

An Ecological Assessment of Alternative Management Options
Related to the Tranquille Wildlife Management Area



Prepared for
BC Ministry of Environment
by
Thomas E. Dickinson (PhD)
Thompson Rivers University



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Executive Summary

This report combines new information on the ecology of the Tranquille Wildlife Management Area and adjacent associated lands (here collectively referred to as the Tranquille WMA) with knowledge from existing reports and the published literature. The project's goal has been to develop a perspective on what potential natural communities might develop under different alternative management scenarios in the WMA. The area consists of a large seasonally flooded wetland, associated riparian areas, and a fenced field currently used for hay production and winter cattle grazing. The area is highly attractive to a variety of bird species and other wildlife and is recognized as a federally designated "Important Bird Area". It also has extremely high wildlife viewing value.

Annually, the WMA floods completely in early June and a pond is naturally drawn down throughout the summer as floodwaters recede. Due largely to past agricultural practices, much of the area is currently dominated by Reed Canary Grass (RCG) an invasive European cultivar that limits both the occurrence of native wetland species and the expansion of stands of native cottonwood into otherwise suitable habitats within the WMA. A comparison of the WMA with remnants of cottonwood riparian stands in the region was used to identify the natural features present in the community and how a restored stand might change through succession. A review of the potential wildlife values associated with black cottonwood stands in BC suggests that partial or full restoration of the existing cottonwood stand would be both possible and desirable and would greatly enhance the habitat available for fauna present on the WMA. Some of the wildlife species are listed as species of concern federally and/or provincially. Because the present stand of RCG suppresses the natural establishment of cottonwood and other colonizing species, some form of management intervention would be required to achieve a more natural community. A perspective of the potential community that might possibly be generated in the area is developed using insights from similar areas in BC.

A review of the published literature on RCG control suggests that a mixture of different physical and perhaps chemical control techniques applied at critical periods throughout the year would be needed to successfully reduce or eliminate RCG infestation. Previous suggestions that mowing and grazing might serve to increase biodiversity of the existing RCG stands is not supported by a comparison of plots which are grazed and those from which grazing has been excluded. Any increases in the diversity accompanying combined mowing and grazing seems to come from other invasive species or early seral stage colonizers that accommodate disturbances. Annual mowing for hay does have some benefits in that it makes new vegetative growth accessible to waterfowl.

Six management scenarios are developed ranging from simply maintaining the *status quo* to extensive active restorative intervention and are analysed with respect to five key target values that reflect previously stated management priorities. Under a *status quo* or *status quo* with development options, the biodiversity value of the area is very likely to erode. A major cause is the inability of overmature stands of black cottonwood and other tree species to regenerate and the continued invasiveness of RCG. Other options that include RCG control generate more diverse wetland ecosystems in areas where cottonwood and shrubs currently cannot grow. With intensive restoration work the wetland so formed could be enhanced within 10-15 years to support a young cottonwood stand and within 50 years to contain most of the features of a late seral stand would be achieved.

Several recommendations are made including the eventual discontinuation of cattle grazing in the designated areas and the development of a vision for how this area would fit within a broader landscape of habitats within the Kamloops region.

1.0 Introduction

This document aims to provide information relevant to the management of the Tranquille Wildlife Management Area (WMA) and adjacent lands that fall Inside Lac du Bois Grasslands Protected Area, near Kamloops, British Columbia. It builds on previous detailed background documents, particularly one prepared by Howie (2007), which identified both challenges related to the management of the area and information gaps that need to be filled before those management challenges could be adequately met. In particular, this report addresses four identified topics:

1. The potential successional trend of habitats within the WMA area toward natural ecological communities, as indicated by areas in the region that experience similar annual conditions;
2. The habitat impacts of mowing and grazing in one portion of the area (DL341) with reference to the plant species in an adjacent portion of the area where hay mowing does not take place and cattle grazing does not currently occur;
3. The potential of different management tools that are available to control and/or potentially eradicate Reed Canary Grass, should that management option be adopted;
4. The possible outcomes of several different management scenarios including the *status quo* and a range of different levels of active management such as the elimination of certain current uses and an intensive programme of active habitat restoration.

The goal of this study has not been to develop a full cost/benefit analysis of the impacts of the different management scenarios on the full range of other interests in the area. However, two particular interests identified by Howie (2007) are relevant to the discussion. The first involves the possible development of an Eco-Resort on adjacent lands to the Northwest of the area. The second interest involves an existing permit to remove hay from the portion of the area termed DL 341.

2.0 Methodology

2.1 Area Included in this Study

The lands referred to in this study have been thoroughly described by Howie (2007) and are illustrated in Figure 2.1.a &b. The WMA is outlined in red on the lower portion of the figure and includes a seasonal pond. A dike and walking trail occurs on the eastern border of Lot 341 and small dark fragments in the lower portions visible along it are the remnants of a stand of cottonwood that likely historically grew along sandbars throughout the eastern half of DL341.



Figure 2.1. Aerial imagery (a) and mapping (b) showing the locations of WMA and DL 341.

2.2 Areas Used for Comparison of Remnant Black Cottonwood Stands

Three areas within 20 km of the WMA were chosen as reference points to understand some of the physical processes that generate and maintain cottonwood stands in the dry interior of BC (Figure 2.2). The first (a) was located on the Whispering Pines Indian Band reserve on the Western bank of the North Thompson River. The second area (b) was located on the Kamloops Indian Band reserve on the Eastern banks of the North Thompson River, just north of the Halston Bridge. The final area for comparison (c) was located on land owned currently by Domtar Canada located immediately west of the Kamloops Wastewater Treatment facility at the junction of the Thompson River and Kamloops Lake (immediately South of Tranquille.)

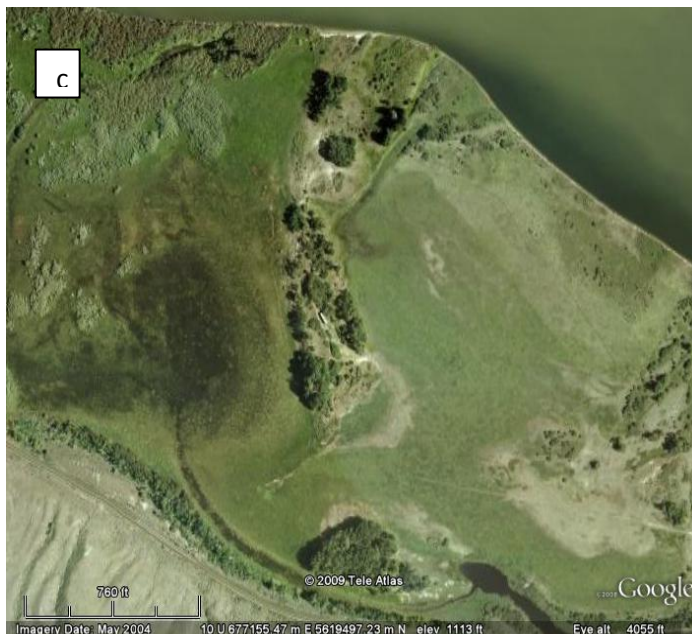


Figure 2.2. Three cottonwood stands along the North Thompson and Thompson Rivers used as comparators in studying local cottonwood stands. a. Whispering Pines Reserve 4; b. Kamloops Indian Band Halston; c. City of Kamloops Wastewater Treatment Plant.

