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Strathcona Elk Winter Range Enhancement Project (BCRP Project # 04.W.Ca.03)

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(BCRP Project # 04.W.Ca.03)
- 2004 Final Report -

Executive Summary

This is the third year of habitat enhancement trials in the Thelwood and Elk Valleys of Strathcona Provincial Park. The current report summarizes enhancement and monitoring-related activities from April 2004 to March 2005. Three sites were enhanced in 2004, bringing the total number of sites to 13 for the project. All enhancement sites are within 80 km of the town of Campbell River, ranging from 220 m to 330 m elevation.

The main objective of the 2004 work plan was to increase the winter carrying capacity of second-growth stands in the Thelwood Valley by spacing, pruning, and brushing 2 sites (6.4 ha) and seeding 1 site (1.0 ha). Documenting vegetation and elk responses to treatments from previous years were key secondary objectives.

Total project expenditures for the year were approximately $50,300. Work relied entirely on funding from the Bridge Coastal Fish and Wildlife Restoration Program, with significant in-kind assistance from BC Parks. Enhancement costs for the 2004 sites ranged from $5,614 to $11,840. On a per hectare basis, scarification and native-seeding was the most costly technique, at $ 9,357/ha. Modifications to stand-tending specifications in 2004 reduced treatment costs to $2,960/ha from $3,700 - $5,300/ha in prior years. The modified specifications removed the need to locate work zones and increased falling production.

Vegetation monitoring in 2004 involved herbage plots within seeding areas, browse plots within stand-tending areas, and a survival survey within browse planting areas.

Herbage plot monitoring revealed that forage production at an agronomic seeding area (Site 1) dropped significantly in 2004, from 1294-1488 kg in 2003 to 519–656 kg. The drop was associated with the replacement of perennial late ryegrass by fescues and clovers. In contrast, production at the oldest native-seeding area (Site 3) increased slightly in 2004 (2134-2374 kg vs. 1978-2199 kg in 2003). In 2004, the carrying capacity of Site 3 increased twofold to threefold over pre-enhancement levels. The first year post-enhancement results from a fall seeding area (Site 9) showed no significant increase in forage production over pre-treatment levels (803-998 kg vs. 705-945 kg in 2003). However, seed head production appeared much higher than in the spring seeding areas, suggesting a large potential for increased production next year.

None of the browse monitoring plots revisited in 2004 showed detectable differences in browse cover or elk utilization compared to baseline conditions.

The browse planting survival survey revealed a large drop in the overall survival rate at Site 5, from 95 % survival a year after planting to 50 % survival after two growing seasons. Roughly half of the cottonwood, willow and maple plantings succumbed during the dry spring of 2004, but almost all Saskatoon shrub plantings survived.

Elk use monitoring in 2004 involved winter pellet group counts and an aerial survey. Pellet group data from the four oldest enhancement sites were analysed. A large drop was recorded the agronomic seeding area (Site 1) in 2004 (106 pellet groups/km vs. 191 in 2003), consistent with recorded decreases in forage production. Pellet groups counted at a spacing area (Site 2) have increased steadily since treatment. However, no increase in understorey coverage has been detected as yet. The 2003 closing of an adjacent logging road may best explain the Site 2 pellet count trend. At the oldest native seeding area (Site 3) pellets counted in 2004 were twice as high as previous years (97 pellet-groups/km vs. 48-51 pellet groups/km). Counts at Site 4 showed low levels of use prior to enhancement (25 pellet groups/km). The observed increase in 2004, two years after enhancement, were statistically significant (43 pellet groups/km) and indicated a twofold increase in elk use.

A total of 45 elk were recorded across the study area during the annual aerial survey, down from the 2003 count of 68. A more persistent snow pack in 2003 confined herds to valley bottoms and improved elk sightability. Observed calf production remains high in both the Elk and Thelwood valleys, at 50 and 60 calves per 100 cows, respectively. An historical high of 50 calves per 100 cows was recorded in the Elk Valley in the 1980's.

With 2004 work complete, all areas identified in the enhancement planning report have now been treated. It was recommended that a modest annual monitoring program be maintained over 2005, 2006 and 2007, to assist in data analysis and map sites for long-term monitoring. A more comprehensive monitoring plan should be developed for the 2008 BCRP funding year in order to re-evaluate forage production indices, herd strength and productivity.

If these enhancement trials ultimately prove successful and cost-effective, consideration should be given to applying them more broadly within the study area and beyond. Provincial biologists have stated a long-term goal of enhancing 80 ha of habitat in the Elk Valley. To date only about 10 ha has been enhanced here. Optimizing habitat in the Thelwood Valley could support a herd of 39-76 wintering elk, but this may require enhancement of an additional 50 ha on floodplains and alluvial fans. The apparent demise of the Wolf Valley elk herd, on the west side of the Buttle Lake Reservoir, may warrant investigation into the Wolf River as a potential area for future habitat enhancement in Strathcona Park.

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1.0 INTRODUCTION

1.1 Background

Elk winter range enhancement has been carried out for several decades in the B.C. Interior. However, relatively little is known about restoration techniques suitable for Vancouver Island and the adjacent Mainland coast, where a Blue–Listed subspecies of elk occurs (Roosevelt elk; *Cervus elaphus roosevelti*). Some winter forage enhancement trials were carried out in the Campbell River Watershed during the mid-1980's through the Habitat Conservation Fund (Janz 1982; Davies 1986). However, these were of short duration and had little follow-up monitoring. In 1993, BC Hydro commissioned a wildlife restoration study for the Campbell River drainage which outlined some possible means of enhancing elk winter range in park and non-park land (Blood 1993).

In 2000, the creation of BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program (BCRP), a compensation program addressing footprint impacts of hydro development, provided biologists with an opportunity to conduct operational trials on a range of enhancement techniques within Strathcona Provincial Park, on Vancouver Island (Figure 1). Project planning got underway in 2000 with the identification of potential sites and review of available techniques (Materi and Blood 2000). A detailed five-year implementation and monitoring plan was developed for 10 sites in Strathcona Provincial Park in 2001 (Materi 2001). The BCRP Program funded enhancement of 6 sites in 2002, 4 sites in 2003, and 3 sites in 2004. This report summarizes activities in the project area from April of 2004 through March of 2005.

1.2 Project Rationale

Since completion of the Strathcona Dam in 1958, about 31 km^2 (3,100 ha) of previously forested valley bottom habitat has been inundated in the Upper Campbell / Buttle system. Although no pre-flooding studies of habitat conditions were conducted, Canada Land Inventory mapping suggests the habitat capability for Roosevelt elk would have been high on the inundated lands. Preliminary estimates in Blood (1993) indicate that flooding reduced the total watershed's carrying capacity for elk by about 75 to 100 individuals. That investigator recommended that compensation measures be *"intensive and involve large areas of the remaining winter range in the area".*

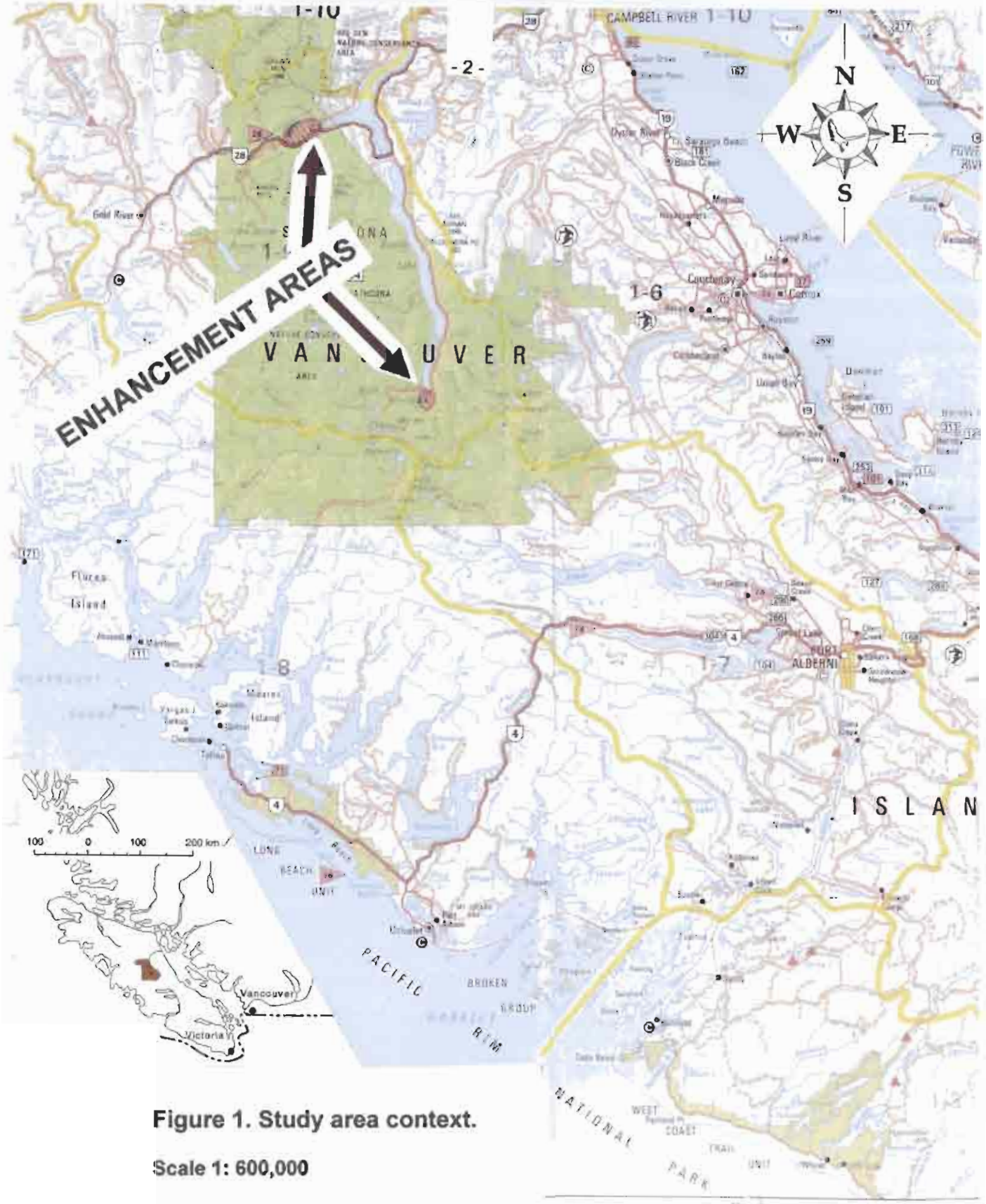


Figure 1. Study area context.

Scale 1: 600,000

Providing suitable winter range is a key factor in the long-term persistence of elk herds on Vancouver Island (Nyberg and Janz 1990). Winter and early spring can be periods of severe nutritional stress because most types of forage are generally of low quality at those times of the year. Although elk can digest forage of lower nutritional quality than deer, their social nature necessitates access to more concentrated forage resources than deer. This factor, and the fact that snowfall is considerably lower in valley bottoms than at higher elevation, makes rich valley bottom stands and swamps important winter habitats for elk. BC Hydro has recognized the loss of valley bottom habitats to flooding as a factor limiting ungulate production in the BCRP Strategic Plan for the Campbell River watershed (BC Hydro 2000). The Strathcona Provincial Park Master Plan (BC Parks 1993) acknowledges that critical ungulate winter ranges have also been affected by other non-conforming activities park (e.g. mining, highways).

2.0 GOALS AND OBJECTIVES

2.1 Project Goals

Since this project's initiation in 2000, its main goals have remained the same. The primary goal has been to improve winter range in Strathcona Provincial Park to ensure the long-term persistence of its Roosevelt elk herds. The development and refinement of enhancement techniques for this subspecies that can be applied in other coastal locations is considered a key secondary goal. Raising public awareness and interest in the park's wildlife resources in general, and Roosevelt elk in particular, constitute the third major goal of the project.

2.2 Project Objectives

The main objective of the 2004 work was to increase forage production at three sites by:

- enlarging gaps in the forest canopy in 2 sites (4.0 ha and 2.0 ha)
- pruning tree limbs of retained conifers within the above sites
- cutting deciduous trees and shrubs to stimulate coppicing within 1 of the above sites (parts of the 2.0 ha site)
- scarification and seeding with native grass at 1 site (1.0 ha)

An important secondary objective of the 2004 work plan was to provide on-going monitoring, so the enhancement trials underway since 2002 can be adequately assessed and, if necessary, modified for future enhancement projects. Specific monitoring objectives were to determine:

- pre-enhancement forage production at the one site seeded in 2004.
- post-enhancement forage production at the three sites seeded in 2002 and 2003.
- pre-enhancement winter use by elk at the three sites enhanced in 2004.
- post-enhancement winter use by elk at eight sites enhanced over 2002 and 2003.
- pre-enhancement browse abundance at two sites thinned and pruned in 2004.
- survival rates of winter browse plantings at one site enhanced in 2002.
- elk herd strength and composition in the study area.

It should be noted that the project will assist BC Parks in meeting wildlife-related objectives of the Strathcona Provincial Park Master Plan, including restoring impacted habitats, conducting management-oriented research and providing information to the public on vulnerable species.

3.0 STUDY AREA

3.1 Location

All enhancement sites are within 80 km of the town of Campbell River. They are located along Thelwood Creek, which drains into Buttle Lake (Figure 2). The study area also includes the Elk River Valley, which drains into Upper Campbell Lake (Figure 3). Both Buttle Lake and Upper Campbell Lake function as reservoirs for the BC Hydro's power generation facilities at the Strathcona and Ladore Dams.

