The Development and Testing of a Reconnaissance Level Wetland Assessment Form on the TaTa/Skookumchuck Range Unit

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EXECUTIVE SUMMARY

In southeastern British Columbia the conservation of wetlands has traditionally focused on large wetlands or large floodplain wetland complexes. Although the habitat values of large wetlands and wetland complexes are easily recognized, small, lentic wetlands may be equally important in maintaining regional biodiversity.

The Columbia Basin Fish and Wildlife Compensation Program initiated a two-phase project to develop a wetland assessment tool and conduct preliminary assessments on 25 wetlands in the TaTa/Skookumchuck Range Unit. The system defines 12 wetland types ranging from sites; where soils are ponded (lakes, ponds and shallow water), where soils are either saturated or ponded (swamps, marshes, fens and bogs), where soils are inundated or saturated for part of the season, (shrub carr, graminoid meadow, forb meadow and deciduous margin). Five indicators are used to evaluate wetland systems; plant community composition, plant community structure, litter, bare soil and invasive plant species. A score-card ranks the status of the site against a reference condition plant community. Descriptive features include; site description, wildlife habitat features, and potential management actions. Competent technicians should be capable of assessing the condition of the vegetation and related attributes in small wetlands within a time frame of 30-100 minutes.

A total of 31 wetlands in the TaTa/Skookumchuck Range Unit were assessed. Nine of the surveyed sites were rated as in reference condition, 12 were slightly altered and five were moderately altered. Water was not found in 16 of the wetlands where it was expected; leading to the conclusion that hydrology is a major limiting factor in these wetlands. The majority (21) of the wetlands were impacted by industrial activity. Disturbance from off-road vehicle impacts was found at eight wetlands, and from other recreation pursuits at 10 wetlands. Disturbance from herbivores watering, grazing and browsing was noted in 28 wetlands.Wildlife habitat features found included snags and coarse woody debris (25 sites), loafing sites (13), and caves/rocks for nesting (11).

Recommendations include;

1. a detailed hydrological study in at least one watershed in the study area,
2. two of the wetlands found in moderate condition be selected in order to devise appropriate management actions,
3. further refinement of the tool by surveying additional wetlands in the Rocky Mountain Trench, small lentic wetlands associated with wetter forest types, lentic systems, lotic wetlands on large river systems, and lotic wetlands associated with secondary streams.

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TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

In south-eastern British Columbia the conservation of wetlands has traditionally focused on large wetlands or large floodplain wetland complexes. Although the habitat values of large wetlands are recognized, recent work suggests that small isolated wetlands may be equally important in maintaining regional biodiversity (Semlitsch and Bodie 1998; Knapp and Matthews 2000). A literature review and GIS inventory was conducted to identify conservation issues for small wetlands in the Columbia Basin (Machmer et al. 2004). Recommendations emphasized improving small wetland inventory, research on wildlife use of small wetlands, habitat protection, and stewardship. Areas that have a high density of wetlands per landscape unit such as the units found in the drier, low elevation zones of the Rocky Mountain Trench were identified as a priority.

Based on these recommendations, the Columbia Basin Fish and Wildlife Compensation Program (CBFWCP) is conducting a two-phase project to develop a wetland assessment tool that will identify restoration potential and priority, and to conduct preliminary assessments on wetlands in the TaTa/Skookumchuck Range Unit. An assessment tool that can be used throughout the Columbia Basin will complement efforts to restore grasslands and open forests in the Rocky Mountain Trench and assist in addressing issues around wetland management throughout the Basin.

1.1 Objectives

This project will be carried out in two phases. The objectives for Phase 1 in fiscal year 2005-06 were:

1. The development of an assessment tool for small lentic wetlands
2. The development of an associated instruction manual
3. An assessment of 25 wetlands in the TaTa/Skookumchuck Range Unit to test this tool
4. Produce a short list of wetlands with potential for restoration action and a rationale for how to prioritize wetland restoration activity.
5. A summary report on the work completed in fiscal 2005/06.

The second phase of the project is scheduled for 2006-07. Deliverables will be:

1. Assessment of an additional 15 wetlands in the TaTa/Skookumchuck Range Unit
2. Further testing and refinement of the assessment tool
3. Developing a wetland restoration plan for the range unit
4. Developing a restoration prescription for at least one wetland or wetland complex
5. Provide an information session on the use of the assessment tool and project overview for CBFWCP, Ministry of Environment, and Ministry of Forests and Range staff
6. A final report

1.2 Literature Review

A wide range of wetland assessment techniques were investigated to determine their applicability to the East Kootenay (Hruby et al. 2000; Smyth and Allen 2001; Fennessy et al. 2002; Forest Practices Board 2002; Fennessy et al. 2004; Alberta Riparian Habitat Management Committee 2005; Duck's Unlimited 2005; Van Wieren and Zorn 2005; Wikeem and Wikeem 2005). The development of an assessment tool must be based on an understanding of ecological factors that are driving wetland conditions and the objectives of the assessment. A requirement for a "rapid assessment", however, limits the scope of the investigation.

Assessment methods may include one or all of three functions (Alberta Riparian Management Society 2005):

1. Wetland classification based on soil, hydrology and plant physiognomy to differentiate wetland types
2. Assessment of the wetland's ability to perform functions such as sediment trapping, shoreline maintenance, water storage, aquifer recharge, maintenance of biotic diversity and primary production
3. Provide a site rating useful for setting management priorities and stratifying wetland sites for remedial action or closer analytical attention

Wetland classification systems are needed to reduce the variability that must be addressed in looking at a range of wetland types. Fennessy et al. (2002) reviewed 40 approaches used in the USA, and concluded classification systems should be based on topography, hydrologic conditions, vegetation and soils, or combinations of these four characteristics. Mitsch and Gosselink (2003) identify hydrology as the "master" variable in wetland systems, driving the development of wetland (hygric) soils, and biotic communities.

Fennessy et al. (2002) identified three tiers in assessment,

1. Landscape scale assessments (using air photos)
2. Rapid field assessment
3. Intensive biological, physical and chemical measures

The first two tiers are applicable to a "rapid assessment" as they provide an organizational structure for inventory, and the assessment itself. The third tier should be considered for sites that have received low scores in the assessment relative to survey objectives, and for which management actions will be derived.

Fennessy et al. (2004) reviewed 16 rapid assessment methods and summarized:

- The time to conduct a "rapid assessment" ranged from three hours to two days in field and office
- Consistency and repeatability between users and across years are required if these assessments are to have long-term value in the management of wetlands
- The goal should be to reduce variability within a class to allow more sensitivity in detecting differences between wetlands and scoring wetlands in comparison to other similar wetlands
- The assessment tool should provide a score for comparison only to other wetlands of similar type
- At least 50 sites per class should be evaluated to ensure adequate sample size

Breaux et al. (2005) looked at a set of wetlands in the San Francisco Bay area and compared a variety of US rapid assessment methods. They note the value of such assessments is in "providing a consistent protocol for evaluations, but that the ultimate assessment will rely heavily on professional judgment, regulatory experience, and the garnering of pre-assessment information".

Van Wieren and Zorn (2005) did a similar comparison of tools as part of Parks Canada's development of a monitoring program for the Great Lakes bioregion. They identified recommended sampling protocols for amphibians, birds, macro-invertebrates, water quality, water levels, aquatic vegetation, fish presence, and landscape measures. Their assessment procedure requires three to five man-days per wetland unit.

For a reconnaissance level assessment, it is important to recognize that water levels change, elevation above surface level defines expected plant communities, and plant community composition may fluctuate with water levels. Work in lotic systems in the Upper Columbia Basin notes wetland plant communities are driven by water levels, and that seasonal and cyclic flood events are important events (Jamieson and Braatne 2001).

Machmer et al. (2004) conducted a review of 10 wetland classification systems and provided an assessment of their applicability to wetlands in the Upper Columbia Basin. Assessment criteria and the advantages and disadvantages of the systems are summarized. Systems most applicable to this work are discussed below.

The most appropriate systems for the classification of wetlands in the East Kootenay are those proposed by MacKenzie (1999) and MacKenzie and Moran (2004). They build on previous work in the Cariboo/Chilcotin (Runka and Lewis 1981) that is applicable to East Kootenay wetlands. Hydrology, soils and physiognomy are used to differentiate wetland types. This system has the advantages of being compatible with the existing BEC system, site classes are identifiable on airphotos, and it provides a high level of detail for wetlands based on site associations. According to Machmer et al. (2004) the principal disadvantage to this system is that wetland classifications that have been pre-typed on air photos must be verified in the field. As the principal objective of this project is designing a field assessment procedure, this was not viewed as a limitation.

Systems to assess "function" or "health" of an ecological site vary in their approach but share many attributes. Some, such as the Riparian Function Checklist (BCMOF), Proper Functioning Condition (Forest Practices Board 2002), and the Montana-based Riparian and Wetlands Research Program (Hansen et al. 1995) follow the riparian function approach. Site description information is collected, and a number of queries with which to gather information regarding hydrologic, biotic/vegetation, erosion/deposition and nutrient inputs and water quality are answered yes, no or N/A. This disadvantage of this approach is that many of the queries attempt to assess more than one parameter. An overall score is calculated by tallying the "yes" scores to determine status as in proper functioning condition, at risk or non-functional.

The Alberta Lentic Health Assessment User Manual (Alberta Riparian Habitat Management Committee 2005) and Rangeland Health Assessment (Adams et al. 2003)

survey a number of "indicators" to describe ecosystem "health". The Lentic Health Assessment score sheet does not provide reference communities, rather all vegetation, except for invasive species are assumed to provide wetland "health" attributes. In contrast, the Rangeland Health Assessment compares sites to an appropriate reference condition site. The score-card places the site as healthy, healthy with problems, or unhealthy.

Wikeem and Wikeem (2005) have developed a rapid assessment process for fescue grasslands in the BC interior that builds on the approach of Adams et al. (2003). Their approach replaces "health" with the degree of "alteration" of a grassland community against a "reference condition" for that community. Similar to Adams et al. (2003), it includes a scoring system based on vegetation composition, vegetation structure, litter cover, soil disturbance and invasive species. Data collected in the assessment are used to score vegetation condition as reference condition, slightly altered, moderately altered or greatly altered.

Most of the systems described above provide a site rating for setting management priorities and stratifying wetland sites for remedial action or closer analytical attention, but few identify specific management inputs. The Alberta Lentic Health Assessment form has an Additional Management Concerns section, which does not contribute to scoring. These descriptors are used to assist in planning future site management, but do not identify actions. The Forests Practices Board (2002) method was modified to assess the impacts of livestock grazing, but provides no direction as to management implications. The "proper functioning condition" approach has no section to deal with any anticipated actions. The Ducks Unlimited form (2005) describes parameters that are pertinent to waterfowl such as physical attributes of the site and wetland vegetation. Dominant plant species for the riparian and upland zones are listed collectively. There is no rating system.

The rapid assessment process Wikeem and Wikeem (2005) have developed for fescue grasslands scores sites, but does not identify potential management actions to restore low-scoring sites. The Rangeland Health Assessment (Adams et al. 2003) interpretive section is primarily concerned with livestock grazing management.

Vegetation condition constitutes the only element of these systems that can be evaluated in a reconnaissance level survey. The assessment method is based on the assumption that vegetation in and around a wetland expresses the net impact of all sources of disturbance.

2.0 STUDY AREA

2.1 The Columbia Basin

The assessment tool developed in this project is designed to be applicable across the Canadian portion of the Columbia Basin. This project focuses on low elevation sites as the majority of wetlands are found here, as are the major disturbance factors affecting them.

Landscape units with high numbers of wetlands, as identified by Machmer et al. (2004), include the benches to the west of Golden and Spillamacheen, the Toby Creek bench west of Invermere, the Cherry Creek to Skookumchuck River area, the Jaffray area, and the Newgate area. The TaTa/Skookumchuck Range Unit was selected as a study area as it contains numerous wetlands, and exhibits the major wetland management issues.

2.2 TaTa/Skookumchuck Study Area

The Ta Ta/Skookumchuck Range Unit is located 50 km north of Cranbrook on the west side of the Kootenay River (Figure 1). It extends from the Kootenay River on the east to the first minor range of the Purcell Mountains in the west, referred to in this report as Pommier Ridge. The unit is divided to the east and west by one major highway, (93/95), the CPR tracks, and two major utility right-of-ways (BC Hydro, TransCanada Pipelines). The unit borders other Crown land to the north and west, and there are significant private land holdings to the south and bordering Highway 93/95. The unit encompasses approximately 8500 ha and is divided into nine pastures.

2.2.1 Climate

The study area receives an average of 37.1 cm of precipitation annually, of which 23.7 cm falls during the growing season (Appendix 1). This area has been subject to large-scale climatic fluctuations over the post-glacial period (Hebda 1982). Wetlands have evolved under relatively dynamic conditions. A discussion of these issues is beyond the scope of this work, but the development of an assessment tool for wetlands needs to be based on an understanding of climatic factors that are driving wetland condition in the longer term. Since the assessment tool is designed to be used on a single visit, it can only provide a snap shot of wetland systems that may be in transition over decades and centuries, responding to large-scale, long-term ecological, climatic and disturbance factors.

2.2.2 Landscape Units

The range unit is located within the Rocky Mountain Trench physiographic unit (Holland 1976) and includes four major landscape areas. These are:

- The active floodplain of the Kootenay River. Wetlands in this area are charged directly (over ground) by the annual spring freshette and through groundwater movement within the floodplain. This unit has few wetlands.
- Pond and wetland levels on the first bench of the Kootenay River are driven by subsurface water flows from the river due to the porosity of the underlying glaciofluvial parent material. Wetlands in this unit respond to river levels with a lag time defined by the rate of water movement. Several wetlands occur.
- The complex topography (glaciofluvial, morainal and rock outcrops) on the second bench has resulted in a large number of wetlands in depression features and in drainages between the north/south ridges. This unit contains the majority of the wetlands.

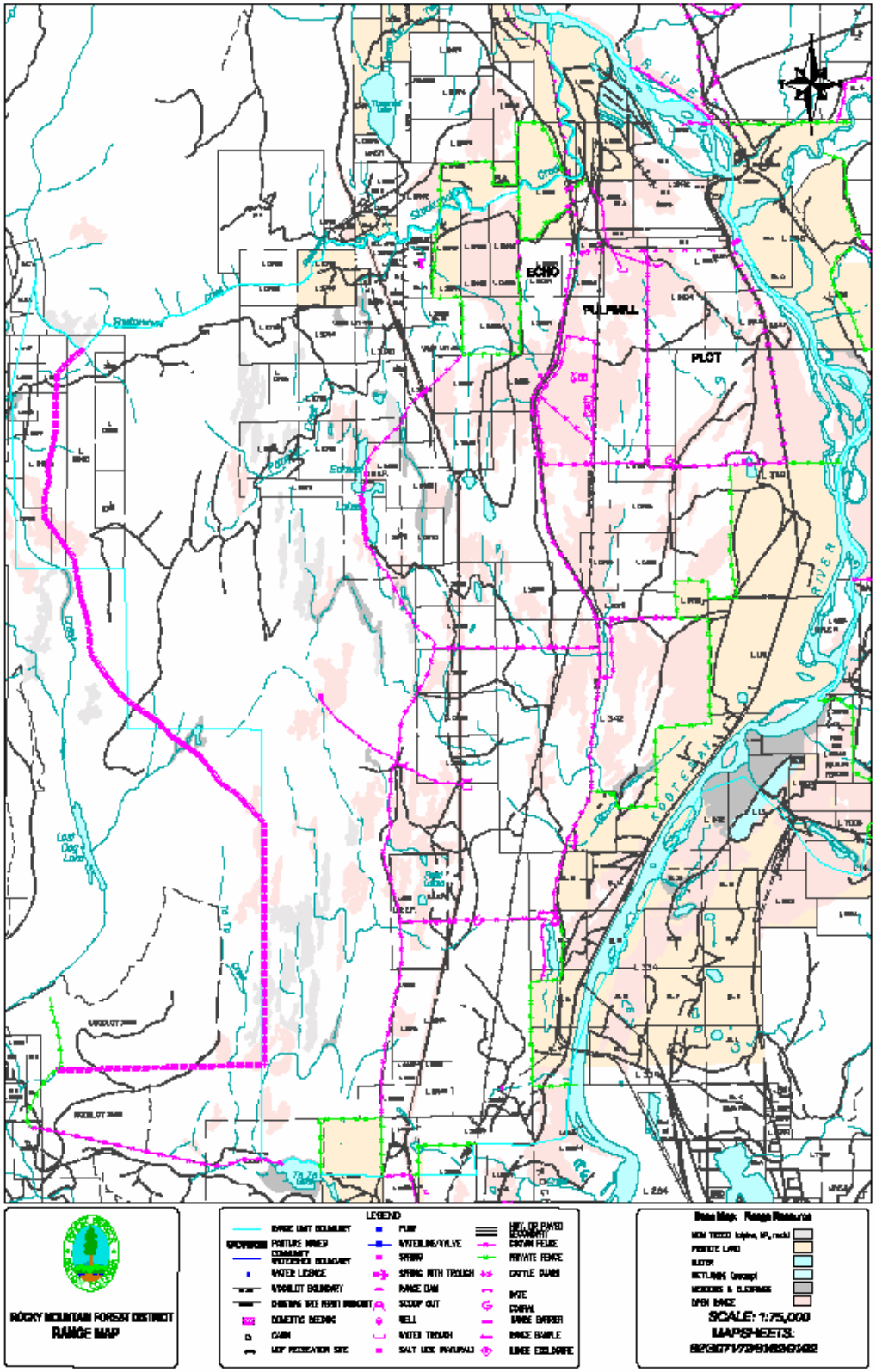


Figure 1. TaTa/Skookumchuck Range Unit

- Pommier Ridge supports few wetlands except on the ridge-top between Pommier and Mather Creeks, however surface and groundwater flows from this area charge wetlands at lower elevations.

2.2.3 Landforms and Soils

The Kootenay River floodplain is composed of fluvial deposits derived mainly from limestone, dolomite and phyllite (Figure 2). Fort Steele soils are found on gravelly, sandy deposits, while Salishan soils developed on silty clay to silty sandy material. These soils have insignificant soil development due to periodic flooding and surface additions of new material (Lacelle 1990).

On the first bench and the southern portion of the second bench, glaciofluvial deposits, in the form of outwash terraces derived from calcareous bedrock, predominate (Figure 2). Fishertown and Elko soils are the most common, but Saha (first bench) and Keeney (second bench) soils are also found. These soils are basic with textures ranging from fine sandy loam to gravelly sandy loam. Saha and Keeney soils have developed in silty, sandy fluvial or aeolian veneers overlying glaciofluvial deposits (Lacelle 1990).

The second bench is comprised of glaciofluvial soils to the south, and morainal soils, which often over-lie bedrock, to the north. This results in complex terrain. Morainal soil associations include; Wycliffe (WY), Plumbob (P) and Marmalade (Figure 2). These soils are derived from calcareous bedrock, and are well-drained silt loams and gravelly silt loams (Lacelle 1990).

