Colorado Department of Transportation's

FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWet) METHOD

USER MANUAL – Version 3.0

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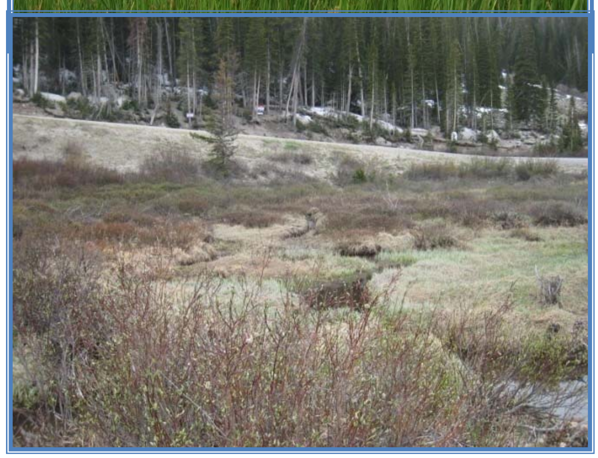

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DEPARTMENT OF TRANSPORTATION

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FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWet) METHOD – VERSION 3.0

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Acknowledgments

The development of the FACWet has been a true team effort, and the methodology has benefited from the insights of many talented people. First and foremost the authors would like to thank the Colorado Department of Transportation for their continued commitment to improving wetland management in Colorado and their support of the FACWet program. Ms. Rebecca Pierce, of CDOT Head Quarters, has been an integral part of FACWet's continued evolution has been more than essential to the successful implementation of the method. Ms. Pierce has served as everything from scientist to environmental planner to realist to liaison to technical editor to administrator to event coordinator. Each of these many, diverse, and precisely-executed roles was absolutely critical to the development of this assessment program. All of the staff at the U.S. Army Corps of Corps of Engineers, Denver Regulatory office were instrumental in developing the FACWet. We would especially like to extend our thanks to Tim Carey, Matt Montgomery, and Scott Franklin. As always, Rich Sumner of the U.S. Environmental Protection Agency provided critical insight into the "big" assessment picture and guidance on how to make this piece fit into the larger puzzle.

Andy Herb and Mary Powell have provided excellent insights, especially with regard to handling wetland evaluation in challenging urban situations. The authors are also greatly appreciative of the stimulating discussions with workshop attendees, who are too many to list, and the observations and experiences that they have shared. Lastly, I'd like to acknowledge the longtime mentorship of Mike Gilbert of U.S ACE. Although the authors take responsibility for any errors and shortcomings of this methodology, I can say with certainty that the FACWet would not have been developed without his tutorship.

The limitations of this paper medium does not suffice to convey our deep appreciation to all those who helped develop the FACWet, nor does space allow us to be able to single out the efforts of every deserving individual. Instead we will simply say thanks for all the help and hope to see you in the hills.

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Executive Summary

Section 404 (b)(1) guidelines of the Clean Water Act (CWA) require that impacts to wetlands be avoided or minimized to the extent practicable. If impacts to wetlands are unavoidable, compensatory mitigation of those losses is generally required under the Act. In particular the CWA calls for impact mitigation to compensate for the wetland functions lost as the result of a federally-permitted action. This requirement necessitates a means of assessing and denominating wetland functioning. Prior to the development of FACWet, the State of Colorado lacked this capacity.

In their normal operation, Colorado Department of Transportation (CDOT) at times requires CWA Section 404 permits for wetland impacts. Without an accurate, federally-approved functional assessment method, CDOT could not be sure that the agency was truly providing adequate compensatory mitigation for unavoidable impacts to the State's wetlands. To address this unacceptable situation, CDOT assembled a joint agency study panel and funded a study to develop a functional assessment methodology for the agency and the State of Colorado, in general. Colorado State University, with Brad Johnson as the Primary Investigator, was awarded the contract for the study and work commenced on February 1, 2006. Four additional grants and a total of twelve CDOT-sponsored training workshops have continued the implementation and development of the methodology throughout the state. Watershed approaches to compensatory mitigation planning and review are required by current federal policy. FACWet was included in a US Environmental Protection Agency ("EPA")-funded national demonstration project of the watershed approach in the Colorado Front Range. The FACWet program shows Colorado's leadership in innovative natural resource management.

The FACWet was developed by surveying existing wetland rapid assessment methodologies and blending the best aspects these approaches with the most recent advances in wetland science. FACWet is an information framework and stressor-based rapid assessment method, founded on Hydrogeomorphic theory and classification. In overall structure, it is strongly influenced by the California Rapid Assessment Methodology (CRAM). In approach, FACWet is the formalization of an investigative process, in which evidence is gathered to support a best professional judgment on the condition of eight ecological forcing factors (i.e., "State Variables") that control wetland functioning. FACWet then relates State Variable condition to functional capacity. Functional capacity is a relative index that gauges the departure from the expected level of functioning exhibited by the Reference Standard. The evidence supporting a rating will commonly be a best professional judgment on the effect of visibly detectable stressors or their indicators, reinforced with readily obtained data and information, for instance, from web-based sources. Information from quantitative investigations of ecological condition can be directly incorporated into a FACWet evaluation if circumstances should warrant additional rigor. FACWet provides the framework within which to place all of the information gathered during project permitting, mitigation planning or monitoring.

