Alberta Wetland Rapid Evaluation Tool-Actual (ABWRET-A) Guide

June 2015

Title:	**Alberta Wetland Rapid Evaluation Tool – Actual (ABWRET-A) Guide**
Number:	**AEP, Water Conservation, 2015, No. 9**
Program Name:	**Water Policy Branch**
Effective Date:	**June 1, 2015**
This document was updated on:	
ISBN No.	**978-1-4601-2364-5 (Print)** **978-1-4601-2365-2 (PDF)**

Purpose

To provide a manual with instructions and references for assessing the relative value of wetlands.

Policy Context

This directive supports the Alberta Wetland Policy and related wetland assessment tools

Reference Documents

- Alberta Wetland Regulatory Requirements Guide
- Alberta Wetland Assessment and Impact Report Directive
- Alberta Wetland Mitigation Directive
- Alberta Wetland Classification System
- Alberta Wetland Identification and Delineation Directive

Enforcement / Compliance

All proponents must use this directive to delineate wetlands for the purpose of making a wetland assessment under the *Water Act* or *Public Lands Act*

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Citation

Government of Alberta. 2015. *Alberta Wetland Rapid Evaluation Tool –Actual (ABWRET- A) Manual.* Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta.

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Executive Summary

ABWRET-A is a standardized method for rapidly assessing some of the important natural functions of all types of wetlands present in the White Zone of Alberta. The "A" stands for "actual", meaning it uses on-site observations and off-site spatial data to inform the regulatory value of a wetland as part of the Wetland Mitigation Directive. ABWRET-A consists of this manual and its appendices, three data forms (one of which is completed by Alberta Environment and Parks (AEP), the others by the applicant), a GIS Tool and an Excel® spreadsheet containing the model formulas used to derive a wetland value.

ABWRET-A generates scores for a wetland's functions which then are used, with other inputs, to assign a wetland to a value category (A, B, C, or D) in a consistent and transparent manner. That category is intended to assist the wetland approvals applicant and AEP in decisions about wetland avoidance, minimization and replacement, as well as the replacement ratios where that is required.

Standardized criteria for assigning wetlands to these value categories are based on both science and policy. *Science* enters into the criteria in the form of on-site observations by a Qualified Wetland Science Practitioner (QWSP), the use of existing spatial data that is compiled case-by-case by AEP, and the use of models (logic-based formulas) to generate scores representing the relative levels of 14 wetland functions[1]. Those models reflect studies published in scientific journals and the judgment of wetland scientists. *Policy* enters into the criteria at a later stage. Wetlands are placed in one of four categories ("a", "b", "c", "d") that advise the Government of Alberta (GOA) about specific administrative actions that may be taken. Those categories are defined partly by ranges of scores generated by ABWRET-A and which reflect relative levels of wetland functions. As a matter of policy, the GOA has specified that in Alberta's White Area wetlands with value scores that are above the 90th percentile in the frequency distribution of value scores for all wetlands in the White Area should be categorized as "a" (the most protective category), between the 70th and 90th percentile as "b", between the 40th and 70th percentile as "c", and scores below the 40th percentile as "d". Also, historical trends in the loss of wetland number and area within a RWVAU[2] are separately estimated and then factored into a wetland's category determination in a standardized manner.

To assess a particular wetland, a QSWP[3], after being trained in the use of ABWRET-A, performs a desktop review and then visits the wetland to delineate its boundaries according to procedures in the Alberta Wetland Identification and Delineation Guide. During the same or a subsequent visit, the QWSP answers approximately 77 questions (depending on site characteristics) based on observations, and, if

[1] Some internal AEP documents have called these "subfunctions" and synthesized them into 4 groups called "functions". Consistent with long-standing scientific use, the term "functions" is used generically throughout this manual to denote **either** hierarchical level -- subfunctions or functions.

[2] Relative Wetland Value Unit, a landscape unit delimited by hydrological and ecological similarity within which wetlands are assessed relative to other wetlands within the unit. The GOA has divided the province into 21 RWVAUs.

[3] or until May 2016, an interim wetland science practitioner

necessary and possible, on conversations with the person on whose property the wetland exists. Completing the on-site part of ABWRET-A typically takes 1-3 hours, depending on wetland size, access, and the QWSP's prior experience applying the tool and familiarity with the area. Although most data form questions (indicators) are applied to estimate several wetland functions, users need only enter the data for each indicator in one place on the data form. In most cases, not all questions need to be answered because the data form allows many to be skipped depending on specified characteristics of a wetland.

The QWSP emails the completed field data form and the spatial file of the digitized wetland boundaries to a regulatory ABWRET-A support technician at AEP, who enters the field data into the ABWRET-A spreadsheet calculator and uses the Off-Site GIS tool to generate the off-site indicator scores which are then combined with the field data in the ABWRET-A spreadsheet calculator. In its calculations, the spreadsheet accounts for differences among wetland types by ignoring responses to questions that are not relevant to the type of wetland being assessed, instead of scoring them "0." After the spreadsheet calculates the function scores, it automatically applies the policy-based relative value rating criteria and abundance factor rules to assign the wetland to value category A, B, C, or D. Results are returned to the user.

ABWRET's scoring is based on logic models programmed into the calculator spreadsheet which generates the function scores and value categories. Although this has the potential to create a "black box" wherein underlying assumptions and calculations are not transparent to the user, transparency has been assured by the open architecture of the Excel™ spreadsheet as well as by detailed explanations of the assumptions and mathematics of each scoring model (Appendix C of this manual). ABWRET-A is a refinement of the first wetland assessment method that was peer-reviewed and then used widely throughout the U.S. (Wetland Evaluation Technique, WET; Adamus 1983, Adamus et al. 1987) and a similar protocol (ORWAP) developed, peer-reviewed, and adopted for routine use by Oregon Department of State Lands with funding from the USEPA (Adamus et al. 2009). ABWRET-A also incorporates elements of the Hydrogeomorphic (HGM) Approach (Brinson 1993, Smith et al. 1995). Most components of ABWRET-A or its predecessors have been peer-reviewed by scientists in the various disciplines that its models cover. Repeatability of results among different users of ABWRET-A's predecessor (WESPAB) was independently tested in Alberta's Grasslands Region and found to be relatively high (mean confidence interval of ±0.76 around function scores on a 0-10 scale).

In 2014, ABWRET-A was developed and applied to 175 wetlands selected without bias through a statistical procedure to encompass the range of variation mainly in Albert's Parkland Region. Collecting such data was necessary to determine the range of function scores and then normalize the scores to a consistent 0-to-1 decimal scale, as necessary before the scores could be combined with other information required to assign a value category. Future refinement of ABWRET-A may include using the same or similar unbiased procedures to select additional calibration wetlands in other parts of the White Area, as needed to enhance its specificity for those areas. That being said, until further notice, the ABWRET-A tool may be used to assess any wetland located in the White Area of Alberta.

1. Introduction

1.1. General Description

Directly measuring the natural functions of wetlands (Table 1) is expensive and may require years of data. Thus, a need has existed for a tool that can be applied rapidly by one person during a single visit to a wetland, which standardizes the data collected and the way it is interpreted, to indirectly yield relative estimates of a wide variety of important wetland functions.

Nature is complex, and varies enormously from place to place. As natural systems, wetlands are no exception. Thus, the use of one word or phrase describing a wetland's type (e.g., bog, swamp, fen) or a short list of its characteristics cannot meaningfully predict which processes occur in a particular wetland and how those may benefit people and ecosystems. The roles of dozens of factors and their interactions must be considered and addressed systematically.

Fortunately, there is a growing capacity to illustrate and encode some of nature's complexity in models. This, along with the commonplace availability of powerful personal computers that make those models quick and easy to use, has made some types of models simple to apply in the support of decisions and policies, while at the same time reassuring users and decision-makers that assumptions in these models are transparent.

ABWRET-A is a standardized method for rapidly assessing some of the important natural functions of all types of wetlands present in Alberta. The "A" stands for "actual", meaning it uses data obtained partly from an on-site visit, as contrasted with data obtained using only remote sensing, GIS, and other tools and data sources that do not require an on-site visit. ABWRET-A consists of this manual and its appendices, three data forms (one of which is completed by Alberta Environment and Parks (AEP), the others by the applicant), and an Excel™ spreadsheet calculator containing models (formulas).

Table 1. Wetland functions and human uses scored by ABWRET-A in the White Area of Alberta.

Function	Definition	Potential Benefits
HYDROLOGIC FUNCTIONS:		
Water Storage & Delay	The effectiveness for storing runoff or delaying the downslope movement of surface water for long or short periods.	Flood control, maintain ecological systems
Stream Flow Support	The effectiveness for contributing water to streams during the driest part of a growing season.	Support fish and other aquatic life
WATER QUALITY FUNCTIONS:		
Water Cooling	The effectiveness for maintaining or reducing temperature of downslope waters.	Support coldwater fish and other aquatic life
Sediment Retention & Stabilization	The effectiveness for intercepting and filtering suspended inorganic sediments thus allowing their deposition, as well as reducing energy of waves and currents, resisting excessive erosion, and stabilizing underlying sediments or soil.	Maintain quality of receiving waters. Protect shoreline structures from erosion.
Phosphorus Retention	The effectiveness for retaining phosphorus for long periods (>1 growing season)	Maintain quality of receiving waters.
Nitrate Removal & Retention	The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonium to nitrogen gas while generating little or no nitrous oxide (a potent greenhouse gas).	Maintain quality of receiving waters.
Organic Nutrient Export	The effectiveness for producing and subsequently exporting organic nutrients (mainly carbon), either particulate or dissolved.	Support food chains in receiving waters.
ECOLOGICAL (HABITAT) FUNCTIONS:		
Fish Habitat	The capacity to support an abundance and diversity of native fish (both resident and visiting species)	Support recreational and ecological values.
Invertebrate Habitat	The capacity to support or contribute to an abundance or diversity of invertebrate animals which spend all or part of their life cycle underwater or in moist soil. Includes dragonflies, midges, clams, snails, water beetles, shrimp, aquatic worms, and others.	Support fish and other aquatic life. Maintain regional biodiversity.
Amphibian Habitat	The capacity to support or contribute to an abundance or diversity of native frogs, toads, and salamanders.	Maintain regional biodiversity.
Waterbird Habitat	The capacity to support or contribute to an abundance or diversity of waterbirds that nest or migrate through the region.	Support hunting and ecological values. Maintain regional biodiversity.
Songbird, Raptor, & Mammal Habitat	The capacity to support or contribute to an abundance or diversity of native songbird, raptor, and mammal species and functional groups, especially those that are most dependent on wetlands or water.	Maintain regional biodiversity.
Native Plant & Pollinator Habitat	The capacity to support or contribute to a diversity of native, hydrophytic, vascular plant species, communities, and/or functional groups, as well as the pollinating insects linked to them.	Maintain regional biodiversity and food chains.
HUMAN USE[4]	Prior designation of the wetland as some type of officially protected area. Also, the potential and actual use of a wetland for low-intensity outdoor recreation, education, or research.	Ecotourism and social benefits of recreation. Protection of prior public investments.

[4] Human Use is conventionally considered a value, not a function, of wetlands, but for purposes of categorizing Alberta wetlands, the actual, current, and sustainable uses of wetlands are treated the same as functions.

ABWRET-A generates scores for a wetland's functions which then are used, with other inputs, to assign a wetland to a value category (A, B, C, or D) in a consistent and transparent manner. That category is intended to assist the applicant and AEP in decisions about wetland avoidance, minimization and replacement, as well as the replacement ratios where that is required. ABWRET-A can also be used with other tools (e.g., Rooney & Bayley 2012b, Wilson et al. 2013, Nwaishi et al. 2015) to help ensure that wetland replacement, when it is required, is genuine and addresses the loss of specific wetland functions, not just loss of wetland area.

Standardized criteria for assigning wetlands to these value categories are based on both science and policy. *Science* enters into the criteria in the form of on-site observations by a Qualified Wetland Science Practitioner (QWSP), the use of existing spatial data that is compiled case-by-case by AEP, and the use of models (logic-based formulas) to generate scores representing the relative levels of 14 wetland functions[5]. Those models reflect studies published in scientific journals and the judgment of wetland scientists. *Policy* enters into the criteria at a later stage. Wetlands are placed in one of four categories ("a", "b", "c", "d") that advise the Government of Alberta (GOA) about specific administrative actions that may be taken. Those categories are defined partly by ranges of scores generated by ABWRET-A and which reflect relative levels of wetland functions. As a matter of policy, the GOA specified that in Alberta's White Area an estimated 10% of the wetlands should fall into category A (the most protective), 20% in category B, 30% in category C, and 40% in category D. Also, historical trends in the loss of wetland number and area within a RWVAU[6] are separately estimated and then factored into a wetland's category determination in a standardized manner.

As a standardized approach, ABWRET-A provides consistency and comparability when using wetland functions as a way to prioritize wetlands. It also can be used to assess the consequences of wetland alterations, in terms of the wetland functions that may be affected. ABWRET-A's assessment of a specific wetland function may not always be more accurate than ratings of that wetland made by someone who is a specialist on that function, particularly if such a person is experienced locally. Such expertise is seldom routinely available to wetland regulators for every function of concern.

ABWRET-A uses visual and GIS-based assessments of weighted ecological characteristics (indicators, or sometimes termed metrics) to generate the scores for a wetland’s functions. The number of indicators that is applied to estimate a particular wetland function depends on which function is being assessed, and not all indicators are assessed for every wetland. The indicators are combined in a spreadsheet using mathematical formulas (models) to generate the score for each wetland function. The models are logic-based rather than deterministic. Together they provide a profile of the processes a wetland performs and how well it performs them, compared with other wetlands. ABWRET-A indicators and models attempt to incorporate the best and most recent scientific knowledge available on what determines the levels of functions provided by individual wetlands.

[5] Some internal AEP documents have called these "subfunctions" and synthesized them into 4 groups called "functions". Consistent with long-standing scientific use, the term "functions" is used generically throughout this manual to denote either hierarchical level -- subfunctions or functions.

[6] Relative Wetland Value Unit, a landscape unit delimited by hydrological and ecological similarity within which wetlands are assessed relative to other wetlands within the unit. The GOA has divided the province into 21 RWVAUs.

Each indicator has a suite of *conditions,* e.g., different categories of percent-slope. For each wetland function, weights have been pre-assigned to all conditions potentially associated with each indicator used to predict the level of that function. The weights can be viewed in column E of the individual worksheets (tabs at bottom) contained in the calculator spreadsheet. They were assigned by the author based partly on review of technical literature and emphasizing Alberta research.

For most models of wetland functions, the indicators were grouped by the underlying *processes* they inform. Indicator and process selection is described in section 2.3 of Appendix C. Further details about the development and regional calibration of ABWRET-A are provided in Appendix B. This manual addresses only the White Area, and within that, focuses mainly on the Parkland Region and small parts of the Boreal Region that are within the White Area (**Figure 1**).

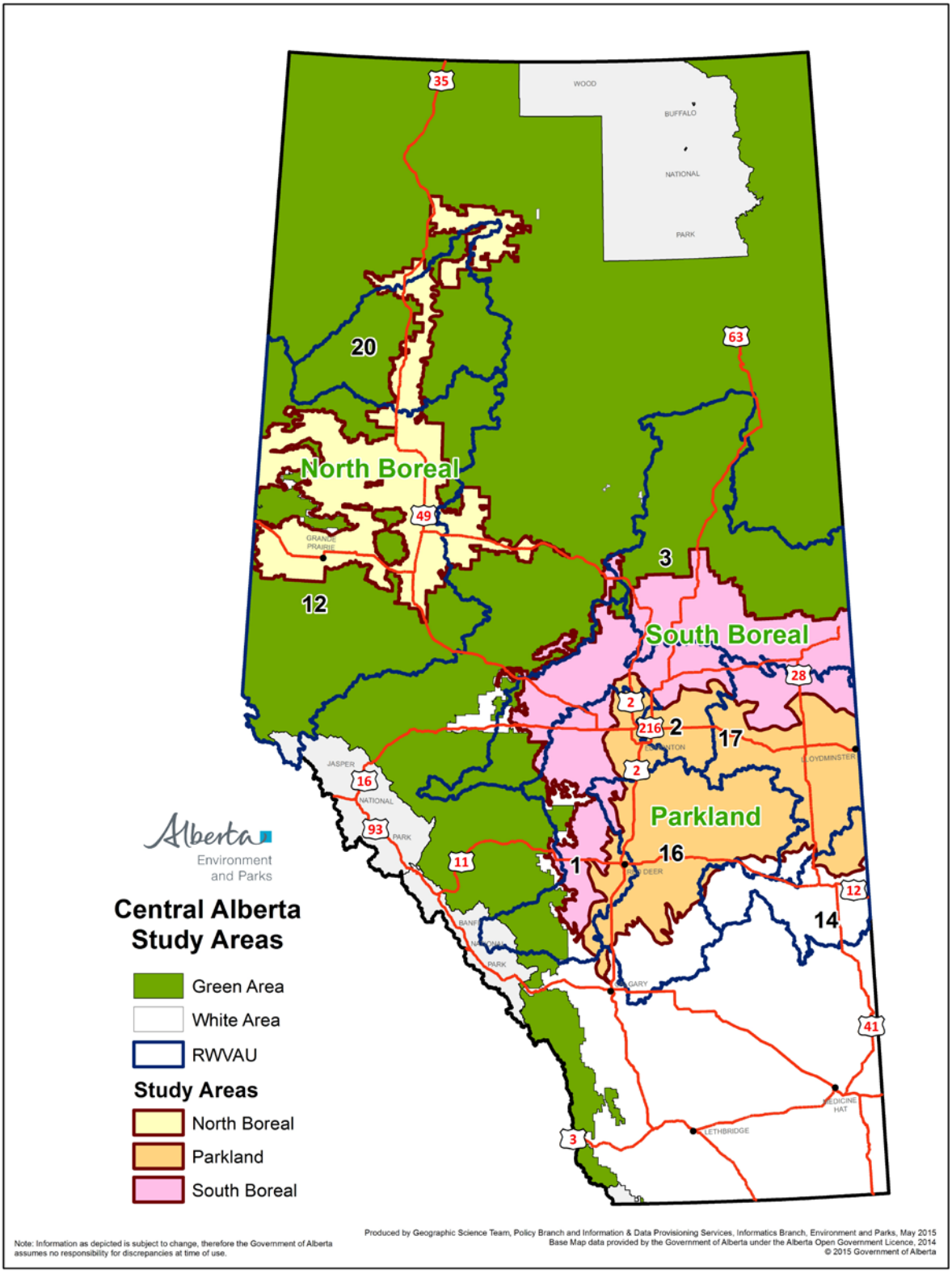


Figure 1. Portions of Natural Regions and RWVAUs where ABWRET-A was field-calibrated during 2014

Before AEP conceived ABWRET-A, over one hundred persons from government, non-profits, and industry were trained in a somewhat similar method specific to southern Alberta called WESPAB (Wetland Ecosystem Services Protocol for Alberta). That tool formed much of the basis for ABWRET-A as both were developed by the same primary author. The methods share many features. The field data forms are structured similarly, as is the spreadsheet calculator. Many of the indicators (questions) are the same, although choices for answers to some questions are worded differently. Thirteen of the 14 functions for which ABWRET-A calculates scores are ones also featured by WESPAB, although the formulas used to compute them differ somewhat. Compared to WESPAB, the most significant differences of ABWRET-A are as follows:

- In addition to providing scores for individual wetland functions, the calculator provides an overall wetland rating (A, B, C, or D), partly by combining the scores of the functions according to criteria established by AEP
- Scores for "benefits" of wetland functions and some other wetland attributes relevant to determining wetland ecosystem services and ecological condition are no longer calculated.
- The function "Stream Flow Support" has been added due to its increased relevance among wetlands in northern and central Alberta
- The function "Carbon Sequestration" has been dropped at the request of AEP partly because existing carbon offset regulations may conflict with the province's Wetland Policy if carbon sequestration is scored as a wetland function
- The functions "Native Plant Habitat" and "Pollinator Habitat" have been combined into a single function for purposes of simplifying the scoring
- A regionally-specific set of function scores (that resulted from applying ABWRET-A to a statistical sample of wetlands in central Alberta during 2014) was used to help define and adjust the expected score range for each function. (see Appendix B for procedures used to select the reference wetlands)
- The calculator spreadsheet now allows users, if they wish, to submit data from more than one wetland (or from the same wetland using multiple scenarios of development or restoration) and have it processed all at once
- Persons applying for an approval to alter a wetland must under certain circumstances specified by government, survey their wetland for plant and animal species officially considered to be endangered, threatened, or otherwise sensitive in Alberta, and to use approved protocols (when available from Fish and Wildlife) for those surveys

1.2. Limitations

ABWRET-A is not intended to answer all questions necessary for wetland approvals decisions. Users should understand the following important limitations:

1. ABWRET-A does not change any current procedures for determining wetland legal status, delineating wetland boundaries, or requirements for restoration and monitoring wetland projects
2. Use of ABWRET-A is predicated on registration with AEP as a Qualified Wetland Specialist (QWSP) or an interim wetland science practitioner until that designation expires in May 2016. Users should be able to:
    - delineate a wetland boundary according to formal guidance provided by AEP
    - in aerial imagery, digitize approximate areas of different wetland cover types (e.g. open water area, emergent area)
    - recognize the most common wetland plants and invasive plants in this region
    - determine soil texture broadly (fine, coarse, loamy, or organic)
    - understand wetland hydrology and local climate
    - delineate wetland catchment (contributing area) boundaries from a topographic map
3. Some of the requested information may not be accurately inferred during a single visit to a wetland, particularly if that visit occurs outside the growing season. Some wetland conditions vary dramatically from year to year and even within a growing season. Thus, the accuracy of results will be greater if users are familiar with the changes in wetland conditions that typically occur locally, or consult landowners or others who are familiar with local conditions and variability
4. For the portion of ABWRET-A which incorporates existing digital data, it is understood that those data were originally created at scales much coarser than represented by the region's typically small wetlands. Consequently, when those data are interpolated to the scale of an individual wetland, some of the data are likely to be inaccurate. Also, some of the conditions described by the spatial data, such as for land cover, may have changed since the layer was created or last updated. Nonetheless, it was decided that the advantages of judiciously using the existing spatial data as a component of each wetland's ABWRET-A scores outweighed the disadvantages
5. ABWRET-A scores only indicate a wetland's functions relative to other wetlands in a specified region. Intensive or long-term field measurements might subsequently determine that even the wetlands scored lowest by ABWRET-A are, in fact, performing a particular function at a very high absolute level, or some wetlands that score very high are found to barely provide the function (see Appendix B for more on model validation). Thus, the numeric estimates that ABWRET-A provides of wetland functions are not actual measures of those attributes, nor does ABWRET-A combine the data using deterministic models of ecosystem processes. Rather, the scores, like those of most rapid assessment methods (Hruby 1999), are estimates arrived at by using standardized criteria (models). The models systematically combine well-accepted indicators in a logically sophisticated manner that attempts to recognize context-specific, functionally contingent relationships among indicators, such as wetland type

6. There is an inherent conflict in attempting to develop a rapid assessment method based on science without over-simplifying complex natural systems to the point of disconnect. AEP is fully aware of this conflict and its implications. While it has been necessary for ABWRET-A to employ some untested assumptions, those assumptions are based on scientific principles and many were peer-reviewed

7. As is true of all other rapid assessment methods, ABWRET-A scoring models have not been validated in the sense of comparing their outputs with those from long-term direct measurement of wetland processes. That is the case because the time and cost of making the measurements necessary to fully determine model accuracy would be exorbitant. Nonetheless, the lack of validation is not, by itself, sufficient reason to avoid use of any standardized rapid method, because the only practical alternative—relying entirely on non-systematic judgments (best professional judgment)—is not demonstrably better overall. When properly applied, ABWRET's scoring models and their indicators are believed in most cases to adequately describe the relative effectiveness of a wetland for performing particular functions

8. ABWRET-A converts raw scores to estimates of relative wetland function, and then normalizes these to the scores of other wetlands within a RWVAU. However, if 90% of the wetlands in a RWVAU had raw scores for the Fish Habitat function of 0 and among the remainder the maximum score was 0.4, after those raw scores are normalized (i.e., mathematically spread out into a scale of 0 to 1.0), a wetland with a score of 0.3 would have a normalized score of 0.9 (because 0.3 is close to the maximum score of 0.4 for this function in this RWVAU). The high normalized score implies the wetland is functioning very well for Fish Habitat, when in fact its very low raw score of 0.3 (out of a theoretically possible score of 1.0) indicates it probably is not

9. It is possible that two ABWRET-A users, viewing the same wetland, will interpret some indicator questions differently. Potentially, this could result in different scores for one or more of the wetland functions. This is true regardless of whether they use ABWRET-A, another tool, or their professional judgment. However, AEP independently tested the repeatability of ABWRET-A's similar predecessor tool (WESPAB) and determined that the statistical confidence intervals around the scores, depending on the particular function, averaged ± 0.76 of the score mean on a scale of 0 to 10. For example, allowing for differing user perceptions of a wetland, a score of 6.00 could be interpreted as actually being between 5.24 (6.00 - 0.76) and 6.76 (6.00 + 0.76). Considering that ABWRET scores are then converted to four much-broader value categories (A, B, C, D), the user variability represented by these confidence intervals would seem to be of relatively little concern, despite some subjectivity inherent in some of the indicator questions. The relative narrowness of the score variance among users stems partly from the fact that some ABWRET-A indicators are intentionally redundant, and averaging is often used to combine indicators in the ABWRET-A models

10. ABWRET-A may be used to augment the data or interpretations of a subject professional (e.g., a fisheries biologist, plant ecologist, ornithologist, hydrologist, biogeochemist) when such expertise or finer-resolution data are available. ABWRET-A outputs, like those of other rapid methods, are not necessarily more accurate than judgments of a subject expert, partly because ABWRET-A spreadsheet models lack the intuitiveness and integrative skills of an actual person knowledgeable of a particular function. Also, a model cannot anticipate every situation that may occur in nature. ABWRET-A outputs should always be screened by the user to see if they "make sense." Nonetheless, ABWRET-A scoring models provide a degree of standardization, balance,

and comprehensiveness that seldom is obtainable from a single expert or limited set of measurements

11. ABWRET-A's logic-based process for combining indicators has attempted to reflect currently-understood paradigms of wetland hydrology, biogeochemistry, and ecology. Still, the scientific understanding of wetlands is far less than optimal to support, as confidently as some might desire, the models ABWRET-A and other rapid methods use to score wetland functions
12. ABWRET-A does not assess all natural functions that a wetland might support. Those which it addresses are ones ascribed to wetlands most commonly in this region, and which also are capable of being estimated using indicators (metrics) that can be observed during a single visit to a wetland, analysis of existing spatial data, and manual interpretation of aerial images. Groundwater recharge, for example, is an important wetland function that is not scored because it has no reliable indicators that can be estimated rapidly in this region
13. Science is constantly evolving as new studies refine, refute, or support what currently is known. It is incumbent that planning tools keep pace with new findings and their models be revised at regular intervals, perhaps every 5-10 years, to reflect that. This poses challenges to wetland approvals applicants and regulatory programs if necessary revisions to a method create a "moving target"
14. ABWRET-A does not assess the suitability of a wetland as habitat for any individual wildlife or plant species. Models of greater accuracy, using the same spreadsheet calculator and heuristic modeling framework that ABWRET-A uses, could easily be created for individual species, for more specific biological guilds (e.g., diving ducks vs. surface-feeding ducks instead of Waterbird Habitat) and functions (export of dissolved vs. particulate carbon instead of Organic Nutrient Export). However, as functions are split into finer categories, the amount of output information increases, perhaps gaining accuracy and specificity but losing simplicity in the interpreting and applying of results
15. ABWRET-A is not intended to predict changes to a wetland – only to estimate the likely direction and relative magnitude shifts in various functions if specific wetland characteristics are altered. If proposed changes to a wetland are projected to cause little or no change in a particular function score, it cannot be assumed automatically that no impacts will occur. That is because ABWRET-A is a fairly coarse tool and no method or model is capable of anticipating all possible changes

2. Conceptual Basis

Fundamentally, the levels and types of functions that wetlands individually and collectively provide are determined by the processes and disturbances that affect the movement and other characteristics of water, soil/sediment, plants, and animals (Zedler & Kercher 2005). In particular, the frequency, duration, magnitude and timing of these processes and disturbances shape wetland functions (Euliss et al. 2004, Smith et al. 2008). Climate, geology, topographic position, and land use strongly influence all of these processes. Well-functioning wetlands can reduce the need for humans to construct and maintain some types of expensive infrastructure at other locations that would otherwise be necessary to perform the same services, such as reducing regional flood damages or treating stormwater (Costanza et al. 1997, Finlayson et al. 2005, Feng et al. 2011, Gascoigne et al. 2011, van Kooten et al. 2011).

3. Procedures for Using ABWRET – Actual

3.1. General Procedures

1. If training in the use of ABWRET-A is offered by a Department-approved trainer, attend that training, which generally lasts 2 or 3 days. Although training is not required at this time, training is strongly encouraged and will be part of certification requirements in the future. In any case you must have read this section of this manual, as well as reviewing the illustrations in Appendix A and any definitions or other sidenotes in the right column of field data form F
2. From AEP web site, download the most recent version of this manual, appendices, and the ABWRET-A Field Form spreadsheet. Although they are identical, printing the data forms from the spreadsheet rather than from Appendix A of the manual is not recommended
3. On an aerial image, draw a preliminary boundary of the wetland. You will later confirm or adjust this in the field in accordance with the Alberta Wetland Identification and Delineation Directive. If it will be impractical during your visit to view most of the wetland up close because it is so large, conditions are physically too hazardous, and/or property ownership status does not allow examination of a significant part, you may need to also draw a line around just the part you are likely to observe effectively. This is called the assessment area (AA). Part of its boundary will likely be the same as the preliminary wetland boundary, but it comprises a subunit of the entire wetland. Read section 3.2 for guidance before drawing this boundary
4. **All the major invasive plant species** and **exotic** plant species must be known before performing wetland assessment. Using a plant identification guide is expected if you are not very familiar with the region's flora. Online resources are also available:
    - http://www.anpc.ab.ca/wiki/index.php/Main_Page
    - http://agr.mt.gov/agr/Programs/Weeds/AquaticWeeds/
    - http://cnr.usu.edu/streamrestoration/files/uploads/2010%20Resources/MV_ShortWestAquaticplantsID_7_10.pdf
5. **Visit the wetland** during the growing season and do the following:

a. Digitally delineate the boundary between wetland and upland of the entire wetland according to AEP Alberta Wetland Identification and Delineation Directive. Or, obtain a digital file with that boundary from a QWSP who has determined it

b. If necessary, adjust your drawing of the AA boundary

c. Fill out a printed copy of Form F and Form S during your visit, following the field protocol described in section 3.3. Also fill out the **Cover Page** form

d. When required by AEP, conduct surveys for rare plant and animal species listed in question F69 of data form F, at an appropriate time of the season and using approved survey protocols if those are available

e. Check to be sure every question on both data forms was answered, except where the form directed you to skip one or more questions, and the data is correctly entered

f. If AEP has provided you with measurements from any of the GIS layers they are querying to characterize and score your wetland, compare that information with what you see in the field, report any discrepancies to AEP

6. Email the data forms (F, S, and Cover Page) as well as digital files of the delineated wetland boundary to a designated contact person at AEP with a request for determination of wetland value rating

7. AEP will reply to that request and send back a spreadsheet showing the determined wetland value category, along with scores for the wetland functions, and the data from your field observations and AEP spatial data queries

8. If you are submitting this in support of an application for wetland approvals or as documentation of restoration progress, you must provide the recipient regulatory agency with:

   - ___ your completed spreadsheet
   - ___ aerial image of the site showing boundaries of the wetland and (if different) your AA
   - ___ drawing of the estimated catchment area

3.2. Drawing Boundaries of the Wetland and Assessment Area (AA)

Please see the *Wetland Identification and Boundary Delineation Directive* for information on how to identify and delineate the wetland boundary. Whenever feasible, entire wetlands should be assessed. However, as explained above, it sometimes will be necessary to delimit a portion of the wetland and assess it separately. This happens if it is impractical to view most of the wetland up close because it is so large, conditions are physically too hazardous, property ownership status does not allow examination of a significant part, and/or only a small proportion of the wetland is expected to be impacted.

The AA will be smaller than the wetland and will normally consist of vegetated wetland ***and*** **--** if that wetland vegetation is in a depression (basin) -- all the **adjoining water and mudflat** within the depression as well as open water up to a depth of 2 metres at midsummer (AEP 2015). The AA boundaries may need to be adjusted during the field component. *Where* you draw the boundaries of

the AA can dramatically influence the resulting scores, so provide a map clearly showing those boundaries. You should also estimate and describe the approximate percent of the mapped AA you were able to visit (taking into account both physical restrictions and private property restrictions). The AA should be representative of the entire wetland and it's plant communities and be situated, if relevant, at the place where a proposed impact will take place. Space is provided for recording this on the CoverPage worksheet.

There are at least three "special cases" in which more specific guidance is provided below for defining an appropriate AA boundary:

- Fragmented wetlands
- Lake-fringe wetlands
- River-fringe and floodplain wetlands

Fragmented Wetlands

If a wetland that once was a contiguous whole is now divided or separated from its formerly contiguous part by a road or dike (Figure 2), assess the two units separately (two AA's) unless a functioning culvert, water control structure, or other opening connects them, and their water levels usually are simultaneously at about the same level. Boundaries of the AA should be based mainly on hydrologic connectivity. They normally should not be based solely on property lines, fence lines, mapped soil series, vegetation associations, elevation zones, land use or land use designations.

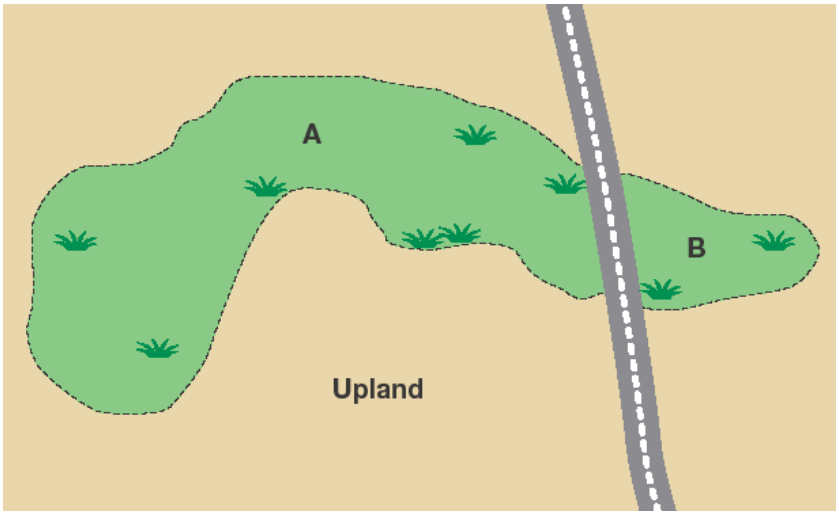


Figure 2. Dissected wetland. A wetland is crossed by a road or filled area. Separate the wetland into two AA's and assess separately if A and B have different water levels and circulation between them is significantly impeded. Otherwise, they can be evaluated as a single wetland.

Lake-fringe Wetlands

If a lake or reservoir (or any ponded water body) that adjoins a vegetated wetland is longer than 1 km, and its open water part is much wider than the width of the vegetated wetland along the shoreline, then the AA should be delimited to include the vegetated wetland plus only the portion of adjoining open water that is believed to be 2 metres at midsummer. If that cannot be estimated, extend the AA outward into the lake a distance equal to about the average width of the wetland that is along its shoreline (measured perpendicular to the shore).

If distinct units of vegetated wetland are located discontinuously along the shoreline, any two adjoining units separated by non-wetland can be combined if the distance separating them, measured parallel to shore, is less than the length of the larger of the two vegetated wetlands, also measured parallel to shore.

River-fringe Wetlands

If a stream, ditch, or other flowing-water channel intersects a vegetated wetland, the AA should normally include that feature if the feature is narrower than the maximum width of the vegetated wetland, as measured perpendicular to shore along one side of the stream, ditch, or channel. If the adjoining stream or river is wider, the AA should consist of the vegetated wetland plus the portion of the open water in the stream or river that is shallower than 2 m at mid-summer. If that cannot be estimated, extend the AA outward into the channel a distance equal to about the average width of the wetland that is along its shoreline (width measured perpendicular to the shore). If the wetland is within an area that floods at least once every two years from river overflow, the AA should include all the contiguous overflow area (floodplain) that exists between the wetland and the channel.

If distinct units of vegetated wetland are located discontinuously along a river shoreline, any two adjoining units separated by non-wetland can be combined if the distance separating them, measured parallel to flow, is less than the length of the larger of the two vegetated wetlands, also measured parallel to flow.

3.3. Instructions for Field Component

The field component of ABWRET-A involves visiting as much of the AA as possible and filling out two field forms (F and S). The field component will generally require less than three hours (large or complex sites may take longer). If circumstances allow, visit the AA during both the wettest and driest times of the growing season. If you cannot, you must rely more on the aerial imagery, maps, other office information, and discussions with the landowner and other knowledgeable sources.

3.3.1. Items to Take to the Field

Take the following with you into the field:

- Blank data forms F and S
- Aerial image that includes entire wetland
- Detailed map of wetland, if any available
- Plant identification guides
- List of exotic, invasive, rare, or other species expected to occur in your area (e.g., Table A.3 in Appendix A)

- Shovel or trowel for soil texture determination
- Handheld GPS, or a smartphone or camera that geo-tags the photographs you take (which you may also project onto a Google Earth image of the wetland using some freely-downloadable photo-viewing software such as Picasa)
- Clip board, pencil, other items you'd normally take in the field

3.3.2. Conduct Field Assessment

Step 1. Review the questions on the F and S forms to refresh your memory of what to observe during the field visit. Be sure to read all the notes in the Explanations column (E) of form F.

Step 2. Plan your visit beforehand to visit each major plant community (these may be evident on the aerial imagery if the AA is large), each different soil type (if mapped), each area with different topography, each area with a different degree of management action or human disturbance, the wetland/upland edge, and all wetland/water feature edges (e.g., shores of bordering ponds, lakes, streams). After you have viewed all those areas adequately from several vantage points and taken appropriate georeferenced photos, you are ready to begin filling out forms F and S.

Step 3. Generally note the extent of invasive and exotic plant cover within the AA and along its upland edge. If you have the skills to identify rare plants or wildlife and the timing of your visit is appropriate, search for these as time allows, following any established survey protocols. Another consultant with that expertise may have to revisit the site and perform specific species surveys if you do not have the appropriate skills to conduct them.

Step 4. If the entire wetland is accessible, look for inlets and outlets, even ones that may flow only for a few days each year (as evidenced by flood marks or culverts that may be dry at the time of visit).

Step 5. Fill out forms F and S, paying attention to all the explanatory notes and definitions in the last column. As you answer the questions dealing with "percent of the area," pay particular attention to the spatial context (area) which the question is addressing. Is it the entire wetland or just the vegetated part? Or just the part covered by emergent or by woody vegetation?

Step 6. Determine the soil texture category nearest the ground surface after removing dead leaves and other loose non-soil materials. You will be asked to categorize the soil simply as *Organic, Clayey, Loamy,* or *Coarse*. Use the *Soil Composition by Feel* diagnostics flow chart in Appendix A.

Step 7. Look uphill of the wetland to see if any artificial feature that adjoins the wetland *unmistakably* diverts *most* of the surface runoff away from it (e.g., high berm) during normal runoff events. If such is found, exclude the area directly above them from the catchment (contributing area) assumed by question F68 and some of the form S questions.

Step 8. If possible, talk with the landowner or other knowledgeable sources to determine the following, at a minimum:

- if the wetland and/or its bordering waters have gone completely dry during most recent years (if this is not obvious during your visit)

- how extensively the wetland floods during the peak of snowmelt or whenever it is wettest during most recent years
- annual duration of surface-water connection with streams and other wetlands

Local government offices may also be sources of useful information that will improve the accuracy of your assessment. An online search of the name of a nearby feature can sometimes be productive. Use the guidance and direction given in the Alberta Wetland Identification and Delineation Directive to investigate changes in water levels from multiple images taken at different seasons and years.

3.4. Reviewing the Output

Before accepting the scores and rating provided by AEP, think carefully about those results. From your knowledge of wetland functions, do they make sense for this wetland? If not, review the worksheet for that function as well as Appendix D (Modeling Principles, and Descriptions of the ABWRET-A Models and Scoring) to see how the score was generated. If you disagree with the results, write a few sentences explaining your reasoning and submit them to AEP in a cover letter or email along with the wetland assessment data. Review the caveats given in the Limitations section (section 1.2). Remember, ABWRET-A is just *one* tool intended to help the decision-making process, and other important tools are your common sense and professional experience with a particular function, wetland type, or species.

4. References

ABMI. 2007 (and revised). Wetland survey methods. Alberta Biodiversity Monitoring Institute, Edmonton, AB.

ABMI. 2009. Manual for estimating species and habitat intactness at the regional scale. Version 2010-03-01. Alberta Biodiversity Monitoring Institute, Edmonton, AB.

ABMI. 2010. Manual for reporting human footprint. Version 2010-05-18. Alberta Biodiversity Monitoring Institute, Edmonton, AB.

Acreman, M. C., R. J. Harding, C. Lloyd, N. P. McNamara, J. O. Mountford, D. J. Mould, B. V. Purse, M. S. Heard, C. J. Stratford, and S. J. Dury. 2011. Trade-off in ecosystem services of the Somerset Levels and Moors wetlands. Hydrological Sciences Journal 56:1543-1565.

Adamus, P. R. 1983. A Method for Wetland Functional Assessment. Vol. II. Methodology. Report No. FHWA-IP-82-24. Federal Highway Administration, Washington, D.C.

Adamus, P.R. 1992a. Condition, values, and loss of natural functions of prairie wetlands of the North-Central United States. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1992b. Conceptual process model for basin-type wetlands of the Prairie Pothole Region. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1992c. Results of application of the risk assessment process to prairie wetlands of the North-Central United States. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P. R. 1996. Bioindicators for assessing ecological integrity of prairie wetlands. EPA/600/R-96/082., U. S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P. R., E. J. Clairain, Jr., R. D. Smith, and R. E. Young. 1987. Wetland Evaluation Technique (WET) Volume II: Methodology. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Adamus, P.R., E.J. Clairain, Jr., D.R. Smith, and R.E. Young. 1992. Wetland Evaluation Technique (WET). Volume I: Literature review and evaluation rationale. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Adamus P.R., J. Morlan, and K. Verble. 2009. Oregon Rapid Wetland Assessment Protocol (ORWAP): Calculator spreadsheet, databases, and data forms. Oregon Dept. of State Lands, Salem, OR.

Adamus, P., J. Morlan, and K. Verble. 2010. Wetland Ecosystem Services Protocol for the United States (WESPUS). Beta test version 1.0. Online: http://people.oregonstate.edu/~adamusp/WESP/

Alberta Natural Regions Committee. 2006. Natural regions and subregions of Alberta. Compiled by D.J. Downing and W.W. Pettapiece. Publication Number T/852. Government of Alberta, Edmonton, AB.

Bayley, S.E., A.S. Wong, and R.D. Galbraith. 2004. Fragmentation and disturbance of the Southern Canadian Yellowstone to Yukon (Y2Y) wetlands due to human infrastructure. University of Alberta report to the Federation of Alberta Naturalists, Edmonton, AB.

Beversbergen, G.W., N. D. Niemuth, and M.R. Norton, coordinators. 2004. Northern Prairie and Parkland Waterbird Conservation Plan. Waterbird Conservation for the Americas initiative. Prairie Pothole Joint Venture, Denver, Colorado.

Blouin, F., B.L. Downey, B.A. Downey, S.L. Frank, D.J. Jarina, P.F. Jones, J.P. Landry-DeBoer, and K. S. Rumbolt. 2010. MULTISAR: A Multi-Species Conservation Strategy for Species at Risk in the Grassland Natural Region of Alberta.

Boyd, J. and L. Wainger. 2003. Measuring ecosystem service benefits: The use of landscape analysis to evaluate environmental trades and compensation. Discussion Paper 02-63. Resources for the Future, Washington, DC.

Brinson, M. M. 1993. A hydrogeomorphic classification of wetlands. Technical Report WRP-DE-11. Environmental Research Laboratory, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Costanza, R., R. d'Arge, R. d. Groot, S. Farberk, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Suttonkk, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387(6630):253-260.

Cows and Fish Program. 2004 (and revised). Alberta Lentic Wetland Health Assessment. Cows and Fish Program, Lethbridge, AB.

DeKeyser, E. S., D. R. Kirby, and M. J. Ell. 2003. An index of plant community integrity: development of the methodology for assessing prairie wetland plant communities. Ecological Indicators 3:119-133.

Ducks Unlimited Canada (DUC). 2011. Ecosystem service approach pilot on wetlands: assessment of current and historic wetland carbon stores in the Sheppard Slough Area. Report to Alberta Environment and Sustainable Resource Development, Edmonton, AB.

