HORSEFLY RIVER BLACK CREEK RESTORATION PROJECT
RIPARIAN ASSESSMENTS AND PRESCRIPTIONS

FINAL REPORT

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INTRODUCTION

In October of 1998, The Land Conservancy (TLC) of British Columbia with contributions from the Habitat Conservation Trust Fund and the federal Department of Fisheries and Oceans (DFO) purchased portions of the Black Creek Ranch properties on the banks of the Horsefly River. This 324 hectare valley bottom land contains prime salmonid spawning and rearing habitat, high potential moose winter range, extensive waterfowl habitat, and habitat for many other common and endangered wildlife species. The land has been leased to the Provincial Ministry of Environment Lands and Parks for 99 years for management under a committee of representatives from the local community, TLC, Provincial Ministries, and DFO.

Due to agricultural uses (haycropping, livestock grazing) on portions of the area, certain habitats fall short of their ecological potential. Although natural-healing processes will eventually restore the site to its ecological potential, restoration efforts can speed and/or nurture the recovery process (Kauffman et. al. 1997). Enhancement and restoration projects are being designed to improve river channel stability, as well as habitat attributes for salmon, trout, and numerous wildlife species. Key objectives are to encourage a diversity of plant and animal species including the reestablishment of connectivity between the adjacent hillslopes and the river environment. In support of this goal the Ministry of Environment Lands and Parks (MELP), the Dept. of Fisheries and Oceans (DFO), and Riverside Forests Products Ltd. have cooperated to initiate this project. Using FRBC funds the project is designed to assess condition and develop prescriptions, which will restore lost and impaired riparian functions. The project has been awarded to this consultant. The analyses and prescriptions which follow aim at restoring these functions by reestablishing diverse plant and associated animal communities which are characteristic of an intact Black Creek Horsefly River ecosystem.

STUDY AREA DESCRIPTION

The Black Creek Ranch is located along the Horsefly River approximately 80 km east of Williams Lake, and approximately 20 km upriver from the small village of Horsefly. The upper end of the project area ends near the confluence with a major tributary, McKinley Creek (see overview map of properties Appendix I). The elevation of the site ranges between 824 meters and 829 meters. The annual precipitation for the area, recorded at the BC Forest Service in Horsefly, is 564 mm. Natural floodplain vegetation for the site is characteristic of site series 6 through 9 of the SBSdw1 biogeoclimatic zone (Steen and Coupe 1997). Peak flows resulting from spring snowmelt are usually over the bank in the lower portions of the property and flooding can last for several weeks in May and June. The mean annual flow at and including McKinley Creek is 25 m^3/s. The mean summer 7 day low flow is 9 m^3/s and the predicted maximum daily discharge for 50 year and 100 year return events is 168 and 178

m^3/s respectively (NHC and CRES 1996). The floodplain width varies between 300 and 800 meters in the lower section. The river is partially constrained in the area from below Tisdall Creek to the confluence of McKinley Creek at the upper properties boundary. The river at the site is a 5^{th} order stream with average wetted widths at low flows ranging between 19 and 38 meters. The stream riparian class is S1.

BRIEF LAND USE HISTORY

The area historically called the Black Creek Ranch is one of the early Euro-American settlements along the upper river dating back to the turn of the century. The natural shrub meadows and rich floodplain soils at the location were ideal for farming and relatively easy to clear with horses and manual labor. The first machines used in clearing did not appear until the 1950's. Unstable soils in the headwaters of Black Creek and Patenaude creek drainages have been a major source of sediment to the river floodplain. Deposition and an unstable channel are characteristic of these creeks, in their lower reaches. Placer mining operations in the headwaters may have contributed to this delivery. At the southern end of the properties near the Black Creek airstrip, Jacobson Brothers sawmill operated a log reload yard during the 1970's. A small sawmill was active at this site for a short period in the 1980's. Land clearing and conversion of shrub dominated floodplains occurred steadily over the century. Forested areas were predominately in the upper portions above Tisdall Creek, except for possibly the alluvial fan a Patenaude Creek.

PROJECT OBJECTIVES

The overall project objectives are to assess riparian conditions and prepare prescriptions that will restore impaired and lost riparian functions by reestablishing natural communities of streambank and floodplain vegetation. Specific objectives include:

- determine the variety of potential natural communities for the project area
- establish polygon boundaries which define a general treatment and/or general potential community type
- prescribe various site treatments and planting scenarios (i.e. site scarification, reestablishment of coarse woody debris, planting of conifers and hardwoods), which will restore natural plant communities to the benefit of the river channel, fisheries, and wildlife.
- prescribe a variety of restoration trials for educational purposes
- provide a schedule and cost estimate for restoration activities
- establish a photo point monitoring system

METHODS

1) *Determine potential natural communities* – Forest cover maps, topographic maps, and low elevation air photos were analyzed to produce an overview riparian assessment. Three different site series were determined for the project area from "A Field Guide to Forest Site Identification and Interpretation for the Cariboo Forest Region" (Steen and Coupe, 1997). Twenty-one treatment polygons and eight riparian vegetation types (RVT)'s, were determined. Site visits confirmed to overview assessments. Polygons marked with a "t" were used as potential natural community templates for the corresponding polygons. Woody species (existing and potential) were identified for each polygon. An unaltered site 6.5 km up river having a similar gradient, floodplain, and channel type was used to confirm the overall ecological context. An analysis of low elevation photo imagery (provided by Simon Fraser Geography Department) provided additional site specific overview information. Long term residents of the area i.e. Lawrence Jones, Ernie Gruhs, Geoff Patenaude, and Bill Zimmer were interviewed regarding the natural and anthropogenic history of the area. Historic photos and other information were reviewed at the Horsefly Museum.

2) *Assess riparian condition and determine ecological context for prescriptions* – Low elevation air photo mosaics were analyzed. Ocular surveys were conducted at all polygons having lost or impaired riparian functions. A field reconnaissance was conducted as soon as the snow had melted. Copies of the air photo mosaics and colored pens were used for field notes and sketching. Walking visits were also conducted following leaf out and during the high water period. All river banks with altered vegetation and all sod dominated fields on both sides of the river were visited. Polygon boundaries were determined based on ecological context and potential treatment. The ecology of the river and its floodplain was analyzed (i.e. channel forming processes, condition of habitat, bank stability, state and stage of vegetation, soils, etc.). Cost effective prescriptions were designed to compliment ecological processes and/or stages of succession.

3) *Determine restoration prescriptions,* – Literature was reviewed, local and regional silviculturalists were consulted, and equipment operators were contacted in the process of reviewing regeneration requirements, flood tolerances, site preparation, and mixed planting scenarios. A literature search was also conducted in reference to establishing deciduous trees and shrubs from cuttings, bio-engineering of degraded streambanks, seed mixes for erosion control. Designs were modeled to initiate recovery towards enhanced natural processes, structures, and composition. Bio-diversity based on a patch-like spatial concept was used as a basis for the cluster concept. Preliminary prescriptions were submitted to the project review committee (MELP, DFO, and community rep) for comment. Polygon areas were determined using a dot grid. Lengths of sod only streambanks were measured from low elevation airphotos. Educational trials were included in the design.

ECOLOGICAL CONTEXT FOR PRESCRIPTIONS

Floodplain topography, soils, and flooding regime - Five tributaries join the Horsefly River in close proximity at the upper end of the Black Creek properties. The delivery of coarse substrates (gravels and cobbles) by these tributaries and their associated alluvial fans roughly divides the project area into two distinct ecologies. Historically (and to this day) this deposition, plays major roles in shaping the local river morphology, its environment, and its vegetation. The valley bottom in the area near and just downriver of these tributary junctions contains an irregular topography due to coarse material deposition below these junctions (Ecology I, see Appendix I). Soil profiles in this section would be varied and generally coarse textured. The floodplain width is relatively narrow, and the river is somewhat constrained. The higher well drained coarse soils in these locations support open and mixed conifer/hardwood forests, where wildfire has occasional set the clock back to an early successional forest. Sorted gravel and cobble deposition below these tributaries has in the river produced some of the best spawning sites for the entire Horsefly drainage (pers. comm. D. Lawrence).

