ESTABLISHMENT OF A NATIVE GRASS SEED INDUSTRY FOR THE WEST COAST OF BRITISH COLUMBIA

FINAL REPORT – 1996-2006

Prepared for

Cascadia Forest Products Ltd., International Forest Products Ltd., and Western Forest Products Inc.

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ABSTRACT

Since the 1970's, the use of native plants has often been suggested as a potential answer to problems associated with revegetation of disturbed areas. However, native seed for large-scale reclamation purposes has neither been available in sufficient quantity, nor at a reasonable price. Thus, from April, 1996 to March, 2001, Forest Renewal British Columbia provided the funding for this long-term applied research program to determine the utility of native Vancouver Island grasses in restoration of disturbed areas, and ultimately provide a source of native grass seed for use on Vancouver Island and the adjacent mainland coast. Subsequently, funding to continue the program has been provided by the BC Ministry of Forests, TimberWest Forest Ltd., Canadian Forest Products Ltd., Weyerhaeuser Company Ltd., International Forest Products Ltd., Cascadia Forest Products Ltd., and Western Forest Products Inc. Funding for the 2005/06 fiscal year was provided by the latter three companies. The private sector funding from 2001 to 2005 has been a transfer of funds from the provincial Forest Investment Account.

The long-term objective of the program was the harvest of sufficient seed from the Seed Production Plots to allow established seed merchants to grow the seed, at field-scale, for purchase by large-scale users. For this to happen, three basic conditions had to be met. These were:

- there must be sufficient native seed available for large-scale reclamation by major seed users
- native species trial plot results must be comparable to results achieved on control introduced agronomic species plots
- while initial costs may be higher, the long-term cost of native species seeds must be no more than minimally higher than the cost of agronomic seeds

This report is the annual progress report for the 2005/06 fiscal year, and the summary report for the entire ten-year program. The report describes the activities undertaken from March 1, 1996 to February 28, 2006. These consisted of fill planting, maintenance and seed harvesting at the Seed Increase Nursery; evaluation of the existing trial plots which had not been previously evaluated for five years; assessment, maintenance and harvesting of the Seed Production plots; cleaning and weighing the seed harvested from the Nursery and Seed Production plots; and various extension activities. As the program was in its final year, no new trial, demonstration or operational sites were established in 2005. In previous years biometric analysis of ground cover production from the replicated trial sites indicated that native grasses produced cover comparable to that produced by introduced, agronomic grasses on the control plots. This was the case throughout the program. Results from the unreplicated demonstration sites were also very strong throughout the life of the program, while the final evaluation, in 2005, of the more recently established operational sites, again indicated that these continued to be the most successful of all sites in the program.

The most successful species were *Bromus sitchensis, Deschampsia cespitosa*, *Deschampsia elongata*, *Elymus glaucus*, *Festuca rubra* ssp *arenicola* and *Festuca rubra* ssp *pruinosa*. The first step in future field-scale seed production of these species was taken in 2004 with transfer of seed stock to a Canadian seed company, and the establishment of seed multiplication plots in Oregon. Other successful species with market potential are *Agrostis exarata*, *Agrostis scabra*, *Bromus carinatus*, *Calamagrostis stricta* and *Poa compressa.* In 2005, seed of these latter species was also transferred, and seed multiplication plots were established in Oregon. The author's involvement in future field-scale, commercial seed production has now been completed with the transfer of appropriate seed stock, and future field-scale seed production decisions will be made by others, based on the potential market for each species.

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1.0 INTRODUCTION

Revegetation is required after disturbance caused by logging operations, the completion of transportation corridors such as highways and pipelines, and prior to the closure of mines. Benefits obtained through reseeding can be any of the following:

- aid in erosion and dust control
- reduction of siltation of fish streams
- provision of forage for wildlife and domestic species
- improvement of aesthetic values
- improvement of soil through
  a) nitrogen fixation by legumes
  b) provision of organic matter

Sound ecological restoration includes the use of native species. Their use has been recommended since the 1970's for the North-West Territories (Berger 1977). Similar recommendations have been made for Yukon Territory (Kennedy 1993, Hill et al 1996) and in Alberta (Native Plant Working Group 2000). In British Columbia, the 1995 Clayoquot Sound Scientific Panel (Clayoquot 1995) recommended that native species be used in forestry revegetation and this was reiterated in 2004 (Coast Information Team 2004). Possible benefits that may occur through the use of native species include any of the following:

- assistance in retention of local biodiversity
- creation of a more harmonious end vista because they blend into the landscape
- higher long-term survival prospects because of adaptation to local climate
- greater reseeding potential because of adaptation to the local photosynthetic regime
- lower costs through lower fertilization and seeding rates
- less rapid colonization by undesirable, invasive species

With grasses, the problem is related to agricultural economics and plant biology. If native grass species that are appropriate to any given region are selected for reclamation, they will grow and survive. The questions that needed to be answered were:

- Will the use of native grasses achieve the goals of any specific reclamation scenario?
- Which native grasses produce seed in sufficient quantity so that they can used by end-users at reasonable cost?

In 1995 there was not a source of native Vancouver Island seed available to implement the recommendation of the Clayoquot Sound Scientific Panel in the foreseeable future. Thus, Forest Renewal BC provided funding for five years to initiate this long-term applied research program to determine which native grasses can be successfully utilized in reclamation projects on the west coast of British Columbia, and which of these can be successfully grown for field-scale seed production. In 2005 the ten-year program was completed with funding provided by International Forest Products Ltd., Western Forest Products Inc., and Cascadia Forest Products Ltd.

The conclusions from this program are applicable to the CWH biogeoclimatic zone of Vancouver Island, and are likely to also be applicable to the CWH biogeoclimatic zone on the adjacent Mainland Coast, and to the CDF biogeoclimatic zone on Vancouver Island. The vast majority of program activities were undertaken on Vancouver Island. However, the initial greenhouse

program took place at the University of British Columbia in Vancouver, and the large Seed Production Plots were located near Dawson Creek. This report describes activities undertaken in the tenth year of the program; from March, 2005 through February, 2006; and also provides a summary of all activities and results from 1996 to 2006. Most details of previous activities are not repeated herein, but can be found in previous years' Final Reports (Vaartnou 2001, 2002, 2003, 2004, 2005).

2.0 OBJECTIVES

The long-term objective of the program was the harvest of sufficient seed from the Seed Production Plots to allow established seed merchants to grow the seed at field-scale for purchase by large-scale users. For this to happen, three basic conditions had to be met. These were:

- there must be sufficient native seed available for large-scale reclamation by major seed users
- native species trial plot results must be comparable to results achieved on control introduced agronomic species plots
- the long-term cost of native species seeds must be no more than minimally higher than the cost of agronomic seeds

Precise objectives varied from year to year, but the following list indicates activities that were undertaken in the course of the program:

- collection, from the wild, of seed of grasses, which are native to the west coast of British Columbia
- sowing these seeds to flats in a greenhouse at U.B.C., or in the greenhouse on site at the Duncan Seed Increase Nursery
- transplanting the emergent seedlings to a Seed Increase Nursery established just south of Duncan
- establishment of replicated native grass seed trial plots with accompanying agronomic grass seed control plots throughout Vancouver Island
- establishment of demonstration and operational sites on areas which could not be replicated because of a lack of homogeneity in site characteristics
- annual evaluation of all replicated sites, demonstration sites and operational sites until five years of data was available from each
- establishment of large Seed Production Plots near Dawson Creek to determine the seed production capability of the native grasses
- maintenance and harvesting of the Seed Increase Nursery and Seed Production Plots
- assessment of germination percentages of selections which were successful in field trials
- maintenance of a pictorial record of all aspects of the program
- annual extension activity through E-mail distribution of the annual Final Reports, open house/field days at the Seed Increase Nursery, and presentation of papers and/or poster displays at relevant conferences
- ongoing communication with established seed merchants re future field-scale seed production

3.0 METHODS

3.1 NATIVE GRASS SEED COLLECTION

Seeds of grasses native to the west coast of British Columbia were collected from the wild from locations throughout Vancouver Island. The majority of the collection took place in the first two years of the program; the summers of 1996 and 1997. The author also added some species, which had not been previously collected, from 1999 to 2002. Seeds were then sown to flats and seedlings were grown in greenhouses; originally at U.B.C., and subsequently in Duncan. Emergent seedlings were then transplanted to a Seed Increase Nursery in Duncan. Selections which were successful in the Nursery, and which were in the program in 2005, are listed in Table 2, section 4.1.

3.2 SEED INCREASE NURSERY PROGRAM

Since this was the concluding year of a ten-year program, the Seed Increase Nursery was handled in a different manner than in previous years. Seedlings that grew from seed drop in 2004 were transplanted into rows, if their rows were incomplete. No new seedlings were grown in flats in the adjacent greenhouse because these would not have produced seed in 2005.