Euliss, N. H., J.W. LaBaugh, L.H. Fredrickson, D.M. Mushet, M.K. Laubhan, G.A. Swanson, T.C. Winter, D.O. Rosenberry, and R.D. Nelson. 2004. The wetland continuum: a conceptual framework for interpreting biological studies. Wetlands 24(2): 448-458.

Fiera (Fiera Biological Consulting Ltd.). 2010. Aquatic Environmentally Significant Areas in Alberta. Report prepared for Alberta Environment, Edmonton, Alberta. Fiera Biological Consulting Report Number 9030-2.

Finlayson, C. M., R. D'Cruz, and N. Davidson. 2005. Ecosystems and Human Well-being: Wetlands and Water: Synthesis. World Resources Institute, Washington, DC.

Guntenspergen, G. R., S. A. Peterson, S. G. Leibowitz, and L. M. Cowardin. 2002. Indicators of wetland condition for the Prairie Pothole Region of the United States. Environmental Monitoring and Assessment 78:229-252.

Hargiss, C. L. M., E. S. DeKeyser, D. R. Kirby, and M. J. Ell. 2008. Regional assessment of prairie wetland plant communities using the index of plant community integrity. Ecological Indicators 8:303-307.

Hruby, T. 1999. Assessments of wetland functions: what they are and what they are not. Environmental Management 23:75-85.uby 1999

Irena F. Creed Consulting. 2011. Ecosystem service approach pilot on wetlands: Ecosystem service assessment of wetland water purification for the Shepard Slough Study Area. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8686.pdf

Jenks, G. F. 1967. The data model concept in statistical mapping. International Yearbook of Cartography 7: 186–190.

Jones, W. M. 2005. A vegetation index of biotic integrity for small-order streams in southwestern Montana and a floristic quality assessment for western Montana wetlands. Report to the Montana Department of Environmental Quality and U.S. Environmental Protection Agency. Montana Natural Heritage Program, Helena, MT.

Lesica, P. and P. Husby. 2001 (revised 2006). Field guide to Montana's wetland vascular plants. Montana Wetlands Trust, Helena, MT.

Loomis, J. and L. Richardson. 2007. Benefit transfer and visitor use estimating models of wildlife recreation, species and habitats. Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, CO.

Nwaishi, F., R.M. Petrone, J.S. Price, and R. Andersen. 2015. Towards developing a functional-based approach for constructed peatlands evaluation in the Alberta oil sands region, Canada. Wetlands 35: 211-225.

O2 Planning + Design Inc. 2011a. Ecosystem service approach pilot on wetlands: Assessment of Water Storage and Flood Control Ecosystem services. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8687.pdf

O2 Planning + Design Inc. 2011b. Ecosystem service approach pilot on wetlands: Wetland Ecosystem services Protocol for the United States (WESPUS) site assessments. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8688.pdf

Raab, D. and S. E. Bayley. 2012. A vegetation-based index of biotic integrity to assess marsh reclamation success in the Alberta oil sands, Canada. Ecological Indicators 15:43-51.

Raudsepp-Hearne, C. and G. Kerr. 2011. Ecosystem service approach pilot on wetlands: Operationalizing an ecosystem service approach within the Government of Alberta: Steps and lessons learned. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8683.pdf

Rocchio, F. J. 2011. Western Washington Floristic Quality Assessment. Washington Natural Heritage Program and Washington Department of Natural Resources, Olympia, WA.

Rooney, R. C. and S. E. Bayley. 2012a. Community congruence of plants, invertebrates and birds in natural and constructed shallow open-water wetlands: Do we need to monitor multiple assemblages? Ecological Indicators 20:42-50.

Rooney, R. C. and S. E. Bayley. 2012b. Development and testing of an index of biotic integrity based on submersed and floating vegetation and its application to assess reclamation wetlands in Alberta's oil sands area, Canada. Environmental Monitoring and Assessment 184(2):749-761.

Rooney, R. C., S. E. Bayley, I. F. Creed, and M. J. Wilson. 2012c. The accuracy of land cover-based wetland assessments is influenced by landscape extent. Landscape Ecology 27:1321-1335.

Rosen, B. H., P. Adamus, and H. Lal. 1995. A conceptual model for the assessment of depressional wetlands in the Prairie Pothole Region. Wetlands Ecology and Management 3:195-208.

Russi, D., P. ten Brink, A. Farmer, T. Badura, D. Coates, J. Förster, R. Kumar, and N. Davidson. 2013. The economics of ecosystems and biodiversity for water and wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland, Switzerland.

Smith, R.D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Tech. Rept. WRP-DE-9, Waterways Exp. Stn., US Army Corps of Engineers, Vicksburg, MS.

Smith, L.M., N.H. Euliss, D.A. Wilcox, and M.M. Brinson. 2008. Application of a geomorphic and temporal perspective to wetland management in North America. Wetlands 28:563-77.

van Kooten, G. C., P. Withey, and L. Wong. 2011. Bioeconomic modeling of wetlands and waterfowl in western Canada: Accounting for amenity values. Canadian Journal of Agricultural Economics 59:167-183.

Wilson, M. J. and S. E. Bayley. 2012. Use of single versus multiple biotic communities as indicators of biological integrity in northern prairie wetlands. Ecological Indicators 20:187-195.

Wilson, M. J., A. S. Forrest, and S. E. Bayley. 2013. Floristic quality assessment for marshes in Alberta's northern prairie and boreal regions. Aquatic Ecosystem Health and Management. 16: 288-299.

Wray, H.E. and S.E. Bayley. 2006. A review of indicators of wetland health and function in Alberta’s prairie, aspen parkland, and boreal dry mixedwood regions. University of Alberta and Alberta Environment, Edmonton, AB.

Zedler, J. and S. Kercher. 2005. Wetland resources: Status, trends, ecosystem services, and restorability. Annual Review of Environment and Resources 30:39-74.

Appendix A. Data Forms, Illustrations, Reference Tables

Before visiting the wetland, for each wetland you assess, print one copy of A.1 (the Cover Page, and forms F and S). Print one copy of the other sections for general reference.

A.1 Cover Page and Data Forms F and S

Cover Page. ABWRET-A for northern part of Alberta's White Area	
Site Name:	
Investigator Name:	
Date of Field Assessment:	
Nearest Town:	
Latitude (decimal degrees):	
Longitude (decimal degrees):	
Approximate size of the Assessment Area (AA, in hectares)	
AA as percent of entire wetland (approx.)	
What percent (approx.) of the **wetland** were you able to visit?	
What percent (approx.) of the **AA** were you able to visit?	
Have you attended a training session for this tool? If so, indicate approximate month & year.	
How many wetlands have you assessed previously using this tool (approx.)?	
Comments about the site or this assessment (attach extra page if desired):	

Site Name:	Investigator & Date:

Data Form F. ABWRET-A for northern part of Alberta's White Area. version 1.0

DIRECTIONS: Conduct an assessment only after reading the accompanying Manual and explanations in column E below. In the Data column, change the 0 (false) to a 1 (true) for the best choice, or for multiple choices where allowed and so indicated. Answer these questions primarily based on your onsite observations and interpretations. Do not write in any shaded parts of this data form. Answering some questions accurately may require conferring with the landowner or other knowledgable persons, and/or reviewing aerial imagery. Although some conditions can vary greatly by season and from year to year, report only the conditions known to prevail during the majority of the past 5 years, or if unknown, then the conditions found in the available aerial imagery. Abbreviations in brackets in column E indicate the wetland functions related to that question: AM= Amphibian Habitat, FH= Fish Habitat, HU= Human Use, INV= Aquatic Invertebrate Habitat, NR= Nitrate Removal & Retention, OE= Organic Nutrient Export, PR= Phosphorus Retention, SBM= Songbird, Raptor, & Mammal Habitat, SFS= Stream Flow Support, SR= Sediment Retention & Stabilization, WB= Waterbird Habitat, WC= Water Cooling, WS= Water Storage & Delay. See Appendix C for descriptions of how the ABWRET-A calculator uses the data you enter in this form to calculate relative estimates of these wetland functions.

#	Indicator	Condition Choices	Data	Explanations, Definitions
F1	Wetland Type - Predominant	Most of the **vegetated** part of the AA (wetland Assessment Area) is a (select ONE):		*By intent, these types are not exactly the same as those in the Alberta Wetland Classification System (AWCS). All functionally important features of the AWCS classes are addressed elsewhere in this form.* If AA is larger than 10 ha, see imagery-based answer provided by AEP, but field-verify. "Vegetated" does not include plants that are entirely underwater or floating-leaved. For this question, it does include ground-dwelling moss and lichens. [FH, INV, NR, OE, PH, SBM, SFS, WB, WC]
F1.1		Wooded Swamp	0	Tall (>2 m) shrubs or trees comprise >25% of the vegetation cover but unlike Fen, the soils are usually mineral. If organic soil, muck is more prevalent than peat. Common woody species are willow, alder, birch. Includes both Shrubby Swamps and Wooded Swamps from the AWCS.
F1.2		Bog	0	Few or no trees, and <5% cover of shrubs taller than 2m. Nearly all the ground layer is moss-covered and soils are peaty. Seldom in a depression (surface often raised slightly from surrounding terrain). If known, pH is less than 4.6. When woody cover is present, the common woody species include black spruce, birch, lodgepole pine, broad-leaved conifer shrubs and less often, tamarack (larch).
F1.3		Fen	0	More tree and/or shrub cover than Bog, but not a Wooded Swamp because nearly all the ground layer is moss-covered. Some sites lack woody cover entirely but they are not Marsh because ground is mostly covered by moss and sedges. Soils are peaty. Surface water is more likely to be present than in bogs. Many fens are at the base of naturally steep slopes. Includes Wooded, Shrubby, and Graminoid Fens from the AWCS.
F1.4		Marsh	0	Unflooded parts, if any, have little or no moss and tree cover, and shrub cover is less than 25%. Soils are mostly mineral (clay, sand, loam), or if organic then mostly muck. Surface water is usually present during at least part of the year in at least part of the AA (it may be saline). Usually in depressions, excavated pits, along lakeshores, or on floodplains.

F2	Wetland Types - Subordinate	Mark all *other* vegetated wetland types in the AA that occupy more than 1 hectare or more than 1% of the vegetated AA. Do not mark the predominant type again. If AA is larger than 10 ha, you may consult preliminary imagery-based answer provided by AEP, but field-verify.		The 1 hectare and 1% thresholds represent the minimum cumulative area of that type within the vegetated AA, i.e., add up the multiple patches. [INV, PH. SBM, WC] [Data cell name choice #5 is NoOtherWettypes]
		Wooded Swamp	0	
		Bog	0	
		Fen	0	
		Marsh	0	
		no types other than the predominant one in F1 meet the area threshold.	0	
F3	% Saturated Only	The percentage of the AA that never contains surface water during an average year (that is, except perhaps for a few hours after snowmelt or rainstorms), but which is still a wetland, is:		This is the cumulative acreage of all areas lacking surface water in the AA. [AM, FH, INV, NR, PH, PR, SBM, WB, WC] [Data cell name choices #5 & 6 are AllSat1 and AllSat]
		less than 1%, or <0.01 hectare (about 10 m on a side) never has surface water. In other words, all or nearly all of the AA is inundated permanently or at least seasonally.	0	
		1-25% of the AA never contains surface water.	0	
		25-50% of the AA never contains surface water.	0	
		50-99% of the AA never contains surface water.	0	
		>99% of the AA never contains surface water, except for water flowing in channels and/or in pools that occupy <1% of the AA. SKIP to F26 (Channel Connection & Outflow Duration)	0	
		>99% of the AA never contains surface water, and AA is not intersected by channels that have flow, not even for a few days per year. SKIP to F26.	0	
F4	% with Persistent Surface Water	The percentage of the AA that has surface water (either ponded or flowing, either open or obscured by vegetation) during all of the growing season during most years is:		0.01 hectare is about 100 m on a side if square. This is the cumulative acreage of all areas that have surface water. If you are unable to determine the condition at the driest time of year, asking the land owner or neighbors about it will be particularly important. Indicators of persistence may include fish, some dragonflies, beaver, and muskrat. Sites fed by unregulated streams that descend on north-facing slopes tend to remain wet longer into the summer. [FH, INV, NR, PH, PR, SBM, WB] [Data cell name choice #1 is NoPersis]
		less than 1%, or <0.01 hectare (whichever is less). SKIP to F8 (% Flooded Only Seasonally).	0	
		1-25% of the AA, and mostly in narrow channels and/or small scattered pools.	0	
		1-25% of the AA, and mostly in a single large pool, pond, and/or channel.	0	
		25-50% of the AA	0	

		50-95% of the AA	0	
		>95% of the AA	0	
F5	% of Summertime Water That Is Shaded	At mid-day during the warmest time of year, the area of surface water within the AA that is shaded (by emergent or woody vegetation, incised channels, streambanks, or other features also present within the AA) is:		Emergent plants are herbaceous plants whose foliage characteristically extends above the water surface. Do not include shade from floating-leaved plants or moss, or shade from trees rooted outside the AA. [FH, OE, WC]
		<5% of the water is shaded, or no surface water is present then.	0	
		5-25% of the water is shaded	0	
		25-50% of the water is shaded	0	
		50-75% of the water is shaded	0	
		>75% of the water is shaded	0	
F6	Fringe Wetland	If the AA meets the following conditions, it is a fringe wetland: (a) Open water that adjoins the vegetated wetland in a lake, stream, or river during annual low water condition is much wider than the vegetated wetland, and if the AA adjoins a lake (b) the maximum dimension of the lake is greater than 1 km. If true, enter "1" and continue.	0	[FH, HU]
F7	Lacustrine Wetland	The AA borders a body of ponded open water whose size -- not counting the vegetated AA -- exceeds 8 hectares (about 300 x 300 m) during most of the growing season. Enter "1" if true, "0" if false.	0	[FH, HU, PR, WB]
F8	% Flooded Only Seasonally	The percentage of the AA that is covered by surface water only during the wettest time of year (and for >2 consecutive days during that time) is:		This is the cumulative acreage of all areas in the AA that flood ONLY seasonally. The times of greatest seasonal runoff in this region typically are from early spring to midsummer, especially while parts of the land surface are still frozen and spring snowmelt is occurring. Flood marks (algal mats, adventitious roots, debris lines, ice scour, etc.) are often evident when not fully inundated. Also, such areas often have a larger proportion of upland and annual (vs. perennial) plant species. In riverine systems, the extent of this zone can be estimated by multiplying by 2 the bankful height and visualizing where that would intercept the land along the river. [INV, NR, OE, SR, WB, WS] [Data cell name choice #1 is NoSeasonal]
		<1%.	0	
		1-25%	0	
		25-50%	0	
		50-95%	0	
		>95%	0	
F9	Annual Water Fluctuation Range	The annual fluctuation in surface water level within most of the parts of the AA that contain surface water is:		Observations made while delineating a wetland according to AEP protocols will often apply to this question. Because the annual range of water levels is difficult to estimate without multiple visits, asking the land owner or neighbors about it is particularly important. [AM, INV, NR, OE, PH, PR, SR, WB, WS]
		<10 cm change (stable)	0	
		10 cm - 50 cm change	0	
		0.5 - 1 m change	0	
		1-2 m change	0	
		>2 m change	0	
Is the AA smaller than 0.01 hectare? If so, enter "1" in column D and SKIP TO F23 (Beaver)			0	[Data cell name is SmallAA]

F10	Predominant Depth Class	During most of the time when water is present, its depth in **most** of the area is: [*Note: This is not asking for the maximum depth.*]		This question is asking about the spatial median depth that occurs during most of that time, even if inundation is only seasonal or temporary. If inundation in most but not all of the wetland is brief, the answer will be based on the depth of the most persistently inundated part of the wetland. Include surface water in channels and ditches as well as ponded areas. In some large wetlands whose center can be safely accessed during winter ice cover, depths of deeper areas can be measured after drilling holes in the ice . [FH, INV, PH, PR, SFS, SR, WC]
		<10 cm deep (but >0)	0	
		10 - 50 cm deep	0	
		0.5 - 1 m deep	0	
		1 - 2 m deep	0	
		>2 m deep. True for many fringe wetlands.	0	
F11	Depth Classes - Evenness of Proportions	When present, surface water in most of the AA usually consists of (select one):		Estimate these proportions by considering the gradient and microtopography of the site. See diagram in the manual. [FH, INV, WB]
		One depth class that comprises >90% of the AA's inundated area (use the classes in the question above).	0	
		One depth class that comprises 60-90% of the AA's inundated area.	0	
		Neither of above. Multiple depth classes; none occupy more than 50% of the AA.	0	
F12	% of Water Ponded vs. Flowing	The percentage of the AA's surface water that is **ponded** (stagnant, or flows so slowly that fine sediment is not held in suspension) during most of the time it is present, and which is **either open or shaded by emergent vegetation** is:		Nearly all wetlands with surface water have some ponded water. [AM, FH, NR, OE, SR, WB, WC, WS] [Data cell name choice #1 is NoPonded]
		<1% or none, or occupies <0.01 hectare cumulatively. Nearly all water is flowing. Enter "1" and **SKIP to F21** (Stained Surface Water).	0	
		1-5% of the water, and mainly in small pools. The rest is flowing.	0	
		1-5% of the water, and mainly in a single large pool or pond. The rest is flowing.	0	
		5-30% of the water	0	
		30-70% of the water	0	
		70-95% of the water	0	
		>95% of the water. Little or no visibly flowing water **within** the AA.	0	
F13	Ponded Open Water - Minimum Size	During most of the growing season, the largest patch of **open** water that is **ponded** and is in or bordering the AA is **>0.01 hectare** (about 10 m by 10 m) **and mostly deeper than 0.5 m.** If true enter "1" and continue, If false, enter "0" and **SKIP to F20** (Floating Algae & Duckweed).	0	**Open water** is water that is not obscured by vegetation in aerial ("duck's eye") view. It includes vegetation floating on the water surface or entirely submersed beneath it. It may be flowing or ponded. Ponded water is defined above. [Data cell name is OpenW]

F14	% of Ponded Water That Is Open	In ducks-eye aerial view, the percentage of the ponded water that is **open** (lacking emergent vegetation during most of the growing season, and unhidden by a forest or shrub canopy) is:		Open water may have floating aquatic vegetation provided it does not usually extend above the water surface. [AM, FH, HU, INV, NR, OE, PH, PR, SBM, SR, WB, WC, WS] [Data cell name choice #1 is NoOpenPonded; #2 is NoOpenPonded1; #6 is AllOpenPond]
		<1% or none, or largest pool occupies <0.01 hectares. Enter "1" and **SKIP to F20** (Floating Algae).	0	
		1-5% of the ponded water. Enter "1" and **SKIP to F20**.	0	

		5-30% of the ponded water.	0	
		30-70% of the ponded water.	0	
		70-99% of the ponded water.	0	
		100% of the ponded water.	0	
F15	Flat Shoreline Extent	The length of the AA's shoreline (along its ponded open water) that is bordered by lands that are **nearly flat** (a slope less than about 5%, measured within 3 m from the water) is:		See diagram in the manual. If several isolated pools are present in early summer, estimate the percent of their collective shorelines that has such a gentle slope. [SR, WB]
		<1% of the shoreline	0	
		1-25%	0	
		25-50%	0	
		50-75%	0	
		>75%	0	
F16	Predominant Width of Vegetated Zone	At the driest time of year (or lowest water level), the average width of vegetated area in the AA that separates adjoining uplands from open water within the AA is:		"Vegetated area" does not include underwater or floating-leaved plants, i.e., aquatic bed. Width may include wooded riparian areas if they have wetland soil or plant indicators. Free apps are available for estimating distance through the camera lens of most smartphones. For most sites larger than 10 hectares and with persistent water, measure the width using aerial imagery rather than estimate in the field. [AM, NR, OE, PH, PR, SBM, SR, WB, WS]
		<1 m	0	
		1 - 9 m	0	
		10 - 29 m	0	
		30 - 49 m	0	
		50 - 100 m	0	
		> 100 m	0	
F17	Non-vegetated Aquatic Cover	Near waters that are deeper than 0.5 m, the cover for fish, aquatic invertebrates, and/or amphibians that is provided by horizontally incised banks and/or partly-submerged accumulations of wood thicker than 10 cm (NOT by living vegetation) is:		For this question, **do not consider herbaceous plants**. Consider only the wood that is at or above the water surface. Estimates of underwater wood based only on observations from terrestrial viewpoints are unreliable so should not be attempted. [AM, FH, INV]
		Little or none, or all water is shallower than 0.5 m most of the year.	0	
		Intermediate	0	
		Extensive	0	
F18	Interspersion of Emergents & Open Water	During **most** of the growing season, the spatial pattern of herbaceous vegetation that has surface water beneath it (emergent vegetation) is **mostly**:		[AM, FH, INV, NR, OE, PH, PR, SBM, SR, WB]
		scattered in small clumps, islands, or patches throughout the surface water area.	0	
		intermediate	0	
		clumped at one or a few sides of the surface water area, or mostly surrounds a central area of open water. Or such vegetation is absent or covers <9 sq m and <1% of the AA.	0	
F19	Isolated Island	The AA contains (or is part of) an island or beaver lodge within a lake, pond, or river and is isolated from the shore by water depths >2 m on all sides during an average June. The island may be solid, or it may be a floating vegetation mat suitable for nesting waterbirds.	0	[WB]

F20	Floating Algae & Duckweed	At some time of the year, mats of algae and/or duckweed cover most of the AA's otherwise-unshaded water surface or blanket the underwater substrate. If true, enter "1" in next column. If untrue or uncertain, enter "0".	0	[HU, PR]
F21	Stained Surface Water	Most surface water is naturally tea-colored (from tannins, not iron bacteria or silt), and/or its pH is usually <5.5. Nearby vegetation is mostly moss and/or conifers.	0	[AM, FH, INV, OE, WB]
F22	Fish	Fish (native or stocked) are known to be present in the AA. Or fish from a stream or larger water body can access at least part of the AA during one or more days annually.	0	[AM, FH, INV, WB]
F23	Beaver Probability	Use of the AA by beaver during the past 5 years is (select most applicable ONE):		[AM, FH, PH, SBM, WB]
		evident from direct observation or presence of gnawed limbs, dams, tracks, dens, lodges, or extensive stands of water-killed trees (snags).	0	
		likely based on known occurrence in the region and proximity to suitable habitat, which may include: (a) a persistent freshwater wetland, pond, or lake, or a perennial low or mid-gradient (<10%) channel, and (b) a corridor or multiple stands of hardwood trees and shrubs in vegetated areas near surface water.	0	
		unlikely because site characteristics above are deficient, and/or this is a settled area or other area where beaver are routinely removed. But beaver occur in this part of the region (i.e., within 25 km).	0	
		none. Beaver are absent from this part of the region.	0	
F24	Inflow	At least once annually, surface water moves into the AA from a tributary that is >100m long, or from a larger water body. It may enter directly in a channel, or as unconfined overflow from a contiguous river or lake, or via a pipe or hardened conduit. If true, enter 1 and continue. If false, enter 0 and **SKIP to F26** (Channel Connection & Outflow Duration).	0	[Data cell name choice is Inflows] [PH]
F25	Throughflow Complexity	During its travel through the AA at the time of peak annual flow, **most of** the water arriving in channels [select only the ONE encountered by most of the incoming water]:		[FH, INV, NR, OE, PR, SR, WS]
		Does not bump into plant stems as it travels through the AA. Nearly all the water continues to travel in unvegetated (often incised) channels that have little contact with wetland vegetation, or through a zone of open water such as an instream pond or lake.	0	
		bumps into **herbaceous** vegetation but mostly remains in fairly straight channels.	0	
		bumps into **herbaceous** vegetation and mostly spreads throughout, or is in widely meandering, multi-branched, or braided channels.	0	
		bumps into **tree trunks and/or shrub stems** but mostly remains in fairly straight channels.	0	
		bumps into tree trunks and/or shrub stems and follows a fairly **indirect** path from entrance to exit (meandering, multi-branched, or braided)	0	

F26	Channel Connection & Outflow Duration	The most persistent surface water connection (outlet channel or pipe, ditch, or overbank water exchange) between the AA and the closest off-site downslope water body is:		A channel is an observably incised landform that transports surface water in a downhill direction during some part of a normal year. A larger difference in elevation between the wetland-upland boundary and the bottom of the wetland outlet (if any) indicates shorter outflow duration. The frequencies given are only approximate and are for a "normal" year. The connection need not occur during the growing season. [FH, NR, OE, PR, SFS, SR, WC, WS] [Data cell name choice #4 is OutNone1; #5 is OutNone]
		persistent (>9 months/year, including times when frozen)	0	
		seasonal (14 days to 9 months/year, not necessarily consecutive, including times when frozen)	0	
		temporary (<14 days, not necessarily consecutive -- must be unfrozen)	0	
		none -- but maps show a stream or other water body that is downslope from the AA and within a distance that is less than the AA's length. If so, mark "1" here and SKIP TO F28 (Groundwater).	0	
		no surface water flows out of the wetland except possibly during extreme events (<once per 10 years). Or, water flows only into a wetland, ditch, or lake that lacks an outlet. If so, mark "1" here and SKIP TO F28 (Groundwater).	0	
F27	Outflow Confinement	During major runoff events, in the places where surface water exits the AA or connected waters nearby, it:		"Major runoff events" would include biennial high water caused by storms and/or rapid snowmelt. [NR, OE, PR SR, WS]
		mostly passes through a pipe, culvert, narrowly breached dike, berm, beaver dam, or other partial obstruction (other than natural topography) that does not appear to drain the wetland artificially during most of the growing season.	0	
		leaves through natural exits (channels or diffuse outflow), not mainly through artificial or temporary features		
		exported more quickly than usual due to ditches or pipes within the AA (or connected to its outlet or within 10 m of the AA's edge) which drain the wetland artificially, or water is pumped out of the AA.	0	
F28	Groundwater: Strength of Evidence	Select first applicable choice.		Consult topographic maps to detect breaks in slope described here. Localized orange coloration associated with groundwater seeps may be most noticeable in ice formations along streams during early winter. [AM, FH, INV, NR, PH, SFS, WC, WS]
		Groundwater monitoring has demonstrated that groundwater primarily discharges to the wetland for longer periods during the year than periods when the wetland recharges the groundwater. Or, springs are known to be present within the AA.	0	
		One or more of the following are true: (a) the upper end of the AA is located very close to the base of (but mostly not ON) a natural slope much steeper (usually >15%) than that within the AA and longer than 100 m, OR (b) rust deposits ("iron floc"), colored precipitates, or dispersible natural oil sheen are prevalent in the AA, OR (c) AA water is remarkably clear in contrast to naturally stained waters typical in nearby wetlands, OR (d) AA is located at a geologic fault.	0	

		Neither of above is true, although some groundwater may discharge to or flow through the AA. Or groundwater influx is unknown.	0	

F29	Internal Gradient	The gradient along most of the flow path within the AA is:		This is not the same as the shoreline slope. It is the elevational difference between the AA's inlet and outlet, divided by the flow-distance between them and converted to percent. If available, use a clinometer to measure this. Free apps for measuring gradient (clinometers) can be downloaded to smartphones. [AM, NR, OE, PR, SR, WB, WS]
		<2%, or, no slope is ever apparent (i.e., flat). Or, the wetland is in a depression or pond with no inlet and no outlet.	0	
		2-5%	0	
		6-10%	0	
		>10%	0	
F30	Total Woody Cover -% of the Vegetated AA	Within the entire vegetated part of the AA, the percentage occupied by trees or shrubs taller than 1 m is:		Do not count trees or shrubs if they merely hang into the wetland. They must be rooted in soils that are saturated for several weeks of the growing season. The "vegetated part" should not include floating-leaved or submersed aquatics. [NR, PH, SBM WB, WS] [Data cell name choice #1 is NoWoodyVeg]
		<5% of the vegetated AA, or there is no woody vegetation in the AA. SKIP to F38 (N Fixers)	0	
		5-25%.	0	
		25-50%	0	
		50-75%	0	
		>75%	0	
F31	Interspersion of Herbaceous and Woody Cover	The following best represents the distribution pattern of woody vegetation VS. unshaded herbaceous/ moss vegetation within the AA:		In larger forested wetlands, patchiness is best interpreted from aerial imagery. Images that show "coarse-grained" forests indicate presence of multiple age classes and/or numerous small openings, whereas those that show "fine-grained" forests suggest more even-aged, even-sized forest with little interspersion. [AM, INV, PH, SBM]
		(a) Woody cover and herbaceous/ moss cover EACH comprise 30-70% of the vegetated part of the AA, AND (b) There are many patches of woody vegetation scattered widely within herbaceous/ moss vegetation, or many patches of herbaceous vegetation scattered widely within woody vegetation.	0	
		(a) Woody cover and herbaceous/ moss EACH comprise 30-70% of the vegetated AA, AND (b) There are few patches ("islands") of woody vegetation scattered widely within herbaceous vegetation, or few patches of herbaceous/ moss vegetation ("gaps") scattered widely within woody vegetation.	0	
		(a) Woody cover OR herbaceous/ moss comprise >70% of the vegetated AA, AND (b) There are several patches of the other scattered within it.	0	
		(a) Woody cover OR herbaceous/ moss comprise >70% of the vegetated AA, AND (b) The other is absent or is mostly in a single area or distinct zone with almost no intermixing of woody and unshaded herbaceous/ moss vegetation.	0	
F32	Tall Woody Canopy- % of the Vegetated AA	Within the vegetated part of the AA, just the woody plants taller than 3 m occupy:		Do not count trees if they merely hang into the wetland. They must be rooted in soils that are saturated for several weeks of the growing season. The "vegetated part" should not include floating-leaved or submersed aquatics. [PH, SBM, SFS] [Data cell name choice #1 is NoTrees]
		<1% of the vegetated AA, or the AA lacks trees. Enter "1" and SKIP to F35 (Exposed Shrub).	0	
		1-25% of the vegetated AA	0	
		25-50% of the vegetated AA	0	

		50-95% of the vegetated AA	0	
		>95% of the vegetated part of the AA	0	

F33	Woody Diameter Classes	Mark all the classes of woody plants within the AA, but only IF they comprise more than 5% of the woody canopy within the AA. Do not count trees that adjoin but are not within the AA.		The trees and shrubs need not be wetland species. Measurements are the d.b.h., the diameter of the tree measured at 4.5 ft above the ground. [AM, PH, SBM, WB]
		coniferous, 1-9 cm diameter and >1 m tall	0	
		broad-leaved deciduous 1-9 cm diameter and >1 m tall	0	
		coniferous, 10-19 cm diameter	0	
		broad-leaved deciduous 10-19 cm diameter	0	
		coniferous, 20-40 cm diameter	0	
		broad-leaved deciduous 20-40 cm diameter	0	
		coniferous, >40 cm diameter	0	
		broad-leaved deciduous >40 cm diameter	0	
F34	Downed Wood	The number of downed wood pieces longer than 2 m and with diameter >10 cm, and not persistently submerged, is:		Exclude temporary "burn piles." [AM, INV, PH, SBM]
		Several (>5 if AA is >5 hectares, less for smaller AAs)	0	
		Few or none	0	
F35	Exposed Shrub Canopy	Woody vegetation 1 to 3 m tall that is not under the drip line of taller woody vegetation comprises:		The "vegetated part" may include moss, but it should not include floating-leaved or submersed aquatics. The "drip line" is the area directly beneath a tree canopy. [PH, SBM] [Data cell name choice #1 is NoShrub]
		<5% of the vegetated AA and (if a fringe wetland) <5% of its water edge. Or <0.01 hectare. SKIP to F38 (N Fixers).	0	
		5-25% of the vegetated AA or (if a fringe wetland) 5-25% of the water edge -- whichever is greater.	0	
		25-50% of the vegetated AA or the water edge, whichever is greater.	0	
		50-95% of the vegetated AA or the water edge, whichever is greater.	0	
		>95% of the vegetated part of the AA or the water edge, whichever is greater.	0	
F36	Dominance of Most-abundant Shrub Species	Determine which two native shrub species (1 to 3 m tall) comprise the greatest portion of the native shrub cover. Then choose one of the following:		[PH, SBM]
		those species together comprise > 50% of the areal cover of native shrub species.	0	
		those species together do not comprise > 50% of the areal cover of native shrub species.	0	
F37	Broad-leaved Deciduous Trees and	The percentage of the AA's tree or shrub cover that is broad-leaved deciduous and is taller than 1 meter is:		Select only the first true statement. The trees or shrubs do not have to be wetland species, as long as they are in the AA or overhang its water. [INV, OE, PH, SBM]
		<1%, or largest patch occupies less than 0.01 hectare	0	

	Shrubs	1-25% of the tree or shrub cover (whichever has more)	0	
		25-50% of the tree or shrub cover (whichever has more)	0	
		50-75% of the tree or shrub cover (whichever has more)	0	
		>75% of the tree or shrub cover (whichever has more)	0	

F38	N Fixers	The percent of the AA's shrub plus ground cover that is nitrogen-fixing plants (e.g., alder, baltic (wire) rush, sweetgale, lupine, clover, other legumes) is:		"Ground cover" includes both moss and herbaceous vegetation. Do not include N-fixing algae or lichens. Select only the first true statement. [INV, OE, PH]
		<1% or none	0	
		1-25% of the shrub plus ground cover, in the AA or along its water edge (whichever has more).	0	
		25-50% of the shrub plus ground cover, in the AA or along its water edge (whichever has more).	0	
		50-75% of the shrub plus ground cover, in the AA or along its water edge (whichever has more).	0	
		>75% of the shrub plus ground cover, in the AA or along its water edge (whichever has more).	0	
F39	Snags	The number of large snags (diameter >20 cm) in the AA plus the upland area within 10 m of the wetland edge is:		Snags are standing trees at least 3 m tall that often (not always) lack bark and foliage. [PH, SBM, WB]
		Several (>2/hectare) and a pond, lake, or slow-flowing water wider than 10 m is within 1 km.	0	
		Several (>2/hectare) but above not true.	0	
		Few or none	0	
F40	Moss Extent	Within the part of the AA that lacks persistent surface water, the cover of moss is:		Exclude moss growing on trees or rocks. [INV, OE, PH]
		<5% of the ground cover	0	
		5-25% of the ground cover	0	
		25-50% of the ground cover	0	
		50-95% of the ground cover	0	
		>95% of the ground cover	0	
F41	% Bare Ground & Thatch	Consider the parts of the AA that lack surface water at the driest time of the growing season. Viewed from directly above the ground layer, the predominant condition in those areas at that time is:		Thatch is dead plant material (stems, leaves) resting on the ground surface. Bare ground that is present under a tree or shrub canopy should be counted. Wetlands that are heavily shaded or are dominated by annual plant species tend to have more extensive areas that are bare during the early growing season. [NR, OE, PR, SR]
		Little or no (<5%) *bare ground* is visible between erect stems or under canopy anywhere in the vegetated AA. Ground is extensively blanketed by dense thatch, moss, lichens, graminoids with great stem densities, or plants with ground-hugging foliage.	0	
		Slightly bare ground (5-20% bare between plants) is visible in places, but those areas comprise less than 5% of the unflooded parts of the AA.	0	
		Much bare ground (20-50% bare between plants) is visible in places, and those areas comprise more than 5% of the unflooded parts of the AA.	0	
		Other conditions	0	
		Not applicable. Surface water (either open or obscured by emergent plants) covers all of the AA all the time.	0	

F42	Ground Irregularity	Consider the parts of the AA that lack surface water at some time of the year. Excluding slash from logging, the number of small pits, raised mounds, hummocks, boulders, upturned trees, animal burrows, gullies, natural levees, wide soil cracks, and microdepressions is:		"Microtopography" refers mainly to the patchiness of vertical relief of >6 inches and is represented only by inorganic features, except where living plants have created depressions or mounds (hummocks) of soil. If parts of the AA are flat but others are highly irregular, base your answer on which condition predominates in the parts of the AA that lack persistent water. [AM, INV, NR, PH, PR, SR, WS]
		Few or none (minimal microtopography; <1% of that area)	0	
		Intermediate	0	
		Several (extensive micro-topography)	0	
F43	Upland Inclusions	Within the AA, inclusions of upland soil that individually are >100 sq.m. are:		Inclusions are slightly elevated "islands" or "pockets" dominated by upland vegetation and soils. Do not count as inclusions the elevated roots of trees or logs unless supported by a mound of soil meeting the size threshold. Upland inclusions may sometimes be created by fill. [NR, SBM]
		Few or none	0	
		Intermediate (1 - 10% of vegetated part of the AA).	0	
		Many (e.g., wetland-upland "mosaic", >10% of the vegetated AA).	0	
F44	Soil Texture	In parts of the AA that lack persistent water, the texture of soil in the uppermost layer is mostly: [*To determine this, use a trowel to check in at least 3 widely spaced locations, and use the soil texture key in Appendix A of the Manual]*		"Organic" includes muck, mucky peat, peat, and mucky mineral soils that comprise the "Oi" horizon. These soils are much less common in floodplains. Do not include duff (loose organic surface material, e.g., dead plant leaves and stems). If texture varies greatly, base your answer on which texture predominates in the parts of the AA that lack persistent water. [NR, OE, PH, PR, SFS, WS]
		Loamy: includes loam, sandy loam, sandy clay loam, silty loam, silty clay loam	0	
		Fines: includes silt, glacial flour, clay, clay loam, silty clay, sandy clay	0	
		Organic (peat or organic muck)	0	
		Coarse: includes sand, loamy sand, gravel, cobble, stones, boulders, fluvents, fluvaquents, riverwash.	0	
F45	Shorebird Feeding Habitats	During any 2 consecutive weeks of the growing season, the extent of mudflats, bare unshaded saturated areas not covered by thatch, and unshaded non-acidic waters shallower than 6 cm (see definition in column E) is:		This addresses needs of many migratory sandpipers, plovers, and related species, but not Wilson's snipe. [WB]
		none, or <100 sq. m within the AA.	0	
		100-1000 sq. m within the AA.	0	
		1000 – 10,000 sq. m within the AA.	0	
		>10,000 sq. m within the AA.	0	
F46	Herbaceous - Percent of Vegetated Wetland	In aerial ("ducks eye") view, the maximum annual cover of dense herbaceous vegetation (graminoids + forbs, but not mosses and submerged and floating aquatics) is:		[WB] [Data cell name choice #1 is NoHerbCover]
		<5% of the vegetated part of the AA (excluding parts that are moss-covered or beneath shrubs or trees), or <0.01 hectare (whichever is less). Mark "1" here and SKIP to F50 (Invasive Plant Cover).	0	
		5-25% of the vegetated AA.	0	
		25-50% of the vegetated AA.	0	
		50-95% of the vegetated AA.	0	
		>95% of the vegetated AA.	0	
F47	Forb Cover	The areal cover of forbs reaches an annual maximum of:		forbs = flowering non-woody vascular plants (excludes grasses, sedges, ferns, mosses). Although technically a forb, include
		<5% of the herbaceous & moss cover	0	

		5-25% of the herbaceous & moss cover	0	horsetail (Equisetum) as a graminoid, not a forb. Do not include non-wetland forb species, or floating-leaved aquatic plants. Areal cover (percentage of an area) is not the same as aerial cover (viewed from the air). [PH, SBM] [Data cell name choice #5 is AllForbCov]
		25-50% of the herbaceous & moss cover	0	
		50-95% of the herbaceous & moss cover	0	
		>95% of the herbaceous & moss cover. SKIP to F50 (Invasive Plant Cover).	0	

F48	Sedge Cover	Sedges (*Carex* spp.) and/or cottongrass (*Eriophorum* spp.) occupy:		[PH, SBM]
		<5% of the herbaceous cover, or <0.01 hectare	0	
		5-50% of the herbaceous cover	0	
		50-95% of the herbaceous cover	0	
		>95% of the herbaceous cover	0	
F49	Dominance of Most Abundant Herbaceous Species	Determine which two native herbaceous (forb and graminoid) species comprise the greatest portion of the herbaceous cover that is unshaded by a woody canopy. Then choose one of the following:		[INV, PH, SBM]
		those species together comprise > 50% of the areal cover of native herbaceous plants at any time during the year.	0	
		those species together do not comprise > 50% of the areal cover of native herbaceous plants at any time during the year.	0	
F50	Invasive Plant Cover	In central Alberta, common invasive graminoids include smooth brome, most bluegrasses, quackgrass, timothy, alfalfa, reed canarygrass, red fescue, spreading bentgrass. Common invasive forbs include most thistles and sow-thistles, most clovers, sweetclover, black medick, dandelion, great plantain, hemp-nettle, lamb's-quarters, shepherd's-purse, curly dock, pennycress, wallflower, hawksbeard, tansy, chickweed, sticky-willy bedstraw, stickseed, tall buttercup. Select first applicable choice:		Listing the species you find is encouraged but optional. See Plant List table in Appendix A for full list of invasives. [PH]
		invasive or other non-native species appear to be absent in the AA, or are present only in trace amount (a few individuals)	0	
		Invasive species are present in more than trace amounts, but comprise <5% of herbaceous cover (or woody cover, if the invasives are woody).	0	
		Invasive species comprise 5-20% of the herb cover.	0	
		Invasive species comprise 20-50% of the herb cover.	0	
		Invasive species comprise >50% of the herb cover.	0	
F51	Weed Source Along Edge	Along the wetland-upland boundary, the percent of the upland edge (within 3 m of wetland) that is occupied by plant species that are considered invasive (see above) is:		If the AA has no upland edge, or upland edge is <10% of AA's perimeter, then answer for the portion of the upland closest to the wetland. Listing the species you find is encouraged but optional. [PH]
		none of the upland edge (invasives apparently absent)	0	
		some (but <5%) of the upland edge	0	
		5-50% of the upland edge	0	
		most (>50%) of the upland edge	0	

F52	Natural Cover in Buffer	Along the wetland-upland edge and extending 30 m upslope, the percentage of the upland that contains **natural** (not necessarily native -- see column E) land cover taller than 10 cm is:		Natural land cover includes wooded areas, peatlands, vegetated wetlands, and most other areas of perennial vegetation. It does not include water, annual crops, residential areas, golf courses, recreational fields, fields mowed >1x per year, pavement, bare soil, rock, bare sand, or gravel or dirt roads. Natural land cover is not the same as native vegetation. It can include areas with invasive plants. If the AA does not adjoin upland, base your answer on the closest upland. [AM, FH, INV, PH, SBM, WB] [Data cell name choice #5 is BuffAllNat]
		<5%	0	
		5 to 30%	0	
		30 to 60%	0	
		60 to 90%	0	
		>90%. **SKIP to F54** (Cliffs).	0	
F53	Type of Cover in Buffer	Within 30 m upslope of the wetland-upland edge closest to the AA, the upland land cover that is NOT unmanaged vegetation or water is mostly (mark ONE):		[INV, PH, SBM]
		impervious surface, e.g., paved road, parking lot, building, exposed rock.	0	
		bare or nearly bare pervious surface or managed vegetation, e.g., lawn, annual crops, mostly-unvegetated clearcut, landslide, unpaved road, dike.	0	
F54	Cliffs, Steep Banks, or Salt Lick	In the AA or within 100 m, there is a known salt lick, or elevated terrestrial features such as cliffs, talus slopes, stream banks, or excavated pits (but not riprap) that extend at least 2 m nearly vertically, are unvegetated, and potentially contain crevices or other substrate suitable for nesting or den areas. Enter 1 (yes) or 0 (no).	0	[PH, SBM]
F55	New Wetland	The AA is (or is within, or contains) a "new" wetland resulting from **human** actions (e.g., excavation, impoundment) or debris flows, or other factors affecting what once was **upland (non-hydric) soil**.		Do not include wetlands created by beaver dams except for the part where former uplands were flooded. Determine this using historical aerial photography, old maps, soil maps, or permit files as available [NR, OE, PH]
		No	0	
		yes, and created 20 - 100 years ago	0	
		yes, and created 3-20 years ago	0	
		yes, and created within last 3 years	0	
		yes, but time of origin unknown	0	
		unknown if new within 20 years or not	0	
F56	Visibility	From the best vantage point on public roads, public parking lots, public buildings, or well-defined public trails that intersect, adjoin, or are within 100 m of the wetland, **some part** of the wetland is (select best case):		[HU]
		easily visible	0	
		somewhat visible	0	
		barely or not visible	0	
F57	Ownership	Most of the AA is (select one):		http://ESRD.alberta.ca/fish-wildlife/fwmis/access-fwmis-data.aspx [HU]
		publicly owned **conservation** lands that exclude new timber harvest, roads, mineral extraction, and intensive summer recreation (e.g., off-road vehicles). Includes most Protected Lands.	0	
		publicly owned **resource use** lands (allowed activities such as timber harvest, mining, or intensive recreation), or unknown. Includes most Crown Reservations/Notations.	0	

		Owned by non-profit conservation organization or lease holder who allows public access.	0	
		Other private ownership, including First Nations.	0	