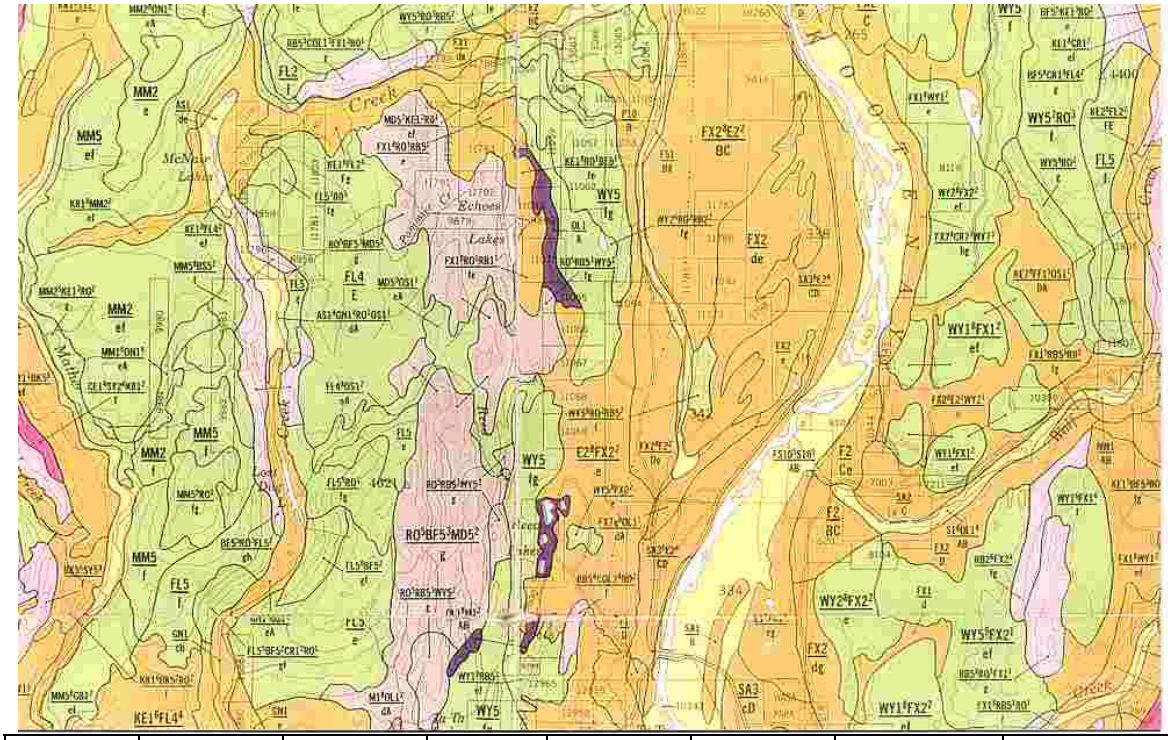
Pommier Ridge is composed of colluvium-derived soils in the Rockbluff and Big Fish soil associations. Parent material is derived from calcareous bedrock, is <1 m thick and found on slopes exceeding 30%. Texture ranges from gravelly silt loam to very gravelly loamy sand. Coarse fragment content varies between 30 and 90% and is characterized by white carbonate coatings on the undersides (Lacelle 1990). Rock outcrops, where bedrock occurs at or within 10 cm of the soil surface, are common features on Pommier Ridge and on the second bench (Lacelle 1990).

Organic soils are associated with wetlands in the range unit, although they are usually too small to map at 1:100,000 (map presentation scale - Lacelle 1990). An exception is an area of Olivia soils on the second bench. They have developed in organic accumulations of sedges, reeds and rushes that may exceed 160 cm in depth. The water table is at or near the surface for most of the year but the middle tier (40-120 cm) is usually partly decomposed.

2.2.4 Watersheds and Groundwater Dynamics

Eight watersheds are wholly or partially included within the range unit; the Kootenay River, the Skookumchuck River at the north end, TaTa Creek at the south end, and Pommier, Bradford, North Reed, South Reed and Bare Hill creeks (Figure 1, 2).

Groundwater dynamics are a feature of wetland process. Although groundwater flow is not well understood for complex terrain such as that in the TaTa/Skookumchuck Range Unit, recharge from groundwater sources may be changing in at least some portions of the study area. Area residents report springs and creeks have dried up or are flowing at reduced rates, and several families have had to drill their wells to greater depths (M. Jamieson, L. Canning, pers. comm., 2005).



Symbol	Soil Assoc'n	Parent Material	Texture	Drainage	Soil	Vegetation Zone	Description
BF	Big Fish	colluvium	gsil	r	Orthic Eutric Brunisol	LP- IDF sub-zone	stony limestone soil; steep slopes
E	Elko	glaciofluvial	fsl/gsl	w	Orthic Eutric Brunisol	PP- IDF sub-zone	non-stony, basic soil; shallow solum
FX	Fishertown	glaciofluvial	gsl	r	Orthic DB, Calc. DB Chernozem	PP- IDF sub-zone	gravelly basic soils shallow solum
FS	Fort Steele	fluvial	gsl	m	Cumulic Regosol	LP- IDF sub-zone	limestone-derived floodplain soils
KE	Keeney	glaciofluvial	fsl/gsl	w	Orthic Eutric Brunisol	LP- IDF sub-zone	limestone-derived terraces and fans
MD	Marmalade	moraine	gsil	w	Orthic Eutric Brunisol	LP- IDF sub-zone	limestone-derived shallow solum soils
OL	Olivia	organic	m	vp	Typic Mesisol	LP- IDF sub-zone	partly decomposed orgnic soils
P	Plumbob	moraine	sil	w	Orthic Dark Brown Chernozem	PP- IDF sub-zones	grassland, shallow solum soils
RB	Rockbluff	colluvium	gsil	r	Orthic Eutric Brunisol	PP- IDF sub-zones	stony, limestone soils, steep slopes
SA	Saha	glaciofluvial	fsl/gsl	w	Orthic Dark Brown Chernozem	PP- IDF sub-zones	basic, nonstony grassland soils
S	Salishan	fluvial	sil	i	Gleyed Cumulic Regosol	PP- IDF sub-zones	silty floodplain soils
WY	Wycliffe	moraine	gsil	w	Orthic Eutric Brunisol	PP- IDF sub-zones	limestone derived shallow solum soils

Figure 2. Soils of the TaTa/Skookumchuck Range Unit.

2.2.5 Vegetation

The study area falls within three biogeoclimatic units; the Kootenay Dry Hot Ponderosa Pine Variant (PPdh2), the Kootenay Dry Mild Interior Douglas-fir Variant (IDFdm2), and the Dry Cool Montane Spruce Subzone (MSdk) at higher elevations along the slopes of the Purcell Range (Braumandl and Curran 1992). The bulk of the study area is within the IDFdm2, with upper areas transitional to the MSdk and lower areas to the PPdh2.

In wetlands the major species found are rushes[1], cattail, sedges, and tule. Riparian areas are characterized by sedges, rushes, redtop, foxtail barley, bluejoint and silverweed (Appendix 2). In the upland areas, Douglas-fir and ponderosa pine co-dominate; however, trembling aspen, lodgepole pine and western larch are also present. Common shrubs include bitterbrush, snowberry, rose, Saskatoon, juniper, bearberry, chokecherry, soopolallie, and bog-birch. Grass species present on upland areas include bluebunch wheatgrass, needle-and-thread, prairie Junegrass, Kentucky bluegrass, Canada bluegrass, rough fescue, Idaho fescue, western needlegrass, Columbia needlegrass, Richardson's needlegrass, pinegrass, bearded wheatgrass and blue wildrye. Hairy goldaster, western yarrow, shaggy fleabane, common fleabane, balsamroot, asters, pussytoes and twinflower are common native forbs. Weedy forb species include Canada thistle, common mullein, sulphur cinquefoil, spotted knapweed, houndstongue and St. John's-wort. There are red- and blue-listed plants and ecosystems in this region, some of which are associated with wetland ecosystems (Appendix 3).

2.2.6 Wildlife

TaTa/Skookumchuck Range Unit is rated as having a moderate to high (Class 1, 1W, 2W and 3W) capability to support ungulates, in particular white-tailed deer, mule deer and elk (Canada Land Inventory 1976). A small wetland literature review of classification and mapping systems prepared by Machmer et al. (2004) discussed the importance of wetlands to invertebrate and vertebrate species. Several red-blue listed animal and invertebrate species (Conservation Data Center 2004) may be found in the TaTa/Skookumchuck Range Unit (Appendix 3).

2.2.7 Disturbance Types

Wetlands in the Rocky Mountain Trench have evolved in the presence of a variety of natural disturbance factors including; major climatic changes, cycles of drought and wetter periods, and landscape-level wildfire events. Natural, site-specific disturbance factors include the effects of wetland habitat altering species such as muskrats, beaver and the presence of large ungulates in adjacent areas. Nutrient cycling, sediment deposition, plant communities, and the wildlife assemblages using these wetlands have all been shaped by these forms of disturbance.

Wetland systems in this area have also evolved in the presence of long-term human induced disturbance, including fires initiated by the Ktunaxa people and grazing disturbance from domestic and feral horses, and cattle over the last 100 years. More recently, road and right-of-way construction, mining, forest harvest, settlement and agriculture have led to a variety of wetland disturbances.

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[1] Plant species names follow Hitchcock and Cronquist (1973).

Disturbance from mechanized recreational use (ATVs and other vehicles) and management inputs including prescribed fire, cattle grazing and mechanized disturbance of wetlands to reduce cattail dominance have also altered wetlands in significant ways. Forest ingrowth has resulted in dense stands of small diameter conifers around many wetlands.

These forms of disturbance can have both positive and negative implications. For example, wetland managers routinely use disturbance in the form of grazing, fire and cattail removal to maintain marshes in a mix of open water and cattail stands that is considered optimal for most wetland species (Murkin et al. 2000).

3.0 METHODOLOGY

This project included three basic elements:

1. The development of the assessment tool
2. The development of a process for identifying high priority sites for wetland restoration
3. The application and testing of this tool in the assessment of wetlands in the TaTa/Skookumchuck Range Unit

The development of the assessment tool was based on the following principles:

- Wetland function, the value of wetlands for wildlife, and the impact of various forms of disturbance concern not only the wetland, but also the adjacent riparian and upland zones. Disturbance in any zone of a wetland system could potentially affect its value for wildlife. Therefore, all wetland systems should be evaluated considering the wetland, the riparian, and the adjacent upland zones.
- This project specified that it should be useable by technical level staff. This required that the tool be simple to use and required minimal professional judgement in making assessments.
- An assessment tool should be based on objective, quantitative measures.

A number of definitions were necessary.

- "Rapid assessment" has been used to describe a procedure that may require as much as two days time. "Reconnaissance level survey" is the proposed term for this 30-90 min procedure.
- Ideally, to determine the impact of a disturbance on a wetland the assessor must possess a sense of what the undisturbed conditions of that wetland would be. However, undisturbed wetlands that represent higher "seral stages" are rare in the Trench. "Reference condition" plant communities have been devised and are substituted for seral stage.
- "Health" and "functionality" are concepts that have been used by others. This method will use "alteration" of the vegetation community from a reference condition as the measure of past disturbance.
- "Restoration" has been used interchangeably with conservation and protection, but it should more properly be described as a series of actions that will enable the accomplishment of a set of well-defined objectives. "Management action" is therefore substituted for "restoration".

3.1 Development of the Assessment Tool

This approach is based on that of Wikeem and Wikeem (2005) who developed a rapid assessment process for fescue grasslands in the BC interior that builds on the approach of Adams et al. (2003). Their approach replaces the concept of "ecosystem health" as used by Adams et al. (2003) with an analysis based on the degree of "alteration" of a grassland community against a "reference condition" for that community. Similar to Adams et al. (2003), it includes a scoring system based on vegetation composition, vegetation structure, litter cover, soil disturbance and invasive species. The system scores ecosystems against a reference condition. Data collected in their assessment are used to score vegetation condition as reference condition, slightly altered, moderately altered or greatly altered.

The development of a rapid assessment system included three basic elements; the definition of wetland types, definition of plant communities within these types, and the compilation of invasive plants found in each wetland type.

3.1.1 Wetland Types

It is important to identify wetland types with similar attributes, in order to make comparisons of disturbance history within types, and to identify those that will respond similarly to management actions (Table 1). Wetlands in the study area are defined by the permanent or seasonal presence of water, the duration of inundation or soil saturation, and whether soils are derived from acidic or basic parent material. Classes range from permanent, stable water systems (lakes, ponds, shallow water), through those with seasonal water (swamps, marshes), to units that are "transitional" between wetland and upland systems (shrub carr, graminoid meadow). A distinction is made between "mineral" or non-peat forming wetlands, and "peat" forming wetlands.

Two wetted soil types are included that are not identified in MacKenzie (1999), MacKenzie and Moran (2004) or other wetland typing systems. These were "aspen stringers" along underground watercourses, and the "deciduous margin", a tree and shrub community at the upper edge of long-term inundation. Though perhaps not traditionally viewed as a "wetlands", they occur as a result of wetted ground and are populated by moisture-loving species such as trembling aspen, bog-birch, rose and red-osier dogwood. They vary in size from narrow margins (1-5m) on some wetlands, to stands of >5 ha and often mark a transition between riparian and upland areas. These sites provide nesting and roosting sites for many wetland-dependant bird species.

Each wetland system was evaluated considering the wetland, the riparian, and the adjacent upland zones (Hennan 1998).

- **The wetland** is the portion of the system where soils are either saturated or ponded, including lakes, ponds, shallow water, swamps, marshes, fens and bogs.
- **The riparian zone** is the banks and adjacent areas of water bodies, watercourses, seeps and springs, where soil moisture levels are higher than in the surrounding upland. It includes the shrub carr, graminoid meadow, forb meadow, deciduous margin and aspen stringers.
- **The upland zone** is the area within 100 m of each wetland. The surrounding landscape is a source of recharge, shade for wetland areas, sediment transfer, and nesting, feeding, resting, and refuge sites for wetland species.

Table 1. Lentic wetland[1] types in the East Kootenay region of the Columbia Basin.

Group [1]	Class	Water Source	Features	Group characteristics	Vegetation
Freshwater	**Lake**	flooding inflow	Permanent flooding >2.0 m	>5 ha	Submergents
	Pond	flooding inflow	Permanent flooding >2.0 m	<5 ha	Submergents
	Shallow Water	flooding inflow	Permanent flooding 0.5-2.0 m	Mineral soils or well-humified sedimentary peat	Submergents, emergents
Wetland	**Swamp**	groundwater surface flow	Significant surface and groundwater flow	Mineral soils with <40cm of peat accumulation	Tall shrubs or trees, forbs grasses, leafy mosses
	Marsh	groundwater surface flow	Protracted shallow flooding	Surface organic tier on deeper peat Typically alkaline soils	Graminoid or forbs; emergent species; shrubs/trees are < 10% cover
Peatland	**Fens**	groundwater inflow	Water table at or just below peat surface most of the growing season	pH >5.0 relatively high mineral content within rooting zone	Few trees; graminoid or low shrubs; sedges, brown mosses
	Bogs	groundwater basin accumulations	Surface peat accumulated above groundwater flow	pH <5.0 low in dissolved nutrients	Coniferous trees or low shrubs; Ericaceous shrubs, sphagnum mosses
Transition	**Shrub carr**	Groundwater	Seasonally saturated but rarely inundated	Frost-prone sites with moist or very moist soils, Mineral substrate, Aerated (not peat) organic matter accumulations of <15cm	Shrub dominated, grasses, sedges, rushes, forbs
	Gram-inoid meadow	Groundwater	Brief period of inundation, early season saturation, water table below root zone for most of growing season	Alkaline soils, often slightly to highly saline, Cold air ponding sites, fine-textured soils in grassland areas	Grasses, sedges, rushes, forbs, halophytic plants
	Forb meadow	Heavy snowfall regions, snow accumulation areas, prolonged seepage	Slopes and valley bottoms where there is cold air drainage and persistent ground water flow	Usually montane or subalpine, Persistent snowpack and seepage preclude tree est., Mineral soils may have thin, dark organic veneer	Tall forbs and sedges
Others	**Decid-uous margin**	Groundwater	Wetted soils	Usually at the high water mark of a small basin, Riparian margin	Aspen, shrubs, grasses and forbs
	Aspen stringer	Groundwater	Wetted soils	Usually in drainage channels or other low spots	Aspen, shrubs, grasses and forbs

[1] Wetland types after MacKenzie (1999) and MacKenzie and Moran (2004).

3.1.2 Reference Condition Plant Communities

Reference condition is defined as the condition where the plant community is unaltered by disturbance, natural or human-caused. Reference condition plant communities (Table 2) are developed from minimally disturbed sites that share similar ecological potential (Adams et al. 2003, Wikeem and Wikeem 2005). This approach is broad enough to allow for the natural variation that results from annual weather patterns or site conditions. Leading species for each wetland type "reference community" were defined from field-work conducted during this project, as well as from Hitchcock (1971), Hitchcock and Cronquist (1973), Runka and Lewis (1981), Braumandl and Curran (1992) and Parish, Coupe and Lloyd (1996) and Smyth and Allen (2001).

3.1.3 Invasive Plants

The presence of invasive plants is an indicator of disturbance. Invasive species are listed by wetland type (Table 3).

3.1.4 Development of the Wetland Assessment Form

A wetland assessment form was developed based on the wetland types and plant communities described above. In the initial testing of the form, a wide range of descriptors of site conditions and wildlife habitat was compiled. This list was taken to the field and those elements that were objective and applicable to the Trench and Upper Columbia Basin were identified. The list was refined to include approximately 30 attributes to describe site features and wildlife habitat that make up the assessment form (Appendix 4).

The form, as developed, is divided into five sections.

1. Site description
2. Vegetation assessment
3. Wildlife habitat features
4. Vegetation score-card
5. Potential management actions

Site Description

The first section identifies the location and type of the wetland being assessed. Wetland number, name, area and location descriptors, along with GPS locations, permanent photo points and a sketch map comprise the site description portion of the checklist. Wetland type and water quality descriptors are also provided.

Vegetation Assessment

Vegetation provides the most readily observable indicators with which to evaluate wetlands. Each indicator used describes the status of an ecological factor or process that often cannot be seen or measured (Wikeem and Wikeem 2005). Status at a site is measured by comparing the functioning of these indicators against a standard (Adams et al. 2003).

Table 2. Reference plant communities for lentic wetlands in the East Kootenay region of the Upper Columbia basin.

Group [1]	Class	Grasses	Forbs	Shrubs	Trees
Freshwater	**Lake**	tule	water lily, whorled water-milfoil		
	Pond	tule, cattail	water lily		
	Shallow Water	tule, cattail	buckbean, water plantain		
Wetland	**Swamp**	bluejoint, small flowered bulrush,	pink wintergreen, ladyfern, bunchberry, trailing raspberry	willow spp., mountain alder, red-osier dogwood, black twinberry	spruce, aspen, black cottonwood
	Marsh	tule, cattail, sedge, tufted hairgrass	common mare's tail, water parsnip, purple-leaved willow herb		
Peatland	**Fens**	tule, cattail		Labrador tea, dwarf cranberry	spruce
	Bogs	sedge		Labrador tea, dwarf cranberry	
Transition (Riparian)	**Shrub carr**	Nuttal's alkali grass, redtop, sedge, rushes		glandular birch, wolf-willow, willow spp.	
	Graminoid meadow	Nuttal's alkali grass, tufted hairgrass, alkali saltgrass, alkali cordgrass, redtop, sedge, rushes	silverweed, tufted white prairie aster,	willow spp., glandular birch	
	Forb meadow		arrow-leafed groundsel		
Others	**Deciduous margin**	bluejoint, tufted hairgrass, beaked sedge, blue wildrye, rough fescue	creamy peavine, cow parsnip, pink wintergreen, rattlesnake plantain, wild strawberry, western meadowrue, violet	glandular birch, willow spp., red-osier dogwood, Saskatoon, snowberry,	aspen, spruce, ponderosa pine
	Aspen stringers	bluejoint, pinegrass, blue wildrye, beaked sedge	star-flowered Solomon's seal, pink wintergreen, wild sarsaparilla, bunchberry, large leaved avens, western meadowrue, Canada violet	willow spp., prairie rose, Oregon grape, white stemmed gooseberry, black twinberry	aspen, spruce, ponderosa pine

[1] Wetland types after MacKenzie (1999) and MacKenzie and Moran (2004).

Table 3. Invasive plant species in lentic wetlands in the East Kootenay region of the Upper Columbia basin.