3.2 Terrain and Climate

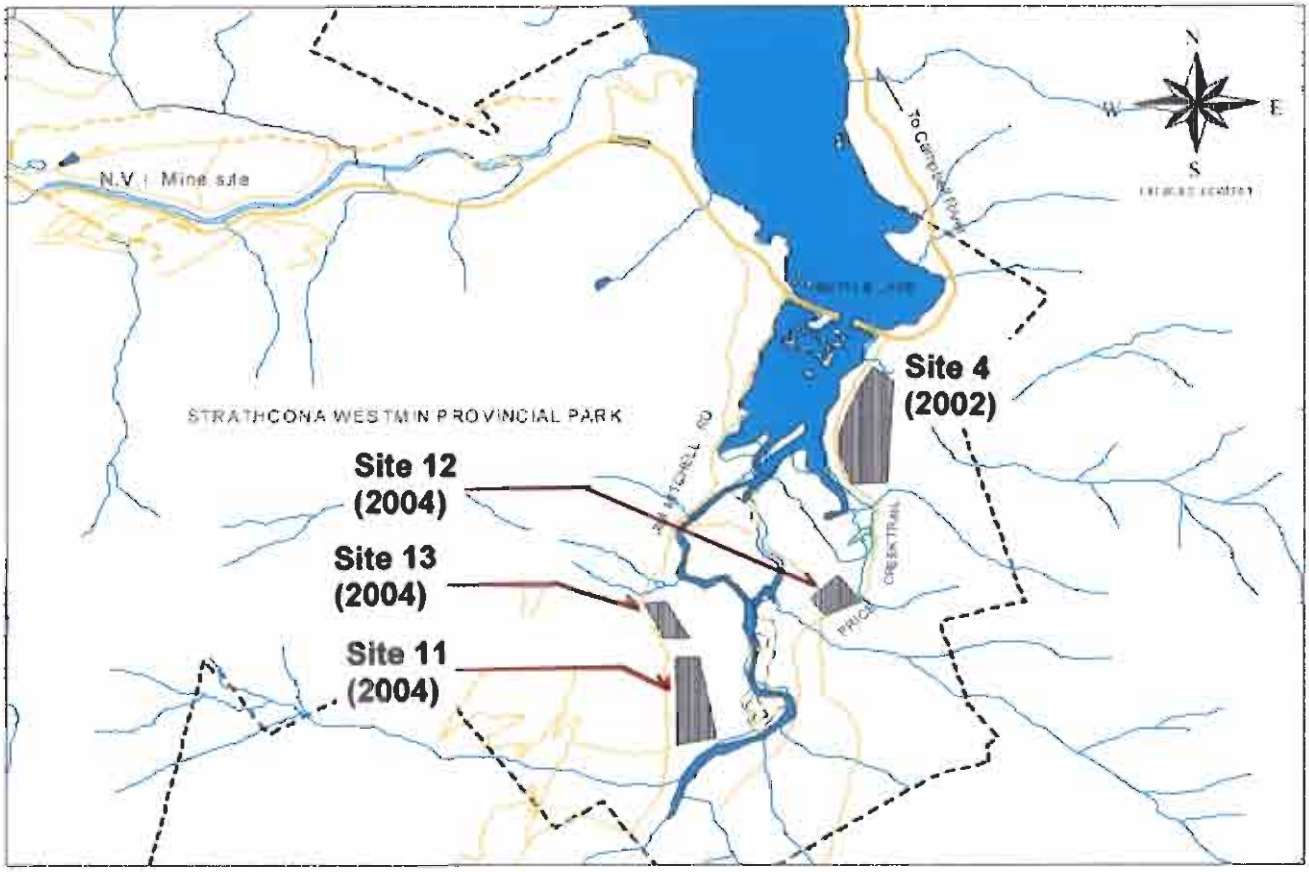
The study area is situated in mountainous terrain within the Leeward Island Mountains Ecosection. Valley-bottom elevations in the study area range from approximately 220 m to 330 m. Elevations between 200 m and 600 m on this part of Vancouver Island fall into the Moderate Snowpack Zone described by Nyberg and Janz (1990). Within this zone, accumulations are usually shallow but persistent. However, "critical" snowfall accumulations (i.e. those >45 cm deep and persisting for four weeks or more) occur every 5 to 15 years on average. Review of snowfall data from a reporting station on Highway 28 near Crest Lake (elev. 270 m) indicates snow accumulations greater than 45 cm occurred in 19 of 30 years between 1955 and 1985 (MoE Water Management Branch 1985).

Two variants of the Coastal Western Hemlock (CWH) Biogeoclimatic Zone are present in valley bottoms within the study area. The lower elevation variant, the CWHxm2, is relatively dry and extends from the valley floor to about 300 m elevation (Figure 4). The higher elevation variant, the CWHvm1, ranges to upwards of 650 m elevation, and is moister (Green and Klinka 1994). As most elk winter range is in the CWHxm1, enhancement activities have been focused within that subzone.

3.3 Site History of Enhancement Areas

All forest areas selected for enhancement in 2004 are approximately 50 years old. Stands were initiated following a wildfire in the Thelwood Valley in 1958 which consumed about 2000 ha. Salvage logging operations were conducted in burned areas in the following years (Blood 1988). Areas enhanced in 2004 support coniferous, deciduous and mixed forest types. Coniferous stands occur mainly on alluvial fans and are dominated by Douglas-fir (Figure 5). Deciduous stands occur on high-bench floodplains, and are nearly pure stands of red alder (Figure 6). They apparently supported old-growth western redcedar prior to 1958. The lack of coniferous regeneration in alder flats has been attributed to the scarcity of potential seed sources (Blood 1988), but competitive exclusion by alder seedlings also seems likely. Mixed coniferous-deciduous stands occur along streamside benches and the toe of alluvial fans (Figure 7).

Figure 2. Location of 2002-2004 Thelwood Valley enhancement sites.



Site Treatments

Site 4 - Intensive Stand-tending
Site 11 – Intensive Stand-tending
Site 12 – Intensive Stand-tending
Site 13 – Scarification & Native Grass Seeding

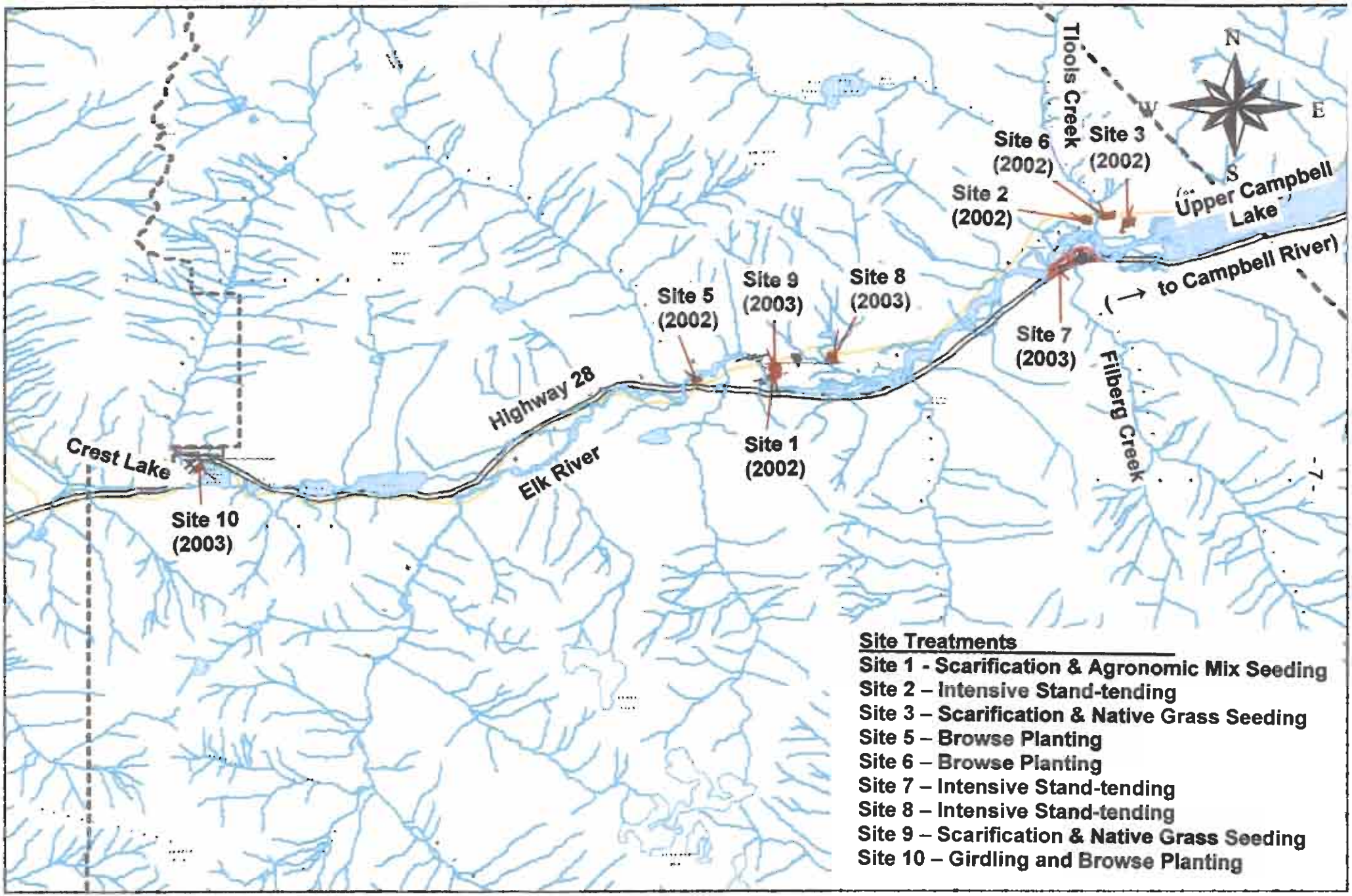
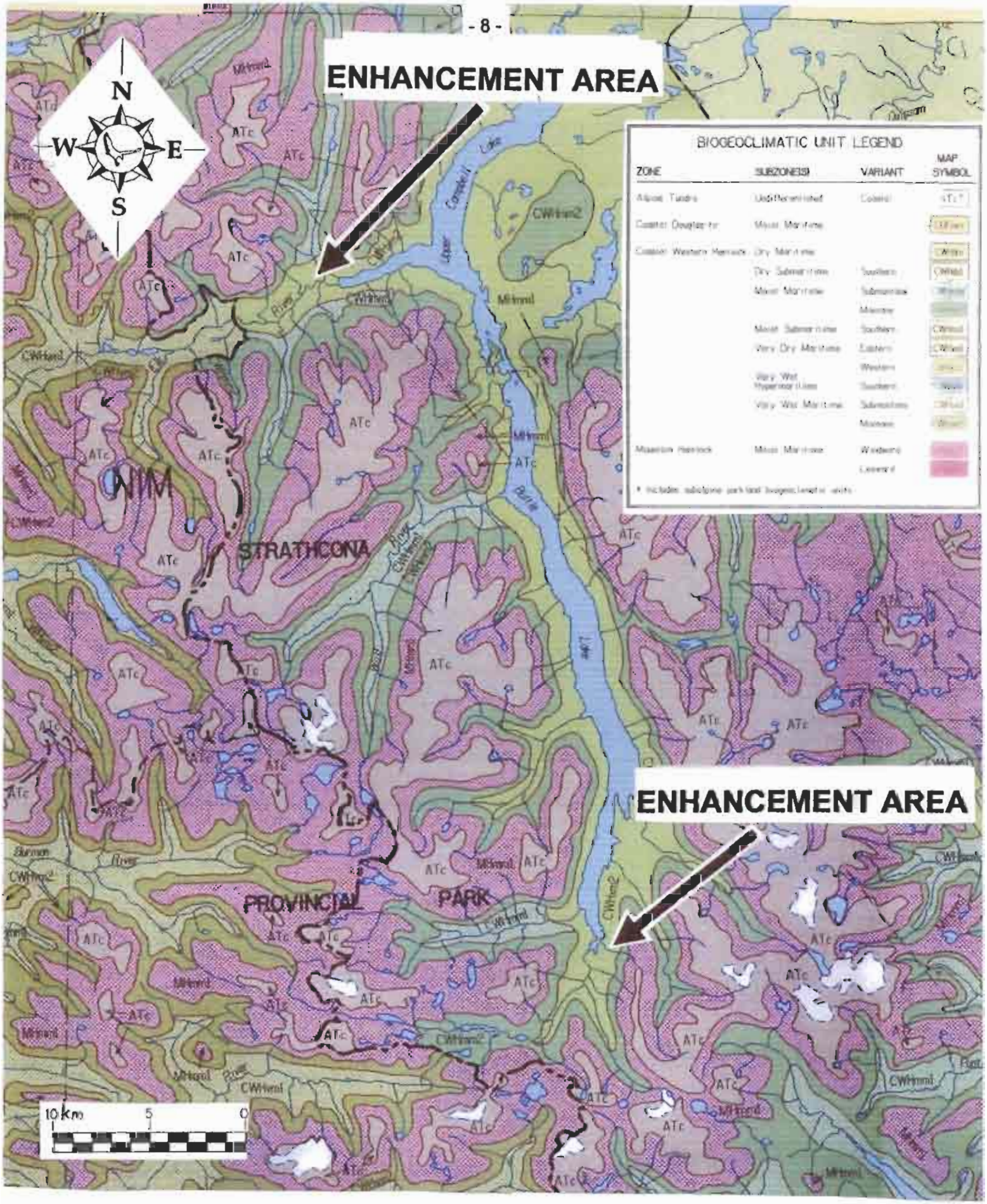


Figure 3. Location of 2002-2004 of Elk Valley enhancement sites.

Scale 1: 70,000

1 0 1 Kilometers



Scale 1: 250,000

Figure 4. Biogeoclimatic zonation in the study area.

Figure 5. Coniferous forest on alluvial fan (Site 11) prior to thinning and pruning treatment in 2004.

Figure 6. Deciduous forest on high-bench floodplain (Site 13) prior to scarification and seeding in 2004.

Figure 7. Mixed coniferous-deciduous forest on river bench (Site 12) prior to thinning, pruning and brushing treatment in 2004.

4.0 METHODS

4.1 Enhancement Trials in 2004

Enhancement trials in 2004 involved replicating some techniques used in 2002 and 2003 and modifying others. Intensive-standing techniques were modified from previous years in an attempt to reduce overall lay-out and treatment costs. Other than withholding the use of fertilizer, the methods used for creating a native grass meadow were the same as in 2003.

Intensive Stand-tending

This type of treatment was used at two sites covering a total area of 6.4 ha. Site 11 (Jim Mitchell Lake Road – South), a mid-seral coniferous stand located on the western side of the Thelwood Valley, was 4.0 ha in total area. Rather than identifying "site-specific" work areas as in 2002 and 2003, a single "blanket" work boundary 400 m long and 100 m wide was marked within Site 11. A 30 m wide vegetated buffer was retained along the western margin of the site, to provide screening cover from the adjacent Jim Mitchell Lake Road. In order to provide a better dispersion of forage and cover areas, coniferous trees less than 35 cm diameter at breast height (DBH) were felled within the treatment area (Figure 8). Trees that met the criteria for falling, but would require cutting of larger trees to safely drop, were retained at the falling contractor's discretion. Subsequent to falling, downed trees were limbed to maintain elk access to the stand. To hasten the decomposition process, stem pieces were bucked to provide contact with the forest floor.