Also, the selections that had proven to be successful were allowed to volunteer into the aisles between the rows. These aisles were not rototilled in 2005. This allowed for the harvest of more seed from these successful selections in 2005. Originally, if sufficient plants were available, rows were 50 metres long, and spacing between rows was 1 metre. A maximum of 250 plants were planted to each row, but many rows had more plants in 2005 as a result of seed drop, and the lack of rototilling in the aisles adjacent to rows of hair bentgrass (*Agrostis scabra*), slimstem reedgrass (*Calamagrostis stricta*), Alaska brome (*Bromus sitchensis*), slender hairgrass (*Deschampsia elongata*) and blue wild rye (*Elymus glaucus*).

A combination of manual and chemical weed control was used throughout the year to minimize the presence of weeds. In previous years the maintenance was undertaken by Cairnpark Nursery Services Inc. hired labour under the author's direction. However, in 2005, because of the complexity of weeding within the aisles, all weeding, chemical and manual, was undertaken by the author. Irrigation was not needed in 2005.

From mid June to late August, the seed produced in the Nursery was hand harvested by the author. Some selections, which had even maturity, needed only one harvest, while for others, from two to seven harvests were needed to minimize the loss of seed through shattering. The plants in the Nursery were photographed just prior to the first harvest for each selection.

3.3 ESTABLISHMENT OF REPLICATED SITES

From 1997 through 1999, 34 replicated sites were established throughout Vancouver Island. These sites were on abandoned logging roads that had a compacted growth medium not favourable for the growth of grasses. However, these roads had to be used, as fully deactivated roads, slide tracks and ditch lines do not provide the homogeneity in site characteristics required for reasonable replication and subsequent biometric analysis. These sites were 80 sq m in size (5m x 16m). All were hand seeded at 40kg/ha and fertilized with 18-18-18 at 250kg/ha. Each site had a plot seeded to a control mixture of agronomic grasses. Both the native grass mixtures and the agronomic control mixture contained three common agronomic legumes because legumes are used in operational seeding, but native legume seed was not available in sufficient quantity. The

locations of the replicated sites are found in Appendix B. The seed mixtures that were sown to these sites are found in Appendix C.

3.4 ESTABLISHMENT OF DEMONSTRATION SITES

In the 1990's, eleven demonstration sites were also established on Vancouver Island. These sites, which included sites on fully deactivated roads and ditch lines, were on more suitable soil, but could not be replicated. Methodology was identical to that discussed above in Section 3.3. The seed mixtures that were sown to these sites are found in Appendix C.

3.5 ESTABLISHMENT OF OPERATIONAL SITES

Large operational sites were added to the program from 2000 to 2003. The first of these sites was seeded in the fall of 2000, four were added in 2001 and the final site was seeded in 2003. These sites are approximately 1000sq m (+/-20%); other site characteristics are found in Table 1.

Seeding rate was 50-55kg/ha. The seed mixtures sown to the operational sites are found in Appendix C. Primary considerations in the formulation of the mixtures were the quantity of each species that was available, and performance in other parts of the program. The number of seeds per gram of each species was also considered, and species with larger, heavier seeds were included at much higher percentages by weight than species with small seeds. The sites were fertilized with 18-18-18 at approximately 250kg/ha.

TABLE 1. CHARACTERISTICS OF THE LARGE OPERATIONAL SITES

Name	BGC	General Location	Time of Seeding	Type of Site	Soil Type	Aspect	Slope
Wd101	CWH xm2	Ward Lake	Fall, 2000	Deactivated Road	Sandy Loam	Nil	Nil
TahE1	CWH vm1	Tahsis	Spring, 2001	Creek Banks & Ditch	Sandy& Silt Loam	Variable	5-35%
SiSk	CWH ms1	Silverhope Creek	Spring, 2001	Road Cut Slope	Sand	West	40-65%
Br31Y	CWH xm2	Wiener Creek	Fall, 2001	Deactivated Road	Sandy Loam	North-east	<10%
LeCk	CWH vm1	Port Renfrew	Fall, 2001	Creek Bank	Sandy Loam	North	0-20%
NiLk	CWH xm2	Port McNeill	Spring 2003	Deactivated Road	Sandy Loam	East	0-10%

3.6 SEED PRODUCTION PLOTS

Seed Production plots were established to ascertain both immediate and long-term information. These large Seed Production plots were located just north of Dawson Creek, B.C. (Mile 3 – Alaska Highway) on property owned by Glen Mielke. These plots had short and long-term objectives.

Short-term objectives:

- to determine if any of the Vancouver Island selections will winterkill in the Peace River region
- to determine the amount of seed per hectare that can be produced by each selection
- to determine for how long the plots will produce significant quantities of seed prior to becoming sod-bound
- to determine if there are any major large-scale seed cleaning problems with any selection which would raise the cost to an impractical level

Long-term objective:

- to use these plots as a source of seed for field-scale seed production by established seed merchants once a market has been established for any given selection

All activities were identical to what would be done in a field-scale seeding program. The site was initially cleared of existing vegetation with an application of glyphosate. Subsequently, the seed and fertilizer (16-32-6) were mixed to provide a continuous flow from the drill seeder. Holes in the drill seeder were taped over to seed a row every 18in. The size of the plots varied, depending upon available seed. Maximum size was 12ft x 600ft (most plots), while minimum size was 12ft x 100ft (*Festuca rubra* ssp *pruinosa* #56B). Large gaps were left between the plots. These were seeded annually to a tall annual crop, fall rye (*Secale cereale*), to conform to Agriculture Canada isolation standards. Each fall the native grass plots were weeded.

Selections that were seeded to Seed Production Plots during the course of the program were:

Agrostis exarata #10
Agrostis scabra #43
Bromus sitchensis #45
Bromus sitchensis #48
Calamagrostis stricta #84
Deschampsia cespitosa #30
Deschampsia elongata #72
Elymus glaucus #17
Elymus glaucus #20
Elymus trachycaulus #40
Festuca idahoensis var. *roemeri* #116
Festuca rubra ssp *arenicola* #91
Festuca rubra ssp *pruinosa* #56
Festuca rubra ssp *pruinosa* #56A
Festuca rubra ssp *pruinosa* #56B
Hordeum brachyantherum #7
Leymus mollis #15
Phleum alpinum #97
Poa compressa #83

Plots that were not successful, or which became sod-bound, were eliminated over time. Selections that were still in Seed Production plots in 2005 were:

Bromus sitchensis #48
Elymus glaucus #17
Elymus glaucus #20
Elymus trachycaulus #40
Festuca rubra ssp *arenicola* #91
Poa compressa #83

3.7 EXTENSION ACTIVITIES

Extension activity for the year was initiated on March 22, with an impromptu field day at the Seed Increase Nursery. In attendance were two teachers, and about twenty students from Malaspina College in Nanaimo.

Further extension activity for the year was undertaken in early April by E-mailing a copy of the 2004/05 Final Report of this program (Vaartnou, 2005) to more than 500 individuals. Included in this message were members of the private and public forestry sector, other government agencies,

seed merchants, reclamation consultants, university and college teachers, seed growers, environmental groups, nursery owners and other interested citizens.

On June 14th, the annual field day/open house was held at the Duncan Seed Increase Nursery. This was attended by twenty-four people. Among the attendees were several senior west coast foresters, the BC Transportation and Highways Roadside Development Manager, reclamation consultants, Cowichan First Nations representatives, Malaspina College and University of Victoria representatives, two members of the Habitat Acquisition Trust and various other interested citizens.

The next extension activity consisted of presentation of a poster display at the 29th Annual B.C. Mine Reclamation Symposium on September 21/22, 2005 in Abbotsford. Subsequently, a copy of the 2004/05 Final Report was E-mailed to another sixteen individuals who requested this at the above conference. Final extension activity for the year consisted of presentation of a paper at the annual Coast Silviculture Committee Winter Workshop in Nanaimo on February 1/2, 2006.

4.0 RESULTS

4.1 SEED INCREASE NURSERY

Irrigation was not needed in 2005 and very few plants died in the spring or summer. On the whole, seed production was very successful with the exception of rows that had most of their plants die in the summer/fall of 2004. These selections produced no or little seed in 2005. The selections that were allowed to spread to the aisles between the rows in the fall of 2004 were very successful, and produced more seed than in previous years.

Selections that had even maturity only required one harvest, while others, that had plants of different ages, required from two to seven harvests to minimize seed drop. Harvest dates, and the quantity at each harvest, are found in Table 2.

4.2 TRIAL SITE EVALUATION

The replicated trial site evaluations were completed from 2002 to 2004, depending upon the year that any site was established. Each site was evaluated for five years.

Eight measurements were taken from each plot using the traditional ‘Daubenmire’ (Daubenmire 1959,1968) technique for the evaluation of herbaceous species. Each seeded species was assessed individually for ground cover production. The ‘Daubenmire’ numbers were converted to percentages and the total seeded ground cover attained on the native grass plots was ‘t’ tested with, and without, the presence of the ground cover produced by the agronomic legumes which are included on all plots.

The work tables for the fifth and final year of evaluation for the ‘t’ tests of all the replicated sites are found in Table 3. These indicate that, as was the case in all the previous years, the ground cover produced on the agronomic control and native grass mixture plots was not significantly different at the 0.05 level. For any differences to be significant at this level the ‘t’ statistics would have had to exceed 2.132 or 1.860 for 4 and 8 degrees of freedom, respectively.