Under the 2008 joint-agency Final Rule on Compensatory Mitigation for Losses of Aquatic Resources (40 CFR 230), permit applications and mitigation plans must be reviewed by the Corps' District Engineer using a watershed approach (§230.98(h)). FACWet can interface with various watershed approaches and it is an integral component of the watershed approach that has been developed in Colorado through a joint-agency effort. A training syllabus describes the watershed approach and how FACWet, as well as wetland boundary delineation, fit together to form a concise, informative and systematic account of resources and circumstances involved in projects involving wetland impacts or their mitigation. The training syllabus is currently being adapted into *The Colorado Watershed Approach to Mitigation Planning and Review (COWAP).* Both the syllabus and the COWAP are (or will be) available on the FACWet webpage (www.rydberg.biology.colostate.edu/**FACWet**/).

Having been developed to meet the needs of CWA administration, FACWet is designed to engender consistency in reporting, aid in mitigation planning, improve mitigation performance and inform monitoring plan design. FACWet is now required by CDOT and it is required or recommended for certain CWA permits by Colorado's three U.S. Army Corps of Engineers ("Corps") districts.

Implementation Statement

The FACWet is in the implementation phase. It is recommended that FACWet be used in CDOT projects whenever information on wetland functioning is needed. Moreover, FACWet evaluation is required by the Corps as part of some CWA Section 404 permit applications.

Comments from workshop attendees strongly suggest that training in FACWet is extremely valuable for understanding the method's use. It is recommended that the CDOT-sponsored FACWet user training program be continued on an annual basis. FACWet has undergone four years of field trial. It is recommended that testing, validation, and calibration be continued throughout Colorado's diverse wetland settings. FACWet should be utilized whenever possible during State-wide wetland mapping and assessment initiatives whenever possible. Integration of FACWet into watershed approaches to compensatory mitigation planning continues to ensure that Colorado has the tools necessary to regulate wetland impacts according to federal mandates.

This executive summary concludes the technical reporting section of this document. What follows is the FACWet User Manual Version 3.0 that includes datasheets as an appendix. The User Manual will be updated periodically and version numbers will be correspondingly advanced. If this document is being referenced as part of actual field implementation of the method, the user is directed to consult the FACWet webpage to ensure that the most current version will be used (http://rydberg.biology.colostate.edu/FACWet/). The version number should be reported by any project using the FACWet.

Preface to the FACWet User Guide Version 3.0

Welcome to the Functional Assessment of Colorado Wetlands (FACWet) User Guide! This document represents Version 3.0 of the FACWet user guide. It is a descendent of Versions 2.0, 1.0 and the preliminary Beta-review version. FACWet Version 3.0 represents the continued evolution and improvement of the methodology, and provides significant refinements and clarifications. Method revisions are based on four-years of field testing and three years of regulatory usage, along with input from and discussions with hundreds of workshop participants. In total, fifteen training sessions have now been held across the state, with participants spanning the professional spectrum from agencies to private consultants and with experience levels ranging from seasoned wetland professionals with decades of experience to geologists and managers with little direct exposure to wetland field work. The authors cannot over emphasize the importance of exchanges with workshop attendees in the refinement of the methodology.

As with all wetland assessment procedures, the development of the FACWet is an iterative process in which a version is released, applied by users for a period of time, and then revised and improved based on those experiences as well as focused studies of method performance. The primary changes in Version 3.0 are:

- Additional information of FACWet's aims, approach and application are provided in the introductory sections.

- ***The Landscape Context and Buffer Attribute has been restructured.*** It now includes two variables: Habitat Connectivity and Contributing Area. The Habitat Connectivity variable represents the merging of the two FACWet 2.0 Habitat Connectivity variables (V1 and V2). These variables are now treated as sub-variables and their combined scores drive variable rating. This was done in response to findings of field testing in the Front Range corridor, which showed that the FACWet 2.0 Variable 1 scores (Neighboring Wetland and Riparian Habitat Loss) often inappropriately inflated Functional Capacity Index (FCIs) scores in landscapes with a naturally low densities of wetlands. The new sub-variables are scored in exactly the same manner as their FACWet 2.0 variable counterparts.