Site 12 (Price Creek Trail), a mid-seral mixed stand located on the eastern side of the Thelwood Valley, was to be 2.0 ha in total area. The area actually enhanced was slightly larger (2.4 ha). A "blanket" area 335 m long by 80 m wide was flagged at this site. A 15 m vegetated buffer was retained along the northeast margins of the site, to provide screening cover from the adjacent Price Creek Trail. In order to protect riparian habitat values, a 15 m wide vegetated buffer was retained along an unnamed ephemeral stream bisecting the site. Treatment in this area involved a combination of falling, brushing, pruning and browse rejuvenation (Figure 9). Pruning and the creation of small gaps in the existing forest canopy were intended to stimulate understorey browse and herbage production while maintaining snow interception and security cover values. Woody debris management required the silvicultural contractor, Tsolum Forestry, to buck and limb felled trees to maintain elk access. As indicated in Table 1, the significant deciduous component of Site 12 necessitated contractor specifications that were more complex than those used at 11.

Figure 8. Completion of spacing and pruning at Site 11 (November 2004).

Figure 9. Completion of spacing, pruning and brushing at Site 12 (October 2004)

Table 1. Silvicultural contractor specifications for Site 12.

Specification	Rationale
1. Fall all Douglas-fir trees < 25cm. DBH. Stumps to be cut level with the existing ground.	Partially open forest canopy to stimulate forage production.
2. Retain all western redcedar and western hemlock trees.	Retain important winter browse species
3. Fall or girdle deciduous all red alder trees.	Partially open forest canopy, reduce shrub competition by removing seed sources.
4. Cut outer 50 % of multi-stemmed big leaf maple trees.	Stimulate development of shoots (coppicing) for elk browse production.
5. Buck stem pieces as required to provide full contact with the forest floor. Limb all felled trees.	Hasten decomposition process to maintain elk access to stand.
6. Prune all lower branches on trees >25 cm. DBH using collar cuts. Pruning to extend 2 m. up the stem from ground level	Improve light penetration to understorey and create bedding sites in proximity to foraging areas.
7. Cut all shrubs back (exception: native black hawthorn bushes).	Rejuvenate browse abundance and improve accessibility to elk.

Clearing, Scarification & Seeding

This treatment was undertaken at Site 13, which is located on the west side of the Thelwood Valley and due north of Site 11. Unlike the latter, pre-restoration forest cover at Site 13 was dominated by young red alder trees 20cm to 30 cm in diameter. Understorey vegetation was reasonably well-developed consisting primarily of swordfern and salmonberry, with a lesser cover of thimbleberry and trailing blackberry. Juvenile deciduous trees and a variety of native herbs were also present in places. Although the original plan called for a 1.0 ha treatment area, difficult terrain around the periphery of this site and a shortage of native grass seed limited the restoration works to an area 0.6 ha in size (Figure 10).

Honourable Environmental Excavating of Campbell River cleared and scarified the site from October 6th to 8th using a fully-caged excavator. Woody debris generated by clearing was strategically placed along the western treatment area boundary, to provide winter screening cover from Jim Mitchell Lake Road (Figure 11). As with other seeded sites in the project area, native grass seed was broadcast by hand. Approximately 34 kg of seed, predominantly Alaska Brome (*Bromus sitchensis*) with a minor component of Canada bluegrass (*Poa compressa*), Hairy wildrye (*Deschampsia elongata*) and Blue wildrye (*Elymus glaucus*) were spread at a rate of 56 kg/ha. No fertilizer was applied to this site, as pre-restoration cover indicated high soil nutrient levels were present.

Figure 10. Site 13 shortly after scarification and seeding (November 2004).

Figure 11. Debris piled near Jim Mitchell Lake Road to improve winter security cover at Site 13.

4.2 Monitoring Methods

The experimental nature of the enhancement treatments carried out over 2002 to 2004, and their potential value to forest and other land managers, necessitated a significant monitoring effort. The overall goals of the monitoring program were to document vegetation response to treatments and elk utilization within the treatment areas (Figure 12). The latter involved a several techniques which, it is hoped, will support each other in providing a realistic picture of actual elk responses. Monitoring activities carried out in 2004 included:

- herbage production quadrats
- browse abundance/utilization plots
- shrub planting survival survey
- periodic ground inspections
- winter pellet group counts
- elk aerial survey.

Herbage Production Quadrats

To quantify pre-treatment herbage production at the site to be seeded in 2004 (Site 13), sampling was carried out at four stations. As at seeding sites from 2002 and 2003, representative sampling locations were selected following a thorough reconnaissance of the area to understand the pattern and diversity of available forages. Two stations were selected representing the highest and lowest herbage production, and two others were chosen to represent average conditions for the site. Sampling stations at each of Sites 1, 3 and 9 were revisited in 2004 to determine post-restoration yields.

Herb cover was recorded at browse sampling plots within intensive stand treatment areas, but was not clipped and weighed, as increased browse production was expected to provide the largest increase in forage values at these sites.

At each herbage production sampling station, all palatable forage within each 1 m x 1 m quadrat was described and clipped at the end of the growing season. It was then placed in an over for 30 minutes and dried. The weights from each site's four stations were averaged, and the average value was extrapolated to estimate herbage production for the entire site.

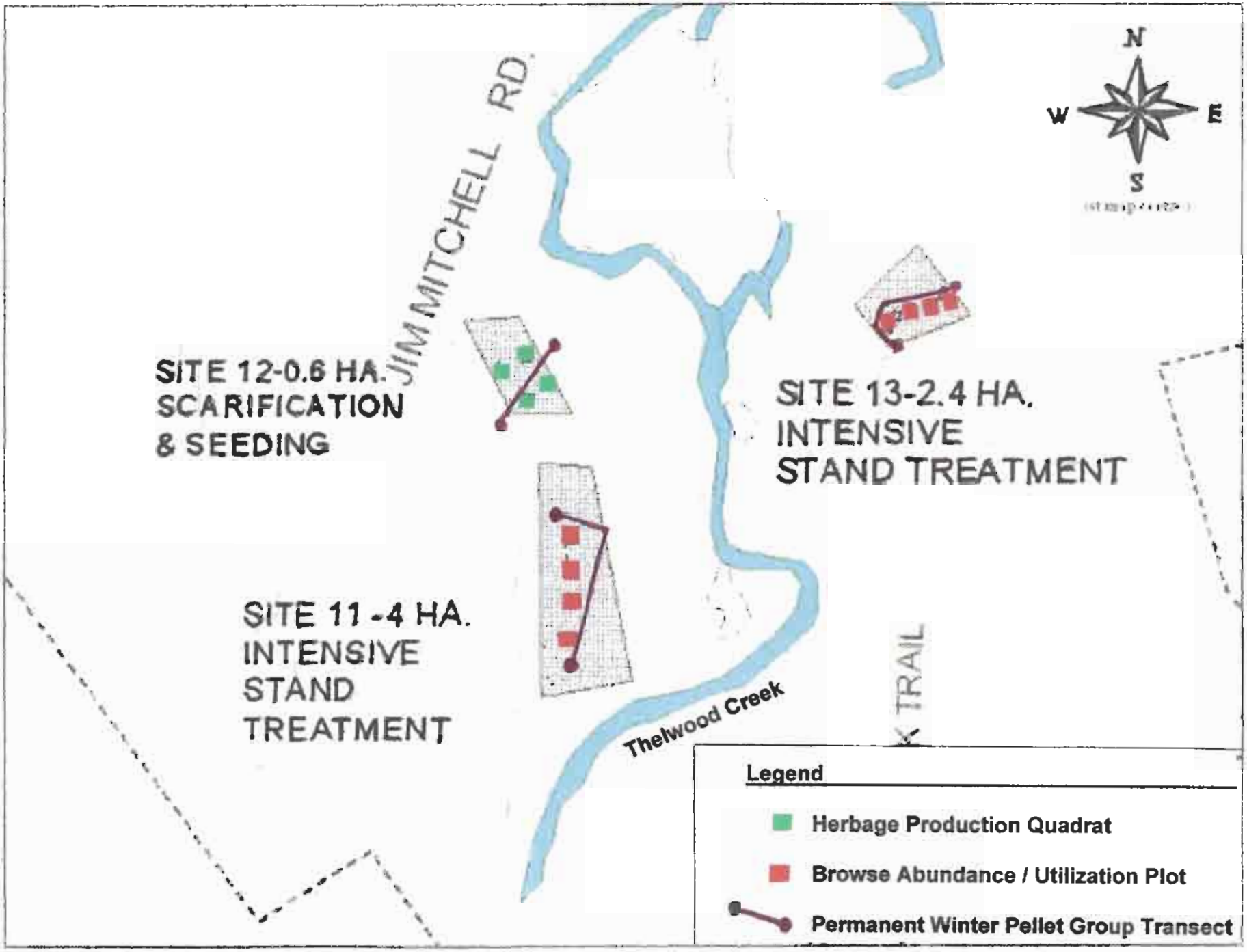


Figure 12. Location of monitoring activities within 2004 enhancement sites.

Winter Pellet Group Counts

To provide an indication of elk use prior to enhancement, winter pellet-group counts were conducted at each of Sites 11, 12 and 13 in 2004 (Figure 12). To monitor post–enhancement elk use, winter pellet-group counts were carried out within 8 of 10 sites treated in previous years. One 2002 site, a reclaimed logging road, was dropped from counting because it was believed to function as an elk movement corridor, and did not reflect site use. A 2003 site was dropped from counting because it had been seeded the previous autumn, and no significant grass cover was present at the time of the count.

Pellet-group counts involved walking traditional fixed-width transects ranging from 150 m to 400 m in total length. This method was preferred over RIC (1998) methods involving circular plot transects because of perceived difficulties in relocating circular plot centres over several years. The size of the treatment area was used as a general guide to determining transect length. The orientation of fixed-width transects attempted to use cardinal directions as much as possible to aid in relocating them in subsequent years. During the counts, all elk winter droppings observed within 1 m on either side of the transect centerline. The abundance of deer pellets was also noted on each transect, to better understand habitat partitioning by the two species. The counts were conducted in the early spring, prior to green-up on the forest floor. Since droppings may persist for more than one season, well-weathered pellets were recorded in field notes, but excluded from pre-enhancement tallies. All pellets were removed from transects to prevent double counting in subsequent years.

Browse Abundance/Utilization Plots

In order to follow long-term shrub cover and use changes, pre-enhancement browse monitoring plots were established in the two sites involving intensive stand-tending in 2004 (i.e. Sites 11 and 12). A total of four browse monitoring plots were established per site in the summer of 2004, prior to treatment. Within each 5 m radius plot, pre-enhancement canopy closure was visually estimated with the aid of comparison charts in Luttmerding *et al.* (1990). These charts were also used to estimate coverage by individual browse species. The average height of browse species was estimated using a tape measure. Browse forage utilization codes described by Luttmerding *et al.* (1990) were assigned to each browse species appearing in a plot. Browse monitoring plots at each of the sites restored in 2002 (Sites 2 and 4) and 2003 (Sites 7 and 8) were revisited in 2004.

Shrub Planting Survival Survey

A shrub survival survey of browse plantings installed at Site 5 in 2002 was carried out in May of 2003. A similar survey intended for Site 4 in the Lower Thelwood Valley was abandoned after dry conditions killed all but a handful of

the 90 browse plantings. Surviving shrub plantings at Site 10 were not enumerated because they had only been installed six weeks previously. Over 300 shrubs were planted at Site 5 in 2002 including: big leaf maple, thimbleberry, Scouler's willow, Sitka willow, Saskatoon, black cotton-wood and red-flowering currant. The survey was a total count of all planted shrubs with leaves (or viable leaf buds) and those no leaves and dead cambium.

Periodic Inspections

Inspections of Sites 1, 3, 9 and 13 were conducted in early and late autumn of 2004 to assess growth and grazing pressure. It was intended to visit intensive stand-tending Sites 4, 7 and 8 to determine if woody debris was restricting ungulate winter access in these areas, but the study area remained virtually snow-free between December 2004 and February 2005.

Elk Aerial Survey

The monitoring program included an aerial census to document elk herd size and composition in the two valleys during the late winter period. It is hoped the effectiveness of the enhancement program will ultimately be reflected in both increased herd size and higher calf survival (i.e. higher calf/cow ratios) over pre-enhancement conditions. However, it must be acknowledged that other factors such as winter severity and predator density can exert a significant influence on a given herd.

The aerial survey took place under partly cloudy skies on March 17, 2005 using a Eurocopter Astar from West Coast Helicopters Ltd in Campbell River. The flight took place in the late afternoon period (1625 to 1815). In addition to the pilot, Craig Houston, there were three observers aboard the aircraft during the survey. Steve Pratt of BC Parks sat in the left front seat and was responsible for total counts. Kim Brunt, MWLAP Wildlife Biologist sat in the left rear seat. He classified elk following Resources Inventory Committee protocols (RIC 1998) and recorded them on standard reporting forms. Joe Materi of Ursus Environmental sat in the left rear seat, and provided assistance as an observer. Flight speed during the surveys averaged 50 – 60 knots. The aircraft was flown from 50 m to 100 m above the ground surface for the duration of the surveys.

When an elk, or group of elk, was detected the helicopter backed away slightly to determine if more individuals might be present in nearby cover. If there were animals in nearby cover, helicopter approach would slowly push them out into clearings where they could be more easily counted and classified.

5.0 RESULTS AND DISCUSSION

5.1 Enhancement Costs

Labour and materials costs for the three 2004 restoration sites ranged from $ 5,614 to $11,840. On a per hectare basis, treatment involving clearing, scarification and seeding was the most costly, at $ 9,357/ha. The high cost of this technique results from the need to mobilize heavy equipment in a relatively remote setting, as well as the use of native seed mix, which is currently not widely available. Pickseed Nurseries Ltd. in Abbottsford has apparently gone in to full-scale commercial production of some native coastal grasses, and the price of this type of seed is expected drop significantly in the near future. The cost of native seeding treatments at other sites ranged from $7,610/ha to $8,222/ha over 2002 and 2003. The higher cost for seeding treatment this year is likely attributable to heavy equipment mobilization.