On the other hand, somewhat below the areas of coarse deposition (from the five creeks, the finer sediments transported by the river and delivered by the five tributaries (the silts and fine sands) settle out. This has and is creating a broad low gradient and fine textured floodplain, where the river readily meanders (migrates laterally) over decades and centuries from toeslope to toeslope and different plant communites have developed. Loops of meandering river occasionally cut back upon themselves becoming side channel loops and oxbow lakes. These loops then over decades and centuries of time fill in with fine sediments (silts, clay), eventually becoming a part of an undulating surface topography. Ancient filled in river channels contribute to a soil/moisture mosaic of shrub/sedge/grass community types. The process is slow and progressive whereby naturally eroding banks (outside meander bend) are balanced by bank building process (newly formed point bars, lateral bars, and colonizing flood tolerant vegetation i.e. willows). The entire broad meadow complex progressively stretches down the Horsefly valley, mixing with the deposits from Woodjam Creek. Annual lateral migration of the river varies between no movement along well-vegetated straight stretches and crossovers to a meter or more at some meander lobes. This is an estimate taken from historic airphotos and comments by local residents.

Flood Tolerance and Type of Vegetation - Due to the annual flooding and long periods of saturated soil (4 to 8 weeks) only well adapted species become established and thrive. Conifer seedlings are relatively intolerant to extended flooding (more than 7 days) and they rarely survive (Coates et.al. 1994). Planted spruce seedlings have been observed to drown if under water more than a few days (pers. comm. W. Henke and R. McArthur). Cottonwood seedlings are also intolerant of extended flooding. They possess strict moisture requirements that in most years preclude establishment along the riverbanks of the lower Black Creek properties (Ecology II, see Appendix I). Consequently, these annually inundated areas are dominated by shrub/sedge communities, which can tolerate anaerobic conditions. These low lying areas of the properties are typical of a meadow system with remnant old channels, oxbow lakes, and sloughs. They are potentially rich in food and habitat for many species of

wildlife and when young the oxbows provide side channel and backwater habitats important for rearing juvenile salmonids. The river runs slower and deeper through this lower section of the Black Creek properties. Deep pool habitats occur on the outside of the meander bends.

River Bank Stability – In the Ecology II section of the properties the rate of meander (lateral migration) is largely governed by soil textures and soil reinforcement by a matrix of roots. Clay soils for example are more cohesive and less erodible than the silts and fine sand. The roots of grasses and shrubs can easily penetrate and reinforce the coarser silts and sands, both were observed to penetrate to a depth of two meters. The undercut sod and willow banks are typical of those found in a meandering meadow system, i.e. Rosgen Channel Type C5 (Rosgen 1985), with playing a different reinforcing role. The strength of the fine roots (sod) is well demonstrated by the over hanging clumps of soil estimated to often be in excess of five metric tons.

River bank integrity for these ecologies is relatively intact, i.e., banks are often near vertical, or undercut. Cohesive soils and the strong soil binding character of the sod forming grasses contribute to relative this stability. Sand deposited on newly forming point bars at the inside of meander turns is progressively being colonized by vigorous populations of rhizomatous willows and other sandbar species. Bank building processes are estimated to be in balance with bank erosion processes; rates of erosion and meander equal that of point bar formation and colonization, such that the river while moving laterally remains relatively narrow and deep, similar to its historic condition.

Riparian Function – Willows and Grasses – Large woody debris, unable to anchor in the deeper waters, plays little to no role as a channel influencing element in the lower meadow sections of the properties, although it is occasionally deposited on top of the bank or on the floodplain. Consequently, it is the grasses and willows, which provide most of the riparian streambank functions (structure and substrates), in the meadow section.

In addition to bank reinforcement willows and grasses growing on the river banks perform numerous riparian functions. Both while overhanging and after collapsing, they diversify and roughen the shape of the bank morphology. Thereby they deflect nearbank flow energies and create armor. Willows and grasses (sod) are also important sources of litter and small organic debris (SOD), and insect detritus. They are sources of terrestrial insects as well as food for microbes and invertebrates and eventually fish after they fall into the river. While attached to the bank, they create micro habitats in the form of shoreline pocket pools, back eddies, and localized cover. Overhanging banks provide shade along seepage areas. Fallen clumps above or in the river can often reroot and/or persist for several years providing armor to lower bank areas.

Flood Zone Ecology - Due to decades of land clearing, livestock grazing, and farming activity on the project area floodplain, much of the property has lost its characteristic shrub communities and is now dominated by a tight ground cover of various native and introduced grasses. However, remnant shrubs (willows, rose) still survive as stubble in some locations. These surviving shrubs should exhibit vigorous growth with the elimination of farming

activities. In other locations, due to the tight ground cover by the grasses, rates of spread from locations with remnant shrub roots and by seed will likely be slow (decades) without some removal of this cover. Willows and cottonwood are pioneering species and need a maximum amount of light. Tall grasses (i.e., reed canary grass, which can be more than 2 meters tall), now dominate many areas converted to hay production. To reduce this dominance and competition, the removal and or killing of the sod in strips or patches (in some areas) has been made a part of these prescriptions.

Alluvial Fan Ecology – In the area of the alluvial fans where soils will support forests, early successional mixed forests of aspen, lodgepole pine, and spruce have been prescribed. To speed the process toward a fully functioning ecosystem the reintroduction of coarse woody debris (CWD) has been prescribed. Coarse woody debris (CWD) plays numerous roles in the ecology and recovery of a forest ecosystem (Harmon et. al. 1991). It acts as surface roughage to intercept seed, pollen, and materials traveling down the slope. CWD on contours will buffer downslope cold air drainage, diverse microsites will encourage mixed plant communities, and it will provide nurse sites for reestablishing small critter food and habitat (rodents, small mammals, birds, and invertebrate). South sides of logs will provide warm sites for conifer regeneration and it will aid in protecting seedlings from snow creep and veg press. To create a diverse open early seral stand planting is to be in clusters, which include a scattered shrub component.

RIPARIAN ASSESSMENTS AND PRESCRIPTIONS SUMMARY

An assessment and prescription summary is presented in Table 1. The table is based upon recommendations given in the Watershed Restoration Technical Circular #6, Riparian Assessment and Prescription Procedure . A combined and modified version of tables was created to accommodate the uniqueness of the project. Species codes were changed to a simple abbreviated form. To simplify presentation only relevant and abbreviated information is presented. In the column “Riparian Functions” only relevant impaired functions are mentioned. The level of functioning is a professional judgment based on a scale of 0 to 5. “0” meaning dysfunctional and 5 being fully functioning. Polygons noted with a “b” refer to the riverbank portion containing no woody vegetation. RVT labels and Potential Natural Community labels are ordered by species dominance. Willows always denote 2 or more species. A minimum of 5 species of willow has been observed on the site. Prescriptions are fully described in the following sections. A template polygon for defining desired future conditions or potential natural community is included. The riparian vegetation type RVT# designates an existing community type.