Group [1]	Class	Grasses	Forbs
Freshwater	**Lake**		Eurasian millefoil, purple loosestrife
	Pond	reed canarygrass	Eurasian millefoil, purple loosestrife
	Shallow Water	reed canarygrass	Eurasian millefoil, purple loosestrife
Wetland	**Swamp**		
	Marsh	reed canarygrass	oak leaved goosefoot, strawberry blight, buttercup spp., plantain, curled dock, marsh yellow-cress, prickly sow-thistle, Canada thistle, bull thistle, yellow salsify
Peatland	**Fens**		
	Bogs		
Transition (Riparian)	**Shrub carr**		slender hawkweed, curled dock,
	Graminoid meadow	Foxtail barley,	slender hawkweed, prickly sow-thistle, yellow salsify
	Forb meadow		orange hawkweed
Others	**Deciduous margin**		houndstongue, slender hawkweed, prickly sow-thistle, great burdock
	Aspen stringers		houndstongue, slender hawkweed, prickly sow-thistle, great burdock

Note: these species often intergrade between sites.

The wetland, riparian and upland zones were assessed separately. Five indicators evaluate the plant community at the site as to the state of alteration from a reference community (Adams et al. 2003, Wikeem and Wikeem 2005). These were:

- **Plant community composition.** Plant community affects the structure and the productivity of the wetland. The leading species and estimated cover are recorded for each vegetation layer; trees, shrubs, tall grasses and forbs and ground cover.
- **Plant community structure.** As plant communities are modified by disturbance, species composition changes and so does the structure of the community. This affects light, water and nutrient distribution and also impacts habitat capability. The presence and alteration of expected vegetation layers is assessed (trees, shrubs, tall grasses/grasslike plants and forbs, and ground cover).
- **Litter.** Litter aids in the nutrient cycle by contributing minerals and organic matter, and in the hydrologic cycle by insulating the soil surface from evaporation, and slowing water movement over the soil, which decreases erosion and promotes infiltration. Litter cover was estimated based on % coverage of the ground.
- **Bare soil.** Bare soil is an indicator of whether soil erosion at the site exceeds natural levels, and thus is an indicator of site stability. Percentage of bare ground was estimated and source of disturbance were noted.
- **Invasive species.** Indicator of past site disturbance as any disturbance can create conditions for invasive species establishment. Percent cover of invasives and their distribution was noted.

Ocular estimates of vegetation cover, litter cover, bare ground and cover of invasive species are recorded using Daubenmire cover classes (Daubenmire 1959) (Appendix 4). Daubenmire cover classes are: 1=0-5%; 2=6-25%; 3=26-50%; 4=51-75%; 5=76-95%; 6=96-100%. Mid-points are used for tabulation on the scorecard.

Wildlife Habitat Features

This reconnaissance level assessment form is focussed primarily on habitat features, rather than actual sightings, or productivity surveys, since there are the only elements that can be objectively assessed in a single visit to a wetland. Habitat features such as beaver dams or muskrat houses, islands/peninsulas for nesting, rocks/logs for loafing, snags for cavity nesters, and over water nesting options were identified.

Vegetation Scorecard

This system uses the concept of vegetation alteration from a reference community (Wikeem and Wikeem 2005) to evaluate the five indicators. The scoring system assigns a score between 0 and 100, which rates the state of alteration of the vegetation at a site relative to a reference plant community.

Potential Management Actions

A list of potential management actions is provided as a checklist.

3.2 Prioritizing Sites for Management Action

The identification of high priority sites for Management Actions is achieved through the scoring system. The wetland site's score is placed on a continuum that places the site in one of four states;

1. Reference condition (76-100)
2. Slightly altered (51-75)
3. Moderately altered (26-50)
4. Greatly altered (0-25)

Those that are greatly or moderately altered would be given a higher priority for restoration.

3.3 Testing the Assessment Tool on the TaTa/Skookumchuck Range Unit

Once the assessment tool was developed, it was applied and tested. Wetlands in the TaTa/Skookumchuck Range Unit were surveyed between September 2 and October 15, 2005. The focus of the survey in 2005 was on low-elevation wetlands in the PPdh2 and IDFdm2 biogeoclimatic zones. Pastures were logical units with which to organize the survey. The survey first concentrated on the lower elevation pastures east of the CPR rail tracks (Figure 1), commencing in Plot, 42 and Foster pastures. On the second bench, Dune, Reed and portions of Echo pasture were surveyed. Two wetlands in Camp/Skook pasture, on Pommier Ridge, were also surveyed.

To apply the assessment tool the steps included;

- Assembling maps, airphotos, wetland data, historical and anecdotal information
- Transferring map information to airphotos
- Construction of a database listing wetlands by pasture, landscape unit and drainage
- Site visits and reconnaissance level surveys for 25 wetlands
- Establishing permanent photopoints
- Using a GPS to locate photopoint locations
- Use of the actual checklist and scoring system
- Identification of potential management actions.

The CBFWCP provided a GIS spreadsheet and a series of maps based on a supervised classification of the TRIM II data set. (Available at the CBFWCP office). These maps were reviewed and used to delineate wetlands. Wetlands in the unit were identified, assigned a unique number, and area calculations were provided (Appendix 5).

Representative photographs are found in Appendix 6. Information from the inventory and assessment of these wetlands is presented in Appendix 7. Data was entered into an MS Excel spreadsheet to create an initial database. The spreadsheet included all data that was recorded on the written forms. Detailed methodology is provided in the supporting manual that was developed as part of this project (Appendix 8). This manual explains the rationale behind the approach, and ensures that assessors understand the expectations, requirements, and limitations of the assessment procedure.

4.0 RESULTS

4.1 Mapping

A wide range of wetland types is arrayed across a variety of topographic, hydrologic and climatic circumstances. The TRIM2 mapping for the unit identified 106 wetland habitat units in 80 wetland systems (wetlands plus adjacent riparian areas classified separately). These ranged from small lakes (Echo Lake) to very small sedge meadow sites (<0.5 ha). Appendix 8 provides a map indicating the general distribution of wetlands across the study area.

The TRIM II mapping was the most effective in identifying small wetlands, including those that were less than 0.1 ha in size. The TRIM II mapping identified >95% of the wetlands present, while the PEM, VRI and TRIM (earlier version) products identified in the order of 60-80% of the wetlands identified in the TRIM2 mapping. Some small wetlands, primarily small depressions with associated meadows, were not identified in the mapping, but were found during the airphoto typing. These were less than 0.1 ha and were found in Echo and Camp/Skook pastures. No wetland typing errors were found in the TRIM 2 mapping on crown land within the survey area, but one error was noted on adjacent private land. Wetland #20 (23 ha), at the confluence of the Skookumchuck and Kootenay rivers, is a former cultivated field.

Smaller units that included more than one wetland type were commonly identified as single units in the TRIM II data-set. Conversely, several sets of wetlands that functioned as systems were evaluated as single units. Only eight surveyed wetlands contained a single wetland type. Where a wetland was situated on Crown and Private lands, only the Crown portion was surveyed. Wetlands that were mis-typed in the TRIM II GIS database were not included in the database. Wetlands within the study area were grouped within four major landscape units, 13 drainages and six pastures. A total of 106 wetlands comprising nearly 147 ha were identified (Appendix 5). Eighteen wetlands included in the database are located on private land and were not surveyed. The remaining 88 wetlands that were located on Crown land totalled slightly more than 74 ha.

4.2 Wetlands in the TaTa/Skookumchuck Range Unit

Wetlands were most numerous in Camp/Skook and Echo pastures (Table 4). These pastures are located on the second bench above the CPR track (Figure 1).

4.3 Distribution of Wetlands by Type

Thirty-one wetland units were assessed in 26 separate site inspections (Table 5). Marshes were the most frequently encountered wetland type. Marshes and marshes with other associated types accounted for 25 of the 31 wetlands (Table 5). The most typical unit was a marsh adjoining a graminoid meadow, which accounted for nearly one-half of the surveyed wetlands. Graminoid meadows were the next most numerous type with 19 occurrences, either as single wetlands or associated with other types (Table 5). Eight wetlands contained the deciduous margin, either alone or in association with other types. Four wetlands were typed as shrub carrs. Only three lake, pond or shallow water types were surveyed. Marshes and associated types also contained the most area by wetland type, encompassing more than one-half of the surveyed area (Table 5).

Table 4. Distribution of wetlands by pasture at the TaTa/Skookumchuck Range Unit.

Pasture	Pasture Area (ha)	Wetland Numbers	Wetland Area (ha)
Camp/Skook	4040.0	40	40.4
Dune	546.0	6	29.3
Echo	1032.0	25	45.9
Foster	332.8	2	1.5
Plot	500.0	4	2.2
Reed	969.6	9	24.5
River	125.6	0	0.0
Pulp	420.0	0	0.0
42	492.4	2	2.0
Crown Land Total	**8458.4**	**88**	**145.8**

Table 5. Distribution of wetlands by type at the TaTa/Skookumchuck Range Unit.

Wetland type	Total area	Number	Wetland systems
Pond	1.34	1	94
Pond, Marsh, Deciduous Margin	3.56	1	112
Shallow Water, Marsh, Deciduous Margin	16.72	1	195
Marsh	2.00	3	72, 78, 92
Marsh, Deciduous Margin	0.87	2	148, 179
Marsh, Graminoid Meadow	34.57	14	192, 193, 197, 79, 157, 206, 204, 188, 189, 107, 119, 187, 190, 191
Marsh, Graminoid Meadow, Deciduous Margin	2.20	3	129, 130, 186
Marsh, Shrub – Carr	1.85	1	70
Graminoid Meadow	5.54	2	143, 199
Shrub-Carr	1.47	2	176, 177
Shrub-Carr, Deciduous Margin	4.22	1	201
Total	**74.34**	**31**	**26**

4.4 The State of Assessed Wetlands

Scores ranged from a low of 30 for wetlands #188 and 189 in Reed Pasture, to a high of 95 at wetland #179, also in Reed Pasture (Table 6). Nine of the surveyed sites were rated as reference condition (76-100), 12 were slightly altered (51-75), and five were moderately altered (26-50). No surveyed wetlands scored in the greatly altered class. Appendix 6 provides photos of wetlands from the reference condition and moderately altered classes.

4.5 Sources of Disturbances

The identification of disturbances that have affected plant communities is an important component of the assessment procedure, and demonstrates the effectiveness of the scoring system by identifying sites that require management actions. Surveyed wetlands commonly experienced more than one type of disturbance.

Browsing and grazing were the most common forms of disturbance (Table 7). Hydrology is a primary limiting factor for wetlands in this unit. Three wetland sites with alkali deposits at their margin were used as mineral licks. Water was not present in 16 of the wetlands where water was expected in the system. Twenty-one wetlands were impacted by industrial development, which included right-of-ways, roads, and activities associated with forest harvest. Range water developments and water control structures were noted at 12 units. Impacts from recreational vehicles were noted at eight surveyed wetlands, while other recreation impacts were recorded at a further 10 wetlands.

4.6 Wildlife Habitat Features

The description of wildlife habitat features is an important component of the wetland survey. Snags and coarse woody debris were found at 25 and 26 of the surveyed wetlands, respectively (Table 8). Rocks and logs suitable for loafing (turtles) were found at 13 sites, and 11 sites contained either peninsulas/islands or caves/rocks suitable for nesting. One surveyed site had an active muskrat house. No active beaver dams or lodges were observed. This is in part due to the sites surveyed. Only three lake, pond or shallow water systems where muskrats would be expected were sampled, and active beaver dams are likely more common in wetlands at higher elevations in Camp/Skook pasture that were not surveyed in 2005.

4.7 Time Requirements

One of the objectives of this project was to develop a tool that could be completed in one to three hours. Completion of a wetland assessment requires three phases; a pre-organization phase where information is compiled, the actual assessment, including time to locate and travel to and from the wetland, and data entry and analysis. Based on this preliminary test, the assessments can be completed in slightly less than two hours per wetland (Table 9). The time to complete the form while at the wetland was about one-half of the time required. Field assessments can be completed very quickly (15 min) for a small wetland without major resource issues, whereas larger wetlands may require up to 60 minutes. A complex wetland system, in which several wetland types are represented, may require as long as 100 minutes.

Table 6. Wetland assessment scoring at the TaTa/Skookumchuck Range Unit.

Wetland Number	Wetland Name	Pasture	Score
Ref. Condition			
179	North of North Reed Lake	Reed	95
70	Rail Fence Slough	Camp/Skook	94
72	Telus Pond #1	Plot	88
195	Chatterson North –Crown	Dune	86
177	Pond North End	Foster	80
78	Telus Pond #3	Plot	79
148	South Depression	Echo	76
201	Aspen to south	Dune	76
Slightly Altered			
79	Telus Pond #2	Plot	73
187, 190, 191	North Reed Meadow, North Reed, N. Reed Marsh	Reed	72
178	Meadow north	Foster	71
94	Green Lake	Plot	70
192,193	South Reed Meadow	Reed	64
157	42 Mile	42 Pasture	64
204	Pump dry marsh	Dune	62
199	Big Alkali Meadow	Dune	60
186	Close to Lake	Reed	58
107	Camp 1 Dry	Echo	58
112	Camp 1 Pond	Echo	52
129,130	Deciduous at North, South Pond	Echo	52
119	Deep Depression	Echo	50
Moderately Altered			
143	42 Slough	42 Pasture	48
197	Reed South	Dune	47
206	½ PL	Dune	44
188, 189	East Reed Meadow, Marsh	Reed	30
Average Score			**67**

Table 7. Disturbance types in the TaTa/Skookumchuck Range Unit.

Disturbance type	Number(s) of wetland(s)
Browsing	28
Grazing	27
Watering	18
Hydrology	16
Industrial (roads)	16
Recreation	10
Off road vehicles	8
Water control structures	8
Logging/prescribed fire	5
Range water developments	4
Mineral lick (alkaline/saline soils)	3

Note: Some wetlands had more than one type of disturbance.

Table 8. Wildlife habitat features at the TaTa/Skookumchuck Range Unit.

Habitat feature	Number(s) of wetland(s)
Snags	26
Coarse woody debris	25
Rock/logs for loafing	13
Peninsula/islands for nesting	6
Caves/rocks	5
Muskrat houses	1
Beaver dams	0

Note: Some wetlands have more than one type of habitat feature.

Table 9. Time requirements for completing wetland assessments.

Task	**Time per wetland (min)**
Office	
Pre-organisation	10
Interviews with local residents	10
Data Entry	20
	40
Field	
Travel within study area	15
Site description	15
Vegetation assessment	30
Wildlife habitat	5
Management actions	5
Scoring	5
	75
Average time per wetland	**115**

5.0 DISCUSSION

5.1 Evaluation of the Reconnaissance Assessment Method

The development of a method to assess wetlands in a single visit is challenging, as many parameters in wetland ecology vary over time, and therefore cannot be measured in a single visit to a wetland. A single visit can only assess some of the variables that may be important in determining the state of wetlands and associated wildlife habitat capability. Limitations such as this must be recognised with this approach.

This form focuses on vegetation and site parameters, elements that may be rapidly surveyed. The absence of reference sites has led to the development of reference condition plant community descriptions. These community descriptions will need to be refined with additional surveys. Reference plant communities must also be developed for other wetland types in the region.

This assessment method also identifies options for management action. However, because this assessment is based on a single site visit, it is not feasible to develop a restoration plan during the visit. A detailed follow-up assessment is required to fully determine restoration options. The presence of turtles or nesting waterfowl, for example, can only be assessed during the parts of the spring and summer. Water quality indicators (pH, hardness, etc.) also require measurements over the season in order to provide a complete data set.

The development of management actions requires experienced personnel who are familiar with the objectives of the assessment program. For example, Ducks Unlimited staff use a form to assess a wetland, but then apply practical and professional expertise to develop detailed approaches to the management and enhancement of wetlands chosen for action. Other agencies use a range of strategies, generally using professional judgement to identify management options. In the form developed here, the final section asks the user to identify options for management action only. Asking technical level users to proceed further than this in identifying or prioritizing specific actions is not a viable approach.

The assessment method is a useful tool to evaluate:

- Site parameters
- Wetland type
- Wetland, riparian and upland vegetation composition and structure
- Disturbance
- Litter cover
- Invasive plants
- Wildlife habitat
- Vegetation relative to a reference condition
- Broad options for potential management actions
- Baseline data for future monitoring

Further testing of the checklist, refinement of reference condition plant communities, and developing a better understanding of long-term hydrologic cycles will augment the effectiveness of this tool.

5.2 Initial Survey Results

The data discussed in this report was collected from assessments of 31 of the 88 wetlands in the TaTa/Skookumchuck Range Unit (Table 4). These data provide a sample of conditions of the wetlands in the study area, from which the following observations were made.

Hydrology is a primary limiting factor for wetlands in this unit. Water was not present in 16 of the wetlands where water was expected in the system (Table 7). This would suggest a long-term decline in water levels or declines resulting from decadal scale drought and wet periods. Any analysis of these issues was beyond the scope of this work.

Twenty-one wetlands were impacted by industrial development, which included right-of-ways, roads, and activities associated with forest harvest (Table 7). Wetlands #204 and 206 in Dune pasture are part of a system that may have been impacted by industrial development. Wetland #204 is bisected by the BC Hydro right-of way where a cut and fill was conducted as part of road construction, and road construction has taken place to the north and west of wetland #206. No water was present in either wetland. Range water developments and water control structures were noted at 12 units. A pump and trough system to provide livestock water is in place on a well located in #204.
Forest harvest activities and the construction of associated roads and landings are ongoing in the range unit, most recently in the lower elevation portions. The extent of activity and future plans are outside the scope of this report, but these activities can affect surface and groundwater flow on a local, watershed or regional level. Forest harvest may increase surface and groundwater storage as more precipitation will be available for surface flow and infiltration. Between 10 and 15% of precipitation is intercepted by foliage and returned to the atmosphere by evaporation (Fitzgerald 1993). Harvesting can improve water yields from watersheds by removing trees that consume water, and by affecting the placement and storage of the snowpack.

Road-building, landing construction and some aspects of mechanized harvest can cause soil exposure, compaction and displacement. This promotes overland flow, erosion and sedimentation. Poorly constructed road cuts in mineral soil tend to be the greatest source of sedimentation associated with forest harvest (Fitzgerald 1993). Buffer areas between wetlands and roads are important to trap any soil particles eroded by overland flow. Harvest activities primarily affect infiltration rates, but may disrupt groundwater flow if springs or stream channels are affected (Hewlett 1982).

Other wetlands may have been affected by past industrial disturbance that is not obvious in the present era. Wetland #112 (Camp 1 pond) was used as a logging camp and mill-pond in the 1930's. The substrate of the pond is believed to have a deposition of bark and wood. It is likely that the wetland, riparian and upland components of the system were impacted.

Grazing, browsing and watering by cattle and wild ungulates caused alteration from the reference plant community at many of the surveyed wetlands. These disturbances are separated in the data, but often occur together. For eighteen of the surveyed wetlands watering only was listed as a disturbance, while on approximately 28 sites cattle or wild ungulates had grazed or browsed. The presence of water in the system and the size of the foraging area are key determinants affecting ungulate use of a wetland. Three wetland sites

with alkali deposits at their margin were used as mineral licks. Typically, the disturbances by domestic and wild ungulates using a wetland site are the alteration of the plant community composition and structure by grazing and browsing, and the formation of bare soil by means of trails, pugging etc. as they go to water. The extent of the disturbance is the key issue, but timing of use is also important. Woody vegetation is usually selected for in fall by domestic and wild ungulates, as it is still green and succulent, palatable, and higher in protein and energy content than herbaceous vegetation (Buckhouse and Elmore 1993). In contrast, early spring grazers will select herbaceous species and use fewer browse species (Hennan 1998). Wikeem and Ross (2002b) found elk eat primarily grasses, but will switch to trees and shrubs in winter if grasses become less available. Deer browse year-round, but grasses make up about 20% of spring diets. Grasses and forbs generally dominate cattle diets while shrubs are eaten sparingly.

