High	
Vexar Tubes	92	6	3		60 (24 - 104)
Freegro EF	96	8		4	75 (30 - 126)
Freegro F	94	3	3		68 (35 - 123)
Growcone	96	16	9	2	66 (25 - 118)
Sinocast	80	3	13	15	53 (20 - 114)
Unprotected	72			100	33 (30 - 39)

respectively. The Sinocast suffered significant damage with only 44% of the guards fully upright and intact and an additional 26% leaning more than 30^o after three years in the field (Table 2).

During the measurement period, average daily temperatures inside the browse guards did not vary significantly from the ambient air, although as average temperatures exceeded about 12^{o}C, differences became more pronounced (Figure 3). More noticeable differences were evident in the maximum daily temperature readings. The Sinocast and Growcone shelters had average maximum daily temperatures 4.5^{o}C and 4.1^{o}C higher than the ambient air, respectively. The Freegro EF shelters had average maximum daily temperatures 2.2^{o}C higher than the ambient air (Figure 4). This difference in temperature also tended to increase as the ambient air temperature increased. Maximum temperature differences of 8.5^{o}C and 8.6^{o}C higher than ambient air were recorded in the Sinocast and Growcone shelters, respectively (Figure 4). On warm, sunny days, air temperatures in excess of 36^{o}C were recorded inside the shelters . The Freegro EF shelter had a maximum difference of 5.5^{o}C and reached a maximum temperature of 34.7^{o}C.

Discussion

The use of seedling protectors has become quite common in many coastal reforestation programs, especially when the species being planted is western redcedar. There are a number of factors that a manager should consider before deciding which type of shelter to use. In this trial, we examined five different shelters and evaluated them on the following criteria: effectiveness at preventing browse damage; ease of installation (based on planter comments); durability; and survival and growth of the protected seeding. Shelter cost is obviously a concern to managers; however, given the small scale of this trial, we made no attempt to examine this issue.

The Vexar tubes did a good job of protecting the planted tree but the open mesh design did allow many lateral branches to become exposed as the trees grew and these were quickly browsed off. In some cases, the leader grew out through the side of the guard and was also browsed. Repeated damage of this type can have a detrimental effect on the form of the tree. The Vexar tubes were supported by two, one metre long metal pins placed on opposite sides of the shelter. This configuration proved to be a problem when high winds and/or snow folded over the top of the shelter (Figure 5). Once this type of damage has occurred, it is impossible to repair unless a full length stake is added. The problem can be avoided if full length stakes are used for support initially. The Vexar tubes are shipped in a "nested" configuration and although light, they are somewhat bulky and carrying more than a few "nests" was described as cumbersome. The Vexar were easy to place over the seedlings and the

Table 2. Condition of seedling protectors, by type, after three years

Protector Type	Protector Condition: Upright / Intact (%)	Leaning > 30^o (%)	Over on ground (%)
Vexar Tubes	76	0	24
Freegro EF	80	8	12
Freegro F	76	8	16
Growcone	84	10	6
Sinocast	44	26	30