Treatment costs associated with "blanket" intensive stand-tending averaged $2,960/ha in 2004. This is considerably lower than earlier "site-specific" stand-tending treatments which cost $3,700/ha to $5,300/ha in 2003 and $4,217/ha in 2002. While some savings in 2004 may have resulted from the competitive bid process, it is believed most resulted from increased production. The "blanket" approach removes the need to relocate work zone centres and reduces the time spent planning each tree to be cut.

A detailed breakdown of budgeted and actual line item expenditures in 2004 is given in the project financial statement (Appendix I).

5.2 Vegetation Monitoring

Herbage Production Quadrats

Scarification and seeding trials have been underway since 2002. There are currently three enhancement sites that have been seeded with native grass mixtures, one was seeded in the spring of 2002 (Site 3) and two were seeded in the autumn of 2003 and 2004 (Sites 9 and 13, respectively). There is a single area (Site 1) that was seeded with an agronomic seed mix in the spring of 2002.

The cumulative results of clipping studies from seeding trials are provided in Table 2. Due to spring seeding at Sites 1 and 3, collection of pre-enhancement data would have grossly under-reported forage production. As a result, it was decided to extrapolate information from fall-seeding areas where vegetation, soil and moisture conditions were considered similar. Pre-enhancement herbage production at Site 1, along a Hydro transmission line, was likely similar to that of Site 9, located < 100 m to the northeast. Pre-existing herbage production at Site 3, a floodplain alder forest, was likely similar to that of Site 13.

Table 2. Elk forage production at seeded enhancement sites.

Enhancement Area	Dry Wt. of Forage (kg)			
	Pre-enhancement	**1st Year Post-enhancement**	**2nd Year Post-enhancement**	**3rd Year Post-enhancement**
Site 1 - Hydro R-o-W (agronomic seed mix)	No data due to spring seeding			
Station 1-1		0.070	0.138	0.100
Station 1-2		0.100	0.500	0.032
Station 1-3		0.075	0.218	0.050
Station 1-4		0.032	0.120	0.230
Average Dry Wt./m^2 (± 95 % Confidence Interval)		0.069 ± 0.007	0.244 ± 0.017	0.103 ± 0.012
Area of Site (m^2)		5700	5700	5700
Available Forage at Site		353 – 433	1294 - 1488	519 – 656
Estimated Carrying Capacity		**60 – 73 elk-days**	**219 – 252 elk-days**	**88 - 111 elk-days**
Site 3 - Tlools Cr. East (native seed mix)	No data due to spring seeding			
Station 3-1		0.070	0.135	0.120
Station 3-2		0.194	0.353	0.275
Station 3-3		0.057	0.218	0.353
Station 3-4		0.054	0.200	0.230
Average Dry Wt./m^2 (± 95 % Confidence Interval)		0.094 ± 0.010	0.227 ± 0.012	0.245 ± 0.013
Area of Site (m^2)		9200	9200	9200
Available Forage at Site		773 – 957	1978 - 2199	2134 – 2374
Estimated Carrying Capacity		**131 – 162 elk-days**	**335 – 373 elk-days**	**362 - 402 elk-days**

Enhancement Area	Dry Wt. of Forage (kg)			
	Pre-enhancement	**1st Year Post-enhancement**	**2nd Year Post-enhancement**	**3rd Year Post-enhancement**
Site 9 – Abandoned ERT Camp (native seed mix)	Fall Seeding			
Station 9-1	0.060	0.133	--	--
Station 9-2	0.000	0.067		
Station 9-3	0.350	0.275		
Station 9-4	0.030	0.005		
Average Dry Wt./m^2 (± 95 % Confidence Interval)	0.110 ± 0.016	0.120 ± 0.013		
Area of Site (m^2)	7500	7500		
Available Forage at Site	705 – 945	803 - 998		
Estimated Carrying Capacity [1]	**119 – 160 Elk-days**	**136 – 169 Elk-days**	--	--
Site 13 – Mitchell Lake North (native seed mix)				
Station 13-1	0.033	--	--	--
Station 13-2	0.052			
Station 13-3	0.210			
Station 13-4	0.055			
Average Dry Wt./m^2 (± 95 % Confidence Interval)	0.088 ± 0.012			
Area of Site (m^2)	6000			
Available Forage at Site	456 – 600			
Estimated Carrying Capacity	**77 – 102 Elk-days**	--	--	--

Table 2 shows the 95 % confidence interval for the total amount of forage produced and an estimate of the number of elk-days of use it could have supported, if entirely consumed by elk. The former was determined by averaging the dry-weight production at each 1 m^2 clipping station in a given site, then multiplying it the area of that site (again, in m^2). Estimating elk-days of use from the clipping data made use of a formula derived by Beck and Peek (2000) for estimating the carrying capacity of elk on summer ranges in Nevada. The anticipated duration of elk on local winter ranges is essentially the same as that used by these researchers for summer. Continuous occupation from October through May is equates to 210 days. The formula used was as follows:

Elk Carrying Capacity (K) = Available Forage (kg)/0.025 DMI x 236 kg x 210 days

Where: DMI= 2.5 % Dry Matter Intake
(the percentage of body weight consumed daily);

236 kg = average weight of a cow elk; and

210 days = length of time on winter range (Oct. - May)

Using the above assumptions, a single elk-day of use is equivalent to approximately 5.9 kg dry weight of forage. This value compares favourably to published daily winter intake rates of another large ungulate, the moose. Persson *et al.* (2000) reported average daily dry-weight winter intake rates for moose as ranging between 4.2 kg and 5.5 kg.

Available forage at Site 1 at the end of the first growing season (353-433 kg dry weight) was probably similar to, or perhaps slightly lower than, pre-enhancement levels. However, a threefold to fourfold increase in available forage was evident at Site 1 in the second year post-enhancement (1294-1488 kg dry weight). This dropped significantly in the third year post-enhancement, back to levels seen in the first year. At the time of the 2004 sampling, a clear shift in species dominance was observed, with agronomic fescues and clovers increasing and perennial late ryegrass disappearing. Between 2002 and 2003, the carrying capacity rose to 210 to 252 elk-days from 60 to 73 elk-days.

If Site 13 is comparable to Site 3, total forage availability at the latter one season after enhancement (773-957 kg dry weight) would have differed little from pre-enhancement production. Like Site 1, the total forage availability at this native-seeding site increased dramatically in the second growing season following treatment (twofold to threefold). Unlike the agronomic mix at Site 1, the amount of available forage in the native seeding area the third year after enhancement remained high, perhaps even increasing slightly (2134-2374 kg dry weight in 2004 vs. 1978-2199 kg in 2003). The estimated carrying capacity of Site 3 has increased from approximately 7 days use for a herd of 20 animals to roughly 19 days use for a herd the same size in 2004.

At Site 9, a pattern similar to that of Sites 1 and 3 was evident in the first growing season following enhancement, with little or no recognizable increase in the total amount of available forage over pre-treatment levels. Similarly, the estimated carrying capacity of the site one year post-enhancement was within the pre-enhancement range of values (136-169 elk-days in 2004 vs. 119-160 elk-days in 2003).

The first-year results at Site 9 were somewhat surprising, as fall seeding was expected to produce better first-season results than spring seeding. The assumption was that seed germination rates would be higher and young plants would grow faster due to high winter soil moisture levels. Possibly other factors are at play, such as consumption of more seeds by birds in the autumn. It may be the case that native grasses grow quickly and reach maximum height whether planted in autumn or mid-spring. Though perhaps not adding much in terms of dry weight, first-season seed head production appears to be greatly improved by autumn seeding compared to spring seeding. This should be reflected in clipping study results from Site 9 in 2005.

Browse Abundance/Utilization Plots

Browse monitoring plots established within 2004 intensive stand-tending areas indicate that pre-enhancement canopy closure ranged from 60 - 85 % in Site 11 and 10 - 75 % in Site 12. Pre-enhancement shrub cover ranged from 2–10 % in Site 11 and from 10–45 % in Site 12. With shrub heights extending from 0.3 m to 2.5 m in Site 11, the small amount of browse that was available could be easily accessed by elk. Salmonberry, red elderberry and red-osier dogwood were the only shrubs that showed evidence of heavy browsing in Site 11. At Site 12, shrub heights ranged from 0.2 m to 3.0 m, permitting elk winter access to browse. Pacific ninebark, juvenile western hemlock, and red-osier dogwood were the only heavily browsed shrubs recorded in Site 12.

Although browse monitoring plots at Sites 2, 4, 7, and 8 were revisited in 2004, no detectable differences in browse cover or utilization were observed compared to baseline conditions. It is therefore recommended that any follow-up inspections of browse monitoring sites be postponed for at least 2 additional growing seasons.

Shrub Planting Survival Survey

Over 300 native shrubs were installed in 2002 to enhance browse abundance and diversity at Site 5, an abandoned gravel pit near Highway 28. With the exception of a few draught-affected willows, virtually all the browse plantings at this site survived the first winter (survival rate of 95 % in Table 3 below). By the spring of 2003, it was apparent that most of the plantings were well enough rooted to resist being pulled out by browsing elk. As a result, protective fencing was removed in that summer. An extended period of drought in the summer of 2003 resulted in considerable mortality of the shrub plantings.

As indicated in Table 3, the overall survival rate dropped to just 50 % when inspected in the spring of 2004. Roughly half of the cottonwood, willow and maple plantings succumbed to the prolonged dry conditions of the previous year. However, despite the challenging growing conditions of 2002 and 2003, virtually all Saskatoon shrub plantings appeared to be in good vigour. Red-flowering currant was expected to do well at Site 5, but few survived into the second year. With the browse fencing down, numerous plantings showed evidence of winter use by elk, and the 2004 winter pellet group count was 180 % higher than the pre-restoration count.

BC Parks personnel installed some additional shrubs in the area in early spring of 2004, using surplus Sitka willow cuttings (approx. 500) which were initially collected for Site 10 the previous budget year.

Table 3. Browse planting survival rates at Site 5.

Browse Species	# Planted in 2002	1st Year Survival (%)	2nd Year Survival (%)
Cottonwood	103	98	48
Willow spp.	123	89	54
Maple	69	98	62
Saskatoon	11	100	100
Thimbleberry	4	100	25
Currant	11	100	9
Overall	**321 plants**	**95 %**	**50 %**

Periodic Inspections and Opportunistic Observations

Due to the lack of snow, far fewer site inspections were carried out in 2004 than the previous year. Two of the older native grass seeding sites (Sites 3 and 9) were inspected in the autumn of 2004. Inspection of Site 9 took place in early November, about 12 months after it was seeded. The site visit revealed 4 fresh elk beds, large winter pellet groups and fresh antler rubs consistent with use by a small group of adult bulls. At that time, it was estimated that approximately 20 % of the green herbage produced that summer had been grazed.

Site 3, which was seeded in the spring of 2002, was inspected in mid-December of 2004. Fourteen fresh elk beds and numerous elk droppings and tracks were evident within this treatment area at this time. Despite the apparent high levels of elk activity at this site, grazing did not appear to be as intense as observed in the first autumn post-enhancement. It should be noted, however, that there was considerably more herbage present now than was available in the

autumn of 2002. It was estimated that about one-quarter to one-third of the standing herbage had been grazed at Site 3 in mid December of 2004.

In the Thelwood Valley, the silvicultural contractor reported seeing a herd of 14 elk while working at Site 12 in mid-October. Three mature bulls were observed in the recently cleared Site 13 a few days later, suggesting a total herd strength of 17 animals. This would be two more than observed during the 2003 aerial survey and one more than the 2002 aerial survey. More importantly, this report indicates that elk concentrate in the Thelwood Valley as early as mid-October.

5.3 Elk Use Monitoring

Winter Pellet Group Counts

Winter pellet group (WPG) counts may provide a straightforward means of monitoring elk responses to various habitat enhancement techniques. However, caution needs to be exercised in interpreting the limited data presented in Tables 4 and 5 below. It should be noted that operational scheduling prevented us from documenting variability in pellet group numbers prior to enhancement activities. Reliance on a single count obviously does not reflect elk use under the full range of winter conditions. This may make interpretation of data from the Elk Valley especially problematic, since there is evidence to suggest that twice as many animals are concentrated on traditional winter ranges under moderately severe winters than during mild ones. Differential weathering of winter droppings further complicates our interpretation of baseline conditions. To address these issues, it is recommended a number of "control" transects be established in untreated areas of both valleys and monitored in future years.

Table 5 extrapolates pellet group data from transects to entire enhancement areas, and provides a first approximation of actual winter use in terms of elk-days. The main assumptions used to derive these estimates were that transect lines were randomly selected; defecation rates of elk are relatively constant; and pellet groups are distributed more or less evenly across individual habitat types.

Tables 4 and 5 suggest low levels of winter use by elk prior to enhancement at the two areas where intensive stand-tending was carried out in 2004. Site 11 supported approximately 40 to 50 elk-days of winter use, which is equivalent to 2 or 3 days use by a herd of 20 elk. Site 12 supported slightly less, at 25-31 elk-days. These sites recorded from 25 to 26 WPG/km. Pre-enhancement winter use at Site 13, the 2004 native-seeding area, supported approximately 10 to 12 elk-days of use, which is fairly high for a relatively small area. This site recorded 40 WPG/km, which is similar to another deciduous area (Site 3) seeded in the Elk Valley (51 WPG/km).

Table 4 . Summary of winter pellet group count data 2002-2004.

Site ID	Site Treatment	Winter Pellet Groups / Lineal km		
		Pre-enhancement	1st Winter Post-enhancement	2nd Winter Post-enhancement
1	Seeding (agronomic)	100	191	106
2	Stand-tending	26	60	91
3	Seeding (native)	51	48	97
4	Stand-tending	25	30	43
5	Browse Planting	33	0 (fenced)	93
7	Stand-tending	20	9	n/a
8	Stand-tending	23	37	n/a
10	Browse planting	105	n/a	n/a
11	Stand-tending	25	n/a	n/a
12	Stand-tending	26	n/a	n/a
13	Seeding (native)	40	n/a	n/a

Notes:

Site 6 excluded due to potential use as movement corridor. Timing of work at Site 9 precluded pre-enhancement pellet group counts.

Table 5. Estimated elk-days of winter use based on pellet count data.