Impacts from recreational vehicles were noted at eight surveyed wetlands, while other recreation impacts were recorded at a further 10 wetlands (Table 8). Recreational impacts usually impact plant community composition and structure, which may result in soil disturbance. This may result in bare and compacted soils, thereby reducing infiltration and increasing overland flow, erosion potential and water quality. Soil type is an important determinant. For example, Saha or Plumbob soils, in which a veneer of silt overlies stony sub-soil, are very erosive, especially on steep slopes (Lacelle 1990). Soil disturbance also increases opportunities for weed invasion.

Wetlands #190 and 191 (Reed Lakes) are examples of wetlands where deep ruts had been formed in soils in the riparian and wetland areas from “mud-bogging” (Appendix 7). Simultaneously, use of the adjoining uplands as a camping and party location had trampled and compacted vegetation at the site such that slopes above the wetland were bare and rill erosion was occurring.

5.3 Defining Potential Management Actions

Potential management actions to move wetland plant community composition and structure toward reference condition are listed below:

- Minimizing disturbance with protection (fencing)
- Alter livestock grazing plans
- Work with range tenure holder
- Provide alternate livestock watering sources
- Retain alleyway access to watering sites
- Construct gravelled watering sites
- Alternate salting practices
- Remove excess vegetation with prescribed grazing
- Remove excess vegetation with prescribed fire
- Prevent inundation by beaver trapping
- Plant emergents to test assumptions regarding reference condition in seasonally declining water level wetland types
- Control of ATV and off-road vehicle use
- Reduce forest cover on surrounding uplands
- Retain forest cover in riparian margin
- Invasive plant control

The assessment form will provide managers with a measure of wetland status, relative to reference condition, and a list of identified management options. Managers can then use this data to identify those wetlands in greatest need of management action, identify the potential actions that might be applicable and then make a decision on future actions. Doing so in a multi-disciplinary environment would likely be most effective.

Based on the present sample, the wetlands that should be given immediate consideration for management actions are those listed as moderately altered in Table 6. Further surveys in Echo and Camp/Skook pastures will be required to identify all candidate sites in need of management actions.

6.0 CONCLUSIONS

With the necessary training and experience, a competent technician should be able to use this tool to conduct a reconnaissance level wetland survey in a time efficient manner. The technician doing the assessment does not need a strong background in botany since only lead species are documented. A detailed plant inventory is not required as part of this assessment process rather, the goal is to describe the leading plant species and plant community structure. Surveyors can be trained in compiling site information, identifying leading plant species for each wetland type, identifying invasive species, documenting major habitat features, evaluating levels of disturbance, and assessing which management actions may be options at the site.

7.0 RECOMMENDATIONS

1. Refine the checklist with further testing.
The testing of the tool on 31 wetlands, as completed here, is insufficient to document its overall value. More wetlands in this study area should be assessed, to obtain the full range of variability in wetland condition. Additional wetlands should be surveyed in other range units in the Trench to complement these data. Fennessey et al. (2004) suggests a minimum of 50 wetlands per type.

Further work on establishing reference conditions for all wetland types should occur. These surveys should be conducted during June and July, the period of maximum floristic diversity.

2. Establish and monitor reference condition sites
Several wetlands on Crown lands in the Trench have been fenced in recent decades. Regular monitoring of the vegetation at these sites should be instituted to document their shift toward reference condition. In the longer term these sites could provide solid data on reference condition to aid this approach to wetland assessment.

3. Test the assessment form in other areas of the Columbia Basin
In future years the assessment tool should be tested in small lentic wetlands associated with wetter forest types (e.g. the Spillimacheen and Golden benches, areas in the West

Kootenay with low elevation wetlands). Reference plant communities will need to be developed for these sites.

4. Test the assessment form on lotic systems
This tool could potentially be applied to wetlands found on lotic systems. These would range from the beaver dam systems found on Bradford Creek and the DU project on Ta Ta Creek, in this study area; to the larger floodplain wetland systems found in the Creston Valley and along the Columbia and Kootenay rivers.

5. Develop data management procedures
Data management procedures should be confirmed before the system is used at an operational level. A standardized record of the data compiled at each assessment is essential in order to conduct analysis for a variety of purposes related to wetland management. One agency needs to be identified for maintaining this database.

6. Develop an intensive assessment method
To compliment the reconnaissance level assessment, an intensive assessment method should be developed to provide more comprehensive data on wetlands being considered for management action. Data collected would ideally be related to specific objectives, and would include soils, water and other physical parameters including:

- Seasonal hydrology (changes in water levels over the annual cycle, with the growing period being the most important period)
- Decadal hydrology (long term fluctuations in water levels over decades)
- Primary productivity (as driven by water and soil pH, water temperature and nutrient inputs)
- Secondary productivity (as measured by macro-invertebrate surveys)
- Invertebrate, amphibian, fish and bird surveys

7. Establish a long-term hydrologic study
Understanding hydrologic and groundwater effects on a regional and local scale are important in assessing the present status of wetlands in the study area, and in devising management actions. If, as a result of climate and landscape change, present dry conditions continue into the future, then management options are limited. One watershed should be selected for an intensive hydrologic survey to quantify watershed inputs and outputs.

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9.0 Appendices

Appendix 1. Precipitation at the Cranbrook Airport between 1996 and 2005.

Month	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Long-Term Average
							(cm)					
January	3.28	3.28	3.45	4.57	2.39	3.68	0.41	1.63	2.88	2.40	2.51	2.51
February	1.04	3.02	0.48	0.56	3.58	2.01	0.76	4.24	1.34	0.96	0.44	2.16
March	4.42	1.55	3.51	4.19	0.91	3.33	1.96	1.70	2.82	1.06	2.44	2.11
April	3.48	3.63	2.49	0.94	1.85	1.93	3.33	2.64	3.77	2.28	0.58	2.84
May	3.45	7.47	6.35	10.57	4.37	1.93	1.27	12.83	3.68	3.62	4.86	4.57
June	13.03	4.62	3.33	7.80	5.87	2.21	4.93	3.30	3.39	4.26	19.00	5.08
July	6.78	3.18	1.40	4.04	5.64	2.31	3.73	3.38	0.38	4.38	1.54	3.40
August	4.06	0.71	1.75	0.94	2.77	1.09	0.46	1.14	1.54	6.75	6.28	2.92
September	2.51	2.72	2.26	3.15	0.18	2.67	1.55	4.39	4.86	6.37	6.54	3.07
October	2.41	3.81	1.96	1.12	2.51	0.51	1.07	0.28	1.92	3.01	2.78	1.83
November	4.50	8.86	0.30	4.83	5.56	1.57	2.11	1.04	3.22	N/A	3.78	3.61
December	6.78	9.32	0.66	3.43	1.50	3.05	3.76	5.41	2.44	N/A	2.30	3.00
Total	55.75	52.17	27.94	46.13	37.13	26.29	25.34	41.98	32.24	35.09	53.05	37.11
Growing Season (Apr-Oct)	35.72	26.14	19.54	28.56	23.19	12.65	16.34	27.96	19.54	30.67	41.58	23.71

Appendix 2. Plant Species. [1]

Latin Name	Common Name
Acer glabrum,ACGL, 3	Douglas maple
Achillea millefolium,ACMI, 2	Western yarrow
Agrostis alba,AGAL, 1	Redtop
Agropyron cristatum,AGCR, 1	Crested wheatgrass
Agropyron dasytachyum,AGDA, 1	Western wheatgrass
Agropyon riparium,AGRI, 1	Streambank wheatgrass
Agropyron spicatum,AGSP, 1	Bluebunch wheatgrass
Agrostis scabra,AGSC, 1	Hair bentgrass
Agropyron subsecundum,AGSU, 1	Bearded wheatgrass
Agropyron trachycaulum,AGTR, 1	Slender wheatgrass
Allium cernuum,ALCE, 2	Nodding onion
Alnis tenuiflolia,ALTE, 3	Mountain alder
Amelanchier alnifolia,AMAL, 3	Saskatoon
Antennaria dimorpha,ANDI, 2	Pussytoes
Antennaria microphylla,ANMI, 2	Pussytoes
Anemone multifida,ANMU, 2	Pacific anemone
Antennaria parvifolia,ANPA, 2	Pussytoes
Anemone patens,ANPT, 2	Prairie crocus
Androsace septentrionalis,ANSE, 2	Fairy candelabra
Apocynum androsaemifolium,APAN, 2	Spreading dogbane
Artemesia frigida,ARFR,2	Pasture sage
Arnica fulgens,ARFU, 2	Orange arnica
Arabis holboellii,ARHO, 2	Hoelboel's rockcress
Artemesia spp.,ARSP, 3	Sage
Arctostaphylos uva-ursi,ARUV, 3	Bearberry
Aster campestris,ASCA, 2	Western meadow aster
Aster ciliolatus,ASCI, 2	Lindley's aster
Aster foliaceous,ASFO, 2	Leafy aster
Aster pansies,ASPA, 2	Tufted white prairie aster
Astragalus miser,ASMI, 2	Timber milkvetch
Balsamorhiza sagittata,BASA, 2	Balsamroot
Betula glandulosa, BEGL, 3	Bog-birch
Berberis repens,BERE, 3	Low Oregongrape
Beckmannia syzigachne,BESY, 1	Beckmannia
Bromus inermis,BRIN, 1	Smooth bromegrass
Bromus tectorum,BRTE, 1	Cheatgrass
Bryophytes,BRYO, 4	Mosses and Lichens
Calochortus apiculatus,CAAP, 2	Baker's mariposa lily
Calamagrostis canadensis, CACA, 1	Bluejoint

[1] Plant species list represents common PPdh2 and IDFdm2 species.

Appendix 2. Plant Species (cont'd).

Latin Name	Common Name
Carex douglasii,CADO, 1	Douglas sedge
Calochortus macrocarpum,CAMA, 2	Mariposa lily
Calochortus apiculatus,CAAP, 2	Baker's mariposa lily
Calamagrostis canadensis, CACA, 1	Bluejoint
Carex douglasii,CADO, 1	Douglas sedge
Calochortus macrocarpum,CAMA, 2	Mariposa lily
Campanula rotundifolia,CARO, 2	Scottish bells
Calamagrostis rubescens,CARU, 1	Pinegrass
Carex spp.,CARX, 1	Sedge
Castilleja thompsonii,CATH, 2	Thompsons paintbrush
Cerastium arvense,CEAR, 2	Chickweed
Centaurea diffusa,CEDI, 2	Diffuse knapweed
Centaurea maculosa,CEMA, 2	Spotted Knapweed
Ceanothus velutinus,CEVE, 3	Buckbrush
Chenopodium capitatum, CHCA, 2	Alkali goosefoot
Chrysanthemum leucanthemum,CHLE, 2	Oxeye daisy
Cirsium hookerianum, CIHO, 2	Hooker's thistle
Chrysothamnus nauseosus,CHNA, 3	Rabbitbrush
Chrysopsis villosa,CHVI, 2	Hairy goldaster
Cirsium arvense.,CIAR, 2	Canada thistle
Cirsium vulgare,CIVU, 2	Bull thistle
Collinsia parviflora,COPA, 2	Blue-eyed Mary
Commandra umbellata,COUM, 2	Bastard toadflax
Crepis atrabarba,CRAT, 2	Slender hawksbeard
Cynoglossum officianale,CYOF, 2	Houndstongue
Danthonia intermedia,DAIN, 1	Timber oatgrass
Dactylis glomerata,DAGL, 1	Orchardgrass
Delphinium nuttallianum,DENU, 2	Upland larkspur
Distichlis stricta, DIST, 1	Inland saltgrass
Dodecatheon pauciflorum,DOPA, 2	Shooting star
Echium vulgare,ECVU, 2	Viper's bugloss
Elaeagnus commutata, ELCO, 3	Wolf-willow
Elymus cinereus, ELCI, 1	Giant wild-rye
Elymus glauca,ELGL, 1	Blue wild-rye
Epilobium angustifolium,EPAN, 2	Fireweed
Erigeron compositus,ERCO, 2	Compound fleabane
Erigeron pumilis,ERPU, 2	Shaggy fleabane
Eriogonum umbellatum,ERUM, 2	Sulphur buckwheat
Festuca idahoensis,FEID, 1	Idaho fescue
Fern species,FERN, 2	Fern
Festuca scabrella,FESC, 1	Rough fescue

Appendix 2. Plant Species (cont'd).

Latin Name	Common Name
Fragaria virginiana,FRVI, 2	Wild strawberry
Gaillardia aristata,GAAR, 2	Brown-eyed susan
Gallium boreale,GABO, 2	Northern bedstaw
Geum triflorum,GETR, 2	Old man's whiskers
Grindellia squarosa,GRSQ, 2	Curly-cup gumweed
Heuchra cylindrica,HECY, 2	Alum root
Hieracium gracile,HIGR, 2	Slender hawkweed
Hypericum perforatum,HYPE, 2	St. John's-wort
Juniper communis, JUCO, 3	Common juniper
Juncus spp.,JUNC, 1	Rush species
Juniper scropulorum, JUSC, 3	Rocky Mountain juniper
Koeleria cristata,KOCR, 1	Prairie Junegrass
Lappula echinata,LAEC, 2	Stickseed
Lepidium densiflorum,LEDE, 2	Field peppergrass
Lewisia rediviva,LERE, 2	Bitterroot
Linnaea borealis,LIBO, 2	Twinflower
Linnum perenne,LIPE, 2	False flax
Lithospermum ruderale,LIRU, 2	Stoneseed
Lotus corniculatus,LOCO, 2	Birdsfoot trefoil
Lolium perenne,LOPE, 1	Perennial ryegrass
Lomatium macrocarpum,LOMA, 2	Large-leafed desert parsley
Lomatium triternatum,LOTR, 2	Nine-leafed lomatium
Medicago lupulina,MELU, 2	Black medic
Medicago sativa,MESA, 2	Alfalfa
Melilotus alba,MEAL, 2	White sweet-clover
Monarda fistulosa,MOFI, 2	Wild bergamot
Mustard,MUST, 2	Mustard species
Oryzopsis asperifolia,ORAS, 1	Rough-leaved ricegrass
Orthocarpus luteus,ORLU, 2	Thin-leafed owlclover
Oxytropis campestris,OXCA, 2	Locoweed
Penstemon confertus, PECO, 2	Tiny penstemon
Penstemon procerus, PEPR, 2	Small-flowered penstemon
Philadelphus lewisii,PHLE, 3	Mock-orange
Phalaris arundinacea, PHAR, 1	Reed canarygrass
Phleum pratense,PHPR, 1	Timothy
Phlox rigida,PHRI, 2	Spiny phlox
Pinus contorta. PICO, 3	Lodgepole pine
Picea spp., PISP, 3	Spruce
Pinus ponderosa,PIPO, 3	Ponderosa pine
Plantago patigonica,PLPA, 2	Narrow-leafed plantain
Potentilla anserina,POAN, 2	Silverweed

Appendix 2. Plant Species (cont'd).

Latin Name	Common Name
Poa compressa,POCO, 1	Canada bluegrass
Potentilla gracilis,POGR, 2	Graceful cinquefoil
Potentilla hippiana,POHI, 2	Woolly cinquefoil
Poa junctifolia, POJU, 1	Alkali bluegrass
Poa pratensis,POPR, 1	Kentucky bluegrass
Potentilla recta,PORE, 2	Sulphur cinquefoil
Poa sandbergii,POSA, 1	Sandberg bluegrass
Poa spp.,POSP, 1	Bluegrass
Populus tremuloides,POTR, 3	Trembling aspen
Prunus virginiana,PRVI, 3	Chokecherry
Pseudotsuga menziesii,PSME, 3	Douglas-fir
Puccinellia nuttallianum, PUNU, 1	Alkaligrass
Purshia tridentata,PUTR, 3	Bitterbrush
Ranunculus acris,RAAC, 2	Meadow buttercup
Ranunculus glaberrimus,RAGL, 2	Sagebrush buttercup
Ribes spp.,RISP, 3	Currant
Rosa spp.,ROSA, 3	Rose
Rubus spp., RUSP, 3	Raspberry
Rumex crispus,RUCR, 2	Curled dock
Senecio canus,SECA, 2	Prairie groundsel
Shepherdia canadensis,SHCA, 3	Soopolallie
Sonchas arvense,SOAR, 2	Prickly sow-thistle
Solidago spathulata,SOSP, 2	Dune goldenrod
Spirea betulifolia,SPBE, 3	Birch-leafed spirea
Spartina gracilis,SPGR, 1	Alkali cordgrass
Stipa columbiana,STCL, 1	Columbia needlegrass
Stipa comata,STCO, 1	Needle-and-thread
Stipa occidentalis,STOC, 1	Western needlegrass
Stipa richardsonii,STRI, 1	Richardsons needlegrass
Symphoricarpus albus,SYAL, 3	Snowberry
Taraxacum officinale,TAOF, 2	Dandelion
Trisetum cernuum,TRCE, 1	Nodding trisetum
Trifolium hybridum,TRHY, 2	Alsike clover
Trifolium pratense,TRPA, 2	Red clover
Tragopogon pratense,TRPR, 2	Goatsbeard
Trifolium repens,TRRE, 2	White clover
Verbascum thapsis,VETH, 2	Common mullein
Viola adunca,VIAD, 2	Early blue violet
Vicia americana,VIAM, 2	American vetch
Zygadenus venenosus,ZYVE, 2	Death camas

Scientific name	**Common name**	**Biogeoclimatic Ecosystem Classification Unit(s)**	**Provincial Rank**	**Provincial List**	**Successional Status**	**Structural Stage**
Betula glandulosa / Equisetum	Scrub birch / horsetail	IDFdm2/06	S3Q	Interim Blue	EC	3
Distichlis stricta - Hordeum jubatum	Saltgrass - foxtail barley	IDFdm2/00	S1	Red	EC	2
Elymus spicatus - Koeleria macrantha	Bluebunch wheatgrass - junegrass	IDFuu/00 IDFdm1/02 PPdh2/02a PPdh2/02b	S2Q	Interim Red	DC	2
Pinus ponderosa - Populus tremuloides / Rosa woodsii	Ponderosa pine - trembling aspen / rose [Solomon's seal]	PPdh2/03	S2	Red	DC	7
Pinus ponderosa / Elymus spicatus - Lupinus	Ponderosa pine / bluebunch wheatgrass - lupine	PPdh1/01 PPdh2/01	S2	Red	DC	7
Populus balsamifera ssp. *trichocarpa / Cornus stolonifera - Rosa nutkana*	Black cottonwood / red-osier dogwood - Nootka rose	PPdh2/04	S1S2	Red	EC DC	7
Pseudotsuga menziesii / Symphoricarpos albus / Balsamorhiza sagittata	Douglas-fir / snowberry / balsamroot	IDFdm2/03	S2	Red	CC	7
Purshia tridentata / Elymus spicatus	Antelope-brush / bluebunch wheatgrass	IDFdm2/02 PPdh2/00	S2	Red	EC DC	3
Symphoricarpos occidentalis - Festuca idahoensis	Western snowberry - Idaho fescue	IDFdm2/00 ?	S2?	Red	EC DC	3

10 Natural Plant Communities Listed

Biogeoclimatic Ecosystem Classification (BEC) Unit(s): This column gives the BEC unit(s) in which each plant community can occur. These units are described in the Ministry of Forests' "Field Guide to Site Identification and Interpretation" for the appropriate Forest Region. Please note that the BEC units listed are for the entire Forest Region, and may not all occur in this Forest District. Units numbered "00" have not yet been assigned site series numbers by the Ministry of Forests. Site series are NOT equivalent to natural plant communities as defined by the CDC; visit the CDC's Ecology web page (www.elp.gov.bc.ca/rib/wis/cdc/ecology.htm) for an explanation.