TABLE 1. RIPARIAN ASSESSMENT AND PRESCRIPTION SUMMARY

polygon #	RVT #	RVT Labels	Ecolog. Context	Site Series	Site Description	Annual Flooding	Riparian Functions (Aquatic and Terestrial) - Lost or Impaired – (levels 0-5)	Potential Natural Community	Template	Prescription	Photo #'s	Priority
1	1	Sod/ Grasses	Shrub meadow	9	Cleared field with some remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0	SHts/wills, dogw, alder, twinb	1t	1 – leave and observe regrowth 2 – experimental - hand scalp and plant (POTR, BEPA, Sxw) 10 spots	1, 2, 3	L
1t	2	SHts/willows twinb, alder, rose	Shrub meadow	9	Natural shrub meadow – good template	yes	wildlife habitat 5 – riverbank integrity 5	SHts/wills, dogw, alder, twinb	1t	1 – use as a template	4	N
2	2	SHts/wills, twinb, hawth, cottonw, alder, dogw, rose, birch, spruce	Mixed forest	8, 9	Higher better drained soils – good species mixture – logged in the 80's - includes spuce seedlings/saplings and mature cottonwood – heavy use by moose in winter	part	quality wildlife habitat 5, excellent riverbank integrity 5, good template for polygons 3&5	MF,OG/spruce, cottw, wills, alder twinb, hawth, dogw, rose	2	1 Use as a template 2 Optional – brush 2 meters around spruce seedl 3 Optional – plant 20 to 30 spruce on high spots and next to stumps	4	L
3	3	Sod/grasses	Mixed forest	7, 8	Toe of Black Creek alluvial fan – coarse textured soils, well drained,	no	Riverbank integrity 3 – LWD 0 SOD 0 – stream shade 0 Structural diversity 0 – wildlife habitat 1	YF,MF,OG/, aspn, pine, spruce, cottw sask, snowb,	3t 5t	1 Turn sod over with 3 bottom plow (2.5m wide, 10m between rows 2 Place CWD logs at 20/ha 3 Plant clusters every 10 m – 4 aspen, 2 spruce, 2 pine 2 saskatoon, & 2 snowberry	45,46, 47	H
3b	4	Sod/ grasses, forbes	Mixed forest	7,8	Toe of Black Creek alluvial fan – coarse textured soils, well drained, riverbank damage from livestock	no	Riverbank integrity 3 – LWD 0 SOD 0 – nutrient/sediment filtering 3 - stream shade 0	YF,MF,OG/ spruce cottn, wills, sask, aldr,	3t 5t	1 Plant willow and cottonwood cuttings in three rows spaced at 1.5 meters	45,46, 47	H
4	5	OGd/cottonw, wills	Cotton wood gallery forest		Open old-growth cottonwood willow forest along Black Creek – active gravel/cobble deposition area – heavily grazed – understory sparse –few spruce seedlings at mouth	no	Streambank stability 2 – riverbank integrity 5 - LWD 2 – SOD 3 – stream shade 4 Wildlife habitat 2	OGd/Cottwood, willows, spruce,alder	N	1 Hand scarify and plant spruce on high finer textured stable soils (mimic existing spruce regen) 2 Plant cottonwood live stakes in gravel bars and banks 3 Plant willow cuttings in finer textured gravel bars 4 Transplant alder	6, 7	M
5	3	Sod/grasses	Mixed forest	7, 8	Toe of Black Creek alluvial fan – hay field - coarse textured soils, well drained,	no	Riverbank integrity 4 – LWD 0 SOD 2 – shade 2 Structural diversity 0 – wildlife habitat 1	YF,MF,OG/, aspn, pine, spruce, cottw sask, snowb,	3t 5t	1 Turn sod over with 3 bottom plow (2.5m wide, 10m between rows 2 Place CWD logs at 20/ha 3 Plant clusters every 10 meters – 4 aspen, 2 spruce, 2 pine, 2 saskatoon, & 2 snowberry		H
6	3	Sod/grasses	Mixed forest	7, 8	Middle alluvial bench above river at east end - west end alluvial fan from Black Creek – coarse well drained soils – leased for spring livestock calving	no	Runoff of nutrients and sediment pollution generated by concentrated livestock activity	YF,MF,OG/, aspn, pine, spruce, cottw sask, snowb,	3t 5t	1 Leased area – no treatment 2 Manage sediment nutrient runoff	3	N

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7	6	Sod/grasses	Shrub meadow	9	Cleared field with scattered remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave 1+ year then map remnant shrubs 2 Invert sod with plow along old/ancient channel banks and depressions-3 rows 7m apart 3 Plant 4 willow and 1 dogwood cutting, and 1 twinberry seedling every 10 meters of plowed strip	8 9 11 12	H
7b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 7 - Cleared field with scattered remnant shrub stubble (rose, willows)– low elevation seasonally saturated flood zone - fine texture soils	yes	SOD 0 – riverbank integrity 3 – shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Invert sod and plow 3 - 2.5m wide strips 7m apart along top of grass dominated banks 2 Plant 4 willow, 1 cottonwood, and 1 dogwood cutting and 1 twinberry seedling - 7 m along plowed strips 3 Experimental – plant spruce 615 plugs on highest microsites along plowed strips, 1 every 7 meters	10 13 14	H
8	6	Sod/grasses	Shrub meadow	9	Cleared field with scattered remnant shrub stubble rose willows– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave – use as a control (reference) - observe regrowth	29 32	H
8b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 8 - Cleared field with scattered remnant shrub stubble (rose, willows)– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 4 – shade 0 – nutrient/sediment filtering 4 –	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave – use as a control (reference) site – observe regrowth	29 30 31 32 33	H
9	6	Sod/grasses	Shrub meadow	9	Cleared field with scattered remnant shrub stubble (rose, willows)– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave 1+ year then map remnant shrubs 2 Invert sod with plow along old/ancient channel banks and depressions,-3 rows, 7m apart 3 Plant 4 willow and 1 dogwood cutting every 10 meters of plowed strip 4 Plant twinberry seedlings 1 every 10 meters	16 17 18 19	H
9b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 9 - Cleared field with scattered remnant shrub stubble (rose, willow)– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 3 – shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Invert sod and plow 3 - 2.5m wide strips 7m apart along top of grass dominated banks 2 Plant 4 willow, 1 cottonwood, and 1 dogwood cutting and 1 twinberry seedling - 7 m along plowed strips 3 Experimental – plant spruce 615 plugs on highest microsites along plowed strips, 1 every 7 meters	15 18 20	H
10	6	Sod/grasses	Shrub meadow	9	Cleared field with scattered remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave use as a control (reference) – observe natural regrowth	35	H