F58	Non-consumptive Uses - Actual or Potential	Assuming access permission was granted, select ALL statements that are true of the AA as it currently exists:		[HU]
		For an average person, walking is physically possible in (not just near) >5% of the AA during most of the growing season, e.g., free of deep water and dense shrub thickets.	0	
		Maintained roads, parking areas, or foot-trails are within 10 m of the AA, or the AA can be accessed part of the year by boats arriving via contiguous waters.	0	
		Within or near the AA, there is an interpretive center, trails with interpretive signs or brochures, and/or regular guided interpretive tours.	0	
		The AA contains or adjoins a public boat dock or ramp, or is within 1 km of a campground, picnic area, or winter sports park.	0	
F59	Unvisited Core Area	The percentage of the AA almost never visited by humans during an average growing season probably comprises: [*Note: Do not include visitors on trails outside of the AA unless more than half the wetland is visible from the trails and they are within 30 m of the wetland edge. In that case, imagine the percentage of the AA that would be covered by the trail if it were placed within the AA.*]		Include visits by foot, canoe, kayak, or any non-motorized mode. Judge this based on proximity to population centers, roads, trails, accessibility of the wetland to the public, wetland size, usual water depth, and physical evidence of human visitation. Exclude visits that are not likely to continue and/or that are not an annual occurrence, e.g., by construction or monitoring crews. [AM, HU, PH, SBM, WB]
		<5% and no inhabited building is within 100 m of the AA	0	
		<5% and inhabited building is within 100 m of the AA	0	
		5-50% and no inhabited building is within 100 m of the AA	0	
		5-50% and inhabited building is within 100 m of the AA	0	
		50-95%	0	
		>95% of the AA	0	
F60	Frequently Visited Area	The percentage of the AA visited by humans almost daily for several weeks during an average growing season probably comprises: [*Note: Do not include visitors on trails outside of the AA unless more than half the wetland is visible from the trails and they are within 30 m of the wetland edge. In that case, imagine the percentage of the AA that would be covered by the trail if it were placed within the AA.]*		Include visits by foot, canoe, kayak, or any non-motorized mode. Exclude visits that are not likely to continue and/or that are not an annual occurrence, e.g., by construction or monitoring crews. [AM, HU, PH, SBM, WB]
		<5%. If F59 was answered ">95%", SKIP to F63 (Consumptive Uses).	0	
		5-50%	0	
		50-95%	0	

		>95% of the AA	0	
F61	BMP - Soils	Boardwalks, paved trails, fences or other infrastructure and/or well-enforced regulations appear to effectively prevent visitors from walking on soils within nearly all of the AA when they are unfrozen. Enter "1" if true.	0	[HU, PH]
F62	BMP - Wildlife Protection	Fences, observation blinds, platforms, paved trails, exclusion periods, and/or well-enforced prohibitions on motorized boats, off-leash pets, and off road vehicles appear to effectively exclude or divert visitors and their pets from the AA at critical times in order to minimize disturbance of wildlife (except during hunting seasons). Enter "1" if true.	0	[AM, HU, SBM, WB]

F63	Consumptive Uses (Provisioning Services)	Recent evidence was found within the AA of the following potentially-sustainable consumptive uses. Select all that apply.		"Low impact" means adherence to Best Management Practices such as those defined by certification groups. Evidence of these consumptive uses may consist of direct observation, or presence of physical evidence (e.g., recently cut stumps, fishing lures, shell cases), or might be obtained from communication with the land owner or manager. [HU]
		Low-impact commercial timber harvest (e.g., selective thinning)	0	
		Extraction of surface water without noticeably affecting surface water area, depth, or persistence.		
		Grazing by livestock	0	
		Harvesting of native plants, native hay, or mushrooms (observed or known, not assumed)	0	
		Hunting (observed or known, not assumed)	0	
		Furbearer trapping	0	
		Fishing (observed or known, not assumed)	0	
		No evidence of any of the above	0	
F64	Domestic Wells	The closest wells or water bodies that currently provide drinking water are:		If unknown, assume this is true if there is an inhabited structure within the specified distance and the neighborhood is known to not be connected to a municipal drinking water system (e.g., is outside a densely settled area). [HU]
		Within 100 m of the AA	0	
		100-500 m away	0	
		>500 m away, or no information	0	
F65	Salinity, Alkalinity, Conductance	Based on measurement from a surface water area larger than .01 hectare, the AA's surface water is mostly:		[AM, FH, PR, WB] [Data cell name choice #1 is TooSaline]
		Brackish or saline (conductance of >25 mS/cm, or >5000 ppm TDS). Or plants that indicate saline conditions comprise >20% of ground cover. Trees and shrubs mostly absent. Salt crust obvious around the perimeter and on flats.	0	
		Slightly brackish (conductance of 2.5- 25 mS/cm, or 500 - 5000 ppm TDS). Or plants that indicate saline conditions comprise 1-20% of ground cover. Salt crust may or may not be present along perimeter.	0	
		Fresh (conductance of < 2.5 mS/cm, or <500 ppm TDS). Plants that indicate saline conditions are sparse or absent. No salt crust along perimeter.	0	
		Unknown condition (was not measured because surface water absent or insufficient, or measurement conflicted with plant indicators).	0	

F66	Water Quality Problem Area Located Upslope	Sampling indicates problems with the quality of surface waters or sediment within the AA, or within 5 km upstream or upslope, as caused by (enter 1 for ALL that apply):		If no quality-controlled sampling has been done, then a statement or rating documenting the problem and published in a recent agency report or official correspondence may be counted. Do not speculate or infer from presence of potential pollution sources. The water quality problem must be ongoing, not historical. [AM, FH, INV]
		nutrients (phosphorus, nitrate, ammonia), or a water body within 5 km that contributes to the AA has been labeled "hyper-eutrophic" based on excessive levels of either total phosphorus or chlorophyll-a.	0	
		suspended sediment or turbidity	0	
		metals (mercury, lead, zinc, copper, cadmium, others)	0	
		petrochemicals (pesticides, herbicides, PCBs, others)	0	
		None of above, or no data.	0	
F67	Prior Investment in the AA	Mark ALL of the following that apply to this AA:		[HU]
		Regulatory Investment: The AA is all or part of a mitigation site used explicitly to offset impacts elsewhere	0	
		Non-regulatory Investment: The AA is part of or contiguous to a wetland on which public or private organizational funds were spent to preserve, create, restore, enhance, the wetland (excluding mitigation wetlands)	0	
		Sustained Scientific Use: Plants, animals, or water in the AA have been monitored for >2 years, unrelated to any regulatory requirements, and data are available to the public. Or the AA is part of an area that has been designated by an agency or institution as a benchmark, reference, or status-trends monitoring area.	0	
		None of the above, or no information for any.	0	
F68	Wetland as a % of Its Contributing Area (Catchment)	View the approximate boundaries of the wetland's catchment (CA) as shown in the map AEP provides in response to your data request. Then adjust those boundaries if necessary based on your field observations of the surrounding terrain, and/or by using procedures described in the ABWRET Manual. Relative to the extent of this catchment (but excluding the area of the AA), this AA and any bordering waters together comprise (select ONE):		[NR, PR, SR, WS]
		<1% of their catchment	0	
		1 to 10% of their catchment	0	
		10 to 100% of their catchment	0	
		Larger than the area of their catchment (wetland has essentially no catchment, e.g., isolated by dikes with no input channels, or is a raised bog).	0	
F69	Plants or Animals of Conservation Concern	Use of this tool does not require you to survey the AA for plant or animal species believed to be of conservation concern in Alberta. However, you are encouraged to do so at appropriate times of the year, especially if the data review conducted during the office phase of this assessment indicated their past presence in the general vicinity. If you do detect these species or have reliable knowledge of their recent (within ~5 years) occurrence within the AA, indicate that below. If not found or no data, leave as "0".		[AM, FH, PH, SBM, WB]. For plants, see PlantListAB worksheet in Appendix A of ABWRET manual. Fish are: lake sturgeon, pygmy whitefish, brassy minnow, river shiner, northern squawfish, silver redhorse, logperch. Amphibians are: northern leopard frog, Columbia spotted frog, Canadian toad, western toad, long-toed salamander. Waterbirds are: American western grebe, white pelican, white-faced ibis, trumpeter swan, harlequin duck, white-winged scoter, hooded

		One or more of the rare plant species was detected within the AA.	0	merganser, yellow rail, Virginia rail, whooping crane, piping plover, long-billed curlew, Arctic tern, Caspian tern. Songbirds & raptors are: ferruginous hawk, peregrine falcon, short-eared owl, common nighthawk, olive-sided flycatcher, willow flycatcher, great crested flycatcher, Sprague's pipit, black-throated green warbler, bay-breasted warbler, Cape May warbler, rusty blackbird. Mammals are: wandering shrew, taiga vole, red bat, silver-haired bat, western small-footed bat, hoary bat, northern myotis, prairie vole, American badger, woodland caribou, grizzly bear. The lists here exclude species not strongly associated with any wetland type and species that do not regularly breed in the region covered by this version of ABWRET-A. Based on lists from AEP and COSEWIC.
		One or more of the rare fish species was detected within the AA.	0	
		One or more of the rare or sensitive amphibian species was detected within the AA.	0	
		One or more of the rare or sensitive waterbird species was detected within the AA during nesting season.	0	
		One or more of the rare mammal species was detected within the AA, or one or more of the sensitive songbird or raptor species was detected in the AA during the nesting season.	0	

Site Name:	Investigator:	Date:

#	**Data Form S (Stressors). ABWRET-A for northern part of Alberta's White Area. Version 1.0**	Data
S1	**Wetter Water Regime - *Internal* Causes**	
	In the last column, place an X next to any item that is likely to have caused a part of the AA to be inundated more extensively, more frequently, more deeply, and/or for longer duration than it would be without that item or activity. Consider only items occurring within past 100 years or since wetland was created (whichever is less). The items you check are not used automatically in subsequent calculations. They are included as guides when evaluating the factors in the table beneath them.	check marks
	an impounding dam, dike, levee, weir, berm, or road fill -- within or downgradient from the AA, or raising of outlet culvert elevation.	
	excavation within the AA, e.g., artificial pond, dead-end ditch	
	excavation or reflooding of upland soils that adjoined the AA, thus expanding the area of the AA	
	plugging of ditches or drain tile that otherwise would drain the AA (as part of intentional restoration, or due to lack of maintenance, sedimentation, etc.)	
	vegetation removal (e.g., logging) within the AA	
	compaction (e.g., ruts) and/or subsidence of the AA's substrate as a result of machinery, livestock, or off road vehicles	
	If any items were checked above, then for each row of the table below, you may assign points (3, 2, or 1 as shown in header) in the last column. However, if you believe the checked items had no measurable effect in making any part of the AA wetter, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present. The sum and final score will compute automatically. If this is a created or restored wetland, only consider changes occurring since the creation/restoration.	

	Severe (3 points)	Medium (2 points)	Mild (1 point)	points
Spatial extent of resulting wetter condition	>95% of AA or >95% of its upland edge (if any)	5-95% of AA or 5-95% of its upland edge (if any)	<5% of AA and <5% of its upland edge (if any)	0
When most of AA's wetter condition began	<3 yrs ago	3-9 yrs ago	10-100 yrs ago	0

	Score the following 2 rows only if the wetter conditions began within past 10 years, and only for the part of the AA that got wetter.			
	Inundation now vs. previously	persistent vs. seldom	persistent vs. seasonal	slightly longer or more often	0
	Average water level increase	>30 cm	15-30 cm	<15 cm	0

S2

Wetter Water Regime - *External* Causes

In the last column, place an X next to any item occurring in the AA's Contributing Area (CA, which includes channels flowing into the AA) that is likely to have caused a part of the AA to be inundated more extensively, more frequently, more deeply, and/or for longer duration than it would be without that item or activity. Consider only items occurring within past 100 years or since wetland was created (whichever is less).

subsidies from stormwater, wastewater effluent, or septic system leakage	
pavement, ditches, or drain tile in the CA that incidentally increase the transport of water into the AA	
removal of timber in the CA or along the AA's tributaries	
removal of a water control structure or blockage in tributary upstream from the AA	

If any items were checked above, then for each row of the table below, assign points (3, 2, or 1 as shown in header) in the last column. However, if you believe the checked items had no measurable effect in making any part of the AA wetter, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Spatial extent of resulting wetter condition	>20% of the AA	5-20% of the AA	<5% of the AA	0
When most of AA's wetter condition began	<3 yrs ago	3-9 yrs ago	10-100 yrs ago	0
Score the following 2 rows only if the wetter conditions began within past 10 years, and only for the part of the AA that got wetter.				
Inundation now vs. previously	persistent vs. seldom	persistent vs. seasonal	slightly longer or more often	0
Average water level increase	>30 cm	15-30 cm	<15 cm	0

S3

Drier Water Regime - Internal Causes

In the last column, place an X next to any item located **within or immediately adjacent to** the AA, that is likely to have caused a part of the AA to be inundated less extensively, less deeply, less frequently, and/or for shorter duration that it would be without that item. Consider only items occurring within past 100 years or since wetland was created (whichever is less).

ditches or drain tile in the AA or along its edge that accelerate outflow from the AA	
lowering or enlargement of a surface water exit point (e.g., culvert) or modification of a water level control structure, resulting in quicker drainage	
accelerated downcutting or channelization of an adjacent or internal channel (incised below the historical water table level)	
placement of fill material	
withdrawals (e.g., pumping) of natural surface or ground water directly out of the AA (not its tributaries)	

If any items were checked above, then for each row of the table below, assign points in the last column. However, if you believe the checked items had no measurable effect in making any part of the AA drier, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pt)	Mild (1 pt)	
Spatial extent of AA's resulting drier condition	>95% of AA or >95% of its upland edge (if any)	5-95% of AA or 5-95% of its upland edge (if any)	<5% of AA and <5% of its upland edge (if any)	0
When most of AA's drier condition began	<3 yrs ago	3-9 yrs ago	10-100 yrs ago	0
Score the following 2 rows only if the drier conditions began within past 10 years, and only for the part of the AA that got drier.				
Inundation now vs. previously	seldom vs. persistent	seasonal vs. persistent	slightly shorter or less often	0
Water level decrease	>30 cm	15-30 cm	<15 cm	0

S4

Drier Water Regime - External Causes

In the last column, place an X next to any item within the AA's Contributing Area (CA) that is likely to have caused a part of the AA to be inundated less extensively, less deeply, less frequently, and/or for shorter duration that it would be without those. Consider only items occurring within past 100 years or since wetland was created (whichever is less).

a dam, dike, levee, weir, berm, that interferes with natural inflow to the AA	
a ditch or tile drain within 50 m of the AA that accelerates subsurface or surface outflow from the AA	
relocation of natural tributaries whose water would otherwise reach the AA	
instream water withdrawals from tributaries whose water would otherwise reach the AA	
groundwater withdrawals that divert water that would otherwise reach the AA	

If any items were checked above, then for each row of the table below assign points that describe the combined maximum effect of those items in creating a drier water regime in the AA. To estimate that, contrast it with the condition if checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Spatial extent of AA's resulting drier condition	>20% of the AA	5-20% of the AA	<5% of the AA	0
When most of AA's drier condition began	<3 yrs ago	3-9 yrs ago	10-100 yrs ago	0
Score the following 2 rows only if the drier conditions began within past 10 years, and only for the part of the AA that got drier.				
Inundation now vs. previously	seldom vs. persistent	seasonal vs. persistent	slightly shorter or less often	0
Water level decrease	>30 cm	15-30 cm	<15 cm	0

S5

Altered Timing of Water Inputs

In the last column, place an X next to any item that is likely to have caused the **timing** of water inputs (but not necessarily their volume) to shift by hours, days, or weeks, becoming either **more muted** (smaller or less frequent peaks spread over longer times, more temporal homogeneity of flow or water levels) **or more flashy** (larger or more frequent spikes but over shorter times).

flow regulation in tributaries or water level regulation in adjoining water body, or control structure at water entry points that regulates inflow to the AA	
irrigation runoff or seepage	
snow storage areas that drain directly to the wetland	
increased pavement and other impervious surface in the CA	
straightening, ditching, dredging, and/or lining of tributary channels in the CA	

*If any items were checked above, then for each row of the table below, assign points. However, if you believe the checked items had no measurable effect on the timing of water conditions in any part of the AA, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present. [*INV, FR, PH, STR]

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Spatial extent within the AA of timing shift	>95% of AA	5-95% of AA	<5% of AA	0
When most of the timing shift began	<3 yrs ago	3-9 yrs ago	10-100 yrs ago	0
Score the following 2 rows only if the altered inputs began within past 10 years, and only for the part of the AA that experiences those.				
Input timing now vs. previously	shift of weeks	shift of days	shift of hours or minutes	0
Flashiness or muting	became very flashy or controlled	intermediate	became mildly flashy or controlled	0

S6

Accelerated Inputs of Nutrients

In the last column, place an X next to any item -- occurring in either the AA or its CA -- that is likely to have accelerated the inputs of nutrients (nitrogen, phosphorus) to the AA.

stormwater or wastewater effluent (including failing septic systems), landfills	
fertilisers applied to lawns, ag lands, or other areas in the CA	
livestock, dogs	
artificial drainage of upslope lands	
other waterborne human-related nutrient sources within the CA	

If any items were checked above, then for each row of the table below assign points that describe the combined maximum effect of those items in generating loads of nutrients reaching the AA. To estimate that, contrast it with the condition if checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Usual load of nutrients	large (e.g., feedlots, extensive residential on septic)	moderate (e.g., grazing, light residential on septic, light agriculture)	limited (e.g., a few animals, lawns, sewered residential)	0
Frequency & duration of input	frequent and year-round	frequent but mostly seasonal	infrequent & during high runoff events mainly	0
AA proximity to main sources (actual or potential)	0 - 15 m	15-100 m or in groundwater	in other part of contributing area	0

S7

Accelerated Inputs of Contaminants and/or Salts

In the last column, place an X next to any item -- occurring in either the AA or its CA -- that is likely to have accelerated the inputs of contaminants or salts to the AA.

stormwater or wastewater effluent (including failing septic systems), landfills, snow storage areas	
metals & chemical wastes from mining, shooting ranges, oil/ gas extraction, other sources	
irrigation of lands, especially those with saline soils	
oil or chemical spills (not just chronic inputs) from nearby roads	
road salt	
pesticides applied to lawns, ag lands, roadsides, or other areas in the CA	
artificial drainage of contaminated or saline soils	
erosion of contaminated soils	
other contaminant sources within the CA	

If any items were checked above, then for each row of the table below, assign points. However, if you believe the checked items did not cumulatively expose the AA to significantly more contaminants and/or salts, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Usual toxicity of most toxic contaminants	industrial effluent, metals mine, or AA is cropped (& sprayed) annually	crops in catchment but not in AA, fossil fuel extraction or pipeline, power station	mildly impacting (e.g., residential/ commercial, road salt)	0
Frequency & duration of input	frequent and year-round	frequent but mostly seasonal	infrequent & during high runoff events mainly	0
AA proximity to main sources (actual or potential)	0 - 15 m	15-100 m or in groundwater	in other part of contributing area	0

S8

Excessive Sediment Loading from Runoff Contributing Area

In the last column, place an X next to any item present in the Contributing Area (CA) that is likely to have elevated the load of waterborne or windborne sediment reaching the AA from its CA. In general, erosion of more than 0.5 mg/hectare per year indicates excessive conditions for prairie contributing areas.

erosion from plowed fields, fill, timber harvest, dirt roads, vegetation clearing, fires	
erosion from construction, in-channel machinery in the CA	
erosion from off-road vehicles in the CA	
erosion from livestock or foot traffic in the CA	
stormwater or wastewater effluent	
sediment from gravel mining, other mining, oil/ gas extraction	
accelerated channel downcutting or headcutting of tributaries due to altered land use	
other human-related disturbances within the CA	

If any items were checked above, then for each row of the table below, assign points. However, if you believe the checked items did not cumulatively add significantly more sediment or suspended solids to the AA, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Erosion in CA	extensive evidence, high intensity*	potentially (based on high-intensity* land use) or scattered evidence	potentially (based on low-intensity* land use) with little or no direct evidence	0
Recentness of significant soil disturbance in the CA	current & ongoing	1-12 months ago	>1 yr ago	0
Duration of sediment inputs to the AA	frequent and year-round	frequent but mostly seasonal	infrequent & mainly during high runoff or severe wind events	0
AA proximity to actual or potential sources	0 - 15 m, or farther but on steep erodible slopes	15-100 m or in groundwater	in other part of contributing area	0

* high-intensity= plowing, grading, excavation, erosion with or without veg removal; low-intensity= veg removal only with little or no apparent erosion or disturbance of soil or sediment

S9

Soil or Sediment Alteration *Within the Assessment Area*

In the last column, place an X next to any item present in the AA that is likely to have compacted, eroded, or otherwise altered the AA's soil.

compaction from livestock, machinery, off-road vehicles, or mountain bikes, especially during wetter periods	
leveling or other grading not to the natural contour	
tillage, plowing (but excluding disking for enhancement of native plants)	
fill or riprap, excluding small amounts of upland soils containing organic amendments (compost, etc.) or small amounts of topsoil imported from another wetland	
excavation	
dredging in or adjacent to the AA	
boat traffic in or adjacent to the AA and sufficient to cause shore erosion or stir bottom sediments	
artificial water level or flow manipulations sufficient to cause erosion or stir bottom sediments	

If any items were checked above, then for each row of the table below, you may assign points. However, if you believe the checked items did not measurably alter the soil structure and/or topography, then leave the "0's" for the scores in the following rows. To estimate effects, contrast the current condition with the condition if the checked items never occurred or were no longer present.

	Severe (3 pts)	Medium (2 pts)	Mild (1 pt)	
Spatial extent of altered soil	>95% of AA or >95% of its upland edge (if any)	5-95% of AA or 5-95% of its upland edge (if any)	<5% of AA and <5% of its upland edge (if any)	0
Recentness of significant soil alteration in AA	current & ongoing	1-12 months ago	>1 yr ago	0
Duration	long-lasting, minimal veg recovery	long-lasting but mostly revegetated	short-term, revegetated, not intense	0
Timing of soil alteration	frequent and year-round	frequent but mostly seasonal	infrequent & mainly during scattered events	0
			Stressor Subscore=	0.00

A.2 Explanatory Illustrations

These are keyed to questions on Form F which preceded.

Questions F1 & F2. Wetland Types

By intent, these four types -- Wooded Swamp, Bog, Fen, and Marsh -- are not exactly the same as those in the more detailed Alberta Wetland Classification System (AWCS). All functionally important features of the AWCS classes are addressed by other parts of the ABWRET tool.

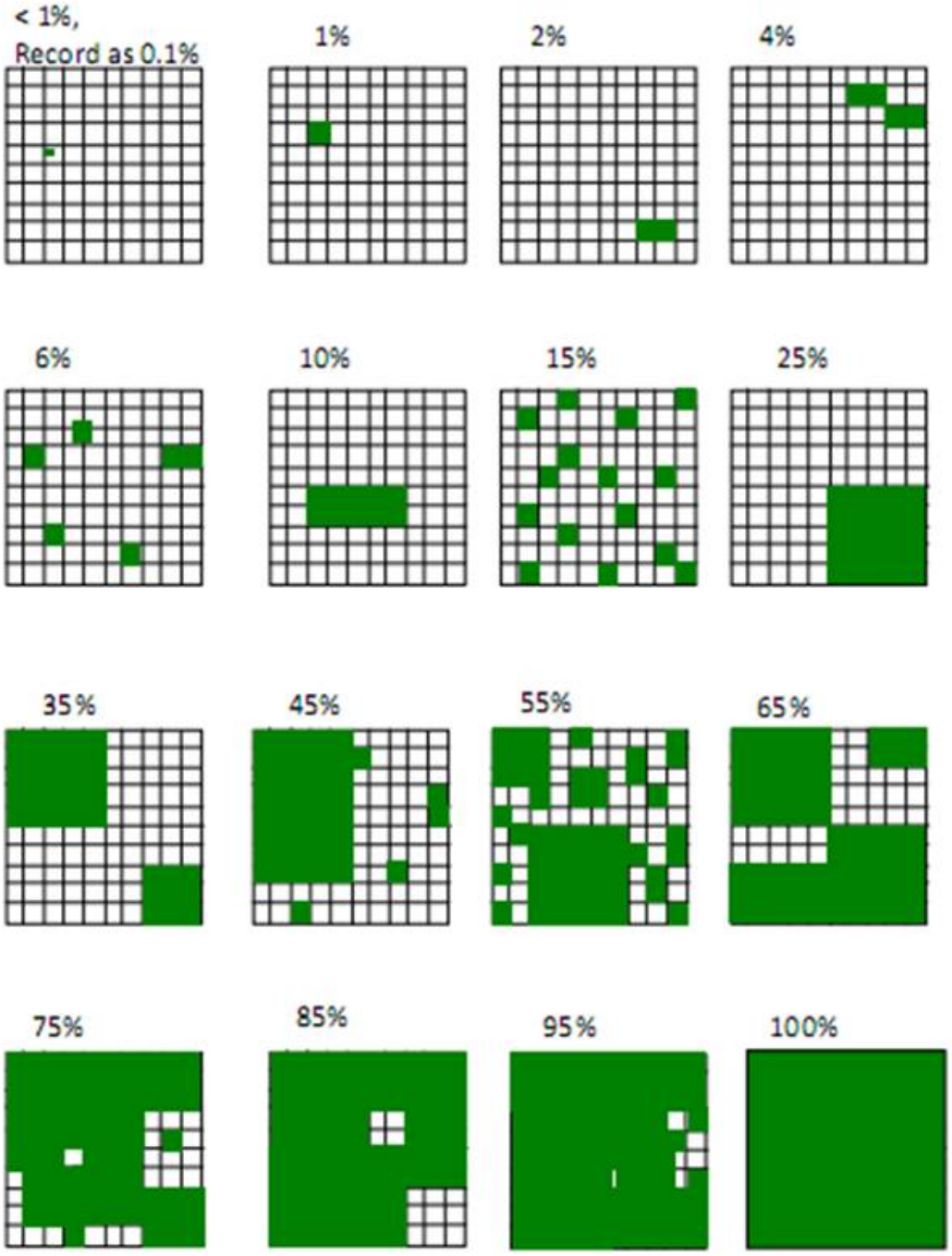
Wooded Swamp. Tall (>2 m) shrubs or trees comprise >25% of the vegetation cover but unlike Fen, the soils are usually mineral. If organic soil, muck is more prevalent than peat. Common woody species are willow, alder, birch. Includes both Shrubby Swamps and Wooded Swamps from the AWCS.

Bog. Few or no trees, and <5% cover of shrubs taller than 2m. Nearly all the ground layer is moss-covered and soils are peaty. Seldom in a depression (surface often raised slightly from surrounding terrain). If known, pH is less than 4.6. When woody cover is present, the common woody species include black spruce, birch, lodgepole pine, broad-leaved conifer shrubs and less often, tamarack (larch). Rare in most of southern and central Alberta lowlands.

Fen. Often more tree and/or shrub cover than Bog, but not a Wooded Swamp because nearly all the ground layer is moss-covered. Some sites lack woody cover entirely but they are not Marsh because ground is mostly covered by moss and sedges. Soils are peaty. Surface water is more likely to be present than in bogs, and sedge is more extensive. Many fens are at the base of naturally steep slopes. Includes Wooded, Shrubby, and Graminoid Fens from the AWCS. Frequency of this type increases as one goes north or gains elevation.

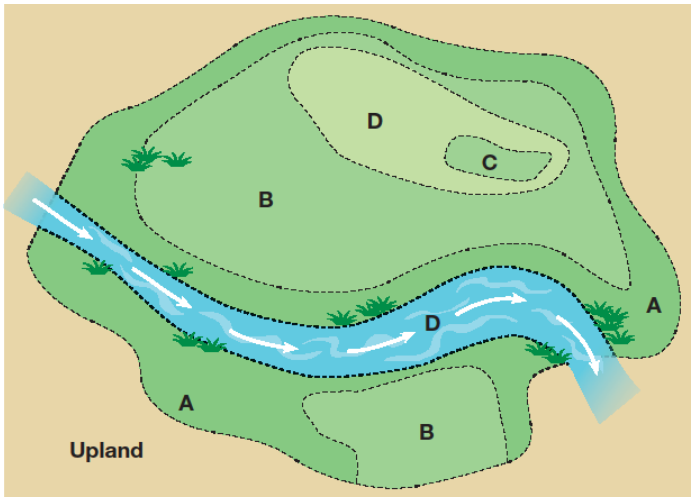
Marsh. Unflooded parts, if any, have little or no moss and tree cover, and shrub cover is less than 25%. Soils are mostly mineral (clay, sand, loam), or if organic then mostly muck. Surface water is usually present during at least part of the year in at least part of the AA (it may be saline). Usually in depressions, excavated pits, along lakeshores, or on floodplains.

Question F3 and others. Visually estimating percentage of a cover type (or hydrologic zones) within a polygon (from USEPA 2011). *Imagine the wetland as a square. "Squeeze together" all the patches of a type into one corner. Then estimate that as a percent of the wetland.*



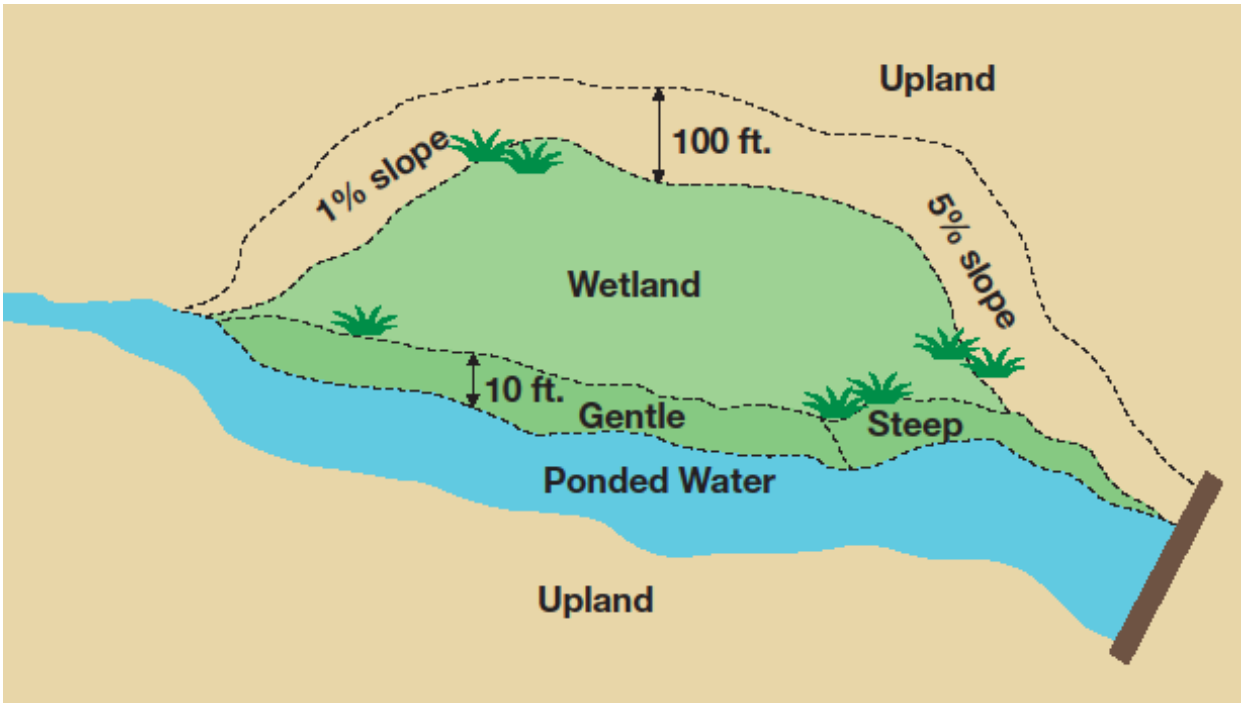
F6	Depth Class Distribution (DepthEven)	When present, surface water in most of the AA (including bordering waters deeper than 2 m) usually consists of (select one):
		One depth class that comprises >90% of the AA's inundated area (use the classes in the question above).
		One depth class that comprises 50-90% of the AA's inundated area.
		Neither of above. There are multiple depth classes; none occupy >50%.

In this diagram, assuming all the vegetation (green) is inundated, the two areas in depth class B together comprise more than 50% of the wetland, so the second choice is correct. Numeric ranges that define the depth classes are given in question F5. Wetland size, shape, surrounding topography, and vegetation should be used to estimate the depth classes that possibly are present.

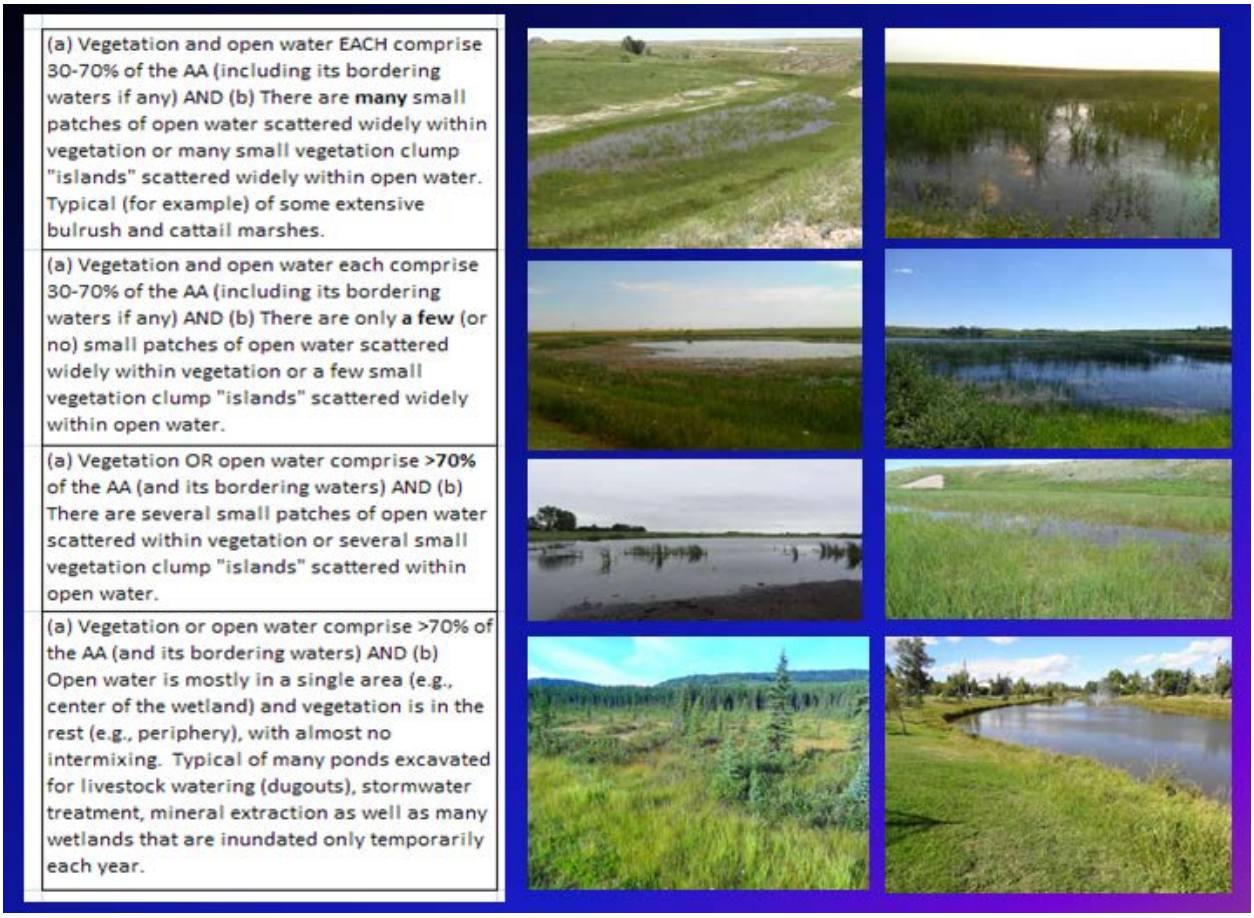


F15	Flat Shoreline Extent (ShoreSlope)	During an average June, the percentage of the total length of the AA's wetted edge (extending 3 m landward of surface water, into either the wet meadow zone or upland) that is nearly flat (has a slope less than about 2%) is:
		<1% of the shoreline length (true for many excavated ponds).
		1-25% of the shoreline length
		25-50% of the shoreline length
		50-75% of the shoreline length
		>75% of the shoreline length
		not applicable because no open water patch occupies >0.1 hectare of the AA during an average June.

In this diagram, 50-75% of the area within 3 m (10 ft) of surface water (in this case ponded water) is classified as having a gentle (less than 2%) slope.



Question F18 (Interspersion of Robust Emergents & Open Water)
Photos on right correspond to the 4 categorical choices on the same row to the left.



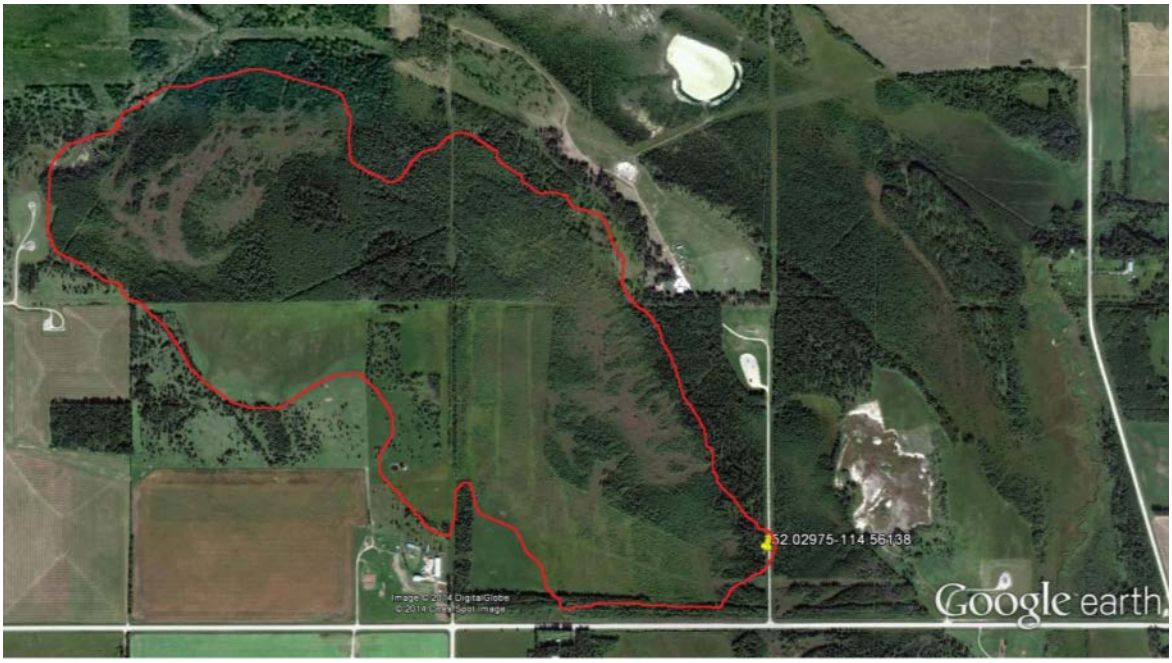
F48. Sedge Cover. *Sedges usually have sharp edges (but so do some other grasslike plants). Note the large brownish or greenish fruit, usually located partway up the stem or near the tip .*

Question F31 (Interspersion of Herbaceous and Woody Cover).

The red-outlined wetland below has >30% woody vegetation intermixed with herbaceous vegetation, which is lighter green in colour and has flatter visual texture.

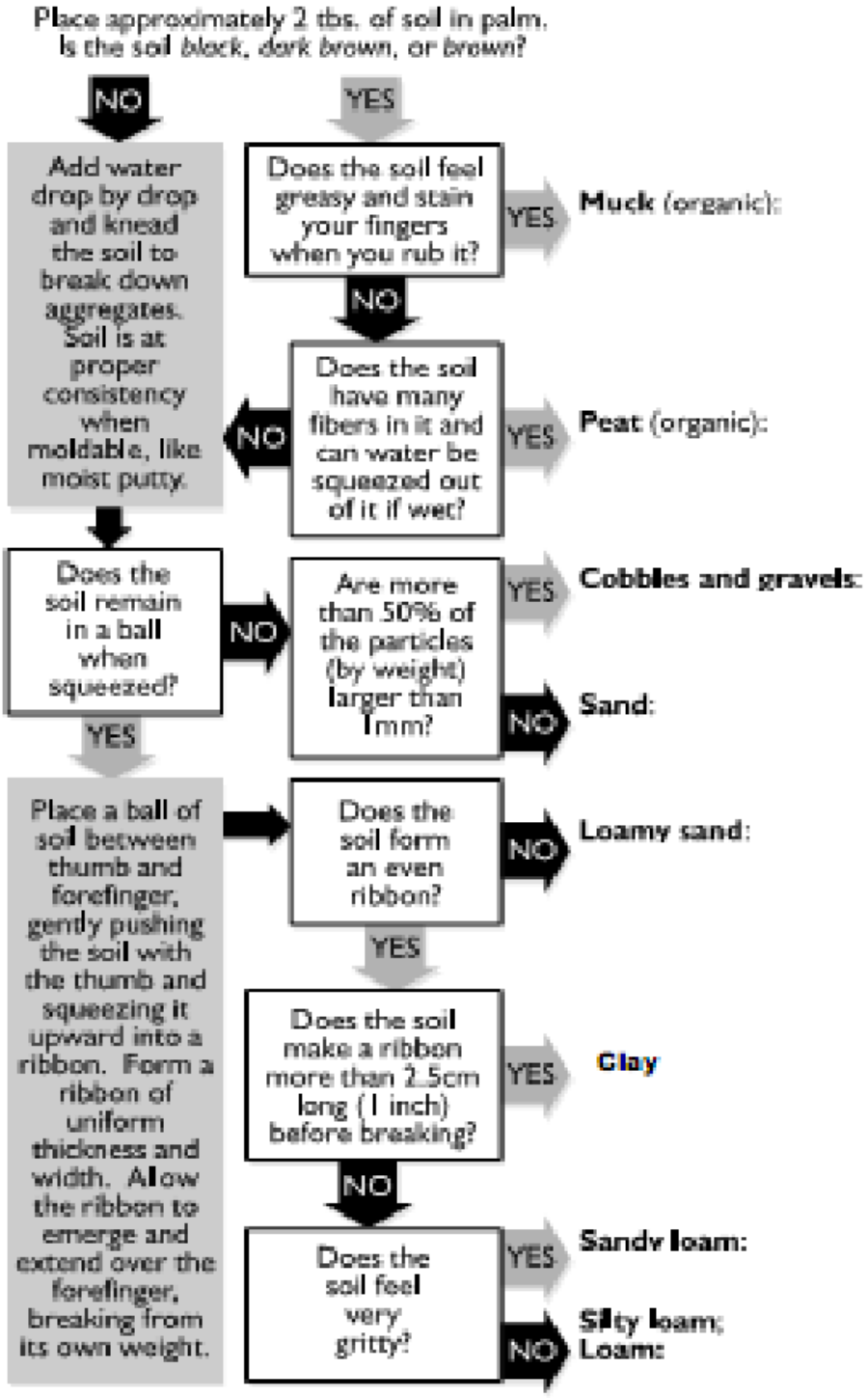
The red-outlined wetland below is almost 100% woody vegetation with few or no gaps of herbaceous vegetation. The presence of deepwater ponds within the wetland should be ignored in this question.

The red-outlined wetland has about an equal mix of woody (darker-shaded) and herbaceous vegetation, but they are not well-interspersed. Most of the woody vegetation is in one patch and likewise with the herbaceous.



In the wetland below, neither woody vegetation nor herbaceous vegetation comprise >70% of the wetland, and they are well interspersed.

Question F44. *The procedure in the diagram below should be used to diagnose the soil texture. However, you need only determine if the soil is Loam (including Sandy Loam, Silty Loam), Coarse (including Loamy Sand, Sand, Cobbles & Gravels), Organic (Peat or Muck), or Fines (Clay).*



Flow Chart for Identifying Soil Texture (from: Washington Dept. of Ecology 2004)

A.3 Plant Species Considered Invasive by the Alberta Native Plant Council or Alberta Weed Act.