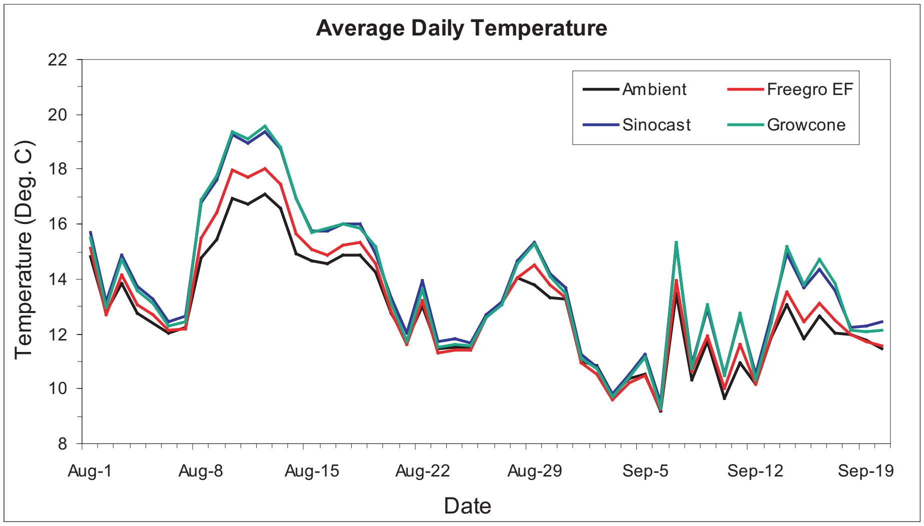

Figure 3. Average daily temperatures (Aug 1-Sept. 20, 2001).

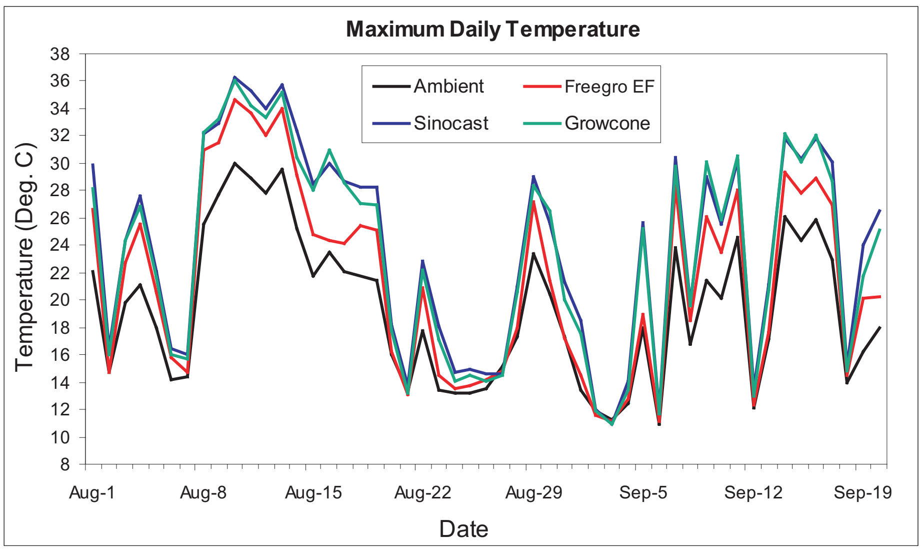

Figure 4. Maximum daily temperatures (Aug1-Sept 20, 2001).

Figure 5. Vexar tube folded over at pin height by strong winds and heavy snow.

short metal pins were easy to install. The weight of the pins was described by the planters as potentially problematic on a large operational scale. The protected seedlings grew well inside the Vexar with only 9% showing any foliage damage.

The Growcone shelters performed well in most assessment categories. They fully protected the planted trees and the small vent holes did not allow much foliage to become exposed. The Growcone shelters were the most durable of all the protectors tested with only 6% on the ground after two years. The size and shape of the shelter offers minimal wind resistance, an important feature in many coastal environments. The shelters are solid and packaged individually so they are bulky and carrying them into the planting block for installation can be awkward and time consuming. The diameter of the shelters is small (9 cm) and care must be taken to ensure the seedling is not damaged during installation. Survival and growth of the planted seedlings was very good with the tallest trees getting close to the top of the shelter after only three years (Table 1). Foliage damage was evident on 27% of the seedlings and may be related to a combination of increased air temperatures and compression of a large volume of foliage into a small area (Figure 6).