  The new Contributing Area variable is rated by evaluating four sub-variables related to the characteristics of the Assessment Area's buffer habitat (three sub-variables) and its surrounding land use (one sub-variable). The term "buffer" has been redefined in FACWet 3.0 to specifically refer to the natural habitats adjacent to and contiguous with the AA – as opposed to the zone within 250 m of the AA as in FACWet 2.0. This was done to place increased emphasis on the critical importance of habitats in contact with the AA. The Surrounding Land Use Variable is simply the FACWet 2.0 Buffer Variable (V3) renamed and treated as a sub-variable. Its scoring procedure is identical to V3 of FACWet 2.0.

- Data sheets for the Vegetation Structure and Complexity Variable have been slightly reconfigured to include places to record the expected and observed cover values of each vegetation stratum. This was done to make it easier to gauge the degree of stratum alteration.

- A section on FACWet's suggested usage in Colorado's regulatory program has been incorporated into the user guide, including examples of how to use FACWet in CWA mitigation and reporting. The described usage of FACWet is **not** required by regulatory agencies. Exactly how and when FACWet is employed must be determined on a case-by-case basis in consultation with agencies.

We have attempted to make this user-guide as self-explanatory as possible, but formal training in use of the methodology is strongly recommended. Evaluations performed by individuals who have not received training may contain misperceptions as to the method's approach and should be interpreted with caution.

Current versions of the FACWet user guide and datasheets are available on-line at http://rydberg.biology.colostate.edu/FACWet/. Workshop participants will receive updates on the developments in the FACWet. For more information or to provide comments and input, contact Brad Johnson: bjohnson@lamar.colostate.edu.

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Overview

The key points about FACWet is that:

- It is a weight-of-evidence approach based on Hydrogeomorphic theory.

- FACWet guides the user through an evaluation of wetland condition based on interpretation of ecological stressors and their effects on eight fundamental variables that drive wetland functioning.

- It is an information framework with an embedded rapid wetland assessment methodology.

- It is the formalization of an investigative process that seeks to uncover agents impairing the ability of a wetland to function in a manner characteristic of its type.

- It provides scientific context to evaluator observations and site information.

- In routine application FACWet utilizes the best evidence available within a rapid assessment timeframe to develop and support variable ratings. When circumstances dictate, information obtained through more rigorous approaches can be incorporated to support any or all variable ratings. In FACWet, the quality of evidence, analytical uncertainties and data gaps are made explicit and transparent.

- It applies the fundamental assumption that if no stressors can be identified, wetland functions are being performed at natural or characteristic rates and capacities.

- It considers the severity and extent of stressors to gauge the departure of each State Variable from Reference Standard condition.

- It uses variable scores to index the status of seven important wetland functions relative to the natural ranges of variation exhibited by the wetland's hydrogeomorphic subclass.

- It incorporates a flexible concept of assessment area to make the method adaptable to the needs of Colorado's diverse wetlands program needs.

- It is a tool to aid mitigation planning, design and reporting, and increase the effectiveness of compensatory mitigation.

- It may be used to help structure more intensive, quantitative investigations when required.

- Is readily integrable into watershed approaches to permitting and mitigation, landscape surveys and watershed planning efforts.

- Is consistent with the aims of Federal regulatory guidance and policy mandates, including the 2008 Rule on Compensatory Mitigation for Loss of Aquatic Resources.

Introduction to the FACWet Approach

FACWet is a weight-of-evidence, forensic assessment method that is used to rate the functional condition of wetlands according to the best evidence obtainable under the circumstances of a specific project. In routine application, a FACWet evaluation is carried out in a rapid assessment timeframe. That is, an evaluation should be allotted no more than four hours of effort, and often considerably less (not including travel and reporting). FACWet works by guiding the evaluator through a process of evidence gathering, to develop and support a professional judgment as to the ecological condition of critical aspects of the assessment area (AA) and its surrounding landscape. As such, FACWet is the formalization of an investigative process.

This user guide will focus on employment of FACWet during rapid wetland assessments that are built on best professional judgment. There is, however, always the implication that more rigorous methods could be employed to provide the rationale for variable ratings.

In the rapid assessment format, FACWet guides the user through an evaluation of wetland condition and a diagnosis of its causes of impairment. FACWet does so by directing the user to consider the effects that deleterious, anthropogenic alterations ("**stressors**[1]") have on the key physical and vegetational attributes ("**State Variables**") that drive wetland functioning. That is, stressors are used as indicators of functional impairment. The degree of State Variable degradation is rated according to the estimated severity and extent of the stressor(s) acting upon it. Based on this estimation, the condition of each State Variable is rated on a scale of 0.0 to 1.0 (non-functioning to Reference Standard or essentially pristine, respectively) with the aid of tabular scoring guidelines. Algorithms then relate the degree of State Variable alteration to the functions they most strongly influence (Fig. 1).