Site ID	Approximate Area Enhanced (m2)	Estimated Elk – Days of Winter Use[1]		
		Pre-enhancement	1st Winter Post-enhancement	2nd Winter Post-enhancement
1	6,000	24-30	46-57	25-32
2	40,000	42-52	96-120	146-182
3	10,000	20-26	19-24	39-49
4	60,000	60-75	72-90	103-129
5	7,500	10-12	0	28-35
7	40,000	32-40	14-18	--
8	63,000	58-73	93-117	--
10	5,000	21-26	--	--
11	40,000	40-50	--	--
12	24,000	25-31	--	--
13	6,000	10-12	--	--

Notes:

[1]Upper limit based on elk defecation rate published in Neff (1968).

Winter pellet group data are plotted against time for the four oldest enhancement sites in Figure 13. The large drop in the number of winter pellet groups at Site 1 in 2004 may have resulted from die-back of the main species of non-native grass present in 2003, late perennial ryegrass. However, the proportion of non-native fescues also rose considerably in 2004. It may be reasonable to expect more intensive use of herbage in low snow pack years due to increased accessibility. This might be offset by the greater dispersion of animals under the same conditions.

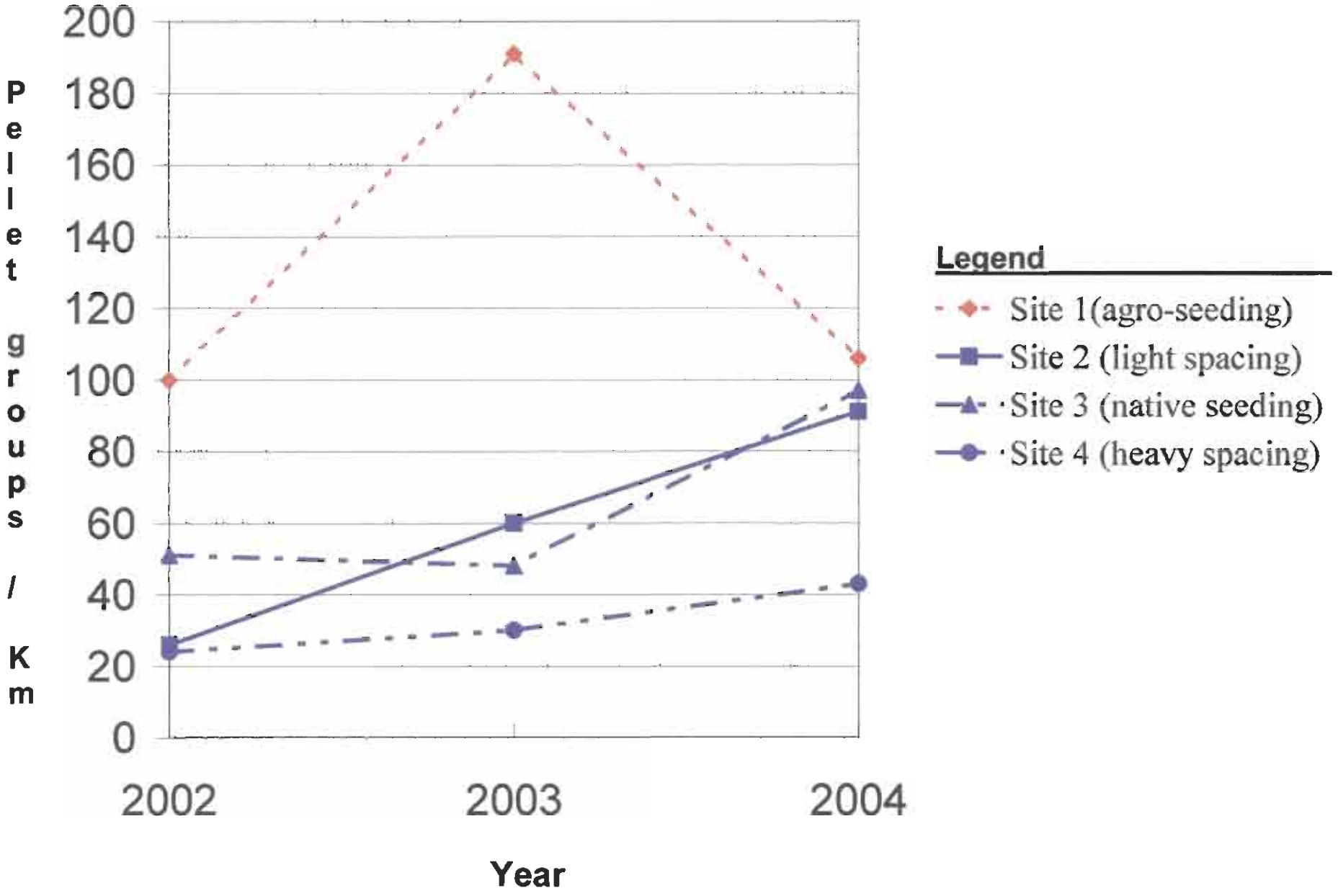
Winter pellet group counts at Site 2 have increased steadily since it underwent a light spacing treatment in 2002. However, ground inspections in subsequent years failed to detect any significant understorey response to the treatment. It is possible that the increased winter use of Site 2 has resulted from the 2003 decommissioning of the adjacent ERT Logging Road and the reduced human presence. Conversely, the data from Site 2 may reflect the kind of variation to be expected in annual pellet group counts.

Unlike Site 2, a dramatic understorey response was evident at Site 3, the first native seeding trial in the Elk Valley, at the end of the first growing season (i.e. September 2002). Interestingly, although nearly all available herbage was grazed to the nubbins that autumn, the winter pellet group results from first winter post-enhancement were not significantly different from the previous year (48 vs. 51 WPG/km). In 2004, the number of winter pellet groups counted per km doubled over the previous and pre-enhancement year. Based on elk sign, Site 3 was estimated to support 20 to 25 elk-days of use in each of 2002 and 2003. The figure rose to approximately 40 to 50 elk-days in 2004.

The best indication of whether certain enhancement techniques are likely to be successful may come from monitoring in the Thelwood Valley, where there is a single migratory herd uses a relatively compact and well-defined winter range. The WPG count at Site 4, on the east side of the Thelwood Valley, suggested low levels of use prior to enhancement (25 WPG/km). Observed increases in 2003, the first year after enhancement were not statistically significant (30 WPG/km). However, the 2004 increase to 43 WPG/km was statistically significant (at $\alpha = 0.05$). Based on observed elk sign, estimated use of Site 4 nearly doubled from 60-75 elk-days prior to enhancement to 103-129 elk-days two years after enhancement.

Like other intensive stand-tending treatment areas, observed pre-enhancement levels of elk winter use were relatively low at both Sites 7 and 8 in the Elk Valley. The former recorded 20 WPG/km prior to enhancement (2003), equivalent to between 32 and 40 elk-days of use for the entire site (or approximately 2 days use by a herd of 20 animals). The latter recorded 23 WPG/km before treatment, equating to 58 to 73 elk-days of use for the site in its entirety. The first-year following enhancement (2004), fewer winter pellets were recorded at Site 7, while the Site 8 saw a modest increase.

Figure 13. Winter pellet-group count results for Sites 1 to 4 (2002-2004).



Ground inspections of Site 7 suggest that the arrangement of falling debris may have made elk access more difficult in parts of the stand. Unfortunately, winter site inspections in 2004 were not carried out due to lack of snow cover for track counts.

Aerial Survey Results

The results of the March 17th, 2005 flight in the two valleys comprising the study area are summarized in Table 6. Elk observations and generalized flight paths are given in Figures 13 and 14. A total of 45 individuals were recorded across the study area. Valley bottoms were snow-free at the time of the survey, and snow was restricted to mountain crests and ridges with cool aspects. The season-long closure of the neighbouring Mt. Washington ski resort suggests low snowpack conditions persisted even in alpine/sub-alpine areas of this region throughout the past winter.

With a total count of 20 animals, elk numbers in the Thelwood Valley this year appeared to be up slightly over both 2002 (16, including 3 mature bulls) and 2003 (15, but no mature bulls seen). The main herd of 19 animals was comprised of 12 cows, 6 calves and 1 spike (or immature) bull. They were observed just west of a large wetland complex in the lower part of the valley, a few metres from where the group was spotted in 2002. The main herd was located under forest cover in Site 4 in 2003, possibly due to the greater snow depths that year. A lone adult bull observed in 2004 was located on an avalanche track well up the Thelwood valley (elevation approximately 600 m). The bull had shed its antlers and could not be positively classified. Based on its small size, it appeared to be young, possibly the lone spike bull recorded in the Thelwood the previous winter. No other bulls were recorded during the flight, although three mature bulls had previously been seen at Site 13 in mid-October of 2004. As a result, the best estimate of the Thelwood Valley herd this year is 23 individuals.

A total of 25 elk were enumerated in the Elk River Valley and immediately adjacent tributary valleys. Groups were comprised of cows, calves, and spike-bulls or similar-aged bulls. The largest single group observed was of 20 animals. It was detected along the lower reaches of Tlools Creek, near the mouth of the Elk River. The main herd was comprised of 10 cows, 6 calves, and 4 spike bulls. Only 4 mature bulls (2 pairs) were observed in the Elk Valley this year. As was the case in the Thelwood Valley, three of four bulls had cast their antlers.

Observed elk numbers from the 2004 flight were down sharply from the 2003 total of 68. However, a more persistent snow pack in 2003 appeared to have confined elk to valley bottom habitats and the few warm aspect slopes. This year's results are quite similar to 2002 survey, when the Elk River Valley was also largely free of snow in late winter. In that year the main herd was also comprised of 12 cows, but had 2 fewer calves and 1 less spike bull. The 2004 aerial survey results provide further evidence that the Elk River herd has both a

resident and migratory component. The latter appears to remain in more densely forested various side valleys whenever snow pack conditions permit.

Table 6. Summary of March 17, 2005 aerial survey results.

Area	Lat. & Long.	Unclassified Bull	Ragthorn Bull	Spike Bull	Cows	Calf
Elk River	49° 52.93' N. 125° 44.08 W.	0	0	4	10	6
	49° 51.31' N 125° 47.62' W	0	0	0	1	0
Heber River	49° 50.69' N. 125° 57.29' W.	1	1	0	0	0
	49° 51.39' N. 125° 56.40' W.	2	0	0	0	0
Subtotal	25 Elk	3	1	4	11	6
Thelwood River	49° 33.45' N. 125° 33.12' W.	0	0	1	12	6
	49° 31.91' N 125° 34.42' W	1	0	0	0	0
Subtotal	20 Elk	1	0	1	12	6
Totals	**45 Elk**	**4**	**1**	**5**	**23**	**12**

Figure 14. Results of March 17, 2005 aerial survey in the Thelwood Valley.

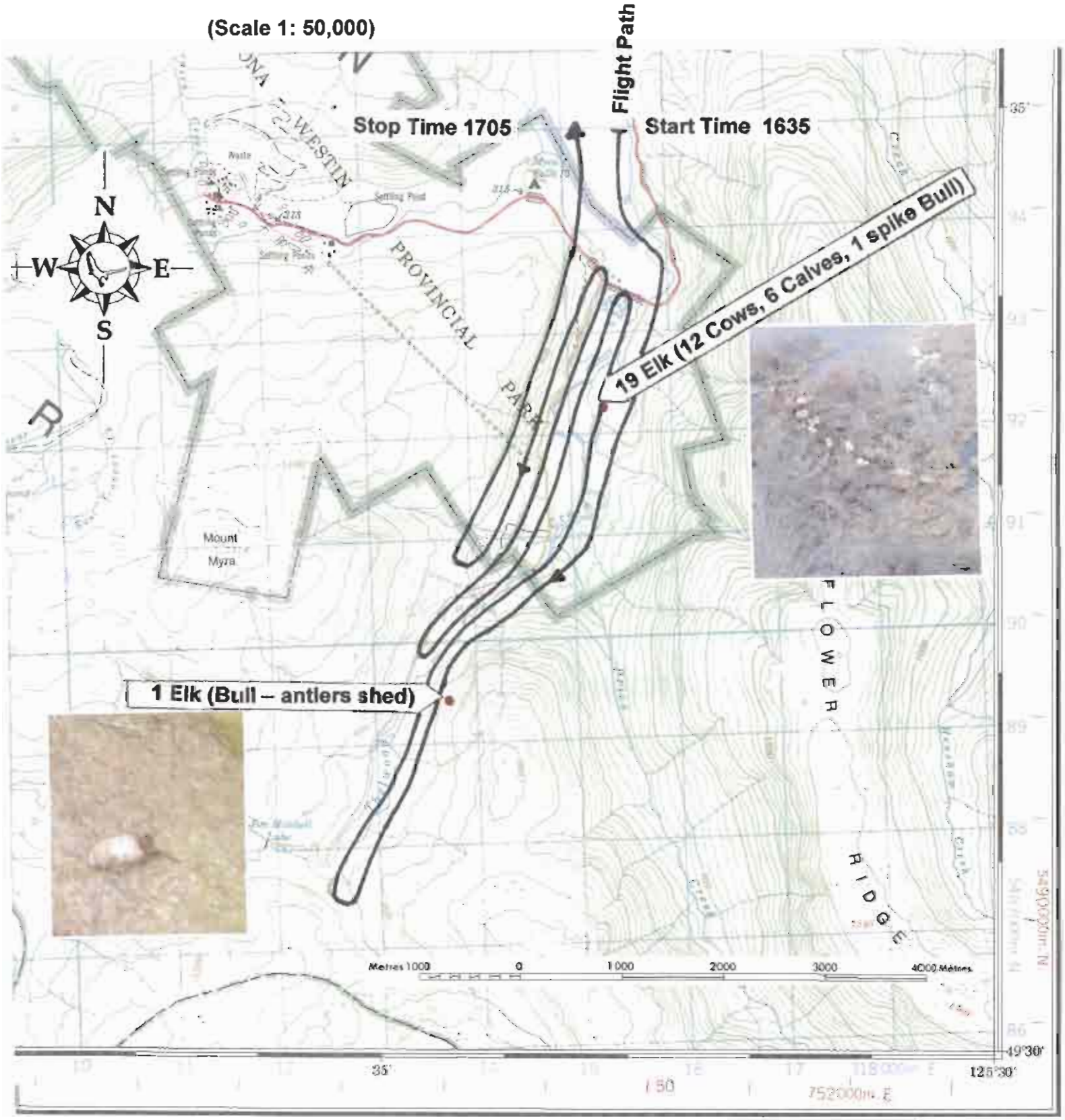


Fig. 15a. Results of March 17, 2005 aerial survey – Elk Valley (east)