TABLE 2. SEED INCREASE NURSERY RESULTS				
Col.#	**Species**	**Harvest Dates**	**Grams per Harvest**	**Total Grams**
1	*Calamgarostis nutkaensis*	8/2.	278.	278.
10	*Agrostis exarata*	8/1.	4.	4.
13	*Deschampsia elongata*	7/1.	1008.	1008.
14	*Elymus glaucus*	7/13,8/4.	1085,32.	1117.
15	*Leymus mollis*	8/4.	257.	257.
17	*Elymus glaucus*	7/13.	49.	49.
20	*Elymus glaucus*	7/14.	777.	777.
28	*Elymus hirsutus*	7/5.	19.	19.
30	*Deschampsia cespitosa*	7/14.	277.	277.
32	*Panicum occidentale*	8/2.	4.	4.
36	*Elymus hirsutus*	7/11.	38.	38.
37	*Danthonia californica*	7/13,8/1.	206,10.	216.
40	*Elymus trachycaulus*	8/4,8/10.	38,134.	172.
43	*Agrostis scabra*	7/28,8/4.	280,31.	311.
44	*Deschampsia elongata*	6/30.	86.	86.
45	*Bromus sitchensis*	7/5,7/12,7/21,8/3.	863,199,318,153.	1533.
46	*Hordeum brachyantherum*	7/6,8/3.	101.	101.
47	*Deschampsia cespitosa*	7/20.	49.	49.
48	*Bromus sitchensis* Row 43	7/5,7/11,7/15,7/28.	467,166,120,368.	1121.
48	*Bromus sitchensis* Row 49	7/4,7/13.	1374,267.	1641.
51	*Deschampsia cespitosa*	7/14.	854.	854.
52	*Agrostis exarata*	8/1.	88.	88.
54	*Panicum occidentale*	8/2.	15.	15.
56	*Festuca rubra*	7/20,8/2.	220,32.	252.
56A	*Festuca rubra*	7/13,7/21,7/27.	113,201,60.	374.
56B	*Festuca rubra*	7/20/7/28.	417,32.	449.
61	*Agrostis scabra*	7/25,8/3.	331,28.	359.
72	*Deschampsia elongata*	6/30.	839.	839.
74	*Bromus ciliatus*	7/13.	<1.	<1.
76	*Glyceria elata*	6/30.	10.	10.
83	*Poa compressa*	8/4.	107.	107.
84	*Calamagrostis stricta*	7/27.	638.	638.
90	*Danthonia intermedia*	6/30,7/5.	3,1.	4.
91	*Festuca rubra*	7/13,7/20.	50,175.	225.
93	*Alopecurus aequalis*	8/3.	4.	4.
96	*Calamagrostis stricta*	7/28.	392.	392.
105	*Danthonia californica*	7/5.	266.	266.
109	*Koeleria macrantha*	7/20.	3.	3.
112	*Melica harfordii*	7/27.	9.	9.
115	*Danthonia spicata*	7/15,8/3.	35,2.	37.
116	*Festuca idahoensis*	6/30,7/6,7/13.	184,99,96.	379.
117	*Stipa lemmonii*	6/24,7/1,7/14.	120,62,32.	214.
121	*Bromus vulgaris*	6/30,7/6.	154,29.	183.
122	*Hierochloe odorata*	8/2,8/30.	12,3.	15.
123	*Agrostis* sp. (*idahoensis*?)	7/28.	3.	3.
124	*Vahlodea atropurpurea*	6/24,6/30.	7,1.	8.
126	*Vahlodea atropurpurea*	6/30,7/6.	4,1.	5.
127	*Bromus carinatus*	6/23,6/30,7/13, 7/20,7/28,8/4,8/29.	81,87,18,53.53,47, 3,5.	374.

Over the course of program, the most successful species in the agronomic control plots were red fescue (*Festuca rubra*), red top (*Agrostis gigantea*), and to a lesser extent, timothy (*Phleum pratense*). The most successful species in the various native seed mixture plots were combined into the seed mixture seeded later in the program to the large operational sites. These are listed in Table 5, in Section 4.3.1.

TABLE 3. BIOMETRIC ANALYSIS WORK TABLES FOR THE REPLICATED SITES

Native Seed Mixture #1 – Legumes Omitted
Seeded Fall 1997 (2002 results - evaluation completed in 2002)

Type	#	Df	SS	MS	Mean	't'
Native	4	3	173.2	57.7	8.1	
						0.415
Agronomic	4	3	26.4	8.8	9.8	

Native Seed Mixture #1 – Legumes Included
Seeded Fall 1997 (2002 results - evaluation completed in 2002)

Type	#	Df	SS	MS	Mean	't'
Native	4	3	471.4	157.1	14.1	
						0.294
Agronomic	4	3	58.3	19.4	12.1	

Native Seed Mixture #2 – Legumes Omitted
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	1231.7	307.9	19.0	
						0.374
Agronomic	5	4	270.1	65.5	15.7	

Native Seed Mixture #2 – Legumes Included
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	3178.3	794.6	29.1	
						0.132
Agronomic	5	4	2012.6	503.1	31.3	

Native Seed Mixture #3 – Legumes Omitted
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	1035.1	258.79	17.9	
						0.023
Agronomic	5	4	217.6	54.4	18.1	

Native Seed Mixture #3 – Legumes Included
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	2549.5	637.4	25.0	
						0.093
Agronomic	5	4	1124.9	281.2	26.3	

Native Seed Mixture #4 – Legumes Omitted
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	60.1	15.0	9.9	
						1.696
Agronomic	5	4	105.8	26.5	10.9	

Native Seed Mixture #4 – Legumes Included
Seeded Fall 1998 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	281.7	70.4	12.0	
						1.468
Agronomic	5	4	177.6	44.58	13.4	

Native Seed Mixture #1 – Legumes Omitted
Seeded Spring 1999 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	3	2	455.5	227.8	17.2	
						0.263
Agronomic	3	2	324.9	162.5	20.2	

Native Seed Mixture #1 – Legumes Included
Seeded Spring 1999 (2003 results – evaluation completed in 2003)

Type	#	Df	SS	MS	Mean	't'
Native	3	2	486.4	243.2	28.0	
						0.066
Agronomic	3	2	480.2	240.1	27.2	

Native Seed Mixture #5 – Legumes Omitted
Seeded Fall 1999 (2004 results – evaluation completed in 2004)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	1906.2	476.6	31.3	
						1.062
Agronomic	5	4	1339.5	334.9	22.8	

Native Seed Mixture #5 – Legumes Included
Seeded Fall 1999 (2004 results – evaluation completed in 2004)

Type	#	Df	SS	MS	Mean	't'
Native	5	4	3429.8	857.4	40.6	
						0.708
Agronomic	5	4	2076.6	519.2	33.2	

4.3 OPERATIONAL SITE EVALUATIONS

The large operational sites were also evaluated using the methodology described in Section 4.2. However, as these latter sites are larger, sixteen measurements were taken at each site.

The operational sites were evaluated for ground cover production in late July or early August each year. These results (Table 4) indicate that ground cover production remained very high on all sites, and these sites continued to be the most successful sites in the entire program. Thus, long-term success is likely. Individual species success again varied from site to site. In 2005, the most successful species were spike bentgrass (*Agrostis exarata*), Alaska bromegrass (*Bromus sitchensis*),

blue wild rye (*Elymus glaucus*) and a Vancouver Island selection of red fescue (*Festuca rubra* ssp *arenicola*). In general, these are the identical species that have been the most successful elsewhere in the program. However, it should be noted that there have been vast changes in the composition of the ground cover over time on three of the sites. On the two mid-island sites (Wd101 and Br31Y), the indigenous subspecies of red fescue (*Festuca rubra* ssp *arenicola*) provided over 50% of the ground cover in 2005 while on the southern west coast site (LeCk), ground cover in 2005 was nearly a monoculture, dominated by blue wild rye (*Elymus glaucus*). This dominance was first apparent in 2003, as neither of these species had this level of dominance in previous years. The slender hairgrass (*Deschampsia elongata*), usually successful in the initial year of seeding, continued to decrease in cover production, and was eliminated from all sites except TahE1 and NiLk. Also, hair bentgrass (*Agrostis scabra*) continued to decrease in ground cover production in 2005. These latter two species are short-lived perennials that are important in restoration activities because they provide considerable initial cover; thus minimizing soil erosion. However, they will not provide long-term ground cover. Mean cover provided by each species over the past five years is found in Table 5.