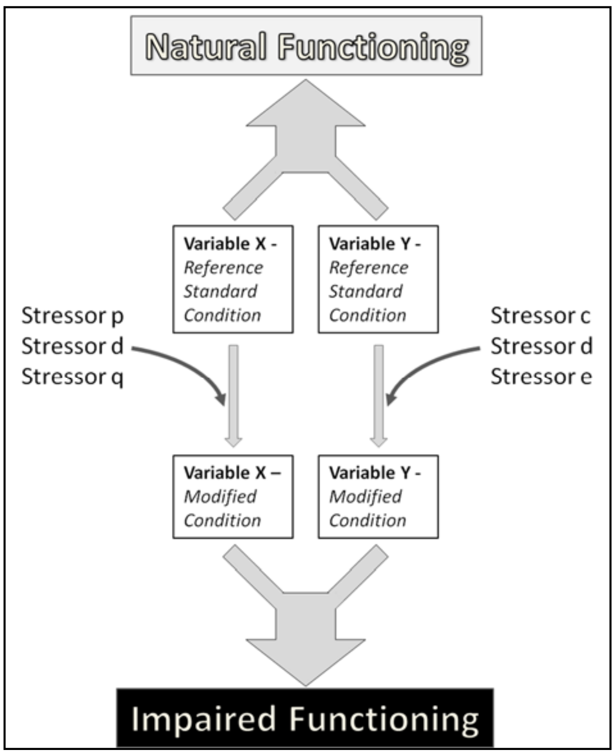


Figure 1. Schematic illustration of the FACWet model. State Variables interact to create the natural or characteristic functions associated with a wetland. Stressors modify the form of State Variables and consequently alter functioning. Notice that the stressors present in a wetland may or may not affect multiple variables.

The methodology provides the user with: 1) a logical framework for making condition determinations based on the presence of stressors; 2) a systematic means of relating the evidence supporting determinations; 3) scoring guidelines to improve consistency between evaluators; and 4) an algorithm for rating the observed versus expected natural functioning based on the status of the eight State Variables. The outcome of a rapid FACWet evaluation under routine application is a best professional judgment rating of the condition of a wetland's State Variables and the level functional impairment, as evidenced by the presence of detectable stressors.

[1] Key terms that are defined in the glossary are highlighted in bold-faced type on their first usage.

FACWet denominates ecological condition in terms of wetland functioning. Other assessment methods may relate ecological condition using different currencies, such as biological integrity. That is, other methods base their conclusions on different lines of evidence than those primarily in force in FACWet. Despite the differing tactics, both biologically- and functionally-based assessment methods have the same fundamental goal – description of the ecological condition or health of a wetland. Evaluators must realize, however, that FACWet does not assess the perceived societal **value** of a wetland or any of its associated functions. Consideration of societal value is strictly and purposefully avoided in FACWet scoring. While FACWet should be used to document potential "red-flag" issues (e.g., presence of Threatened or Endangered species), questions of valuation are left to case-by-case debate as is intended by the Clean Water Act (CWA) permit review process.

Appropriate to a rapid assessment level of analysis, no quantitative data are collected during a routine FACWet assessment. Therefore, the result of a FACWet analysis is a professional opinion backed by the body of evidence available at the time of sampling. Because it is evidence based, any facet of a FACWet evaluation can be corroborated or modified based on the accumulation of additional evidence, such as collection of quantitative data, information gleaned from the scientific literature or web-based data mining tools, reliable local knowledge, or subject-specific expertise.

Use of rapid assessment over quantitative approaches can at times impart a tradeoff of analytical certainty for speed of application. In FACWet, different lines of observational evidence are ranked according to the level of certainty they impart to conclusions. For instance direct "cause-and-effect" observations can provide highly compelling evidence of functional impairment on par with quantitative data. At the other end of the spectrum, evidence based solely on first principle expectations is inherently more speculative or open to interpretation. If the level of uncertainty associated with rapid assessment is unacceptable based on the ambiguity of readily available evidence, the circumstances of a project, or the value of the wetland resource in question, FACWet can be used to identify the critical unknowns and guide the development of more intensive, quantitative approaches. Data from these more rigorous investigations can be directly incorporated into the FACWet framework to bolster the rationales underlying variable scores. As an information framework FACWet provides a systematic organizational structure for communicating project data that engenders information with a scientific, hydrogeomorphic context.

Among other things, the 2008 Rule on Compensatory Mitigation for Loss of Aquatic Resources ("2008 Rule") requires watershed approaches to compensatory mitigation (hereafter "**mitigation**"**)** planning (40 CFR 230). FACWet was explicitly designed to meet the requirements of this rule and to incorporable within watershed approaches to mitigation planning. The U.S. Environmental Protection Agency (US EPA) has developed a three-tiered hierarchy that structures wetland assessment methodologies (US EPA 2006; Fig. 2). FACWet includes a Level 2 rapid assessment methodology, which was designed to mesh with large-scale Level 1 tools relevant to the watershed approach such as Hydrogeomorphic Wetland Profiling (Gwinn and Kentula 1999, Johnson 2005, Lemly, Johnson, et al. 2013). It can incorporate or be supported by intensive Level 3 methodologies, including the Indices of Biologic Integrity being developed by the Colorado Natural Heritage Program, Ecological Integrity Assessment from Nature Serve and the Hydrogeomorphic Approach (Smith et al. 1995). FACWet is an integral component of the watershed approach to mitigation planning and review that has been developed through a joint-agency, national demonstration project in Colorado. This watershed approach is described in a "Training Syllabus", which is being expanding into *A Provisional Colorado Watershed Approach to Compensatory Wetland Mitigation Planning and Decision Making Framework* (Lemly, Johnson, et al. 2013). Colorado's example watershed approach is currently under review by Colorado's three Corps districts.