Scale 1: 50,000

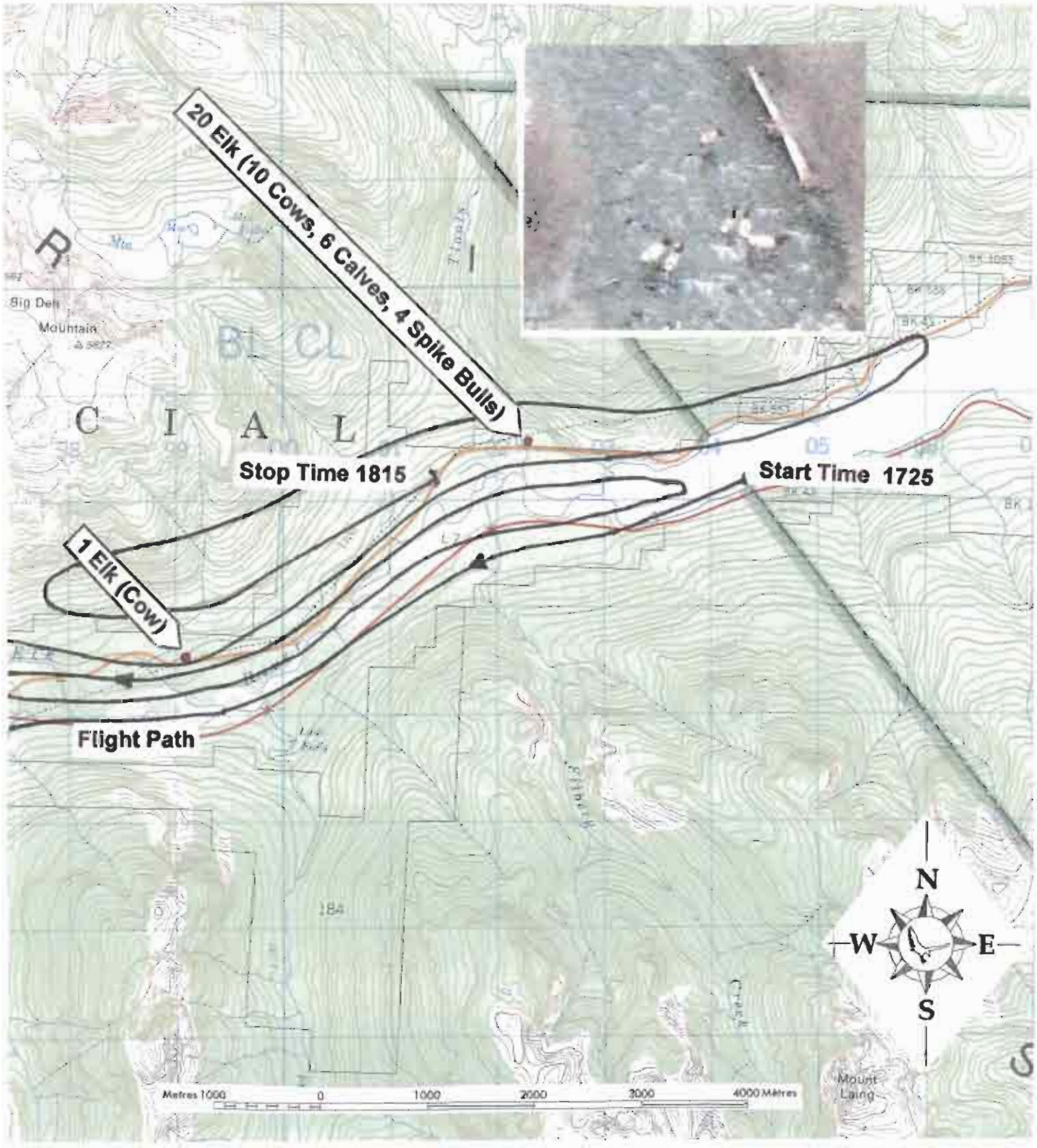


Fig. 15b. Results of March 17, 2005 aerial survey – Elk Valley (west)

Scale 1: 50,000

Calf – Cow Ratio Analysis

As twin calves have not been recorded on Vancouver Island (Nyberg and Janz 1990) the theoretical maximum calf-cow ratio for a given herd is 100 calves per 100 cows. In reality, however, young cows may not be sexually mature (cows are usually 2.5 years old at first breeding) and cows aged 11 years and older are frequently sterile. In addition to these factors, calves are frequently lost to illness and predation before they are enumerated on the winter range. As a result, ratios in the range of 40-50 calves per 100 cows are considered relatively high in free-roaming populations. Ratios in the range of 10-20 calves per 100 cows are generally considered low. Oregon State's elk management objective is to maintain calf productivity between 20 and 40 calves per 100 cows (Oregon Dept. of Fish & Wildlife 2005).

With observed ratios of 44 calves per 100 cows in the Thelwood Valley prior to enhancement in 2002, calf-cow ratios were relatively high. As shown in Table 7, calf-cow ratios have remained high in the years following enhancement, increasing slightly to 56 calves per 100 cows in 2003 and 50 calves per 100 cows in 2004. Elk have only re-colonized the Thelwood Valley since the early 1990's. Growing from 16 to over 20 (estimated 23) animals since 2002, there is likely a demographic "time-lag" in effect. Analysis of aerial survey data indicates the number of elk classified as cows in the Thelwood grew by 33 % between 2003 and 2004. With females less apt to leave the valleys of their birth, it is reasonable to assume the new cows were recruited from 2003's contingent of calves. While these recruits are physically mature (>1 year old), they will probably not be bred until the fall of 2005 (age 2.5 years). In the absence of other factors, calf-cow ratios within the Thelwood herd can be expected to rise significantly in a few years, when nearly all its cows have entered their prime reproductive period (4 - 10 years old).

Data from the Elk Valley herd were more difficult to interpret, as two distinct cow-calf-spike bull groups were observed in 2003, but only one group was observed in each of 2002 and 2004 (both low snow pack years). Jones (1983) reported that elk from the Heber River herd winter in the middle reaches of the Elk Valley some years, so the higher elevation group seen in 2003 could well have been part of the Heber herd. All recent observations from the lower part of the Elk Valley, believed to be the resident component of the herd, are shown in Table 7. At 33 calves per 100 cows, the observed calf-cow ratio was in the average range prior to enhancement in this valley. The ratio rose dramatically in 2003 to 67 calves per 100 cows, and remained high in 2004 (60 calves per 100 cows). Interestingly, the two valleys exhibited a similar pattern of increasing in 2003 followed by a slight decline in 2004. Historical records indicate that observed productivity in the Elk valley in the early 1970's ranged from 8 to 50 calves per 100 cows. Over the late 1970's and early 1980's the observed productivity in this valley ranged between 23 and 26 calves per 100 cows (Jones 1983).

Table 7. Observed productivity of resident herds in the study area.

Aerial Survey Results	2002[1]	2003[1]	2004[1]
Thelwood Valley			
Calves	4	5	6
Cows	9	9	12
Calf-cow ratio	**44 calves per 100 cows**	**56 calves per 100 cows**	**50 calves per 100 cows**
Elk River Valley			
Calves	4	6	10
Cows	12	9	6
Calf-cow ratio	**33 calves per 100 cows**	**67 calves per 100 cows**	**60 calves per 100 cows**

Notes:

aerial survey results as follows:

2002 - March 3, 2003 flight
2003 - March 1, 2004 flight
2004 - March 17, 2005 flight.

6.0 RECOMMENDATIONS

With 2004 work complete, all areas identified in the enhancement planning report by Materi and Blood (2000) have now been treated. Approximately 10 ha of valley bottom habitats have been enhanced in the Elk Valley (and a similar area in the Thelwood Valley), well short of the long-term goal of 80 ha of enhanced elk habitat espoused by Provincial Biologists for this valley in the early 1980's (Jones 1983). Nevertheless, it seems appropriate to monitor and evaluate existing treatment areas for several more years before attempting to enhance new areas in either of the two study valleys. In February of 2005, BCRP approved funding for post-enhancement monitoring from May 2005 through March 2006.

The following recommendations are offered for consideration:

6.1 Near-term

1. The slow rates of change observed in browse plot and aerial survey data suggests these monitoring activities be suspended until at least 2008.

2. A nominal annual monitoring program involving winter pellet group counts and herbage clipping samples should be continued over 2006 and 2007, to assist in data analysis. "Control" pellet group transects in untreated areas should be established in several locations to better understand annual variation in count data.

3. Given the modest funding required for the above ($ < 5,000 per year), and the onerous BCRP application process, funding for the above should sought through either BC Parks or the Habitat Conservation Trust Fund (Roosevelt Elk Special Projects Account).

4. Manual control of bracken fern should be undertaken within Site 4 to limit its potential negative impact on winter browse production.

5. To facilitate long-term monitoring, the 2005 Project Final Report should include UTM coordinates and detailed site maps of all existing treatment areas, and the sampling locations within them.

6.2 Medium-to-Long Term

1. Provided near-term monitoring data continue to support increased elk use of seeding and spacing/pruning areas, additional enhancement sites should be identified in the Elk Valley, with a view to achieving the Province's long-term goal of 80 ha of enhanced habitats in this valley.

2. Re-establishment of an elk herd in the Thelwood Valley was the goal Provincial wildlife officials in the early 1980's. With the natural re-colonization of this valley, the current focus should be optimizing habitat for the long-term maintenance of the herd. Blood (1988) estimated the Thelwood Valley could support up to 39-76 wintering elk. To approach this number, additional enhancement sites covering perhaps 50 ha would need to be identified on floodplains and alluvial fans in the Thelwood Valley.

3. With a relatively confined valley and sizeable wintering elk herd, opportunities to develop interpretation facilities (e.g. trails and viewing platforms) should be explored in the Thelwood Valley.

4. Recent aerial surveys have noted occasional winter elk presence in the Wolf River Valley, which is tributary to the Buttle Lake Reservoir and within the Strathcona Provincial Park boundary. In 1965, this valley supported 15-20 elk (Jones 1983), suggesting habitats there have declined over time and may benefit from techniques developed during the current study. A study should be conducted into the feasibility of conducting elk habitat enhancement in the Wolf River Valley.

5. Some cover enhancement techniques have been investigated during the recent work, but the main focus has been improving forage production. Initiation of a longer-term study investigating stand treatments to enhance snow interception cover should be incorporated into future habitat enhancement plans in the study area.

7.0 ACKNOWLEDGEMENTS

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APPENDIX I. FINANCIAL STATEMENT

BCRP Project #04.W.Ca.03
Strathcona Elk Habitat Enhancement

Summary of Project Expenditures - 2004 Budgeted vs. Actual

Item	Approved 2004 BCRP Budget	Actual Project Costs	Budget Surplus
Labour			
Contract Biologist	21,700.00	**16,975.00**	4,725.00
Day Labour Falling, Bucking, Pruning & Brushing [1]	27,000.00	**18,944.00**	8,056.00
Expenses			
Contract Biologist – Travel	1,950.00	**300.00**	1,650.00
Equipment & Mobilization	5,000.00	**3,921.40**	1,078.60
Expendable Field Supplies	300.00	**0.00**	300.00
Planting Supplies	2,300.00	**1,692.50**	607.50
Interpretive Signage (3 signs)	3,375.00	**3,375.00**	0.00
Helicopter-based Survey	4,000.00	**2,677.50**	1,322.50
Administration			
Contract Admin	3,150.00	**2,450.00**	700.00
Total BCRP Portion	$ 68,775.00	**$ 50,335.40**	$ 18,439.60

Notes:

[1] Line item amounts for brushing/browse rejuvenation have been combined with day labour for falling, as these tasks were undertaken concurrently by the same contractor.

APPENDIX II. PERFORMANCE MEASURES – ACTUAL OUTCOMES

Project type

Maintenance or restoration of habitat forming process.

- other upland habitat enhancement for wildlife.

Primary habitat benefit targeted by project

Improve functional area of habitat.

Primary Target Species

Roosevelt elk (*Cervus elaphus roosevelti*)

Targeted Outcomes

To improve 10,000 m^2 of Lowland Deciduous habitat.

To improve 70,000 m^2 of Lowland Coniferous habitat.

Actual Outcomes

Improved 6,000 m^2 of Lowland Deciduous habitat.

Improved 64,000 m^2 of Lowland Coniferous habitat.

APPENDIX III. CONFIRMATION OF BCRP RECOGNITION

BCRP support for the Strathcona Elk Winter Range Enhancement Project in 2004 was acknowledged in the following ways over the 2004 Funding Year:

<u>May, 2004</u>
Article in the *Campbell River Mirror* acknowledges the support of BCRP in elk enhancement (article attached).

<u>August, 2004</u>
Financial assistance from BCRP was recognized during a paper delivered at the International Conference on Restoration Ecology in Victoria (conference proceedings attached).

<u>September, 2004</u>
BCRP support was recognized during a site tour provided to the Vancouver Island Wildlife Management Society (photo attached).

<u>March, 2005</u>
Three interpretive signs to be installed at prominent locations within Strathcona Provincial Park recognized the key role of BCRP in providing sole funding for elk habitat enhancement (available drafts of signs attached).

Campbell River part of $1.

Local projects receive funding

■ Elk River Channel Stabilization. Streamline Environmental Consulting ($95, 370). The project will use live gravel bar staking to stabilize key sites in the lower Elk River, encouraging sediment deposition leading to vegetative succession on treated areas. This in turn will promote channel stability and enable the recovery of riparian vegetation, and impacted fish and wildlife habitats.

■ Backchannel Creation on Baikie Island – Phase 1 – Baikie Island. Discovery Coast Greenways Land Trust ($4,675). The project will complete the planning phase for the creation of two backwater channels in the Campbell River Estuary, specifically in the Central Baikie Island rehabilitation zone, with an implementation timeline of 2005 summer fisheries window. The project will also explore the option of including an eelgrass embayment area as a major component of one channel. This embayment area will protect and enhance fisheries values and provide high quality, additional rearing habitat for Pacific Salmon, summer and winter runs of steelhead trout, cutthroat trout, lamprey and small populations of Dolly Varden char. It will also provide additional habitat structural diversity for the rearing area and estuarine habitat.