2.3 Quantitative Comparison of Grazed and Ungrazed plots

Cover

Two parallel transect lines were run along the fence that borders the south side of the pasture in DL341. Canopy cover (by layer) was determined using a standard Daubenmire frame (20x50 cm). One line was set-up 5 m from the fence in the pasture (hay/grazed area) area and the other was set-up 5 m outside the fence on the ungrazed side. Both lines started at the east end of the pasture and ran parallel with the fence (east to west direction). Frames were placed every 5 fence posts (approximately 14 m) for a total of 15 frames (approximately 200m) on each of the fence line.

Biomass

Biomass samples were clipped on the outside of the pasture only because very little stubble was left on growth inside the fence. A Daubenmire frame was used (20x50cm) and only this year's growth was clipped. Litter was left and not sampled. A total of five frames were sampled, each being approximately 10 fence posts (approximately 28m) apart. Plant material was dried for 24 hours to a constant weight and then weighed.

2.4 Review of Management Tools for Controlling Reed Canary Grass

Reed Canary Grass – RCG – (*Phalaris arundinacea* L.) is an aggressive invasive grass species in wetland ecosystems throughout North America and has been on the study site for at least fifty years (and very likely much longer). Numerous studies have demonstrated that it has strong negative impacts on native wetland species and wetland restoration requires that it be controlled. It is one of the main management concerns that need addressing at Tranquille (Hennan 2001; Howie 2007).

A survey of managers in the United States who regularly attempt to control *P. arundinacea* concludes that customary pre-restoration site preparation usually consists of a spring prescribed burn followed by an application of glyphosate herbicide (Reinhardt 2004, Adams and Galatowitsch 2006). Although 95% of managers surveyed employed this technique only short-term control has been reported (Apfelbaum & Sams 1987; Preuninger & Umbanhowar 1994; Solecki 1997; Kilbride & Paveglio 1999), or little control beyond a few weeks after implementation has been observed (Apfelbaum & Sams 1987; Henderson 1990; Kilbride & Paveglio 1999).

In an attempt to better understand the “best practices” used to control RCG abundance and spread in restoration projects, a review of the current literature was carried out. The literature on RCG control resides in a diverse range of journals and reports. A search was made in databases relevant to the fields of agriculture, ecology, geography and restoration biology. It uncovered numerous experimental studies that have been conducted over the last

decade. The possible practices in the context of the Tranquille area are summarized and described.

2.5 Management Scenario Comparisons

A central goal of this project is to compare the future ecological conditions that might emerge if managers altered current management practices, or adopted a more active restoration program on the site. The goal is to identify which of a range of management options might serve the short and long term ecological goals for the site. Thus, a range of six different scenarios were developed that ranged from a situation in which no specific management actions are taken and events such as proposed residential / commercial development unfold, to a scenario in which active intervention is to be taken as quickly as possible to restore the area to likely pre-settlement conditions.

The effects of the different management options on five key target values that derive from the existing management plans for the area are projected. These values are those associated with: the existence of a native plant community; maintaining habitat for a variety of waterfowl species; habitat for other wildlife species; opportunities for viewing wildlife; and an area for pasturing and calving cattle. The projections of the future conditions are based on a combination of output from existing habitat models for different species, from discussions with experienced managers, and from the published literature.

3.0 Interpreting the Past, Present & Future Conditions of the Study Area

Over the post-glacial period the floodplain of the river may have changed numerous times. However, there are several lines of evidence indicating that the nature of the study area was most dramatically altered by the introduction of agriculture soon after European settlement. Photographs from as early as 1871 (Figure 3.1) show the fields cleared and grain crops (likely wheat or barley) were planted on the cleared floodplain and the grain was milled on the local homestead. Water control structures still remain on the study area that were salvaged from gold dredging equipment that likely fell out of service around this time. Finally, photographs of bullocks pulling hay wagons from this time suggest that multiple crops were being harvested from the current area.

Early photographs of the area also indicate that a line of black cottonwoods was left along what is now the raised dike on the Eastern side of the study area. Although difficult to interpret with any certainty, the original line of black cottonwoods appears to be fuller and more densely packed than currently is the case. The cottonwoods were likely left for their value in moderating the degree and extent of flood damage, by reducing the velocity of water entering the pond area.

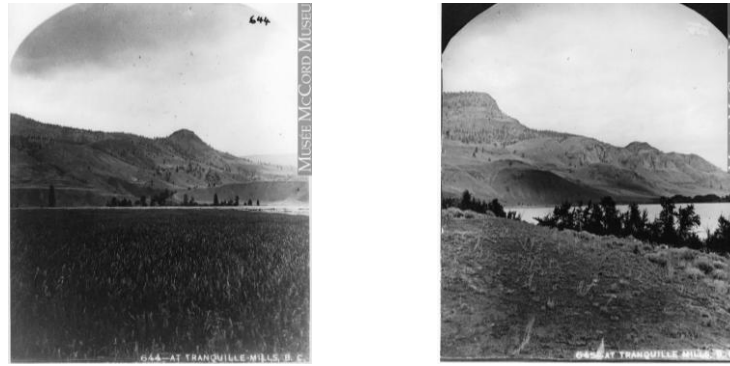


Figure 3.1 Historic photos (ca. 1871) of the Tranquille Site. The perspective is likely from the Fortune family homestead looking NE. a) A grain field on the farm; b) the plain flooded in late spring with a stand of cottonwoods appears on the distant shore (from the McCord Museum Archives, Montreal).

Today, the black cottonwood stand that persists on the area today is only a thin line of trees, mainly along the eastern edge of the area (Figure 3b). Currently the trees are largely decadent with an abundance of downed branches and other coarse woody debris, as well as several dead standing trunks. The understory is dominated by a shrub layer, often wild rose and herbs and grasses (see Howie 2007). Regeneration of cottonwood saplings is taking place outward from the dike into a 10 m wide band that extends W from the dike on the Eastern side of the area. The saplings stop at a fence bordering the mowed and grazed area of the field. Where grazing occurs, the cottonwood suckers all but disappear.

Figure 3.2 provides a photographic record of the extent of inundation of floodwaters in 2008 and the recession of the floodwaters from early June to early September. The pattern of inundation points to a geomorphic position that would have been ideal for the development of a cottonwood stand in the south eastern corner of the area. Originally, this area would likely have extended well into the area that is currently fenced and hayed. Visible as dry areas between wetter swale in the photoseries are a number of raised sandbars that would have likely historically supported black cottonwood originally. (These are the locations that would be ideally situated for any future restoration efforts.) Along these raised beds, a system of cottonwood would have had sufficient access to water throughout the key growing season to enhance the likelihood of their successful establishment. Restoring cottonwood to these raised beds was suggested by Hennan (2001) and will be discussed in more detail later.