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10b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 10 - Cleared field with scattered remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 4 – shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Leave use as a control (reference)– observe natural regrowth	34	H
11	8	Sod/grasses	Mixed forest	7, 8	Alluvial fan from unnamed tributary on southside of river– coarse textured soils, well drained	no	Structural diversity 0 – wildlife habitat 1 – woody debris 0 - species diversity 0	YF,MF,OG/, aspn, pine, spruce, cottw sask, snowb,	11t	Leave		M
12	3	Sod/grasses	Mixed forest	7, 8	Toe of Patenaude Creek alluvial fan – coarse textured soils, well drained, CWD may not stay due to high water except at highest location	part	Structural diversity 0 – wildlife habitat 1 – woody debris 0 - species diversity 0	YF,MF,OG/, aspn, pine, spruce, sask, snowb,	12t 3t	1 Invert sod with a plow - strips 2.5m wide 10m apart 2 Place CWD logs at 20/ha 3 Plant in clusters – w/ 4 aspen, 2 spruce, 2 pine, 2 saskatoon, & 2 snowberry	26	H
13	9	Sod/grasses	Shrub meadow	9	field with remnant shrub stubble– low elevation seasonally saturated fine texture soils – high elevation banks inside of old oxbows –deposit area for drift logs	yes	wildlife habitat 2 – structural diversity 1 –woody debris 1 species diversity 1	SHts/wills, dogw, twinb, rose, hawth	13t 16t 9t 7t	1 Map remnant shrubs 2 Invert sod along old/ancient channel banks and at the experimental cluster locations using a plow, 3 rows, 2.5m wide– avoid areas with remnant shrub 3 Plant 4 willows and 1 dogwood cutting, 1 twinberry seedlings every 10 meters along plowed strips 4 In addition plant 3 spruce, 3 cottonwood, and 2 pine at the experimental cluster location	22 23 24	H
13b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 13 - Cleared field with scattered remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 3 – shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t 13t	1 Invert sod and plow 3 - 2.5m wide strips 7m apart along top of grass sod dominated banks 2 Plant 4 willow and 1 dogwood cutting, and 1 twinberry seedling every 7 meters along plowed rows	34	H
14	5	OGd/cottonw, wills	Cotton wood gallery forest		Open old-growth cottonwood willow forest along Patenaude Creek – active gravel deposition area – unstable channel	no	Streambank integrity 2 – riverbank integrity 4 – woody debris 2 – SOD 4 – stream shade 4 wildlife habitat 3	OGd/Cottw, wills, spruce	N	1 Experimental - Spot plant spruce on high stable spots using planter selection 2 Plant cottonwood live stakes in stable gravel bars and banks		M
15	3	Sod/grasses	Mixed forest	7, 8	Patenaude Creek alluvial fan – coarse textured soils, well drained,	no	Structural diversity 0 – wildlife habitat 1 – woody debris 0 - species diversity 0	YF,MF,OG/, aspn, pine, spruce, sask, snowb,	15t 3t	1 Invert sod with a plow - strips 2.5m wide 10m apart 2 Place CWD logs at 20/ha 3 Plant in clusters – 4 aspen, 2 spruce, 2 pine, 2 saskatoon, & 2 snowberry	28	H

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16	6	Sod/grasses	Shrub meadow	9	Cleared field with scattered remnant shrub stubble (rose, willows) – low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	16t 7t	1 Map remnant shrubs 2 Invert sod along old/ancient channel banks and at the experimental cluster locations using a plow, 3 rows, 2.5m wide– avoid areas with remnant shrub 3 Plant 4 willows and 1 dogwood cuttings, 1 twinberry seedlings every 10 meters of plowed strip	27 28	H
16b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 16 - Cleared field with scattered remnant shrub stubble ROAC, SASP– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 3 – Shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t 13t	1 Invert sod and plow 3 - 2.5m wide strips 7m apart along top of grass sod dominated banks 2 Plant 4 willow and 1 dogwood cutting, and 1 twinberry seedling every 7 meters along plowed rows 3 In addition plant 3 spruce, 3 cottonwood, and 2 pine at the experimental cluster on unique high banks (see map)	27	H
17	3	Sod/grasses	Mixed forest	7, 8	Unnamed Creek alluvial fan – coarse textured soils, well drained,	no	Structural diversity 0 – wildlife habitat 1 – woody debris 0 - species diversity 0	YF,MF,OG/, aspn, pine, spruce, sask, snowb,	15t 3t	1 Invert sod with a plow - strips 2.5m wide 10m apart 2 Place CWD logs at 20/ha 3 Plant in clusters – 4 aspen, 2 spruce, 2 pine, 2 saskatoon, & 2 snowberry	28	H
18	5	Sod/grasses	Mixed forest	7, 8	alluvial fan from Patenaude Creek – coarse well drained soils – leased for livestock and alfalfa	no	Source of nutrients and sediment from concentrated livestock activity	YF,MF,OG/, aspn, pine, spruce, sask, snowb,	3t 5t 12t 15t	Leased area – no treatment – manage sediment/nutrient runoff from feeding area	26	N
19	6	Sod/grasses	Shrub meadow	9	field with remnant shrub stubble– seasonally saturated fine texture soils – earthen dike berm has potential for planting cottonwood and spruce – contains old barbwire fence	yes	Wildlife habitat 1 – structural diversity 1 –woody debris 1 Species diversity 1	SHts/wills, dogw, twinb, rose, hawth Cottonw, spruce	13t 16t 9t 7t	1 Plant Spruce, Cottonwood, on berm at planter selected hand scarified spots 2 Remove barbwire fencing	39 40 41	H
19b	7	Sod/grasses	Shrub meadow	9	Sod riverbank in polygon 19 - Cleared field with scattered remnant shrub stubble (rose, willows)– low elevation seasonally saturated fine texture soils	yes	SOD 0 – riverbank integrity 4 – Shade 0 – nutrient/sediment filtering 4 – wildlife habitat 1	SHts/wills, dogw, twinb, rose, hawth,	7t 8t 9t 10t 13t	1 Invert sod and plow 3 - 2.5m wide strips 7m apart along top of grass dominated banks 2 Plant 4 willow and 1 dogwood cutting, and 1 twinberry seedling every 7 meters along plowed strips 3 In addition plant 1 cottonwood and 1-615 spruce plug plug/7m	27	H

TABLE 1. RIPARIAN ASSESSMENT AND PRESCRIPTION SUMMARY

polygon #	RVT #	RVT Labels	Ecolog. Context	Site Series	Site Description	Annual Flooding	Riparian Functions (Aquatic and Terestrial) - Lost or Impaired – (levels 0-5)	Potential Natural Community	Template	Prescription	Photo #'s	Priority
20	6	Sod/grasses	Shrub meadow	9	Large cleared field with scattered remnant shrub stubble (rose, willows)– low elevation seasonally saturated fine texture soils	yes	wildlife habitat 1 – structural diversity 0 –woody debris 0 species diversity 0	SHts/wills, dogw, twinb, rose, hawth	7t 8t 9t 10t	1 Map remnant shrubs 2 Invert sod along old/ancient channel using a plow, 3 rows, 2.5m wide– avoid areas with remnant shrub 3 Plant 4 willows and 1 dogwood cuttings, 1 twinberry seedlings every 10 meters of plowed strip 4 Breach berm 30m in two locations 5 Remove old plastic tarps	39 40 42 43	H
21	8	Sod/grasses	Mixed forest	7, 8	Toe slopes of south side of river – coarse textured soils, well drained – possibly an old landing and an equipment shed- naturally regenerating with spruce	no	Structural diversity 1 – wildlife habitat 1 – species diversity 1	YF,MF,OG/, aspn, pine, spruce, cottw, birch, willows	11t	1.Leave and observe 2 Cleanup tires fencing eetc		L

PRESCRIPTIONS

POLYGON #1 - RVT[1] #1 This is a shrub cleared field now dominated by sod forming grasses on the lowest bench next to the river. Soils are fine textured and saturated for several weeks during the spring runoff period. The ecological context for the site is a shrub meadow dominated by old growth willows. Spruce seedlings do not survive flooding but cottonwood may if the soil water contains enough oxygen (flowing). Potential natural communities include red osier dogwood, black twinberry, rose, hawthorne, and alder. A good template for this site is the adjacent 1t site, which includes a band along the river. On the next bench up, the adjacent better-drained sites also support aspen, spruce and cottonwood.

Treatment

1) Because there are good population of remnant shrub stubble, the recommendation is a no treatment polygon. A good template for the area is the adjacent 1t, which has the same flooding regime and soil textures. The 1t site also contains the riverbank, which is well vegetated with fully functioning riparian attributes.

2) To increase structural diversity, on an experimental basis, cottonwood cuttings and seedlings of spruce and birch can be planted in hand scarified patches, on the highest microsites. Twenty of each can be tried and observed.