TABLE 4. TOTAL GROUND COVER PRODUCTION ON THE OPERATIONAL SITES

	Ground Cover (%)				
Site	**Year**				
	2001	**2002**	**2003**	**2004**	**2005**
Wd101	46.2	65.1	75.0	67.9	73.4
TahE1	38.4	72.9	67.0	52.3	64.6
SiSk	30.7	44.7	53.0	40.7	37.2
Br31Y	----	40.6	74.5	74.9	76.3
LeCk	----	52.2	56.4	54.1	60.5
NiLk	----	-----	44.0	70.8	79.9

4.4 DEMONSTRATION SITE EVALUATIONS

4.4.1 DITCHLINE SITES

The fifth evaluation of the ditchline sites occurred in 2004 (Table 6). In the first two years of evaluation, the agronomic mixture produced more ground cover than the native mixture on LS100, while the native grasses produced more ground cover on RMn. However, in 2002 and 2003 the native grass mixture produced more ground cover on both sites. This occurred because two selections, tufted hairgrass (*Deschampsia cespitosa*) and a native subspecies of red fescue (*Festuca rubra* ssp *arenicola*), which are slower to develop than most agronomic species, now had large plants on LS100. There were also some large plants of blue wild rye (*Elymus glaucus*) on LS100 but very few agronomic grasses. On Site RMn, blue wild rye (*Elymus glaucus*) was the dominant species with additional cover provided by Alaska brome (*Bromus sitchensis*). The most successful agronomic species on RMn in 2003 were timothy (*Phleum pratense*) and red fescue (*Festuca rubra*).

The 2004 evaluation indicated a decrease in seeded ground cover on both sites. In particular, there was a large decrease on the RMn site. This occurred because the thimbleberry (*Rubus parviflorus*) plants, which had been cut to ground level for safety reasons just prior to seeding, are now again fully grown plants which are shading out the herbaceous species. Individual species prominence in 2004 was similar to that discussed above for the 2003 evaluation.

TABLE 5. MEAN INDIVIDUAL SPECIES GROUND COVER PRODUCTION ON THE OPERATIONAL SITES					
	Ground Cover (%)				
Species	Year				
	2001	**2002**	**2003**	**2004**	**2005**
***Agrostis exarata*#10**	0.3	0.0	0.8	4.4	4.0
***Agrostis scabra*#61**	5.5	2.5	7.1	0.7	0.7
***Bromus sitchensis*#45**	9.1	13.2	10.4	9.2	6.3
***Calamagrostis stricta*#84**	0.7	4.9	1.8	0.5	0.1
***Deschampsia cespitosa*#30**	0.4	0.1	0.0	0.1	1.0
***Deschampsia elongata*#13**	8.4	9.0	1.4	0.7	0.3
***Elymus glaucus*#20**	3.1	9.0	17.9	17.8	22.1
***Elymus trachycaulus*#40**	0.0	0.1	0.1	0.0	0.0
Festuca rubra* ssp *arenicola*#91	10.6	14.4	39.1	40.6	46.1
Festuca rubra* ssp *pruinosa*#56*	1.1	6.4	1.2	3.8	5.0
***Poa compressa*#83**	0.6	0.1	0.3	0.0	0.3
Trifolium hybridum	2.8	3.9	0.9	0.5	0.3
Trifolium pratense	0.1	0.0	0.1	0.1	0.4
Trifolium repens	0.1	0.0	0.2	4.0	4.3

*Only seeded at sites Wd101, SiSk and Br31Y
** Only seeded at sites TahE1, LeCk and NiLk

TABLE 6. GROUND COVER ON THE DITCHLINE SITES										
	GRASSES ALONE									
	Ground Cover (%)									
SITE	Native Mixture					Agronomic Mixture				
	2000	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
LS100	9.7	11.3	30.0	32.5	28.1	16.6	20.9	11.5	9.4	1.3
RMn	43.7	54.0	46.9	46.9	7.2	29.9	24.7	42.2	28.8	9.1
	GRASSES + LEGUMES									
	Ground Cover (%)									
SITE	Native Mixture					Agronomic Mixture				
	2000	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
LS100	9.7	16.0	32.8	32.5	28.1	16.6	25.0	18.8	20.3	16.3
RMn	48.7	54.6	61.6	46.9	7.2	46.6	26.9	42.8	32.5	9.4

4.4.2 DEACTIVATED ROAD SITES

Evaluation of the deactivated road sites was completed in 2003. These sites are not amenable to statistical analysis because they are unique and have no true replication. Ground cover percentages are found below in Table 7. In the early years of evaluation the native grass seed mixture produced more ground cover than the agronomic mixture on sites Had390, PW1000A and Ash200 while the agronomic mixture produced more cover site LS120. In 2003, the native

seed mixture produced more cover on each site. On sites Had390 and PW1000A, there was a shift in individual species prominence among the three native grasses in the seed mixture. In 1999, the Alaska brome (*Bromus sitchensis*) produced the most ground cover, followed by blue wild rye (*Elymus glaucus*), with comparatively little tufted hairgrass (*Deschampsia cespitosa*). In 2000, these three grasses produced similar amounts of ground cover. However, from 2001 to 2003, the tufted hairgrass (*Deschampsia cespitosa*) was clearly dominant, and the Alaska brome (*Bromus sitchensis*) was least successful. On Site Ash200 the dominant species in 2003 was blue wild rye (*Elymus glaucus*) while on site LS120, the indigenous subspecies of red fescue (*Festuca rubra* ssp *arenicola*) was clearly dominant.

Species prominence on the agronomic grass plots has remained constant throughout the course of the program. Red top (*Agrostis gigantea*) and red fescue (*Festuca rubra*) have consistently been the most successful species. However, there were some surviving Canada bluegrass (*Poa compressa*) plants on sites PW1000A and LS120, and some timothy (*Phleum pratense*) plants on site PW1000A in 2003.

TABLE 7. GROUND COVER ON THE DEACTIVATED ROAD SITES

GRASSES ALONE										
Ground Cover (%)										
SITE	**Native Mixture**					**Agronomic Mixture**				
	1999	**2000**	**2001**	**2002**	**2003**	**1999**	**2000**	**2001**	**2002**	**2003**
Ash200	16.6	40.9	38.4	44.1	54.1	7.2	23.8	33.5	27.5	49.7
PW1000A	20.9	14.5	30.7	34.7	48.4	37.8	18.8	20.2	13.8	38.8
Had390	27.6	70.6	63.7	59.4	48.4	45.3	32.4	32.1	31.3	9.1
LS120	----	18.8	25.3	12.5	25.9	----	22.8	33.8	18.1	25.9
GRASSES + LEGUMES										
Ground Cover (%)										
SITE	**Native Mixture**					**Agronomic Mixture**				
	1999	**2000**	**2001**	**2002**	**2003**	**1999**	**2000**	**2001**	**2002**	**2003**
Ash200	22.2	61.8	58.4	45.0	54.1	21.9	40.7	66.3	43.1	49.7
PW1000A	33.7	56.2	65.7	36.6	48.4	42.8	46.6	57.7	29.7	54.7
Had390	41.4	86.9	66.5	60.0	48.4	48.1	52.6	52.1	32.5	9.1
LS120	----	19.1	25.3	12.5	25.9	----	22.8	33.8	18.1	25.9

4.4.3 KayRd (PARKSVILLE)

The majority of the evaluation of this site was completed in 2003; and the final evaluation of Seed Mixture #5 was undertaken in 2004. Results from this site were consistently stronger than results from the replicated trial sites. This occurred because this site has a better growth medium than the replicated trial sites. It is less compacted and has more mineral soil. This site has now been sold, and will be part of a housing development in the future. However, the results from the six years of the program clearly support the use of native grasses in restoration of disturbed sites in the central section of Vancouver Island (Table 8). The most successful agronomic grass was red fescue (*Festuca rubra*). This rhizomatous species continued to increase in cover and is now clearly dominant on the agronomic seed plot. Red top (*Agrostis gigantea*) and Canada bluegrass (*Poa compressa*) still had some plants on this plot, although both decreased in ground cover production over time.

On the native grass plots the most successful species were Alaska brome (*Bromus sitchensis*), blue wild rye (*Elymus glaucus*), and two subspecies of red fescue (*Festuca rubra* ssp *arenicola* and *F. rubra* ssp *pruinosa*). Also, while hair bentgrass (*Agrostis scabra*) was eliminated from the Native Seed Mixture #1 plot, it still provided significant ground on the Native Seed Mixture #4 plot in 2003. Slender hairgrass (*Deschampsia elongata*), which was successful in the early years of the program, was eliminated from this site.

The site is now overgrown by Colonial bentgrass (*Agrostis capillaris*), Scotch broom (*Cytisus scoparius*) and cat's ears (*Hypochaeris radicata).* Nonetheless, while this suggests that native grasses cannot eliminate invasion by introduced species, they can delay such invasion. Specifically, it took six years for the introduced species to become a major factor on these plots, but directly adjacent to the plots, the same introduced species have had a very significant presence since 2001.