Also visible in the series of photographs is the apparent natural tendency for a string of ponds to occur (July 9) and then retreat to a single water body. This natural tendency points to an opportunity to expand the size of the existing pond or to develop a second pond. This was also an option discussed by Hennan (2001) that could be implemented with very little new infrastructure. However, in order to allow for the expansion of the pond, current practices would have to be altered and new infrastructure may need to be developed.

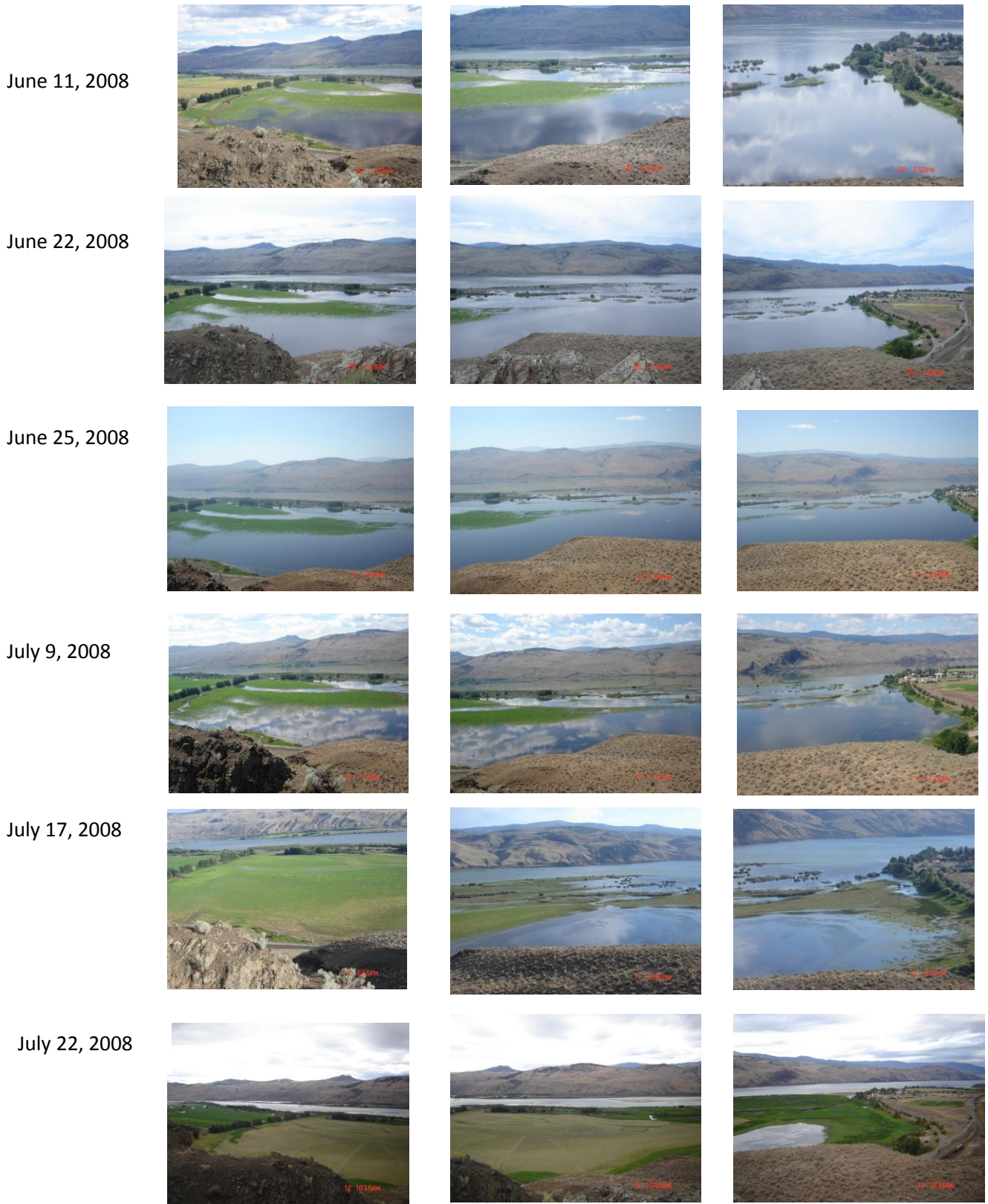


Figure 3.2. A photographic record of the inundation of the study area by floodwaters and their subsequent retreat (left to right looking SE, S and SW from Mara Hill).

3.1 Natural Dynamics in Cottonwood Riparian Stands like those at Tranquille

In the past, periods of large scale flooding (or occasionally perhaps fires) likely removed much of the vegetation from this floodplain for varying periods of time. The dynamics of succession in riparian areas that contain black cottonwood stands has been well documented in the Pacific Northwest (Fierke and Kauffman 2005). Stand initiation typically begins with the establishment of cottonwood and willow seedlings on recently deposited moist alluvial substrates following floods. These sites typically occur on gravel bars in areas subject to seasonal inundation and scouring, such as those described above.

The development of the stand next moves through a 5-10 year phase post-establishment during which large numbers of small pioneer seedlings and saplings are removed as weaker individuals die. Depending on the microclimate of the site, desiccation can be an important force in seeding mortality. Early seral stands develop an understory of shade tolerant shrub species. In Oregon and Washington State, later successional stages are characterized by increasingly large individual cottonwoods and higher densities of late successional tree species such as Oregon Ash (*Faxinus latifolia*). Local remnant stands lack ash but contain paper birch and occasionally veteran Douglas Fir and Ponderosa Pines.

3.2 Reference Black Cottonwood Stands Compared with those at Tranquille

The cottonwood stands at Whispering Pines, Halston, and the Treatment Plant provide a chronosequence that, to a degree, reflects the successional pattern described above. The Whispering Pines site would qualify as an early seral forest with no grazing occurring. It contains abundant young cottonwood in the 40-60 year range and a few older individuals. The trees occur on raised gravel bars and consists of diverse understory of herbs, including star flowered Solomon seal, aster, bedstraw, and horsetail with a shrub and small tree layer consisting of water birch, paper birch, snowberry, Oregon Grape (*Mahonia*) and several *Ribes* species.

The site at Halston consists of more large trees in the 50-100 year range again arranged on gravel bars that parallel the river's edge. A border of willow adjacent to the river is likely maintained at the stand establishment phase of development by annual inundations at a high flooding intensity. The understory is much the same as that described at Whispering Pines, but contains more birch species on the river side and more hawthorns on the upland side. Sporadic cattle and horse grazing at this site has greatly reduced the herb layer of the understory. Much of an expected grass cover is missing as is much of the herbaceous layer described in the previous paragraph. The site is dominated by horsetail in wetter areas and yarrow and goldenrod species that have invaded drier areas.

The Treatment Plant site is directly south of the WMA less than a kilometre across the Thompson River. It is currently owned by Domtar and has traditionally been leased for hay production. For many years fields that have been converted to a mixture of bluegrass, brome and timothy produce hay crops. In addition, a small herd of horses ranges over the property and grazes year-round, except when the land is inundated by floods. Although greatly altered by agricultural disturbances, the site contains fragments of late seral cottonwood stands in several

locations. Where horses have access to the stand, the understory is greatly diminished and consists of shade tolerant species of low palatability (such as *Mahonia* and *Ribes*). Where the interior of the stand is inaccessible to the horses due to considerable amounts of coarse woody debris that has accumulated, the understory is dominated by a community of shade tolerant herbs, similar to those found in some parts of the early seral stands.