3) In general, this site will make a good control site where establishment and spread of existing and invading species can be observed

POLYGON # 2 - RVT #2 This site is on a second low bench above the river, which may include some of the Black Creek alluvial fan. It is a better drained site than RVT #1 and much of it is not flooded during spring runoff. Scattered spruces was logged from this site about 20 years ago. Spruce is regenerating over the area with stocking varying from 100%. In general the site is dominated by a good variety of moisture loving shrubs including about a 30% stocking with young and mature cottonwood (on 20% of the area). The riverbank along this polygon is densely vegetated with tree form willows. This polygon and its river bank make a good template for polygon #3. The area is heavily used by moose in the winter. Waterfowl were observed using ponded locations.

Treatment

1) This polygon is also recommended to be a leave polygon. It is well stocked with a diversity of woody species including willows, alder twinberry, hawthorne, birch, cottonwood, saskatoon, and spruce.

[1] RVT – riparian vegetation type

2) A low priority treatment for this polygon is to brush (with a brush saw) 2-3 meter diameter clearings around the spruce seedlings. This would speed their growth, but they are not improved with more than 30-40% light (Coates et. al. 1994).

3) Succession on this site can be speeded up by planting spruce seedlings next to the stumps, and on high spots. Although this is not necessary since the site is well vegetated with valuable species. Early seral stages, an open patchy overstory, multiple species, and diversity of vertical structure is best for wildlife (Hansen 1991).

POLYGON #3 and #5- RVT #3 This area is at the toe of the Black Creek alluvial fan. It has been logged, cleared, and farmed to produce feed for livestock. The area has been used for winter feeding and spring calving. The soil textures are coarse with origins from the Black Creek drainage. Good templates for this area are the benches above the river and below the McKinley Road Bridge, also the adjacent polygon #2.

Treatment

1) In August 2000 use a three bottom plow behind a strong farm tractor to invert the sod in 1.25 meter (4 ft) wide strips. Two passes would create a total strip width of 2.5 meters containing 6 mounds of inverted sod edge to edge. In this case strips should be 10 meters apart and created to be discontinuous by raising the plow periodically (every 20 meters or so). This would interrupt the flow of channelized water. An alternative but more expensive treatment would be to use a Wyatt Silvi-Tiller (WS Tiller). This is a hydraulically powered rototilling attachment mounted on a crawler excavator. The tiller works on the same principle as a garden rototiller. The 1 meter long tiller drum with teeth rotates chopping and mixing organic matter with mineral material to produce an aerated mixed medium. A typical patch for this site should be 2 meter by 4 meters spaced at 15 meters (plus or minus) on center, rows 10 meters apart. The excavator arm can reach 10 meters on each side of the machine so that in this case three rows of scarified patches can be produced in one pass. Patches should be more focused on the higher microsites not a geometric pattern. This would produce 60-80 patches per hectare.

2) To reestablish CWD on the denuded site, in August 2000, obtain cull logs from a nearby harvesting operation. Cull logs should be species suited to the site, i.e., aspen, pine, fir, spruce, cottonwood, and birch as available and no less than 20cm diameter. Using a skidder distribute the logs 20 pieces per hectare lying along contours. South sides of logs will provide warm sites for conifer regeneration and it will aid in protecting seedlings from snow creep and veg press. The pieces should be placed as much as possible next to or on the plowed strips.

3) In September and/or October 2000 plant plowed strips in a group or cluster configuration to assimilate a natural patchy open forest mosaic. Plant the hardwood species (grown at the selected nursery) aspen, saskatoon and snowberry at the ratio of 4:2:2 for each cluster approximately every 10 meters along the plowed strip. In April 2001 add pine and spruce

2 each to the cluster at no less than a 1.0 meter spacing. A 2.5m x 4m patch or strip area should contain 4 aspen, 2 spruce, 2 pine, 2 saskatoon, and 2 snowberry. Conifers should be placed on the mounds and preferably on the south side of the logs when available. Species mix per grouping can vary but overall deciduous trees should equal conifers on the site. Shrubs should be separated from conifers by at least 2 meters. Other appropriate shrubs can be tried as available including rose, soopolallie, hawthorne, and gooseberry depending on seed collection opportunities and arrangements with the nursery.

POLYGON #3b[2] RIVERBANK- RVT #4 This is the same polygon but refers only to the riverbank portion. Due to decades of grazing and trampling by livestock, portions of this river bank are degraded (losses in structural integrity). Some of the once vertical and undercut banks have collapsed, raveled, and slowly wash away. This 360 meter long bank is the only bank on the project properties, which can be assessed as in part seriously degraded. With the removal of livestock and with the reestablishment of herbaceous and woody vegetation this bank should return to a stable dynamic. Because the main river currents (thalweg) along this section are near the middle of the channel, the bank is not subject to heavy erosive river forces. As the recently exposed fine sediments (last seasons trampling) in the disturbed section wash away (this season) the pebble/gravel size materials that remain will start to form an armor. Bio-engineering and other techniques, which further disturb this bank, will only serve to set the process back. Prompt revegetation of this bank is the key to reestablishing its normal relative stability. Good templates (desired future conditions) for this riverbank are contained in polygons #1t and #2.

Treatment - Bank area to be seeded 0.1 ha.

1) In August 1999 hand seed exposed soils on the river bank with 2 kg of the following riparian herbaceous seed mixture (Dave Polster pers. comm.). Seeding in August should trick the plants into thinking that next spring is their second growing season and they should flower and produce seed.

Custom Seed Mix - Richardson Seed, Burnaby

4.95% Creeping Red Fescue
7.85% Osprey Hard Fescue
29.25% Hycrest Crested Wheat
2.37% Alma Timothy
19.58% Soder Streambank Wheatgrass
10.97% Perennial Ryegrass
18.95% Rangelander Alfalfa
6.06% Alsike Clover

[2] The letter b designates the riverbank portion of a polygon.

Use a standard blend of fertilizer 13-16-10 or 19-19-19 with the application.

2) In September/October 1999 gather and plant willow and cottonwood cuttings at a ratio of about 5:1, at a 1 meter spacing in three rows, i.e. along the waters edge, half way up the bank, and near the upper bank. Pilot holes should be made with a bar or a bar and hammer at least 50 cm deep. Cuttings stuck in vertical banks may not hold where erosive enerbies are strong, i.e., at the down river bend. The cuttings on the higher part of the bank need deep pilot holes so that the base of the cutting will reach to the summer low watertable or its capillary fringe. Where clumps of grass have broken off the bank and created a shelf, plant on top of the shelf. Carefully tamp the soil so that it is in contact with the stem over its entire length. Cottonwood cuttings can be inserted into deep pilot holes, one per scarified patch on top of the bank. Red-osier dogwood can be planted as a cutting, but willows should be the principle species used on the channel bank. Cuttings of all three species should be gathered, then stored for a minimum of 24 hours in water (the river or a bucket), then planted the following day.

POLYGON #4 - RVT #5 This polygon describes the area adjacent to Black Creek. Its ecological context is a cottonwood gallery forest. It is on the alluvial fan built by the creek. It is highly unstable in its lower reaches. Quantities of transported and deposited coarse sediment fill and shift the channel regularly, thus contributing to the building of the fan. Due to decades of livestock activity along the creek highly palatable small diameter classes of cottonwood and willow are rare. Tree form willows are co-dominant at the mouth of the drainage and a few spruce seedlings are regenerating on bars with finer textured gravels. An intensive planting program should be undertaken (stakes and cuttings), in hopes of stabilizing some of these shifting bars.

Treatment

1) Plant live cottonwood stakes (5-8 cm diameter) in the finer textured gravel bars along Black Creek. Use a bar or shovel or pick to create a pilot hole and gently drive the stakes with a fiber or wood mallet. Try to get 30 to 50 cm of the stake buried into the gravel with no more than 20 cm (3 buds) above the soil surface.