Successional Status: This column indicates the successional status of each natural plant community. Natural plant communities are, almost without exception, climax plant communities. Younger successional stages are considered to be different plant communities, though they may eventually develop into climax plant communities. For more information on successional status, visit the CDC's Ecology web page (www.elp.gov.bc.ca/rib/wis/cdc/ecology.htm) or consult the Field Manual for Describing Terrestrial Ecosystems (www.for.gov.bc.ca/RIC/Pubs/teEcolo/fmdte/deif.htm).

Code	Successional Status	Definition
CC	Climatic climax	The oldest expression of an ecosystem, where succession has been unimpeded by edaphic (site) limiting factors or ecological disturbance. This state is self-perpetuating in the absence of disturbance.
ED	Edaphic climax	The oldest possible expression of an ecosystem given edaphic (site) limiting factors atypical for the landscape which arrest or redirect succession so that the climatic climax is never achieved. Edaphic limiting factors include extremely dry soil, extremely wet soil, and very poor nutrient regime, relative to the landscape norms.
DC	Disclimax	The oldest possible expression of an ecosystem given a natural disturbance regime which arrests or redirects succession so that the climatic climax is never achieved. Natural disturbances include periodic surface fires and annual flooding.

Structural Stage: This column indicates the structural stage(s) of each natural plant community. Similar plant communities at younger structural stages are considered to be different plant communities, though they may eventually develop into natural plant communities. For definitions, see the Field Manual for Describing Terrestrial Ecosystems (www.for.gov.bc.ca/RIC/Pubs/teEcolo/fmdte/deif.htm).

Code	**Structural Stage**	**Code**	**Structural Stage**
1	Sparse/bryoid	3	Shrub/Herb
1a	*Sparse*	*3a*	*Low shrub*
1b	*Bryoid*	*3b*	*Tall shrub*
2	Herb	4	Pole/Sapling
2a	*Forb-dominated*	5	Young Forest
2b	*Graminoid-dominated*	6	Mature Forest
2c	*Aquatic*	7	Old Forest
2d	*Dwarf shrub-dominated*		

Appendix 3. Red and blue-listed species for the TaTa/Skookumchuck Range Unit.

Scientific name	Common Name	Global	Prov. Rank	Prov. List
Amphibians				
Rana pipiens	Northern Leopard Frog	G5	S1	Red
Bufo boreas	Western toad*			Special
Reptiles				
Chrysemys picta	Painted Turtle*	G5	S3S4	Blue
Charina bottae	Rubber Boa	G5	S3S4	Blue
Eumeces skiltonianus	Western skink*			Blue
Birds				
Botaurus lentiginosus	American Bittern*	G4	S3B,SZN	Blue
Ardea herodias herodias	Great Blue Heron* *herodias* subspecies	G5T5	S3B, S5N	Blue
Haliaeetus leucocephalus	Bald Eagle	G4	S4	Yellow
Buteo swainsoni	Swainson's Hawk*	G5	S2B,SZN	Red
Falco peregrinus anatum	Peregrine Falcon*, *anatum* subspecies	G4T3	S2B,SZN	Red
Falco mexicanus	Prairie Falcon*	G5	S2B,SZN	Red
Tympanuchus phasianellus columbianus	Sharp-Tailed Grouse, *columbianus* subspecies	G4T3	S3	Blue
Grus canadensis	Sandhill Crane	G5	S3B,SZN	Blue
Numenius americanus	Long-Billed Curlew	G5	S3B,SZN	Blue
Otus flammeolus	Flammulated Owl*	G4	S3S4B,SZN	Blue
Otus kennicottii macfarlanei	Western Screech-Owl, *macfarlanei* subspecies	G5T?	S2	Red
Asio flammeus	Short-Eared Owl	G5	S2N,S3B	Blue
Aeronautes saxatalis	White-Throated Swift	G5	S3S4B, SZN	Blue
Melanerpes lewis	Lewis's Woodpecker*	G5	S3B,SZN	Blue
Sphyrapicus thyroideus nataliae	Williamson's Sapsucker, *nataliae* subspecies	G5TU	S1S2B	Red
Dolichonyx oryzivorus	Bobolink*	G5	S3B,SZN	Blue
Mammals				
Corynorhinus townsendii	Townsend's big-eared bat*			Blue
Myotis septentrionalis	Northern Long-Eared Myotis	G4	S2S3	Blue
Tamias minimus oreocetes	Least Chipmunk, *oreocetes* subspecies	G5T3	S1S3	Red
Tamias ruficaudus ruficaudus	Red-Tailed Chipmunk, *ruficaudus* subspecies	G5T5	S2	Red
Clethrionomys gapperi galei	Southern Red-Backed Vole, *galei* subspecies	G5T?Q	S3S4	Blue
Ursus arctos	Grizzly Bear	G4	S3	Blue
Taxidea taxus	Badger*	G5	S2	Red
Ovis canadensis canadensis	Rocky Mountain Bighorn Sheep*	G4G5T4T5	S2S3	Blue
Insects				
Lycaena dione	Dione copper butterfly*			Red

Fish				
Salvelinus confluentus	Bull trout*			Blue

Red and blue listed plants

Scientific Name	Common Name	Global Rank	Prov Rank	Prov list
Agastache foeniculum	Giant-hyssop	G4G5	SH	Red
Anemone canadensis	Canada anemone	G5	S2S3	Blue
Apocynum x floribundum		HYB	S2S3	Blue
Arnica chamissonis ssp. incana	Meadow arnica	G5T?	S2S3	Blue
Atriplex argentea ssp. argentea	Silvery orache	G5T5	S1	Red
Bouteloua gracilis	Blue grama	G5	S1	Red
Brickellia grandiflora	Large-flowered brickellia	G5	S1	Red
Calamoviilfa longifolia				
Carex geyeri	Geyer's sedge	G5	S2S3	Blue
Carex sychnocephala				
Carex xerantica	Dry-land sedge	G5	S2S3	Blue
Castilleja cusickii	Cusick's paintbrush	G4G5	S2S3	Blue
Castilleja pallescens				
Castilleja tenuis	Hairy owl-clover	G5	S1	Red
Chenopodium leptophyllum var. oblongifolium				
Cirsium scariosum	Elk thistle	G5	S2S3	Blue
Cryptantha ambigua	Obscure cryptantha	G4	S2	Red
Delphinium bicolor ssp. bicolor	Montana larkspur	G4G5T?	S2S3	Blue
Epipactis gigantea	Giant helleborine	G4	S2S3	Blue
Erigeron lanatus	Wooly daisy	G3G4	S3	Blue
Euphorbia serpylliforum var. paucilflorum				
Euphorbia serpylliflora				
Gaura coccinea	Scarlet gaura	G5	S1	Red
Gayophytum ramosissimum	Hairstem groundsmoke	G5	S1	Red
Gentiana affinis	Prairie gentian	G5	S2S3	Blue
Glyceria leptostachya	Slender-spike manna grass	G3	S2S3	Blue
Glycyrrhiza lepidota	Wild licorice	G5	S1	Red
Hedeoma hispida	Rough pennyroyal	G5	S1	Red
Helenium autumnale var. grandiflorum	Mountain sneezeweed	G5T?	S2S3	Blue
Helianthus nuttallii var. nuttallii	Nuttall's sunflower	G5T5	S1	Red
Heterocodon rariflorum				
Hypericum scouleri ssp. nortoniae	Western St. John's-wort	G5T?	S2S3	Blue
Impatiens ecalcarata	Spurless touch-me-not	G3G4	S2S3	Blue
Lathyrus bijugatus	Pinewood peavine	G4	S1	Red
Lewisia triphylla	Three-leaved lewisia	G4?	S2S3	Blue
Linanthus septentrionalis	Northern linanthus	G5	S2	Red
Lomatium sandbergii	Sandberg's desert parsley	G4	S2S3	Blue
Lupinus arbustus ssp. neolaxiflorus	Spurred lupine	G5T?	SH	Red

Lupinus arbustus ssp. pseudoparviflorus	Montana lupine	G5T?	S1	Red
Orobanche corymbosa ssp. mutabilis	Flat-topped broomrape	G4T?	S2	Red
Pellaea atropurpurea				
Phacelia lyallii	Lyall's phacelia	G3	S2S3	Blue
Phlox hoodii	Hood's phlox	G5	S2S3	Blue
Physaria didymocarpa var. didymocarpa	Common twinpod	G5T4	S2S3	Blue
Plantago eriopoda	Alkali plantain	G5	S2	Red
Potentilla diversifolia var. perdissecta	Diverse-leaved cinquefoil	G5T4	S2S3	Blue
Potentilla ovina var. ovina		G4T?	S2S3	Blue
Ranunculus flabellaris				
Salix boothii	Booth's willow	G5	S2S3	Blue
Sanguisorba occidentalis				
Schizachyrium scoparium	Little bluestem	G5	S1	Red
Scolochloa festucacea	Sprangle-top	G5	S2	Red
Scutellaria angustifolia	Narrow-leaved skullcap	G5	S2S3	Blue
Silene spaldingii	Spalding's campion	G2	S1	Red
Sphaeralcea coccinea	Scarlet globe-mallow	G5?	S1	Red
Sphenopholis intermedia	Prairie wedgegrass	G5	S1	Red
Sphenopholis obtusata var. obtusata	Prairie wedgegrass	G5T5	S1	Red
Stellaria obtusa	Blunt-sepaled starwort	G5	S2S3	Blue
Thalictrum dasycarpum				
Thermopsis rhombifolia	Prairie golden bean	G5	S1	Red
Townsendia exscapa				
Townsendia parryi	Parry's townsendia	G4?	S1	Red
Veronica catenata	Pink water speedwell	G5	S1	Red

63 Taxa Listed

Appendix 4. Wetland Assessment Checklist.

Wetland Assessment Checklist						
Form completed by:						
Survey Date dd/mm/yy / /				Weather:		
Type of Year (i.e. warm/cold/wet/dry):						
Wetland Name(s)						
Wetland Number(s):						
Wetland Area:						
Subunits of a single wetland?	☐ Yes	☐ No	☐ Don't Know / N/A			
Location	Range Unit		Pasture			
Forest District		Ownership				
Mapsheet (1:20,000)		Airphoto Number				
Biogeoclimatic Unit/Subzone:						
Watershed/Catchment Basin/Drainage:						
Directions to find wetland:						
GPS Location at Photopoint	Zone: Easting: Northing:					
	Waypoint #:	Elevation from GPS m				
Tiepoint	Tag tree species:	Tag tree dbh cm				
	Bearing/Distance from Tiepoint	Degrees: Distance: m				
Photos: (Please describe photo type.)	Photo Type	Bearing of Photo	Photo #	Notes		
	#1 Overview Photo					
	#2					
	#3					
	#4					
Wetland Description - please tick appropriate category(s)						
☐ Lake (>2m	☐ Shallow Water <2m	☐ Swamp	☐ Marsh	☐ Fen	☐ Bog	
☐ Shrub-carr	☐ Graminoid meadow	☐ Deciduous margin				
☐ Other (Describe):						
Water in the system? ☐Yes ☐ No						
Evidence of water level changes? ☐Yes ☐ No ☐ Unsure						
Water Quality						
Water quality ☐ algae blooms ☐ pollution						
Degree of water turbidity	☐ clear	☐ translucent	☐ opaque			
☐ Saline ☐ Alkaline						
Describe evidence of pH (ie. indicator plants, alkali on rocks, actual measurements)						
Describe:						
Notes:						

Sketch Map (Include: north, tiepoint, photopoint, rough areas of different veg. types etc.)

Vegetation Assessment								
1. Plant Community Description (list dominant species, mark reference condition species)								
Wetland	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species								(%)
Riparian	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species (%)								
Upland	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species								(%)

2. Vegetation Structure	Ground Cover	Grasses / forbs	Shrubs	Trees
Wetland				
Riparian				
Upland				

Plant Vigour in Wetland	☐ Low	☐ Medium	☐ High
Plant Vigour in Riparian Margin	☐ Low	☐ Medium	☐ High
Plant Vigour in Upland w/in 100 m of wetland	☐ Low	☐ Medium	☐ High

Daubenmire cover classes: 1=0-5%, 2=6-25%, 3=26-50%, 4=51-75%, 5=76-95%, 6=96-100%
Midpoints: 1=3; 2=15; 3=38; 4=63, 5=85; 6= 98

3. Litter	Wetland	Riparian	Upland
Cover (%)			
Comments:			
4. Erosion/ Disturbance	Wetland	Riparian	Upland
Bare Soil (%)			
Exposed Rock Substrate & Cobbles (%)			
Soil movement			
Soil loss			
Physical (pugging, trails etc.)			
Vehicles			
Water level changes			
Industrial			
Comments:			
5. Invasive Species	Wetland	Riparian	Upland
Cover (%)			
Distribution (single patch, >1 patch, continuous)			
Wetland System Comments:			

Scorecard						
		Ref'ce	**Slightly**	**Mod.**	**Greatly**	**Score**
			Altered	**Altered**	**Altered**	
Plant Community (40)		>75%	51-75%	26-50%	<25%	
Key Species Canopy Cover (%)	Wetland	10	8	4	0	
Note: refers to % of expected species						
These apply for each wetland and upland type	Riparian	20	16	8	0	
	Upland	10	8	4	0	
Plant Community Structure (15)		All layers	-1 layer	-2 layer	-3 layer	
Expected Layers	Wetland	5	3	1	0	
Trees, Shrubs, Tall grasses & forbs, Ground cover						
Layers absent or altered	Riparian	5	3	1	0	
	Upland	5	3	1	0	
Litter (15)		100%+	76-100%	51-75%	<50%	
Litter Cover (%)	Wetland	4	5	3	0	
Note:100%+ refers to excess standing litter						
	Riparian	4	5	3	0	
	Upland	4	5	3	0	
Disturbance (15)		<10%	10-25%	25-50%	>50%	
Bare Soil (%)	Wetland	5	3	1	0	
Note: type of disturbance is described in checklist						
	Riparian	5	3	1	0	
	Upland	5	3	1	0	
Invasive Plant Species (15)		0%	<1%	1-10%	>10%	
Invasive Species Cover (%)	Wetland	3	3	1	0	
	Riparian	3	2	1	0	
	Upland	3	2	1	0	
Distribution		None	1 patch	>1patch	Cont.	
	Wetland	2	1	0	0	
	Riparian	2	1	0	0	
	Upland	2	1	0	0	
Total (100)						

Wildlife Habitat	Wetland	Riparian	Upland
Beaver Dams?			
Muskrat Nests?			
Peninsulas and Islands for nesting?			
Large Rocks/Logs for Loafing sites?			
Snags Present			
Snag Density (low, medium, high)			
Coarse Woody Debris			
Bird nests?			
Muskrats?			
Fish?			
Beaver?			
Turtles?			
Turtle Nesting Sites?			
Frogs?			
Watering?			
Grazing?			
Browsing?			
Caves/ Rock Features?			
Notes:			
Manmade Disturbances	Wetland	Riparian	Upland
Vehicle Damage			
Roads adjacent to wetlands			
Dams, structures etc			
Water Removals			
Fences			
Burns and/or Logging			
Range Water Developments			
Recreation (campsites, fire rings etc)			
Notes:			
Natural Disturbances	Wetland	Riparian	Upland
Wildfire			
Hydrology (water levels)			
Watering			
Grazing			
Browsing			
Mineral Lick			
Habitat altering wildlife			
Notes:			

Potential Management Actions			
Grazing Management			
Change Season of Cattle Use	☐ Yes	☐ No	☐ Maybe
Change Cattle Behaviour	☐ Yes	☐ No	☐ Maybe
Fencing Wetland to Exclude Cattle	☐ Yes	☐ No	☐ Maybe
Fencing Wetland to Exclude Cattle & Ungulates	☐ Yes	☐ No	☐ Maybe
Alternative Watering Sources for Cattle	☐ Yes	☐ No	☐ Maybe
Altering Adjacent Fences and Pasture Divisions	☐ Yes	☐ No	☐ Maybe
Alter adjacent upland areas to alter Cattle/Ungulate behaviour	☐ Yes	☐ No	☐ Maybe
Landscape Management			
Reserve Wetland from Prescribed Burning	☐ Yes	☐ No	☐ Maybe
Reserve Areas from Logging	☐ Yes	☐ No	☐ Maybe
Revegetation (suggest species in notes)	☐ Yes	☐ No	☐ Maybe
Noxious Weed Management	☐ Yes	☐ No	☐ Maybe
Recreational Use Management			
Limit mechanical recreational use	☐ Yes	☐ No	☐ Maybe
Other?			
Water Management			
Water Control/Management	☐ Yes	☐ No	☐ Maybe
Options to Bring Water into Wetland	☐ Yes	☐ No	☐ Maybe
Mechanical Vegetation Control	☐ Yes	☐ No	☐ Maybe
Fertilization to increase productivity	☐ Yes	☐ No	☐ Maybe
Species Specific Actions			
Artificial Nesting Structures	☐ Yes	☐ No	☐ Maybe
Snag Creation	☐ Yes	☐ No	☐ Maybe
Construction of Insular Habitat	☐ Yes	☐ No	☐ Maybe
Level Ditching/pothole blasting (increase pair space)	☐ Yes	☐ No	☐ Maybe
Addition of loafing sites			
Other?			

Appendix 5. TaTa/Skookumchuck Range Unit wetlands by pasture, landscape unit and drainage.

Pasture	Landscape Unit	Drainage	Wetland Number	Area	Comments
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	69	0.31	dumb fence 1
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	70	1.85	dumb fence 2
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	71	2.27	half private to west
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	77	1.25	south marsh
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	85	0.47	depression 4
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	86	0.08	depression 3
Camp/Skook	Second Bench/striated bedrock	Deep Valley complex	87	0.84	west of 149 pond
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	90	0.08	depression 1
Camp/Skook	Second Bench/striated bedrock	Skook Falls area	91	0.32	depression 2
Camp/Skook	Second Bench/striated bedrock	Deep Valley complex	92	1.60	149 pond
Camp/Skook	Purcell Slopes	Pommier Creek	98	0.52	west pond of Pommier rd
Camp/Skook	Purcell Slopes	Pommier Creek	101	0.32	end of west pond
Camp/Skook	Second Bench/striated bedrock	Echo Lakes complex	102	6.96	North Echo Lake
Camp/Skook	Second Bench/striated bedrock	Echo Lakes complex	116	0.72	North Echo march
Camp/Skook	Purcell Slopes	Pommier Creek	123	0.81	lentic swamp dec.
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	133	3.43	beaver marsh 1
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	136	0.11	beaver dam 1
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	139	0.37	beaver dam 4
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	141	0.09	beaver dam 2
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	142	1.57	beaver marsh 2
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	144	0.08	beaver dam 3
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	147	0.17	beaver pond 5
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	149	2.21	beaver march 3
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	153	0.67	big pond
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	169	0.30	beaver march 4
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	171	0.17	other tributary pond
Camp/Skook	Purcell Slopes		172	0.18	Upper Mather meadow

Appendix 5. TaTa/Skookumchuck Range Unit wetlands by pasture, landscape unit and drainage.