Neither this nor previous studies at Tranquille located any federally or provincially listed plant species at risk that are restricted to black cottonwood stands (Howie 2007). The potential natural plant community that might be expected to develop in late successional cottonwood stands in BC's interior has been described (Petersen *et al.* 1996). Table 3.1 lists some of the plant species that would be expected to dominate a late successional stand of black cottonwood at Tranquille. The species listed in this table were indeed the most common terrestrial species recorded in remnant cottonwood stands studied here and all appear on Hennan's (2001) plant list for the site and on Petersen *et al.*'s (1996) associates of mature black cottonwood stands in BC.

Table 3.1. Tree, shrub, and herbaceous associates of black cottonwood in the interior of BC.

Trees	Shrubs	Herbs, ferns & low shrubs
Black Cottonwood	Red-osier dogwood	Horsetail
Aspen	Beaked hazelnut	Scouring Rush
Douglas Fir	<i>Rosa</i> spp. (Wood's/ Nootka)	Canada Violet
Ponderosa Pine	Common snowberry	Common bedstraw
White spruce	Black twinberry	Touch-me-not
	Black hawthorn	Blue joint grass
	Choke Cherry	Star-flowered Solomon seal
	Sandbar Willow (<i>Salix</i> spp)	Oregon grape
	Mountain Ash	<i>Carex</i> sedge spp.
		Wild Strawberry

As black cottonwood stands develop, after about 50 years (depending on site quality) individual cottonwood trees begin to slow their growth in height (Petersen *et al* 1996). With this maturation, trunks increase greatly in diameter as the stand thins. In late successional stands individual trees can reach 200 years old before they senesce and drop out of the canopy. As they do, in some regions and biogeoclimatic zones, other tree species come to occupy increasing amounts of the stand. Historically, stands would often have been destroyed by floods (or other events) before they reached this late seral stage. The landscape, however, would have contained stands of many different ages with some containing the attributes of mature stands.

As is common for many forested ecosystems, the greatest biological diversity is supported by periodic intermediate levels of disturbance which maintain a mixture of early, mid, and late-seral conditions. The presence of grazing does however seem to reduce the herb layer in these stands. Nonetheless, the three locations used for comparison provide a chronosequence of later succession that might be produced in any managed situation at Tranquille.

The same disturbances that maintain diverse communities also create conditions favourable to invasion by weedy species, such as Reed Canary Grass (RCG) (Kercher and Zedler, 2004). RCG was found sporadically in the interior of some of the comparison stands. Where RCG occurs in forest stands it has been shown (Cordes et al. 1997) to be a major factor inhibiting understory and late successional tree species establishment. Stands with >15% cover of Canary Grass typically have lower structural diversity than other stands. Moreover, they contain fewer small cottonwoods, fewer total understory trees and fewer late successional tree species.

3.3 Plant Communities in Current Reed Grass Dominated Systems

The past history of haying and mowing (and perhaps planting) has resulted in the DL341 portion of the study area being dominated by RCG. Previous reports of the plant community in the unmanaged and managed areas of Tranquille have been ambiguous about whether mowing and grazing might actually improve overall plant species diversity (Howie 2007, Hennan 2001). As noted with respect to forest communities, ecological theory also suggests that in grass-dominated systems intermediate levels of disturbance can increase diversity compared with communities that experience no, or very high intensity disturbances.

Table 3.2 shows the results of a paired comparison of vegetation (cover by species) along a transect that crossed the majority of the mowed and grazed portion of the area. Outside of the fence, the community consisted of a monoculture of RCG. Other species occurred in the vicinity of the plots, but none of the sampling frames recorded them. Inside the fence, the community was similarly heavily dominated by RCG. In some frames bare ground was recorded. These areas were places where persistent cattle trampling occurred. In a few of those spots, the soil was dampened and a species of *Carex* sedge occurred. Periodically a few stems of alfalfa were encountered.

Although community indices would record that the grazed plots would have higher diversity, it would be due to Kentucky bluegrass and other cultivars and one or more pioneer species. Thus, there is no quantitative support for the comments made in other studies regarding beneficial outcomes for diversity from grazing in this pasture.

It is possible that large portions of the field may have historically been maintained in a non-forested condition because of the intensity of flooding. However, because of the high agricultural value of floodplains in this region, most similar sites have been heavily altered. As a result it is not possible to find reference sites that show what unaltered communities may have been like. In some periods the area may have supported a cattail marsh and in others a prairie. Nevertheless, in order to restore this ecosystem, a control program for RCG would undoubtedly have to occur. Hennan (2001) has provided some suggestions about the logistics of restoring habitat both inside and outside the currently fenced mowed and grazed areas.

Table 3.2 a comparison of percentage ground cover by species for grazed and ungrazed sampling plots related to DL341 at Tranquille.

Outside Fence

<u>Frame</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>Avg.</u>
Bare ground	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Litter	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100.0
Canary grass	40	98	100	100	100	100	100	100	100	100	100	95	100	100	100	95.5

*other species noted in surrounding area were cottonwood and willow

Inside Fence - Grazed Area

<u>Frame</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>Avg.</u>
Bare ground	0	0	0	0	0	0	5	5	15	0	0	0	90	1	0	7.7
Litter	85	80	85	90	85	60	50	60	60	85	75	90	15	85	80	72.3
Canary grass	60	50	70	70	65	70	42.5	25	60	85	80	25	5	70	50	55.2
Sedge	0	0	0	0	0	10	15	10	0	3	0	0	5	0	0	2.9
Kentucky bluegrass	0	0	0	0	0	0	12.5	5	0	0	0	0	0	0	0	1.2

*other species noted in surrounding area were alfalfa, *chenopodium* (chickweed)

3.4 Potential Wildlife Value of a Restored Black Cottonwood Stand at Tranquille

Because of the value of floodplains for agriculture and residential settlement, black cottonwoods stands are identified as an ecosystem at risk in BC's interior. The wildlife values of black cottonwood stands are large and derive from habitat created by standing live trees (that retain dead branches of substantial diameter), dead standing snags (that provide a gradual exposure of decayed wood for cavity-nesting opportunities) and dead downed coarse woody debris (Petersen *et al.* 1996). In addition, broad leaf trees such as cottonwood support an abundance of insects and thus a variety of foliage-gleaning and insect-catching bird species. Previous reports (Hennan 2001, Howie 2007) have described some possible benefits of management actions that would increase the amount of black cottonwood wildlife habitat at Tranquille. Because this is one of the few areas in the interior of BC that a fairly large area of restoration of this threatened ecosystem could occur, it is an idea that should be given serious consideration.