TABLE 8. GROUND COVER ON THE PARKSVILLE DEMONSTRATION SITE

	Ground Cover (%)					
Mixture	**GRASSES ALONE**					
	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Agronomic	23.7	42.6	35.3	50.3	46.9	-----
Native #1	24.3	41.0	52.5	49.7	37.2	-----
Native #2	17.5	29.9	52.5	56.3	64.7	-----
Native #3	30.0	46.6	46.6	54.4	72.5	-----
Native #4	22.1	22.9	44.4	34.8	31.9	-----
Native #5	-----	35.6	40.3	45.3	68.8	56.3
	GRASSES + LEGUMES					
	1999	**2000**	**2001**	**2002**	**2003**	**2004**
Agronomic	27.1	42.6	35.3	50.3	46.9	-----
Native #1	27.4	41.9	52.8	49.7	37.2	-----
Native #2	22.0	30.5	52.5	56.3	64.7	-----
Native #3	33.4	47.9	46.6	54.4	72.5	-----
Native #4	24.0	24.2	44.4	35.1	31.9	-----
Native #5	-----	38.4	40.3	45.3	61.8	56.3

4.4.4 ErMn (CAMPBELL RIVER)

There was a marked change in ground cover production on this site in 2003. In previous years all three seed mixtures had been very successful. However, in 2003, while both the native grass mixture and the naturalized land race mixture remained very successful, the agronomic seed mixture was nearly eliminated from the site. This occurred because both the native grasses and the naturalized land races seeded themselves into the agronomic mixture plot, and crowded out the agronomic grasses. On the agronomic mixture plot, only the red top (*Agrostis gigantea*) still provided cover of more than 1%. Velvet grass (*Holcus lanatus*) and tall oatgrass (*Arrhenatherum elatius*) provided the vast majority of the cover on the naturalized land race plot, while a native red fescue (*Festuca rubra* ssp *arenicola*) was dominant on the native grass plot. Other successful species on the native grass plot were spike bentgrass (*Agrostis exarata*) and blue wild rye (*Elymus glaucus*).

In 2004, the native seed mixture plot retained the highest amount of seeded cover. However, both this plot, and the naturalized land race plot had very large decreases in seeded cover. This occurred because all plots have now been invaded by introduced species such as Scotch broom (*Cytisus scoparius*) and Colonial bentgrass (*Agrostis capillaris*), and various native sedges (*Carex* spp.) and rushes (*Juncus* spp.). Results are found in Table 9.

TABLE 9. GROUND COVER ON THE CAMPBELL RIVER DEMONSTRATION SITE

Mixture	Ground Cover (%)				
	2000	**2001**	**2002**	**2003**	**2004**
Agronomic	54.7	58.1	58.4	6.6	3.8
Naturalized Land Race	42.5	67.0	67.5	67.5	18.8
Native	46.5	62.9	75.0	66.9	27.8

4.4.5 BBRS (BUCKLEY BAY)

The Buckley Bay site, seeded in the fall of 1999, was inadvertently overseeded to agronomic grasses by contractors working for the Ministry of Transportation and Highways in the following month. However, the native grasses crowded out nearly all of these agronomic grasses. This development, first apparent in 2001 and 2002, was even more pronounced in the following two years. This site had an extremely high level of native grass ground cover in the last three years of evaluation. This will not be sustained in the future because the site has now been invaded by scotch broom (*Cytisus scoparius*), which will eventually shade out most of the existing grasses. However, over the course of the program this site has provided an excellent demonstration of the viability of seeding native grasses to disturbed areas. Cover percentages of the native grass mixtures are found in Table 10.

TABLE 10. GROUND COVER ON THE BUCKLEY BAY DEMONSTRATION SITE

Mixture	Ground Cover (%)									
	GRASSES ALONE					**GRASSES + LEGUMES**				
	2000	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
Native #1	11.2	28.1	52.5	83.4	87.2	54.4	69.4	69.1	83.4	87.2
Native #2	4.1	24.3	51.6	87.5	93.8	40.7	54.0	76.6	87.5	93.8
Native #3	34.3	33.7	40.6	85.3	85.0	64.0	68.1	79.1	85.3	85.0
Native #4	32.6	26.6	64.7	84.1	81.2	58.3	58.8	75.3	84.1	81.2
Native #5	8.7	45.0	69.7	84.1	85.0	36.5	71.6	74.1	84.1	85.0

Ground cover on this site at the time of the final evaluation was dominated by six selections. These were both selections of Alaska brome (*Bromus sitchensis*), both selections of blue wild rye (*Elymus glaucus*), and two indigenous subspecies of red fescue (*Festuca rubra* ssp *arenicola* and *F. rubra* ssp *pruinosa*). The other native grasses were marginally represented, but some plants of Canada bluegrass (*Poa compressa*) were present on the Native Mixture #4 plot, while the Native Mixture #5 plot contained some meadow barley (*Hordeum brachyantherum*). Two short-lived perennials, slender hairgrass (*Deschampsia elongata*) and hair bentgrass (*Agrostis scabra*), that were successful in the early years, failed to survive the course of the program. This is similar to their behaviour in the wild, as they seldom survive more than three years in nature.

4.4.6 HdBay (PORT HARDY)

This site is on a deactivated logging road in Hardy Bay that is submerged during high tide. Thus, the seed mixture used comprises three native grasses that are found on the beaches of Vancouver Island. First-year results in 2001 indicated some success with tufted hairgrass (*Deschampsia cespitosa*) and spike bentgrass (*Agrostis exarata*), but no success with meadow barley (*Hordeum brachyantherum*). The increase in ground cover in 2002 indicated that the tufted hairgrass and spike bentgrass were developing into mature plants. This trend continued from 2003 to 2005. The meadow barley was not successful. Ground cover percentages are found in Table 11.

TABLE 11. GROUND COVER ON THE HARDY BAY DEMONSTRATION SITE

Species	Ground Cover (%)				
	2001	**2002**	**2003**	**2004**	**2005**
***Agrostis exarata*#52**	8.1	11.6	18.1	11.6	14.8
***Deschampsia cespitosa*#30**	14.4	21.9	39.4	42.8	43.4
***Hordeum brachyantherum*#7**	0.3	0.0	0.0	0.0	0.0

4.4.7 Bl854 – FERTILIZER TRIAL

This site is unique within the program. When the site was offered to the author for use, its availability could only be guaranteed for two years because the land was projected to be used as the site of a future forestry office building. Thus, it was not suitable as the location of a replicated trial site as the replicated sites needed evaluation for five years. Consequently, a one-time fertilizer trial was established at this location. Four plots were established in 1999 using methodology identical to that used for the replicated trial sites (Section 3.3). These consisted of a plot seeded to Native Seed Mixture #2, a plot seeded to Native Seed Mixture #3, and two control plots seed to the Agronomic Seed Mixture. In each case one half of each plot was fertilized with the standard fertilization used throughout the program; and the other half of each plot received twice this amount of fertilizer at the time of seeding. As it turned out, the forestry office building was not constructed, so five years of data were recorded from this site.

The first three years of evaluation, from 1999 to 2001 showed inconsistent results. On the native seed plots there was no consistent correlation between fertilization rate and ground cover production on the plot seeded to Native Seed mixture #2. There was a consistent increase in ground cover production on the double fertilized side of the plot seeded to Native Seed Mixture #3. However, this increase was entirely attributable to the increase in cover production from one species, slender hairgrass (*Deschampsia elongata*). On the Agronomic Seed Mixture plots there was no consistent correlation between fertilization rate and ground cover in the first three years. The 2002 and 2003 evaluations indicated that the effect of the extra fertilization was no longer discernible. Despite the extra fertilization, the slender hairgrass, which is a short-lived perennial, had largely died.

The most successful grasses on the native seed plots were Alaska brome (*Bromus sitchensis*), tufted hairgrass (*Deschampsia cespitosa*), blue wild rye (*Elymus glaucus*), a Vancouver Island red fescue (*Festuca rubra* ssp *pruinosa*), and, in the early years, slender hairgrass (*Deschampsia elongata*). Red top (*Agrostis gigantea*) and red fescue (*Festuca rubra*) were most prominent on the agronomic grass seed plots.

TABLE 12. GROUND COVER ON THE FERTILIZER TRIAL SITE										
	Ground Cover (%)									
Seed Mixture	**GRASSES ALONE**					**GRASSES + LEGUMES**				
	1999	**2000**	**2001**	**2002**	**2003**	**1999**	**2000**	**2001**	**2002**	**2003**
Agronomic – Fert. 1	13.7	26.9	6.9	30.0	68.1	23.1	30.1	32.5	31.9	76.9
Agronomic – Fert. 2	16.3	50.0	18.8	38.7	38.7	22.5	59.4	41.3	51.3	59.4
Agronomic – Fert. 1	11.9	12.5	13.2	28.1	42.5	26.3	25.0	30.7	50.0	42.5
Agronomic – Fert. 2	11.8	16.3	11.3	23.8	45.0	25.0	38.8	48.2	40.7	48.2
Native #2 – Fert. 1	10.6	11.3	28.1	15.0	53.1	21.2	43.8	44.4	37.5	52.5
Native #2 – Fert. 2	8.8	25.6	26.3	32.5	66.3	28.8	37.5	65.7	49.4	71.3
Native #3 – Fert. 1	18.2	13.0	11.3	16.3	50.0	24.4	35.1	37.0	40.0	63.8
Native #3 – Fert. 2	27.1	20.6	18.2	15.0	33.7	40.7	53.1	52.6	46.3	53.8

4.5 GERMINATION TESTS

In 1999 and 2000, germination tests were carried out on most potential Seed Production Plot candidates. These tests were undertaken over four week periods by an independent laboratory, Yellow Point Propagation Ltd., of Ladysmith, B.C. Results are found in Table 13.