■ Quinsam River Fish Passage – Planning Phase, Haig-Brown Kingfisher Creek Society/Haig-Brown Institute ($10,000). A plan will be developed to improve fish passage on the Quinsam River by examining the cascades and rock formation of the area in detail. An assessment will also be conducted to determine the potential gains of a spawning habitat and determine the amount of spawning habitat required in the 14-kilometre area above the cascades.

■ Salmon River Nutrient Enrichment for Fish Habitat Restoration. BC Conservation Foundation ($21,200). This project will provide nutrient enrichment to steelhead and coho salmon, as well as resident trout and Dolly Varden Char in the upper Salmon River and Grilse Creek, just north of Campbell River, in order to increase number and diversity of salmonid stocks in the area.

■ Campbell River Mainstem Spawning Gravel Purchase and Placement, Tyee Club of British Columbia ($58,620). The project will increase available spawning habitat on the Campbell River through the strategic placement of gravel in historic spawning areas with protection from high flows. Site stability tests and inventory procedures to calculate the number of chinook supported by the habitat will also be conducted.

■ Campbell/Buttle Elk Winter Range Restoration, Ministry of Water, Land and Air Protection, Environmental Stewardship Division – Parks and

■ New money: Funding provided for fish and wildlife restoration

The BC Hydro Bridge Coastal Fish and Wildlife Restoration Program (BCRP) has announced that it will allocate $1,428,004 to fund 27 fish and wildlife restoration projects in southwestern B.C. and Vancouver Island over the next year.

The objective of these projects is to restore fish and wildlife populations and habitats in watersheds impacted by the construction of BC Hydro hydroelectric facilities.

BCRP has allocated $258,640 to support the following six fish and wildlife restoration projects in the Campbell River area:

■ enabling the recovery of riparian vegetation, and impacted fish and wildlife habitats in the lower Elk River.

■ creating additional fish rearing habitat in the Campbell River Estuary.

■ developing a plan to improve fish passage on the Quinsam River.

■ increasing available spawning habitat on the Campbell River.

■ providing nutrient enrichment to the steelhead and coho salmon, as well as resident trout and Dolly Varden Char along the Salmon River.

■ improving forage production and diversity for Roosevelt Elk winter range in areas affected by the Upper Campbell Lake reservoir.

Another project, investigating the impact of

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Campbell River are
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"British Colum
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said BCRP board
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The BCRP is o
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of the B.C. and Alberta Bat Conservation Strategy. It is expected to provide information pertinent to the Campbell River area and all the watersheds covered by the BCRP.

"British Columbians have demonstrated strong support for programs that restore fish and wildlife populations and habitats," said BCRP board chair, Craig Orr. "Funding these projects will provide significant benefits not only to the local community, but to the entire province as well."

The BCRP is one of three programs funded by BC Hydro to help offset the impacts from the construction of its hydroelectric facilities. Each year, BC Hydro contributes $1.6 million to the BCRP to support eligible fish and wildlife restoration projects in the Coastal Generation area.

The other two programs, Columbia Basin Fish and Wildlife Compensation program and Peace Williston Fish and Wildlife Compensation program, cover the Peace-Williston and the Columbia Basin areas.

■ **Protected:** Roosevelt Elks will have their winter foraging ranges protected thanks to $68,775 in new provincial money

Project proposals are evaluated and selected by the BCRP management board, with the assistance of four technical review committees. The board, which oversees all funding allocations, consists of nine members: three First Nations members, three public members, and three government agency members (one each from BC Hydro, the Government of Canada, and the Province of B.C.)

"The calibre of the 27 projects we are funding this year is outstanding," said BCRP program manager, Janice Doane. "We have been delighted with the results achieved with projects over the past few years, and the projects to be undertaken by this year's successful applicants promise to be no exception. All of the projects are deserving with their objective of restoring fish and wildlife populations and habitats."

Each fall, community groups, consulting firms, agencies, universities and individuals are invited to submit proposals for BCRP funding. The next call for proposals is Nov. 15, 2004. Projects funded through the BCRP must be in watersheds affected by the footprint of a BC Hydro hydroelectric facility in the Fraser Valley, Vancouver Island, Coastal, Bridge River or Shuswap areas; scientifically supportable; and provide positive benefits to fish or wildlife.

More BCRP information, including an online application form, is available online at www.bchydro.com/bcrp or call the BCRP program manager, Janice Doane, at 604 528-8189.

Canadian International Development Agency

Agence canadienne de développement international

SER
SOCIETY FOR ECOLOGICAL RESTORATION

BRITISH COLUMBIA
Ministry of Water, Land and Air Protection

Parks Canada

Parcs Canada

PROGRAM

The 16th Annual Conference of the Society for Ecological Restoration

August 24 - 26, 2004

Victoria, British Columbia
Canada

Co-sponsored By

University of Victoria

CLRA ACRSD

SER-BC

Welcome!

Society for Ecological Restoration delegates.

The University of Victoria is proud to support this conference
for people committed to the ideas and values of ecological restoration.

The School of Environmental Studies at UVic
promotes restoration education through:

- The option of an environmental restoration focus for an undergraduate degree
- A commitment to graduate studies in restoration by special arrangement
- Opportunities for professionals working in the field through the Restoration of Natural Systems (RNS) program. The RNS program is offered through the Division of Continuing Studies and is guided by a widely representative advisory committee (including several people who are active in SER). For more information about courses and formats, pick up a brochure at the conference or see the Web site at ***www.uvcs.uvic.ca/restore/***
- Student involvement in on-campus restoration projects (with Facilities Management), the local SER chapter, and other community projects.

The School of Environmental Studies and the Division of Continuing Studies extend a special thanks to the President's Office for support of the salmon barbeque, and to all the departments and individuals at the University of Victoria who have contributed to the conference.

University of Victoria

Presenter	Authors	Title
Jonathan Long	Jonathan Long, and Mae Burnette	Effects of wildfires on riparian restoration sites
Jonathan Long	Jonathan Long, Mae Burnette, and Alvin Medina	Restoration of Soldier Spring: An isolated habitat for native Apache trout
Jonathan Long	Mae Burnette, Glenn Burnette, and Jonathan Long	Restoring the balance at springs damaged by wildfire
Jonathan Long	Jonathan Long, and Mae Burnette	Restoring wetlands after the Rodeo-Chediski Wildfire, Arizona
Hugo López	Hugo López, and Patricia Moreno-Casasola	Proposed restoration of a tropical freshwater marsh invaded by a non-native grass: The use of shade as an effective tool against C4 invaders.
Sarah Lowe	Sarah Lowe, and Ken Zimmerman	Ecological restoration of a quarry contributes to a proposed urban greenbelt
Hongfang Lu	Shaolin Peng, and Hongfang Lu	Observation and research of restoration and succession processes in a forest ecosystem
Roy A Lubke	Roy A. Lubke, Deborah Vromans and Linda Redfern ;	Plant rescue for rehabilitation in the Coega Industrial Development Zone, Eastern Cape, South Africa
Victoria Luiting	Victoria T. Luiting, and Frederick D. Goetz	Is urban restoration a good idea? Case studies from Seattle
M L. Peter MacDonagh	L. Peter MacDonagh	Using native plant communities as models for aggregate mine restoration
Andrew MacDougall	Andrew S. MacDougall, and Roy Turkington	Are invasive species the drivers or passengers of ecological change in highly disturbed plant communities?
Louis Machabée	Louis Machabée	Investigating the principles of justice in the actors' decisions-making process: A case study of an urban ecological restoration project
Ellen Mackey Bart O'Brien	Ellen Mackey, Bart O'Brien, and Maria Lopez	The development of landscaping guidelines and plant palettes for the Los Angeles River, California
Alex MacLeod	Alex MacLeod	An assessment of greenhouse gas sink and sequestration options for application in mine site reclamation
Alex MacLeod	Alex MacLeod, and Bryan Tisch	The microbiology and mineralogy of a paper mill sludge that was applied as a dry cover on copper tailings
Mikael Malmaeus	Mikael Malmaeus	Identifying internal phosphorus loading problems in lakes under climate change: Implications for lake management
Lehna K. Malmkvist	Lehna K. Malmkvist, Rob. A. Miller, and Craig Mount	Designing future successes: An evolution of urban watershed management planning.
E. Todd Manning	E. Todd Manning	Using fungal inoculation as a habitat enhancement tool
Amy Martin	Amy Martin, John Harrington, and Steve Swenson	Establishment and persistence of prairie species at varying seeding densities
Dennis Martinez	Dennis Martinez Moderator	Conservation restoration and wood fiber production in the forest matrix: How to do holistic restoration forestry
Dennis Martinez	Dennis Martinez	Restoring Indigenous History and Culture to Forest Ecosystems: Conservation, Restoration, and Wood Timber Production in the Forest Matrix
Dennis Martinez	Dennis Martinez: Moderator	Restoring indigenous history and culture to North American landscapes: The role of traditional ecological knowledge (TEK) in community-based ecocultural restoration
Susanne Masi	Susanne Masi	Plants of concern: Volunteers monitor rare species in a standardized regional program (Northeast Illinois)
Joe Materi	Joe Materi	Restoring elk winter range in coastal second-growth stands
David McAdoo	David McAdoo, Rusty Sydnor, and Clare Fitzgerald	Riparian restoration on the Cascades Dam removal project
Barry McCovey	Barry McCovey	Yurok Tribal Park
Kathleen McGill	Kathleen McGill	Assumptions on the edge: A 'local' looks at two visions of restoration

Restoring elk winter range in coastal second-growth stands

Joe J. Materi [1]

Abstract: The use of prescribed fire to restore winter range for Rocky Mountain elk (*Cervus elaphus nelsoni*) has taken place for many years in British Columbia. However, methods for restoring winter range of its coastal counterpart, the Roosevelt elk (*Cervus elaphus roosevelti*) have received little attention. With the creation of BC Hydro's Bridge Coastal Fish & Wildlife Restoration Program in 2000, development of restoration techniques for this Listed subspecies began within two Vancouver Island watersheds impacted by historical logging and hydro-electric development. Following two seasons of planning, restoration activities were undertaken at 10 sites within Strathcona Provincial Park over 2002 - 2003. The sites were located within the Elk and Thelwood River Valleys. The Elk River Valley currently supports a herd of 45-50 elk, while the Thelwood supports 15-20 animals. Restoration sites range in size from 0.7 ha to 4 ha. The main focus of the project was increasing elk winter/spring forage production, however, techniques to improve resting and security cover were also undertaken. Forage production was increased through scarification and seeding, intensive stand-tending, and browse plantings. Elk resting cover was improved by pruning clusters of trees with good snow-interception qualities and planting screens of conifers. Vegetation responses to treatment were monitored through use of an exclosure, pre- and post-treatment browse plots, clipping studies, and winter survival surveys. Elk responses to treatment were monitored using winter pellet group transects, periodic inspections, and aerial surveys. Preliminary results indicate high initial use of seeded areas by elk and other native herbivores. Second-season increases in herbage production of 141 % were recorded for native grasses and 252 % for agronomic seed. Annual pellet group counts show increases in elk winter use of 70 % - 250 % within intensively-tended stands and 180 % in a browse planting area after two years. Stand-tending at one sight apparently resulted in elk avoidance the first winter due to heavy debris loading. Aerial surveys showed that herd size in both study areas remained relatively stable, although a modest decrease in the cow-calf ratio was observed in the Elk River Valley, indicating improved calf survivorship in the area where restoration efforts have been most concentrated.

INTRODUCTION

Winter range restoration for Rocky Mountain elk (*Cervus elaphus nelsoni*) has been carried out for several decades in the Interior of British Columbia. This typically involves the use of prescribed fire to rejuvenate understorey vegetation. Relatively little investigation has been conducted, however, into restoration techniques that might be suitable for Vancouver Island and the adjacent Mainland coast, where the wet climate makes controlled burns more difficult to carry out. Coastal areas support a Blue–Listed subspecies of elk, the Roosevelt elk (*Cervus elaphus roosevelti*), which has a total population of approximately 3,500 animals. A winter forage restoration trials were carried out in the Campbell River Watershed during the mid-1980's (Janz 1982; Davies 1986). However, these were of short duration and had limited resources for monitoring. In 1993, BC Hydro commissioned a wildlife restoration study for the Upper Campbell/ Buttle Lake Reservoir system outlining possible means of restoring elk winter range in park and non-park lands (Blood 1993).

In 2000, the creation of BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program (BCRP), a compensation program addressing historical footprint and ongoing operational impacts of hydro development, provided an opportunity to conduct field trials on a range of enhancement and restoration techniques within Strathcona Provincial Park, on Vancouver Island. Project planning commenced in 2000 with the identification of potential sites and review of potential techniques (Materi and Blood 2000). A detailed five-year implementation and monitoring plan was developed for 10 sites in 2001 (Materi 2001).

Since completion of the Strathcona Dam in 1958, approximately 3,100 ha of forest land has been inundated in the Upper Campbell / Buttle Lake Reservoir system. Although no pre-flooding studies of habitat conditions were conducted, habitat capability mapping on adjacent lands suggested the carrying capacity for Roosevelt elk would have been high on the inundated lands. Blood (1993) estimated that reservoir construction reduced the total watershed's carrying capacity for elk by about 75 to 100 individuals.

Providing suitable winter range is a key factor in the long-term persistence of elk herds on Vancouver Island (Nyberg and Janz 1990). Winter and early spring can be

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ACKNOWLEDGEMENTS

Funding for this project was provided by BC Hydro's Bridge Coastal Fish and Wildlife Restoration Program. Special thanks to BCRP Program Manager, Janice Doane, for her assistance over 2002 -2003.

Substantial "in-kind" contributions for this project were provided by BC Parks. Brent Blackmun, Area Supervisor, provided administrative support while Park Rangers Steve Pratt and Will Hastings supplied invaluable assistance in planning, site supervision and monitoring. Technical advice was provided by Kim Brunt, B.C. Ministry of Water, Land & Air Protection and Manny Vaartnou, M. Vaartnou & Associates Ltd.

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Roosevelt Elk Habitat Restoration in Strathcona Park

Roosevelt Elk

In Canada, this elk subspecies inhabits only Vancouver Island and the Sunshine Coast, where it numbers less than 4,000 animals. It also occurs west of the Cascade Mountains to northern California. Elk are the largest land mammals on Vancouver Island, with males (or bulls) weighing up to 400 kg. They graze herbage and browse the tips of shrubs and trees. Females (or cows) can live up to 20 years but bulls rarely survive 10 years in the wild.