Table 3.3 lists some of the most regionally important groups of wildlife that would most likely benefit from the habitat features provided by future condition that contained a restored black cottonwood stand with interspersed waterways. The Bald Eagle, one beneficiary, is blue-listed provincially and uses large, mature cottonwoods and other species for nesting locally. In addition, like the eagles, Western Grebes, Osprey, White pelicans, Great Blue Herons, Sandhill Cranes and Double Crested Cormorants fish for a variety of species (such as carp) that spawn in the adjacent vernal ponds. Most of these have been identified as species of special concern.

Western Screech Owls are red-listed provincially and endangered federally have been identified as occurring near Kamloops as associates of old cottonwood stands. Other owl species, such as the Long-eared owl, regularly uses nearby cottonwood habitats. Another wildlife species at risk that uses old cottonwood is the Lewis' Woodpecker (blue-listed provincially) which has been historically common near the study area. This species both nests in cavities in large diameter trees and hunts aerial insects. Another important federally endangered species is Townsend's big-eared bat which has been anecdotally observed in the area. Its association with mature cottonwood stands is because large trees provide both roosting and foraging habitat. Finally, several *Myotis* bat species have been identified foraging over the flooded parts of the study area in the spring and summer (personal observation). Their association with cottonwood stands throughout their range is likely linked to the availability of roost sites. Several other

cottonwood-associated wildlife species have been identified as deserving special attention because of their reliance of large diameter trees for their habitat requirements. The amphibian species associated with cottonwood stands require the decomposing coarse woody debris they produce as overwintering sites and favour locations close to breeding ponds.

Table 3.3. Some common wildlife species recorded at Tranquille that are regularly associated with black cottonwood (Footnotes indicate their species at risk status)

Category	Species (¹-red listed; ²-blue listed; ³-yellow listed)
Primary cavity nesters	Lewis' woodpecker ² , Pileated woodpecker, Hairy woodpecker, Northern Flicker, Red-naped sapsucker, Downy woodpecker
Secondary cavity nesters	Barrow's Goldeneye, Bufflehead ³ , Common merganser, Hooded merganser ³ , Wood duck ³ , Western Screech Owl ¹ , Northern Saw-whet Owl, Merlin, Kestrel
Common nesters	Great horned Owl, Long eared Owl, Bald Eagle ² , Osprey, Pacific Slope Flycatcher, Coopers Hawk, Ruffed grouse
Small mammals	Pacific water shrew ² , Pacific jumping mouse, Townsend's big-eared bat ¹ , Southern red bat ² , Western spotted bat, Silver haired bat, Northern Flying Squirrel
Furbearers	Bobcat ³ , mink, Ermine ³ , River Otter, Black Bear, (Fisher),
Amphibians and Reptiles	Long-toed salamander, Pacific Tree Frog, Western toad

The shores of the Thompson River, which includes the study area, is also important for bird migration and has been identified as part of Canada's Important Bird Areas. Several of the species previously recorded as being resident in the area are listed as species of concern either federally, or provincially, or by conservation groups such as Partners in Flight (see Table). Several species of reptiles and amphibians might also benefit from an increase in the extent of the cottonwood at Tranquille. Among the amphibians, the pacific treefrog, the western toad and the long-toed salamander would benefit from more overwintering habitat. Western painted Turtle numbers would likely increase if water levels were regulated so as to provide more permanent pools with logs for basking.

Table 3.4 gives a list of the bird species that have been recorded on the study area (along with their breeding status) and whose numbers might be affected by the restoration of cottonwood habitats at Tranquille. No one species that does not already occur at Tranquille is expected to become newly established. However, at least forty that have been recorded would be expected to increase in number, or move from a status of possibly breeding to breeding. Howie

(2007) noted the bird species of concern that currently use the WMA. Among some possible changes that could occur that involve these species would be increases in Great blue heron (blue listed) as a result of increased breeding habitat,

Table 3.4 Bird species likely to increase in number with cottonwood habitat restoration. Those in bold are recognised as ‘Priority landbirds’ by Partners in Flight.

Species	Scientific Name	Current status
Barrow’s Goldeneye	<i>Bucephala islandica</i>	migrant, breeds
Wood Duck	<i>Aix sponsa</i>	visitor, breeds near
Red-tailed Hawk	<i>Buteo jamaicensis</i>	summer visitor, breeds near
Merlin	<i>Falco columbarius</i>	resident
Pergrine Falcon	<i>Falco peregrinus</i>	resident
Great Horned Owl	<i>Bubo virginianus</i>	resident
Long-eared Owl	<i>Asio otus</i>	occasional visitor
Vaux’s Swift	<i>Chaetura vauxi</i>	summer visitor
Rufous Hummingbird	<i>Selasphorus rufus</i>	summer visitor
Calliope Hummingbird	<i>Stellula calliope</i>	summer visitor
Lewis’s Woodpecker	<i>Melanerpes lewis</i>	summer visitor, breeds
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>	summer visitor
Downy Woodpecker	<i>Picoides pubescens</i>	resident
Hairy Woodpecker	<i>Picoides villosus</i>	resident
Northern Flicker	<i>Colaptes auratus</i>	resident, some migrate
Pileated Woodpecker	<i>Dryocopus pileatus</i>	resident
Western Wood Pewee	<i>Contopus sordidulus</i>	migrant
Dusky Flycatcher	<i>Empidonax oberholseri</i>	migrant
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>	migrant, breeds near
Cassin’s Vireo	<i>Vireo cassinii</i>	migrant
Warbling Vireo	<i>Vireo gilvus</i>	migrant, breeds near
Red-eyed Vireo	<i>Vireo olivaceus</i>	migrant, breeds near
Tree Swallow	<i>Tachycineta bicolor</i>	summer visitor
Violet-green Swallow	<i>Tachycineta thalassina</i>	summer visitor
Black-capped Chickadee	<i>Poecile atricapilla</i>	resident
Mountain Chickadee	<i>Poecile gambeli</i>	resident
Red-breasted Nuthatch	<i>Sitta canadensis</i>	resident
Brown Creeper	<i>Certhia americana</i>	migrant
House Wren	<i>Troglodytes aedon</i>	summer visitor
Mountain Bluebird	<i>Sialia currucoides</i>	summer visitor
Gray Catbird	<i>Dumetella carolinensis</i>	summer visitor
Cedar Waxwing	<i>Bombycilla cedrorum</i>	summer visitor
Orange-crowned Warbler	<i>Vermivora celata</i>	migrant
Nashville Warbler	<i>Vermivora ruficapilla</i>	migrant
Yellow Warbler	<i>Dendroica petechia</i>	migrant
Yellow-rumped Warbler	<i>Dendroica coronata</i>	migrant
Spotted Towhee	<i>Pipilo maculates</i>	winter visitor, migrant
Dark-eyed Junco	<i>Junco hyemalis</i>	resident, also migrant
Lazuli Bunting	<i>Passerina amoena</i>	summer visitor
Bullock’s Oriole	<i>Icterus bullockii</i>	summer visitor

4.0 Options for On-site Control of Reed Canary Grass

The restoration of mature cottonwood on the area is a prerequisite for providing many of the wildlife values that Tranquille would be capable of supporting. As described earlier, for this to occur, the proliferation and invasion of RCG would need to be controlled.