Being a stressor-based approach, FACWet naturally lends itself to mitigation planning, since alleviation of stressors is the underlying goal of ecological restoration. A FACWet evaluation provides a catalog of the stressors impairing the functioning of a site, it allows an evaluator to rank the relative importance of each, and it provides a format to identify stressors that can or cannot be remediated through mitigation. This information can then be used to conceptualize and justify mitigation plans and model predicted mitigation outcomes.

Upon completion, FACWet analyses:

- Catalog the stressors impacting an **assessment area** (AA).
- Specify which State Variable(s) are affected by which specific stressors.
- Rate the relative capacity of individual functions and generate a composite score for overall functional condition.
- Can provide a structure upon which to base mitigation planning.
- May facilitate modeling of realistic mitigation goals or best-attainable site condition based on the potential for stressor remediation.
- Can provide insights into the potential functional equivalency of proposed compensatory mitigation.
- Can be used to structure success criteria and post-mitigation monitoring programs based on quantifying the effects of stressor alleviation.

Assessment Tier	Products/Applications
Level 1 – Landscape Assessment Evaluate general condition of the study area using readily digital data	•Status and trends •Sample frame for site-level assessments •Wetland Profiling
Level 2 – Rapid Assessment Evaluate the general condition of individual wetlands using relatively simple indicators. Takes two people no more than a half day to complete	•401/404 permit decisions •Identify impacts and stressors •Regional or watershed assessments •FACWet
Level 3 – Intensive Assessment Provide comprehensive data on individual wetlands. Takes four to six people a full day in the field	•Evaluate and refine the rapid and landscape assessments •Provide diagnostic capability •Establish relationship with rapid assessment to extrapolate to level 3 information •Index of Biotic Integrity

Figure 2. US EPA's three-tiered assessment framework. In the right column, examples of tier-specific methodologies developed in Colorado are listed (From M. Kentula, U.S. EPA, pers. comm.).

Scientific Basis and Structure of the FACWet

Wetland functioning and the provision of ecosystem services are the direct result of the physical properties of the wetland and its surrounding landscape (Brinson 1993, Bedford 1996, Winter 2001, Johnson 2005, Collins et al. 2008). Hydrology, geomorphology and **hydrodynamics** control the basic form and function of a wetland. Brinson (1993) devised a hydrogeomorphic (HGM) classification for wetlands that begins by classifying all wetlands into seven classes according to the configuration of these three factors (Fig. 2a). On a large scale, climate and hydrogeology dictate the occurrence, frequency and distribution of HGM wetland classes within a landscape. Within-region heterogeneity of these factors creates diversity within wetland classes and shapes the specific ways wetlands within a class function. Variation within HGM classes is categorized into subclasses. Variation within subclasses can be further differentiated by **regional subclasses** which account for biogeographical patterns and ecoregional controls on functioning.

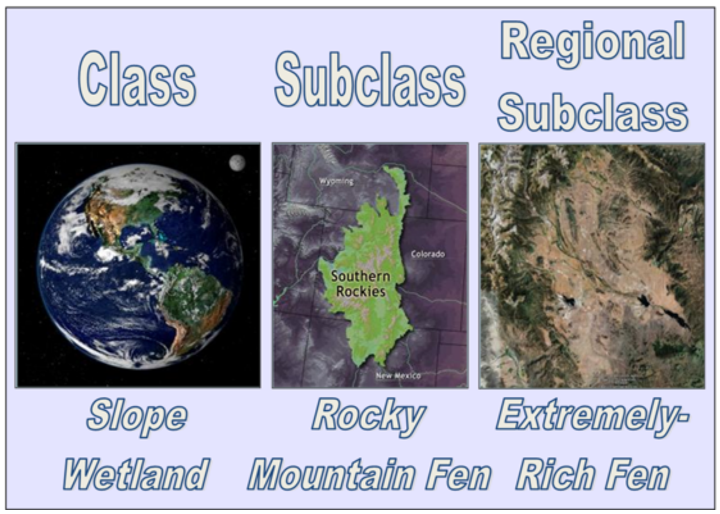


Figure 2a. An illustration of the relationship between HGM category and geographical extent. HGM classes such as slope wetlands are found globally. Subclasses are identified within major ecoregions. Finally, Regional Subclasses pertain to a particular subvariant of the subclass that associated is associated with a limited climatic or hydrogeological province.