Pasture	Landscape Unit	Drainage	Wetland Number	Area	Comments
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	173	0.13	North Reed
Camp/Skook	Purcell Slopes	Upper Reed Creek	174	0.29	sedge meadow above rd
Camp/Skook	Purcell Slopes		175	0.16	further west
Camp/Skook	Purcell Slopes		176	0.28	sedge shrub meadow
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	180	1.56	marsh and carr on road
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	182	0.72	south reed creek
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	183	1.43	Upper south reed 1
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	184	3.61	Upper south reed 2
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	185	1.29	Upper south reed 3
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	196	0.28	isolated marsh
Camp/Skook	Second Bench/striated bedrock	North & South Reed Cr.	198	0.20	isolated marsh 2
Camp/Skook	Second Bench/striated bedrock	Bald Hill Creek	200	1.86	sedge meadow
Camp/Skook	Second Bench/striated bedrock	Bald Hill Creek	202	0.87	sedge meadow
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	?		swamp below not identified
Camp/Skook	Second Bench/striated bedrock	Beaverdam Creek	?		raised meadow an confluence
Dune	First Bench above floodplain	Kootenay River	195	16.72	Catterson north crown
Dune	Second Bench/striated bedrock	Reed Lakes	197	1.17	south reed -DU project
Dune	Second Bench/striated bedrock	Bald Hill Creek	199	5.12	big alkali meadow
Dune	Second Bench/striated bedrock	Bald Hill Creek	201	4.22	aspen to south
Dune	First Bench above floodplain	North TaTa Cr. drainage	204	0.51	pump dry marsh
Dune	First Bench above floodplain	North TaTa Cr. drainage	205	1.53	alkali meadow

Appendix 5. TaTa/Skookumchuck Range Unit wetlands by pasture, landscape unit and drainage.

Pasture	Landscape Unit	Drainage	Wetland Number	Area	Comments
Echo	Second Bench/striated bedrock	Pommier woodlot	73	1.06	woodlot marsh
Echo	Second Bench/striated bedrock	Deep Valley complex	96	17.00	deep valley marsh sys.
Echo	Second Bench/striated bedrock	Deep Valley complex	97	0.60	deep valley pond
Echo	Second Bench/striated bedrock	Echo Lakes complex	107	1.92	
Echo	Second Bench/striated bedrock	Camp 2 Complex	108	0.73	west of power line
Echo	Second Bench/striated bedrock	Echo Lakes complex	109	0.36	east echo marsh 1
Echo	Second Bench/striated bedrock	Camp 2 Complex	110	2.17	tule marsh west of pl
Echo	Second Bench/striated bedrock	Echo Lakes complex	111	12.46	South Echo Lake
Echo	Second Bench/striated bedrock	Camp 2 Complex	112	3.56	Camp 2 pond
Echo	Second Bench/striated bedrock	Camp 2 Complex	113	0.09	depression meadow
Echo	Second Bench/striated bedrock	Echo Lakes complex	114	0.24	east echo marsh 2
Echo	Second Bench/striated bedrock	Echo Lakes complex	117	0.15	pond?
Echo	Second Bench/striated bedrock	Camp 2 Complex	119	0.61	deep depression east
Echo	Second Bench/striated bedrock	Echo Lakes complex	120	0.29	east echo marsh 3
Echo	Second Bench/striated bedrock	Camp 2 Complex	122	0.11	depression meado2
Echo	Second Bench/striated bedrock	Camp 2 Complex	124	0.33	lost pond
Echo	Second Bench/striated bedrock	Deep Valley complex	128	0.10	small pond at south
Echo	Second Bench/striated bedrock	Camp 2 Complex	129	0.29	deciduous at north
Echo	Second Bench/striated bedrock	Camp 2 Complex	130	1.65	south pond
Echo	Second Bench/striated bedrock	South Echo Cr. ponds	132	0.19	north side
Echo	Second Bench/striated bedrock	South Echo Cr. ponds	135	0.61	turtle pond
Echo	Second Bench/striated bedrock	South Echo Cr. ponds	137	0.81	marsh west
Echo	Second Bench/striated bedrock	South Echo Cr. ponds	145	0.13	south 1
Echo	Second Bench/striated bedrock	South Echo Cr. ponds	146	0.11	south 2
Echo	Second Bench/striated bedrock	Camp 2 Complex	148	0.29	south depression

Appendix 5. TaTa/Skookumchuck Range Unit wetlands by pasture, landscape unit and drainage.

Pasture	Landscape Unit	Drainage	Wetland Number	Area	Comments
42	First Bench above floodplain	Kootenay River	143	0.42	42mile pond
42	First Bench above floodplain	Kootenay River	157	1.55	42mile decid.
Foster	First Bench above floodplain	Kootenay River	177	0.06	pond at north end
Foster	First Bench above floodplain	Kootenay River	178	1.46	meadow north
Plot	First Bench above floodplain	Kootenay River	72	0.20	telus pond1
Plot	First Bench above floodplain	Kootenay River	78	0.20	telus pond 3
Plot	First Bench above floodplain	Kootenay River	79	0.49	telus pond 2
Plot	First Bench above floodplain	Kootenay River	94	1.34	Green Lake
Reed	Second Bench/striated bedrock	North & South Reed Cr.	179	0.58	north of north reed lake
Reed	Second Bench/striated bedrock	North & South Reed Cr.	186	0.26	closer to lake
Reed	Second Bench/striated bedrock	Reed Lakes	187	7.38	north reed - meadow
Reed	Second Bench/striated bedrock	Reed Lakes	188	2.77	east reed- meadow
Reed	Second Bench/striated bedrock	Reed Lakes	189	0.37	east reed- marsh (dry)
Reed	Second Bench/striated bedrock	Reed Lakes	190	0.13	North Reed
Reed	Second Bench/striated bedrock	Reed Lakes	191	0.98	north reed-marsh
Reed	Second Bench/striated bedrock	Reed Lakes	192	10.70	south reed- meadow
Reed	Second Bench/striated bedrock	Reed Lakes	193	1.32	south reed- marsh
Crown Land Total			88	145.77	
Private Land Total			18	40.89	
Range Unit Total *			106	186.66	
* within map boundary					

Appendix 6. Representative Photos of scored wetlands.

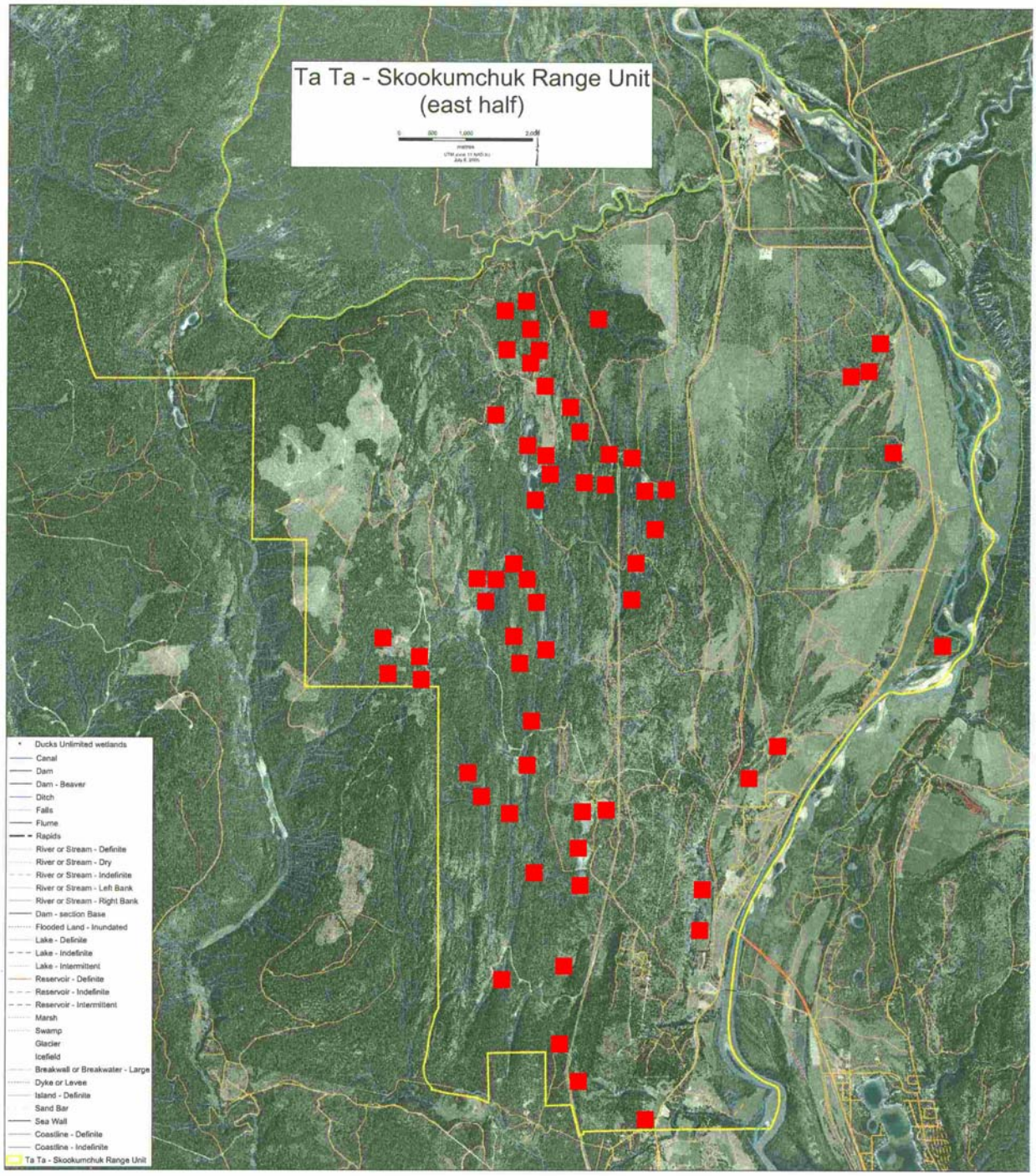
Wetland#72 - Telus Pond 1 (score = 88)

Wetland #70 - Rail Fence Slough (score = 94)

Wetland#143 - 42 Mile Slough (score = 48)

Wetlands #188, 189 - East Reed Meadow and Marsh
(score= 30)

Appendix 7. The location of wetlands in the Ta Ta/Skookumchuck range unit.



Appendix 8. Reconnaissance survey data
(Data disk attached)

Appendix 9. Wetland Reconnaissance Assessment Manual
(attached as separate document)

Wetland Reconnaissance Assessment Manual:

A Prototype for the Lentic Wetlands of the Rocky Mountain Trench

by:

M.E. Keefer
T.J. Ross
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for:

Columbia Basin
Fish and Wildlife
Compensation Program

Appendix 9

Version 1.0

March 2006

Table of Contents

List of Appendices

1.0 Introduction

This manual is written to guide the surveyor in the use of the reconnaissance level Wetland Assessment Method, and in completing the accompanying checklist. The assessment tool is intended to provide baseline information on surveyed wetlands to assist in identifying potential restoration efforts. Further information on this assessment tool can be found in Ross et al. (2006) and other documents in the reference section.

This method uses elements from other approaches to assessment in four ways:

1. It is a reconnaissance level assessment, intended to take <90 min to complete
2. The assessment examines the wetland, riparian and upland areas
3. A number of indicators of wetland condition are evaluated
4. Alteration from a reference condition is assessed

This tool uses indicators that are readily observable and require no sampling. Roughly 30 attributes are recorded in a checklist format (Appendix 1). The form is divided into five sections:

1. Site description
2. Vegetation assessment
3. Vegetation score-card
4. Wildlife habitat
5. Management actions

A key outcome of using this tool is that users will become familiar with observing key indicators of wetland condition in a structured and non-biased manner. By using such an approach it is possible to obtain reliable assessments of the state of an individual wetland, to collect baseline information for future monitoring, and to collect data that may be compared statistically at a later date.

2.0 Concepts

2.1 Wetland Types

When surveying wetlands, it is important to separate wetland types with similar attributes to enable comparisons of disturbance history within types, and to identify those that will respond similarly to management actions.

Wetland types are defined by the permanent or seasonal presence of water, the duration of inundation or soil saturation, and whether soils are derived from acidic or basic parent material (MacKenzie 1999, McKenzie and Moran 2004). Classes range from permanent, stable water systems (lakes, ponds, shallow water), through those with seasonal water (swamps, marshes), to units that are “transitional” between wetland and upland systems (shrub carr, graminoid meadow) (Appendix 2). A distinction is made between “mineral” or non-peat forming wetlands (fens), and “peat” forming wetlands (bogs).
The wetland system contains three zones for evaluation:

1. The wetland is the portion of the system where soils are either saturated or ponded, including lakes, ponds, shallow water, swamps, marshes, fens and bogs.

2. The riparian zone is the banks and adjacent areas of water bodies, watercourses, seeps and springs, whose waters provide soil moisture levels that are higher than in the surrounding upland zone. It includes the shrub carr, graminoid meadow, deciduous margin and forb meadow types.

3. The upland zone is defined as the area within 100 m of each wetland. The surrounding landscape is an important component of wetland systems as a source of recharge, shade for wetland areas, sediment transfer, and nesting, feeding, resting, and refuge sites for wetland species.

2.2 Wetland Plant Communities

Vegetation is one of the few parameters that may be examined throughout the snow-free periods of the year, and assessed during a single visit. The present status of a site is compared to a "reference condition" plant community.

Reference condition defines a plant community that is unaltered by disturbance, natural or human-caused. Reference condition descriptions are developed from minimally disturbed sites that share similar ecological potential (Adams et al. 2003, Wikeem and Wikeem 2005). This approach is broad enough to allow for the natural variation that results from annual weather patterns or site conditions. Leading species for each wetland type reference condition plant community were defined from field-work conducted during this project, from Smyth and Allen (2003) and from other sources including; Hitchcock (1971), Hitchcock and Cronquist (1973), Runka and Lewis (1981), Braumandl and Curran (1992), and Parish, Coupe and Lloyd (1996).

Reference condition plant communities are summarized in Appendix 3 and 4. Invasive and increaser species are listed by type in Appendix 5.

3.0 Getting Started

3.1 Equipment

Below is a list of recommended equipment and information sources to bring in the field:

- ✓ Reconnaissance Form
- ✓ Manual
- ✓ Wetland/Plant Guides
- ✓ Maps and Airphotos
- ✓ Surveyors vest
- ✓ Pencils, eraser
- ✓ Penknife
- ✓ GPS
- ✓ Compass
- ✓ Measuring tape (30 m)
- ✓ Camera
- ✓ Plastic tags and nails
- ✓ Hammer
- ✓ Rebar pegs
- ✓ Range pole or metre board with 15 or 20 cm graduations
- ✓ Sign board and dry wipe markers
- ✓ First Aid Kit
- ✓ Mobile radio and/or cell phone
- ✓ Emergency phone numbers

3.2 Background Information

Prepare for the field by reading available background information, acquiring maps and airphotos, and talking with others who are knowledgeable about the area you are examining. The objectives of the survey will help determine what level of background information is required. If the intent is surveying individual wetlands on a case-by-case basis, there is little need to gather extensive background information. However, if the survey is assessing a wide number of wetlands in a constrained geographic area then it is recommended that a thorough pre-field work stage be completed. Such efforts may involve the use of a supervised classification of wetlands, airphoto analysis, and the use of local subject experts.

Recommended information sources include:

- Maps including biogeoclimatic, Terrestrial Resource Information Mapping (TRIM), Forest Cover, TEM (Terrestrial Ecosystem Mapping), PEM (Predictive Ecosystem Mapping), VRI (Vegetation Resource Information), soils and others
- Airphotos (both recent and historic)
- Past vegetation, wetland and range assessments
- Local knowledge

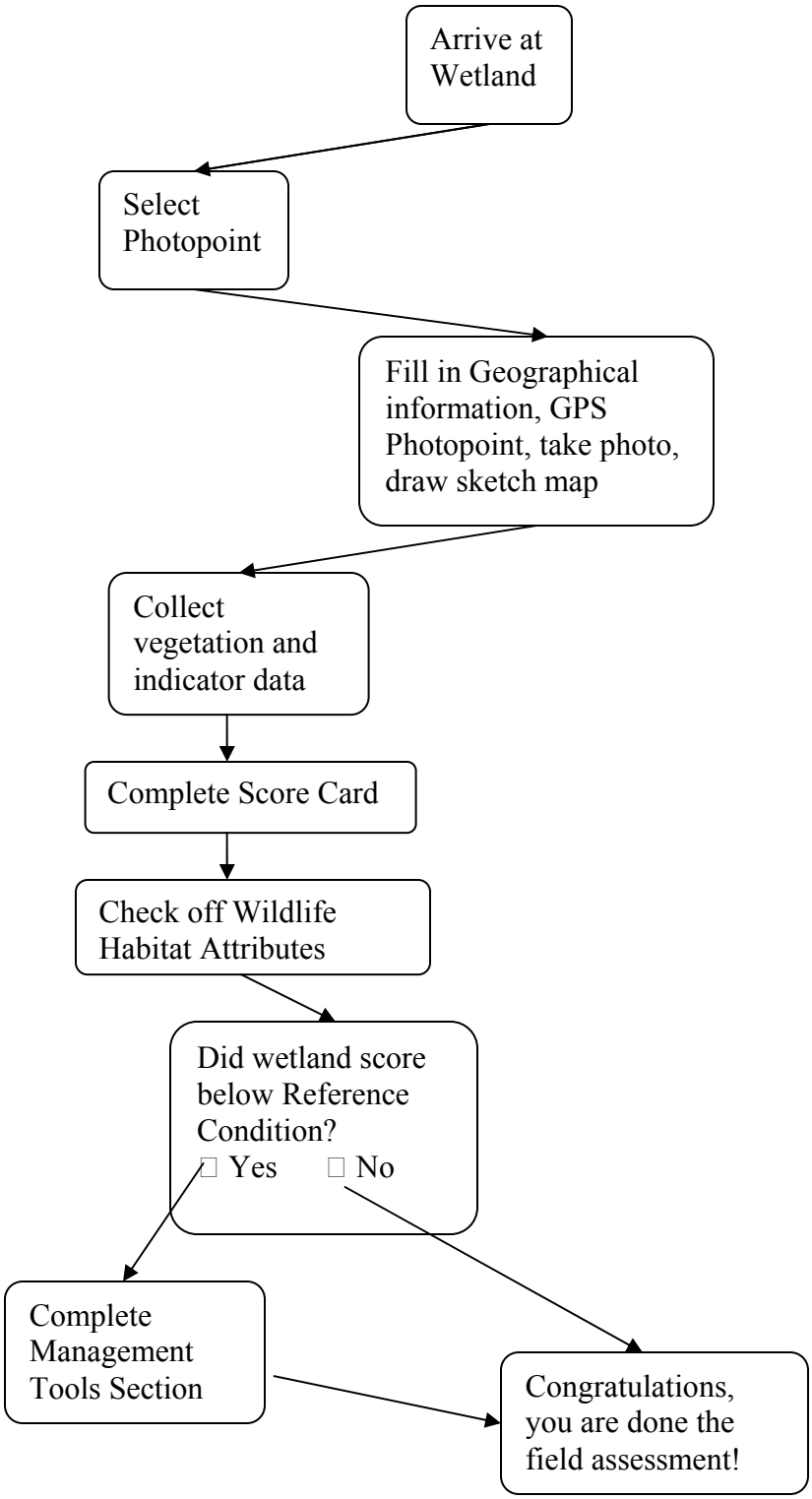
This background research should provide the assessor with adequate information to proceed to the field phase. For example, information gathered may include:
- How long have the wetlands been dry?
- Have there been any restoration activities to date?
- What species at risk are known to be in the area?

3.3 Conducting the Survey

This manual will walk you through the steps to a successful survey, including:

- Assembling maps, airphotos, wetland data, historical and anecdotal information
- Establish permanent photopoints
- GPS photopoint locations
- Site description (including sketch map)
- Use of checklist
- Use of scoring system
- Noting wildlife habitat features
- Identification of potential management actions
- Data entry
- Data analysis and interpretation

The flow chart below depicts the assessment process.


Arrive at Wetland
Select Photopoint
Fill in Geographical information, GPS Photopoint, take photo, draw sketch map
Collect vegetation and indicator data
Complete Score Card
Check off Wildlife Habitat Attributes
Did wetland score below Reference Condition?
Yes
No
Complete Management Tools Section
Congratulations, you are done the field assessment!

4.0 Assessment Form

The following sections are found on the reconnaissance form, and details on how to fill them out are provided. Following field work in 2006, a completed copy of the revised form will be scanned and added as an appendix.