4.1 Review of Control Alternatives

When RCG has been present and has established itself long enough to exclude native species, there is little capacity to exclude it naturally. The literature on control measures for RCG is extensive and is spread through a diverse range of published sources. Fortunately, Lavergne (2006) has assembled the knowledge into an extremely comprehensive review. The following relies heavily on the conclusions he reached. The main types of controls for invasive plants involve biological, physical, and chemical methods.

4.1.1 Biological Control

Although some experimental results have suggested that viruses and certain insect species act to control the impact of RCG in its native European ecosystems, there has been no research to develop these agents as biological controls elsewhere. Similarly, some fungal pathogens have been shown to experimentally reduce growth and seedling development on at least a few genetic varieties of RCG, but no biological controls have been commercially developed.

Experimental evidence suggests that RCG is also sensitive to competition for light, so may be outcompeted by some shade tolerant species, or species that would form a closed canopy as would cottonwood. In addition, some native species of sedges (*Carex*) appear to have a competitive advantage over RCG when nutrients (especially nitrogen) are limited. Thus, manipulating nutrient availability may be a strategy to contain new RCG infestations if coupled with the use of seed of native species as a competing crop. However, where disturbance and nutrient loading are recurrent phenomena, the life history characteristics of RCG inevitably allow them to invade and reinvade successfully.

4.1.2 Physical Control

In theory, fire could limit RCG infestations in a pure stand by removing growth and a seed bank prior to spring germination, so that fire adapted native species could more readily colonize the site. However, the effectiveness of spring burning is problematic—in some cases actually enhancing RCG spread. To be effective the use of fire needs to be timed carefully and to be coupled with other enhancements such as seeding with native species and close monitoring.

Hydrological controls could also in theory control RCG by affecting growth and survival of adult plants. However, RCG has proven to be exceedingly resilient to flooding. The manipulation of water levels seems to be most effective at limiting new infestations by removing a seed bank. Because this would apply to native species as well, seeding would be required to enhance native diversity.

Because mowing at appropriate periods can remove stems, leaves, and seed of RCG before maturation, it offers an opportunity to promote native species growth. Following from this, mowing twice annually improves the capacity to increase native species diversity. However, mowing can not promote the diversity of plants naturally found in habitats successfully invaded by RCG.

Since RCG can vigorously regrow from a network of rhizomes, other physical control measures aim at reducing its belowground biomass are needed. Most commonly, disking soil and exposing the plant material to air is used as an intervention. However, RCG rhizomes retain a resprouting capacity for at least a year after treatment. Therefore mechanical methods alone are not a sufficient control strategy and must therefore be coupled with other strategies.

4.1.3 Chemical Control

Because of their ease of application, and in spite of the potential for adverse environmental effects, herbicides are the most commonly used methods for attempting to control RCG. The greatest success has come from using herbicide formulations that are specifically designed to be used in the vicinity of wetlands. These herbicides act by being communicated from the above ground parts of the plant throughout its body to suppress growth. As such, the timing of application is crucial.

In some studies coupling spring and fall applications over a period of years was required to eliminate RCG. Even so, reinvasion from adjacent untreated areas through seed transport with flooding suggests an integrated approach to control is not only desirable, but necessary.

4.1.4 Mixed Control Strategies

The most successful reported approach to controlling RCG infestation has involved the integration of mechanical, chemical, and hydrological disturbances into a mixed strategy. This strategy used herbicide treatment early in the year to weaken plants, followed by disking late in the summer to desiccate rhizomes, and overwinter flooding to further suppress regrowth and remove any seed bank. This method reduced RCG abundance by up to 99% in three years and was less labour intensive than some alternative methods.

At Tranquille, several approaches could be taken to control RCG. One would couple late summer mowing prior to seed head development with fall disking to expose and kill rhizomes. An optional herbicide treatment in early April after remaining plants have begun to grow, using a product that would degrade before the late May flooding, could remove much of the stand. It

should be noted however that this would open the ground for invasion by other species, such as Russian Olive, which is common upstream. Vigilance would be needed to ensure that a larger problem was not created than was the one that was solved.

4.2 Possible Control of Reed Canary Grass Infestation at Tranquille

At Tranquille there are two areas that have resulted from the last sowing of RCG in the mid-1950's. Each will be considered separately. The first is within the fenced region of DL341 that is currently mowed and used for grazing that Hennan (2001) refers to as the hay meadow. The second includes the parts of the WMA and parts of DL341 outside of the fenced area. Both could be considered for the control of RCG and the restoration of a community.

4.2.1 Within the WMA lands

The area outside of the area used by hay could be characterized as a large continuous RCG stand punctuated by isolated stands of willow, red osier dogwood, and along more highly elevated ridges more-or-less isolated cottonwood trees. The area also contains channels that communicate with the river. The inundation by flood waters occurs here first and leaves later than in the hay meadow. A thick litter of RCG stems and leaves creates a mat in this area that likely prevents waterfowl from accessing newly emerging sprouts. It also likely makes travel by ungulates difficult.

A mixed control strategy would likely be required to manage this area. After flood water recedes from the area in the fall, the area could be mowed and later disked to make available forage for waterfowl. This treatment could be used alone, or, if eradication of RCG were the goal, a spring herbicide treatment (well before flooding) could be used to weaken plants sprouting from rhizomes.

4.2.2 Within DL 341

As described in section 4.0, the area used for hay and grazing is dominated by RCG and its litter derived from the previous spring flooding. Some species variety, contributed mainly by Kentucky bluegrass and other sedges, does exist within this area. As observed by Hennan (2001), flooded depressions in the hay meadow typically had an abundance of such species as Horsetail (*Equisetum fluviatile*), Spikerush (*Eleocharis palustris*), Arrowhead (*Sagittaria cuneata*), Water Plantain (*Alisma plantago-aquatica*), Variable Pondweed (*Potamogeton gramineus*), Smartweeds (*Polygonum amphibium* and *hydropiperoides*), Sedge (*Carex rostrata*(?)), Marsh Yellow-Cress (*Rorippa palustris*), Water Parsnip (*Sium suave*), and Waterwort (*Elatine triandra*).

A different mixture of controls would be required in this area that would require the elimination of cattle grazing.

5.0 A Comparison of Different Management Scenarios

Table 5.1 provides a summary and comparison of the changes that might be anticipated to accompany each of six potential management scenarios described earlier. Again each of the different scenarios stems from earlier proposed management actions that have been identified for the WMA lands. The predicted changes in target values, which also derive from previously identified management goals for the area, are outlined in more detail below. Because they range the spectrum of no management to extensive management, the values are incrementally increased throughout the range. That is, each additional activity builds on the gains of the previous one.

Scenario 1. Status Quo with Resort Development

One scenario alluded to by Howie (2007) involves the alteration of foreshore environments (particularly the removal of large over-mature aesthetically unattractive trees) by the developers of the “Tranquille on the Lake” community. Because many of these trees are non-native cultivars, the loss to the native plant community from this isolated action would not necessarily be excessive. However, some large cottonwoods do exist in the strip and their loss would exacerbate the disappearance of this habitat in other portions of the area. Furthermore, if understory shrubs and smaller plants were to be affected, local diversity would suffer and there would be a loss of seed and berry producing plants and valuable riparian edge cover for many songbirds.