Because a wetland's functional condition is driven by its physical structure and surrounding landscape, it necessarily follows that perturbation of either will alter functioning (Fig. 1). Anthropogenic alterations of a wetland or its supporting landscape that impair the wetland's natural functional characteristics are termed *stressors*. The FACWet methodology is based on detecting, inferring and interpreting stressors and evaluating their ecological consequences.

Following California's methodology, FACWet decomposes a wetland's functional control to three primary **Attributes**: 1) Buffer and Landscape Context, 2) Hydrology, and 3) Abiotic and Biotic Habitat (Collins et al. 2008). The Buffer and Landscape Attribute is described by two State Variables, while the others are described by three. State Variables may also simply be referred to as "variables". State Variables parameterize the ecological forcing factors that determine the form and function of wetland attributes. In FACWet, variables are rated according to the level of departure between their currently observed condition and their natural or **Reference Standard** condition. Four variables (V1, V2, V7 and V8) are further described by sub-variables. Sub-variables are scored in the same manner as variables, but some composite of their scores is used to generate the final variable score. After scoring, State Variables are then related to the functions over which they have primary control and used to index the capacity of seven societally-important functions (Table 2).

Table 1. Summary of FACWet attributes, State Variables and Sub-variables. The final column provides the total weight assigned to the variable when calculating the overall site score, or composite FCI.

Attribute	Variable Number	State Variable Name	Sub-Variable Name	Total Weight of Variable in Composite FCI
Buffer & Landscape Context	V1	*Habitat Connectivity*	*SV 1.1 – Neighboring Wetland and Riparian Habitat Loss*	*0.04*
			SV 1.2 – Barriers to Migration and Dispersal	
	V2	*Contributing Area*	*SV 2.1 – Buffer Condition*	*0.11*
			SV 2.2 – Buffer Extent	
			SV 2.3 – Buffer Width	
			SV 2.4 – Surrounding Land Use	
Hydrology	V3	*Water Source*	*No sub-variables*	*0.13*
	V4	*Water Distribution*		*0.17*
	V5	*Water Outflow*		*0.17*
Abiotic & Biotic Habitat	V6	*Geomorphology*	*No sub-variables*	*0.15*
	V7	*Chemical Environment*	*SV 7.1 – Nutrient Enrichment*	*0.07*
			SV 7.2 – Sedimentation/turbidity	
			SV 7.3 – Toxic Contamination	
			SV 7.4 – Temperature	
			SV 7.5 – Soil Chemistry and Redox	
	V8	*Vegetation Structure and Complexity*	*SV 8.1 – Tree Stratum*	*0.15*
			SV 8.2 – Shrub Stratum	
			SV 8.3 – Herb Stratum	
			SV 8.4 – Aquatic Stratum	

Table 2. Summary of FACWet functions and controlling variables (after Berglund and McEldowney 2008).

Function	Controlling variables
1. Support of characteristic wildlife habitat	**V1, V2, V8**
2. Support of characteristic fish/aquatic habitat	**V3, V4, V5, V6, V7**
3. Flood attenuation	**V2, V3, V4, V5, V6, V8**
4. Short- and long-term water storage	**V3, V4, V5, V6**
5. Water quality maintenance	**V2, V4, V6, V7**
6. Sediment retention/shoreline or bank stabilization	**V2, V6, V8**
7. Production/food web support	**V1, V5, V6, V7, V8**

ATTRIBUTE, VARIABLE AND FCI DESCRIPTIONS

BUFFER AND LANDSCAPE CONTEXT

This attribute concerns the character and condition of the landscape surrounding the AA. It considers the landscape setting, first, in terms of its effect on the ability of the AA habitat to freely exchange materials and energy with surrounding wetland and riparian habitats. This capacity is described by the **Habitat Connectivity Variable** which is comprised of two sub-variables, *Neighboring Wetland Habitat Loss* (SV 1.1) and *Barriers to Migration and Dispersal* (SV1.2; Fig. 3). Secondly, this attribute concerns the way in which the immediate surroundings of the AA help to maintain or impair its ability to perform characteristic natural functions. These characteristics are evaluated in the **Contributing Area Variable** which is described by four sub-variables describing the condition of the AA buffer and its surrounding landscape.

Every wetland serves as an element of a landscape system that encompasses everything from hydrogeology to genetic diversity. Each type of wetland within the system possesses a unique functional signature that helps maintain the beneficial natural processes and ecosystem functions that occur in the watershed. Wetlands exchange a disproportionate amount of material and energy with the surrounding landscape, as compared to uplands, in the form of water, and the sediment, nutrients, and microorganisms carried by it. To a lesser degree, material and energy is exchanged by the movement of plant material and animals in and among the habitats through riparian or wetland connections, or across uplands. Because of wetlands' tight connection to water and hydrogeological processes, and because of their importance as habitat for the majority of plants and animals, wetlands have an inflated influence on the functioning of landscape and ecosystem processes relative to uplands.