Scientific Name	Common Name	Wetland Indicator?
Agropyron cristatum	Crested Wheatgrass	Yes
Agrostis stolonifera	Spreading Bent	Yes
Alopecurus arundinaceus	Creeping Meadow-Foxtail	Yes
Alopecurus pratensis	Field Meadow-Foxtail	Yes
Arctium minus	Lesser Burrdock	NO
Astragalus cicer	Chickpea Milkvetch	Yes
Avena fatua	Wild Oat	NO
Bassia hyssopifolia	Five-Horn Smotherweed	Yes
Bassia scoparia	Burningbush	Yes
Bromus arvensis	Field Brome	NO
Bromus inermis	Smooth Brome	Yes
Bromus tectorum	Cheatgrass	NO
Butomus umbellatus	Flowering-Rush	Yes
Capsella bursa-pastoris	Shepherd's-Purse	Yes
Caragana arborescens	Siberian peashrub	NO
Cardaria chalapensis	Lenspod whitetop	NO
Cardaria pubescens	Globe-Pod Hoarycress	Yes
Cerastium fontanum	Common Mouse-Ear Chickweed	NO
Chenopodium album	Lamb's-Quarters	Yes
Cirsium arvense	Canadian Thistle	Yes
Cirsium vulgare	Bull Thistle	NO
Conium maculatum	Poison-Hemlock	Yes
Crepis tectorum	Narrowleaf Hawksbeard	Yes
Cyperus esculentus	Yellow Nutsedge	Yes
Dactylis glomerata	Orchard Grass	NO
Descurainia sophia	Flixweed; Herb Sophia	Yes
Echinocystis lobata	Wild Cucumber	Yes
Elaeagnus angustifolia	Russian-Olive	NO
Elymus repens	Quackgrass; Creeping Wild Rye	Yes
Erucastrum gallicum	Common Dogmustard	NO
Erysimum cheiranthoides	Worm-Seed Wallflower	Yes
Euphorbia esula	Leafy Spurge	Yes
Festuca rubra	Red Fescue	Yes
Galeopsis tetrahit	Brittle-Stem Hemp-Nettle	Yes
Galium aparine	Sticky-Willy Bedstraw	NO
Glyceria grandis	American Manna Grass	Yes
Gypsophila paniculata	Baby's Breath	NO
Lappula squarrosa	European Stickseed	NO

Scientific Name	Common Name	Wetland Indicator?
Lepidium latifolium	Broad-Leaf Pepperwort	Yes
Lythrum salicaria	Purple Loosestrife	Yes
Medicago lupulina	Black Medick	NO
Medicago sativa	Alfalfa	NO
Melilotus alba	Sweetclover	NO
Melilotus officinalis	Yellow Sweet-Clover	Yes
Myriophyllum spicatum	Eurasian Water-Milfoil	Yes
Nasturtium officinale	Watercress	Yes
Phalaris arundinacea	Reed Canary Grass	Yes
Phleum pratense	Common Timothy	Yes
Plantago major	Great Plantain	Yes
Poa compressa	Flat-Stem Blue Grass	NO
Poa pratensis	Kentucky Blue Grass	Yes
Polygonum persicaria	Spotted Ladysthumb	Yes
Potamogeton crispus	Curly Pondweed	Yes
Ranunculus acris	Tall Buttercup	Yes
Ranunculus repens	Creeping Buttercup	Yes
Rhamnus cathartica	Common Buckthorn	NO
Rhaponticum repens	Russian knapweed	NO
Rumex crispus	Curly Dock	Yes
Rumex longifolius	Door-Yard Dock	Yes
Sisymbrium altissimum	Tall Hedge-Mustard	NO
Sonchus arvensis	Field Sow-Thistle	Yes
Sonchus asper	Spiny-Leaf Sow-Thistle	Yes
Sonchus oleraceus	Common Sow-Thistle	NO
Tamarix aphylla	Athel Tamarisk	Yes
Tamarix chinensis	Five-Stamen Tamarisk	Yes
Tamarix gallica	French Tamarisk	Yes
Tamarix parviflora	Small-Flower Tamarisk	Yes
Tanacetum vulgare	Common Tansy	Yes
Taraxacum officinale	Common Dandelion	Yes
Thlaspi arvense	Field Pennycress	Yes
Tragopogon dubius	Yellow Salsify	NO
Trifolium hybridum	Alsike Clover	Yes
Trifolium pratense	Red Clover	NO
Trifolium repens	White Clover	Yes

A.4 Rare Plant Species Documented in Central Alberta and Tracked by ABMI

Wetland Classes: B= bog, F- fen, M- marsh, S- swamp, W- water

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Forb/Fern	Adiantum aleuticum	Aleutian Maidenhair	Yes	
Forb/Fern	Almutaster pauciflorus	few-flower aster	Yes	M, W
Forb/Fern	Amaranthus californicus	California Amaranth	Yes	
Forb/Fern	Anemone quinquefolia	wood anemone	Yes	S
Forb/Fern	Arabidopsis salsuginea	mouse-ear cress		
Forb/Fern	Arnica longifolia	Spear-Leaf Leopardbane	Yes	
Forb/Fern	Astragalus bodinii	Bodin's Milk-Vetch	Yes	
Forb/Fern	Atriplex powellii	Powell's saltbush	Yes	M
Forb/Fern	Atriplex truncata	saltbush	Yes	M, W
Forb/Fern	Bacopa rotundifolia	water hyssop	Yes	M
Forb/Fern	Bidens frondosa	common beggarticks	Yes	M
Forb/Fern	Botrychium ascendens	Triangle-Lobe Moonwort	Yes	
Forb/Fern	Botrychium crenulatum	scalloped grapefern		
Forb/Fern	Botrychium hesperium	western grape fern		
Forb/Fern	Botrychium lanceolatum	Lance-Leaf Moonwort	Yes	
Forb/Fern	Botrychium matricariifolium	chamomile grape-fern		
Forb/Fern	Botrychium michiganense	Michigan grapefern		
Forb/Fern	Botrychium oneidense	blunt-lobe grape-fern		
Forb/Fern	Botrychium pallidum	pale moonwort		
Forb/Fern	Botrychium pinnatum	northwestern grapefern		
Forb/Fern	Botrychium simplex	Least Moonwort	Yes	
Forb/Fern	Brasenia schreberi	watershield	Yes	F, M, W
Forb/Fern	Campanula aparinoides	Marsh Bellflower	Yes	
Forb/Fern	Cardamine parviflora	Sand Bittercress	Yes	
Forb/Fern	Cerastium brachypodum	Nodding Mouse-Ear Chickweed	Yes	
Forb/Fern	Chrysosplenium iowense	golden saxifrage	Yes	F, M
Forb/Fern	Cirsium scariosum	Meadow Thistle	Yes	
Forb/Fern	Cypripedium acaule	stemless lady's-slipper	Yes	B, S
Forb/Fern	Cystopteris montana	mountain bladder fern		
Forb/Fern	Dermatocarpon moulinsii	stippleback		
Forb/Fern	Diphasiastrum sitchense	ground-fir		
Forb/Fern	Doellingeria umbellata var. pubens	flat-topped white aster		
Forb/Fern	Dryopteris cristata	crested shield fern	Yes	S
Forb/Fern	Dryopteris filix-mas	male fern		
Forb/Fern	Elatine triandra	waterwort	Yes	M
Forb/Fern	Eleocharis elliptica	Elliptic Spike-Rush	Yes	

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Forb/Fern	Ellisia nyctelea	waterpod	Yes	M
Forb/Fern	Elodea bifoliata	two-leaved waterweed	Yes	F, M
Forb/Fern	Elodea canadensis	Canada waterweed	Yes	M, W
Forb/Fern	Epilobium halleanum	Glandular Willowherb	Yes	
Forb/Fern	Epilobium lactiflorum	White-Flower Willowherb	Yes	
Forb/Fern	Epilobium leptocarpum	Slender-Fruit Willowherb	Yes	
Forb/Fern	Epilobium saximontanum	Rocky Mountain Willowherb	Yes	
Forb/Fern	Erigeron flagellaris	Trailing Fleabane	Yes	
Forb/Fern	Eupatorium maculatum	spotted Joe-pye weed		
Forb/Fern	Gentiana fremontii	Moss Gentian	Yes	
Forb/Fern	Gentianopsis detonsa ssp. raupii	northern fringed gentian		
Forb/Fern	Geranium carolinianum	Carolina wild geranium		
Forb/Fern	Gratiola neglecta	clammy hedge-hyssop	Yes	M
Forb/Fern	Gymnocarpium disjunctum	western oak fern		
Forb/Fern	Gymnocarpium jessoense	northern oak fern		
Forb/Fern	Hedyotis longifolia	long-leaved bluets		
Forb/Fern	Heliotropium curassavicum	spatulate-leaved heliotrope	Yes	M
Forb/Fern	Hypericum majus	large Canada St. John's-wort	Yes	M
Forb/Fern	Iris missouriensis	western blue flag	Yes	M
Forb/Fern	Isoetes echinospora	northern quillwort	Yes	M, W
Forb/Fern	Lactuca biennis	tall blue lettuce	Yes	S
Forb/Fern	Lathyrus palustris	Marsh Vetchling	Yes	
Forb/Fern	Liparis loeselii	Yellow Wide-Lip Orchid	Yes	
Forb/Fern	Listera convallarioides	Broad-Lip Twayblade	Yes	
Forb/Fern	Lobelia dortmanna	water lobelia	Yes	M
Forb/Fern	Lobelia spicata	Pale-Spike Lobelia	Yes	
Forb/Fern	Lomatogonium rotatum	marsh felwort	Yes	M
Forb/Fern	Lupinus polyphyllus	Blue-Pod Lupine	Yes	
Forb/Fern	Lysimachia hybrida	lance-leaved yellow loosestrife	Yes	M
Forb/Fern	Malaxis paludosa	Bog Adder's-Mouth Orchid	Yes	
Forb/Fern	Marsilea vestita	hairy pepperwort	Yes	M, W
Forb/Fern	Mimulus floribundus	Purple-Stem Monkey-Flower	Yes	
Forb/Fern	Mimulus glabratus	Round-Leaf Monkey-Flower	Yes	
Forb/Fern	Mimulus guttatus	Seep Monkey-Flower	Yes	
Forb/Fern	Mimulus ringens	Allegheny Monkey-Flower	Yes	
Forb/Fern	Mimulus tilingii	Subalpine Monkey-Flower	Yes	
Forb/Fern	Monotropa hypopithys	pinesap		
Forb/Fern	Montia linearis	Linear-Leaf Candy-Flower	Yes	
Forb/Fern	Montia parvifolia	Little-Leaf Candy-Flower	Yes	
Forb/Fern	Muhlenbergia racemosa	Green Muhly	Yes	

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Forb/Fern	Najas flexilis	slender naiad	Yes	M
Forb/Fern	Nymphaea leibergii	Dwarf Water-Lily	Yes	
Forb/Fern	Nymphaea tetragona	white water-lily	Yes	F, M
Forb/Fern	Oenothera flava	Long-Tube Evening-Primrose	Yes	
Forb/Fern	Osmorhiza longistylis	smooth sweet cicely	Yes	S
Forb/Fern	Osmorhiza purpurea	Purple Sweet-Cicely	Yes	
Forb/Fern	Packera subnuda	Buek's Groundsel	Yes	
Forb/Fern	Pedicularis sudetica	Sudetic Lousewort	Yes	
Forb/Fern	Pellaea glabella	smooth cliff brake		
Forb/Fern	Pellaea glabella ssp. simplex	smooth cliff brake		
Forb/Fern	Phegopteris connectilis	northern beech fern		
Forb/Fern	Pinguicula villosa	small butterwort	Yes	F, B
Forb/Fern	Plantago maritima	sea-side plantain	Yes	F, M
Forb/Fern	Platanthera stricta	Slender Bog Orchid	Yes	
Forb/Fern	Poa stenantha	Narrow-Flower Blue Grass	Yes	
Forb/Fern	Polygala paucifolia	fringed milkwort	Yes	S
Forb/Fern	Polygonum minimum	Zigzag Knotweed	Yes	
Forb/Fern	Potamogeton foliosus	leafy pondweed	Yes	F, M, W
Forb/Fern	Potamogeton nodosus	Long-Leaf Pondweed	Yes	
Forb/Fern	Potamogeton obtusifolius	Blunt-Leaf Pondweed	Yes	
Forb/Fern	Potamogeton robbinsii	Fern Pondweed	Yes	
Forb/Fern	Potamogeton strictifolius	Straight-Leaf Pondweed	Yes	
Forb/Fern	Potentilla multifida	branched cinquefoil		
Forb/Fern	Potentilla plattensis	Platte River Cinquefoil	Yes	
Forb/Fern	Primula egaliksensis	Greenland Primrose	Yes	
Forb/Fern	Ranunculus glaberrimus	Sagebrush Buttercup	Yes	
Forb/Fern	Romanzoffia sitchensis	Sitka Mistmaiden	Yes	
Forb/Fern	Rorippa curvipes	Blunt-Leaf Yellowcress	Yes	
Forb/Fern	Rorippa sinuata	Spreading Yellowcress	Yes	
Forb/Fern	Rorippa tenerrima	Modoc Yellowcress	Yes	
Forb/Fern	Rubus x paracaulis	hybrid dwarf raspberry		
Forb/Fern	Rumex paucifolius	Alpine Sheep Sorrel	Yes	
Forb/Fern	Ruppia cirrhosa	widgeon-grass	Yes	M, W
Forb/Fern	Sagina nivalis	Snow Pearlwort	Yes	
Forb/Fern	Sagittaria latifolia	broad-leaved arrowhead	Yes	M
Forb/Fern	Saxifraga odontoloma	Streambank Saxifrage	Yes	
Forb/Fern	Spergularia salina	salt-marsh sand spurry	Yes	B, F, M
Forb/Fern	Spiranthes lacera	Northern Slender Ladies'-Tresses	Yes	
Forb/Fern	Stellaria crispa	Ruffled Starwort	Yes	
Forb/Fern	Stellaria obtusa	Rocky Mountain Starwort	Yes	

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Forb/Fern	Stellaria umbellata	Umbrella Starwort	Yes	
Forb/Fern	Streptopus roseus	rose mandarin		
Forb/Fern	Suckleya suckleyana	poison suckleya	Yes	F, M, W
Forb/Fern	Suksdorfia ranunculifolia	Buttercup-Leaf Mock Brookfoam	Yes	
Forb/Fern	Utricularia cornuta	horned bladderwort	Yes	M, W
Forb/Fern	Viola pallens	Macloskey's violet		
Forb/Fern	Wolffia columbiana	watermeal	Yes	M, W
Graminoid	Agrostis exarata	Spiked Bent	Yes	
Graminoid	Arctagrostis arundinacea	polar grass		
Graminoid	Blysmus rufus	Red Bulrush	Yes	
Graminoid	Bolboschoenus fluviatilis	river bulrush	Yes	
Graminoid	Bromus latiglumis	Early-Leaf Brome	Yes	
Graminoid	Carex adusta	browned sedge	Yes	
Graminoid	Carex aperta	Columbian Sedge	Yes	
Graminoid	Carex arcta	Northern Cluster Sedge	Yes	
Graminoid	Carex crawei	Crawe's Sedge	Yes	
Graminoid	Carex garberi	Elk Sedge	Yes	
Graminoid	Carex heleonastes	Hudson Bay sedge	Yes	B, F, M, S
Graminoid	Carex hystericina	Porcupine Sedge	Yes	
Graminoid	Carex illota	Small-Head Sedge	Yes	
Graminoid	Carex infirminervia	Weak-Nerved Sedge	Yes	
Graminoid	Carex lachenalii	Arctic Hare-Foot Sedge	Yes	
Graminoid	Carex lacustris	lakeshore sedge	Yes	F, M, S
Graminoid	Carex mertensii	Mertens' Sedge	Yes	
Graminoid	Carex nebrascensis	Nebraska Sedge	Yes	
Graminoid	Carex oligosperma	few-fruited sedge	Yes	B, M, F
Graminoid	Carex pedunculata	Long-Stalk Sedge	Yes	
Graminoid	Carex podocarpa	Short-Stalk Sedge	Yes	
Graminoid	Carex scoparia	Pointed Broom Sedge	Yes	
Graminoid	Carex umbellata	umbellate sedge	Yes	
Graminoid	Carex vesicaria	Lesser Bladder Sedge	Yes	
Graminoid	Carex vulpinoidea	fox sedge	Yes	M
Graminoid	Cyperus squarrosus	Awned Flat Sedge	Yes	
Graminoid	Danthonia spicata	poverty oat grass		
Graminoid	Deschampsia elongata	Slender Hair Grass	Yes	
Graminoid	Eleocharis engelmannii	Engelmann’s spike-rush	Yes	M
Graminoid	Glyceria elata	Tall Manna Grass	Yes	
Graminoid	Juncus brevicaudatus	short-tailed rush	Yes	M
Graminoid	Juncus nevadensis	Sierran Rush	Yes	
Graminoid	Luzula acuminata	Hairy Wood-Rush	Yes	

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Graminoid	Luzula rufescens	reddish wood-rush		
Graminoid	Oryzopsis canadensis	Canadian rice grass		
Graminoid	Oryzopsis micrantha	little-seed rice grass		
Graminoid	Panicum leibergii	Leiberg's millet		
Graminoid	Rhynchospora capillacea	slender beak-rush	Yes	M
Graminoid	Schoenoplectus heterochaetus	slender bulrush	Yes	M
Graminoid	Scirpus pallidus	Pale Bulrush	Yes	
Graminoid	Sisyrinchium septentrionale	Northern Blue-Eyed-Grass	Yes	
Graminoid	Sparganium fluctuans	Floating Burr-Reed	Yes	
Graminoid	Sparganium glomeratum	Clustered Burr-Reed	Yes	
Graminoid	Sparganium hyperboreum	northern bur-reed	Yes	
Graminoid	Spartina pectinata	prairie cord grass	Yes	M
Graminoid	Sphenopholis obtusata	Prairie Wedgescale	Yes	
Graminoid	Trichophorum clintonii	Clinton's bulrush	Yes	M
Lichen	Anaptychia crinalis	fringe lichen		
Lichen	Bacidia bagliettoana	dot lichen		
Lichen	Bacidia pallens	dot lichen		
Lichen	Biatora porphyrospoda	dot lichen		
Lichen	Biatora pullata	dot lichen		
Lichen	Biatora subduplex	disk lichen		
Lichen	Biatora vacciniicola	dot lichen		
Lichen	Biatora vernalis	dot lichen		
Lichen	Bryoria nadvornikiana	old man's beard		
Lichen	Buellia arborea	button lichen		
Lichen	Buellia griseovirens	button lichen		
Lichen	Buellia schaereri	Schaerer's disc lichen		
Lichen	Calicium salicinum	stubble lichen		
Lichen	Calicium trabinellum	yellow collar stubble lichen		
Lichen	Caloplaca ahtii	firedot lichen		
Lichen	Caloplaca flavovirescens	sulphur-firedot lichen		
Lichen	Caloplaca xanthostigmoidea	firedot lichen		
Lichen	Candelariella efflorescens	powdery goldspeck lichen		
Lichen	Candelariella lutella	goldspeck lichen		
Lichen	Catinaria atropurpurea	lichen		
Lichen	Cetrelia olivetorum	sea-storm lichen		
Lichen	Chaenothecopsis debilis	stubble lichen		
Lichen	Cladonia acuminata	cladonia lichen		
Lichen	Cladonia bellidiflora	floral pixie		
Lichen	Cladonia digitata	finger pixie-cup		
Lichen	Cladonia glauca	cladonia lichen		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Lichen	Cladonia gracilis ssp. gracilis	smooth cladonia		
Lichen	Cladonia grayi	Gray's cup lichen		
Lichen	Cladonia macrophylla	cladonia lichen		
Lichen	Cladonia merochlorophaea	cladonia lichen		
Lichen	Cladonia norvegica	cladonia		
Lichen	Cladonia ochrochlora	smooth-footed powderhorn		
Lichen	Cladonia portentosa	reindeer lichen		
Lichen	Cladonia ramulosa	cladonia lichen		
Lichen	Cladonia rei	wand lichen		
Lichen	Cladonia squamosa	dragon cladonia lichen		
Lichen	Cladonia stricta	cladonia lichen		
Lichen	Cladonia stygia	reindeer lichen		
Lichen	Cladonia symphycarpia	split-peg lichen		
Lichen	Cladonia umbricola	shaded cladonia		
Lichen	Cyphelium tigillare	soot lichen		
Lichen	Elixia flexella	lichen		
Lichen	Flavopunctelia soredica	powder-edged speckled greenshield lichen		
Lichen	Heterodermia speciosa	powdered fringed lichen		
Lichen	Hypocenomyce friesii	clam lichen		
Lichen	Hypocenomyce leucococca	clam lichen		
Lichen	Hypocenomyce sorophora	clam lichen		
Lichen	Hypocenomyce xanthococca	clam lichen		
Lichen	Hypogymnia metaphysodes	deflated tube lichen		
Lichen	Hypogymnia rugosa	wrinkled tube lichen		
Lichen	Juncus stygius var. americanus	marsh rush		
Lichen	Lecania dubitans	bean-spored rim-lichen		
Lichen	Lecanora boligera	rim lichen		
Lichen	Lecanora cateilea	rim-lichen		
Lichen	Lecanora expallens	rim-lichen		
Lichen	Lecanora farinaria	rim-lichen		
Lichen	Lecanora hybocarpa	bumpy rim-lichen		
Lichen	Lecanora hypopta	rim-lichen		
Lichen	Lecanora hypoptoides	rim-lichen		
Lichen	Lecanora laxa	rim-lichen		
Lichen	Lecanora persimilis	rim lichen		
Lichen	Lecanora subintricata	rim-lichen		
Lichen	Lecidea albohyalina	tile lichen		
Lichen	Lecidea carnulenta	disk lichen		
Lichen	Lecidea laboriosa	disk lichen		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Lichen	Lecidea leprarioides	disk lichen		
Lichen	Lecidea nylanderi	disk lichen		
Lichen	Lecidella elaeochroma	disk lichen		
Lichen	Lepraria incana	dust lichen		
Lichen	Lepraria lobificans	fluffy dust lichen		
Lichen	Leptorhaphis atomaria	lichen		
Lichen	Leptorhaphis epidermidis	lichen		
Lichen	Lichenomphalia umbellifera	lichen		
Lichen	Melanelia panniformis	shingled camouflage lichen		
Lichen	Melanelixia fuliginosa	camouflage lichen		
Lichen	Melanohalea infumata	smoked camouflage lichen		
Lichen	Melanohalea multispora	many-spored camoflage lichen		
Lichen	Melanohalea olivacea	spotted camouflage lichen		
Lichen	Melanohalea subelegantula	camouflage lichen		
Lichen	Melanohalea trabeculata	camouflage lichen		
Lichen	Micarea myriocarpa	dot lichen		
Lichen	Micarea prasina	green dot lichen		
Lichen	Micarea sylvicola	dot lichen		
Lichen	Mycobilimbia carneoalbida	dot lichen		
Lichen	Mycobilimbia epixanthoides	dot lichen		
Lichen	Mycobilimbia hypnorum	dot lichen		
Lichen	Mycoblastus affinis	kindred blood lichen		
Lichen	Mycoblastus sanguinarius	bloody-heart lichen		
Lichen	Mycocalicium calicioides	lichen		
Lichen	Mycocalicium subtile	lichen		
Lichen	Mycoglaena myricae	lichen		
Lichen	Myxobilimbia sabuletorum	dot lichen		
Lichen	Nephroma bellum	naked kidney lichen		
Lichen	Ochrolechia gowardii	lichen		
Lichen	Omphalina hudsoniana	mushroom lichen		
Lichen	Pannaria conoplea	shingle lichen		
Lichen	Peltigera collina	tree pelt lichen		
Lichen	Peltigera horizontalis	flat fruited pelt lichen		
Lichen	Peltigera polydactyla	alternating dog-lichen		
Lichen	Phaeocalicium compressulum	lichen		
Lichen	Phaeocalicium flabelliforme	lichen		
Lichen	Phaeophyscia adiastola	shadow lichen		
Lichen	Phaeophyscia cernohorskyi	shadow lichen		
Lichen	Phaeophyscia endococcina	shadow lichen		
Lichen	Phaeophyscia hirsuta	shadow lichen		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Lichen	Phaeophyscia nigricans	shadow lichen		
Lichen	Phlyctis argena	whitewash lichen		
Lichen	Physcia dimidiata	rosette lichen		
Lichen	Physcia tenella	fringed rosette lichen		
Lichen	Physconia enteroxantha	frost lichen		
Lichen	Physconia isidiigera	frost lichen		
Lichen	Placynthiella dasaea	tar-spot lichen		
Lichen	Placynthiella icmalea	ink lichen		
Lichen	Ramalina calicaris	ramalina lichen		
Lichen	Ramalina farinacea	dotted ramalina		
Lichen	Ramalina intermedia	rock ramalina		
Lichen	Ramalina obtusata	hooded ramalina		
Lichen	Ramalina roesleri	frayed ramalina		
Lichen	Rinodina archaea	brown pepper-spore lichen		
Lichen	Rinodina degeliana	pepper-spore lichen		
Lichen	Rinodina disjuncta	pepper-spore lichen		
Lichen	Rinodina metaboliza	pepper-spore lichen		
Lichen	Rinodina orculata	pepper-spore lichen		
Lichen	Rinodina stictica	pepper-spore lichen		
Lichen	Scoliciosporum chlorococcum	city dot lichen		
Lichen	Scoliciosporum umbrinum	umber dot lichen		
Lichen	Seligeria calcarea	chalk brittle moss		
Lichen	Solorina spongiosa	fringed chocolate chip lichen		
Lichen	Sphinctrina turbinata	lichen		
Lichen	Stenocybe major	lichen		
Lichen	Stenocybe pullatula	alder stickpin lichen		
Lichen	Stereocaulon condensatum	foam lichen		
Lichen	Trapeliopsis flexuosa	mottled-disk lichen		
Lichen	Tuckermannopsis orbata	variable wrinkle lichen		
Lichen	Umbilicaria muehlenbergii	plated rock tripe lichen		
Lichen	Usnea fulvoreagens	beard lichen		
Lichen	Usnea scabiosa	beard lichen		
Lichen	Xanthomendoza fulva	bare-bottomed sunburst lichen		
Lichen	Xanthomendoza hasseana	polar sunburst lichen		
Lichen	Xanthoparmelia conspersa	rock-shield lichen		
Lichen	Xylographa parallela	black woodscript lichen		
Lichen	Xylographa vitiligo	white-spotted woodscript lichen		
Lichen	Xyloschistes platytropa	lichen		
Moss/Liverwort	Aloina brevirostris	short-beaked rigid screw moss		
Moss/Liverwort	Aloina rigida	aloe-like rigid screw moss		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Moss/Liverwort	Amblyodon dealbatus	moss		
Moss/Liverwort	Anastrophyllum helleranum	liverwort		
Moss/Liverwort	Anomodon minor	moss	Yes	F
Moss/Liverwort	Aongstroemia longipes	spring moss		
Moss/Liverwort	Atrichum undulatum	undulated crane's bill moss		
Moss/Liverwort	Barbilophozia attenuata	liverwort		
Moss/Liverwort	Barbilophozia kunzeana	liverwort		
Moss/Liverwort	Blasia pusilla	liverwort		
Moss/Liverwort	Blindia acuta	sharp-pointed weissia		
Moss/Liverwort	Brachythecium acuminatum	moss		
Moss/Liverwort	Brachythecium acutum	moss		
Moss/Liverwort	Brachythecium frigidum	moss		
Moss/Liverwort	Brachythecium hylotapetum	moss		
Moss/Liverwort	Brachythecium reflexum	moss		
Moss/Liverwort	Brachythecium rutabulum	moss		
Moss/Liverwort	Bryobrittonia longipes	moss		
Moss/Liverwort	Bryum algovicum	moss		
Moss/Liverwort	Bryum cyclophyllum	round-leaved bryum		
Moss/Liverwort	Bryum flaccidum	moss		
Moss/Liverwort	Bryum pallens	moss		
Moss/Liverwort	Bryum uliginosum	moss		
Moss/Liverwort	Buxbaumia aphylla	bug on a stick moss		
Moss/Liverwort	Callicladium haldanianum	moss		
Moss/Liverwort	Calypogeia integristipula	liverwort		
Moss/Liverwort	Calypogeia muelleriana	liverwort		
Moss/Liverwort	Calypogeia suecica	liverwort		
Moss/Liverwort	Campylium radicale	campylium moss		
Moss/Liverwort	Cephalozia bicuspidata	liverwort		
Moss/Liverwort	Cephalozia loitlesbergeri	liverwort		
Moss/Liverwort	Cephaloziella hampeana	liverwort		
Moss/Liverwort	Chiloscyphus polyanthos	liverwort		
Moss/Liverwort	Conardia compacta	moss		
Moss/Liverwort	Conocephalum salebrosum	liverwort		
Moss/Liverwort	Desmatodon cernuus	narrow-leafed chain-teeth moss		
Moss/Liverwort	Desmatodon heimii	long-stalked beardless moss		
Moss/Liverwort	Dicranella cerviculata	red-necked fork moss		
Moss/Liverwort	Dicranella heteromalla	silky fork moss		
Moss/Liverwort	Dicranum ontariense	cushion moss		
Moss/Liverwort	Dicranum spadiceum	cushion moss		
Moss/Liverwort	Dicranum tauricum	broken-leaf moss		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Moss/Liverwort	Didymodon fallax	fallacious screw moss		
Moss/Liverwort	Didymodon rigidulus	rigid screw moss		
Moss/Liverwort	Drepanocladus capillifolius	brown moss		
Moss/Liverwort	Drepanocladus crassicostatus	brown moss		
Moss/Liverwort	Drepanocladus sendtneri	brown moss	Yes	F
Moss/Liverwort	Entodon concinnus	moss		
Moss/Liverwort	Entodon schleicheri	Schleicher's silk moss		
Moss/Liverwort	Fontinalis antipyretica	aquatic moss		
Moss/Liverwort	Funaria americana	cord moss		
Moss/Liverwort	Gymnocolea inflata	liverwort		
Moss/Liverwort	Hygroamblystegium noterophilum	moss		
Moss/Liverwort	Hygroamblystegium tenax	moss		
Moss/Liverwort	Hypnum callichroum	moss		
Moss/Liverwort	Hypnum pallescens	moss	Yes	B, F, S
Moss/Liverwort	Leptodictyum humile	moss		
Moss/Liverwort	Leskea polycarpa	moss		
Moss/Liverwort	Leskeella nervosa	moss		
Moss/Liverwort	Limprichtia cossonii	moss		
Moss/Liverwort	Lophozia ascendens	liverwort		
Moss/Liverwort	Lophozia badensis	liverwort		
Moss/Liverwort	Lophozia collaris	liverwort		
Moss/Liverwort	Lophozia excisa	liverwort		
Moss/Liverwort	Lophozia grandiretis	liverwort	Yes	B
Moss/Liverwort	Lophozia guttulata	liverwort	Yes	B, F
Moss/Liverwort	Lophozia heterocolpos	liverwort		
Moss/Liverwort	Lophozia incisa	liverwort		
Moss/Liverwort	Lophozia laxa	liverwort		
Moss/Liverwort	Lophozia longidens	liverwort		
Moss/Liverwort	Lophozia obtusa	liverwort		
Moss/Liverwort	Lophozia rutheana	liverwort	Yes	B, F
Moss/Liverwort	Lophozia wenzelii	liverwort		
Moss/Liverwort	Mannia pilosa	liverwort		
Moss/Liverwort	Meesia longiseta	moss		
Moss/Liverwort	Mnium ambiguum	moss		
Moss/Liverwort	Moerckia hibernica	liverwort	Yes	B, F
Moss/Liverwort	Myurella tenerrima	moss		
Moss/Liverwort	Neckera pennata	moss		
Moss/Liverwort	Pellia endiviifolia	liverwort	Yes	S
Moss/Liverwort	Phascum cuspidatum	cuspidate earth moss		
Moss/Liverwort	Physcomitrium hookeri	bladder-cap moss		

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Moss/Liverwort	Physcomitrium immersum	moss		
Moss/Liverwort	Physcomitrium pyriforme	urn moss		
Moss/Liverwort	Plagiobryum demissum	Plagiobryum moss		
Moss/Liverwort	Plagiochila porelloides	liverwort	Yes	F
Moss/Liverwort	Plagiomnium ciliare	moss		
Moss/Liverwort	Plagiomnium rostratum	moss		
Moss/Liverwort	Pohlia atropurpurea	moss		
Moss/Liverwort	Pohlia bulbifera	moss		
Moss/Liverwort	Pohlia filum	moss		
Moss/Liverwort	Polytrichum longisetum	slender hairy-cap moss		
Moss/Liverwort	Porella platyphylla	liverwort	Yes	S, B
Moss/Liverwort	Pseudobryum cinclidioides	moss	Yes	B, F, S
Moss/Liverwort	Pseudoleskeella sibirica	moss		
Moss/Liverwort	Racomitrium microcarpon	moss		
Moss/Liverwort	Radula complanata	liverwort	Yes	F, M, S
Moss/Liverwort	Rhizomnium andrewsianum	moss		
Moss/Liverwort	Rhizomnium magnifolium	moss		
Moss/Liverwort	Rhodobryum ontariense	moss		
Moss/Liverwort	Riccardia latifrons	liverwort		
Moss/Liverwort	Riccardia multifida	liverwort	Yes	S
Moss/Liverwort	Riccardia palmata	liverwort		
Moss/Liverwort	Riccia beyrichiana	liverwort		
Moss/Liverwort	Riccia cavernosa	liverwort		
Moss/Liverwort	Riccia fluitans	crystalwort	Yes	M, W
Moss/Liverwort	Ricciocarpos natans	purple-fringed heartwort	Yes	F, M, W
Moss/Liverwort	Scapania apiculata	liverwort		
Moss/Liverwort	Scapania curta	liverwort		
Moss/Liverwort	Scapania cuspiduligera	liverwort		
Moss/Liverwort	Scapania glaucocephala	liverwort		
Moss/Liverwort	Scapania paludicola	liverwort		
Moss/Liverwort	Scapania paludosa	liverwort	Yes	B
Moss/Liverwort	Schistidium agassizii	elf bloom moss		
Moss/Liverwort	Sphagnum balticum	balticum peat moss	Yes	B, F
Moss/Liverwort	Sphagnum compactum	neat bog moss		
Moss/Liverwort	Sphagnum contortum	twisted bog moss	Yes	B, F
Moss/Liverwort	Sphagnum fallax	peat moss	Yes	B, F
Moss/Liverwort	Sphagnum fimbriatum	shore-growing peat moss	Yes	B, F
Moss/Liverwort	Sphagnum lindbergii	Lindberg's bog moss	Yes	B, F
Moss/Liverwort	Sphagnum platyphyllum	moss		
Moss/Liverwort	Splachnum ampullaceum	flagon-fruited splachnum	Yes	B

Form	Scientific Name	Common Name	Wetland Indicator	Wetland Classes
Moss/Liverwort	Splachnum luteum	yellow collar moss		
Moss/Liverwort	Splachnum rubrum	red collar moss	Yes	B
Moss/Liverwort	Splachnum sphaericum	globe-fruited splachnum	Yes	B
Moss/Liverwort	Splachnum vasculosum	large-fruited splachnum	Yes	B
Moss/Liverwort	Tayloria serrata	slender splachnum moss		
Moss/Liverwort	Thuidium philibertii	moss		
Moss/Liverwort	Trichodon cylindricus	narrow-fruited fork moss		
Moss/Liverwort	Tritomaria exsecta	liverwort		
Moss/Liverwort	Tritomaria scitula	liverwort		
Moss/Liverwort	Warnstorfia pseudostraminea	brown moss		
Moss/Liverwort	Warnstorfia tundrae	brown moss		
Moss/Liverwort	Weissia controversa	green-cushioned weissia moss		
Moss/Liverwort	Zygodon viridissimus	Zygodon moss		
Shrub	Salix commutata	Undergreen Willow	Yes	
Shrub	Salix sitchensis	Sitka Willow	Yes	
Tree	Fraxinus pennsylvanica	Green Ash	Yes	

A.5 Plant Species Tentatively Identified as Indicative of Wetlands in Alberta or Adjoining Parts of the United States

In last column, "IF DOM" means indicative of wetland conditions only if a dominant part of the vegetation in an area.

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Tree	Abies balsamea			Balsam Fir		US	IF DOM
Tree	Acer glabrum			Rocky Mountain Maple		US	IF DOM
Tree	Acer negundo			Ash-leaf Maple		US	IF DOM
Tree	Betula neoalaskana			Alaska birch	S	AEP	IF DOM
Tree	Betula papyrifera			white birch	S	AEP	IF DOM
Tree	Fraxinus pennsylvanica			Green Ash		US	IF DOM
Tree	Larix laricina			tamarack	F, S	AEP	
Tree	Picea engelmannii			Engelmann's Spruce		US	IF DOM
Tree	Picea mariana			black spruce	B, F, S	AEP	
Tree	Picea pungens			Blue Spruce		US	IF DOM
Tree	Pinus contorta			Lodgepole pine		US	IF DOM
Tree	Populus angustifolia			narrow-leaf cottonwood	S	AEP	
Tree	Populus balsamifera			balsam poplar	S	AEP	
Tree	Populus deltoides			plains cottonwood	S	AEP	IF DOM
Tree	Populus tremuloides			Quaking Aspen		US	IF DOM
Shrub	Alnus incana	ssp.	tenuifolia	river alder	S	AEP	
Shrub	Alnus viridis			green alder	S	AEP	IF DOM
Shrub	Andromeda polifolia			bog rosemary	B, F, S	AEP	
Shrub	Arctostaphylos rubra			Red Fruit Bearberry		US	IF DOM
Shrub	Betula glandulosa			bog birch	F	AEP	
Shrub	Betula occidentalis			water birch	F, S	AEP	
Shrub	Betula pumila			dwarf birch	B, F, S	AEP	
Shrub	Chamaedaphne calyculata			leatherleaf	B, F	AEP	
Shrub	Cornus sericea			red-osier dogwood	S	AEP	
Shrub	Crataegus douglasii			Black Hawthorn		US	IF DOM
Shrub	Elaeagnus commutata			silverberry	S	AEP	NO
Shrub	Empetrum nigrum			crowberry	B, F	AEP	IF DOM
Shrub	Gaultheria hispidula			creeping snowberry	B, F, S	AEP	
Shrub	Kalmia microphylla			mountain laurel	B, F	AEP	IF DOM
Shrub	Kalmia polifolia			northern laurel	B, F, S	AEP	
Shrub	Ledum groenlandicum			Rusty Labrador-Tea		US	YES
Shrub	Ledum palustre			Marsh Labrador Tea		US	YES
Shrub	Linnaea borealis			twinflower	B, F, S	AEP	NO

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Shrub	Lonicera caerulea			fly honeysuckle	B, F, S	AEP	IF DOM
Shrub	Lonicera dioica			twining honeysuckle	S	AEP	
Shrub	Lonicera involucrata			bracted honeysuckle	F, S	AEP	IF DOM
Shrub	Myrica gale			sweet gale	F, S	AEP	
Shrub	Oplopanax horridus			Devil's club		US	IF DOM
Shrub	Prunus virginiana			choke cherry	S	AEP	NO
Shrub	Rhamnus alnifolia			alder-leaved buckthorn	F, S	AEP	
Shrub	Rhododendron albiflorum			Cascade Azalea		US	YES
Shrub	Rhododendron groenlandicum			common Labrador tea	B, F, S	AEP	IF DOM
Shrub	Rhododendron tomentosum			northern Labrador tea	B	AEP	
Shrub	Ribes americanum			wild black currant	S	AEP	
Shrub	Ribes glandulosum			skunk currant	S	AEP	
Shrub	Ribes hirtellum			Hairy-Stem Gooseberry		US	IF DOM
Shrub	Ribes hudsonianum			northern black currant	F, S	AEP	
Shrub	Ribes inerme			White-Stem Gooseberry		US	YES
Shrub	Ribes lacustre			bristly black currant	F, S	AEP	
Shrub	Ribes triste			wild red currant	F, S	AEP	
Shrub	Rubus idaeus			wild red raspberry	B, F, S	AEP	NO
Shrub	Salix amygdaloides			Peach-Leaf Willow		US	YES
Shrub	Salix arbusculoides			shrubby willow	F, S	AEP	
Shrub	Salix athabascensis			Athabasca Willow		US	YES
Shrub	Salix barclayi			Barclay's Willow		US	YES
Shrub	Salix bebbiana			beaked willow	F, S	AEP	
Shrub	Salix boothii					US	YES
Shrub	Salix brachycarpa					US	YES
Shrub	Salix candida			hoary willow	F, S	AEP	
Shrub	Salix commutata			Undergreen Willow		US	YES
Shrub	Salix discolour			pussy willow	F, S	AEP	
Shrub	Salix drummondiana			Drummond's Willow		US	YES
Shrub	Salix exigua			sandbar willow	F, S	AEP	
Shrub	Salix famelica					US	YES
Shrub	Salix farriae			Farr's Willow		US	YES
Shrub	Salix glauca			smooth willow	F, S	AEP	
Shrub	Salix interior					US	YES
Shrub	Salix lasiandra					US	YES
Shrub	Salix lucida			shiny willow	F, S	AEP	
Shrub	Salix lutea			Yellow Willow		US	YES

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Shrub	Salix maccalliana			velvet-fruited willow	F, S	AEP	
Shrub	Salix melanopsis			Dusky Willow		US	YES
Shrub	Salix myrtillifolia			Blueberry Willow		US	YES
Shrub	Salix pedicellaris			bog willow	F, S	AEP	
Shrub	Salix petiolaris			basket willow	F	AEP	
Shrub	Salix planifolia			flat-leaved willow	F, S	AEP	
Shrub	Salix prolixa			Mackenzie's Willow		US	YES
Shrub	Salix pseudomonticola			False Mountain Willow		US	YES
Shrub	Salix pseudomyrsinites			Firmleaf Willow		US	YES
Shrub	Salix pyrifolia			balsam willow	F, S	AEP	
Shrub	Salix scouleriana			Scouler willow	F, S	AEP	IF DOM
Shrub	Salix serissima			autumn willow	F	AEP	
Shrub	Salix sitchensis			Sitka Willow		US	YES
Shrub	Sambucus racemosa			red elderberry	S	AEP	NO
Shrub	Sarcobatus vermiculatus			greasewood	M	AEP	IF DOM
Shrub	Sorbus sitchensis			Sitka Mountain-Ash		US	IF DOM
Shrub	Spiraea alba			narrow-leaved meadowsweet	F, S	AEP	
Shrub	Tamarix aphylla			Athel Tamarisk		US	YES
Shrub	Tamarix chinensis			Five-Stamen Tamarisk		US	YES
Shrub	Tamarix gallica			French Tamarisk		US	YES
Shrub	Tamarix parviflora			Small-Flower Tamarisk		US	YES
Shrub	Vaccinium caespitosum			Dwarf Blueberry		US	IF DOM
Shrub	Vaccinium myrtilloides			Velvet-Leaf Blueberry		US	YES
Shrub	Vaccinium oxycoccos			small bog cranberry	B, F, S	AEP	
Shrub	Vaccinium uliginosum			Alpine Blueberry		US	IF DOM
Shrub	Vaccinium vitis-idaea			bog cranberry	B, F, M, S	AEP	IF DOM
Shrub	Viburnum edule			low-bush cranberry	S	AEP	
Shrub	Viburnum opulus	var.	americanum	high bush-cranberry	F, S	AEP	IF DOM
Moss/Liverwort	Amblystegium serpens			moss	F, S	AEP	
Moss/Liverwort	Aneura pinguis			liverwort	F, S	AEP	
Moss/Liverwort	Anomodon minor			moss	F	AEP	
Moss/Liverwort	Aulacomnium palustre			tufted moss	B, F, S	AEP	
Moss/Liverwort	Blepharostoma trichophyllum			liverwort	F, S	AEP	
Moss/Liverwort	Brachythecium campestre			moss	B, F	AEP	
Moss/Liverwort	Brachythecium mildeanum			moss	F	AEP	

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Moss/Liverwort	Brachythecium turgidum			moss	B, F, S	AEP	
Moss/Liverwort	Bryum pseudotriquetrum			moss	B, F, S	AEP	
Moss/Liverwort	Calliergon cordifolium			moss	F	AEP	
Moss/Liverwort	Calliergon giganteum			giant calliergon moss	F	AEP	
Moss/Liverwort	Calliergon richardsonii			brown moss	F, S	AEP	
Moss/Liverwort	Calliergon stramineum			brown moss	F, S	AEP	
Moss/Liverwort	Calliergon trifarium			moss	F	AEP	
Moss/Liverwort	Calliergonella cuspidata			moss	F	AEP	
Moss/Liverwort	Calypogeia sphagnicola			liverwort	F, S	AEP	
Moss/Liverwort	Campylium chrysophyllum			moss	F, S	AEP	
Moss/Liverwort	Campylium polygamum			moss	F	AEP	
Moss/Liverwort	Campylium stellatum			yellow starry fen moss	F	AEP	
Moss/Liverwort	Cephalozia connivens			liverwort	B, F, S	AEP	
Moss/Liverwort	Cephalozia lunulifolia			liverwort	F	AEP	
Moss/Liverwort	Cephalozia pleniceps			liverwort	F	AEP	
Moss/Liverwort	Ceratodon purpureus			purple horn-toothed moss	F, S	AEP	
Moss/Liverwort	Cinclidium stygium			moss	B, F, S	AEP	
Moss/Liverwort	Climacium dendroides			moss	F, S	AEP	
Moss/Liverwort	Dicranum fragilifolium			cushion moss	B, F	AEP	
Moss/Liverwort	Distichium capillaceum			moss	S	AEP	
Moss/Liverwort	Distichium inclinatum			inclined-fruited didymodon	F, S	AEP	
Moss/Liverwort	Drepanocladus aduncus			aduncus brown moss	F, M, S	AEP	
Moss/Liverwort	Drepanocladus sendtneri			brown moss	F	AEP	
Moss/Liverwort	Eurhynchium pulchellum			moss	B	AEP	
Moss/Liverwort	Geocalyx graveolens			liverwort	F, S	AEP	
Moss/Liverwort	Hamatocaulis lapponicus			hamatocaulis moss	F	AEP	
Moss/Liverwort	Hamatocaulis vernicosus			hamatocaulis brown moss	F	AEP	
Moss/Liverwort	Helodium blandowii			Blandow's feathermoss	B, F, S	AEP	
Moss/Liverwort	Hylocomium splendens			stair-step moss	B, F, S	AEP	
Moss/Liverwort	Hypnum lindbergii			moss	B, F	AEP	
Moss/Liverwort	Hypnum pallescens			moss	B, F, S	AEP	
Moss/Liverwort	Hypnum pratense			moss	F, S	AEP	
Moss/Liverwort	Isopterygium pulchellum			moss	B, S	AEP	
Moss/Liverwort	Jamesoniella autumnalis			liverwort	B, F, S	AEP	
Moss/Liverwort	Lepidozia reptans			liverwort	B, F, S	AEP	
Moss/Liverwort	Leptobryum pyriforme			moss	B, F, S	AEP	
Moss/Liverwort	Leptodictyum riparium			streamside leptodictyum	F, S	AEP	