Loss of this barrier could also result in a greater access by residents of the community and their pets, which could result in more harassment of waterfowl and their broods in late spring – early summer. Although visibility would be improved, the trade-off would be a lower diversity of species, especially migrant songbirds, as fewer species would have their food, shelter and security needs met. Management of this habitat will likely also affect other wildlife species, such as small mammals and bears that occasionally use the habitat. Loss of bear, mule deer and other wildlife will undoubtedly occur due to other disturbances associated with residential development.

Although cattle should not be affected by development activities, the larger number of residents in the area may bring the effects of the manure in DL341 being washed into the river during the flood up as more of an issue.

Scenario 2. Status Quo

Under this scenario, the existing depression in the diversity of native wetland plants will continue as the stand of RCG in the fenced region of DL341 and the remainder of the area continues to resist invasion and successional changes. In addition, without some management action occurring, the existing overmature stand of cottonwood on the E boundary of the area may become more patchy as dying trees are not replaced by recruitment. As noted, without the scouring action produced by high flood levels, suckering is less likely to occur. As the effects of fencing become realized, that stand may move a short distance away from the dike.

In the absence of management activities, it is likely that the dense stand of RCG on the remainder of the area will also continue to resist the spread of cottonwood and willow. The portions of the area closer to the river will continue to provide little habitat for ground dwelling species because of the tight closure of the canopy formed by the monoculture.

Likely due to the scarcity of undeveloped wetlands elsewhere, the habitat currently available in the WMA will continue to attract the variety of wildlife listed in Howie (2007). It is unlikely that the abundance levels will increase without active management. Nevertheless, the high value for wildlife viewing will likely continue in the short term, until the decadent cottonwood stands become diminished.

The value of the area for hay and seasonal cattle grazing will likely remain unchanged. However, the effect of short-term grazing outside of the fence would continue to limit the spread of cottonwood by suckering and perhaps also limit the development of willow stands. As in some of the remnant stands that were used as comparators, the herb layer would likely remain diminished.

Scenario 3. Elimination of Seasonal Grazing

Under the scenario that hay mowing continued, but grazing was eliminated from DL341, there would possibly be an increase in the availability of spring and fall forage for waterfowl. In the long-term, there could possibly be a colonization of cottonwood, willow, and dogwood of some of the growing sites in wet areas that currently have a low density of RCG. Alternatively, the loss of cattle grazing from the site might actually increase RCG density, due to lower levels of trampling and/or grazing.

With the elimination of cattle, there would also be the elimination of possible conflicts with other interests over the accumulation and washing away of manure accumulations during

flooding periods. Of course the elimination of cattle grazing would bring with it the economic cost of replacing this grazing opportunity.

Scenario 4. Integrated Management of Reed Canary Grass Stands

The degree to which the Canary Grass is controlled will affect the degree of change in the target values. In turn, the degree of control will likely be in proportion to the total effort expended. This is illustrated by the changes that can be expected in the community if native plants increase in the area.

Based on the published results of the most successful control programs, large and rapid changes in the nature of the plant community would require that control measures be carried out annually for at least 3-5 years and that native plant seed and stock be used to replace the existing stand. Some colonization by native sedges and rushes may take place quickly as a natural seed bank may arrive with flooding and with waterfowl. Rarer plants may arrive much more slowly and some might only occur with repeated re-introduction. Furthermore, the risk of the reestablishment by Canary Grass or other invasive species will be there due to the disturbance caused by the control measures.

The effects of Canary Grass management on waterfowl forage may be mixed. On the one hand, native species that would likely colonize the site would unlikely produce the biomass of young shoots and spring forage, especially on raised ridges within the meadow. However, an increased productivity of other microsites, such as depressions that remain wetter longer, may provide for a greater diversity of forage types and thus support a broader diversity of waterfowl.

Depending on whether activities such as mechanically disturbing the soil are continued annually, habitat for shorebirds could be greatly enhanced, as it is in freshly turned soils in agricultural settings. In such instances, replacing Canary Grass with an alternative crop, such as alfalfa on raised sites that experience less and shorter episodes of flooding could be used to actively attract certain species, such as bobolink.

As a result of Canary Grass control, the abundance of waterfowl that frequent the existing fields in spring might be lower. However, the greater diversity of species that could be attracted by the combination of the pond and a more natural wetland (and other habitats) could provide compensatory benefits for wildlife viewing.

The elimination of a highly productive forage crop for cattle such as Canary Grass would need to be replaced by an alternative source. At present, the forage is available for little effort.

Scenario 5. Partial Restoration and Enhanced Viewing Opportunities

This scenario adds intervention to promote the diversification of woody shrubs and trees in the WMA to the control of Canary Grass stands discussed in scenario 4. This would include establishing more willow in areas currently dominated by Canary Grass. Considerable effort could be required to control the activity of beaver, so as to protect expanding cottonwood stands. Depending on the natural regeneration of willow affected by previous management actions (prescribed burning) and insect damage (stem borers); some active replanting could be required.

The active management of the shrub component of the community to a healthier condition could add little to the diversity of native plants, but enormously to the diversity of other wildlife that use the area. Both resident and migrating songbirds would benefit from the increased availability of food and security cover. Depending on the mosaic of habitats created by the management of Canary Grass, a diversity of other bird species such as shorebirds could benefit by expanded habitat availability.

The diversity of species available for wildlife viewing would be enhanced under this scenario, and the development of facilities for viewing would capitalize on the opportunities. It is possible that increased human disturbance to the restored habitat along boardwalks could occur. In order that the habitat values not be eroded, some control of access may need to be implemented. Values for cattle are no longer part of the comparison.

Over time, it is anticipated that the ecosystems promoted under this scenario would develop into those resembling a fully natural climatic climax ecosystem.

Scenario 6. Full Restoration Management

This scenario assumes an acceleration of the attainment of a climax ecosystem as a consequence of aggressive restoration activities. Even with the most aggressive efforts it would be decades before the final conditions could be achieved.

The target conditions would approach pre-European settlement conditions. As discussed earlier, at Tranquille these would likely have been an extensive cottonwood stand along the ridges created by sandbars in the floodplain that is self renewing through suckering into gaps created by the loss of mature trees and by cottonwoods seeding into newly created habitats in marginal locations. Natural waterways would cross the system seasonally in low swales.

Dogwood and then spatially further away stands of willows would create a marginal habitat to the cottonwoods that would be maintained by the flood action and the seasonal

persistence of flood waters. A large open pond would remain in the existing location with a margin dominated by sedges and other native flood resistant species (such as annual grasses), until it merges with the shrub community. The extent of the sedge meadow would be determined by the frequency and intensity of flood disturbance.

The diversity of native plants would be the highest in this scenario, because of the range of physical niches that would exist. The diversity of wildlife other than waterfowl would also be high because of niche diversity. Waterfowl numbers would be lower and the diversity probably different; while current conditions attract a community of grassland species (such as migrating pintail), a climax community would support more woodland species (such as wood duck). Wildlife viewing opportunities would emphasize the diversity of species rather than the impressive numbers that currently are supported.