Each wetland hosts a mosaic of interacting habitats which are in turn interconnected to other wetlands, commonly through riparian corridors and stream channels. But even seemingly isolated wetlands form important components of the landscape-scale hydrologic system and are linked by the mobile organisms which depend on the occurrence of these habitats for refuge, forage or shelter. While upland connections, particularly in terms of mobile wildlife and dispersing plants are significant, the wetland–riparian linkages are overwhelming in terms of importance. Because of this, each wetland on the landscape represents an individual unit of a meta-population, strongly connected by riparian corridors and less so by overland links (Fig 3a).

The **Habitat Connectivity Variable** considers two ways in which the AA's connectivity to surrounding habitats can be disrupted: 1) *Neighboring Wetland/Riparian Habitat Loss* that results in the removal of pre-existing linkages (SV 1.1); and 2) *Barriers to Migration & Dispersal* that disrupt existing linkages between an AA and surrounding habitats (SV 1.2; Fig. 3b).

The second FACWet variable, **Contributing Area**, considers the landscape in which the AA is set. The **Contributing Area Variable** includes four sub-variables: *Buffer Condition* (SV2.1), *Buffer Extent* (SV2.2), *Buffer Width* (SV 2.3) and *Surrounding Land Use* (SV 2.4). The three Buffer sub-variables are concerned with the condition of the area immediately surrounding the AA. Many stressors originate outside of the wetlands. The buffer stands between the wetland and potential sources of stress, diminishing (or exacerbating) their impacts. Therefore buffers have an important influence on wetland functioning. Changes in *Surrounding Land Use* can be a primary source of stressors to the wetland. Together evaluation of the AA Buffer and the severity and extent of land use changes around it are used to describe the balance between external stressor generation and their off-site attenuation.