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				moss			
Moss/Liverwort	Limprichtia revolvens			limprichtia brown moss	F	AEP	
Moss/Liverwort	Lophocolea heterophylla			liverwort	F, S	AEP	
Moss/Liverwort	Lophocolea minor			liverwort	F	AEP	
Moss/Liverwort	Lophozia grandiretis			liverwort	B	AEP	
Moss/Liverwort	Lophozia guttulata			liverwort	B, F	AEP	
Moss/Liverwort	Lophozia rutheana			liverwort	B, F	AEP	
Moss/Liverwort	Lophozia ventricosa			liverwort	B, F	AEP	
Moss/Liverwort	Marchantia polymorpha			green tongue liverwort	B, F, M, S	AEP	
Moss/Liverwort	Meesia triquetra			three-angled thread-moss	F, S	AEP	
Moss/Liverwort	Meesia uliginosa			moss	F, S	AEP	
Moss/Liverwort	Moerckia hibernica			liverwort	B, F	AEP	
Moss/Liverwort	Mylia anomala			liverwort	B, F, S	AEP	
Moss/Liverwort	Myurella julacea			moss	F, S	AEP	
Moss/Liverwort	Oncophorus wahlenbergii			mountain curved-back moss	F, S	AEP	
Moss/Liverwort	Orthotrichum speciosum			moss	F, S	AEP	
Moss/Liverwort	Paludella squarrosa			moss	F	AEP	
Moss/Liverwort	Pellia endiviifolia			liverwort	S	AEP	
Moss/Liverwort	Plagiochila asplenioides			liverwort	B, F, S	AEP	
Moss/Liverwort	Plagiochila porelloides			liverwort	F	AEP	
Moss/Liverwort	Plagiomnium cuspidatum			moss	F, S	AEP	
Moss/Liverwort	Plagiomnium ellipticum			moss	B, F, S	AEP	
Moss/Liverwort	Plagiomnium medium			moss	B, F, S	AEP	
Moss/Liverwort	Pleurozium schreberi			Schreber's moss	B, F, S	AEP	
Moss/Liverwort	Pohlia nutans			copper wire moss	B, F, S	AEP	
Moss/Liverwort	Polytrichum commune			common hair-cap	B, F, S	AEP	
Moss/Liverwort	Polytrichum strictum			slender haircap-moss	B, F, S	AEP	
Moss/Liverwort	Porella platyphylla			liverwort	S, B	AEP	
Moss/Liverwort	Pseudobryum cinclidioides			moss	B, F, S	AEP	
Moss/Liverwort	Ptilidium ciliare			liverwort	B, F, S	AEP	
Moss/Liverwort	Ptilidium pulcherrimum			liverwort	B, F, S	AEP	
Moss/Liverwort	Ptilium crista-castrensis			knight's plume moss	B, F, S	AEP	
Moss/Liverwort	Pylaisiella polyantha			moss	F, S	AEP	
Moss/Liverwort	Radula complanata			liverwort	F, M, S	AEP	
Moss/Liverwort	Rhizomnium gracile			fringed bog moss	F, S	AEP	
Moss/Liverwort	Rhizomnium pseudopunctatum			moss	B, F, S	AEP	
Moss/Liverwort	Rhytidiadelphus			red-stemmed	F, S	AEP	

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	triquetrus			pipecleaner moss			
Moss/Liverwort	Riccardia multifida			liverwort	S	AEP	
Moss/Liverwort	Riccia fluitans			crystalwort	M, W	AEP	
Moss/Liverwort	Ricciocarpos natans			purple-fringed heartwort	F, M, W	AEP	
Moss/Liverwort	Sanionia uncinata	var.	uncinata	hook moss	F	AEP	
Moss/Liverwort	Scapania paludosa			liverwort	B	AEP	
Moss/Liverwort	Scorpidium scorpioides			scorpidium moss	F	AEP	
Moss/Liverwort	Scorpidium turgescens			moss	F	AEP	
Moss/Liverwort	Sphagnum angustifolium			poor-fen sphagnum; peat moss	B, F, S	AEP	
Moss/Liverwort	Sphagnum balticum			balticum peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum capillifolium			acute-leaved peat moss	B, F, S	AEP	
Moss/Liverwort	Sphagnum centrale			peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum contortum			twisted bog moss	B, F	AEP	
Moss/Liverwort	Sphagnum fallax			peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum fimbriatum			shore-growing peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum fuscum			rusty peat moss	B, F, S	AEP	
Moss/Liverwort	Sphagnum girgensohnii			Girgensohn's moss	B, F, S	AEP	
Moss/Liverwort	Sphagnum jensenii			pendant branch peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum lindbergii			Lindberg's bog moss	B, F	AEP	
Moss/Liverwort	Sphagnum magellanicum			midway peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum majus			peat moss	F	AEP	
Moss/Liverwort	Sphagnum obtusum			blunt-leaved peat moss	B, F	AEP	
Moss/Liverwort	Sphagnum riparium			shore-growing peat moss	F	AEP	
Moss/Liverwort	Sphagnum russowii			wide-tongued peat moss	F	AEP	
Moss/Liverwort	Sphagnum squarrosum			squarrose peat moss	F, S	AEP	
Moss/Liverwort	Sphagnum subsecundum			twisted bog moss	B, F	AEP	
Moss/Liverwort	Sphagnum teres			thin-leaved peat moss	F	AEP	
Moss/Liverwort	Sphagnum warnstorfii			Warnstorf's sphagnum	F, S	AEP	
Moss/Liverwort	Splachnum ampullaceum			flagon-fruited splachnum	B	AEP	
Moss/Liverwort	Splachnum rubrum			red collar moss	B	AEP	
Moss/Liverwort	Splachnum sphaericum			globe-fruited splachnum	B	AEP	
Moss/Liverwort	Splachnum vasculosum			large-fruited splachnum	B	AEP	
Moss/Liverwort	Tetraphis pellucida			moss	B, F, S	AEP	
Moss/Liverwort	Tetraplodon angustatus			narrow-leaved splachnum	B, F, S	AEP	
Moss/Liverwort	Thuidium recognitum			moss	B, F, S	AEP	
Moss/Liverwort	Tomentypnum falcifolium			golden moss	B, F	AEP	

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Moss/Liverwort	Tomentypnum nitens			golden moss	F	AEP	
Moss/Liverwort	Warnstorfia exannulata			Brown moss	B, F, S	AEP	
Moss/Liverwort	Warnstorfia fluitans			warnstorfia peat moss	B, F, S	AEP	
Moss/Liverwort	Warnstorfiia tundrae			moss	F	AEP	
Graminoid	Achnatherum nelsonii			Nelson's Rice Grass		US	IF DOM
Graminoid	Acorus americanus			sweet flag	M	AEP	
Graminoid	Agropyron cristatum			Crested Wheatgrass		US	IF DOM
Graminoid	Agropyron fragile			Siberian Wheatgrass		US	IF DOM
Graminoid	Agrostis exarata			Spiked Bent		US	YES
Graminoid	Agrostis scabra			rough hair grass	F, M, S	AEP	IF DOM
Graminoid	Agrostis stolonifera			redtop	M, S	AEP	
Graminoid	Alopecurus aequalis			short-awned foxtail	M	AEP	
Graminoid	Alopecurus arundinaceus			Creeping Meadow-Foxtail		US	YES
Graminoid	Alopecurus carolinianus			Tufted Meadow-Foxtail		US	YES
Graminoid	Alopecurus geniculatus			Marsh Meadow-Foxtail		US	YES
Graminoid	Alopecurus pratensis			meadow foxtail	M, S	AEP	
Graminoid	Amphiscirpus nevadensis			Nevada bulrush	M	AEP	
Graminoid	Anthoxanthum hirtum					US	YES
Graminoid	Beckmannia syzigachne			sloughgrass	M	AEP	
Graminoid	Bolboschoenus maritimus	ssp.	paludosus	prairie bulrush	M	AEP	
Graminoid	Bromus ciliatus			fringed brome	F, M, S	AEP	IF DOM
Graminoid	Bromus inermis			smooth brome	M	AEP	NO
Graminoid	Bromus latiglumis			Early-Leaf Brome		US	YES
Graminoid	Butomus umbellatus			Flowering-Rush		US	YES
Graminoid	Calamagrostis canadensis			bluejoint	F, M, S	AEP	
Graminoid	Calamagrostis stricta	ssp.	inexpansa	northern reed grass	F, M, S	AEP	
Graminoid	Carex albonigra			Black-and-White-Scale Sedge		US	IF DOM
Graminoid	Carex aperta			Columbian Sedge		US	YES
Graminoid	Carex aquatilis			water sedge	F, M, S	AEP	
Graminoid	Carex arcta			Northern Cluster Sedge		US	YES
Graminoid	Carex atherodes			awned sedge	F, M	AEP	
Graminoid	Carex athrostachya			Slender-Beak Sedge		US	YES
Graminoid	Carex atratiformis					US	YES
Graminoid	Carex atrosquama					US	IF DOM
Graminoid	Carex aurea			golden sedge	B, F, M, S	AEP	
Graminoid	Carex bebbii			Bebb's sedge	F, M, S	AEP	
Graminoid	Carex brevior			slender-beaked sedge	B, F, M	AEP	IF DOM
Graminoid	Carex brunnescens			brownish sedge	B, F, M, S	AEP	IF DOM

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Graminoid	Carex buxbaumii			brown sedge	F, M	AEP	
Graminoid	Carex canescens			hoary sedge	B, F, M, S	AEP	
Graminoid	Carex capillaris			hairlike sedge	B, F, M, S	AEP	
Graminoid	Carex capitata			Capitate Sedge		US	YES
Graminoid	Carex chordorrhiza			prostrate sedge	B, F, M, S	AEP	
Graminoid	Carex concinna					US	IF DOM
Graminoid	Carex crawei			Crawe's Sedge		US	YES
Graminoid	Carex crawfordii			Crawford's sedge	M	AEP	
Graminoid	Carex deweyana			two-stamened sedge	F, M, S	AEP	NO
Graminoid	Carex diandra			soft-leaf sedge	B, F, S	AEP	
Graminoid	Carex disperma			Dewey's sedge	S	AEP	
Graminoid	Carex douglasii			Douglas' Sedge		US	YES
Graminoid	Carex echinata			Star Sedge		US	YES
Graminoid	Carex flava			Yellow-Green Sedge		US	YES
Graminoid	Carex garberi			Elk Sedge		US	YES
Graminoid	Carex gynocrates			northern bog sedge	B, F, M, S	AEP	
Graminoid	Carex heleonastes			Hudson Bay sedge	B, F, M, S	AEP	
Graminoid	Carex heteroneura			Different-Nerve Sedge		US	YES
Graminoid	Carex hystericina			Porcupine Sedge		US	YES
Graminoid	Carex illota			Small-Head Sedge		US	YES
Graminoid	Carex incurviformis			Coastal-Sand Sedge		US	IF DOM
Graminoid	Carex infirminervia			Weak-Nerved Sedge		US	IF DOM
Graminoid	Carex interior			inland sedge	F, M, S	AEP	
Graminoid	Carex lachenalii			Arctic Hare-Foot Sedge		US	YES
Graminoid	Carex lacustris			lakeshore sedge	F, M, S	AEP	
Graminoid	Carex lasiocarpa			hairy-fruited sedge	B, F, M, S	AEP	
Graminoid	Carex lenticularis			Lakeshore Sedge		US	YES
Graminoid	Carex leptalea			bristle-stalked sedge	B, F, S	AEP	
Graminoid	Carex limosa			mud sedge	F, M, S	AEP	
Graminoid	Carex livida			livid sedge	B, M, F	AEP	
Graminoid	Carex loliacea			rye-grass sedge	M	AEP	
Graminoid	Carex macloviana			Falkland Island Sedge		US	YES
Graminoid	Carex magellanica	ssp.	irrigua	bog sedge	B, F, M	AEP	
Graminoid	Carex maritima					US	IF DOM
Graminoid	Carex media					US	YES
Graminoid	Carex mertensii			Mertens' Sedge		US	IF DOM
Graminoid	Carex microglochin			False Uncinia Sedge		US	YES
Graminoid	Carex microptera			Small-Wing Sedge		US	IF DOM
Graminoid	Carex nebrascensis			Nebraska Sedge		US	YES

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Graminoid	Carex nigricans			Black Alpine Sedge		US	YES
Graminoid	Carex norvegica			Norway Sedge		US	YES
Graminoid	Carex oligosperma			few-fruited sedge	B, M, F	AEP	
Graminoid	Carex pachystachya			Thick-Head Sedge		US	IF DOM
Graminoid	Carex parryana					US	YES
Graminoid	Carex pauciflora			few-flowered sedge	B, F, M, S	AEP	
Graminoid	Carex peckii			Peck's Sedge		US	YES
Graminoid	Carex pedunculata			Long-Stalk Sedge		US	YES
Graminoid	Carex pellita			woolly sedge	M	AEP	
Graminoid	Carex podocarpa			Short-Stalk Sedge		US	IF DOM
Graminoid	Carex praegracilis			graceful sedge	F, M	AEP	
Graminoid	Carex prairea			prairie sedge	F, M, S	AEP	
Graminoid	Carex praticola			meadow sedge	M, S	AEP	IF DOM
Graminoid	Carex pseudocyperus			cyperus-like sedge	B, F	AEP	
Graminoid	Carex raymondii			Raymond's Sedge		US	YES
Graminoid	Carex retrorsa			turned sedge	F, M	AEP	
Graminoid	Carex richardsonii			Richardson's Sedge		US	IF DOM
Graminoid	Carex rostrata			beaked sedge	F, S	AEP	
Graminoid	Carex sartwellii			Sartwell sedge	M	AEP	
Graminoid	Carex saxatilis			rocky-ground sedge	M	AEP	
Graminoid	Carex scoparia			Pointed Broom Sedge		US	YES
Graminoid	Carex scopulorum			Holm's Rocky Mountain Sedge		US	YES
Graminoid	Carex siccata			Dry-Spike Sedge		US	YES
Graminoid	Carex simulata			Analogue Sedge		US	YES
Graminoid	Carex spectabilis			Northwestern Showy Sedge		US	YES
Graminoid	Carex stipata			awl-fruited sedge	M, S	AEP	
Graminoid	Carex sychnocephala			long-beaked sedge	M	AEP	
Graminoid	Carex tenera			broad-fruited sedge	B, F, M, S	AEP	
Graminoid	Carex tenuiflora			thin-flowered sedge	B, M, S	AEP	
Graminoid	Carex torreyi			Torrey's sedge	M	AEP	IF DOM
Graminoid	Carex trisperma			three-seeded sedge	B, F, M, S	AEP	
Graminoid	Carex utriculata			small bottle sedge	B, F, M	AEP	
Graminoid	Carex vaginata			sheathed sedge	B, F, M, S	AEP	
Graminoid	Carex vesicaria			Lesser Bladder Sedge		US	YES
Graminoid	Carex viridula			green sedge	M	AEP	
Graminoid	Carex vulpinoidea			fox sedge	M	AEP	
Graminoid	Carex xerantica			Whitescale Sedge		US	YES
Graminoid	Catabrosa aquatica			brook grass	M	AEP	

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Graminoid	Cinna latifolia			drooping wood-reed	S	AEP	
Graminoid	Cyperus esculentus			Yellow Nutsedge		US	YES
Graminoid	Cyperus squarrosus			Awned Flat Sedge		US	YES
Graminoid	Danthonia californica					US	IF DOM
Graminoid	Danthonia intermedia			Timber Wild Oat Grass		US	IF DOM
Graminoid	Deschampsia cespitosa			tufted hairgrass	B, F, M	AEP	
Graminoid	Deschampsia elongata			Slender Hair Grass		US	IF DOM
Graminoid	Dichanthelium acuminatum			hot-springs millet	M	AEP	IF DOM
Graminoid	Distichlis spicata	ssp.	stricta	Inland saltgrass	M	AEP	
Graminoid	Draba albertina			Slender Whitlow-Grass		US	IF DOM
Graminoid	Draba aurea			Golden Whitlow-Grass		US	IF DOM
Graminoid	Echinochloa crus-galli					US	IF DOM
Graminoid	Echinochloa muricata					US	YES
Graminoid	Elymus canadensis			Canada wild rye	M	AEP	IF DOM
Graminoid	Elymus repens			quackgrass	M	AEP	NO
Graminoid	Elymus trachycaulus			slender wheatgrass	M	AEP	NO
Graminoid	Elymus virginicus			Virginia Wild Rye		US	IF DOM
Graminoid	Eriophorum angustifolium			narrowleaf cottongrass	B, F, M, S	AEP	
Graminoid	Eriophorum brachyantherum			close-sheathed cotton grass	M	AEP	
Graminoid	Eriophorum chamissonis			russet cotton grass	B, F, M, S	AEP	
Graminoid	Eriophorum gracile			slender cottongrass	F, M, S	AEP	
Graminoid	Eriophorum scheuchzeri			one-spike cottongrass	B, F, M, S	AEP	
Graminoid	Eriophorum vaginatum			sheathed cottongrass	B, F, S	AEP	
Graminoid	Eriophorum viridicarinatum			Tassel Cotton-Grass		US	YES
Graminoid	Festuca rubra			Red Fescue		US	IF DOM
Graminoid	Glyceria borealis			northern manna grass	M	AEP	
Graminoid	Glyceria elata			Tall Manna Grass		US	YES
Graminoid	Glyceria grandis			common tall mannagrass	M	AEP	
Graminoid	Glyceria pulchella			graceful manna grass	M	AEP	
Graminoid	Glyceria striata			fowl manna grass	F, M, S	AEP	
Graminoid	Holcus lanatus					US	IF DOM
Graminoid	Hordeum jubatum			foxtail barley	M	AEP	
Graminoid	Iris pseudacorus					US	YES
Graminoid	Juncus albescens			Northern White Rush		US	YES
Graminoid	Juncus alpinoarticulatus			alpine rush	M	AEP	
Graminoid	Juncus arcticus			Wire Rush; Baltic or Arctic Rush		US	YES

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Graminoid	Juncus balticus			wire rush	M	AEP	
Graminoid	Juncus brevicaudatus			short-tailed rush	M	AEP	
Graminoid	Juncus bufonius			toad rush	M	AEP	
Graminoid	Juncus castaneus			Chestnut Rush		US	YES
Graminoid	Juncus compressus			Round-Fruit Rush		US	YES
Graminoid	Juncus confusus			Colorado Rush		US	YES
Graminoid	Juncus drummondii			Drummond's Rush		US	YES
Graminoid	Juncus dudleyi			Dudley's Rush		US	YES
Graminoid	Juncus effusus					US	YES
Graminoid	Juncus ensifolius			Dagger-Leaf Rush		US	YES
Graminoid	Juncus filiformis			Thread Rush		US	YES
Graminoid	Juncus interior					US	IF DOM
Graminoid	Juncus longistylis			long-styled rush	M	AEP	
Graminoid	Juncus mertensianus			Mertens' Rush		US	YES
Graminoid	Juncus nevadensis			Sierran Rush		US	YES
Graminoid	Juncus nodosus			knotted rush	M	AEP	
Graminoid	Juncus stygius			Moor Rush		US	YES
Graminoid	Juncus tenuis			slender rush	M	AEP	IF DOM
Graminoid	Juncus torreyi			Torrey’s rush	M	AEP	
Graminoid	Juncus triglumis					US	YES
Graminoid	Juncus vaseyi			big-head rush	M	AEP	
Graminoid	Kobresia myosuroides			Pacific Bog Sedge		US	IF DOM
Graminoid	Kobresia simpliciuscula			Simple Bog Sedge		US	YES
Graminoid	Leymus cinereus			basin wildrye		US	IF DOM
Graminoid	Lolium perenne					US	IF DOM
Graminoid	Luzula acuminata			Hairy Wood-Rush		US	IF DOM
Graminoid	Luzula multiflora			Common Wood-Rush		US	IF DOM
Graminoid	Luzula parviflora					US	IF DOM
Graminoid	Muhlenbergia asperifolia			scratch grass	M	AEP	
Graminoid	Muhlenbergia glomerata			bog muhly	B, F, M, S	AEP	
Graminoid	Oryzopsis asperifolia			Roughleaf Ricegrass		US	IF DOM
Graminoid	Oryzopsis pungens			Northern Ricegrass		US	IF DOM
Graminoid	Panicum capillare			witch grass	M	AEP	IF DOM
Graminoid	Parnassia fimbriata			Fringed Grass-of-Parnassus		US	YES
Graminoid	Parnassia kotzebuei			Kotzebue's Grass-of-Parnassus		US	YES
Graminoid	Parnassia parviflora					US	YES
Graminoid	Phalaris arundinacea			reed canary grass	M	AEP	
Graminoid	Phalaris canariensis			canary grass	M	AEP	NO

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Graminoid	Phleum alpinum					US	IF DOM
Graminoid	Phleum pratense			timothy	M	AEP	NO
Graminoid	Phragmites australis			reed	M, S	AEP	
Graminoid	Poa abbreviata			Northern Blue Grass		US	IF DOM
Graminoid	Poa alpina					US	IF DOM
Graminoid	Poa arctica			Arctic Blue Grass		US	YES
Graminoid	Poa arida			Prairie Blue Grass		US	IF DOM
Graminoid	Poa interior					US	IF DOM
Graminoid	Poa leptocoma			Marsh Blue Grass		US	YES
Graminoid	Poa nemoralis			inland bluegrass		US	IF DOM
Graminoid	Poa palustris			fowl bluegrass	F, M, S	AEP	
Graminoid	Poa pratensis			Kentucky bluegrass	M	AEP	NO
Graminoid	Poa stenantha			Narrow-Flower Blue Grass		US	IF DOM
Graminoid	Polypogon monspeliensis			Annual Rabbit's-Foot Grass		US	YES
Graminoid	Puccinellia distans			slender salt-meadow grass	M	AEP	
Graminoid	Puccinellia nuttalliana			Nuttall’s salt-meadow grass	M	AEP	
Graminoid	Rhynchospora alba			White Beak Sedge		US	YES
Graminoid	Rhynchospora capillacea			slender beak-rush	M	AEP	
Graminoid	Schizachne purpurascens			purple oat grass	S	AEP	NO
Graminoid	Schoenoplectus acutus	var.	acutus	great bulrush	M	AEP	
Graminoid	Schoenoplectus americanus					US	YES
Graminoid	Schoenoplectus heterochaetus			slender bulrush	M	AEP	
Graminoid	Schoenoplectus maritimus			cosmopolitan bulrush		US	YES
Graminoid	Schoenoplectus pungens	var.	pungens	three-square rush	M	AEP	
Graminoid	Schoenoplectus tabernaemontani			Soft-Stem Club-Rush		US	YES
Graminoid	Schoeoplectus tabernaemontani			common great bulrush	M	AEP	
Graminoid	Scirpus cyperinus			wool-grass	M	AEP	
Graminoid	Scirpus hudsonianus					US	YES
Graminoid	Scirpus microcarpus			small-fruited bulrush	M	AEP	
Graminoid	Scirpus nevadensis			Nevada Bulrush		US	YES
Graminoid	Scirpus pallidus			Pale Bulrush		US	YES
Graminoid	Scolochloa festucacea			spangletop	M	AEP	
Graminoid	Sisyrinchium septentrionale			Northern Blue-Eyed-Grass		US	IF DOM

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Graminoid	Sparganium americanum			American Burr-Reed		US	YES
Graminoid	Sparganium angustifolium			narrow-leaved bur-reed	F, M, W	AEP	
Graminoid	Sparganium emersum					US	YES
Graminoid	Sparganium eurycarpum			giant burreed	M	AEP	
Graminoid	Sparganium fluctuans			Floating Burr-Reed		US	YES
Graminoid	Sparganium glomeratum			Clustered Burr-Reed		US	YES
Graminoid	Sparganium natans			slender bur-reed	M	AEP	
Graminoid	Sparganium natans			small bur-reed		US	YES
Graminoid	Spartina gracilis			alkali cordgrass	M	AEP	
Graminoid	Spartina pectinata			prairie cord grass	M	AEP	
Graminoid	Sphenopholis intermedia			Slender Wedgescale		US	IF DOM
Graminoid	Sphenopholis obtusata			Prairie Wedgescale		US	IF DOM
Graminoid	Torreyochloa pallida			Pale False Manna Grass		US	YES
Graminoid	Trichophorum aespitosum			Hudson Bay bulrush	F, M	AEP	
Graminoid	Trichophorum alpinum			tufted bulrush	B, F, M	AEP	
Graminoid	Trichophorum clintonii			Clinton's bulrush	M	AEP	
Graminoid	Trichophorum pumilum			Rolland's Leafless-Bulrush		US	YES
Graminoid	Typha latifolia			common cattail	F, M	AEP	
Graminoid	Zizania palustris			wild rice	M, W	AEP	
Forb/Fern	Achillea millefolium			common yarrow	M, S	AEP	NO
Forb/Fern	Achillea sibirica			Siberian Yarrow		US	IF DOM
Forb/Fern	Aconitum delphiniifolium			Larkspurleaf Monkshood		US	IF DOM
Forb/Fern	Actaea rubra			red and white baneberry	S	AEP	NO
Forb/Fern	Adiantum aleuticum			Aleutian Maidenhair		US	IF DOM
Forb/Fern	Adoxa moschatellina			moschatel	S	AEP	IF DOM
Forb/Fern	Agastache foeniculum			Blue Giant Hyssop		US	IF DOM
Forb/Fern	Agoseris glauca			yellow false dandelion	M	AEP	NO
Forb/Fern	Agrimonia striata			agrimony	M	AEP	NO
Forb/Fern	Alisma gramineum			narrow-leaved water-plantain	M	AEP	
Forb/Fern	Alisma plantago-aquatica			broad-leaved water-plantain	M	AEP	
Forb/Fern	Alisma triviale			broad-leaved water-plantain	M	AEP	
Forb/Fern	Allium schoenoprasum			wild chives	M	AEP	
Forb/Fern	Almutaster pauciflorus			few-flower aster	M, W	AEP	
Forb/Fern	Amaranthus blitoides					US	YES
Forb/Fern	Amaranthus californicus			California Amaranth		US	YES
Forb/Fern	Amaranthus retroflexus			red-root pigweed	M	AEP	NO

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Forb/Fern	Ambrosia psilostachya			perennial ragweed	M	AEP	
Forb/Fern	Ambrosia trifida					US	IF DOM
Forb/Fern	Amerorchis rotundifolia			Roundleaf Orchid		US	YES
Forb/Fern	Androsace occidentalis			western fairy candelabra	M	AEP	
Forb/Fern	Anemone canadensis			Canada anemone	M, S	AEP	
Forb/Fern	Anemone parviflora					US	YES
Forb/Fern	Anemone quinquefolia			wood anemone	S	AEP	IF DOM
Forb/Fern	Anemone richardsonii					US	IF DOM
Forb/Fern	Angelica genuflexa			Kneeling Angelica		US	IF DOM
Forb/Fern	Antennaria pulcherrima					US	IF DOM
Forb/Fern	Apocynum cannabinum			Indian hemp	M	AEP	IF DOM
Forb/Fern	Aralia nudicaulis			wild sarsaparilla	F, S	AEP	NO
Forb/Fern	Arnica chamissonis			leafy arnica	F, M, W	AEP	
Forb/Fern	Arnica latifolia			Daffodil Leopardbane		US	IF DOM
Forb/Fern	Arnica longifolia			Spear-Leaf Leopardbane		US	YES
Forb/Fern	Arnica mollis			Cordilleran Leopardbane		US	IF DOM
Forb/Fern	Artemisia biennis			biennial sagewort	M	AEP	NO
Forb/Fern	Artemisia campestris			Field Sagewort		US	IF DOM
Forb/Fern	Artemisia ludoviciana			prairie sagewort	M	AEP	NO
Forb/Fern	Artemisia norvegica			Boreal Sagebrush		US	YES
Forb/Fern	Asclepias ovalifolia			Oval-Leaf Milkweed		US	IF DOM
Forb/Fern	Asclepias speciosa			Showy Milkweed		US	IF DOM
Forb/Fern	Astragalus agrestis			purple milkvetch		US	IF DOM
Forb/Fern	Astragalus alpinus			alpine milk vetch	M	AEP	IF DOM
Forb/Fern	Astragalus americanus			American milk vetch	M, S	AEP	IF DOM
Forb/Fern	Astragalus australis			Indian Milkvetch		US	IF DOM
Forb/Fern	Astragalus bisulcatus			Twogrooved Milkvetch		US	IF DOM
Forb/Fern	Astragalus bodinii			Bodin's Milk-Vetch		US	IF DOM
Forb/Fern	Astragalus canadensis			Canadian milk vetch	M	AEP	IF DOM
Forb/Fern	Astragalus cicer			Chickpea Milkvetch		US	IF DOM
Forb/Fern	Astragalus crassicarpus			Groundplum Milkvetch		US	IF DOM
Forb/Fern	Astragalus drummondii			Drummond's Milkvetch		US	IF DOM
Forb/Fern	Astragalus miser			Timber Milkvetch		US	IF DOM
Forb/Fern	Astragalus missouriensis			Missouri Milkvetch		US	IF DOM
Forb/Fern	Astragalus pectinatus			Narrowleaf Milkvetch		US	IF DOM
Forb/Fern	Astragalus robbinsii			Robbins' Milk-Vetch		US	IF DOM
Forb/Fern	Athyrium americanum			American Alpine Lady Fern		US	IF DOM
Forb/Fern	Athyrium filix-femina			Subarctic Lady Fern		US	IF DOM
Forb/Fern	Atriplex argentea			silver saltbrush	M, W	AEP	IF DOM

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Forb/Fern	Atriplex hortensis			Garden Orache		US	IF DOM
Forb/Fern	Atriplex micrantha			saltbush	M	AEP	
Forb/Fern	Atriplex nuttallii			Nuttall's Saltbush		US	IF DOM
Forb/Fern	Atriplex powellii			Powell's saltbush	M	AEP	
Forb/Fern	Atriplex prostrata			prostrate saltbush	M	AEP	
Forb/Fern	Atriplex subspicata			spearscale saltbush	M, W	AEP	
Forb/Fern	Atriplex truncata			saltbush	M, W	AEP	IF DOM
Forb/Fern	Bacopa rotundifolia			water hyssop	M	AEP	
Forb/Fern	Barbarea orthoceras			American winter cress	M	AEP	
Forb/Fern	Barbarea vulgaris					US	IF DOM
Forb/Fern	Bassia hyssopifolia			Five-Horn Smotherweed		US	YES
Forb/Fern	Bassia scoparia			Burningbush		US	IF DOM
Forb/Fern	Bidens cernua			nodding beggarticks	M, F, S	AEP	
Forb/Fern	Bidens frondosa			common beggarticks	M	AEP	
Forb/Fern	Bidens tripartita			Three-Lobe Beggarticks		US	YES
Forb/Fern	Bistorta vivipara			alpine bistort	M	AEP	
Forb/Fern	Botrychium ascendens			Triangle-Lobe Moonwort		US	IF DOM
Forb/Fern	Botrychium lanceolatum			Lance-Leaf Moonwort		US	YES
Forb/Fern	Botrychium lunaria			Common Moonwort		US	IF DOM
Forb/Fern	Botrychium simplex			Least Moonwort		US	IF DOM
Forb/Fern	Botrychium virginianum			Rattlesnake Fern		US	IF DOM
Forb/Fern	Botrypus virginianus					US	IF DOM
Forb/Fern	Brasenia schreberi			watershield	F, M, W	AEP	
Forb/Fern	Calla palustris			water arum	F, M, S	AEP	
Forb/Fern	Callitriche hermaphroditica			northern water-starwort	M, W	AEP	
Forb/Fern	Callitriche palustris			vernal water-starwort	F, M	AEP	
Forb/Fern	Caltha leptosepala			White Marsh-Marigold		US	YES
Forb/Fern	Caltha natans			floating marsh-marigold	F, M, W	AEP	
Forb/Fern	Caltha palustris			marsh marigold	F, M, S	AEP	
Forb/Fern	Calypso bulbosa			Fairy-Slipper Orchid		US	YES
Forb/Fern	Campanula aparinoides			Marsh Bellflower		US	YES
Forb/Fern	Campanula rotundifolia			Bluebell-of-Scotland		US	IF DOM
Forb/Fern	Canadanthus modestus			large northern aster	F, M	AEP	
Forb/Fern	Capsella bursa-pastoris			shepherd's purse	M	AEP	NO
Forb/Fern	Cardamine oligosperma			Little Western Bittercress		US	IF DOM
Forb/Fern	Cardamine parviflora			Sand Bittercress		US	YES
Forb/Fern	Cardamine pensylvanica			bittercress	M, S	AEP	
Forb/Fern	Cardamine pratensis			meadow bitter cress	M	AEP	

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Forb/Fern	Cardaria pubescens			Globe-Pod Hoarycress		US	IF DOM
Forb/Fern	Castilleja miniata					US	YES
Forb/Fern	Castilleja occidentalis			Pale-Yellow Indian-Paintbrush		US	IF DOM
Forb/Fern	Castilleja raupii			purple paintbrush	M	AEP	IF DOM
Forb/Fern	Castilleja rhexiifolia			Rosy Indian-Paintbrush		US	IF DOM
Forb/Fern	Cerastium arvense			field mouse-ear chickweed	M	AEP	NO
Forb/Fern	Cerastium beeringianum			Bering Sea Mouse-Ear Chickweed		US	IF DOM
Forb/Fern	Cerastium brachypodum			Nodding Mouse-Ear Chickweed		US	IF DOM
Forb/Fern	Cerastium nutans			Nodding Mouse-Ear Chickweed		US	IF DOM
Forb/Fern	Chamerion angustifolium	ssp.	angustifoliu m	common fireweed	F, M, S	AEP	IF DOM
Forb/Fern	Chamerion latifolium			broad-leaved fireweed	M, F	AEP	
Forb/Fern	Chenopodium album			lamb's quarters	M	AEP	NO
Forb/Fern	Chenopodium capitatum			strawberry blite	M	AEP	IF DOM
Forb/Fern	Chenopodium glaucum	var.	salinum	oak-leaved goosefoot	F, M. S	AEP	IF DOM
Forb/Fern	Chenopodium pratericola			Desert Goosefoot		US	IF DOM
Forb/Fern	Chenopodium rubrum			red goosefoot	M	AEP	
Forb/Fern	Chenopodium simplex			Mapleleaf Goosefoot		US	IF DOM
Forb/Fern	Chrysosplenium iowense			golden saxifrage	F, M	AEP	
Forb/Fern	Chrysosplenium tetrandrum			green saxifrage	F, M	AEP	
Forb/Fern	Cicuta bulbifera			bulb-bearing water-hemlock	F, M, S	AEP	
Forb/Fern	Cicuta douglasii					US	YES
Forb/Fern	Cicuta maculata			water-hemlock	F, M, S	AEP	
Forb/Fern	Cicuta virosa			narrow-leaved water-hemlock	M	AEP	
Forb/Fern	Circaea alpina			small enchanter's nightshade	S	AEP	
Forb/Fern	Cirsium arvense			creeping thistle	M, S	AEP	NO
Forb/Fern	Cirsium drummondii			Dwarf Thistle		US	IF DOM
Forb/Fern	Cirsium flodmanii			Flodman's Thistle		US	IF DOM
Forb/Fern	Cirsium scariosum			Meadow Thistle		US	IF DOM
Forb/Fern	Claytonia lanceolata			Lance-Leaf Springbeauty		US	YES
Forb/Fern	Clematis ligusticifolia					US	IF DOM
Forb/Fern	Coeloglossum viride			bracted bog orchid	M	AEP	IF DOM
Forb/Fern	Comarum palustre			marsh cinquefoil	B, F, M, S	AEP	
Forb/Fern	Conium maculatum			poison hemlock	M	AEP	

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Forb/Fern	Conyza canadensis			horseweed	M	AEP	
Forb/Fern	Coptis trifolia			goldthread	M, S	AEP	
Forb/Fern	Corallorhiza trifida			pale coralroot	F, S	AEP	IF DOM
Forb/Fern	Corallorrhiza trifida			yellow coralroot		US	IF DOM
Forb/Fern	Coreopsis tinctoria			Golden Tickseed		US	IF DOM
Forb/Fern	Cornus canadensis			bunchberry	S	AEP	IF DOM
Forb/Fern	Corydalis aurea			golden corydalis	M	AEP	IF DOM
Forb/Fern	Crepis runcinata			scapose hawk’s-beard	M	AEP	IF DOM
Forb/Fern	Crepis tectorum			annual hawk's-beard	M	AEP	
Forb/Fern	Cyclachaena xanthifolia			false ragweed	F, M, W	AEP	
Forb/Fern	Cypripedium acaule			stemless lady's-slipper	B, S	AEP	
Forb/Fern	Cypripedium parviflorum			yellow lady's-slipper	M	AEP	
Forb/Fern	Cypripedium passerinum					US	YES
Forb/Fern	Dasiphora fruticosa			shrubby cinquefoil		US	IF DOM
Forb/Fern	Delphinium glaucum			tall larkspur	M, S	AEP	
Forb/Fern	Descurainia sophia			flixweed	M	AEP	
Forb/Fern	Diphasiastrum complanatum			groundcedar		US	IF DOM
Forb/Fern	Dodecatheon pulchellum			Dark-Throat Shootingstar		US	YES
Forb/Fern	Dracocephalum parviflorum			American dragonhead	M	AEP	NO
Forb/Fern	Drosera anglica			great sundew	B, F	AEP	
Forb/Fern	Drosera linearis			slender-leaved sundew	B, F, S	AEP	
Forb/Fern	Drosera rotundifolia			round-leaved sundew	B, F, S	AEP	
Forb/Fern	Dryas drummondii			Drummond's Mountain-Avens		US	IF DOM
Forb/Fern	Dryopteris carthusiana			narrow spinulose shield fern	S	AEP	
Forb/Fern	Dryopteris cristata			crested shield fern	S	AEP	
Forb/Fern	Dryopteris expansa					US	YES
Forb/Fern	Echinocystis lobata			Wild Cucumber		US	IF DOM
Forb/Fern	Elatine triandra			waterwort	M	AEP	
Forb/Fern	Eleocharis acicularis			needle spikerush	M	AEP	
Forb/Fern	Eleocharis elliptica			Elliptic Spike-Rush		US	YES
Forb/Fern	Eleocharis engelmannii			Engelmann’s spike-rush	M	AEP	
Forb/Fern	Eleocharis erythropoda			Bald Spikerush		US	YES
Forb/Fern	Eleocharis macrostachya			Pale Spikerush		US	YES
Forb/Fern	Eleocharis nitida			Quill Spikerush		US	YES
Forb/Fern	Eleocharis palustris			creeping spike-rush	M	AEP	
Forb/Fern	Eleocharis quinqueflora			few-flowered spike-rush	M	AEP	

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Forb/Fern	Eleocharis tenuis			slender spike-rush	F	AEP	
Forb/Fern	Eleocharis uniglumis			Onescale Spikerush		US	YES
Forb/Fern	Ellisia nyctelea			waterpod	M	AEP	
Forb/Fern	Elodea bifoliata			two-leaved waterweed	F, M	AEP	
Forb/Fern	Elodea canadensis			Canada waterweed	M, W	AEP	
Forb/Fern	Elodea nuttallii			Western Waterweed		US	YES
Forb/Fern	Epilobium anagallidifolium			Pimpernel Willowherb		US	IF DOM
Forb/Fern	Epilobium campestre			smooth boisduvalia	F, M. W	AEP	
Forb/Fern	Epilobium ciliatum			northern willowherb	B, F, M, S	AEP	
Forb/Fern	Epilobium glaberrimum			Glaucous Willowherb		US	YES
Forb/Fern	Epilobium halleanum			Glandular Willowherb		US	YES
Forb/Fern	Epilobium hornemannii			Hornemann's Willowherb		US	YES
Forb/Fern	Epilobium lactiflorum			White-Flower Willowherb		US	YES
Forb/Fern	Epilobium leptocarpum			Slender-Fruit Willowherb		US	YES
Forb/Fern	Epilobium leptophyllum			narrow-leaved willowherb	B, F, M, S	AEP	
Forb/Fern	Epilobium palustre			marsh willowherb	F, M, S	AEP	
Forb/Fern	Epilobium saximontanum			Rocky Mountain Willowherb		US	YES
Forb/Fern	Equisetum arvense			common horsetail	B, F, M, S	AEP	IF DOM
Forb/Fern	Equisetum fluviatile			swamp horsetail	B, F, M, S	AEP	
Forb/Fern	Equisetum hyemale			common scouring-rush	M	AEP	
Forb/Fern	Equisetum laevigatum			smooth scouring-rush	M	AEP	IF DOM
Forb/Fern	Equisetum palustre			marsh horsetail	B, F, M, S	AEP	
Forb/Fern	Equisetum pratense			meadow horsetail	F, M, S	AEP	
Forb/Fern	Equisetum scirpoides			dwarf scouring-rush	B, F, M, S	AEP	IF DOM
Forb/Fern	Equisetum sylvaticum			woodland horsetail	B, M, S	AEP	
Forb/Fern	Equisetum variegatum			variegated horsetail	M, S	AEP	
Forb/Fern	Erigeron acris			northern daisyfleabane	M	AEP	IF DOM
Forb/Fern	Erigeron elatus			tall fleabane	M	AEP	
Forb/Fern	Erigeron flagellaris			Trailing Fleabane		US	IF DOM
Forb/Fern	Erigeron glabellus			Streamside Fleabane		US	YES
Forb/Fern	Erigeron humilis					US	YES
Forb/Fern	Erigeron lonchophyllus			fleabane	M	AEP	
Forb/Fern	Erigeron philadelphicus			Philadelphia fleabane	M, S	AEP	IF DOM
Forb/Fern	Erigeron speciosus			Aspen Fleabane		US	IF DOM
Forb/Fern	Eriogonum androsaceum			cushion umbrella-plant	F	AEP	
Forb/Fern	Erysimum cheiranthoides			wormseed mustard	M	AEP	NO

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Euphorbia esula			Leafy Spurge		US	IF DOM
Forb/Fern	Eurybia sibirica			Arctic aster	M	AEP	NO
Forb/Fern	Euthamia graminifolia			flat-topped goldenrod	M	AEP	IF DOM
Forb/Fern	Euthamia graminifolia			flat-top goldentop		US	IF DOM
Forb/Fern	Eutrochium maculatum			spotted Joe-pye weed	S, M	AEP	
Forb/Fern	Fallopia convolvulus			wild buckwheat	F, M, W	AEP	NO
Forb/Fern	Fragaria vesca			woodland strawberry	M	AEP	NO
Forb/Fern	Fragaria virginiana			wild strawberry	M	AEP	NO
Forb/Fern	Galearis rotundifolia			round-leaved orchid	F, S	AEP	
Forb/Fern	Galeopsis tetrahit			hemp-nettle	F, M	AEP	NO
Forb/Fern	Galium boreale			Labrador bedstraw	B, S	AEP	NO
Forb/Fern	Galium labradoricum			northern bog bedstraw	B, F, M, S	AEP	
Forb/Fern	Galium trifidum			small bedstraw	B, F, M, S	AEP	
Forb/Fern	Galium triflorum			sweet-scented bedstraw	F, M, S	AEP	NO
Forb/Fern	Gentiana fremontii			Moss Gentian		US	YES
Forb/Fern	Gentiana prostrata					US	YES
Forb/Fern	Gentianella amarella			Autumn Dwarf-Gentian		US	YES
Forb/Fern	Gentianella propinqua					US	YES
Forb/Fern	Gentianopsis detonsa			northern fringed gentian	M	AEP	
Forb/Fern	Geocaulon lividum			northern bastard toadflax	B, F, S	AEP	IF DOM
Forb/Fern	Geranium bicknellii			Bicknell's Cranesbill		US	IF DOM
Forb/Fern	Geranium richardsonii			White Crane's-Bill		US	IF DOM
Forb/Fern	Geum aleppicum			yellow avens	F, M, S	AEP	NO
Forb/Fern	Geum macrophyllum			large-leaved yellow avens	F, M, S	AEP	
Forb/Fern	Geum rivale			purple avens	M, S	AEP	
Forb/Fern	Glaux maritima			Sea-Milkwort		US	YES
Forb/Fern	Glycyrrhiza lepidota			wild licorice	M	AEP	NO
Forb/Fern	Gnaphalium palustre			marsh cudweed	M	AEP	
Forb/Fern	Gnaphalium uliginosum			Marsh Cudweed		US	IF DOM
Forb/Fern	Goodyera repens			lesser rattlesnake plantain	S	AEP	NO
Forb/Fern	Gratiola neglecta			clammy hedge-hyssop	M	AEP	
Forb/Fern	Gymnocarpium dryopteris			oak fern	S	AEP	IF DOM
Forb/Fern	Halenia deflexa			American Spurred-Gentian		US	IF DOM
Forb/Fern	Hedysarum alpinum			alpine hedysarum	S	AEP	NO
Forb/Fern	Helenium autumnale			sneezeweed	M	AEP	
Forb/Fern	Helianthus maximilianii			narrow-leaved sunflower	M	AEP	