Table 5.1 a Summary of the Potential Ecosystems Developed as a Result of Different Management Scenarios

	Scenario	Potential Ecosystem Description (Key Elements)
1 .	Status Quo with Resort Development Foreshore tree removal Confined hay mowing Restricted grazing	Reduced habitat for nesting and roosting of migratory & resident songbirds Restricted border of decadent cottonwood with limited possibility for spread/infilling Open seasonal pond with concentration of stranded prey fish for birds Goose pasture with spring and fall forage; Outer bank shrub/tree community
2.	Status Quo: Confined hay mowing Restricted grazing	Restricted border of increasingly decadent trees along N&W roadways; Restricted margin of increasingly decadent cottonwoods along Eastern dike; Seasonally open pond with prey fish; goose pasture; outer bank shrub tree community
3.	Grazing Elimination: Continue confined hay mowing	Status quo with elimination of manure and eutrophication of waterways; increased forage for geese and other waterfowl.
4.	Integrated Canary Grass Management: Disking and mulching Herbicide Application Crop replacement (endemics)	Scenario 2 plus increased diversity of native plants in DL341 and WMA; increased diversity of forage types and duration of use by waterfowl; increased waterfowl nesting; increased grassland songbird nesting habitat; increased seasonal ungulate use, risk of invasive recolonization.
5.	Partial Restoration: Eliminate & Control Invasive Species Passive promotion of succession of endemics (Control beaver activity on E & S borders)	Scenario 3 plus increased abundance and diversity of native shrubs and songbird nesting habitat; greater complexity of understory plant community; renewal of decadent cottonwood stands with mix of new and old growth; long-term attainment of Scenario 6.
6.	Full restoration: (presumed pre-European conditions) mature Black Cottonwood ecosystem; ridge and swale features with gradation to willow / red-osier dogwood shrub community	Final stage of Scenario 5 attained more rapidly through active intervention to plant and seed cottonwood, diversity of native shrubs in appropriate microhabitats; and understory vegetation to create new niches at all scales for other species.

Table 5.2 A Summary of the likely Gains and Losses Following the Actions Taken in Different Management Scenarios

	Scenario	Target Value				
		Native plants	Waterfowl	O. Wildlife	Viewing	Cattle
1.	Status Quo with Resort Development Foreshore tree removal Confined hay mowing Restricted grazing	Loss of species	Losses through greater harassment	Loss of habitat	Lower diversity	Manure more obvious
2.	Status Quo: Confined hay mowing Restricted grazing	Depression of diversity	Higher abundance of green forage	Some habitat for rodents & snakes	Open line of sight	Winter pasturage
3.	Grazing Elimination: Continue confined hay mowing	Small increase possible	Small increase possible	Small increase possible	Small increase possible	Better public perception
4.	Integrated Canary Grass Management: Disking and mulching Herbicide Application Crop replacement-endemics	Increase proportional to seeding	Increased diversity; decreased abundance	Increase in diversity proportional to effort	Increased diversity of species	Loss of forage
5.	Partial Restoration: Eliminate & Control Invasive Species Passive promotion of succession to endemics (Control beaver activity on Cottonwood)	Moderate increase in diversity of species and communities	Lower abundance of grazing species; greater diversity	Increase in diversity of species & guilds	Increased diversity; less visible (substitute boardwalks etc)	No longer an issue
6.	Full restoration: (presumed pre-European conditions) mature Black Cottonwood ecosystem; ridge and swale features with gradation to willow / red-osier dogwood shrub community	Increases in diversity of species and communities at each seral stage	Lower abundance of geese; higher abundance and residency of tree nesting species	Increase in diversity of species & guilds esp. deciduous tree dependent	Further increases in diversity of opportunities with enhancements	No longer an issue.

6.0 Discussion and Recommendations

The information presented here leads to the recommendation that some management actions be taken to protect the ecological values present at Tranquille. It is possible that there will be negative consequences of residential development that will need to be offset. There will also be continuing loss of species and habitat from a deteriorating condition of cottonwood stands. Finally, the continued infestation of RCG will prevent natural systems from reversing their decline.

In one sense the simplest management decision to make is to remove cattle grazing from the hay meadow and prevent them from using the area outside of it. As noted, the habitat gains from this option are likely small unless it is coupled with restoration efforts. However, the public perception of the risks associated with the flush of manure into the river with the spring flood will undoubtedly become more of a problem as residential development in the area proceeds. Grazing hundreds of animals for several months on a floodplain only a few hundred meters from the river would not be approved in an Environmental Farm Plan for private land so should not be allowed on crown leased land. Howie (2007) pointed out that respecting historic grazing agreements was part of the Kamloops LRMP agreement, but the intent of that agreement was to allow sustainable practices to continue. The current situation falls well outside that intent.

A discontinuation of grazing could occur with only a small loss of hay mowing for forage. In fact, mowing areas outside of the fenced meadow that might not be deemed suitable for cottonwood establishment (because of the duration of flooding) could increase the total production of forage from the area. If an agreement could be negotiated to displace the cattle currently wintering on the hay meadow to the ALR agricultural lands being developed as part of Tranquille-on-the-Lake project, then no net economic losses need be realized. The government could facilitate this discussion between the lessee and the developers.

Management objectives for both the WMA and adjacent lands have evolved over their histories. The area's importance to birds, especially waterfowl and associated species continues to be high, so objectives related to these should remain a high priority. However, the focus of some earlier initiatives was on providing forage for geese (presumably Canada geese). Arguably, this focus may have changed. The development of substantial irrigated commercial hay operations to the East of the area now provides an attractive replacement for the RCG grown on site. Furthermore, much of the palatable young spring growth of RCG outside of the mowed hay meadow is inaccessible to waterfowl due to the thick litter layer that develops in the fall. Today, the value of mowing an aggressive cultivar to increase goose forage must be very small.

Because cottonwood stands are so rare on the landscape and because there are fewer and fewer opportunities to preserve mature stands of them, restoration will undoubtedly become an increasingly high priority for managers. The exclusion of cattle grazing from the borders of existing stands is allowing them to naturally spread, but under current management, the renewed

stand will be small and fragmented. Historically, the WMA area likely supported a substantial stand of trees and could do so again. Therefore, an important goal for the long-term management of this area should be the full restoration of this system.

Recommendations

In order of priority, therefore, the recommendations that flow from this report are:

1. Eliminate cattle grazing from the DL341 portion of the area and facilitate discussions to ameliorate economic impacts on the current permit holder;
2. If areas are deemed not be suitable for cottonwood restoration, permit mowing of the stand of Reed Canary Grass to make potential forage available to waterfowl;
3. Develop an integrated, multi-faceted, Reed Canary Grass control program with the aim of replacing the current infestation with native species (or less aggressive annual cultivars);
4. Encourage an existing conservation group (or develop a new group) to co-ordinate the development of a plan to fully restore cottonwood to at least 25% of the existing land area (i.e., the raised sandbars) and to monitor and manage the area against invasive species such as Russian olive.

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