TABLE 13. GERMINATION PERCENTAGES OF NATIVE GRASSES			
Selection	**Germination %**	**Selection**	**Germination %**
Bromus ciliatus #35	72.00	*Bromus sitchensis #45*	78.25
Bromus sitchensis #48	90.00	*Calamagrostis nutkaensis#1*	16.00
Deschampsia cespitosa #30	60.00	*Deschampsia cespitosa #51*	17.00
Deschampsia elongata #13	96.00	*Deschampsia elongata #72*	100.00*
Elymus glaucus #17	95.00	*Elymus glaucus #20*	91.50
Elymus hirsutus #28	94.50	*Elymus trachycaulus #40*	86.00
Festuca idahoensis #116	19.50	*Festuca rubra #56*	51.25
Festuca rubra #91	53.25	*Glyceria elata #76*	73.75
Hordeum brachyantherum #7	48.00**	*Hordeum brachyantherum #7*	90.50***
Leymus mollis #15	53.25	*Phleum alpinum #97*	7.50

* Don Pigott of Yellow Point Propagation Ltd. informed the author that this may a touch high because of a possible error by one of his technicians.
** 1998 harvest; 1999 test
*** 1999 harvest, 2000 test

4.6 SEED PRODUCTION PLOTS

The Seed Production plots were very successful from 2000 to 2002. However, in the last three years of the program seed production was minimal (Table 14). This occurred because most of the plots were established in 1999 and had reached the stage where they were sod-bound and produced little seed. This development is normal for agronomic species as most grass seed production fields are ploughed under and reseeded after four or five years. It is evident that this will be the appropriate course of action for these native species in the future.

TABLE 14. SEED PRODUCTION ON THE DAWSON CREEK PLOTS HARVESTED BY COMBINE

Selection	kg/ha					
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
***Bromus sitchensis*#45**	657.8	448.5	837.2	189.9	130.6	------
***Bromus sitchensis*#48**	1,196.0	523.3	583.1	162.8	116.1	179.4
***Elymus glaucus*#17**	49.8	29.9	59.8	------	------	------
***Elymus glaucus*#20**	19.9	------	142.0	------	4.4	104.7
***Elymus trachycaulus*#40**	357.0	357.0	100.9	------	43.5	224.3
***Festuca rubra* ssp *arenicola*#91**	------	------	14.9	------	14.5	------
***Poa compressa*#83**	------	358.8	52.3	135.6	17.4	74.8

5.0 DISCUSSION

The final year of this ten-year applied research project has now been successfully completed. Fill-planting, maintenance and harvesting of the Seed Increase Nursery was carried out as needed. All replicated trial sites had been evaluated for five years prior to 2005. Biometric analysis of data from these sites indicated that the native grasses consistently provided ground cover comparable to that obtained with introduced agronomic grasses (Section 4.2; Table 3). The final evaluation of demonstration sites took place in 2005. The goal was to obtain five years of data, and all replicated and demonstration sites were evaluated for five years.

All of the large operational sites established from 2000 to 2003 had very high levels of ground cover production throughout the term of the program. The very successful performance of the native grasses on these large sites will have a significant bearing on how readily native grasses will be accepted and ordered by reclamation managers. Also of interest was the performance of the native grasses on projects undertaken by other organizations, using seed from this program. While I only visited the projects that were on my direct travel routes to sites within the program, each project that I did see was very successful, and I have not had any reports of poor success on projects I did not visit.

On the Dawson Creek Seed Production plots two important details were identified. First, it is highly probable that the slow recovery of many plots in the spring of 2003 was caused by excessive removal of the herbage during the harvesting of 2002. This was corrected in the summer of 2003 by raising the height of the swather in the first step of the harvesting operation. Consequently, in 2004 the plants recovered from winter dormancy at a much faster rate than in 2003, and were much more vigorous. The other problem that was encountered in 2003 was the infestation of silver top on the Canada bluegrass (*Poa compressa*). This insect-caused disease was thwarted in 2004 by spraying the plants with an insecticide (Matador) at the start of seed-set. However, seed production on all plots was only minimally successful in 2004 and 2005. Most plots were in their sixth or seventh year of existence, and, at this age, many species tend to become sod-bound and produce little seed. In field-scale production of agronomic grass seed, most fields are eliminated and reseeded after four or five years. It is evident that this is also the appropriate strategy for native grass seed production in the Peace River region.

Many Seed Production plots in Dawson Creek were successful in different years, as winterkill was not a problem. However, the quantity of seed production varied from year to year. The reason for this cannot be stated with any certainty. The periodic lack of seed set on otherwise very healthy plants could well be associated with the differences in photosynthetic regime between the Peace River region and the normal west coast range of the candidate plants. On the coast the plants have more days of sunshine during the growing season, but have less hours of daylight per day than they do near Dawson Creek. This difference may influence the amount of seed set.

Thus, while it is clear that seed can be grown in the Peace River region; it is also clear that field-scale production must occur in a region where seed production is consistent from year to year. Now that the program has concluded, the agricultural economics component is the highest priority for the future large-scale use of the native grasses in west coast reclamation. Cost of the seed to the large-scale end user must be addressed prior to acceptance of recommendations that native grasses be used in restoration programs. This is a function of land costs and the amount of seed that can be grown per hectare. Commercial production of native grass seed will not occur on Vancouver Island or the Lower Mainland/Fraser Valley because the cost of land is prohibitive. Also, there is neither the expertise nor the infrastructure that is required for such seed production in southwest British Columbia. Thus, if **consistent** seed production cannot be attained in the Peace River region, then the logical seed production venue is in the northwest United States – in particular, Oregon, where a seed production industry currently exists, and higher rates of seed production are possible.

The program was completed as planned, and seed merchants have expressed some interest in growing and marketing the native grasses after completion of the program. One major seed merchant initiated seed multiplication in September, 2004 with six promising selections, and field-scale production may start in the spring of 2006 with four of these selections (*Bromus sitchensis*, *Deschampsia cespitosa*, *Deschampsia elongata* and *Elymus glaucus*). Also, they will complete their multiplication efforts with both indigenous subspecies of red fescue (*Festuca rubra* ssp *arenicola* and *F. rubra* ssp *pruinosa*) in 2006, with the goal of a start to field-scale seed production in 2007. Five other selections (*Agrostis exarata*, *Agrostis scabra*, *Bromus carinatus*, *Calamagrostis stricta* and *Poa compressa*) were also transferred to them in 2005, and seed multiplication was started in Oregon in the fall of 2005.

6.0 CONCLUSIONS

6.1 REVEGETATION SUCCESS

Results from the replicated trial sites, demonstration sites and operational sites throughout the course of the program indicated that the use of grasses that are native to the west coast of British Columbia resulted in both short and long-term ground cover production similar to, or greater, than ground cover production attained through the use of introduced, agronomic species. Thus, successful reclamation will occur with the use of native species on the west coast of British Columbia.

6.2 SEEDING AND FERTILIZATION RATES

At present there is a very wide range in reclamation seeding rates on the west coast. Usually these range from 50 to 65kg/ha with agronomic grasses; but may approach 100kg/ha in some cases. The strong results from this program indicate that, with native grasses, successful reclamation will occur with seeding rates of 35 to 50kg/ha.

A balanced fertilizer (e.g. 18-18-18), applied at 250kg/ha, is appropriate for seeding with native grasses on the west coast. A higher rate is not beneficial, and it is highly probable that lower rates can be successfully utilized. Small areas, seeded by hand, may not require any fertilization.

6.3 LOCATION OF SEED PRODUCTION

Seed production of west coast native grasses is possible in the Peace River region of British Columbia, as winterkill is not a problem. However, the inconsistent results indicate that large-scale seed production must occur in more southerly regions to ensure that prices to the end-users are consistent, and not excessively high. Since seed production will not occur on Vancouver Island or the adjacent Mainland Coast, because of the cost of land in southwestern British Columbia, the optimal location for large-scale seed production is in the Willamette River valley in Oregon. This latter area is one of the major grass seed production locations in the world. As such, the land and infrastructure are in place, and much higher and more consistent seed production rates can be achieved there than in the Peace River region of Canada.

6.4 SEED MIXTURE RECOMMENDATIONS

At this time, a general native grass seed mixture for reclamation on the west coast of British Columbia can only include those species for which seed multiplication has been successfully started. This mixture is found below in Table 15.

TABLE 15. CURRENT RECOMMENDATIONS FOR WEST COAST RESTORATION WITH NATIVE GRASSES

Botanical Name	Common Name	% by Weight
Bromus sitchensis	Alaska bromegrass	30
Deschampsia cespitosa	Tufted hairgrass	10
Deschampsia elongata	Slender hairgrass	10
Elymus glaucus	Blue wild rye	30
Festuca rubra ssp *arenicola**	Red fescue	10
Festuca rubra ssp *pruinosa**	Red fescue	10

*If both of these subspecies are available in quantity, only ssp *arenicola* should be used on the east coast of Vancouver Island and on the Mainland Coast, and only ssp *pruinosa* should be used on the west coast of Vancouver Island, because they are endemic to the east and west coasts of Vancouver Island, respectively. Either should be included at 20% by weight. If these are only minimally available, then they should be combined as shown in Table 15.