2) In April 2001 plant spruce seedlings in the finer textured soils along the creek bank. Planters should mimic the spots where regenerating spruce seedlings are located along the lower fan.

3) Plant stout willow cuttings (sitka willow, Mackenzie willow, Pacific willow growing abundant along Patenaude Creek) in the fine textured gravel bars and banks using a bar to pilot the hole.

4) Can also try planting alder as seedlings or rooted clumps

POLYGON 6 – RVT#3 This is the area leased back to the Back Creek Ranch. Like polygon 3 this area is on the Black Creek alluvial fan with coarse textured soils. Its potential natural vegetation following a clearing disturbance is a mixed forest containing the pioneer species (aspen, pine, and cottonwood, also spruce).

Treatment No treatment

POLYGONS 7, 9, 16, and 20 – RVT#6 These polygons are down river from the coarse sediment deposit areas of the 5 tributaries. This area is where the fine sediments transported by the river and those delivered by the tributaries settle out (approximately 2.5 km downriver from Black Creek). This begins the portion ecologically defined as a shrub meadow. A broad silty floodplain, ancient river channels, and oxbow lake cutoffs are its characteristic features. The area has been cleared and farmed for hay production (and livestock grazing), which has lead to a more or less pure continuous cover by sod forming grasses (domestic and wild). Old growth tree form willows follow many of the riverbanks and some of the younger oxbows (if they have not been cleared). This area of the Black Creek Ranch properties is flooded for several weeks in the spring each year, thereby limiting woody species establishment to those that can tolerate anaerobic conditions. Remnant shrub stubble has been observed surviving in some locations in the fields. Good templates for determining desired future conditions for this site are the shrub dominated areas next to the river at polygons 7t, 8t, 10t, 16t, and 19t. Another good example of this ecology is up-river 6.5 km at another unaltered low gradient meandering meadow system.

Treatment

1) In early spring following one year of regrowth (without grazing or farming), map the areas of the floodplain supporting recovering remnant shrubs. These areas need no treatment and should be left unaltered.

2) In the shrubless areas along the banks (and in the depressions) of the old and ancient oxbows, use the three bottom plow to peel back the sod (scarify). Plow double wide strips approximately 7 meters apart following the lower banks and depressions of the old oxbows and river channels. Avoid plowing areas with recovering remnant shrubs and lift the plow for a meter or so after every 20 of plowing. Scarification will reduce competition for sunlight, moisture, and nutrients. Treatment should focus first on areas of the floodplain that will promote cross-valley connectivity. Areas with connectivity potential are marked on the map (Appendix I).

3) In late September or October 2000 after dormancy begins, make deep pilot holes in the sod mounds using a bar or bar and hammer. Plant cuttings of willow and dogwood, attempting to make cutting bases reach the mid summer low water table. Black twinberry should be planted as rooted stock at the same time. Plantings should include 4 willow, 1 dogwood, and 1 twinberry for every 10 meters of a doublewide strip.

POLYGON RIVERBANKS 7b, 9b, 13b, 19b – RVT #7 This is the riverbank area of the corresponding polygons. River banks, which are marked with an orange line (Appendix II, map 2 and 3), have nearly no woody vegetation. These are sod dominated banks mostly on the outside corner of a meander turn (inside corners repopulate naturally). They are slowly being undercut and collapsing and in many cases forming a sod shelf rerooted at mid bank. Banks appear moderately stable and within erosion rates typical of a shrub/sedge meadow system. Deep dense root mats formed by the domestic and wild grasses, provides soil reinforcement and bank protection in the upper profiles. Tall and low shrub willow cuttings are prescribed for top of the bank locations. To add strength to the lower soil profiles willows etc. need to get established, which may take 5 years. To allow for lateral movement on corners, these species should be planted back from the bank around 2 meters.

Treatment

1) In the spring and or fall 2 meters back from the edge, using a 3 bottom plow, invert the sod in rows. Locations are where there are no top of the bank shrubs as marked with an orange line on the maps (Appendix I). Areas with recovering remnant shrub should be avoided. Doublewide plowed rows should be 7 meters apart and non-continuous to avoid the channelization of water. The plow should be lifted for a meter after a 20 meter section. Only plow that which will be immediately planted. If not planted until the next growing season the gain of reducing grass competition will be lost.

2) On top of the lowest river banks plant willows, cottonwood, and dogwood cuttings. Black twinberry, dogwood, and rose seedlings can be added to increase biodiversity as available. On higher drier banks also try high bush cranberry, hawthorne and saskatoon. Willows are the main species to be planted, 4 or more should be planted for every 10 meters of bank. Tree form willows growing on the top of the bank locations should be used for cuttings for the upper bank locations. Cuttings should be jammed into pilot holes made with a bar or hammer and bar. Cuttings should be planted immediately after harvesting for best results.

3) On a trial basis (request by MELP) in the spring plant spruce (615 plugs) on the highest micro-sites along the highest river banks, that have been plowed and scarified (shrub meadow polygons #7 and #9). Spruce seedlings have been observed to be intolerant of long periods of flooding (Coates et. al. 1994), so only 200 are recommended on a trial basis. Spruce (615 plugs) should be planted in the turned over sod mounds in April/May 2001.

POLYGONS 8 and 10, RIVERBANKS 8b and 10b– RVT #6 These polygons are similar to polygons 7 to 20 as listed above, in that they are low elevation shrub meadows, which are saturated for several weeks each spring. These polygons are different in that there appears to be a good population of remnant rose and willow shrub. These polygons are on the south side of the river and access is more difficult.

Treatment

The recommended treatment for these two polygons is NO TREATMENT. These polygons make good candidates to use as a control. Surviving shrub stubble scattered in the cutover fields appear to be adequate to reestablish initial stages of shrub meadow succession and cross-valley connectivity. Recovery rates and species establishment should be observed.

POLYGON 11 – RVT #8 This polygon is similar to polygons 3, 5, 12, and 15 except that it lies on the south side of the river and it has a north aspect. This area is part of an alluvial fan built by an unnamed tributary. Soils are coarse textured and well drained. The successional vegetation following clearing includes aspen, birch, cottonwood, willow, and spruce. The treatment regime is similar to the other polygons containing coarse soils and/or alluvial fans (polygons 3, 5, 15, and 17). The area is smaller, and surrounded by natural communities of vegetation, therefore a more rapid colonization by woody species should occur. Attention should be given to expanding the riparian zone along the tributary creek.

Treatment

1) Treatment on this polygon is not a high priority. It could also be a no treatment polygon.

2) Use the 3 bottom plow to invert the sod in double-wide strips 10 meters apart over the entire polygon (similar to RVT#3 below). Scarification should be done just prior to planting to maximize the reduced competition advantage.

3) In September 2000, obtain cull logs from a nearby harvesting operation to be used to reestablish the coarse woody debris (CWD) component. Cull logs should be relevant for the site, i.e., aspen, pine, fir, spruce, cottonwood, and birch as available and not less than 20cm diameter. Using a skidder distribute the logs 20 pieces per hectare placed on contours and adjacent to or across the plowed strips wherever possible.

4) Strips should be planted in groupings or clusters spaced 10m apart. A cluster should contain 4 hardwoods (aspen, cottonwood, and birch) and 4 spruce at no less than a 1.4 meter spacing. Conifers should be placed on high microsites and preferably on the south side of the logs when available. Species mix per grouping can vary from all conifers to an even mix, but overall, deciduous trees should equal conifers on the site.