The Sinocast shelters did not perform well in this trial. Although the shelters were very effective at preventing browse damage, they did not handle the wind and wet soils of the north coast very well. After three years, only 44% of the shelters were still upright and

Figure 6. Compression of healthy foliage due to small diameter of the Growcone.

protecting the seedlings effectively. The survival rate was fairly good (80%), although 14% of the trees recorded as alive were in shelters that were knocked over at the time of assessment so their future survival is unlikely. The design of the Sinocast shelters provides a large sail area and they were often pulled out by repeated high winds (Figure 7). Packing the shelters onto the block was described by the planters as very awkward due to a combination of the pyramid shape and the slipperiness of the material. The shelters had a tendency to "pop out" of a stack and many were found lying around the block. The Sinocast were easy to set up and install and there is lots of room for the seedling to grow. The greenhouse effect of the plastic shelter significantly increased the air temperature and may be partly responsible for the high level of damaged foliage we recorded (31%). While these shelters have proved effective in other areas of the province, redcedar from the north coast may not be well adapted to temperatures in the upper 30°C range (permanent cellular damage for most conifers typically begins around 40°C – Dr. R. Guy, UBC, Pers. Comm. April, 2005).

The Freegro Fine shelters performed well in all areas of assessment in this trial. The shelter mesh did allow some branch tips to grow through (Figure 8) but the trees were generally well protected from browsing and survival was excellent at 94%. The seedlings were healthy and growing well with only 5% showing any signs of foliage damage. Height growth was also very good with an average of 68 cm, the second best of all the protectors tested. The shelters withstood the harsh weather conditions quite well with 81% still fully intact after three years. This early design of the Freegro used a ¾" x ¾" stake for support and most of the damaged shelters were associated with a broken stake (Figure 9). (Note: current Freegro models are designed to accomodate a larger stake). The Freegro Fine shelters are packaged flat with the mesh pressed between the two end rings. They take up very little room and were described by the planters as "extremely easy" to pack and install on the trees. Some problems did occur when a support stake was driven too far into the ground thus preventing proper vertical tensioning of the shelter.

Figure 8. Redcedar foliage growing out through the Freegro Fine shelter mesh.

The Freegro Extra Fine shelters also performed well in this trial. The fine mesh did not allow any foliage to become exposed and the seedlings were completely protected from deer browsing. This Freegro shelter also used a ¾" x ¾" stake for support which resulted in most of the recorded losses (Table 2). This model of Freegro shelter is packaged in a similar fashion to the Freegro F and also received high praise from the planters for ease of

Figure 7. Sinocast protectors (white) uprooted by repeated strong coastal winds.

Figure 9. A broken support stake leads to the loss of the planted seedling.

transport and installation. Shelter tensioning was also an issue with the Freegro EF model. Survival and average height growth of the seedlings in the Freegro Extra Fine was excellent; 96% and 75 cm, respectively. Almost one third of the trees in the shelters had reached one meter in height after only 3 years and some had even overtopped the shelter (Figure 10). There was a small greenhouse effect created in the shelters which

Figure 10. Planted redcedar seedling emerging from Freegro Extra Fine shelter after 3 growing seasons.

appears to have improved height growth, although 12% of the seedlings did show some signs of foliage damage (Table 1).

Summary

The use of seedling protectors has become quite common in many areas of coastal British Columbia and there are several different types currently on the market. This trial examined 5 shelters in a north-coast environment. All of the protectors we tested were quite successful in reducing or eliminating deer browse damage. The main differences between them were more apparent when we examined their durability and the survival and growth of the protected seedlings. There were positive and negative points to each shelter we tested and it will be up to the forest manager to decide which one suits their particular needs. When choosing a seedling protector, it is important that the manager consider not only the immediate cost of the shelters and their installation, but also the other, perhaps less obvious, costs of maintaining the shelters. Damaged shelters can easily lead to the loss of a seedling. Since no seedling protectors we tested were self-supporting, the size and durability of the support stake is absolutely critical. A 2.5 cm x 2.5 cm clear wooden stake, preferably of redcedar, with at least 30 cm in the ground (more if ground is very wet) is highly recommended. Ease of shelter transport and set up by planters is also important as extra effort at this point means lower productivity and higher overall costs. The environment in which the shelter is to be used must also be considered as high winds and / or heavy snow can loosen supports and wreak havoc on some types of shelters. In the north coast environment we examined, the shelters that provided a significant greenhouse effect appear to have caused unacceptable levels of damage to the seedlings. While this may not be an issue with other species or in other areas, it should be considered in a north coast environment.

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