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Helianthus nuttallii			common tall sunflower	M	AEP	
Forb/Fern	Heliotropium curassavicum			spatulate-leaved heliotrope	M	AEP	
Forb/Fern	Heracleum maximum			American Cow-Parsnip		US	IF DOM
Forb/Fern	Heracleum sphondylium	ssp.	montanum	cow parsnip	S, M	AEP	
Forb/Fern	Hieracium umbellatum			narrow-leaved hawkweed	M	AEP	
Forb/Fern	Hippuris vulgaris			common maretail	F, M	AEP	
Forb/Fern	Hypericum majus			large Canada St. John's-wort	M	AEP	
Forb/Fern	Impatiens capensis			spotted touch-me-not	M, S	AEP	
Forb/Fern	Impatiens noli-tangere			western jewelweed	M, S	AEP	
Forb/Fern	Iris missouriensis			western blue flag	M	AEP	
Forb/Fern	Isoetes bolanderi			Bolander's quillwort	M	AEP	
Forb/Fern	Isoetes echinospora			northern quillwort	M, W	AEP	
Forb/Fern	Iva axillaris			povertyweed	M	AEP	IF DOM
Forb/Fern	Kochia scoparia			summer-cypress	M	AEP	
Forb/Fern	Lactuca biennis			tall blue lettuce	S	AEP	IF DOM
Forb/Fern	Lactuca serriola			prickly lettuce	M	AEP	IF DOM
Forb/Fern	Lactuca tatarica					US	IF DOM
Forb/Fern	Lactuca tatarica			chicory lettuce		US	IF DOM
Forb/Fern	Laportea canadensis			Canadian Wood-Nettle		US	IF DOM
Forb/Fern	Lapsana communis			Common Nipplewort		US	IF DOM
Forb/Fern	Lathyrus ochroleucus			cream-coloured vetchling	S	AEP	
Forb/Fern	Lathyrus palustris			Marsh Vetchling		US	YES
Forb/Fern	Lathyrus venosus			Veiny Vetchling		US	IF DOM
Forb/Fern	Lemna minor			common duckweed	M	AEP	
Forb/Fern	Lemna trisulca			ivy-leaved duckweed	M	AEP	
Forb/Fern	Lemna turionifera			Turion Duckweed		US	YES
Forb/Fern	Lepidium densiflorum			common pepper-grass	M	AEP	IF DOM
Forb/Fern	Lepidium latifolium			Broad-Leaf Pepperwort		US	YES
Forb/Fern	Lepidium perfoliatum			Clasping Pepperwort		US	IF DOM
Forb/Fern	Liatris ligulistylis			Strap-Style Gayfeather		US	IF DOM
Forb/Fern	Lilium philadelphicum			western wood lily	M	AEP	IF DOM
Forb/Fern	Limosella aquatica			mudwort	M	AEP	
Forb/Fern	Linaria vulgaris			common toadflax	M	AEP	
Forb/Fern	Liparis loeselii			Yellow Wide-Lip Orchid		US	YES
Forb/Fern	Listera convallarioides			Broad-Lip Twayblade		US	YES
Forb/Fern	Lobelia dortmanna			water lobelia	M	AEP	
Forb/Fern	Lobelia kalmii			Kalm's lobelia	M	AEP	

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Lobelia spicata			Pale-Spike Lobelia		US	IF DOM
Forb/Fern	Lomatogonium rotatum			marsh felwort	M	AEP	
Forb/Fern	Lonicera oblongifolia			Swamp Fly-Honeysuckle		US	YES
Forb/Fern	Lotus corniculatus			bird's-foot trefoil	M	AEP	IF DOM
Forb/Fern	Lupinus polyphyllus			Blue-Pod Lupine		US	YES
Forb/Fern	Lycopodium annotinum			stiff club-moss	S	AEP	IF DOM
Forb/Fern	Lycopodium clavatum					US	IF DOM
Forb/Fern	Lycopus americanus			American water-horehound	F, M, W	AEP	
Forb/Fern	Lycopus asper			western water-horehound	M	AEP	
Forb/Fern	Lycopus uniflorus			northern water-horehound	B, M, S	AEP	
Forb/Fern	Lysimachia ciliata			Fringed Yellow-Loosestrife		US	YES
Forb/Fern	Lysimachia hybrida			lance-leaved yellow loosestrife	M	AEP	
Forb/Fern	Lysimachia lanceolata			lance-leaved loosestrife	M	AEP	
Forb/Fern	Lysimachia maritima			sea milkwort	F, M	AEP	
Forb/Fern	Lysimachia thyrsiflora			tufted loosestrife	B, F, M, S	AEP	
Forb/Fern	Lythrum salicaria			purple loosestrife	F, M	AEP	
Forb/Fern	Maianthemum canadense			wild lily-of-the-valley	S	AEP	NO
Forb/Fern	Maianthemum racemosum			Feathery False Solomon's-Seal		US	IF DOM
Forb/Fern	Maianthemum stellatum			star-flowered Solomon's-seal	M, S	AEP	NO
Forb/Fern	Maianthemum trifolium			three-leaved Solomon’s-seal	B, F, M, S	AEP	
Forb/Fern	Malaxis monophyllos					US	YES
Forb/Fern	Malaxis paludosa			Bog Adder's-Mouth Orchid		US	YES
Forb/Fern	Marsilea vestita			hairy pepperwort	M, W	AEP	
Forb/Fern	Matricaria discoidea			pineappleweed	M	AEP	NO
Forb/Fern	Matteuccia struthiopteris			ostrich fern	M, S	AEP	
Forb/Fern	Melampyrum lineare			narrowleaf cowwheat		US	IF DOM
Forb/Fern	Melilotus officinalis			yellow sweet-clover	M	AEP	NO
Forb/Fern	Mentha arvensis			wild mint	M, S	AEP	
Forb/Fern	Mentha spicata			spearmint	M	AEP	
Forb/Fern	Menyanthes trifoliata			buck-bean	F, S	AEP	
Forb/Fern	Mertensia paniculata			tall lungwort	S	AEP	IF DOM
Forb/Fern	Mimulus floribundus			Purple-Stem Monkey-Flower		US	YES
Forb/Fern	Mimulus glabratus			Round-Leaf Monkey-		US	YES

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
				Flower			
Forb/Fern	Mimulus guttatus			Seep Monkey-Flower		US	YES
Forb/Fern	Mimulus ringens			Allegheny Monkey-Flower		US	YES
Forb/Fern	Mimulus tilingii			Subalpine Monkey-Flower		US	YES
Forb/Fern	Minuartia rubella			Boreal Stitchwort		US	IF DOM
Forb/Fern	Mitella breweri			Feathery Bishop's-Cap		US	IF DOM
Forb/Fern	Mitella nuda			bishop's-cap	B, F, M, S	AEP	
Forb/Fern	Mitella pentandra			Five-Stamen Bishop's-Cap		US	IF DOM
Forb/Fern	Mitella trifida			Pacific Bishop's-Cap		US	IF DOM
Forb/Fern	Moehringia lateriflora			blunt-leaved sandwort	S	AEP	IF DOM
Forb/Fern	Mollugo verticillata			green carpetweed		US	IF DOM
Forb/Fern	Moneses uniflora			one-flowered wintergreen	B, S	AEP	IF DOM
Forb/Fern	Monolepis nuttalliana			spear-leaved goosefoot	F, M, W	AEP	IF DOM
Forb/Fern	Montia linearis			Linear-Leaf Candy-Flower		US	IF DOM
Forb/Fern	Montia parvifolia			Little-Leaf Candy-Flower		US	YES
Forb/Fern	Muhlenbergia racemosa			Green Muhly		US	YES
Forb/Fern	Muhlenbergia richardsonis			mat muhly	M	AEP	IF DOM
Forb/Fern	Mulgedium oblongifolium			blue lettuce	M	AEP	
Forb/Fern	Myosotis arvensis			Rough Forget-Me-Not		US	IF DOM
Forb/Fern	Myosotis laxa			Bay Forget-Me-Not		US	YES
Forb/Fern	Myosurus apetalus			Bristly Mousetail		US	YES
Forb/Fern	Myosurus minimus			Tiny Mousetail		US	YES
Forb/Fern	Myriophyllum alterniflorum			Alternateflower Watermilfoil		US	YES
Forb/Fern	Myriophyllum sibiricum			spike water-milfoil	M, W	AEP	
Forb/Fern	Myriophyllum spicatum			Eurasian Water-Milfoil		US	YES
Forb/Fern	Myriophyllum verticillatum			water-milfoil	F, M, W	AEP	
Forb/Fern	Najas flexilis			slender naiad	M	AEP	
Forb/Fern	Najas guadalupensis			Guadalupe Waternymph		US	YES
Forb/Fern	Nasturtium officinale			water cress	M	AEP	
Forb/Fern	Navarretia leucocephala			White-Flower Pincushion-Plant		US	YES
Forb/Fern	Neottia cordata			heart-leaved twayblade	S	AEP	
Forb/Fern	Nuphar lutea			yellow pond-lily	F, M	AEP	
Forb/Fern	Nuphar variegata					US	YES
Forb/Fern	Nymphaea leibergii			Dwarf Water-Lily		US	YES

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Nymphaea tetragona			white water-lily	F, M	AEP	
Forb/Fern	Oenothera flava			Long-Tube Evening-Primrose		US	YES
Forb/Fern	Onosmodium bejariense			western marbleseed		US	IF DOM
Forb/Fern	Orthilia secunda			one-sided wintergreen	B, F, S	AEP	NO
Forb/Fern	Osmorhiza longistylis			smooth sweet cicely	S	AEP	IF DOM
Forb/Fern	Osmorhiza purpurea			Purple Sweet-Cicely		US	IF DOM
Forb/Fern	Oxyria digyna			Mountain-Sorrel		US	IF DOM
Forb/Fern	Oxytropis monticola			Yellowflower Locoweed		US	IF DOM
Forb/Fern	Packera pauciflora			few-flowered ragwort	S	AEP	IF DOM
Forb/Fern	Packera paupercula			balsam groundsel	S	AEP	
Forb/Fern	Packera subnuda			Buek's Groundsel		US	YES
Forb/Fern	Packera pauciflora			groundsel		US	IF DOM
Forb/Fern	Parietaria pensylvanica			Pennsylvania Pellitory		US	IF DOM
Forb/Fern	Parnassia palustris			northern grass-of-Parnassus	B, F, M, S	AEP	
Forb/Fern	Parthenocissus quinquefolia			Virginia creeper		US	IF DOM
Forb/Fern	Pedicularis bracteosa			Bracted Lousewort		US	IF DOM
Forb/Fern	Pedicularis groenlandica			elephant's-head	F, M	AEP	
Forb/Fern	Pedicularis labradorica			Labrador lousewort	B	AEP	IF DOM
Forb/Fern	Pedicularis macrodonta			muskeg lousewort	B, F, M	AEP	
Forb/Fern	Pedicularis parviflora			swamp lousewort	B, F, M	AEP	IF DOM
Forb/Fern	Pedicularis sudetica			Sudetic Lousewort		US	YES
Forb/Fern	Penstemon confertus			Yellow Penstemon		US	IF DOM
Forb/Fern	Penstemon procerus			slender blue beardtongue	F	AEP	NO
Forb/Fern	Persicaria amphibia			water smartweed	M, S	AEP	
Forb/Fern	Persicaria lapathifolia			pale persicaria	F, M, W	AEP	
Forb/Fern	Petasites frigidus	var	frigidus	sweet coltsfoot	F, M	AEP	IF DOM
Forb/Fern	Petasites frigidus	var.	palmatus	palmate-leaved coltsfoot	F, M, S	AEP	IF DOM
Forb/Fern	Petasites frigidus	var.	sagittatus	arrow-leaved coltsfoot	F, M, S	AEP	IF DOM
Forb/Fern	Physostegia ledinghamii			Ledingham's False Dragonhead		US	YES
Forb/Fern	Physostegia parviflora			false dragonhead	M	AEP	
Forb/Fern	Pinguicula villosa			small butterwort	F, B	AEP	
Forb/Fern	Pinguicula vulgaris			California butterwort		US	YES
Forb/Fern	Plagiobothrys scouleri			Scouler's allocarya	M	AEP	
Forb/Fern	Plantago elongata			Prairie Plantain		US	YES
Forb/Fern	Plantago eriopoda			saline plantain	M	AEP	IF DOM
Forb/Fern	Plantago major			Great Plantain		US	IF DOM

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Plantago maritima			sea-side plantain	F, M	AEP	
Forb/Fern	Platanthera aquilonis					US	YES
Forb/Fern	Platanthera dilatata			tall white bog orchid	B, F	AEP	
Forb/Fern	Platanthera hyperborea			northern green bog orchid	F, M, S	AEP	
Forb/Fern	Platanthera obtusata	ssp.	obtusata	blunt-leaved bog orchid	F, S	AEP	
Forb/Fern	Platanthera orbiculata			round-leaved bog orchid	F, S	AEP	IF DOM
Forb/Fern	Platanthera stricta			Slender Bog Orchid		US	YES
Forb/Fern	Polemonium acutiflorum			tall Jacob's-ladder	M	AEP	IF DOM
Forb/Fern	Polemonium occidentale			Western Jacob's-Ladder		US	YES
Forb/Fern	Polygala paucifolia			fringed milkwort	S	AEP	
Forb/Fern	Polygonum achoreum			striate knotweed	F, M	AEP	
Forb/Fern	Polygonum amphibium			Water Knotweed		US	YES
Forb/Fern	Polygonum bistortoides			American Bistort		US	IF DOM
Forb/Fern	Polygonum erectum			striate knotweed	M	AEP	IF DOM
Forb/Fern	Polygonum lapathifolium			Curlytop Knotweed		US	YES
Forb/Fern	Polygonum minimum			Zigzag Knotweed		US	IF DOM
Forb/Fern	Polygonum persicaria			Spotted Ladysthumb		US	YES
Forb/Fern	Polygonum polygaloides			White-Margin Knotweed		US	YES
Forb/Fern	Polygonum ramosissimum			bushy knotweed	M	AEP	
Forb/Fern	Polygonum viviparum			Alpine Bistort		US	IF DOM
Forb/Fern	Portulaca oleracea			Little-Hogweed		US	IF DOM
Forb/Fern	Potamogeton alpinus			Reddish Pondweed		US	YES
Forb/Fern	Potamogeton berchtoldii					US	YES
Forb/Fern	Potamogeton crispus			Curly Pondweed		US	YES
Forb/Fern	Potamogeton filiformis					US	IF DOM
Forb/Fern	Potamogeton foliosus			leafy pondweed	F, M, W	AEP	
Forb/Fern	Potamogeton friesii			Fries' pondweed	F, M, W	AEP	
Forb/Fern	Potamogeton gramineus			various-leaved pondweed	M, W	AEP	
Forb/Fern	Potamogeton natans			floating-leaf pondweed	F, M, W	AEP	
Forb/Fern	Potamogeton nodosus			Long-Leaf Pondweed		US	YES
Forb/Fern	Potamogeton obtusifolius			Blunt-Leaf Pondweed		US	YES
Forb/Fern	Potamogeton pectinatus			Sago Pondweed		US	YES
Forb/Fern	Potamogeton perfoliatus			Claspingleaf Pondweed		US	YES
Forb/Fern	Potamogeton praelongus			white-stem pondweed	F, M, W	AEP	
Forb/Fern	Potamogeton pusillus			small-leaf pondweed	W	AEP	
Forb/Fern	Potamogeton richardsonii			clasping-leaf pondweed	M	AEP	
Forb/Fern	Potamogeton robbinsii			Fern Pondweed		US	YES

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Potamogeton strictifolius			Straight-Leaf Pondweed		US	YES
Forb/Fern	Potamogeton zosteriformis			flat-stemmed pondweed	F, M, W	AEP	
Forb/Fern	Potentilla anserina			silverweed	F, M	AEP	
Forb/Fern	Potentilla bimundorum			Staghorn Cinquefoil		US	IF DOM
Forb/Fern	Potentilla diversifolia			Mountain-Meadow Cinquefoil		US	YES
Forb/Fern	Potentilla glandulosa			Sticky Cinquefoil		US	IF DOM
Forb/Fern	Potentilla gracilis			graceful cinquefoil	M	AEP	IF DOM
Forb/Fern	Potentilla norvegica			rough cinquefoil	F, M, S	AEP	IF DOM
Forb/Fern	Potentilla plattensis			Platte River Cinquefoil		US	YES
Forb/Fern	Potentilla rivalis			brook cinquefoil	M	AEP	
Forb/Fern	Potentilla supina			Bushy Cinquefoil		US	YES
Forb/Fern	Primula egaliksensis			Greenland Primrose		US	YES
Forb/Fern	Primula incana			mealy primrose	M	AEP	
Forb/Fern	Primula mistassinica			Lake Mistassini Primrose		US	YES
Forb/Fern	Primula pauciflora	var.	pauciflora	pretty shooting star	B, M, S	AEP	
Forb/Fern	Prunella vulgaris			Common Selfheal		US	IF DOM
Forb/Fern	Psilocarphus brevissimus			Dwarf Woollyheads		US	YES
Forb/Fern	Pyrola minor			lesser wintergreen	F, S	AEP	NO
Forb/Fern	Pyrrocoma uniflora			Plantain Goldenweed		US	IF DOM
Forb/Fern	Ranunculus abortivus			small-flowered buttercup	M, S	AEP	IF DOM
Forb/Fern	Ranunculus acris			tall buttercup	M	AEP	
Forb/Fern	Ranunculus aquatilis	var.	diffusus	large-leaved white water crowfoot	M, W	AEP	
Forb/Fern	Ranunculus cardiophyllus			Heart-Leaf Buttercup		US	YES
Forb/Fern	Ranunculus cymbalaria			seaside buttercup	M	AEP	
Forb/Fern	Ranunculus eschscholtzii			Spruce-Fir Buttercup		US	YES
Forb/Fern	Ranunculus flabellaris			Greater Yellow Water Buttercup		US	YES
Forb/Fern	Ranunculus flammula			creeping spearwort	F, M, W	AEP	
Forb/Fern	Ranunculus glaberrimus			Sagebrush Buttercup		US	IF DOM
Forb/Fern	Ranunculus gmelinii			yellow water crowfoot	B, F, M, S	AEP	
Forb/Fern	Ranunculus hyperboreus			Far-Northern Buttercup		US	YES
Forb/Fern	Ranunculus inamoenus			Graceful Buttercup		US	YES
Forb/Fern	Ranunculus lapponicus			Lapland buttercup	M, S	AEP	
Forb/Fern	Ranunculus longirostris			Long-Beak Water-Crowfoot		US	YES
Forb/Fern	Ranunculus macounii			Macoun's buttercup	F, M	AEP	
Forb/Fern	Ranunculus pedatifidus			Northern Buttercup		US	YES
Forb/Fern	Ranunculus			bristly buttercup	F, M, W	AEP	

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
	pensylvanicus						
Forb/Fern	Ranunculus pygmaeus			Dwarf Buttercup		US	YES
Forb/Fern	Ranunculus repens			Creeping Buttercup		US	YES
Forb/Fern	Ranunculus sceleratus			celery-leaved buttercup	M	AEP	
Forb/Fern	Ranunculus uncinatus			Woodland Buttercup		US	YES
Forb/Fern	Rhinanthus minor			northern rattle		US	IF DOM
Forb/Fern	Romanzoffia sitchensis			Sitka Mistmaiden		US	YES
Forb/Fern	Rorippa austriaca					US	IF DOM
Forb/Fern	Rorippa curvipes			Blunt-Leaf Yellowcress		US	YES
Forb/Fern	Rorippa palustris			marsh yellow cress	B, F, M, W	AEP	
Forb/Fern	Rorippa sinuata			Spreading Yellowcress		US	YES
Forb/Fern	Rorippa sylvestris			Creeping Yellowcress		US	YES
Forb/Fern	Rorippa tenerrima			Modoc Yellowcress		US	IF DOM
Forb/Fern	Rubus arcticus			dwarf-raspberry	B, F, M, S	AEP	
Forb/Fern	Rubus chamaemorus			cloudberry	B, F, S	AEP	IF DOM
Forb/Fern	Rubus pubescens			dewberry	B, F, M, S	AEP	
Forb/Fern	Rumex acetosa			Garden Sorrel		US	IF DOM
Forb/Fern	Rumex acetosella			Common Sheep Sorrel		US	IF DOM
Forb/Fern	Rumex aquaticus			Western Dock		US	YES
Forb/Fern	Rumex britannica			water dock	M, S	AEP	
Forb/Fern	Rumex crispus			curled dock	M, S	AEP	IF DOM
Forb/Fern	Rumex fueginus			Tierra del Fuego Dock		US	YES
Forb/Fern	Rumex longifolius			Door-Yard Dock		US	IF DOM
Forb/Fern	Rumex maritimus			golden dock	F, M, W	AEP	IF DOM
Forb/Fern	Rumex occidentalis			Western Dock		US	YES
Forb/Fern	Rumex paucifolius			Alpine Sheep Sorrel		US	IF DOM
Forb/Fern	Rumex pseudonatronatus			Field Dock		US	IF DOM
Forb/Fern	Rumex stenophyllus			Narrow-Leaf Dock		US	YES
Forb/Fern	Rumex triangulivalvis			narrow-leaved field dock	M	AEP	
Forb/Fern	Rumex venosus			Veiny Dock		US	IF DOM
Forb/Fern	Ruppia cirrhosa			widgeon-grass	M, W	AEP	
Forb/Fern	Sagina decumbens			Trailing Pearlwort		US	IF DOM
Forb/Fern	Sagina nivalis			Snow Pearlwort		US	YES
Forb/Fern	Sagina saginoides			Alpine Pearlwort		US	YES
Forb/Fern	Sagittaria cuneata			arum-leaved arrowhead	M	AEP	
Forb/Fern	Sagittaria latifolia			broad-leaved arrowhead	M	AEP	
Forb/Fern	Salicornia rubra			samphire	M	AEP	
Forb/Fern	Salsola kali			Russian-thistle	M	AEP	
Forb/Fern	Sanicula marilandica			snakeroot	S	AEP	IF DOM

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Sarracenia purpurea			pitcher-plant	B, F, S	AEP	
Forb/Fern	Saxifraga adscendens			Wedge-Leaf Saxifrage		US	YES
Forb/Fern	Saxifraga caespitosa					US	IF DOM
Forb/Fern	Saxifraga cernua					US	YES
Forb/Fern	Saxifraga ferruginea			Russet-Hair Saxifrage		US	YES
Forb/Fern	Saxifraga lyallii			Red-Stem Saxifrage		US	YES
Forb/Fern	Saxifraga mertensiana			Woodland Saxifrage		US	YES
Forb/Fern	Saxifraga occidentalis			Mountain Saxifrage		US	IF DOM
Forb/Fern	Saxifraga odontoloma			Streambank Saxifrage		US	YES
Forb/Fern	Saxifraga oppositifolia			Purple Mountain Saxifrage		US	IF DOM
Forb/Fern	Saxifraga oregana			Bog Saxifrage		US	YES
Forb/Fern	Scheuchzeria palustris			scheuchzeria	B, F	AEP	
Forb/Fern	Scrophularia lanceolata			Lance-Leaf Figwort		US	IF DOM
Forb/Fern	Scutellaria galericulata			marsh skullcap	F, M, S	AEP	
Forb/Fern	Selaginella selaginoides					US	YES
Forb/Fern	Senecio congestus			marsh ragwort	M	AEP	YES
Forb/Fern	Senecio eremophilus			cut-leaved ragwort	M	AEP	IF DOM
Forb/Fern	Senecio integerrimus			Lamb-Tongue Ragwort		US	IF DOM
Forb/Fern	Senecio lugens			Small Black-Tip Ragwort		US	YES
Forb/Fern	Senecio triangularis			Arrow-Leaf Ragwort		US	YES
Forb/Fern	Silene acaulis			Cushion-Pink		US	IF DOM
Forb/Fern	Sinapis alba			White Mustard		US	YES
Forb/Fern	Sinapis arvensis			wild mustard	M	AEP	
Forb/Fern	Sisyrinchium montanum			common blue-eyed grass	F, M, W	AEP	IF DOM
Forb/Fern	Sium suave			common waterparsnip	F, M	AEP	
Forb/Fern	Solidago canadensis			Canada goldenrod	M, S	AEP	NO
Forb/Fern	Solidago gigantea			late goldenrod	M	AEP	IF DOM
Forb/Fern	Sonchus arvensis			perennial sow-thistle	M, S	AEP	IF DOM
Forb/Fern	Sonchus asper			prickly annual sow-thistle	M	AEP	IF DOM
Forb/Fern	Spergularia rubra					US	IF DOM
Forb/Fern	Spergularia salina			salt-marsh sand spurry	B, F, M	AEP	
Forb/Fern	Spiranthes lacera			Northern Slender Ladies'-Tresses		US	IF DOM
Forb/Fern	Spiranthes romanzoffiana			hooded ladies'-tresses	B, F, M, S	AEP	
Forb/Fern	Spirodela polyrhiza			common duckmeat		US	YES
Forb/Fern	Stachys palustris			marsh hedge-nettle	M	AEP	
Forb/Fern	Stachys pilosa					US	YES
Forb/Fern	Stellaria borealis			Boreal Starwort		US	YES

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Stellaria calycantha			northern stitchwort	F, M, S, W	AEP	
Forb/Fern	Stellaria crassifolia			fleshy stitchwort	F, M	AEP	
Forb/Fern	Stellaria crispa			Ruffled Starwort		US	YES
Forb/Fern	Stellaria longifolia			long-leaved chickweed	F, M, S	AEP	
Forb/Fern	Stellaria longipes			long-stalked chickweed	M	AEP	
Forb/Fern	Stellaria obtusa			Rocky Mountain Starwort		US	YES
Forb/Fern	Stellaria umbellata			Umbrella Starwort		US	YES
Forb/Fern	Stenanthium occidentale			Western Featherbells		US	IF DOM
Forb/Fern	Streptopus amplexifolius			Clasping Twistedstalk		US	YES
Forb/Fern	Streptopus lanceolatus	var.	roseus	rose mandarin	S	AEP	
Forb/Fern	Stuckenia filiformis			thread-leaved pondweed	M	AEP	
Forb/Fern	Stuckenia pectinata			sago pondweed	M, W	AEP	
Forb/Fern	Stuckenia pectinatus			Sago Pondweed		US	YES
Forb/Fern	Stuckenia vaginata			large-sheath pondweed	W	AEP	
Forb/Fern	Suaeda calceoliformis			western seablite	M	AEP	
Forb/Fern	Suckleya suckleyana			poison suckleya	F, M, W	AEP	
Forb/Fern	Suksdorfia ranunculifolia			Buttercup-Leaf Mock Brookfoam		US	YES
Forb/Fern	Symphyotrichum boreale			marsh aster	F, M, W	AEP	
Forb/Fern	Symphyotrichum ciliatum			rayless aster	M	AEP	
Forb/Fern	Symphyotrichum ciliolatum			Lindley's aster	M, S	AEP	
Forb/Fern	Symphyotrichum ericoides			tufted white prairie aster	M	AEP	NO
Forb/Fern	Symphyotrichum lanceolatum			western willow aster	M	AEP	
Forb/Fern	Symphyotrichum puniceum			purple-stemmed aster	F, M, S, W	AEP	IF DOM
Forb/Fern	Symphyotrichum subspicatum					US	YES
Forb/Fern	Tanacetum vulgare			common tansy	M	AEP	NO
Forb/Fern	Taraxacum erythospermum			red-seeded dandelion	M	AEP	
Forb/Fern	Taraxacum officinale			common dandelion	M, S	AEP	NO
Forb/Fern	Thalictrum dasycarpum			tall meadow rue	S	AEP	IF DOM
Forb/Fern	Thalictrum occidentale			Western Meadow-Rue		US	IF DOM
Forb/Fern	Thalictrum sparsiflorum					US	IF DOM
Forb/Fern	Thalictrum venulosum			veiny meadow rue	S	AEP	IF DOM
Forb/Fern	Thlaspi arvense			stinkweed	M	AEP	NO
Forb/Fern	Tiarella trifoliata			Threeleaf Foamflower		US	IF DOM
Forb/Fern	Tofieldia pusilla			Scotch False Asphodel		US	IF DOM

Form	Scientific Name	Qual -ifier	Variety or Sub species	Common Name	Wetland Classes	Wet Status Source	US Wetland status
Forb/Fern	Triantha glutinosa			sticky false asphodel	M, F, S	AEP	
Forb/Fern	Trientalis borealis			northern starflower	S, M	AEP	IF DOM
Forb/Fern	Trientalis europaea			Arctic starflower	F, S	AEP	NO
Forb/Fern	Trifolium hybridum			alsike clover	M	AEP	NO
Forb/Fern	Trifolium repens			white clover	M	AEP	NO
Forb/Fern	Triglochin maritima			seaside arrow-grass	F, M	AEP	
Forb/Fern	Triglochin palustris			slender arrow-grass	F, S, M	AEP	
Forb/Fern	Trollius laxus			American Globeflower		US	YES
Forb/Fern	Ulmus americana					US	IF DOM
Forb/Fern	Urtica dioica			common nettle	F, S, M	AEP	IF DOM
Forb/Fern	Urtica urens			small nettle	M	AEP	
Forb/Fern	Utricularia cornuta			horned bladderwort	M, W	AEP	
Forb/Fern	Utricularia intermedia			flat-leaved bladderwort	F, M, S, W	AEP	
Forb/Fern	Utricularia macrorhiza			Greater Bladderwort		US	YES
Forb/Fern	Utricularia minor			small bladderwort	F, M, S, W	AEP	
Forb/Fern	Utricularia vulgaris			common bladderwort	F, M, W	AEP	
Forb/Fern	Utricularia macrorhiza			common bladderwort		US	YES
Forb/Fern	Valeriana dioica			northern valerian	F, M, W	AEP	
Forb/Fern	Verbena hastata			swamp verbena		US	IF DOM
Forb/Fern	Veronica americana			American brooklime	M	AEP	
Forb/Fern	Veronica anagallis-aquatica			speedwell	F, M	AEP	
Forb/Fern	Veronica peregrina			hairy speedwell	M	AEP	
Forb/Fern	Veronica scutellata			marsh speedwell	F, M. W	AEP	
Forb/Fern	Veronica serpyllifolia			Thyme-Leaf Speedwell		US	YES
Forb/Fern	Vicia americana			wild vetch	F, M, S	AEP	NO
Forb/Fern	Viola macloskeyi			MacIoskeyi's violet	M	AEP	
Forb/Fern	Viola nephrophylla			Northern Bog Violet		US	YES
Forb/Fern	Viola palustris			marsh violet	M, S	AEP	
Forb/Fern	Viola renifolia			kidney-leaved violet	F, S	AEP	
Forb/Fern	Viola sororia	var.	affinis	bog violet	B, F, M	AEP	
Forb/Fern	Wolffia borealis			northern ducksmeal	M, W	AEP	
Forb/Fern	Wolffia columbiana			watermeal	M, W	AEP	
Forb/Fern	Xanthium strumarium			cocklebur	W	AEP	IF DOM
Forb/Fern	Zannichellia palustris			horned pondweed	M, W	AEP	
Forb/Fern	Zizia aptera			heart-leaved Alexanders	M	AEP	IF DOM

Appendix B. How ABWRET-A Was Developed and Field-calibrated

1. ABWRET-A Origins and Evolution

ABWRET-A is a regionalized modification of WESP, the Wetland Ecosystem Services Protocol (Adamus et al. 2010 and updates). WESP and ABWRET-A build upon indicator-function relationships first described by the author in the early 1980s and in several agency publications since then (Adamus 1983, Adamus et al. 1987, Adamus et al. 1992, Adamus 1992a, 1992b). WESP and ABWRET also incorporate elements of the Hydrogeomorphic (HGM) Approach (Brinson 1993, Smith et al. 1995) and the Millennium Ecosystem Assessment (Finlayson et al. 2005). From 2006 to 2009 a regionalisation of WESP was conducted in Oregon, resulting in ORWAP[7], the Oregon Rapid Wetland Assessment Protocol (Adamus et al. 2009). That version is now required for all major wetlands permitting and compensation in Oregon. Another WESP regionalisation, applicable to all wetlands of Southeast Alaska, has been completed for the U.S. Fish and Wildlife Service and a final version will be published in 2015 for that region[8] .

In March 2011, the Ecosystem Services program within the Department hosted a workshop of about 30 natural resource modelers to identify a protocol or set of models that would give absolute or relative measures of ecosystem services provided by Alberta's wetlands, was practical to use, and was ready (or close to ready) for application. An outcome of that workshop was that Government staff determined that if WESP could be modified easily to reflect wetland and land use features specific to Alberta, it was the most likely of the protocols and models considered, to meet those criteria. Subsequently, the Department initiated and completed a pilot study of ways to assess ecosystem services of wetlands in the Shepard Slough region of east Calgary (Raudsepp-Hearne and Kerr 2011, Irena F. Creed Consulting 2011, DUC 2011, O2 Planning & Design Inc. 2011a). The pilot study was part of the longer term Alberta Ecosystem Services Roadmap, which is intended as a tool under the Cumulative Effects Management Framework to help inform trade-off decisions and assure more robust decision-making. The pilot study aimed to demonstrate the use and replicability of ecosystem services approaches to support the Department priorities. One part of that study involved applying WESP, not yet modified for Alberta, to 21 wetlands in that study area (O2 Planning + Design Inc. 2011b). The assessments were done by a few environmental professionals from City of Calgary, the Department, and O2 Planning + Design Inc. All had first attended a training in June 2011 taught by the author. At the completion of the pilot study, WESP was determined to have a strong potential for use in the wetlands approvals process in Alberta, provided it be modified and calibrated for each major region of the province. With partial support from the North American Waterfowl Management Plan (NAWMP), a regionalized precursor to ABWRET-A, initially termed WESPAB, was developed, field-calibrated, and published in 2013. With funding from the Government, over 100 consultants and Department staff in southern Alberta were trained in its use.

Six months later the Alberta government released a long-anticipated Wetland Policy which, among other things, specified the development within a short time of a field-based tool for rapidly assessing wetland functions in each of Alberta's major natural regions. The Department determined that the framework provided by WESP and WESPAB offered the most practical and relevant foundation for that field tool, and termed it ABWRET-A

[7] http://www.oregon.gov/dsl/WETLAND/Pages/or_wet_prot.aspx

[8] WESPAK-SE (Wetland Ecosystem Services Protocol for Southeast Alaska): http://southeastalaskalandtrust.org/wetland-mitigation-sponsor/wespak-se/

(Alberta Wetland Rapid Evaluation Tool-Actual). Early in 2014, the Government and NAWMP contracted the development and field-calibration of ABWRET-A in parts of the province's "White Area" that had not been the focus of WESPAB.

The basic steps of the ABWRET-A regionalisation process were:

1. Identify and review technical literature from this region, and other regions as relevant. Use that review to modify or add to the indicator variables that ABWRET-A uses to assess wetland functions
2. Select a set of wetlands to which ABWRET-A will be applied in order to (a) calibrate (scale) ABWRET-A scores to this particular region, and (b) identify technical weaknesses in the ABWRET-A indicators and models that can be corrected
3. Collect ABWRET-A data from those wetlands
4. Modify as needed and then complete the protocol

Details of these steps are described below.

2. Literature Review

To better understand relationships among variables that might indicate functions of White Area wetlands specifically, it was first necessary to identify and read previously published studies. The author used keyword searches of *Web of Science* and *Google Scholar* to identify those. In addition to using such obvious keywords as Alberta and wetlands, the author expanded the query to include various forms of terms such as parkland, lake, pond, stream, river, groundwater, catchment, watershed, and paired those with keywords describing geographic features within the 2014 study area (e.g., North Saskatchewan River, Grande Prairie) or nearby regions. An indexed database was created that allows the citations to be sorted quickly by any combination of topics. Most of the citations refer to peer-reviewed scientific publications, and the abstracts of all (and sometimes the entire publication) were read. The database was subsequently used to document the reasons behind using particular variables in particular ABWRET-A models, as well as to support generally the weights assigned to various conditions of a given indicator.

3. Selection of Regional Calibration Wetlands

Although each of ABWRET-A's scoring models has a *theoretical* minimum score of 0 and a maximum of 1, the *actual* range for any given function is usually narrower, even when ABWRET-A is applied to a large number of wetlands. Moreover, in such an application, the resulting range of the raw scores found among all sites will be quite narrow (e.g., 0.3 to 0.8) for some functions whereas for others it will be broad (e.g., 0 to 1.0). Thus, to facilitate rough comparisons among functions, all raw scores had to be converted mathematically to the same 0 to 1 scale. This was done by comparing them with the range of scores determined for 175 wetlands that were visited and assessed in the northern part of the White Area during 2014. This comparison process is termed "calibration" or "normalisation".

The wetlands that served as this base of comparison were chosen in a systematic manner from a population of 258,187 mapped wetlands in the northern White Area (53% in the Parkland subregion, 26% in south Boreal, 20% in north Boreal). Random sampling was not used because our objective was to define the likely range of

ABWRET-A score variation with as few wetlands as possible -- not to use a sample to characterize the condition of wetlands in the study area generally. Our non-random but systematic sample was limited to mapped wetlands located within 300 m of roads because wetlands located farther from roads would require too much time to access, and identifying wetlands not previously mapped (e.g., many that are flooded only ephemerally or temporarily) would require costly and time-consuming analysis of imagery, much of which was not available for parts of the study region. Because the conditions of the ABWRET-A indicators could not be determined prior to field inspection, we used existing spatial data available for all or most of the region, such as a digital soils layer, as surrogates for some of our indicators which are more accurately determined on-site. Doing so required (1) identifying those relevant layers, (2) using GIS to intersect them with the layer showing all the region's mapped wetlands that exist within the 300-m road-proximate buffer, (3) compiling the spatial data for each wetland in an Access database, and (4) within parts of each of 3 subregions that comprise the northern part of Alberta's White Area, conducting a k-means cluster analysis to place each of the road-proximate wetlands into one of 50 groups based on similarity of the wetland's attributes (as detected by existing spatial data) with those of the other mapped wetlands.

The number of groups (50) specified *a priori* for the clustering within each of the 3 subregions was chosen because that is the maximum number we initially estimated could be visited and assessed by 1-2 field technicians within the 2-3 months available for the calibration field effort. Our objective was to assess at least one wetland from each of the 50 clusters in each subregion, because that approach would most likely maximize the variation in indicator variables and thus scores for functions.

As we applied clustering algorithms to the GIS-compiled spatial data, and before selecting the wetlands to be visited and assessed, we noticed that statistical analysis of our spatial data supported the defining of fewer than 50 clusters per subregion (17 clusters in the Parkland, 20 in the south Boreal, 30 in the north Boreal). We ultimately were able to visit and assess at least one wetland in 16 of the supportable 17 clusters in the Parkland (the unvisited cluster comprised <0.01% of the wetlands in that subregion), at least one in 15 of the supportable 20 clusters in the south Boreal (the unvisited clusters comprised 18% of the wetlands in that subregion), and at least one in 14 of the supportable 30 clusters in the north Boreal (the unvisited clusters comprised 43% of the wetlands in that subregion). The main reason we were unable to assess any wetlands in the unvisited clusters was difficulty getting permission to visit wetlands on private lands.

We visited and applied ABWRET-A to 208 wetlands. In many cases multiple wetlands within the same cluster and subregion were assessed in order to meet other survey objectives, but this created an unbalanced sample relative to the proportion of wetlands naturally occurring in each cluster (see Tables B-1 to B-3). To partially offset this distortion, before we normalized the raw score of each wetland to the spread of scores for all White Area wetlands assessed in 2014, we set aside the results from one or more wetlands in clusters that had been oversampled. The resulting 175 wetlands represented a more balanced sample and thus were used to calibrate ABWRET-A scores to the study region. Locations of those wetlands as well as the full 208 are shown in Figures B-1 and B-2.

Table B-1. Selected wetland representation by cluster in the Parkland Region portion of Alberta's White Area

Cluster	# in Subregion	% of Subregion Wetlands	# Visited	# Selected	% of Selected Wetlands
1	10078	7%	19	4	6.15%
2	7508	5%	14	2	3.08%
3	18	0%	7	3	4.62%
4	15678	11%	9	5	7.69%
5	52	0%	3	2	3.08%
6	3672	3%	8	3	4.62%
7	7718	6%	16	6	9.23%
8	1	0%	0	1	1.54%
9	1	0%	1	1	1.54%
10	8428	6%	7	3	4.62%
11	13444	10%	7	5	7.69%
12	16704	12%	5	5	7.69%
13	18284	13%	23	8	12.31%
14	8530	6%	10	4	6.15%
15	12145	9%	10	4	6.15%
16	15301	11%	22	7	10.77%
17	2	0%	2	2	3.08%

Table B-2. Selected wetland representation by cluster in the south Boreal portion of Alberta's White Area

Cluster	# in Subregion	% of Subregion Wetlands	# Visited	# Selected	% of Selected Wetlands
1	3268	4.80%	2	2	9.09%
2	12678	18.62%	2	2	9.09%
3	2063	3.03%	2	2	9.09%
4	9	0.01%	1	1	4.55%
5	4945	7.26%	0	0	0.00%
6	7293	10.71%	0	0	0.00%
7	1	0.00%	0	0	0.00%
8	15	0.02%	1	1	4.55%
9	3083	4.53%	2	2	9.09%
10	1376	2.02%	4	2	9.09%
11	3	0.00%	0	0	0.00%
12	5587	8.21%	1	1	4.55%
13	1835	2.70%	1	1	4.55%
14	1282	1.88%	1	1	4.55%
15	3488	5.12%	3	3	13.64%
16	10398	15.27%	2	1	4.55%
17	27	0.04%	1	1	4.55%
18	1426	2.09%	2	1	4.55%
19	8741	12.84%	1	1	4.55%
20	559	0.82%	0	0	0.00%

Table B-3. Selected wetland representation by cluster in the north Boreal portion of Alberta's White Area

Cluster	# in Subregion	% of Subregion Wetlands	Visited #	Selected #	% of Selected Wetlands
1	914	1.74%	1	1	5.56%
2	80	0.15%	0	0	0.00%
3	899	1.71%	0	0	0.00%
4	1808	3.44%	1	1	5.56%
5	833	1.59%	0	0	0.00%
6	819	1.56%	2	1	5.56%
7	119	0.23%	2	2	11.11%
8	707	1.35%	0	0	0.00%
9	2678	5.10%	2	1	5.56%
10	54	0.10%	1	1	5.56%
11	2230	4.24%	0	0	0.00%
12	490	0.93%	3	3	16.67%
13	13	0.02%	0	0	0.00%
14	653	1.24%	0	0	0.00%
15	8434	16.05%	1	1	5.56%
16	6598	12.56%	0	0	0.00%
17	763	1.45%	0	0	0.00%
18	263	0.50%	1	1	5.56%
19	64	0.12%	1	1	5.56%
20	3772	7.18%	0	0	0.00%
21	2529	4.81%	0	0	0.00%
22	866	1.65%	1	1	5.56%
23	1	0.00%	0	0	0.00%
24	42	0.08%	0	0	0.00%
25	2552	4.86%	1	1	5.56%
26	489	0.93%	1	1	5.56%
27	223	0.42%	0	0	0.00%
28	129	0.25%	0	0	0.00%
29	3162	6.02%	0	0	0.00%
30	10362	19.72%	2	2	11.11%

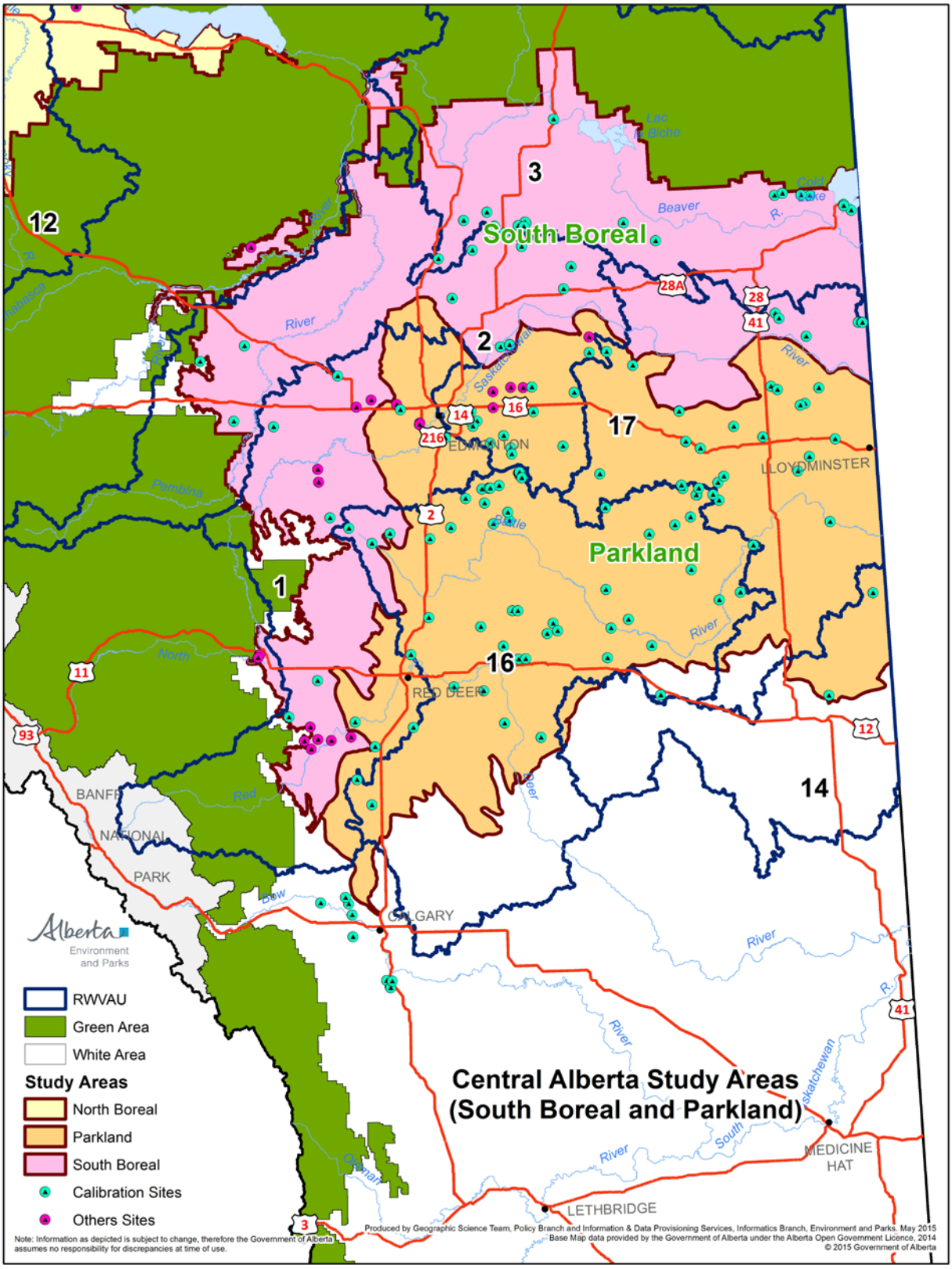

Figure B-1. General locations of the assessed wetlands in parts of the Parkland and south Boreal study areas.