POLYGONS 12, 15, AND 17 – RVT # 3 This area is on the Patenaude Creek and unnamed creek alluvial fans. It has been logged, cleared, and farmed to produce forage for livestock. It is a south facing gentle slope with soils having coarse textures and well drained. Good templates for the area include polygons 12t and 3t.

Treatment – The recommended treatment for these polygons is the same as for polygons 3 and 5. Polygon 12 should not receive CWD except on the highest part of the site (about 25%

of the area). Pieces on the lower polygon are in the flood zone and could float during the highest water.

1) In August 2000, use a 3 bottom plow to invert the sod in double wide rows (2.5 m width) 10 meters apart over the whole polygon. Plowed strips should not be continuous, that is the operator should lift the plow every 20 meters to create an unplowed stretch (2 meters).

2) In early September 2000 obtain cull logs from a nearby harvesting operation to be used as coarse woody debris (CWD). Cull logs should be relevant for the site, i.e., aspen, pine, fir, spruce, cottonwood, and birch as available and no less than 20 cm diameter. Using a skidder distribute the logs 20 pieces per hectare placed on contours. They will act as surface roughage to intercept seed, pollen, and materials traveling down the slope. They will also act to buffer downslope cold air drainage. The debris will provide nurse sites for reestablishing small critter food and habitat (rodents, small mammals, birds, and invertebrate). The diversified microsites will encourage mixed plant communities. South sides of logs will provide warm sites for planting conifers. CWD will also aid in protecting seedlings from snow creep and veg press. The pieces should be placed as much as possible next to or on the plowed strips.

3) In late September and October 2000 plant plowed strips in a group or cluster configuration every 10 meters. A 2.5m x 4m area should contain 4 aspen, 2 spruce, 2 pine, 2 saskatoon, 2 snowberry spaced at no less than 1.0 meters. Conifers should be planted in April/May 2001 and placed on the highest microsites and preferably on the south side of the logs when available. Species mix per cluster can vary, but overall deciduous trees should equal conifers on the site. Other appropriate shrubs can be substituted as available including rose, soopolallie, hawthorne, and gooseberry.

<u>POLYGON 13 AND 16– RVT#9</u> These polygons are similar to the flood-prone shrub meadow polygons 7 through 10. They are unique in that several oxbow lake cutoffs diversify the area of the floodplain and portions of the toe of the Patenaude Creek alluvial fan mix with the fluvial deposits of the river creating some small areas with higher ground. These higher possibly drier spots are mainly along the inside banks of the old oxbows. Old growth tree form willows follow portions of these oxbow banks and the higher ground gives an opportunity for cluster planting trials. Remnant shrub stubble (willows and rose) has been observed surviving in some locations in the field. Good templates, for defining desired future conditions, are the areas next to the river at polygons 2t and 3t. Potential natural vegetation would probably contain less aspen and more cottonwood than polygons 15 and 17, due to proximity to water. Pine is included and should be planted at the sunny south end of the clusters or groupings.

<u>Treatment</u>

1) In the spring of 2000 map and mark the areas of the floodplain with recovering remnant shrubs and identify and mark the unique high ground, which can be used for experimental cluster trials.

2) In the shrubless areas along the moist banks and depressions of the old and ancient oxbows invert the sod using the three bottom plow (like RVT#6). Double wide strips should be non-continuous and broken every 20 meters and spaced 7 meters apart.

3) On the unique high ground locations as identified on the map (Appendix I) for cluster planting, plow double wide strips spaced 10 meters between rows. There should be 2 to 6 doublewide plowed strips depending upon width of the high ground.

4) In September and/or October 2000 gather and plant cuttings of willow based on quantities from the quantity table (Appendix II). Make deep pilot holes (using a bar or bar and hammer) when planting cuttings in the high ground, such that 75% of the one meter cuttings are buried with 2 or 3 buds only above the ground. At both locations, i.e. the moist remnant old river channels and depressions and on the unique high ground clusters should be spaced approximately 10 meters apart along a plowed strip. Plant 4 willow and 1 dogwood cutting at each cluster along the old channels and 2 willow and 1 dogwood at the experimental high ground clusters. Black twinberry should be planted as rooted stock 1 per cluster at both locations. On the experimental high ground cluster sites, in addition to the three shrubs, plant 3 cottonwood cuttings (deep), 3 spruce seedlings, and 2 pine. Pine should be at the south end of the cluster to maximize sunlight exposure. Spacing between seedlings should be no less than 1.0 meter.

POLYGON 14 – RVT#5 This polygon describes the coarse gravel deposits (bars) and alluvial fan adjacent to Patenaude Creek (similar toe RVT#5). The ecological context is a cottonwood gallery forest with willow shrubs dominating the unstable area in the lower reaches. Cottonwood seedlings are present along creek banks (bars) below the corrals. In the absence of grazing pressure and because of a good seed source cottonwood should continue to regenerate in the lower reaches, along this polygon. Spruce should be planted on the higher microsites containing finer textured soils near the toe of the fan.

Treatment

1) April/May 2001 plant spruce seedlings (615 plugs) in the finer textured alluvial soils (high ground) at the base of the fan. Survey cottonwood regeneration along the lowest reach of the creek. Plant stakes and cuttings of cottonwood where needed.

POLYGON 18 – RVT#3 Like polygon 6 this area is leased back to the Black Creek Ranch for winter feeding and alfalfa production. It is at the Patenaude Creek alluvial fan. Its ecological context is a forest site on coarse textured soils. Its potential natural vegetation following denuding is mixed forest initiated by the pioneering species (i.e., aspen, pine, cottonwood, also spruce).

POLYGON 19 – RVT#9 This area is also a low elevation floodplain within the annual flood zone. Its ecological context is a shrub meadow similar to polygons 7 through 10. It lies on the southside of the river and is bounded by an earthen dike or berm. The berm extends for 1.7 km and it is 2 to 3 meters high. Willows including some young cottonwood saplings colonize parts of the berm. Portions at the upper end contain only grass. Remnant willow and rose shrub stubble were observed on the floodplain field. Experimental spruce and cottonwood clusters should be considered for portions of the berm. The berm disconnects the river from its floodplain. It should be breached in two or more locations to allow floating materials (logs, trees, root wads, debris, silt) access to the field. This will nurture the healing process by diversifying microsites and by creating habitat for new plant and animal establishment.

Treatment

1) In the spring when the grass is down observe shrub stubble regrowth on the floodplain and map/mark.

2) Using the 3 bottom plow scarify and plant the top of the riverbank where it is outlined with an orange line (bank without shrubs) as outlined in RVT #7.

3) Plant cottonwood and spruce (rooted stock) as individuals and in groups in hand scarified patches on the berm.

4) Breach the berm with a bulldozer or excavator a minimum of 20 meters in two or more locations as marked on the map (Appendix I, map 3). This will reconnect the river to its floodplain.

5) Cleanup old fencing

POLYGON 20 – RVT#6 This is a large homogeneous field (shrub meadow ecology) needing activities which will re-establish structural and species diversity. Large portions of the field are saturated and underwater for several weeks in the spring. It is well used in the spring by migrating waterfowl. Habitat for numerous species can be easily improved. A few portions along old and ancient oxbow reliefs contain remnant shrub stubble. At least two ditches with berms have been created to drain the field. Willow shrubs occupy some portions along these berms, other areas support domestic and wild grasses. In addition to planting spruce and cottonwood on the major berm defined in polygon 19, spruce and cottonwood should be planted on a trial basis on the ditch berms. Breaching of the major berm (see treatment in polygon 19) will enable transported trees, logs, and debris to be deposited on the floodplain thereby greatly improving micorsite diversity and the substrates that drive the food chain.

Treatment

1) In the spring map and mark the areas of the floodplain with recovering remnant shrubs. These areas need no treatment and should not be scarified.