4.1 Site Description

This section is found on pages one and two of the checklist. It is designed to record site information that can be used as a reference during evaluation, and for long-term monitoring. It may not be possible to complete every box as not all the information will be available for all projects. However, the more background information that can be completed, the more useful the data will be in the future. Throughout the process of filling out the form, please take relevant notes in the spaces provided.

4.1.1 Geographical and Other Information

Background

This first section is designed to:

- identify the surveyor,
- locate and identify the wetland, and
- collect general weather information.

Step by Step

1. Fill in the appropriate information
2. For wetlands that may have been segregated in the mapping exercise, but are obviously one system when viewed in the field, mark yes for the subunits of a single wetland question

4.1.2 Photopoint

Background

Upon arriving at the wetland to be surveyed it is recommended that the surveyor first select a permanent photopoint at a place that is slightly raised in elevation and provides a representative view of the wetland system.

A tie-point should be established on a prominent, nearby, healthy tree that is at least 10 cm in diameter at breast height (dbh). GPS co-ordinates should be collected for the photopoint. The GPS must be set with the correct datum for future relocation; it is recommended that it be set with NAD 83 and UTM for consistency with most maps.

Digital cameras are now commonly in use. Unfortunately, with some cameras the user cannot determine the focal length of the lens. To overcome this challenge it is recommended that the camera be set at its widest angle. To allow for an equitable comparison of photos from different dates, the range pole or meter board must be placed at a prescribed distance from the photopoint (Hall 2002). A distance of 5 m is recommended.

Step by step:

1. Chose a location with a good overview of the wetland, riparian and upland zones
2. Hammer in rebar stake at photopoint
3. Establish a tie-point by tagging a nearby live tree of >10 cm
4. Record the tree species and dbh
5. Record bearing and distance from the tree to the photopoint
6. Record the GPS location of the photopoint
7. Enter metadata (e.g. date, place, direction) on sign board
8. Take the overview photo, and record photo number, bearing and relevant notes

For supplemental photos it is not necessary to establish a permanent photopoint, but the photo location should be noted on the sketch map, and the bearing, photo number and other notes should be recorded on the form.

4.1.3 Determine Wetland Type

Background

Wetland systems frequently contain more than one wetland type. Using Appendix 2 (p. 18) as a reference, identify all wetland types present, and check all relevant boxes.

The presence or absence of water is a key descriptor, along with evidence of change in water level. Evidence of change may include:

- Shrub skeletons (dead or decadent shrubs in the riparian zone)
- Wind-throw trembling aspen in the riparian margin
- Calcium-encrusted rocks that often delineate the high water line
- Mud flats between open water and wetland/riparian vegetation
- Formerly ponded or inundated soils recently vegetated with invasive species

4.1.4 Water Quality

Water quality is an important descriptor of wetlands that is difficult to measure in a reconnaissance level survey. For this assessment, indicate whether the water is eutrophic. Descriptors are algae blooms and water turbidity. Note the source of the turbidity if observed. The pH may be estimated by the presence or absence of alkali on rocks, the presence of saline/alkali tolerant plant species or by actual measurements.

4.1.5 Sketch Map

The final part of the wetland description is a sketch map. The purpose of the sketch is to produce an overview of the wetland and its key features that can be used later for remembering the site, referencing notes, and developing initial plans. Typically the easiest way to get the wetland shape, dimension and position relative to other nearby wetlands is to consult the airphoto. The sketch map needn't take more than five minutes to complete.

The following should be included:

- North arrow
- Location of photopoint and tie-point
- The location and distribution of the upland, riparian and wetland zones
- Approximate locations of plant communities by zone
- Location of major habitat features like islands, large rocks, peninsulas etc.
- Identification of disturbance sources
- Identification of structures, works, range improvements etc.

Step by step:

1. Check off appropriate wetland types and other questions
2. Note any evidence of water level changes
3. Take any other relevant notes
4. Complete the Sketch Map

4.2 Vegetation Assessment

Background

This assessment system is based on vegetation, which provides the most readily observable indicators with which to evaluate wetlands. Each indicator describes the status of an ecological factor or process that often cannot be seen or measured (Wikeem and Wikeem 2005). Status at a site is measured by comparing the condition of these indicators against a standard (Adams et al. 2003). You will be evaluating each of the five factors, comparing them to a reference condition, and then scoring them to provide a wetland "score".

The wetland, riparian and upland zones are assessed separately. Five indicators evaluate the plant community at the site as to the state of alteration from a reference community (Adams et al. 2003, Wikeem and Wikeem 2005). Ocular estimates of vegetation cover, litter cover, bare ground and cover of invasive species are recorded using the cover class system developed by Daubenmire (1959) (Table 1). For examples of cover, please consult Table 1. Exact percentages can be used, or else a general cover class can be assigned and the mid-point used as the percent cover on the scorecard.

Table 1: Daubenmire Cover Classes to be used for estimating plant community composition & structure, litter, bare soil, and invasive species.

Daubenmire Class	Cover	Mid-Point
1	0-5%	2.5%
2	6-25%	15%
3	26-50%	37.5%
5	51-75%	62.5%
6	76-95%	85%
6	96-100%	97.5%

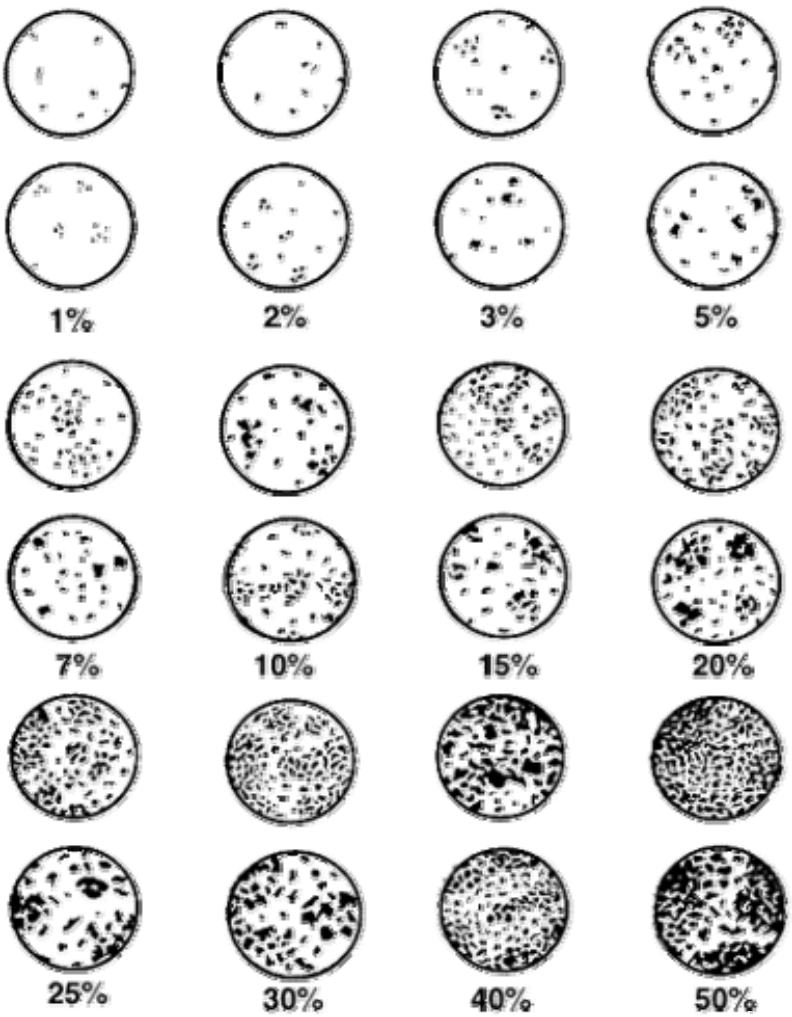


Figure 1: Percent cover examples for vegetation estimates. Figure taken from "Describing Ecosystems in the Field" (MELP and MOF 1998).

1. **Plant community composition**
   Please note that these reference plant lists (Appendix 3, 4) are designed to provide guidance and are not exhaustive. For each wetland zone (wetland, riparian and upland) estimate and record the percent cover for each species using the Daubenmire cover classes. Reference species will be used for scoring.

   To estimate the percent cover, only the area that vegetation could grow in is included. For example, in a marsh with a fringe of cattail and tule, that fringe may represent 100% cover because those species cover the entire area where vegetation is expected.

   You can also add any other dominant species in each zone (e.g. invasive plants or other non-reference species) but they are *not included* in the reference condition cover total. Once you have recorded all the reference species for each layer for each zone, sum the cover for each layer using the mid-points of the Daubenmire cover classes. For example if the marsh contained 70% water lily (as well as 10% purple loosestrife), the cover for water lily would be class 4 – 51-75%. The purple loosestrife would be ignored for this task. The mid-point of class 4 is 63%. Write that number in the "Total" box at the bottom of the column.

   Then total all the values for each wetland type. For example, if there was 20% tule, 20% cattail), 70% forbs (water-lily), and no shrubs or trees for the marsh, the total would be 93%. This would equate to 10 points on the scorecard (>75%).

   Note that the total percent cover may be more than 100% for some wetland types, given that the total is the sum of several plant layers.

2. **Plant community structure**
   As plant communities are modified by disturbance, species composition changes and so does the structure of the community. This affects light, water and nutrient distribution and also impacts habitat capability. Vegetation structure is divided into four layers:
   1) ground cover (moss, lichen, low-growing grasses and forbs)
   2) grasses/forbs
   3) shrubs
   4) trees

   Refer to Appendix 3 and 4 to determine how many layers would be expected in each zone.

   Use the boxes provided under vegetation structure in the Assessment form to tick off which layers are present. Deduct the number present from the number expected to derive the number of layers that are "missing or altered". Use the scorecard to note "all layers", "-1 layer", etc.

Vigour is a descriptive section to with which to make any comments about the health/vigour/robustness of plants in each layer.

3. **Litter**
   Litter aids in the nutrient cycle by contributing minerals and organic matter, and in the hydrologic cycle by insulating the soil surface from evaporation, and slowing water movement over the soil, which decreases erosion and promotes infiltration. Litter is defined as any fallen or standing dead vegetation including woody debris. For example, cattails in a marsh may have a high percentage of "litter" in the form of old standing plants, and grasslands in the upland may also have litter in the form of fallen leaves from forbs, shrubs and trees, woody debris, and fallen or standing grass litter from previous years.

   Estimate litter cover in each of the wetland zones by providing a Daubenmire cover class. Note that it is possible to have >100% litter since there may be litter in each vegetation layer and they are summed.

   Use the mid-point of the cover class you estimated to fill in the scorecard for Litter for each layer. For example, if you had over 100% litter in the wetland, circle "4", and 60% litter in the riparian, circle "3", etc.

4. **Bare soil**
   Bare soil is an indicator of whether soil erosion at the site exceeds natural levels, and thus is an indicator of site stability. Bare soil is defined as exposed mineral soil, and does not include areas that have moss, lichen, or any other living matter. Rocks are not included as bare soil. In an area with water, there would be no exposed bare soil. However, in an area where a wetland has dried up, there may be. Make notes of any sources of disturbance you see, for example a ring of cobbles around the wetland or ATV damage. Estimate the percent cover of exposed bare soil and provide a Daubenmire class.

   Use the mid-point of the cover class on the scorecard under "Disturbance". There should be a score for each of the zones.

5. **Invasive species**
   Consult invasive species list in Appendix 5 for potential species. Estimate the cover class and the distribution of invasive/increaser species in each of the three layers. You may have already listed invasive species with their associated percent covers under the "Plant Community Description". If not, make a visual estimate of the invasive plants and their distribution in each of the three layers. Invasive plant distribution may be considered a single patch, more than one patch, or continuous spread.

   Use the percent cover (total for all invasive species in a particular zone) to transfer to the scorecard. For example, if there was 10% knapweed of and 5% orange hawkweed in the upland, knapweed would be class 2 (mid-point=15) and orange

hawkweed would be class 1 (mid-point=3). The total for the upland would be 18%, so the upland would be score "0" or "greatly altered".

Also record the distribution for each of the zones on the scorecard. If there were several patches of orange hawkweed and knapweed, it would be considered more than one patch and receive a "0" or "moderately altered" on the scorecard.

Step by Step:

1. Note the dominant plant species per layer and zone using the species codes (it is expected that you won't find representatives in every layer in all sites)
2. Estimate the cover class for each species
3. Mark reference condition species with an asterisk
4. Assess vegetation structure by noting the presence/absence and alteration of expected vegetation layers in each zone
5. Estimate plant vigour in each zone and check appropriate boxes
6. Estimate the cover class of litter in each zone (note that it is possible to have >100% litter cover, in these cases mark as cover class 6+)
7. Estimate the cover class of bare soil in each zone
8. Note the disturbances that contributed to bare soil in each zone
9. Check off cover class for each invasive species that is observed, in each zone
10. Note the distribution of invasive species by zone
11. Take notes that will assist in analysing data and interpreting results

It is strongly recommended that users of this form bring the plant species list and species codes to the field until thoroughly familiar (Appendix 5).

4.3 Vegetation Score-card

Background Information

This system uses five indicators to rate a site by comparing the vegetation to a reference condition plant community (Wikeem and Wikeem 2005). Complete the score-card by transferring information from the five indicators in the Vegetation Assessment section to the score-card, and circling the appropriate score for each zone. See the previous sections to determine how to derive the score and record it on the scorecard.

Once scores have been allocated to each criteria, sum the right hand column for a total wetland score. This score will be between 0 and 100, indicating the state of alteration of the vegetation at a site relative to a reference plant community. Based on this final score, classify the wetland as one of four condition classes.

1. reference condition (76-100)
2. slightly altered (51-75)
3. moderately altered (26-50)
4. greatly altered (0-25)

Note that occasionally, there will be a missing indicator for a zone. In these cases the score will be pro-rated. To pro-rate add up the actual score and the total potential score then convert this number to a fraction out of 100.

Step by Step

1. Sum the cover for key plant species for each layer in the Plant Community Description
2. Score the Plant Community Structure based on the presence/absence or alteration of expected layers
3. Note the Litter cover class
4. Observe the Disturbance cover class
5. Observe Invasive Species cover
6. Observe Invasive Species distribution

4.4 Wildlife Habitat, Natural and Manmade Disturbances

Background

The primary purpose of this section is to provide a structured means of rapidly collecting descriptive information on wildlife habitat, and manmade and natural disturbances. If objectives point toward collecting additional data in an intensive survey program, bird-nesting surveys etc. would have to be completed at the appropriate time.

Step by Step

1. Note habitat features applicable to the wetland, riparian and upland zones
2. Note disturbances for each zone

4.5 Potential Management Actions

Background

In addition to identifying low scoring sites, the scoring system is also intended to identify the primary factors limiting wildlife capability for each wetland, and provide baseline information for future monitoring. Low scoring sites may represent priority areas for management actions, depending on objectives. **This section need only be completed on wetlands that score below reference condition.**

Step by Step

1. Critique this list against your observations and check the appropriate boxes

5.0 References

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6.0 Appendices

Appendix 1. Wetland Assessment Checklist

Wetland Assessment Checklist						
Form completed by:						
Survey Date dd/mm/yy / /				Weather:		
Type of Year (i.e. warm/cold/wet/dry):						
Wetland Name(s)						
Wetland Number(s):						
Wetland Area:						
Subunits of a single wetland?	☐ Yes	☐ No	☐ Don't Know / N/A			
Location	Range Unit		Pasture			
Forest District		Ownership				
Mapsheet (1:20,000 series)		Airphoto Number				
Biogeoclimatic Unit/Subzone:						
Watershed/Catchment Basin/Drainage:						
Directions to find wetland:						
GPS Location at Photopoint	Zone: Easting: Northing:					
	Waypoint #:	Elevation from GPS m				
Tiepoint	Tag tree species:	Tag tree dbh cm				
	Bearing/Distance from Tiepoint	Degrees: Distance: m				
Photos: (Please describe photo type.)	Photo Type	Bearing of Photo	Photo #	Notes		
	#1 Overview Photo					
	#2					
	#3					
	#4					
Wetland Description - please tick appropriate category(s)						
☐ Lake (>2m depth)	☐ Shallow Water <2m	☐ Swamp	☐ Marsh	☐ Fen	☐ Bog	
☐ Shrub-carr	☐ Graminoid meadow	☐ Deciduous margin				
☐ Other (Describe):						
Water in the system? ☐Yes ☐ No						
Evidence of water level changes? ☐Yes ☐ No ☐ Unsure						
Water Quality						
Water quality ☐ algae blooms ☐ pollution						
Degree of water turbidity	☐ clear	☐ translucent	☐ opaque			
☐ Saline ☐ Alkaline						
Describe evidence of pH (ie. indicator plants, alkali on rocks, actual measurements)						
Describe:						
Notes:						

Sketch Map (Include: north, tiepoint, photopoint, rough areas of different veg. types etc.)

Vegetation Assessment								
1. Plant Community Description (list dominant species, mark reference condition species)								
Wetland	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species								(%)
Riparian	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species (%)								
Upland	Grass	(%)	Forbs	(%)	Shrubs	(%)	Trees	(%)
Key Species	Total		Total		Total		Total	
Total Cover of Reference Species								(%)

2. Vegetation Structure	Ground Cover	Grasses / forbs	Shrubs	Trees
Wetland				
Riparian				
Upland				

Plant Vigour in Wetland	☐ Low	☐ Medium	☐ High
Plant Vigour in Riparian Margin	☐ Low	☐ Medium	☐ High
Plant Vigour in Upland w/in 100 m of wetland	☐ Low	☐ Medium	☐ High

Daubenmire cover classes: 1=0-5%, 2=6-25%, 3=26-50%, 4=51-75%, 5=76-95%, 6=96-100%
Midpoints: 1=3; 2=15; 3=38; 4=63, 5=85; 6= 98

3. Litter	Wetland	Riparian	Upland
Cover (%)			
Comments:			
4. Erosion/ Disturbance	Wetland	Riparian	Upland
Bare Soil (%)			
Exposed Rock Substrate & Cobbles (%)			
Soil movement			
Soil loss			
Physical (pugging, trails etc.)			
Vehicles			
Water level changes			
Industrial			
Comments:			
5. Invasive Species	Wetland	Riparian	Upland
Cover (%)			
Distribution (single patch, >1 patch, continuous)			
Wetland System Comments:			

Scorecard						
		Ref'ce	**Slightly**	**Mod.**	**Greatly**	**Score**
			Altered	**Altered**	**Altered**	
Plant Community (40)		>75%	51-75%	26-50%	<25%	
Key Species Canopy Cover (%)	Wetland	10	8	4	0	
Note: refers to % of expected species						
These apply for each wetland and upland type	Riparian	20	16	8	0	
	Upland	10	8	4	0	
Plant Community Structure (15)		All layers	-1 layer	-2 layer	-3 layer	
Expected Layers	Wetland	5	3	1	0	
Trees, Shrubs, Tall grasses & forbs, Ground cover						
Layers absent or altered	Riparian	5	3	1	0	
	Upland	5	3	1	0	
Litter (15)		100%+	76-100%	51-75%	<50%	
Litter Cover (%)	Wetland	4	5	3	0	
Note:100%+ refers to excess standing litter						
	Riparian	4	5	3	0	
	Upland	4	5	3	0	
Disturbance (15)		<10%	10-25%	25-50%	>50%	
Bare Soil (%)	Wetland	5	3	1	0	
Note: type of disturbance is described in checklist						
	Riparian	5	3	1	0	
	Upland	5	3	1	0	
Invasive Plant Species (15)		0%	<1%	1-10%	>10%	
Invasive Species Cover (%)	Wetland	3	3	1	0	
	Riparian	3	2	1	0	
	Upland	3	2	1	0	
Distribution		None	1 patch	>1patch	Cont.	
	Wetland	2	1	0	0	
	Riparian	2	1	0	0	
	Upland	2	1	0	0	
Total (100)						

Wildlife Habitat	Wetland	Riparian	Upland
Beaver Dams?			
Muskrat Nests?			
Peninsulas and Islands for nesting?			
Large Rocks/Logs for Loafing sites?			
Snags Present			
Snag Density (low, medium, high)			
Coarse Woody Debris			
Bird nests?			
Muskrats?			
Fish?			
Beaver?			
Turtles?			
Turtle Nesting Sites?			
Frogs?			
Watering?			
Grazing?			
Browsing?			
Caves/ Rock Features?			
Notes:			
Manmade Disturbances	Wetland	Riparian	Upland
Vehicle Damage			
Roads adjacent to wetlands			
Dams, structures etc			
Water Removals			
Fences			
Burns and/or Logging			
Range Water Developments			
Recreation (campsites, fire rings etc)			
Notes:			
Natural Disturbances	Wetland	Riparian	Upland
Wildfire			
Hydrology (water levels)			
Watering			
Grazing			
Browsing			
Mineral Lick			
Habitat altering wildlife			
Notes:			

Potential Management Actions			
Grazing Management			
Change Season of Cattle Use	☐ Yes	☐ No	☐ Maybe
Change Cattle Behaviour	☐ Yes	☐ No	☐ Maybe
Fencing Wetland to Exclude Cattle	☐ Yes	☐ No	☐ Maybe
Fencing Wetland to Exclude Cattle & Ungulates	☐ Yes	☐ No	☐ Maybe
Alternative Watering Sources for Cattle	☐ Yes	☐ No	☐ Maybe
Altering Adjacent Fences and Pasture Divisions	☐ Yes	☐ No	☐ Maybe
Alter adjacent upland areas to alter Cattle/Ungulate behaviour	☐ Yes	☐ No	☐ Maybe
Landscape Management			
Reserve Wetland from Prescribed Burning	☐ Yes	☐ No	☐ Maybe
Reserve Areas from Logging	☐ Yes	☐ No	☐ Maybe
Revegetation (suggest species in notes)	☐ Yes	☐ No	☐ Maybe
Noxious Weed Management	☐ Yes	☐ No	☐ Maybe
Recreational Use Management			
Limit mechanical recreational use	☐ Yes	☐ No	☐ Maybe
Other?			
Water Management			
Water Control/Management	☐ Yes	☐ No	☐ Maybe
Options to Bring Water into Wetland	☐ Yes	☐ No	☐ Maybe
Mechanical Vegetation Control	☐ Yes	☐ No	☐ Maybe
Fertilization to increase productivity	☐ Yes	☐ No	☐ Maybe
Species Specific Actions			
Artificial Nesting Structures	☐ Yes	☐ No	☐ Maybe
Snag Creation	☐ Yes	☐ No	☐ Maybe
Construction of Insular Habitat	☐ Yes	☐ No	☐ Maybe
Level Ditching/pothole blasting (increase pair space)	☐ Yes	☐ No	☐ Maybe
Addition of loafing sites			
Other?			