The Thelwood Valley

A herd of 15 to 20 elk currently over-winter in this valley, usually arriving in October. The lower part of this elk winter range has been affected by reservoir level changes. Habitat quality in the upper part of the range has declined as forest succession shaded the forest floor.

Elk Habitat Restoration Trials

To counter the decline of elk winter ranges in the park, a habitat restoration plan was developed over 2000 & 2001. Four sites in this valley, totaling 10 ha, were restored between 2002 & 2004, using the methods shown below.

Selective Cutting, Pruning & Brushing

Cutting trees allows more light to reach the forest floor, increasing elk food production. Pruning branches creates resting sites close to winter feeding areas, saving elk energy. Cutting some types of shrubs increases the amount & accessibility of browse for several years.

Native Grass Seeding

Seeded meadows provide nutritious food in early spring, when elk need it most. This type of treatment is fairly costly, so it has been targeted at sites with rich soils. Sites are cleared & prepared for seeding using an excavator.

BRITISH COLUMBIA

BC HYDRO FISH & WILDLIFE
BRIDGE COASTAL RESTORATION PROGRAM

APPENDIX IV. SUMMARY OF 2002-03 ELK ENHANCEMENT AREAS

Site 1

Location: BC Hydro Right-of-Way across fm BC Parks wildlife viewing platform off Hwy 28.

Size: 0.57 ha

Elevation: 270 m **BGC Zone:** CWHxm2

Site Series: N/A (disturbed) **Structural Stage:** 3 (Shrub/herb)

Pre-restoration Conditions: Dense patches of young Douglas-fir trees interspersed with a light cover of weedy forbs and grasses. Occasional large stumps.

Objective: Increase herbage production for late winter / early spring use.

Treatment:

- clearing and scarification using excavator on May 13/02.
- seeded at 60 kg/ha on May 26/02 with agronomic mix containing:
  - 25 % perennial late ryegrass
  - 20 % alsike clover
  - 15 % creeping red fescue
  - 10 % sheep fescue
  - 10 % red clover
  - 10 % birdsfoot trefoil
  - 5 % colonial bentgrass
  - 5 % timothy
- fertilized at 150 kg/ha using high phosphorus "turf starter" fertilizer (18-32-6) on May 26/02.
- watered three times in May using portable fire pump.
- fill-seeding with 8 kg of native grass mixture on Sept. 23/02.

Restoration Costs:

- Excavator and mobilization	$ 1,000
- Seed and fertilizer	$ 1,174
Labour & Materials	**$ 2,174**
Cost/ha	**$ 3,814**

Site 2

Location: Alluvial fan due west of Tlools Creek.

Size: 4.0 ha total area (0.4 ha of clearings)

Elevation: 230 m **BGC Zone:** CWHxm2

Site Series: 01 (HwFd – Kindbergia) **Structural Stage:**5 (Young Forest)

Pre-restoration Conditions:

Relatively open stand of second-growth dominated by Douglas-fir trees. Canopy closure averages about 40 %. Moderately well-developed understory of huckleberry, blueberry, Oregon grape and salal. Elk browse species averaged about 17 % cover.

Objective: Increase browse production for winter use.

Treatment:

1. selective falling of trees in 10 small clusters over Aug 1 -13/02 to create canopy gaps covering about 10 % of total site (0.4 ha).

2. Concurrent bucking and piling of downed trees to maintain elk access and facilitate browse production .

Restoration Costs:

- Falling, bucking, & debris handling	$ 2,880
Labour & Materials	**$ 2,880**
Cost/ha	**$ 7,200**

Site 3

Location: Riverside bench approx. 200 m east of Tlools Creek.

Size: 0.92ha

Elevation: 230 m **BGC Zone:** CWHxm2

Site Series: 07 / 08 (Cw – Foamflower / High Bench floodplain)

Structural Stage: 5 (Young Forest)

Pre-restoration Conditions: Relatively rich and moist deciduous stand dominated by young big leaf maple trees and occasional large cottonwoods. Understory consists of a sparse cover of swordfern, vanilla leaf and grasses with patches of salmonberry. Herbage production hampered by dense forest canopy and high leaf litter.

Objective: Increase herbage production for late winter / early spring use.

Treatment:

- clearing, scarification, and leveling of 0.9 ha using a fully caged excavator from May 14 – May 17/02.
- seeded at approx. 90 kg/ha on May 27/02 with native grass mix containing:
  - 50 % Alaska brome
  - 20 % slender wildrye
  - 20 % Canada bluegrass
  - 10 % "Duncan"mix (Alaska brome, tufted hairgrass, slender hairgrass, blue wildrye and native red fescue).
- watered once/week from mid-June to mid-July using a portable fire pump.
- fill-seeding with 8 kg of native grass mixture on Sept. 23/02.

Restoration Costs:

- Excavator & mobilization	$ 4,000
- Native grass seed	$ 3,564
Labour & Materials	**$ 7,564**
Cost/ha	**$ 8,222**

Site 4

Location: Alluvial fan on east side of Thelwood River Valley.

Size: 10 ha (3.1 ha of clearings + 0.2 ha of plantings)

Elevation: 220 m – 240 m **BGC Zone:** CWHxm2

Site Series: 01 (HwFd – Kindbergia) **Structural Stage:** 5 (Young Forest)

Pre-restoration Conditions: Stand dominated by young Douglas-fir with occasional cedar, red alder, and big leaf maple. Understory consists of dense patches of bracken fern, with some areas of salal and vanilla leaf. Canopy gaps are largely filled by juvenile firs and decadent willow.

Objectives: Increase winter browse production and diversity.
Improve security cover (i.e. screening) from roads
Create bedding sites in close proximity to forage production areas.

Treatment:

- brushed 3.1 ha using 3-person silviculture crew between Nov. 5 and Nov. 15/02. Douglas-fir trees < 15 cm DBH selectively removed in 29 work areas. Pruning of lower branches of all firs >15 cm DBH.
- browse rejuvenated by cutting down all deciduous shrubs > 3 m in height and maples < 30 cm DBH.
- wood debris piled outside of 20 m radius treatment areas to facilitate forage production and elk access.
- 100 browse plantings (1 gal.) installed in clusters of 10 at north end of site and fenced off using salmon-pen netting.
- Distribution of browse species was as follows:
  - 20 % big leaf maple
  - 20 % black cottonwood
  - 15 % Scouler's willow
  - 15 % Sitka willow
  - 10 % Saskatoon
  - 10 % red-flowering currant
  - 10 % thimbleberry
- 2 gal. to 5 gal. conifer planting stock installed along 250 m of roadway (individual cedars fenced for protection).

Restoration Costs:

- Pruning, brushing, & debris mgmt	$13,200
- Browse / security plantings	$ 2,996
- Planting & browse protection	$ 2,000
Labour & Materials	**$ 18,196**
Cost/ha	**$ 5,514**

Site 5

Location: Riverbench near Hwy. 28 crossing of Elk River.

Size: 0.75 ha

Elevation: 280 m **BGC Zone:** CWHxm2

Site Series: N/A (disturbed) **Structural Stage:** 3 (Shrub / Herb)

Pre-restoration Conditions: Pavement underlying a thin veneer of gravelly soil and organic material. Sparsely distributed young cottonwood, willow and Douglas-fir trees. Trace amounts of grass, roses and weedy forbs.

Objective: Increase winter browse production and diversity.

Treatment:

- 410 shrub plantings installed in clusters of 7 in late Sept./02. The distribution of browse species was as follows:
  - 30 % black cottonwood
  - 20 % Scouler's willow
  - 20 % Sitka willow
  - 15 % big leaf maple
  - 5 % Saskatoon
  - 5 % red-flowering currant
  - 5 % thimbleberry

- entire site fenced off using approx. 400 lineal m of salmon-pen netting hung from poles.

Restoration Costs:

- Browse plantings	$ 1,500
- Fencing materials	$ 1,659
- Planting & fencing labour	$ 4,000
Labour & Materials	**$ 7,159**
Cost/ha	**$ 9,545**

Site 6

Location: Recently decommissioned part of ERT Logging Road, from Eastern Park Boundary to Tlools Creek area.

Size: 2.0 ha

Elevation: 240 m **BGC Zone:** CWHxm2

Site Series: N/A (disturbed) **Structural Stage:** 1 (Non-vegetated)

Pre-restoration Conditions: Road gravel overturned and mixed with underlying soils to a depth of approx. 30 cm. Some gravelly pockets but overall suitable for planting.

Objective: Increase winter browse production and diversity.
Improve security cover.

Treatment:

- purchased 820 - 1 gal. and 2 gal. browse plantings on Dec. 10/02.
- browse species included:
  - 15 % willows
  - 13 % big leaf maple
  - 10 % red-flowering currant
  - 10 % thimbleberry
  - 10 % dogwood
  - 10 % Saskatoon
  - 6 % western redcedar
  - 6 % western hemlock
  - 6 % evergreen huckleberry

- purchased 90 – 1 gal., 2 gal. & 5 gal. screening cover plants (50 % Douglas-fir; 50 % Sitka alder).
- planting to be arranged in 2003 budget year.

Restoration Costs:

- Browse / security plantings	$ 4,922
- installed by BC Parks & volunteers	$ 0
Materials	**$ 4,922**
Cost/ha	**$ 2,461**

Site 7

Location: Filberg Creek fan, North side of Hwy. 28.

Size: 1.9 ha

Elevation: 240 m **BGC Zone:** CWHxm2

Site Series: 01 (HwFd-Kindbergia) **Structural Stage:** 5 (Young Forest)

Pre-restoration Conditions: Dense patches of young Douglas-fir trees interspersed with occasional Hw, Cw and Mb. Diverse shrub layer, predominantly Oregon grape, red huckleberry and oceanspray. Low herbage values. Coniferous canopy closure ranged from 35 % to 50 %.

Objectives: Increase winter browse production.
Create resting sites in proximity to forage production areas.

Treatment:

- Falling of Douglas-fir trees < 35 cm DBH in 27 work areas (each 15 m radius)
- Pruning of lower branches < 2 m ht. on firs >35 cm DBH.
- Bucking and limbing of all downed trees to place in contact with forest floor (hastens decomposition and facilitates elk access).
- Brushed all competing oceanspray in work areas.
- Wood debris piled outside of tree drip lines areas to create bedding sites.

Restoration Costs:

- 2 person silviculture crew	
- $375/work area	$ 10,125
Labour & Materials	**$ 10,125**
Cost/ha	**$ 5,329**

Site 8

Location: BC Hydro Right-of-Way near intersection with decommissioned ERT Road, 2 km east of Hwy. 28 bridge over the Elk River.

Size: 3.0 ha

Elevation: 260 m **BGC Zone:** CWHxm2

Site Series: 07 (Cw-Foamflower) **Structural Stage:** 5 (Young Forest)

Pre-restoration Conditions: Dense patches of Douglas-fir trees interspersed with Hw, Cw and Mb. Understorey is dominated by vanilla leaf and swordfern with a low cover of red huckleberry and oceanspray. Moderate herbage but low browse values. Coniferous canopy closure ranged from 65% to 85 %. West end of site featured dense clusters of young, open-grown fir with heavy branching growing in high herbage area.

Objectives: Increase winter browse production.
Create resting sites in proximity to forage production areas.
Retard advance of regenerating fir in semi-open area.

Treatment:

- Falling of Douglas-fir trees < 35 cm DBH in 27 work areas (each 15 m radius = 1.9 ha)
- Pruning of lower branches < 2 m ht. on firs >35 cm DBH.
- Bucking and limbing of all downed trees to place in contact with forest floor (hastens decomposition and facilitates elk access).
- Brushed all competing oceanspray in work areas.
- Wood debris piled outside of tree drip lines areas to create bedding sites.
- Pruning and brushing 1.1 ha of open-grown Douglas-fir (west side of site)

Restoration Costs:

2-person silviculture crew:	
- 27 sites @ 345/work area	$ 9,315
- pruning and brushing - west end	$ 1,678
Labour & Materials	**$ 10,993**
Cost/ha	**$ 3,664**

Site 9

Location: Old logging camp along decommissioned ERT Road, 1 km east of Hwy. 28 bridge over the Elk River.

Size: 0.7 ha

Elevation: 270 m **BGC Zone:** CWHxm2

Site Series: N/A (disturbed) **Structural Stage:** 4 (Pole-Sapling)

Pre-restoration Conditions: Dense stand of young red alder 10 cm to 25 cm diameter. Sparse shrub layer of trailing blackberry, oceanspray, and Saskatoon. Patchy herb layer comprised of vanilla leaf, native forbs and grasses.

Objective: Increase herbage production for late winter / early spring use.

Treatment:

- cleared using mid-sized excavator over late Sept./early Oct. 2003. Woody debris piled around margins of work area.
- scarified soil using a 12 foot rake attachment on excavator.
- seeded at 66 kg/ha on Oct. 5/03 with native Alaska Brome seed.
- fertilized at 180 kg/ha using high phosphorus "turf starter" fertilizer (16-32-6) on Oct. 5/03.

Restoration Costs:

- Excavator and mobilization	$ 3,808
- Native grass seed 51kg @ $40/kg	$ 2,040 (purchased 2002)
- Fertilizer	$240
Labour & Materials	**$ 6,088**
Cost/ha	**$ 7,610**

Site 10

Location: Adjacent to Crest Lake Day Use Area, 7 km west of Hwy. 28 bridge over the Elk River.

Size: 0.5 ha

Elevation: 330 m **BGC Zone:** CWHvm1

Site Series: N/A (disturbed) **Structural Stage:** 4 (Pole-Sapling)

Pre-restoration Conditions: Dense stand of young red alder trees 5 to 20 cm in diameter. Deciduous canopy cover approx. 70 %. Understorey shrubs sparse with a moderate cover of weedy forbs and grasses in herb layer.

Objective: Increase winter browse production.
Improve winter security cover.

Treatment:

- Girdled all red alder > 10 cm diameter.
- cut all red alder < 10 cm diameter.
- collected and planted 800 Sitka willow cuttings in clusters.
- placed 16 cubic yards of topsoil near edge of day use parking lot.
- planted three rows of 2 gal. - 5 gal. juvenile conifers (30 trees in total) in topsoil.

Restoration Costs:

2-person silviculture crew	
- 4 days @ $560/day	$ 2,240
- native conifers	490
- Topsoil for screening cover	241
Labour & Materials	**$ 2,971**
Cost/ha	$ 5,942