2) In August 2000, in the shrubless areas along the banks (and in the depressions) of the old and ancient oxbows, scarify double wide rows with a three bottom plow as described in RVT#6 and #7. This takes advantage of the wettest areas of the floodplain for establishing cuttings. Scarification will provide full sun and reduce competition for moisture and nutrients. Willows are pioneering species typically requiring bare soils and full sun. Treatment should focus first on areas of the floodplain that will promote cross-valley connectivity as indicated on the map (Appendix I)

3) In September 2001, plant cuttings of willow and dogwood. Black twinberry should be planted as rooted stock.

4) On the ditch berms plant spruce and cottonwood as individuals and in groups in hand scarified patches (30cm). Cottonwood can be planted as cuttings where the stem can reach the watertable (at the base of the berm) and as rooted stock on top of the berm. On a trial basis plant 200 cottonwood and 120 spruce.

5) Should cleanup the plastic bale covers in the field at midpoint along and next to the berm.

POLYGON 21 – RVT#8 This polygon is located on the south side of the river where hillside toeslopes meet the floodplain. Soils are coarse and well drained. The potential natural vegetation is mixed forests of aspen, spruce, cottonwood, and birch. The template and source for regeneration surrounds the site. Conifers have been removed by selective logging and the openings are probably the landings. Spruce and cottonwood seedlings are scattered and regenerating the area.

Treatment

1) This is not a high priority area since it is regenerating naturally. Leave and observe. Should cleanup old fencing and tires.

SUGGESTED SCHEDULE AND COST ESTIMATES

A schedule of seasonally-based activities was developed to implement restoration activities and is presented in Table 2. Consideration was given to the phenology of plant species, the flooding regime, dormancy requirements, planting windows, and other practicalities. Costs were estimated based on a literature search, consultation with other consultants, nursery requirements, and input from ministry representatives.

The schedule was determined in view of the following factors. It takes a year to grow a deciduous seedling from seed and seeds should be gathered from or near the site. The best time to plant cuttings is in the fall after the establishment of dormancy. Planting cuttings on the vertical banks in the spring is more difficult because of persistent snow banks at the same time as spring runoff and rising water levels. Fall is best for planting cuttings in that root development will be stimulated by the long period of soil saturation beginning in April. It is the most efficient and effective to gather cuttings a day or two before they are to be planted. They should be soaked immediately upon cutting and until they are planted. This eliminates storage costs and losses. August is the driest season for operating machinery on the floodplain. Seeds must be gathered when they are ripe. Remnant shrubs are best observed after 2 growing seasons. Conifers ordered this fall would be ready to plant in spring 2001. Hardwoods sewn this fall would be ready to plant in the fall of 2000. An estimate of the quantities of cuttings and seedlings needed is presented in Table 3.

Additional factors considered in establishing cost estimates included: 1) the cost to transport labor and equipment to the site. 2) the cost to move labor and equipment from one polygon to another on the site. 3) the cost of supervision in the planting and gathering operations. Planting and labor costs were based on $15/hour, which included transportation from Horsefly. Rates for plowing were based on average rates suggested for a 80-100 hp 4x4 farm tractor. Plowing estimates were based on plowing complex configurations (double pass strips) by an experienced operator calculated at a normal production rate of 5 acres/day in dry conditions. Seedling price quotes were obtained from 2 different nurseries. Planting costs were based on relatively easy ground and well organized supervision, except for vertical streambank planting. Costs to gather cuttings were based on relatively easy to reach source materials and well organized supervision. It was assumed that there would be no charge for cull logs just transportation and distribution. The cost of professional project supervision was not included in the cost estimate.

SELECTION, HARVESTING, AND PLANTING OF CUTTINGS

Technical data contained in the following has been taken from USDA (1993). Woody material established as cuttings can be considered for channel bank protection when river velocities are less than 8 ft per second. Herbaceous materials alone can be used for velocities less than 3 ft per second and a combination of the two is suitable at velocities in between. The Horsefly River at the site during high flow is judged to be much below the 8 ft per second threshold.

For the most part, small to medium size shrub type willows and rhizomatous or creeping-type willows should be used within the channel banks and at the wetted edge. These species for our site include Mackenzie willow, sitka willow, and Pacific willow. They are found at point bars and on the low areas on the inside of meander turns. Tree type willows and cottonwood should be selected for the upper river banks. Wetland willows, which are growing in standing water or saturated conditions for long periods should be selected for planting along and in the depressions of old river channels and the ancient oxbow depressions. Species with a tall and wide canopy provide more shade and should be selected for planting along the river banks. Species with a flexible stem should be selected for planting on the channel banks particularly when the bank is on the outside of a turn. An entire section can be planted with the same species (USDA 1993). Plant shorter shrubby species at mid bank and in front of the tree form species. They provide protection for the tree willows.

When harvesting select disease and insect free wood that is not split and at least 2 years old. Diameter should generally be ¾ inch or larger. The best wood is 4 to 5 years old and smooth barked not deeply furrowed. Rhizomatous sandbar type willows rarely reach ¾ inch in size. Larger diameter cuttings have more energy reserves. Highest survival rates occur with cuttings 2 to 3 inches (USDA 1993). Cuttings as large as 8 inches have been tested with excellent success. In our case cottonwood stakes 2 to 3 inches in diameter are recommended for planting in the coarse gravel bars of Black Creek and Patenaude Creek. Cuttings should be 1 to 1.5 meters long. The long cuttings would be used on the vertical banks with 2/3 of the length buried.

Use sharp lopping shears to make clean cuts. No more than a third of any individual plant should be removed. Cut off the apical bud plus several inches of the cutting (horizontal on the top cut) before planting. This is the flowering part of the stem, which will consume much energy, which needs to go to forming roots. Trim off the side branches and cut the base at a 45^{o} angle. With the base at 45^{o} and the top horizontal the top and bottom of the cutting is easily recognized. The top of the prepared cutting should be dipped in a mixture or painted with 50/50 light colored latex paint and water. This will seal the stem from excessive transpiration losses and it reduces the possibility of disease entering the open top (USDA 1993).

All cuttings should be soaked for a minimum of 24 hours prior to planting, it initiates root growth processes. Only the bottom third of the cutting needs to be placed in water. If placed

as bundles in a bucket of water, the tops can be painted and they will be ready for planting the following day.

When planting use a long heavy bar or bar and hammer to make a deep pilot hole in the plowed strip. Select the lower wetter spots. Shrub form willows can be 1 meter or less apart but the tree form willows should be 2 or more meters apart. Be careful to get good soil stem contact. Avoid damaging the buds when inserting the cutting. Use additional soil to drop down the hole and carefully tamp the soil as you fill the hole.

PROJECT MONITORING

To document knowledge gained from this project a monitoring plan is necessary. It is suggested that the representative photos, which were taken at all impaired streambanks and floodplain areas, be used as photo points for monitoring. Photo locations were selected in order to facilitate a monitoring strategy. Photo numbers directions and locations are delineated on the air-photo maps (Appendix II) and they appear in Appendix III. Photos should be retaken after site prep, after planting, and in the spring (before the grasses hides new shoots) for the first three years following treatment. After the 3rd year, photo monitoring could be conducted on 2 or 3 year intervals.

In addition to the photo monitoring scenario, survival and growth should be monitored by measuring seedlings and cuttings in representative locations. Ten percent of clusters at each polygon should be monitored on an annual basis for the first three years and then every 3rd year thereafter. A photo album, monitoring plots, and monitoring forms should be established. Plots could correspond to randomly selected clusters. Number of survivors, height growth, new shoots within the cluster, browsing influences, type of damage, and other ecosystem comments is some of the information that could be included on the monitoring form.

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APPENDIXES