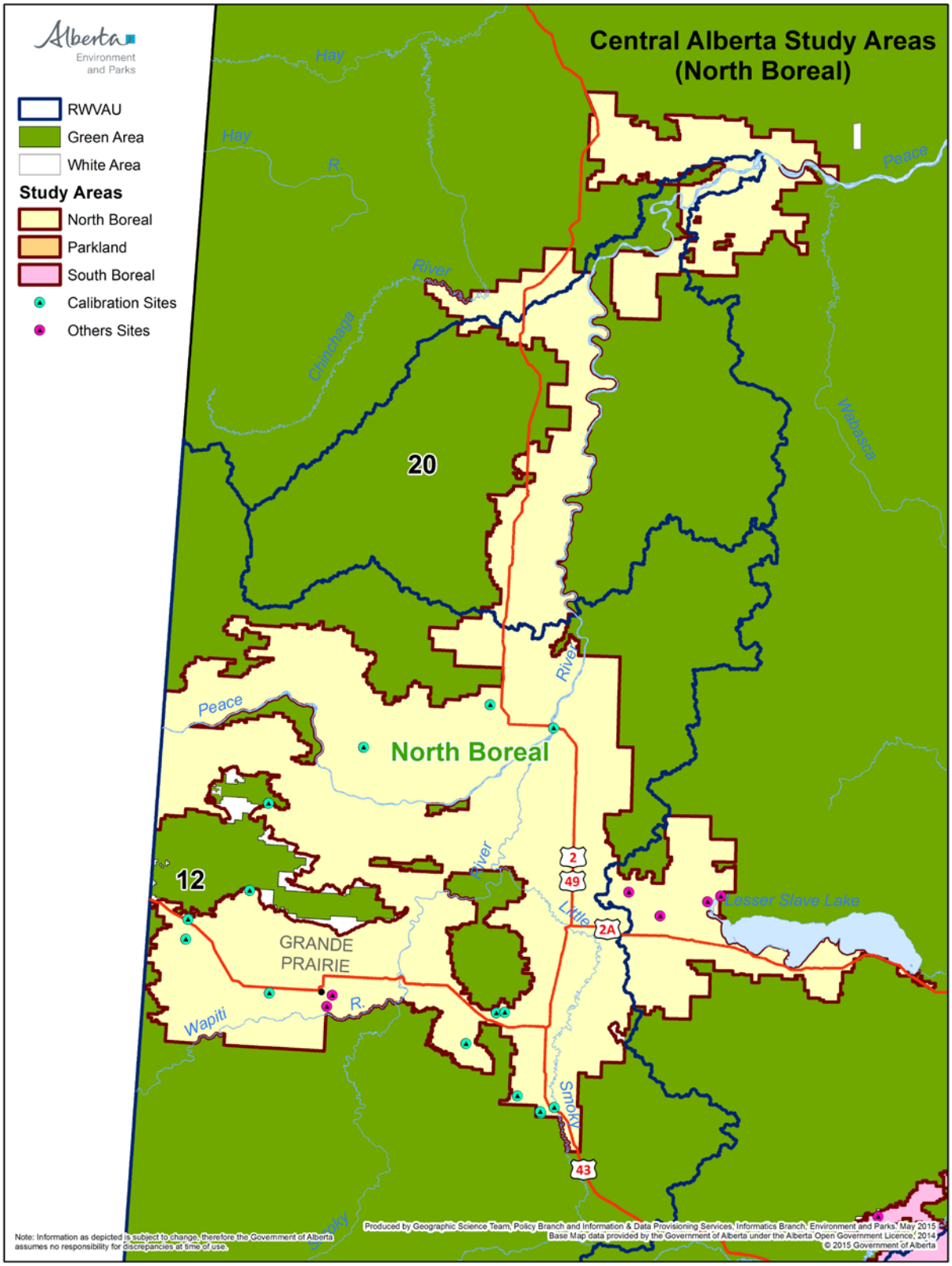

Figure B-2. General locations of the assessed wetlands in parts of the North Boreal study areas.

4. Data Collection and Processing

4.1. Organizing and Conducting the Field Effort

In many instances, the wetlands chosen for visitation and assessment proved to be inaccessible or non-existent. In most such cases, attempts were made at a later date to visit and assess an alternate wetland belonging to the same statistical cluster. Visiting and assessing a wide variety of wetlands was essential not only to calibrate the indicators and model scores as described previously, but also to clarify the wording of questions on the data forms and streamline them by determining the most efficient order of questions , i.e., which sequencing allows users to skip the most questions in various contexts. Thus, limited parts of the data forms (but not the formulas in the scoring models) were changed iteratively by the author in the midst of the field efforts. Revisions were made in response to the author's field observations, feedback from the field technician, or others. The changing of questions throughout the data collection effort could potentially complicate data interpretation. However, close track was kept of revisions made to the data forms, allowing all data to later be successfully "cross-walked" to the final version. No questions were added during the data collecting effort.

Function scores for each of the wetlands visited and assessed are presented in Appendix D.

4.2. Completing the Office Data Component

Field data alone are insufficient to accurately score a wetland's functions. Additional data must be obtained from interpreted aerial images and existing databases. After site visits had been completed, the GPS coodinates were provided to GIS staff at AEP. They subsequently located the wetland in aerial imagery, digitally drew an assumed boundary, and sent that to the principal investigator for review and adjustment based on his field recollections. After the wetland boundaries had been corrected, the GIS staff extracted from existing databases all the digital information required in ABWRET-A's worksheet OF and imported it into the models which combined it with the field observations to generate the function scores.

5. Literature Cited

Adamus, P. R. 1983. A Method for Wetland Functional Assessment. Vol. II. Methodology. Report No. FHWA-IP-82-24. Federal Highway Administration, Washington, D.C.

Adamus, P.R. 1992a. Condition, values, and loss of natural functions of prairie wetlands of the North-Central United States. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1992b. Conceptual process model for basin-type wetlands of the Prairie Pothole Region. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P. R., E. J. Clairain, Jr., R. D. Smith, and R. E. Young. 1987. Wetland Evaluation Technique (WET) Volume II: Methodology. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Adamus, P.R., E.J. Clairain, Jr., D.R. Smith, and R.E. Young. 1992. Wetland Evaluation Technique (WET). Volume I: Literature review and evaluation rationale. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Adamus P.R., J. Morlan, and K. Verble. 2009. Oregon Rapid Wetland Assessment Protocol (ORWAP): Calculator spreadsheet, databases, and data forms. Oregon Dept. of State Lands, Salem, OR.

Adamus, P., J. Morlan, and K. Verble. 2010. Wetland Ecosystem services Protocol for the United States (WESP). Beta test version 1.0. Online: http://people.oregonstate.edu/~adamusp/WESP/

Akbar, T. A., Q. K. Hassan, and G. Achari. 2011. A methodology for clustering lakes in Alberta on the basis of water quality parameters. Clean-Soil Air Water 39:916-924.

Brinson, M. M. 1993. A hydrogeomorphic classification of wetlands. Technical Report WRP-DE-11. Environmental Research Laboratory, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Ducks Unlimited Canada (DUC). 2011. Ecosystem service approach pilot on wetlands: assessment of current and historic wetland carbon stores in the Shepard Slough Area. Report to Alberta Environment and Sustainable Resource Development, Edmonton, AB.

Finlayson, C. M., R. D'Cruz, and N. Davidson. 2005. Ecosystems and Human Well-being: Wetlands and Water: Synthesis. World Resources Institute, Washington, DC.

Irena F. Creed Consulting. 2011. Ecosystem service approach pilot on wetlands: Ecosystem service assessment of wetland water purification for the Shepard Slough Study Area. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8686.pdf

O2 Planning + Design Inc. 2011a. Ecosystem service approach pilot on wetlands: Assessment of Water Storage and Flood Control Ecosystem services. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8687.pdf

O2 Planning + Design Inc. 2011b. Ecosystem service approach pilot on wetlands:Wetland Ecosystem Services Protocol for the United States (WESP) Site Assessments. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8688.pdf.

Raudsepp-Hearne, C. and G. Kerr. 2011. Ecosystem service approach pilot on wetlands: Operationalizing an ecosystem service approach within the Government of Alberta: Steps and lessons learned. Report to Alberta Environment and Sustainable Resource, Edmonton, AB. http://environment.gov.ab.ca/info/library/8683.pdf

Rosen, B. H., P. Adamus, and H. Lal. 1995. A conceptual model for the assessment of depressional wetlands in the Prairie Pothole Region. Wetlands Ecology and Management 3:195-208.

Smith, R.D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Tech. Rept. WRP-DE-9, Waterways Exp. Stn., US Army Corps of Engineers, Vicksburg, MS.

Appendix C. Descriptions of the ABWRET-A Calculations for Scoring and Categorizing Alberta Wetlands

1. Organization of This Appendix

This appendix begins with a discussion of general principles used to score ABWRET-A's indicator variables (questions in data forms) as well as principles used to structure the models of wetland functions which the indicators are intended to predict. The narrative then proceeds to describe, for each function, specifically how the indicator variables were combined in scoring models.

2. Principles Used to Score Indicators and Structure the Models

2.1. Introduction

Many models in ecology and especially hydrodynamics are mechanistic. That is, rates are first estimated or measured for individual processes that comprise (for example) a river channel function, and then mathematical formulas (e.g., hydraulic or thermodynamic equations) are prescribed to combine variables that determine those processes into an actual rate for a function, e.g., grams of phosphorus retained per square meter per year. However, generally applicable measurements of the processes and the variables that determine them simply do not exist for the types of wetlands occurring in much of Alberta. Attempts have been made to build such models on whatever regional data do exist (e.g., Feng et al. 2011, Rahbeh et al. 2011). But due to the lack of data involving direct measures of wetland function from a broad array of wetlands, ABWRET-A uses a different approach to model the various things that wetlands do naturally. Rather than being deterministic, that approach is at times speculative but logic-based and heuristic. Such approaches are well-regarded as an interim or alternative solution when knowledge of system behaviour is scant (e.g., Haas 1991, Starfield et al. 1994, Doyle 2006).

2.2. Indicators

For most ABWRET-A models, physical or biological *processes* that influence a given function were first identified and then *indicators* of those processes were chosen and grouped accordingly. (The term *indicators* is comparable to the term *metrics* used by some other methods). The indicators then were phrased as questions in the data forms. None of ABWRET-A's field-level indicators require *measurement*; they all are based on visual estimates. While the *precision* of measurements is typically greater than for visual estimates, their *accuracy* in predicting functions may or may not be. That is because it is often difficult to obtain sufficient measurements of an indicator, in the span of time typically available to wetland regulators or consultants, to create a full representation of any particular indicator of wetland function, let alone all the indicators that would be needed to assess a common suite of functions.

ABWRET's indicators were mainly drawn from inferences based on scientific literature and the author's experience throughout North America (e.g., Adamus 1993, Adamus et al. 1987, Adamus et al. 1992) and particularly the prairies (e.g. Adamus 1992a,b). Indicators used by other methods for rapidly assessing functions of wetlands in North America were also considered. To qualify as an indicator, a variable not only had to be correlated with or determining of the named process or function, but it also had to be rapidly observable during a single visit to a typical wetland during the Alberta growing season, or information on the indicator's condition had to be obtainable from aerial imagery, existing spatial data, and/or landowner interview.

When developing models of any kind, the factors that contribute to the output can be categorized in three ways: (1) unknown influencers, (2) known influencers that are difficult to measure within a reasonable span of time, and (3) influencers that can be estimated visually during a single visit and/or from existing spatial data. ABWRET-A provides an incomplete estimate of wetland functions because it incorporates only #3. Also, some of the indicator variables it uses may be *correlates* of wetland functions rather than actual influencers. For example, changes in water levels are correlated with changes in nutrient cycling, but it is the difficult-to-measure changes in sediment oxygen and pH that induce the changes in nutrient cycling, not the water level changes themselves (which happen to correlate loosely with those changes in oxygen and pH). These types of limitations apply to all rapid assessment methods.

For regulatory and management applications (e.g., wetland functional enhancement), it's often helpful to understand to which of four categories an indicator belongs:

1. *Onsite modifiable*. These indicators are features that may be either natural or human-associated and are relatively practical to manage. Examples are water depth, flood frequency and duration, amount of large woody debris, and presence of invasive species. More important than the simple presence of these are their rates of formation and resupply, but those factors often are more difficult to control
2. *Onsite intrinsic*. These are natural features that occur within the wetland and are not easily changed or managed. Examples are soil type and groundwater inflow rates. They are poor candidates for manipulation when the goal is to enhance a particular wetland function
3. *Offsite modifiable.* These are human or natural features whose ability to be manipulated in order to benefit a particular wetland function depends largely on property boundaries, water rights, local regulations, and cooperation among landowners. Examples are watershed land use, stream flow in wetland tributaries, lake levels, and wetland buffer zone conditions
4. *Offsite intrinsic*. These are natural features such as a wetland's topographic setting (catchment size, elevation) and regional climate that in most cases cannot be manipulated. Still, they must be included in a wetland assessment method because of their sometimes-pivotal influence on wetland functions

2.3. Weighting and Scoring

Explicitly or implicitly, ABWRET-A assigns relative weights or scores at seven junctures:

1. Scoring of the *conditions* of an indicator variable, as they contribute to that indicator's prediction of a given wetland process, function, or other attribute
2. Scoring of *indicators* (metrics) relative to each other, as they together may predict a given wetland process, function, or other attribute
3. Scoring of wetland *processes*, as they together may predict a given wetland function or other attribute
4. Combining scores for 14 wetland functions into function *group* scores (4 per wetland)
5. Combining wetland group scores into wetland *value scores* (1 per wetland)
6. Converting wetland value scores to value *categories*
7. Modifying wetland categories in some cases by applying an *abundance factor*

Each of these is now described.

2.3.1. Weighting of Indicator Conditions

As an example of #1, consider the following conditions of the indicator, Ponded Open Water Percentage as it is applied by ABWRET-A to estimate the Waterbird Habitat function:

A	B	C	D	E	F	G
F14	% of Ponded Water That Is Open	In ducks-eye aerial view, the percentage of the ponded water that is open (lacking emergent vegetation during most of the growing season, and unhidden by a forest or shrub canopy) is:				0.00
		<1% or none, or largest pool occupies <0.01 hectares. Enter "1" and SKIP to F20 (Floating Algae & Duckweed).	0	1	0	
		1-5% of the ponded water. Enter "1" and SKIP to F20.	0	2	0	
		5-30% of the ponded water.	0	4	0	
		30-70% of the ponded water.	0	6	0	
		70-99% of the ponded water.	0	4	0	
		100% of the ponded water.	0	3	0	

Each row following the first one describes a possible *condition* of this indicator. You must select the one condition that best describes the wetland being assessed by entering a “1” next to that condition in column D). In column E, ABWRET’s author previously assigned relative weights to each of these conditions as they relate to the function. You cannot alter those. In this case, the fourth condition (30-70%) was considered most supportive of that function, other factors being equal, and so had been given a weight of six. This does not necessarily mean it is 6 times more influential than the first condition which has a weight of 1, because this is not a deterministic model. However, available literature seemed to suggest that this intermediate condition is distinctly better than the second and fourth condition choices, and so it was assigned a weight of 6, separating it by 2 points from the next closest conditions, rather than a weight of 5, thus signifying that the relationship of these conditions to the function is believed to be slightly nonlinear rather than linear. When the same indicator is used to score a different function, the weight scheme might be reversed or otherwise differ.

In many instances, considerable scientific uncertainty surrounds the exact relationship between various indicator conditions and a function, and thus which weights should be assigned. However, keep in mind that Ponded Open Water is just one of 47 indicators used to assign a score to the Waterbird Habitat function. To some degree, the use of so many indicators will serve to buffer the uncertainty in our knowledge of exact relationships, and the additional time they add to performing the assessment is miniscule .

ABWRET-A users will also notice that the weighting scale for some indicators ranges from 1 to 8 (especially if there are 8 condition choices) while for others it ranges only from 0 to 2, or some other range. This does not mean that the first indicator is secretly being weighted 4 times that of the second, because before the indicators are combined, their scores are “normalized” to a 0 to 1.00 scale. The Excel spreadsheet accomplishes that by multiplying the “1” signifying a user’s choice (in column D) by the pre-determined condition weight in column E, and placing the product in the last column,

whereupon a formula (not visible here) in the green cell takes the maximum of the values pertaining to this indicator in that last column and divides it by the maximum weight in column E, the condition weight column. The formula in the green cell could just as easily have taken the only non-zero value in the last column and divided it by the maximum weight pre-assigned to the indicator conditions.

Note also that the weight scale for some indicators begins at 0 while for others it begins at 1. Often, "0" was reserved for instances where, if the indicator was the only one being used, that condition of the indicator would suggest a nearly total absence of the function. Because each of the indicator scores is normalized, this difference (0 vs. 1) at the bottom end of the scales for different indicators is probably trivial.

2.3.2. Weighting and Scoring of Indicators of Wetland Functions

In most cases, ABWRET-A does not assign weights so explicitly (i.e., as multipliers) to the various indicators of a function. More often, weights are implicit in the manner in which indicators are combined. For example, if a function model is:

Indicator A + (Average of: Indicator B, Indicator C, Indicator D)

This implies that Indicators B, C, and D individually are likely to have less weight than Indicator A because they are only contributing to an average rather than standing alone, and as such, a low score for one may compensate somewhat for a high score on another.

If one indicator is so important that occurrence of a particular condition of that indicator can solely determine whether a function even exists in a wetland, then conditional ("IF") statements are used in ABWRET-A models to show that. For example, if a wetland dries up annually, it is not on a floodplain, and it contains no inlets or outlets, the Fish Habitat function is automatically scored "0". In this case, "access" (presence/absence of inlets or outlets) is a controlling indicator. If a few indicators are not individually so controlling but at least one is likely to be strongly limiting in some instances, ABWRET-A takes the *maximum* among of the indicators, rather than the average. The latter is applied to situations where indicators are though to be compensatory, collinear, or redundant. ABWRET-A uses averaging as the default operator unless situations can be identified where there is compelling evidence that an indicator is controlling or strongly limiting.

There also are instances where the condition of one indicator (such as wetland type) is used to determine the relevance of others for predicting a wetland function. For example, the effect of vegetation structure within a wetland on the wetland's ability to slow the downslope movement of water in a watershed can be ignored if the wetland has no outlet channel. In the ABWRET-A calculator spreadsheet, all such contingent relationships among indicators that we identified and incorporated into ABWRET-A models are documented in the Rationale column.

2.3.3. Weighting and Scoring of Wetland Processes That Influence Functions

For many functions, dozens of hydrologic (e.g., evapotranspiration) and/or ecological (e.g., juvenile dispersal) processes contribute to its ultimate level of performance. Often, too little is know about the relative importance of these processes in determining a wetland function, and for some processes there are no known indicators that can be estimated visually. Nonetheless, used processes as an organising framework for the many indicators it employed to score each function. For most functions, the

processes are weighted like indicators and used as a "subscore" when computing the score for a function. For example, for the function Phosphorus Retention, the function model contains these processes:

[(3*Adsorb + 2*AVERAGE(Connec, Desorb) + AVERAGE(IntercepWet, IntercepDry)] /6

That means that Adsorption was given half (3/6) of the weight, the average of Connectivity and Desorption was given one-third (2/6) of the weight, and the average of Dry Interception and Wet Interception was given 1/6 of the weight. They are divided by 6 because that is the sum of their weights (3 + 2 + 1) and the resulting function score, for the sake of clear comparisons, must be normalized to the 0 to 1 scale used by all functions.

2.3.4. Normalizing of ABWRET-A Function Scores

ABWRET-A automatically normalizes (converts to a 0-to-1 scale) the raw scores from all wetlands in a study region. Normalizing answers the question, “How does this wetland compare with a large set of others in the study region?” In that sense, normalized scores are like percentiles. Normalizing also allows for straightforward comparison of any function score with any other function score from the same or a different wetland. The normalizing process, which was applied to the scores for each function, employed this widely-recognized formula:

$$\frac{\text{raw score of } \textbf{“wetland x”} - \textbf{minimum} \text{ score from all wetlands in the same RWVAU}}{\textbf{maximum} \text{ score of all wetlands in RWVAU} - \textbf{minimum} \text{ score of all wetlands in RWVAU}}$$

Of course, not every one of the thousands of wetlands in any RWVAU could be visited in order to apply ABWRET-A. Therefore, an abbreviated version that required only the querying of existing spatial data using GIS was applied to all wetlands in each RWVAU to estimate their function scores, and thus inform key parts of the above formula.

2.3.5. Combining of Multiple Wetland Functions Into Rating Categories

A few more steps were required to convert a wetland's series of 14 normalized function scores to a single A, B, C, or D value category for the wetland. Criteria used in these steps were *policy*-based rather than science-based:

1. For a given wetland, its highest normalized function score in each of the following function groups was used to define that group:

   Hydrologic: highest score of Water Storage or Stream Flow Support

   Water Quality: highest score of Water Cooling, Sediment Retention, Phosphorus Retention, Nitrate Removal

   Ecological: highest score of Organic Nutrient Export; Invertebrate Habitat; Fish Habitat; Amphibian Habitat; Waterbird Habitat; Songbird, Raptor, and Mammal Habitat; Plant & Pollinator Habitat.

   Human Use: same as Human Use function model

2. The scores for these four function groups were combined into a "value score" by taking a weighted average, wherein the first three function groups each accounted for 30 percent of the value score and the last accounted for 10 percent
3. The resulting value scores that were above the 90th percentile in the frequency distribution of value scores for all wetlands in the White Area were categorized as A, between the 70th and 90th percentile as B, between the 40th and 70th percentile as C, and scores below the 40th percentile as D
4. The resulting wetland's category was either left unchanged, or elevated one level (e.g., from C to B) if estimates of historical losses of wetland area and number in its RWVAU were large relative to those in other RWVAUs in the White Area, or decreased one level if such losses were estimated as relatively minor. This was called the "Abundance Modifier." Procedures for estimating these historical losses and descriptions of criteria for large and small losses are provided in another document
5. The resulting statistical distribution of A's, B's, C's, and D's among all White Area wetlands was examined. If the percentage of either A's or D's fell below 5 percent, the criteria for that category were modified until the 5 percent criterion was met

3. Model Descriptions

In each section below, a definition is provided of the function, followed by summaries of scientific evidence of it being performed by wetlands generally and in Alberta. This is followed by a simplified description of how the score for that function is computed by ABWRET-A, and finally, a brief note on how the ABWRET-A model for the function might be validated with direct measures of the function. The indicators (i.e., data form questions) that are mentioned in the narratives below are shorthand descriptions of indicators that are defined and explained fully in the ABWRET-A data forms.

3.1. Water Storage (WS)

Function Definition: The effectiveness of a wetland for (a) intercepting snow, (b) storing water aboveground, (c) recharging the moisture in subsurface soils and groundwater, and/or (d) delaying the downslope movement of surface water for long or short periods. In doing so, wetlands potentially influence the height, timing, duration, and frequency of inundation in other wetlands and in downstream or downslope areas. Prediction accuracy is anticipated to be much greater for (a) and (b) because for (c) and (d), measurements of soil depth and texture (at greater depth than is practical to dig during a rapid assessment) would be required, along with an understanding of subsurface water levels, flow direction, and exchange rates during different seasons.

Scientific Support for This Function in Wetlands Generally: Moderate to high. Many wetlands are capable of slowing the downslope movement of water, regardless of whether they have significant storage capacity, simply because wetlands are *relatively* flat areas in the landscape. When that slowing occurs in multiple wetlands, flood peaks further downstream are muted somewhat. When wetlands are, in addition, capable of storing (not just slowing) runoff, that water is potentially available for recharging aquifers and

supporting local food webs. Wetlands are least effective when they act like impervious surfaces, transmitting rather than absorbing precipitation, and accelerating rather than delaying runoff.

In Alberta Wetlands: Many of the province's wetlands should be capable of performing this function, and efforts have been made to quantify it (e.g., Hubbard & Linder 1986, Gleason & Tangen 2008, Huang et al. 2011). Hydrologic functions of prairie wetlands have been described by LaBaugh et al. (1998) and others. Recharge of groundwater by some wetland depressions, especially drier ones (types I, II, and III) has been documented (e.g., Lissey 1971, Richardson and Arndt 1989, Loken 1991, Degenhardt et al. 2011) and occurs regardless of size of the depression. In at least some cases the recharge is shallow, potentially helping to support adjoining crops but usually not infiltrating into deeper aquifers (Hayashi et al. 1998, van der Kamp and Hayashi 2009). This may be a major contributor for sustaining cropland moisture (Berthold et al. 2004, Pham et al. 2009) but can increase the soil salinity along the edges of wetlands, thus limiting crop productivity in that zone. In many Alberta wetlands, the amount of surface water in a wetland in late spring may be influenced more by gains from snow accumulated during the previous fall and winter than by the rainfall during spring or by air temperature effects on evapotranspiration losses during that time and later.

Where this function is performed to some degree, its *benefit* will depend partly on wetland location relative to areas potentially damaged by floods, and public dependency on aquifers that have a proven linkage to wetlands. In one case, recharge from wetlands in a 650-hectare prairie pothole area was estimated to provide 1.48 hectare-meters to the aquifer, enough to support 1699 head of cattle for one year (Hubbard and Linder 1986). A 15% reduction in winter precipitation and 2.5 degrees C increase in winter mean air temperature could dry up many streams in this region (Fang et al. 2010). Thus, any role that wetlands may play in storing water and supporting streamflow is important.

Model Structure:

- If a wetland lacks an outlet (i.e., water never flows out during a typical year), it automatically receives the highest score for this function
- For all other wetland types, the score increases with increasing *Surface Storage*, *Flow Resistance & Delay* and *Infiltration*. These are all considered equally influential in most cases and so are averaged

In the above calculations[9]:

- **Surface Storage** is assumed to be indicated by the average of the scores for wetland area (1/4 of the score, +), amplitude of annual water level fluctuation (1/4 of the score, +), percentage of the wetland that is inundated only seasonally (1/4 of the score, +), and the average of 2 indicator scores: wetland area as a percentage of watershed area (+), and position in watershed (+ if closer to headwater)
- **Flow Resistance & Delay** is indicated by the average of the scores for wetland gradient (+ if flatter), microtopography (+ if more varied), percentage of surface water that is ponded (+),vegetated width (+), outlet constriction (+), and the type and pattern of vegetation that intercepts

[9] Throughout this appendix, a "+" symbol means that indicator tends to increase the function or the referenced process, while a "-" tends to decrease it.

surface waters flowing through the wetland. The first 2 of these indicators are applied to all wetlands, whereas the others are applied only to wetlands with surface water (and the last 2, only if an outlet is present). In addition, the score for the length-gradient index (+) is included in the average if the wetland is larger than 10 ha

- **Infiltration** also partly accounts for evapotranspiration losses, and is expressed as the average of 4 groups, each consisting of averages of scores for multiple indicators. The first group is the average of springs (- if present), presence of groundwater indicators (-), and percentage of wetland that is fen (-). The second is the average of scores for soil texture (+ if coarse) and aquifer vulnerability (+) combined with the score for subzero days (-). The third group is the average of scores for precipitation surplus (-), summertime wind (+), wetland perimeter-area ratio (+), and percent of surface water that is open (+). The fourth group is the average of scores for wetland vegetated area and percentage of wetland vegetation that is woody (both +). For wetlands larger than 10 ha, the GIS-based estimates of soil texture, open water percentage, and woody vegetation cover are automatically substituted for the onsite determinations

Important Note: The model imperfectly addresses the role of wetland surface ***area*** in storing water. Obviously, larger wetlands can potentially store more water. Because the model is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores for this function than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

Potential for Future Validation: The volume, duration, and frequency of water storage could be measured in a series of wetlands that encompass the scoring range, and flows could be measured at their outlets if any, and at various points downstream. This could be done to calibrate detailed mechanistic models of water storage, e.g., SWAT (Abbaspour et al. 2010). Measurements should especially be made during major storm or snowmelt events. Procedures that might be used are described generally by Warne & Wakely (2000) and US Army Corps of Engineers (2005), and for prairie wetlands specifically by Conly et al. (2004) and Minke et al. (2010).

3.2. Surface Water Support

Function Definition: The effectiveness of a wetland for contributing water to streams during the driest part of a growing season.

Scientific Support for This Function in Wetlands Generally: Low to moderate.

In Alberta Wetlands: No measurements are available on the degree to which wetlands in this region may be performing this function.

Model Structure:

- If a wetland lacks an outlet (i.e., water never flows out during a typical year), it automatically is scored 0 for this function
- For all other wetland types, the score increases with increasing average of the scores for 4 indicator groups

- The first group is the average of scores for presence of a spring (+) or other indicators of groundwater discharge (+), percentage of wetland that is classified as fen (+), predominant wetland class (fen preferred), and soil texture (organics considered best)
- The second group is the average of scores for subzero days (+), precipitation surplus (+), summertime wind (-), wetland perimeter-area ratio (-), percentage of wetland that is open ponded water (-), wetland vegetated area (-), and percentage of vegetation that is woody (-)
- The third group is the average of scores for ratio of wetland area to watershed area (+), watershed position (+ if closer to headwaters), and location within a riparian or floodplain area (+)
- The fourth group is the average of scores for wetland depth (+), duration of outflow (+), and probability of having surface water (+)

For wetlands larger than 10 ha, the GIS-based estimates of soil texture, open water percentage, and woody vegetation cover are automatically substituted for the onsite determinations.

The model does not account for the surface area of the wetland or the receiving water body's volume and flow rate. Obviously, larger wetlands could potentially contribute a greater *volume* of water to streams if other factors support this function. Because the model for this function is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

3.3. Streamwater Cooling (WC)

Function Definition: The effectiveness of a wetland for maintaining or reducing the water temperature, primarily in headwater streams. This is potentially significant for supporting the habitat of many recreationally-important coldwater fish, as well as for avoiding conditions that support blooms of nuisance algae (which limit swimming and deprive aquatic animals of oxygen) and proliferation of microbes that cause disease in humans and livestock,

Scientific Support for This Function in Wetlands Generally: Low to moderate.

In Alberta Wetlands: A limited subset of the province's wetlands, particularly those with shade and substantial discharge of groundwater, should be capable of performing this function.

Model Structure:

- If a wetland lacks an outlet (i.e., water never flows out during a typical year), it automatically is scored 0 for this function
- For all other wetland types, the score increases with increasing scores for *Shading, Groundwater Input,* and persistence of *Outflow*, and decreases with increasing exposure to *Water Heating.* These are all considered equally influential in most cases and so are averaged

In the above calculations:

Shading is indicated by the average of scores for wetland class (wooded swamp and fen having the most potential), percent of the wetland that never has surface water (because subsurface water is more protected from sunlight), and for a direct estimate of the percent of the summertime surface water that is shaded.

Water Heating is similar and is indicated by the average of scores for water depth (less heating), percent of wetland that is ponded (more heating), percent of ponded water that is open (more heating), and percent of wetland vegetation that is woody (less heating).

Groundwater Input is assumed greater (and thus more cooling potential) if a spring is present, a large percentage of the wetland is classified as fen, and indicators of groundwater discharge are present. The scores of these 3 indicators are averaged.

Export is indicated by averaging the scores for outflow duration (+), location in a riparian or floodway area (+), and surface water probability (+).

For wetlands larger than 10 ha, the GIS-based estimates of open water percentage and woody vegetation cover are automatically substituted for the onsite determinations, and for Water Heating component, the inverse of the score for the length-gradient ratio is included in the average.

The model does not account for the surface area of the wetland or the receiving water body's volume and flow rate. Obviously, larger wetlands could potentially provide a greater *volume* of cooled water if other factors support this function. Because the model for this function is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

3.4. Sediment Retention and Stabilization (SR)

Function Definition: The effectiveness of a wetland for intercepting and filtering suspended inorganic sediments thus allowing their deposition, as well as reduce current velocity, resist erosion, and stabilize underlying sediments or soil.

Scientific Support for This Function in Wetlands Generally: High. Being relatively flat areas located low in the landscape, many wetlands are areas of sediment deposition, a process facilitated by wetland vegetation that intercepts suspended sediments and stabilizes (with root networks) much of the sediment that is deposited.

In Alberta Wetlands: Net retention of suspended sediment in some Alberta wetlands was demonstrated by Ontkean et al. (2003) and Preston et al. (2013). Many of the region’s wetlands should be capable of retaining much of the sediment that enters them. Well-flushed wetlands, such as those intersected by channels or located on steep slopes, are least capable. In this region the extensive cropland, frequent winds and erosion caused by ice provide opportunities for wetlands to trap sediment and/or to stabilize underlying soils and sediments.

Potentially, the performance of this function has both positive and negative effects. Positives include reduction in turbidity in downstream waters, provision of substrate for outward expansion of marsh vegetation into deeper water, and improved detoxification or immobilisation of some contaminants associated with the retained sediment. Sediment, especially its clay and components, serves as a carrier for heavy metals (Miller & Beasley 2010), phosphorus, and some toxic household chemicals (Hoffman et al. 2009, Kronvang et al. 2009). Negative effects of excessive sedimentation potentially include progressive

filling of productive wetlands, slowing of natural channel migration, and increased exposure of organisms within a wetland to contaminants.

Model Structure:

- If a wetland lacks a surface-flow outlet, i.e., is isolated, then the highest possible score for this function (10.00) is assigned automatically
- For all other wetland types, the score increases with decreasing duration of outflow (half the final score) and with the average of the scores from 3 indicator groups which together characterize the potential for sediment entrainment and storage
- The first group is the average of the scores for wetland vegetated area (+), percentage of ponded water that is open (-), and interspersion between vegetation and open water (+)
- The second group is the average of the scores for wetland gradient (+ if flat), subzero days (-), and slope of the buffer area around the wetland (-)
- The third group is the average of the scores for 12 indicators: wetland area as a percent of its contributing catchment (+), percentage that is flooded only seasonally (+), annual water level fluctuation (-), depth (+), percentage of water edge having a flat slope (+), vegetated width (+), ground cover density (+), percentage of surface water that is ponded (+), constrictedness of outlet (+), throughflow sinuosity (+), microtopographic variation (+), and absence of human-related soil alterations (+)

For wetlands larger than 10 ha, the GIS-based estimates of open water percentage and vegetation-water interspersion are automatically substituted for the onsite determinations. Also, the score for the length-gradient ratio is included in the second average described above.

The model does not account for the wetland's surface area, and obviously, larger wetlands could potentially trap and store more sediment if other factors support this function. Because the model for this function is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

Potential for Future Validation: The volume of accreted sediments could be measured in a series of wetlands that encompass the scoring range. This might be done with sediment markers, with isotopic analysis of past sedimentation rates, or with SET tables (Boumans & Day 1993). Suspended sediment could be measured at inlets and outlets if any, with simultaneous measurement of changes in water volume and flow rate (e.g., Detenbeck et al. 1995).

3.5. Phosphorus Retention (PR)

Function Definition: The effectiveness for retaining phosphorus for long periods (>1 growing season) as a result of chemical adsorption and complexation, or from translocation by plants to belowground zones or decay-resistant peat, resulting in less potential for physically or chemically remobilizing phosphorus into the water column.

Scientific Support for This Function in Wetlands Generally: Moderate. Because phosphorus (P) is commonly adsorbed to suspended sediment, it will be deposited when suspended sediment is intercepted and deposited in wetlands. However, in snowmelt-dominated parts of the region, most P is in soluble rather than particulate form. These soluble forms of P can be chemically precipitated from the water column if there are sufficient levels of certain elements (iron, aluminum, calcium), the water is aerobic, and the pH is acidic (with iron, aluminum) or basic (calcium). This chemical precipitation of P also results in retention within a wetland. Plant roots also can facilitate P retention by aerating the sediment and translocating aboveground P to belowground areas where P-bearing sediments are less likely to be eroded. Phosphorus can potentially accumulate in wetlands more rapidly than nitrogen, and a state can be reached (perhaps after several decades of increased P loading) where sediments become saturated and no more P is retained, at least not until some is desorbed and exported by wind or other means. This saturated state may occur when water extractable soil phosphorus reaches a concentration of about 4 mg P per kg (van Bochove et al. 2012).

Throughout the year, a variable proportion of retained P will re-enter the water column (i.e., be desorbed from sediments or leached from organic matter) and be exported from the wetland (Ontkean et al. 2003). This can happen when sediments or the water column become anaerobic or the pH changes (Table C-2). These changes can be caused by excessive loads of organic matter, rising temperature, and/or reduced aeration due to slowed water exchange rates, increased water depth, or ice (especially snow-covered) that reduces light and seals off diffusion of atmospheric oxygen into the water. The wetland's P balance also depends on the physical stability of deposited sediments or soil. Wind can resuspend sediments rich in P making them vulnerable to being exported downstream by currents, but can also aerate the water column, which helps retain the P in the sediments.

Model Structure: The function model is somewhat similar to the model for Sediment Retention.

- If a wetland lacks a surface-flow outlet, i.e., is isolated, then the highest possible score for this function (10.00) is assigned automatically, based on an assumption that most phosphorus is associated with suspended sediment. However, some amount of phosphorus is soluble and could still escape in groundwater. That pathway cannot be estimated with a rapid assessment method
- For all other wetland types, the score increases with increasing scores for *Sedimentation*, *Adsorption*, and persistence of *Outflow*. These are all considered equally influential in most cases and so are averaged

In the above calculations:

- **Adsorption potential** is represented by 8 indicators organized in 2 groups and then averaged. The first group averages the scores for soil texture (+ in clay and peat soils), soil organic composition (+), and salinity (+). The second group averages the scores for water level fluctuation (-), depth (+), percentage of the wetland that never floods (+), probability of surface water being present (-), and dominance of algae or duckweed (-)
- Sedimentation potential is indicated by averaging two groups. The first group is the average of the scores for wetland vegetated area (+), vegetation-water interspersion (+), and percent of surface water that is open (-). The second group is the average of the scores for subzero days (-), wetland area as a percent of its contributing catchment (+), percentage that is flooded persistently (+), annual water level fluctuation (-), vegetated width (+), ground cover density (+), constrictedness of outlet

(+), throughflow sinuosity (+), wetland gradient (-), microtopographic variation (+), and absence of human-related soil alterations (+)

For wetlands larger than 10 ha, the GIS-based estimates of open water percentage, vegetation-water interspersion, and soil texture are automatically substituted for the onsite determinations.

The model does not account strongly for the wetland's surface area. Obviously, larger wetlands could potentially retain more phosphorus if other factors support this function. Because the model for this function is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

Potential for Future Validation: Among a series of wetlands spanning the scoring range, total phosphorus could be measured simultaneously at wetland inlet and outlet, if any, and adjusted for any dilution occurring from groundwater or runoff (or concentration effect from evapotranspiration) over the intervening distance. Measurements should be made at least once monthly and more often during major runoff events (e.g., Detenbeck et al. 1995). A particular focus should be on the relative roles of soil vs. vegetation characteristics, as they affect adsorption vs. uptake processes.

3.6. Nitrate Removal and Retention (NR)

Function Definition: The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonia to nitrogen gas, primarily through the microbial process of denitrification, *while generating little or no nitrous oxide* (a potent "greenhouse gas"). Note that many published definitions of Nitrate Removal do not include the important restriction on N_2O emission.

Scientific Support for This Function in Wetlands Generally: High. Wetlands are perhaps the single most effective landscape feature for removing nitrate from runoff.

Nonetheless, a variable proportion of the nitrate that enters a wetland in runoff will not be effectively processed and may be exported from the wetland (e.g., Ontkean et al. 2003). Wetlands also emit nitrous oxide, but probably not in as large amounts as many other types of landscapes (Pennock et al. 2010, Badiou et al. 2011).

Although nitrate is essential for plant growth, in chronically high concentrations, such as from urban and agricultural runoff, it can be a significant "nonpoint source" that shifts species composition and habitat structure in ways that sometimes are detrimental to rare plants, aquatic food chains, and benefitted species (Carpenter et al. 1998, Anderson et al. 2002). High concentrations of nitrate in well water also are a human health hazard, and some levels of ammonia impair aquatic life. Nitrate concentrations as low as 1 mg/L can change the structure of freshwater algae communities of streams (Pan et al. 2004) and contribute to blooms of toxic algae in lakes and wetlands. Nitrate concentrations in surface waters receiving runoff from croplands sometimes exceed 18 mg/L (Corriveau et al. 2010).

Model Structure:

- If a wetland with surface water lacks a surface-flow outlet, i.e., is isolated, then the highest possible score (10.00) for this function is assigned automatically

- For all other wetland types, the score increases with increasing scores for *Denitrification: Temperature Control, Denitrification: Labile Carbon Control, Redox, Processing Time,* and less *Export.* These are all considered equally influential in most cases and so their scores are averaged

In the above calculations:

- **Denitrification: Temperature Control** reflects warmer temperatures that favor N loss by accelerating denitrification, and are indicated by the average of the scores for subzero days (-), growing season length (+), southerly aspect (+), and intermediate levels of woody cover and ground cover. In wetlands larger than 10 ha, woody cover is represented instead by scores derived using GIS with coarse spatial data
- **Denitrification: Labile Carbon Control** reflects abundant carbon that favors N loss by accelerating denitrification, and is indicated by the average of the scores for soil texture (organic and finer are better), soil organic content (+), undisturbed soil condition (+), wetland class is bog or fen, not a newly created wetland, and percentage of the wetland that is open water (-). In wetlands larger than 10 ha, open water and soil texture are represented instead by scores derived using GIS with coarse spatial data
- **Redox** reflects the interfacing of oxic and anoxic conditions in close proximity, which increases the potential for N removal. This is assumed to be greater in wetlands that are mostly swamp or marsh, with a large ratio of upland edge to wetland area, greater interspersion of vegetation and open water, greater water level fluctuation and percentage that is flooded only seasonally, less probability of containing surface water, presence of upland inclusions, and evidence of groundwater input. These are considered equally influential and so are averaged. In wetlands larger than 10 ha, interspersion of water and vegetation is represented instead by a score derived using GIS with coarse spatial data
- **Processing Time** is indicated by the average of the scores for wetland gradient (-), sinuosity of flow (+), constrictedness of outlet (+), percentage of the surface water that is ponded (+), wetland vegetated width (+), and microtopographic variation (+). For wetlands larger than 10 ha, the score for the length-gradient ratio (+) is also included in the average
- **Export** is assumed to be less, and thus favor N retention, in wetlands that have outflow for shorter periods

The model does not account for the wetland's surface area, and obviously, larger wetlands could potentially remove more nitrate if other factors support this function. Because the model for this function is estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), nitrate and ammonia could be measured simultaneously at wetland inlet and outlet, if any, and adjusted for any dilution occurring from groundwater or runoff (or concentration effects from evapotranspiration) over the intervening distance. Measurements should be made at least once monthly and more often during major runoff events (e.g., Detenbeck et al. 1995). Monitoring should also

measure denitrification rates (at least potential), the nitrogen fixing rates of particular wetland plants, and nitrous oxide emissions.