6.5 FUTURE ADDITIONS TO THE WEST COAST REVEGETATION MIXTURE

Other candidates for inclusion in west coast restoration mixtures are *Agrostis exarata*, *Agrostis scabra*, *Bromus carinatus*, *Calamagrostis stricta* and *Poa compressa*. Seed multiplication was initiated for these species in the fall of 2005, but results with this multiplication are unknown at this time. If these species are available in quantity in the future, the following substitutions should be made:

Agrostis scabra: If available, this species should be included at 5% by weight, and *Deschampsia elongata* should be reduced from 10% to 5% by weight. Both of these species provide rapid cover, and an optimal mixture would include both.

Bromus carinatus: If available, this species should be substituted for *Bromus sitchensis* on all projects that are in the Coastal Douglas Fir biogeoclimatic zone since it is the more prevalent brome in the CDFmm zone.

Agrostis exarata and ***Poa compressa***: If available, these species should be included at 5% by weight, and *Bromus sitchensis* and *Elymus glaucus* should be reduced to 25% by weight. *Agrostis exarata*, which spreads by rooting from the nodes of its culms, and *Poa compressa*, which spreads by rhizomes, are low-growing, sod-forming grasses. Thus, while they cannot completely thwart the establishment of invasive species, they do have the potential to delay and reduce the presence of undesirable species. The minimization of invasive species is one of the major considerations in future Forest Stewardship plans.

Calamgrostis stricta: If available, this species should be included at 5% by weight; and *Bromus sitchensis* should be reduced by 5% by weight on hygric sites, while *Deschampsia cespitosa* should be reduced by 5% by weight on xeric/mesic sites.

6.6 FUTURE INITIATIVES

With the completion of this program there is a legacy from the previous ten years of work.

a) Seed multiplication of eleven species has been initiated. This is a prelude to commercial seed production in the near future.
b) Using seed donated by the author, Malaspina College in Nanaimo is establishing a small demonstration garden including all species in the Seed Increase Nursery in 2005, and some others that were not successful in this program.
c) Using seed donated by the author, the Cowichan Tribes First Nations are also establishing a demonstration garden of the native grasses, which may also serve as a source of native seed for their own projects.
d) The University of British Columbia Botanical Garden in Vancouver, British Columbia is in the process of creating a "Garry Oak Ecosystem" grass meadow on their land. Seed of six 'Garry Oak' grasses was donated by the author to this project.
e) The use of native grass seeds has been included in Forest Stewardship Plans as a tool for assistance in invasive plant management.

7.0 REFERENCES

Berger, T.R. 1977. Northern Frontier Northern Homeland. The Report of the Mackenzie Valley Pipeline Inquiry. Volume Two Terms and Conditions. Ministry of Supply and Services Canada. 268pp.

Clayoquot Sound Scientific Panel. 1995. Sustainable ecosystem management in Clayoquot Sound - planning and practices. 245pp.

Coast Information Team. 2004. Ecosystem-based management planning handbook. 80pp.

Daubenmire, R. 1959. A canopy-cover method of vegetational analysis. Northwest Science; 33:43-64.

Daubenmire, R. 1968. Plant Communities – A Textbook of Plant Synecology. Harper & Row Publishers; New York, Evanston, and London. 300pp.

Hill, T., C.E. Kennedy and D. Murray (eds). 1996. Guidelines for Reclamation/Revegetation in the Yukon: Volume Two. Department of Renewable Resources. Government of Yukon. pp 180 -266pp.

Kennedy, C.E. (ed). 1993. Guidelines for Reclamation/Revegetation in the Yukon: Volume One. Department of Renewable Resources. Government of Yukon. pp 1-179.

Native Plant Working Group. 2000. Native plant revegetation guidelines for Alberta. H. Sinton-Gerling (ed.), Alberta Agriculture, Food and Rural Development and Alberta Environment. Edmonton, Alberta. 13pp + appendices.

Vaartnou, M. 2001. Establishment of a native seed industry for the west coast of Vancouver Island. Final report – 1996/2001. Prepared for Forest Renewal British Columbia. 26pp + Appendices.

Vaartnou, M. 2002. Establishment of a native seed industry for the west coast of Vancouver Island. Final report – 2001/02. Prepared for International Forest Products Ltd., Weyerhaeuser Company Ltd., TimberWest Forest Ltd. and Western Forest Products Ltd. 22pp + Appendices.

Vaartnou, M. 2003. Establishment of a native seed industry for the west coast of Vancouver Island. Final report – 2002/03. Prepared for International Forest Products Ltd., Weyerhaeuser Company Ltd., TimberWest Forest Ltd., Western Forest Products Ltd. and Canadian Forest Products Ltd. 22pp + Appendices.

Vaartnou, M. 2004. Establishment of a native seed industry for the west coast of British Columbia. Final report – 2003/04. Prepared for International Forest Products Ltd., Weyerhaeuser Company Ltd., and Western Forest Products Ltd. 24pp + Appendices.

Vaartnou, M. 2005. Establishment of a native seed industry for the west coast of British Columbia. Final report – 2004/05. Prepared for International Forest Products Ltd., Weyerhaeuser Company Ltd., and Western Forest Products Inc. 22pp + Appendices.

APPENDIX A - BOTANICAL AND COMMON NAMES OF NATIVE GRASSES

BOTANICAL NAME*	COMMON NAME
Agrostis exarata Trin.	Spike bentgrass
Agrostis idahoensis Nash .	Idaho bentgrass
Agrostis scabra Willd.	Hair bentgrass
Alopecurus aequalis Sobol	Short-awn foxtail
Bromus carinatus Hook. & Arn.	California bromegrass
Bromus ciliatus L.	Fringed bromegrass
Bromus sitchensis Trin.	Alaska bromegrass
Bromus vulgaris (Hook.) Shear.	Columbia bromegrass
Calamagrostis nutkaensis (J.S. Presl in C.B. Presl) Steud.	Pacific reedgrass
Calamagrostis stricta (Timm) Koel.	Slimstem reedgrass
Danthonia californica Boland.	California oatgrass
Danthonia intermedia Vasey	Timber oatgrass
Danthonia spicata (L.)Beauv. ex Roem. & Schult.	Poverty oatgrass
Deschampsia cespitosa (L.) Beauv.	Tufted hairgrass
Deschampsia elongata (Hook.) Munro ex. Benth.	Slender hairgrass
Elymus glaucus Buckley	Blue wild rye
Elymus hirsutus J.S. Presl in C.B. Presl	Hairy wild rye
Elymus trachycaulus (Link) Gould in Shinners	Slender wild rye
Festuca idahoensis var. *roemeri* Pavl.	Roemer's fescue
Festuca rubra ssp *pruinosa* (Hack.) Piper	Red fescue
Festuca rubra ssp. *arenicola* Alexeev	Red fescue
Festuca subulata Trin. in Bong.	Bearded fescue
Glyceria elata (Nash) M.E. Jones	Tall mannagrass
Hierochloe odorata (L.) Beauv.	Sweetgrass
Hordeum brachyantherum Nevski	Meadow barley
Koeleria macrantha (Ledeb.) J.A. Schultes f.	Junegrass
Leymus mollis (Trin. in Spreng.) Pilger	Dune wild rye
Melica harfordii Boland	Harford's melic
Melica subulata (Griseb. in Ledeb.) Scribn.	Alaska oniongrass
Panicum occidentale Scribn.	Western witchgrass
Phleum alpinum L.	Alpine timothy
Poa compressa L.	Canada bluegrass
Stipa lemmonii (Vasey) Scribn.	Lemmon's needlegrass
Trisetum spicatum (L.) Richt.	Spike trisetum
Vahlodea atropurpurea (Wahlenb.) Fries in Hartm.	Mountain hairgrass

* Nomenclature follows: The Vascular Plants of British Columbia Part 4 – Monocotyledons. 1994. Eds. G.W. Douglas, G.B. Straley and D. Meidinger. Ministry of Forests Research Program. 257pp.