Appendix 2. Lentic wetlands in the East Kootenay region of the Upper Columbia basin.

Group [1]	Class	Water Source	Features	Group characteristics	Vegetation
Freshwater	**Lake**	flooding inflow	Permanent flooding >2.0 m	>5 ha	submergents
	Pond	flooding inflow	Permanent flooding >2.0 m	<5 ha	submergents
	Shallow Water	flooding inflow	Permanent flooding 0.5-2.0 m	Mineral soils or well-humified sedimentary peat	submergents emergents
Wetland	**Swamp**	groundwater surface flow	Significant surface and groundwater flow	Mineral soils with <40cm of peat accumulation	Tall shrubs or trees, forbs grasses, leafy mosses
	Marsh	groundwater surface flow	Protracted shallow flooding	Surface organic tier on deeper peat Typically alkaline soils	Graminoid or forbs; one emergent species; shrubs/trees are < 10% cover
Peatland	**Fens**	groundwater inflow	Water table at or just below peat surface most of the growing season	pH >5.0 relatively high mineral content within rooting zone	Few trees; graminoid or low shrubs; sedges, brown mosses
	Bogs	groundwater basin accumulations	Surface peat accumulated above groundwater flow	pH <5.0 low in dissolved nutrients	Coniferous trees or low shrubs; Ericaceous shrubs, sphagnum mosses
Transition	**Shrub carr**	Groundwater	Seasonally saturated but rarely inundated	Frost-prone sites with moist or very moist soils, Mineral substrate, Aerated (not peat) organic matter accumulations of <15cm	Shrub dominated
	Gram-inoid meadow	Groundwater	Brief period of inundation, early season saturation, Water table below root zone for most of growing season	Alkaline soils, often slightly to highly saline, Cold air ponding sites, fine-textured soils in grassland areas	Grasses, sedges, rushes, forbs, halophytic plants
	Forb meadow	Heavy snowfall regions Snow accumulation areas Prolonged seepage	Slopes and valley bottoms where there is cold air drainage and persistent ground water flow	Usually montane or subalpine, Persistent snowpack and seepage preclude tree est., Mineral soils, may have thin, dark organic veneer	Tall forbs and sedges
Others	**Decid-uous margin**	Groundwater	Wetted soils	Usually at the high water mark of a small basin, Riparian margin	Aspen, shrubs, grasses and forbs
	Aspen stringer	Groundwater	Wetted soils	Usually in drainage channels or other low spots	Aspen, shrubs, grasses and forbs

[1] Wetland types after MacKenzie (1999) and MacKenzie and Moran (2004).

Appendix 3. Reference plant communities for lentic wetlands in the East Kootenay region of the Upper Columbia basin.

Group [1]	Class	Grasses	Forbs	Shrubs	Trees
Freshwater	**Lake**	tule	water lily, whorled water-milfoil		
	Pond	tule, cattail	water lily		
	Shallow Water	tule, cattail	buckbean, water plantain		
Wetland	**Swamp**	bluejoint, small flowered bulrush,	pink wintergreen, ladyfern, bunchberry, trailing raspberry	willow spp., mountain alder, red-osier dogwood, black twinberry	spruce, aspen, black cottonwood
	Marsh	tule, cattail, sedge, tufted hairgrass	common mare's tail, water parsnip, purple-leaved willow herb		
Peatland	**Fens**	tule, cattail		Labrador tea, dwarf cranberry	spruce
	Bogs	sedge		Labrador tea, dwarf cranberry	
Transition (Riparian)	**Shrub carr**	Nuttal's alkali grass, redtop, sedge, rushes		glandular birch, wolf-willow, willow spp.	
	Graminoid meadow	Nuttal's alkali grass, tufted hairgrass, alkali saltgrass, alkali cordgrass, redtop, sedge, rushes	silverweed, tufted white prairie aster,	willow spp., glandular birch	
	Forb meadow		arrow-leafed grounsel		
Others	**Deciduous margin**	bluejoint, tufted hairgrass, beaked sedge, blue wildrye, rough fescue	creamy peavine, cow parsnip, pink wintergreen, rattlesnake plantain, wild strawberry, western meadowrue, violet	glandular birch, willow spp., red-osier dogwood, Saskatoon, snowberry,	aspen, spruce, ponderosa pine
	Aspen stringers	bluejoint, pinegrass, blue wildrye, beaked sedge	star-flowered Solomon's seal, pink wintergreen, wild sarsaparilla, bunchberry, large leaved avens, western meadowrue, Canada violet	willow spp., prairie rose, Oregon grape, white stemmed gooseberry, black twinbery	aspen, spruce, ponderosa pine

[1] Wetland types after MacKenzie (1999) and MacKenzie and Moran (2004).

Appendix 4. Upland reference plant communities* in the lower Rocky Mountain Trench.

	Grass	Forbs	Shrubs
Xeric	bluebunch wheatgrass	balsamroot	bitterbrush
	needle-and-thread	shaggy fleabane	Saskatoon
	prairie Junegrass	hairy goldaster	prairie rose
		brown eyed Susan	snowbrush
		alumroot	
Mesic	rough fescue	leafy aster	snowberry
	Idaho fescue	silky lupine	prickly rose
	Richardson's needlegrass	northern bedstraw	chokecherry
		wild strawberry	kinnickinik
Sub-hygric	pinegrass	twinflower	common juniper
	bearded wheatgrass	wild strawberry	soopolallie
	blue wildrye	small flowered penstemon	bearberry
	slender wheatgrass	heart leaved arnica	pussy willow
			currant/gooseberry
			birch leaved spirea
			low oregongrape

*Depending on a host of factors, species in this list intergrade between site moisture conditions.

Appendix 5. Invasive plant species in lentic wetlands in the East Kootenay region of the Upper Columbia basin.

Group [1]	Class	Grasses	Forbs
Freshwater	**Lake**		Eurasian millefoil, purple loosestrife
	Pond	reed canarygrass	Eurasian millefoil, purple loosestrife
	Shallow Water	reed canarygrass	Eurasian millefoil, purple loosestrife
Wetland	**Swamp**		
	Marsh	reed canarygrass	oak leaved goosefoot, strawberry blight, buttercup spp., plantain, curled dock, marsh yellow-cress, prickly sow-thistle, Canada thistle, bull thistle, yellow salsify
Peatland	**Fens**		
	Bogs		
Transition (Riparian)	**Shrub carr**		slender hawkweed, curled dock,
	Graminoid meadow	foxtail barley	slender hawkweed, prickly sow-thistle, yellow salsify
	Forb meadow	orange hawkweed	
Others	**Deciduous margin**		houndstongue, slender hawkweed, prickly sow-thistle, great burdock
	Aspen stringers		houndstongue, slender hawkweed, prickly sow-thistle, great burdock

Appendix 6. Plant Species. [1]

Latin Name	Common Name
Acer glabrum,ACGL, 3	Douglas maple
Achillea millefolium,ACMI, 2	Western yarrow
Agrostis alba,AGAL, 1	Redtop
Agropyron cristatum,AGCR, 1	Crested wheatgrass
Agropyron dasytachyum,AGDA, 1	Western wheatgrass
Agropyon riparium,AGRI, 1	Streambank wheatgrass
Agropyron spicatum,AGSP, 1	Bluebunch wheatgrass
Agrostis scabra,AGSC, 1	Hair bentgrass
Agropyron subsecundum,AGSU, 1	Bearded wheatgrass
Agropyron trachycaulum,AGTR, 1	Slender wheatgrass
Allium cernuum,ALCE, 2	Nodding onion
Alnis tenuiflolia,ALTE, 3	Mountain alder
Amelanchier alnifolia,AMAL, 3	Saskatoon
Antennaria dimorpha,ANDI, 2	Low pussytoes
Antennaria microphylla,ANMI, 2	Rosy pussytoes
Anemone multifida,ANMU, 2	Pacific anemone
Antennaria parvifolia,ANPA, 2	Pussytoes
Anemone patens,ANPT, 2	Prairie crocus
Androsace septentrionalis,ANSE, 2	Fairy candelabra
Apocynum androsaemifolium,APAN, 2	Spreading dogbane
Artemesia frigida,ARFR,2	Pasture sage
Arnica fulgens,ARFU, 2	Orange arnica
Arabis holboellii,ARHO, 2	Hoelboel's rockcress
Artemesia spp.,ARSP, 3	Sage
Arctostaphylos uva-ursi,ARUV, 3	Bearberry
Aster campestris,ASCA, 2	Western meadow aster
Aster ciliolatus,ASCI, 2	Lindley's aster
Aster foliaceous,ASFO, 2	Leafy aster
Aster pansies,ASPA, 2	Tufted white prairie aster
Astragalus miser,ASMI, 2	Timber milkvetch
Balsamorhiza sagittata,BASA, 2	Balsamroot
Betula glandulosa, BEGL, 3	Bog-birch
Berberis repens,BERE, 3	Low Oregongrape
Beckmannia syzigachne,BESY, 1	Beckmannia
Bromus inermis,BRIN, 1	Smooth bromegrass
Bromus tectorum,BRTE, 1	Cheatgrass
Calochortus apiculatus,CAAP, 2	Baker's mariposa lily

[1] Plant species list represents common PPdh2 and IDFdm2 species.
1=grass and grasslike; 2=forbs; 3=shrubs; 4=trees

Appendix 5. Plant Species (cont'd).

Latin Name	Common Name
Calamagrostis canadensis, CACA, 1	Bluejoint
Carex douglasii,CADO, 1	Douglas sedge
Calochortus macrocarpum,CAMA, 2	Mariposa lily
Calochortus apiculatus,CAAP, 2	Baker's mariposa lily
Calamagrostis canadensis, CACA, 1	Bluejoint
Carex douglasii,CADO, 1	Douglas sedge
Calochortus macrocarpum,CAMA, 2	Mariposa lily
Campanula rotundifolia,CARO, 2	Scottish bells
Calamagrostis rubescens,CARU, 1	Pinegrass
Carex spp.,CARX, 1	Sedge
Castilleja thompsonii,CATH, 2	Thompson's paintbrush
Cerastium arvense,CEAR, 2	Chickweed
Centaurea diffusa,CEDI, 2	Diffuse knapweed
Centaurea maculosa,CEMA, 2	Spotted knapweed
Ceanothus velutinus,CEVE, 3	Buckbrush
Chenopodium capitatum, CHCA, 2	Alkali goosefoot
Chrysanthemum leucanthemum,CHLE, 2	Oxeye daisy
Cirsium hookerianum, CIHO, 2	Hooker's thistle
Chrysothamnus nauseosus,CHNA, 3	Rabbitbrush
Chrysopsis villosa,CHVI, 2	Hairy goldaster
Cirsium arvense.,CIAR, 2	Canada thistle
Cirsium vulgare,CIVU, 2	Bull thistle
Collinsia parviflora,COPA, 2	Blue-eyed Mary
Commandra umbellata,COUM, 2	Bastard toadflax
Crepis atrabarba,CRAT, 2	Slender hawksbeard
Cynoglossum officianale,CYOF, 2	Houndstongue
Danthonia intermedia,DAIN, 1	Timber oatgrass
Dactylis glomerata,DAGL, 1	Orchardgrass
Delphinium nuttallianum,DENU, 2	Upland larkspur
Distichlis stricta, DIST, 1	Inland saltgrass
Dodecatheon pauciflorum,DOPA, 2	Shooting star
Echium vulgare,ECVU, 2	Viper's bugloss
Elaeagnus commutata, ELCO, 3	Wolf-willow
Elymus cinereus, ELCI, 1	Giant wild-rye
Elymus glauca,ELGL, 1	Blue wild-rye
Epilobium angustifolium,EPAN, 2	Fireweed
Erigeron compositus,ERCO, 2	Compound fleabane
Erigeron pumilis,ERPU, 2	Shaggy fleabane
Eriogonum umbellatum,ERUM, 2	Sulphur buckwheat
Festuca idahoensis,FEID, 1	Idaho fescue
Fern species,FERN, 2	Fern

Appendix 5. Plant Species (cont'd).

Latin Name	Common Name
Festuca scabrella,FESC, 1	Rough fescue
Fragaria virginiana,FRVI, 2	Wild strawberry
Gaillardia aristata,GAAR, 2	Brown-eyed susan
Gallium boreale,GABO, 2	Northern bedstaw
Geum triflorum,GETR, 2	Old man's whiskers
Grindellia squarosa,GRSQ, 2	Curly-cup gumweed
Heuchra cylindrica,HECY, 2	Alum root
Hieracium gracile,HIGR, 2	Slender hawkweed
Hypericum perforatum,HYPE, 2	St. John's-wort
Juniper communis, JUCO, 3	Common juniper
Juncus spp.,JUNC, 1	Rush species
Juniper scropulorum, JUSC, 3	Rocky Mountain juniper
Koeleria cristata,KOCR, 1	Prairie junegrass
Lappula echinata,LAEC, 2	Stickseed
Lepidium densiflorum,LEDE, 2	Field peppergrass
Lewisia rediviva,LERE, 2	Bitterroot
Linnaea borealis,LIBO, 2	Twinflower
Linnum perenne,LIPE, 2	False flax
Lithospermum ruderale,LIRU, 2	Stoneseed
Lotus corniculatus,LOCO, 2	Birdsfoot trefoil
Lolium perenne,LOPE, 1	Perennial ryegrass
Lomatium macrocarpum,LOMA, 2	Large-leafed desert parsley
Lomatium triternatum,LOTR, 2	Nine-leafed lomatium
Medicago lupulina,MELU, 2	Black medic
Medicago sativa,MESA, 2	Alfalfa
Melilotus alba,MEAL, 2	White sweet-clover
Monarda fistulosa,MOFI, 2	Wild bergamot
Mustard,MUST, 2	Mustard species
Oryzopsis asperifolia,ORAS, 1	Rough-leaved ricegrass
Orthocarpus luteus,ORLU, 2	Thin-leafed owlclover
Oxytropis campestris,OXCA, 2	Locoweed
Penstemon confertus, PECO, 2	Tiny penstemon
Penstemon procerus, PEPR, 2	Small-flowered penstemon
Philadelphus lewisii,PHLE, 3	Mock-orange
Phalaris arundinacea, PHAR, 1	Reed canarygrass
Phleum pratense,PHPR, 1	Timothy
Phlox rigida,PHRI, 2	Spiny phlox
Pinus contorta. PICO, 4	Lodgepole pine
Picea spp., PISP, 4	Spruce
Pinus ponderosa,PIPO, 4	Ponderosa pine
Plantago patigonica,PLPA, 2	Narrow-leafed plantain

Appendix 5. Plant Species (cont'd).

Latin Name	Common Name
Potentilla anserina,POAN, 2	Silverweed
Poa compressa,POCO, 1	Canada bluegrass
Potentilla gracilis,POGR, 2	Graceful cinquefoil
Potentilla hippiana,POHI, 2	Woolly cinquefoil
Poa junctifolia, POJU, 1	Alkali blugrass
Poa pratensis,POPR, 1	Kentucky bluegrass
Potentilla recta,PORE, 2	Sulphur cinquefoil
Poa sandbergii,POSA, 1	Sandberg bluegrass
Poa spp.,POSP, 1	Bluegrass
Populus tremuloides,POTR, 4	Trembling aspen
Prunus virginiana,PRVI, 3	Chokecherry
Pseudotsuga menziesii,PSME, 4	Douglas-fir
Puccinellia nuttallianum, PUNU, 1	Alkaligrass
Purshia tridentata,PUTR, 3	Bitterbrush
Ranunculus acris,RAAC, 2	Meadow buttercup
Ranunculus glaberrimus,RAGL, 2	Sagebrush buttercup
Ribes spp.,RISP, 3	Currant
Rosa spp.,ROSA, 3	Rose
Rubus spp., RUSP, 3	Raspberry
Rumex crispus,RUCR, 2	Curled dock
Senecio canus,SECA, 2	Prairie groundsel
Shepherdia canadensis,SHCA, 3	Soopolallie
Sonchas arvense,SOAR, 2	Prickly sow-thistle
Solidago spathulata,SOSP, 2	Dune goldenrod
Spirea betulifolia,SPBE, 3	Birch-leafed spirea
Spartina gracilis,SPGR, 1	Alkali cordgrass
Stipa columbiana,STCL, 1	Columbia needlegrass
Stipa comata,STCO, 1	Needle-and-thread
Stipa occidentalis,STOC, 1	Western needlegrass
Stipa richardsonii,STRI, 1	Richardson's needlegrass
Symphoricarpus albus,SYAL, 3	Snowberry
Taraxacum officinale,TAOF, 2	Dandelion
Trisetum cernuum,TRCE, 1	Nodding trisetum
Trifolium hybridum,TRHY, 2	Alsike clover
Trifolium pratense,TRPA, 2	Red clover
Tragopogon pratense,TRPR, 2	Goatsbeard
Trifolium repens,TRRE, 2	White clover
Verbascum thapsis,VETH, 2	Common mullein
Viola adunca,VIAD, 2	Early blue violet
Vicia americana,VIAM, 2	American vetch
Zygadenus venenosus,ZYVE, 2	Death camas