3.7. Organic Matter Export (OE)

Function Definition: The effectiveness of a wetland for producing and subsequently exporting organic matter, either particulate (detritus) or dissolved, and including net export of nutrients (C, N, P, Si, Fe) comprising that matter. It does not include exports of carbon in gaseous form (methane and carbon dioxide).

Scientific Support for This Function in Wetlands Generally: Moderate-High. Wetlands which have outlets are potentially major exporters of organic matter to downstream waters. That is partly because many wetlands support exceptionally high rates of primary productivity (i.e., carbon fixation, which provides more carbon that is available for export). Numerous studies have shown that watersheds with a larger proportion of wetlands tend to export more dissolved and/or particulate carbon, and that is important to downstream food webs. The benefit of the exported matter to food webs depends partly on the quality and timing of the export, but those factors cannot be estimated with a rapid assessment method.

In Alberta Wetlands: Both cumulatively and on a per-unit-area basis, the carbon reserves (mainly in the form of peat) in the province's wetlands are enormous, and during snowmelt and spring runoff much of this carbon is exported to streams, rivers, and lakes. Once there, much of it supports food chains important to fish, wildlife, and people. While it is true that much organic matter (and associated nutrients) can be exported even from isolated wetlands by means of the emergence of the adults of aquatic insects during the growing season, that export pathway could not be accounted for by a rapid assessment method.

Model Structure: If no surface flow exits a wetland during a typical year, its OE function is automatically scored 0. For all other wetlands, the score increases with increasing *Organic Matter Stock, Decomposition & Mobility*, and *Export Potential*.

In these calculations:

- **Organic Matter Stock** is indicated by the average of the scores for wetland vegetated area (+), vegetated width (+), percentage of the wetland that is fen, bog, or marsh (+), percentage of the vegetated area that contains moss (+),percentage of the wetland that is open water (-), soil texture is predominantly organic (+), percent organic matter in soil (+), stained water (+), and water level fluctuation (+). In wetlands larger than 10 ha, open water is represented instead by a score derived using GIS with coarse spatial data, and soil texture as derived similarly is included in the average
- **Decomposition & Mobility** is indicated by the average of the scores for growing season length (+), percentage of cover that is deciduous and woody (+) or nitrogen-fixers (+), ground cover (+), wetland class (fen or marsh), percentage of wetland that has ponded water (-), wetland gradient (+), vegetation-water interspersion (+), channel sinuosity (+), percentage of wetland that is flooded only seasonally (+), percentage of water that is shaded (+). In wetlands larger than 10 ha, vegetation-water interspersion is represented instead by a score derived using GIS with coarse spatial data
- **Export Potential** is the average of the scores for outlet constrictedness (-), outflow duration (+), and location in a riparian or floodway area (+)

The model does not account for the wetland's surface area, and obviously, larger wetlands could potentially produce and export more carbon if other factors support this function. Because the model for this function is

estimating relative effectiveness per unit area, some smaller wetlands will have higher scores than larger ones. Thus, in the case of this particular function, a multiplication of function score by effective wetland area may sometimes be appropriate.

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), particulate and dissolved organic carbon would need to be measured regularly at wetland inlet and outlet, if any, along with measurements of changes in water volume and flow rate.

3.8. Aquatic Invertebrate Habitat (INV)

Function Definition: The capacity to support an abundance and diversity of invertebrate animals which spend all or part of their life cycle underwater, on the water surface, or in moist soil. Includes dragonflies, aquatic flies, clams, snails, crustaceans, aquatic beetles, aquatic worms, aquatic bugs, and others, including semi-aquatic species. The model described below will not predict habitat suitability accurately for every species, nor the importance of any species or functional group in the diet of important fish or birds.

Scientific Support for This Function in Wetlands Generally: High. All wetlands support invertebrates, and many wetlands support aquatic invertebrate species not typically found in streams or lakes, thus diversifying the local fauna. Their ecological roles have been described by Euliss et al. (1999) and others.

In Alberta Wetlands: Invertebrates occur in the province's wetlands at seasonally high densities and are highly diverse. On a landscape level, invertebrate production within wetlands may subsidize other ecosystem types (e.g., upland passerines feeding on emerging insects) and wetlands in other regions (e.g., via transport in guts or plumage of migratory birds). However, most invertebrate production probably is utilized or recycled in or near the depressional basins in which it originates. Thus, invertebrate production is primarily a site-specific function. High densities of invertebrates (which usually indicate, but are not synonymous with, high production) have been documented in several prairie basins (e.g., Schultz 1987, LaBaugh and Swanson 1988).

Model Structure: The score is the average of 3 indicators. One is a score for the percentage of the wetland that is marsh (+), the second is a score for the percentage of the wetland that is marsh compared with the percentage of the surrounding landscape that is marsh (+), and the third is a score based on the average of 4 groups: *Aquatic Habitat Structure*, *Primary Productivity*, *Hydrologic Environment*, and *Stressors*.

In these calculations:

- **Aquatic Habitat Structure** is represented by the average of the scores for vegetated wetland area (+), number of wetland classes present (+), interspersion of open water and vegetation (+),submerged aquatic cover (+), water depth diversity (+), sinuosity of channels (+), wetland perimeter-area ratio (+), herbaceous plant diversity (+), interspersion of herbaceous and woody vegetation (+), down wood (+), and percentage of wetland that is open water (+). In wetlands larger than 10 ha, open water, number of wetland classes within the wetland, vegetation-water interspersion, and herbaceous-woody interspersion are all represented instead by scores derived using GIS with coarser spatial data, rather than onsite observations

- **Primary Productivity** is indicated by the average of scores for growing season length (+), deciduous tree cover (+), cover of nitrogen-fixing plants (+), water depth (-), water level fluctuation (+), percentage moss cover (-), and acidic waters (-)
- **Hydrologic Environment** is indicated by the average of the scores representing the probability of surface water (+), percentage of the wetland that is flooded persistently (+), and springs or other evidence of groundwater discharge (+)
- **Stressors** are represented by the average of the scores for fish access (-), soil disturbance (-), sediment inputs (-), recently altered hydroperiod (-), contaminants (-), upland buffer extent (+), percentage of natural cover within 1 km (+), percentage of the wetland perimeter having natural vegetation (+), and water quality risk (-)

Potential for Future Validation: The aquatic invertebrate richness, density, and (ideally) productivity would need to be measured regularly throughout the year among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity).

3.9. Fish Habitat (FH)

Function Definition: The capacity to support an abundance and diversity of *native* fish. The model described below will not predict habitat suitability accurately for every species, nor is it intended to assess the ability to restore fish access to a currently inaccessible wetland.

Scientific Support for This Function in Wetlands Generally: Generally low, but high in accessible wetlands. Many such wetlands provide fish with rich feeding opportunities and shelter from predators.

Model Structure:

- A wetland automatically scores a 10 if it hosts a rare fish species (Lake Sturgeon, River Shiner, Silver Redhorse, Northern Squawfish)
- Unless a wetland is known to contain fish, it automatically scores a 0 if it contains surface water for fewer than 4 consecutive weeks annually, or if salinity exceeds ~9 mS/cm (TDS> 4500 mg/L). It is understood that some native fish species in this region, but perhaps not most, will tolerate higher salinities but at perhaps reduced population productivity
- For all other wetlands, the score is the average of the scores for *Wetland Productivity*, *Water Permanence*, *Habitat Structure*, *Avoidance of Anoxia*, and *Avoidance of Other Stressors*

In these calculations:

- **Wetland Productivity** is indicated by the average of two groups. The first consists of the known presence of fish or at least the wetland is on a lake. The second is the average of the scores for growing season length (+), wetland type (not a bog), fringe wetland (+), beaver evidence (+), groundwater evidence (+), presence of a spring (+), acidic conditions (-), and salinity (-)
- **Water Permanence** is indicated by the average of the scores for surface water probability (+), outflow duration (+), percentage of the wetland that is persistent water (+), and percentage of the wetland that never contains surface water (-)

- **Habitat Structure** is indicated by the average of the scores for percentage of the water that is shaded (+), abovewater wood (+), vegetation-water interspersion (+), channel sinuosity (+), water depth (+), and diversity of depth classes (+). In wetlands larger than 10 ha, interspersion is represented instead by a score derived using GIS with coarse spatial data
- **Avoidance of Anoxia** is indicated by the average of the scores for wetland area (+), water depth (+), percentage of wetland that is open water (+), outflow duration (+), extent of flowing water (+), location in a riparian or floodway area (+), and subzero days (-). In wetlands larger than 10 ha, open water is represented instead by a score derived using GIS with coarse spatial data
- **Avoidance of Other Stressors** are represented by the average of the scores for known water quality problem (-), altered flow timing (-), probable contaminant exposure (-), water quality risk index (-), distance to road (+), road density in HUC8 (-), and percentage of the upland buffer containing natural land cover (+)

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), the number of native fish and their onsite productivity and diversity would need to be measured regularly. For transient species, the duration of use and weight gain throughout the times when usually expected to be present should be determined.

3.10. Amphibian Habitat (AM)

Function Definition: The capacity of a wetland to support an abundance and diversity of native amphibians (frogs, toads, salamanders). The model described below will not predict habitat suitability accurately for **every** species.

Scientific Support for This Function in Wetlands Generally: High. Many amphibian species occur almost exclusively in wetlands. Densities of amphibians are noticeably higher in some wetlands, partly due to high productivity of algae and invertebrates, and partly because submerged and emergent vegetation provides shelter and sites for egg-laying and larval rearing.

Model Structure: The score is the average of the scores of 7 indicators: presence of a rare amphibian species (Northern Leopard Frog, Canadian Toad, Western Toad, Columbia Spotted Frog, Long-toed Salamander), within an AEP-defined "Sensitive Amphibian Range", percentage of the wetland that is marsh (+), wetland density within 1km (+), wetland has a higher percentage of a particular wetland class than surrounding 1km (+), percentage of the wetland perimeter that contains natural vegetation (+), and a group that averages the scores for the following: *Aquatic Habitat Structure*, *Aquatic Productivity*, *Reduced Predation Risk*, and *Stressors*. These are defined as follows:

Aquatic Habitat Structure is indicated by averaging the scores for wetland vegetated area (+), wetland perimeter-area ratio (+), wetland vegetated width (+), number of wetland classes within a wetland (+), percentage of the wetland containing ponded water (+), percentage of the wetland containing open water (+), interspersion of vegetation and open water (+), interspersion of herbaceous and woody vegetation (+), microtopographic variation (+), tree diameter diversity (+), down wood (+), and abovewater wood (+). In wetlands larger than 10 ha, interspersion of water and vegetation, interspersion of herbaceous and woody vegetation, and percentage of the wetland that is open water, are all represented instead by a score derived using GIS with coarse spatial data.

Aquatic Productivity is represented by averaging the scores for two indicators. One is salinity (-, which counts only if it is extreme) and the other is the average of scores for: growing season length (+), wetland gradient (-), number of wetland classes within 1 km (+), percentage of the wetland that is marsh (+), presence of a spring (+), evidence of groundwater input (+), beaver (+), water level fluctuation (-), and percentage of the wetland that never has surface water (-).

Reduced Predation Risk is represented by averaging the scores for fish presence (-), percentage of wetland visited often by people (-), and presence of best management practices to limit recreation impacts (+).

Stressors (exposure to) is represented by averaging the scores for water quality risk (-), summertime wind (-), known water quality problem (-), potential exposure to contaminants (-), road density within 1 km (-), distance to road (+), and distance to development or cropland (+).

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), amphibian density and (ideally) productivity and survival would need to be measured during multiple years and seasons by comprehensively surveying (as applicable) the eggs, tadpoles, and adults.

3.11. Waterbird Habitat (WB)

Function Definition: The capacity to support an abundance and diversity of waterbirds (e.g., ducks, geese, swans, loons, grebes, cormorants, gulls, shorebirds, herons, egrets). The model described below will not predict habitat suitability accurately for every species in this group.

Scientific Support for This Function in Wetlands Generally: High. No other wetland function has been documented as thoroughly. See reviews, for example, by Weller 1981, 1999.

In Alberta Wetlands: High. At a continental scale, waterfowl populations have been declining for many decades. Although a trend towards more frequent drought has been a factor, several statistical analyses, such as that of Bethke & Nudds (1995), have determined that wetland losses in Alberta have been at least partly to blame.

Model Structure: If the wetland has any of the following it automatically scores a 10:

- presence of a rare waterbird species (American White Pelican, White-faced Ibis, Trumpeter Swan, Hooded Merganser, Whooping Crane, Yellow Rail, Piping Plover, Long-billed Curlew, Sprague's Pipit), or
- designated as: Important Bird Area, Waterbird Staging Area, Shorebird Staging Area, Trumpeter Swan Use Area, Piping Plover Water Body, or Nesting Bird Colony

Otherwise, the score is the average of the scores for 7 indicators: nesting waterbird density (+), percentage of the wetland that is marsh (+), ratio of marsh and fen area within the wetland to area of these classes in the surrounding 1 km (+), and the following 4 groups: *Habitat Structure*, *Habitat Productivity*, *Offsite Habitat Influence*, and *Stressors*.

Habitat Structure is represented by averaging the scores for wetland vegetated area (+), vegetated width (+), probability of surface water (+), percentage of wetland containing ponded water (+), percentage of wetland having open water, interspersion of vegetation and open water (+), channel sinuosity (+), herbaceous

vegetation as a percentage of all vegetative cover (+), diversity of water depths (+), extent of shorebird habitat (+), extent of flat shoreline (+), presence of an island (+), presence of large-diameter trees (+), and snags suitable for nesting (+). In wetlands larger than 10 ha, the onsite observations of interspersion of water and vegetation, and percentage of the wetland that is open water, are replaced by a score for them derived using GIS with coarse spatial data.

Habitat Productivity is represented by averaging the scores of 2 subgroups. The first averages the scores for wetland gradient (-) and percentage of the wetland that is marsh or fen). The second subgroup averages the scores for these 11 indicators: growing season length (+), located in riparian or floodway area (+), located on a lake (+), presence of fish (+), presence of beaver (+), percentage of wetland that never has surface water (-), acidic water (-), salinity (-), water level fluctuation (-), and percentage of vegetation that is woody (-).

Offsite Habitat Influence is indicated by averaging the scores for wetland density within 1 km (+), percentage of wetland perimeter that contains natural cover (+), vegetative connectivity with other wetlands (+), and percentage of undeveloped open land within 1 km (+).

Stressor exposure potential is represented by averaging the scores for frequency and extent of human visitation (-), implementation of best management practices to minimize human disturbance of waterbirds (+), distance to developed lands or cropland (+), and percentage of buffer that contains natural land cover (+).

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), nesting waterbird species richness and density would need to be determined during the usual breeding period -- approximately April through July. Ideally, nest success and juvenile survival rates should be measured.

3.12. Songbird, Raptor, And Mammal Habitat (SBM)

Function Definition: The capacity to support, at multiple spatial scales, an abundance and diversity of songbirds, raptors, and mammals, especially species that are most dependent on wetlands or water. It cannot be assumed that Alberta wetlands that are most suitable for a variety of waterbirds will also be suitable for a variety of songbirds (Koper & Schmiegelow 2006, 2007). The model described below will not predict habitat suitability accurately for every species in this group.

Scientific Support for This Function in Wetlands: High. During the nesting season in Alberta, individual wetlands contain more species than any other habitat type (Hvenegaard 2011). And in winter, many or most of the species that remain depend on wetlands for shelter, especially during periods of severe weather. Examples include pheasant and deer (Kramlich 1985, Sather-Blair and Linder 1980, Fritzell 1987). Wind velocity within some wetlands is 95% less than in deciduous-wooded shelterbelts (Schneider 1985). In one area of South Dakota, over 70% of the suitable wintering habitat for pheasants was wetland, even though wetlands comprised a relatively small proportion of the landscape (Sather-Blair and Linder 1980).

Model Structure:

- If a wetland hosts breeding individuals of any of the following rare songbird or mammal species it automatically scores a 10: Ferruginous Hawk, Peregrine Falcon, Sprague's Pipit, Prairie Vole, Wandering Shrew, Silver-haired Bat.

- Otherwise, the score is the average of the scores for the following: *Wetland Class Uniqueness, Habitat Structure, Habitat Productivity, Offsite Habitat Influence,* and *Stressors*. These are described as follows:
- For **Wetland Class Uniqueness**, the percentage of various wetland classes that are present within a wetland is compared with the percentages of those classes within the surrounding landscape (within 1 km). The percentage of the class with the largest ratio (most disproportionately represented by the wetland) is converted to a score
- **Habitat Structure** for wetland-dependent mammals, songbirds, and raptors is represented by the average of 5 groups of indicators. The first group averages the scores for wetland vegetated area (+) , vegetated width (+), and number of wetland classes within a wetland (+). The second averages the scores for upland inclusions (+) and the wetland perimeter-area ratio (+). The third group averages the scores for surface water probability (-), percentage of the wetland with ponded open water (-), and percentage of the wetland that never has surface water (+). The fourth group averages the scores for interspersion of water and vegetation (+), and interspersion of herbaceous and woody vegetation (+). The fifth and largest group averages the scores for snags (+), down wood (+), cliffs (+) , tree diameter diversity (+), species dominance among shrubs (-), species dominance among herbs (-), percentage of vegetation that is woody (+), and percentage of vegetation that is shrubs not under a woody canopy (+)
- **Habitat Productivity** for wetland-dependent mammals, songbirds, and raptors is represented by the average of 2 groups of indicators. For the first group, the maximum indicator score (of 1) is assigned if the wetland contains a raptor nest, or is within a designated Key Wildlife Biodiversity Zone, or contains a spring. The second group averages the scores for growing season length (+), location in a riparian area or floodway (+), beaver presence (+), percentage of woody vegetation that is deciduous (+), percentage of herbaceous cover that is sedges (+), percentage of herbaceous cover that is forbs (+), and percentage of the wetland that is classified as anything other than bog (+)
- **Offsite Habitat Influence** is the average of the scores for wetland density within 1 km (+), other natural cover within 1 km (+), number of wetland classes within 1 km (+), vegetative connectivity with other wetlands (+), proportion of wetland perimeter having natural cover (+), and percentage of wetland buffer having natural cover (+)
- **Stressor** exposure potential is represented by the average of scores for road density within 1 km (-), distance to road (+), distance to settled area (+), water quality risk(-), distance to cropland or developed lands (+), wintertime wind (-), human visitation frequency and extent (-), and best management practices for reducing wildlife disturbance (+)

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), species richness and density of songbirds, raptors, and mammals would need to be determined monthly, and more often during migration or seasonal movements (see USEPA 2001 for methods). Ideally, daily duration of use, interannual consistency of use, and seasonal weight gain of key species should be measured.

3.13. Habitat for Native Plants and Pollinators (PH)

Function Definition: The capacity to support, at multiple spatial scales, a diversity of native vascular and non-vascular (e.g., bryophytes, lichens) species and functional groups, especially those that are most dependent on wetlands or water, as well as the pollinating insects that depend on them. It is recognized that conditions which are optimal for pollinators do not always coincide with conditions that are optimal for plant diversity, and originally these two wetland functions were separate. They now have been merged for the sake of efficiency.

Scientific Support for This Function in Wetlands Generally: High. Many plant species grow only in wetlands and thus diversify the local flora, with consequent benefits to food webs and energy flow.

In Alberta Wetlands: The diversity of plants found within a particular wetland is influenced by factors both within the wetland and in the local and regional landscape. With regard to landscape influences, plant diversity in many Alberta wetlands is most correlated with land cover and other features measured within 300 m of a wetland, as opposed to variables measured at distances of up to 2000 m from the wetland (Rooney & Bayley 2011).

Model Structure:

- If a wetland supports a rare vascular plant that is tracked by the ABMI, it automatically scores a 10
- Otherwise, the score is the average of the scores for the following 3 groups: *Rare Plant Range*, *Wetland Class Uniqueness*, and the average of 5 subgroups: *Vegetation Form & Distribution, Wetland Productivity, Habitable Substrate, Offsite Habitat Influence*, and *Stressors*

These subgroups are described as follows:

- **Rare Plant Range** (+) denotes whether a wetland is within the known Alberta range of at least one of the rare plants tracked by ABMI
- **Wetland Class Uniqueness** (+) compares the percentage of various wetland classes that are present within a wetland with the percentages of those classes within the surrounding landscape (within 1 km). The percentage of the class with the largest ratio (most disproportionately represented by the wetland) is converted to a score
- **Vegetation Form & Distribution** is represented by averaging the scores of 10 indicators: number of wetland classes within the wetland (+), tree diameter diversity (+), species dominance among herbs (-), species dominance among shrubs (-), percentage of vegetation that is woody (+), percentage of woody vegetation that is deciduous (+), interspersion of water and vegetation (+), interspersion of herbaceous and woody vegetation (+), percentage of herbaceous cover that is sedges (+), percentage of herbaceous cover that is forbs (+)
- **Wetland Productivity** is represented by averaging the scores of 12 indicators: growing season length (+), location in a riparian area or floodway (+), beaver presence (+), located in a riparian or floodway area (+), presence of a spring (+), presence of an inflow channel (+), not a new wetland (+), water depth (-), water level fluctuation (+), percentage of cover that is nitrogen-fixing plants (+), percentage of vegetative cover that is moss (-), percentage of the wetland that is classified as

anything other than bog (+), and predominant soil texture is something other than sand or other coarse material (+)

- **Habitable Substrate** is indicated by averaging 2 subgroups. One averages the scores for vegetated width (+), percentage of the wetland with persistent water (-), and percentage of the wetland with ponded open water (-). The other subgroup specifically targets some breeding site needs of pollinators, and averages the scores for down wood (+), snags (+), cliffs (+), and microtopographic variation (+). If the wetland is larger than 10 ha, the onsite estimate of open water is replaced by an estimate using existing spatial data and GIS
- **Offsite Habitat Influence** is represented by averaging the scores of 8 indicators: wetland density within 1 km (+), other natural cover within 1 km (+), number of wetland classes within 1 km (+), vegetative connectivity with other wetlands (+), proportion of wetland perimeter having natural cover (+), percentage of wetland buffer having natural cover (+)
- **Stressor** exposure potential is represented by averaging the score for invasive plant cover within the wetland with a score calculated as the average of the scores of 12 indicators . Those indicators are altered timing of flows or runoff (-), road density within 1 km (-), distance to road (+), water quality risk(-), distance to cropland or developed lands (+), likely presence of pesticides (-), extent of weeds along the wetland border (-), distance to settled area (+), human visitation frequency and extent (-), observed or potential soil disturbance (-), and best management practices for reducing soil disturbance (+)

Potential for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), all plant species would be surveyed and percent-cover determined at their appropriate flowering times during the growing season. Species richness and evenness would then be calculated and if possible, related to the functional traits of the species. Pollinators would be colour-marked and tracked to determine foraging distances in the context of different landscape settings and to identify their use of particular species of wetland plants.

3.14. Human Use (HU)

Definition: The potential and actual capacity of a wetland to sustain low-intensity human uses such as hiking, nature photography, education, and research.

Model Structure: The score for Human Use is calculated as the average of the scores of 5 indicators: Ownership (+ if public), Investment (+ if existing mitigation site, research site, or park), and 3 thematic groups: *Access, Resource Use & Best Management Practices*, and *Wetland Morphology*, described as follows:

- **Access** is represented by averaging the scores of 2 subgroups. One subgroup is the average of the scores for distance to road (-), distance to settled area (-), and road density (+). The other assigns maximum indicator score (=1) if the wetland has a documented trail network (+), is within a designated natural area or ecological reserve (+), or on the Alberta Culture Listing of Historic Resources (+)

- **Resource Use & Best Management Practices** is indicated by averaging the scores for the following indicators: visibility and "walk-a-bility" (+), proximity to domestic well (+), extent and frequency of human visitation (+), best management practices to minimize disturbance of soils and wildlife (+), and recreational facilities such as interpretive signs, parking area, public boat ramp (+)
- **Wetland Morphology** is described by the average of the scores for surface water probability (+), wetland area (+), fringe wetland (+), lakeside wetland (+), and percentage of the wetland that has ponded open water (+). However, if the wetland is mostly covered by nuisance algal blooms at some times of the year, the score for Wetland Morphology is set to 0. (+). If the wetland is larger than 10 ha, the onsite estimate of open water is replaced by an estimate using existing spatial data and GIS

4. Literature Cited

Abbaspour, K.C., M. Faramarzi, and E. Roulohlanejad. 2010. Hydrological modeling of Alberta using SWAT model: A preliminary report. Alberta Innovates, Edmonton, AB.

ABMI. 2011. Alberta Biodiversity Monitoring Institute. Wetland field data collection protocols (abridged version) 2012-06-27. Alberta Biodiversity Monitoring Institute, Edmonton, Alberta, Canada. http://www.abmi.ca/abmi/reports/reports.jsp?categoryId=0

Adamus P.R., J. Morlan, and K. Verble. 2009. Oregon Rapid Wetland Assessment Protocol (ORWAP): Calculator spreadsheet, databases, and data forms. Oregon Dept. of State Lands, Salem, OR.

Adamus, P. R. 1983. A Method for Wetland Functional Assessment. Vol. II. Methodology. Report No. FHWA-IP-82-24. Federal Highway Administration, Washington, D.C.

Adamus, P. R., E. J. Clairain, Jr., R. D. Smith, and R. E. Young. 1987. Wetland Evaluation Technique (WET) Volume II: Methodology. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Adamus, P., J. Morlan, and K. Verble. 2010. Wetland Ecosystem Services Protocol for the United States (WESPUS). Beta test version 1.0. Online: http://people.oregonstate.edu/~adamusp/WESP/

Adamus, P.R. 1992a. Condition, values, and loss of natural functions of prairie wetlands of the North-Central United States. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R. 1992b. Conceptual process model for basin-type wetlands of the Prairie Pothole Region. EPA/600/R-92/249. U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, OR.

Adamus, P.R., E.J. Clairain, Jr., D.R. Smith, and R.E. Young. 1992. Wetland Evaluation Technique (WET). Volume I: Literature review and evaluation rationale. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Anderson, D., P. Gilbert, and J. Burkholder. 2002. Harmful algal blooms and eutrophication: nutrient sources, composition, and consequences. Estuaries and Coasts 25(48):704-726.

Anderson, J., R. Beduhn, D. Current, J. Espeleta, C. Fissore, B. Gangeness, J. Harting, S. Hobbie, E. Nater, and P. Reich. 2008. The potential for terrestrial carbon sequestration in Minnesota. A report to the Terrestrial Carbon Sequestration Initiative. Minnesota Department of Natural Resources, St. Paul, MN.

Badiou, P., R. McDougal, D. Pennock, and B. Clark. 2011. Greenhouse gas emissions and carbon sequestration potential in restored wetlands of the Canadian prairie pothole region. Wetlands Ecology and Management 19:237-256.

Berthold, S., L. R. Bentley, and M. Hayashi. 2004. Integrated hydrogeological and geophysical study of depression-focused groundwater recharge in the Canadian prairies. Water Resources Research 40(6).

Bethke, R. W. and T. D. Nudds. 1995. Effects of climate-change and land-use on duck abundance in Canadian Prairie-Parklands. Ecological Applications 5(3):588-600.

Boumans, R. M. J. and J. W. Day. 1993. High-precision measurements of sediment elevation in shallow elevation in shallow coastal areas using a sedimentation-erosion table. Estuaries 16(2):375-380.

Brander, L. M., R. Florax, and J. E. Vermaat. 2006. The empirics of wetland valuation: A comprehensive summary and a meta-analysis of the literature. Environmental & Resource Economics 33(2):223-250.

Brander, L., R. Brouwer, and A. Wagtendonk. Economic valuation of regulating services provided by wetlands in agricultural landscapes: A meta-analysis. Ecological Engineering.

Bridgham, S. D., J. P. Megonigal, J. K. Keller, N. B. Bliss, and C. Trettin. 2006. The carbon balance of North American wetlands. Wetlands 26:889-916.

BRPRC. 2010. The Bow River Project Research Consortium, Bow River Project final report. Alberta Water Research Institute, Edmonton, AB. www.waterinstitute.ca

Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, and V. H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications 8:559-568.

Conly, F. M., M. Su, G. van der Kamp, and J. J. Millar. 2004. A practical approach to monitoring water levels in prairie wetlands. Wetlands 24(1): 219-226.

Coombs, M. 2008. Indicators for assessing environmental performance of watersheds in Parkland Region: A summary document. Alberta Environment, Edmonton, AB. www.environment.gov.ab.ca/info/library/7944.pdf

Corriveau, J., P. A. Chambers, A. G. Yates, and J. M. Culp. 2011. Snowmelt and its role in the hydrologic and nutrient budgets of prairie streams. Water Science and Technology 64(8):1590-1596.

Degenhardt, A., J. Cessna, R. Raina, A. Farenhorst, and D. J. Pennock. 2011. Dissipation of six acid herbicides in water and sediment of two Canadian prairie wetlands. Environmental Toxicology and Chemistry 30:1982-1989.

Dehnhardt, A. and I. Bräuer. 2008. The value of floodplains as nutrient sinks: Two applications of the replacement cost approach. in: B. Schweppe-Kraft, editor. Ecosystem Services of Natural and Semi-Natural Ecosystems and Ecologically Sound Land Use. Bundesamt für Naturschutz (BfN), Bonn, Germany.

Detenbeck, N. E., D. L. Taylor, A. Lima, and C. Hagley. 1995. Temporal and spatial variability in water quality of wetlands in the Minneapolis/St. Paul, MN metropolitan area: Implications for monitoring strategies and designs. Environmental Monitoring
and Assessment 40(1):11-40.

Doyle, M.W. 2006. A heuristic model for potential geomorphic influences on trophic interactions in streams. Geomorphology 77 (3-4):235-248.

Ducks Unlimited Canada (DUC). 2011. Ecosystem service approach pilot on wetlands: assessment of current and historic wetland carbon stores in the Sheppard Slough Area. Report to Alberta Environment and Sustainable Resource Development, Edmonton, AB.

Euliss, N. H. and D. M. Mushet. 1996. Water-level fluctuation in wetlands as a function of landscape condition in the prairie pothole region. Wetlands 16:587-593.

Euliss, N. H. and D. M. Mushet. 2004. Impacts of water development on aquatic macroinvertebrates, amphibians, and plants in wetlands of a semi-arid landscape. Aquatic Ecosystem Health & Management 7(1):73-84.

Euliss, N. H., Jr., D. A. Wrubleski, and D. M. Mushet. 1999. Wetlands of the Prairie Pothole Region: Invertebrate species composition, ecology, and management. Pages 471–514 in D. P. Batzer, R. B. Rader, and S. A. Wissinger, editors. Invertebrates in Freshwater Wetlands of North America: Ecology and Management. John Wiley & Sons, Inc., New York, NY, USA.

Euliss, N. H., L. M. Smith, D. A. Wilcox, and B. A. Brwaine. 2008. Linking ecosystem processes with wetland management goals: Charting a course for a sustainable future. Wetlands 28(3):553-562.

Feng, M., S. G. Liu, N. H. Euliss, C. Young, and D. M. Mushet. 2011. Prototyping an online wetland ecosystem services model using open model sharing standards. Environmental Modelling & Software 26:458-468.

Fissore, C., C. P. Giardina, R. K. Kolka, and C. C. Trettin. 2009. Soil organic carbon quality in forested mineral wetlands at different mean annual temperature. Soil Biology and Biochemistry 41(3): 458-466.

Fritzell, E. K. 1988. Mammals and wetlands. Pages 213-226 in D. D. Hook, editor. The Ecology and Management of Wetlands, Vol. 1: Ecology of Wetlands. Timber Press, Portland, OR.

Gascoigne, W. R., D. Hoag, L. Koontz, B. A. Tangen, T. L. Shaffer, and R. A. Gleason. 2011. Valuing ecosystem and economic services across land-use scenarios in the Prairie Pothole Region of the Dakotas, USA. Ecological Economics 70:1715-1725.

Ghermandi, A., J. C. Van den Bergh, L. M. Brander, H. L. De Groot, and P. A. Nunes. 2008. The economic value of wetland conservation and creation: a meta-analysis. FEEM Working Paper No. 79.2008. http://ssrn.com/abstract=1273002 or http://dx.doi.org/10.2139/ssrn.1273002

Gleason, R. A. and N. H. Euliss Jr. 1998. Sedimentation of prairie wetlands. Great Plains Research 8:97-112.

Gleason, R. A., M. K. Laubhan, and N. H. Euliss, Jr. 2008. Ecosystem services derived from wetland conservation practices in the United States Prairie Pothole Region with an emphasis on the U.S. Department of Agriculture Conservation Reserve and Wetlands Reserve Programs. U.S. Geological Professional Paper 1745.

Gleason, R. A., and B.A. Tangen, B. A. 2008. Chapter D: Floodwater storage. In: Ecosystem services derived from wetland conservation practices in the United States Prairie Pothole Region with an emphasis on the US Department of Agriculture Conservation Reserve and Wetlands Reserve Programs. U.S. Geological Survey Professional Paper Issue 1745.

Haas, T. C. 1991. A Bayesian Belief Network advisory system for aspen regeneration. Forest Science 37:627-654.

Hansson, L., C. Bronmark, P. A. Nilsson, and K. A. Bjornsson. 2005. Conflicting demands on wetland ecosystem services: Nutrient retention, biodiversity or both? Freshwater Biology 50(4):705-714.

Hayashi, M., G. van der Kamp, and D. L. Rudolph. 1998. Water and solute transfer between a prairie wetland and adjacent uplands, 1. Water balance. Journal of Hydrology 207: 42-55.

Hayashi, M., G. A. Mohammed, C. R. Farrow, G. van der Kamp, and L. R. Bentley. 2011. Little pond on the prairie: Effects of land-surface hydrology on groundwater recharge. Geohydro. http://www.geohydro2011.ca/gh2011_user/cle_usb/pdf/doc-2197.pdf.

Hoffmann, C. C., C. Kjaergaard, J. Uusi-Kamppa, H. C. B. Hansen, and B. Kronvang. 2009. Phosphorus retention in riparian buffers: Review of their efficiency. Journal of Environmental Quality 38(5):1942-1955.

Huang, S. L., C. Young, M. Feng, K. Heidemann, M. Cushing, D. M. Mushet, and S. G. Liu. 2011. Demonstration of a conceptual model for using LiDAR to improve the estimation of floodwater mitigation potential of Prairie Pothole Region wetlands. Journal of Hydrology 405:417-426.

Hubbard, D. E. and R. L. Linder. 1986. Spring runoff retention in Prairie Pothole Wetlands. Journal of Soil and Water Conservation 41(2):122-125.

Hvenegaard, G. T. 2011. Validating bird diversity indicators on farmland in east-central Alberta, Canada. Ecological Indicators 11(2):741-744.

Koper, N. and F. K. A. Schmiegelow. 2006. A multi-scaled analysis of avian response to habitat amount and fragmentation in the Canadian dry mixed-grass prairie. Landscape Ecology 21(7):1045-1059.

Koper, N. and F. K. A. Schmiegelow. 2006. Effects of habitat management for ducks on target and nontarget species. Journal of Wildlife Management 70(3):823-834.

Koper, N. and F. K. A. Schmiegelow. 2007. Does management for duck productivity affect songbird nesting success? Journal of Wildlife Management 71:2249-2257.

Kramlich, T. J. 1985. Evaluation of Seasonal Habitat Use by White-Tailed Deer in Eastern South Dakota. Master's Thesis. South Dakota State University, Brookings, South Dakota.

Kronvang, B., G. H. Rubaek, and G. Heckrath. 2009. International phosphorus workshop: Diffuse phosphorus loss to surface water bodies-risk assessment, mitigation options, and ecological effects in river basins. Journal of Environmental Quality 38(5):1924-1929.

LaBaugh, J. W. and G. A. Swanson. 1988. Algae and invertebrates in the water column of selected prairie wetlands in the Cottonwood Lake Area, Stutsman County, North Dakota, 1984. Open file Report 88 451. U.S. Geological Survey, Lakewood, CO.

LaBaugh, J.V., T.C. Winter, and D.O. Rosenberry. 1998. Hydrologic functions of prairie wetlands. Great Plains Research 8: 17-37.

Lissey, A. 1971. Depression-focused transient groundwater flow patterns in Manitoba. Geological Association of Canada Special Paper No. 9:333–341.

Liu, K., Elliott, J. A., Lobb, D. A., Flaten, D. N., and Yarotski, J. 2013. Critical factors affecting field-scale losses of nitrogen and phosphorus in spring snowmelt runoff in the Canadian Prairies. Journal of Environmental Quality 42(2):484-496.

Loken, L. G. 1991. Wetland soil characteristics of basins in closed groundwater catchment systems. Master's Thesis. North Dakota State University, Fargo, ND.

Lougheed, V. L., M. D. McIntosh, C. A. Parker, and R. J. Stevenson. 2008. Wetland degradation leads to homogenization of the biota at local and landscape scales. Freshwater Biology 53(12):2402-2413.

Miller, J. J. and B. W. Beasley. 2010. Trace elements in the Oldman River of Parkland Region. Water Quality Research Journal of Canada 45(3):365-377.

Minke, A. G., C. J. Westbrook, and G. van der Kamp. 2010. Simplified volume-area-depth method for estimating water storage of prairie potholes. Wetlands 30:541-551.

Neuman, A. D. and K. W. Belcher. 2011. The contribution of carbon-based payments to wetland conservation compensation on agricultural landscapes. Agricultural Systems 104:75-81.

Niemi, G. J., P. DeVore, N. Detenbeck, D. Taylor, A. Lima, J. Pastor, J. D. Yount, and R. J. Naiman. 1990. Overview of case studies on recovery of aquatic systems from disturbance. Environmental Management 14(5): 571-587.

Ontkean, G. R., D. S. Chanasyk, S. Riemersma, D. R. Bennett, and J. M. Brunen. 2003. Enhanced prairie wetland effects on surface water quality in Crowfoot Creek, Alberta. Water Quality Research Journal of Canada 38:335-359.

Pan, Y. D., A. Herlihy, P. Kaufmann, J. Wigington, J. van Sickle, and T. Moser. 2004. Linkages among land-use, water quality, physical habitat conditions and lotic diatom assemblages: A multi-spatial scale assessment. Hydrobiologia 515(1-3):59-73.

Pennock, D., T. Yates, A. Bedard-Haughn, K. Phipps, R. Farrell, and R. McDougal. 2010. Landscape controls on N2O and CH4 emissions from freshwater mineral soil wetlands of the Canadian Prairie Pothole region. Geoderma 155:308-319.

Pham, S. V., P. R. Leavitt, S. McGowan, B. Wissel, and L. I. Wassenaar. 2009. Spatial and temporal variability of prairie lake hydrology as revealed using stable isotopes of hydrogen and oxygen. Limnology and Oceanography 54(1):101-118.

Preston, T. M., R.S. Sojda, and R.A. Gleason. 2013. Sediment accretion rates and sediment composition in Prairie Pothole wetlands under varying land use practices, Montana, United States. Journal of Soil and Water Conservation 68(3):199-211.

Rahbeh, M., D. S. Chanasyk, and J. J. Miller. 2011. Two-way calibration-validation of SWAT model for a small prairie watershed with short observed record. Canadian Water Resources Journal 36(3): 247-270.

Richardson, J. L. and J. L. Arndt. 1989. What use prairie potholes? Journal of Soil and Water Conservation 44(3):196-198.

Richardson, J. L., J. L. Arndt, and J. Freeland. 1994. Wetland soils of the prairie potholes. Advances in Agronomy 52:121-171.

Robarts, R. D., D. B. Donald, and M. T. Arts. 1995. Phytoplankton primary production of 3 temporary northern prairie wetlands. Canadian Journal of Fisheries and Aquatic Sciences 52(5):897-902.

Robarts, R. D., M. S. Evans, and M. T. Arts. 1992. Light, nutrients, and water temperature as determinants of phytoplankton production in two saline, prairie lakes with high sulphate concentrations. Canadian Journal of Fisheries and Aquatic Sciences 49(11):2281-2290.

Rooney, R. C. and S. E. Bayley. 2012. Community congruence of plants, invertebrates and birds in natural and constructed shallow open-water wetlands: Do we need to monitor multiple assemblages? Ecological Indicators 20:42-50.

Royer, F. and R. Dickinson. 2007. Plants of Alberta: Trees, Shrubs, Wildflowers, Ferns, Aquatic Plants and Grasses. Lone Pine Publishing, Edmonton, Canada.

Sather-Blair, S. and R. L. Linder. 1980. Pheasant use of South Dakota wetlands during the winter. South Dakota Academy of Science Proceedings 59:147–155.

Schneider, T. M. 1985. Effectiveness of shelterbelts in improving microclimatic conditions for pheasants in eastern South Dakota. Master's Thesis. South Dakota State University, Brookings, SD.

Schultz, B. D. 1987. Biotic responses of Typha-monodominant semi-permanent wetlands to cattle grazing. Master's Thesis. South Dakota State University, Brookings, SD.

Starfield, A.M., K.A. Smith, and A.L. Bleloch. 1994. How to Model It: Problem Solving for the Computer Age. McGraw-Hill, New York.

Stevenson, R. J. and F. R. Hauer. 2002. Integrating hydrogeomorphic and index of biotic integrity approaches for environmental assessment of wetlands. Journal of the North American Benthological Society 21:502-513.

Stewart, R. E. and H. A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Resource Publication 92., Northern Prairie Wildlife Research Center, Jamestown, ND. http://www.npwrc.usgs.gov/resource/wetlands/pondlake/index.htm

USACE. 2005. US Army Corps of Engineers. Technical Standard for Water Table Monitoring of Potential Wetland Sites. WRAP Technical Notes Collection (ERDC TN-WRAP-05-2). U. S. Army Engineer Research and Development Center, Vicksburg, MS.

USEPA. 2001. Methods for Evaluating Wetland Condition: Biological Assessment Methods for Birds. EPA-822-R-02-023. U.S. Environmental Protection Agency Office of Water, Washington, DC. http://www.epa.gov/waterscience/criteria/wetlands/13Birds.pdf

van der Kamp, G. and M. Hayashi. (2009). Groundwater-wetland ecosystem interaction in the semiarid glaciated plains of North America. Hydrogeology Journal, 17(1), 203-214.

van Bochove, E., G. Thériault, J. Denault, F. Dechmi, S. E. Allaire, and A. N. Rousseau. 2012. Risk of phosphorus desorption from Canadian agricultural land: 25-year temporal trend. Journal of Environmental Quality 41: 1402-1412.

Vezie, C., J. Rapala, J. Vaitomaa, J. Seitsonen, and K. Sivonen. 2002. Effect of nitrogen and phosphorus on growth of toxic and nontoxic Microcystis strains and on intracellular microcystin concentrations. Microbial Ecology 43(4):443-454.

Vitt, D. H., L. A. Halsey, C. Campbell, S. E. Bayley, and M. N. Thormann. 2001. Spatial patterning of net primary production in wetlands of continental western Canada. Ecoscience 8(4):499-505.

Waiser, M. J. 2006. Relationship between hydrological characteristics and dissolved organic carbon concentration and mass in northern prairie wetlands using a conservative tracer approach. Journal of Geophysical Research: Biogeosciences 111(G2).

Warne, A. G. and J. S. Wakely. 2000. Guidelines for conducting and reporting hydrologic assessments of potential wetland sites. WRAP Technical Notes Collection ERDC TN-WRAP-00-01. U. S. Army Research and Development Center, Vicksburg, MS.

Weller, M.W. 1981. Freshwater Marshes: Ecology and Wildlife Management. University of Minnesota Press, Minneapolis, MN.

Weller, M.W. 1999. Wetland Birds: Habitat Resources and Conservation Implications. University of Cambridge Press, Cambridge, UK.

Whalen, S. C. 2005. Biogeochemistry of methane exchange between natural wetlands and the atmosphere. Environmental Engineering Science 22:73-94.

White, J. S. and S. E. Bayley. 2001. Nutrient retention in a northern prairie marsh (Frank Lake, Alberta) receiving municipal and agro-industrial wastewater. Water, Air, and Soil Pollution 126:63-81.

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