APPENDIX B – SITE LOCATIONS

NATIVE GRASS SEED MIXTURE #1 – established, fall 1997

Location	Company	Division
Tur 200	Weyerhaeuser Company	Sproat Lake
M3A	International Forest Products	Ucluelet
Bn100	Weyerhaeuser Company	Franklin River
N500	Western Forest Products	Jordan River

NATIVE GRASS SEED MIXTURE #2 – established fall, 1998

Location	Company	Division
561A	Western Forest Products	Holberg
M24A	Weyerhaeuser Company	Port McNeill
M3B	International Forest Products	Ucluelet
J059	TimberWest Forest	Mesachie Lake
AMsp2	TimberWest Forest	Oyster River

NATIVE GRASS SEED MIXTURE #3 – established, fall 1998

Location	Company	Division
561B	Western Forest Products	Holberg
M24	Weyerhaeuser Company	Port McNeill
J059	TimberWest Forest	Mesachie Lake
AMsp2	TimberWest Forest	Oyster River
AMsp1	TimberWest Forest	Oyster River

NATIVE GRASS SEED MIXTURE #4 – established fall, 1998

Location	Company	Division
M3B	International Forest Products	Ucluelet
Bn140	Weyerhaeuser Company	Franklin River
J059	TimberWest Forest	Mesachie Lake
AMsp2	TimberWest Forest	Oyster River
Amsp1	TimberWest Forest	Oyster River

NATIVE GRASS SEED MIXTURE #1 – established spring, 1999

Location	Company	Division
M3B	International Forest Products	Ucluelet
M24	Weyerhaeuser Company	Port McNeill
Br640	TimberWest Forest	Middlepoint

NATIVE GRASS SEED MIXTURE #5 – established fall, 1999

Location	Company	Division
M3B	International Forest Products	Ucluelet
Br620	TimberWest Forest	Middlepoint
M24A	Weyerhaeuser Company	Port McNeill
SH210a	Western Forest Products	Jordan River
SH210b	Western Forest Products	Jordan River

DEACTIVATED ROAD GRASS SEED MIXTURE #1 – established spring, 1999

Location	Company	Division
Had390	Weyerhaeuser Company	Franklin River
PW1000A	Weyerhaeuser Company	North Island
Ash200	Weyerhaeuser Company	Sproat Lake

DEACTIVATED ROAD GRASS SEED MIXTURE #2 – established spring, 2000

Location	Company	Division
LS120	International Forest Products	Ucluelet

LARGE OPERATIONAL SITES

Location	Company	Division
Wd101	Weyerhaeuser Company	Sproat Lake
TahE1	Western Forest Products	Gold River
SiSk	International Forest Products	Hope
Br31Y	Weyerhaeuser Company	Sproat Lake
LeCk	TimberWest Forest	Honeymoon Bay
NiLk	Canadian Forest Products	Englewood

DEMONSTRATION SITES ON FORESTRY LAND

Location	Company	Division
Bl854	TimberWest Forest	Oyster River
KayRd	Weyerhaeuser Company	Northwest Bay
ErMn	TimberWest Forest	Oyster River
RMn	Western Forest Products	Port McNeill
LS100	International Forest Products	Ucluelet

OTHER DEMONSTRATION SITES

Name	Organization	Location
BBRS	BC Transportation & Highways	Buckley Bay
HdBay	District of Port Hardy	Port Hardy

APPENDIX C – COMPOSITION OF THE SEED MIXTURES

LARGE OPERATIONAL SITE MIXTURES

Species	gm	%
Grasses		
Agrostis exarata #10	60	1.20
Agrostis scabra #61	60	1.20
Bromus sitchensis #45	1000	20.00
Calamagrostis stricta #84	100	2.00
Deschampsia cespitosa #30	100	2.00
Deschampsia elongata #13	100	2.00
Elymus glaucus #20	1000	20.00
Elymus trachycaulus #40	150	3.00
Festuca rubra ssp *pruinosa* #56*	780	15.60
Festuca rubra ssp *arenicola* #91**	780	15.60
Legumes		
Trifolium hybridum	800	16.00
Trifolium pratense	350	7.00
Trifolium repens	350	7.00

* only seeded at sites TahE1, LeCk and NiLk
**only seeded at sites Wd101, SiSk and Br31Y

REPLICATED TRIAL SITE MIXTURES

AGRONOMIC GRASS SEED MIXTURE

Species	gm	%
Grasses		
Agrostis gigantea	20	6.25
Festuca filiformis	20	6.25
Festuca rubra	60	18.75
Phleum pratense	40	12.50
Poa compressa	20	6.25
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

NATIVE GRASS SEED MIXTURE #1

Species	gm	%
Grasses		
Agrostis scabra #43	20	6.25
Bromus sitchensis #45	40	12.50
Danthonia californica #37	20	6.25
Elymus glaucus #20	40	12.50
Elymus trachycaulus #42	40	12.50
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

NATIVE GRASS SEED MIXTURE #2

Species	gm	%
Grasses		
Bromus richardsonii #35	40	12.50
Danthonia californica #37	20	6.25
Deschampsia cespitosa #30	20	6.25
Elymus glaucus #14	60	18.75
Festuca rubra ssp *pruinosa* #56	20	6.25
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

NATIVE GRASS SEED MIXTURE #3

Species	gm	%
Grasses		
Bromus sitchensis #45	60	18.75
Danthonia californica #37	20	6.25
Deschampsia elongata #13	20	6.25
Elymus hirsutus #36	40	12.50
Festuca rubra ssp *pruinosa* #56	20	6.25
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

NATIVE GRASS MIXTURE #4

Species	gm	%
Grasses		
Agrostis scabra #43	10	3.13
Bromus sitchensis #48	50	15.62
Deschampsia elongata #72	20	6.25
Elymus glaucus #17	50	15.62
Festuca rubra ssp *pruinosa* #56	20	6.25
Poa compressa #83	10	3.13
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

NATIVE GRASS MIXTURE #5

Species	gm	%
Grasses		
Calamagrostis stricta #84	10	3.13
Cinna latifolia #101	10	3.13
Elymus trachycaulus #40	20	6.25
Festuca rubra ssp *arenicola* #91	40	12.50
Glyceria elata #76	40	12.50
Hordeum brachyantherum #7	40	12.50
Legumes		
Trifolium hybridum	100	31.25
Trifolium pratense	40	12.50
Trifolium repens	20	6.25

DEACTIVATED ROAD GRASS MIXTURE #1 (Sites Had390, PW1000A & Ash200)

Species	gm	%
Grasses		
Bromus sitchensis #48	100	20.83
Deschampsia cespitosa #30	40	8.33
Elymus glaucus #14	100	20.83
Legumes		
Trifolium hybridum	150	31.25
Trifolium pratense	60	12.50
Trifolium repens	30	6.25

DEACTIVATED ROAD GRASS MIXTURE #2 (Site LS120)

Species	gm	%
Grasses		
Bromus sitchensis #48	110	22.92
Elymus glaucus #17	110	22.92
Festuca rubra ssp *arenicola* #91	40	8.33
Poa compressa #83	40	8.33
Legumes		
Trifolium pratense	40	8.33
Trifolium repens	140	29.17

DITCH LINE AGRONOMIC GRASS MIXTURE (Site RMn)

Species	gm	%
Grasses		
Agrostis gigantea	100	5.00
Festuca rubra	700	35.00
Phleum pratense	400	20.00
Poa compressa	100	5.00
Legumes		
Trifolium hybridum	**300**	**15.00**
Trifolium pratense	300	15.00
Trifolium repens	100	5.00

DITCH LINE NATIVE GRASS MIXTURE #1 (Site RMn)

Species	gm	%
Grasses		
Agrostis scabra #43	50	2.50
Bromus sitchensis #45	500	25.00
Deschampsia cespitosa #30	100	5.00
Deschampsia elongata #13	100	5.00
Elymus glaucus #17	500	25.00
Festuca rubra ssp *pruinosa* #56	200	10.00
Legumes		
Trifolium hybridum	400	20.00
Trifolium pratense	150	7.50

DITCH LINE AGRONOMIC GRASS MIXTURE (Site LS100)

Species	gm	%
Grasses		
Agrostis gigantea	100	5.00
Festuca rubra	700	35.00
Phleum pratense	400	20.00
Poa compressa	100	5.00
Legumes		
Trifolium hybridum	300	15.00
Trifolium pratense	300	15.00
Trifolium repens	100	5.00

DITCH LINE NATIVE GRASS MIXTURE #2 (Site LS100)

Species	gm	%
Grasses		
Bromus sitchensis #48	500	25.00
Deschampsia cespitosa #51	50	2.50
Elymus glaucus #17	500	25.00
Festuca rubra ssp *arenicola* #91	200	10.00
Poa compressa #83	200	10.00
Legumes		
Trifolium pratense	150	7.50
Trifolium repens	400	20.00

PARKSVILLE SITE (KayRd)

Native grass mixtures #1, #2, #3, #4, #5 and the agronomic control mixture

PORT HARDY SITE (HdBay)

Species	**gm**	**%**
Agrostis exarata #52	60	15.00
Deschampsia cespitosa #30	200	50.00
Hordeum brachyantherum #7	140	35.00

BUCKLEY BAY SITE (BBRS)

Native grass mixtures #1, #2, #3, #4 and #5

CAMPBELL RIVER SITE (ErMn)

Agronomic Grass Seed Mixture

Species	**gm**	**%**
Agrostis gigantea	40	8.33
Festuca filiformis	100	20.83
Festuca rubra	240	50.00
Phleum pratense	100	20.83

Naturalized Landrace Grass Seed Mixture

Species	**gm**	**%**
Anthoxanthum odoratum #69	40	8.33
Arrhenatherum elatius #27	110	22.02
Holcus lanatus #21	110	22.92
Poa bulbosa #71	110	22.92
Vulpia myuros #9	110	22.92

Native Grass Seed Mixture

Species	**gm**	**%**
Agrostis exarata #10	15	3.13
Bromus sitchensis #45	130	31.25
Deschampsia elongata #13	25	5.20
Elymus glaucus #20	150	31.25
Festuca rubra ssp *arenicola* #91	75	15.63
Hordeum brachyantherum #7	65	13.54