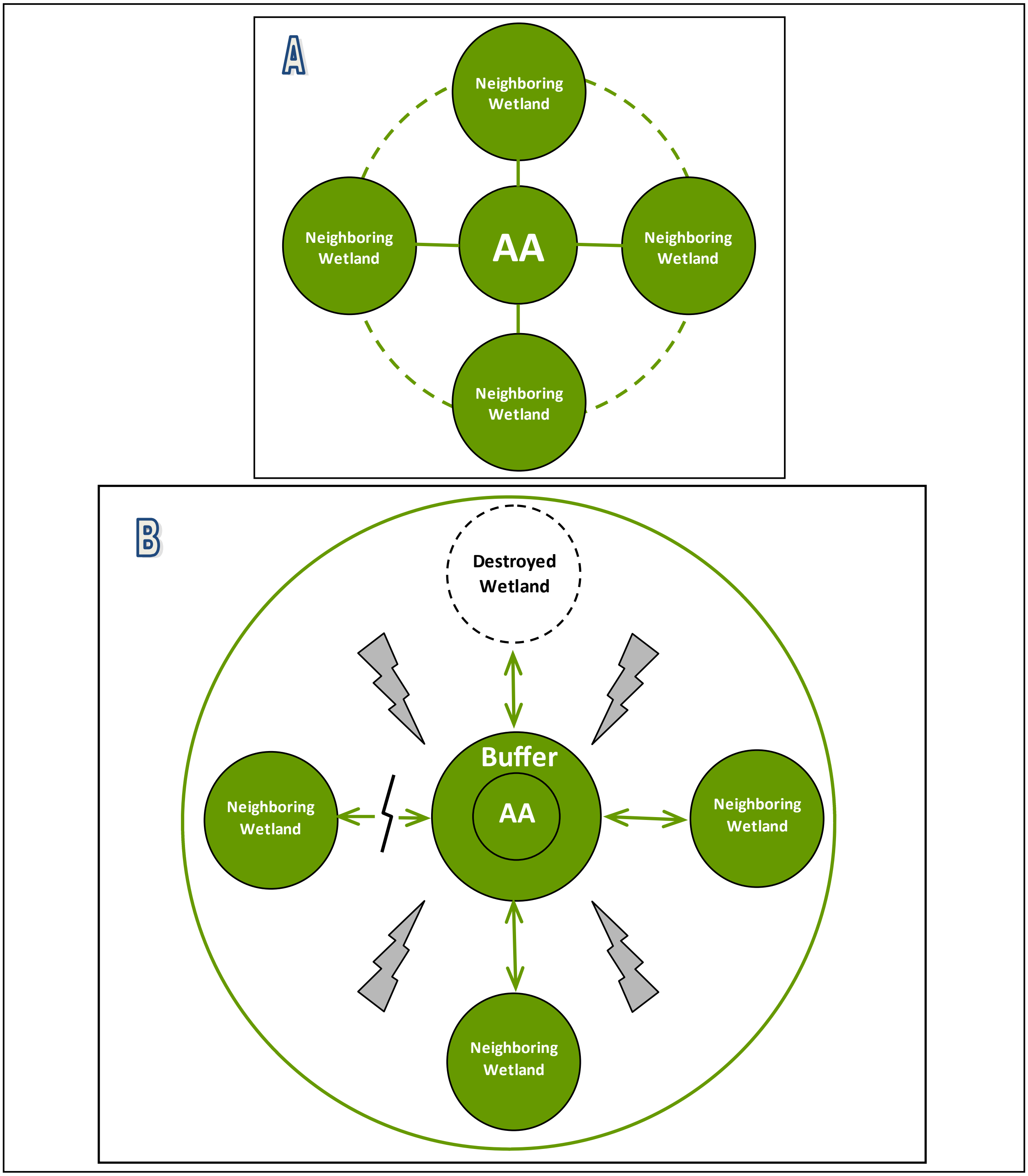


Figure 3. Figure 3a symbolizes the relationship between the AA and neighboring wetland and riparian habitats in a natural landscape. Solid lines represent strong connections between habitats such as would result from interconnection via riparian corridors. Dotted lines indicate weaker connections such as across upland areas. There is no buffer per se in 3A because natural landscapes do not generate external stressors, so there is no threat from which the wetland is protected. Figure 3b symbolizes the way in which the landscape attributes of the AA can be altered by land use changes. Habitat can be destroyed, thereby obviating a potential connection (top), barriers can disrupt existing connections (left), surrounding land use changes can produce stressors which encroach upon the AA (bolts) and alteration of buffer habitat can reduce its capacity to mitigate stressors produced by surrounding land use change.

HYDROLOGY

Almost every unique process attributed to wetlands is driven by the interaction of hydrology and geomorphology. The interaction of these elements controls water table elevation relative to the ground surface which in turn drives most wetland processes, from nutrient cycling to characteristic wildlife usage. FACWet describes hydrology using three fundamental State Variables: **Water Source** (Variable 3); **Water Distribution** (both horizontal and vertical) within the AA (Variable 4); and **Outflow** of water from the AA(Variable 5; Fig. 4). Such a decomposition of the Hydrology Attribute allows attention to be focused purely on the characteristics of hydrology rather than a multitude of interactive or resultant effects. These three variables are factors that control the absolute elevation of the water table in a wetland. Geomorphology then controls the elevation of the water table relative to the ground's surface. Geomorphic condition is considered in Variable 6. Together, these four variables control the wetland hydrograph, which is a measureable characteristic of the wetland. *Considered individually each can be used to explain specifically how and why a wetland's hydrograph has been altered.*

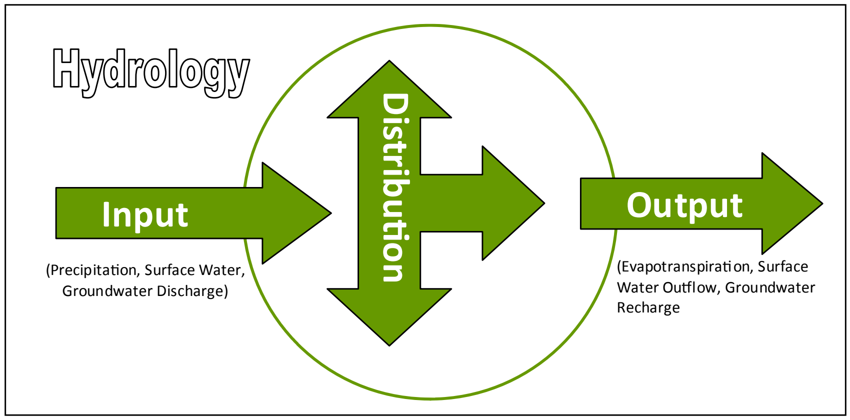


Figure 4. Schematic diagram of the State Variables describing the Hydrology Attribute.

In FACWet, the hydrology-geomorphology interaction is modeled hierarchically (Fig. 5). **Water Source** is *the* keystone variable in a wetland. Removal of the water source eliminates all potential for characteristic water distribution and outflow (Fig.6). Under such circumstances geomorphic condition becomes largely irrelevant in terms of wetland functioning. Given that the water source is the preeminent constraining factor on wetland hydrology and functioning, geomorphology is the secondary control. Geomorphological alterations can cause impairment of water distribution within the wetland and/or alteration of its outflow characteristics (see Figs. 13 and 36, for examples). Thus **Water Distribution** and **Outflow** are the subordinate components of the hydrologic system, whose characteristics are the result of **Water Source** and **Geomorphology**. Unlike the dominant factors, there is a two-way interaction between **Water Distribution** and **Outflow**, and each can affect the other (See Fig. 36).

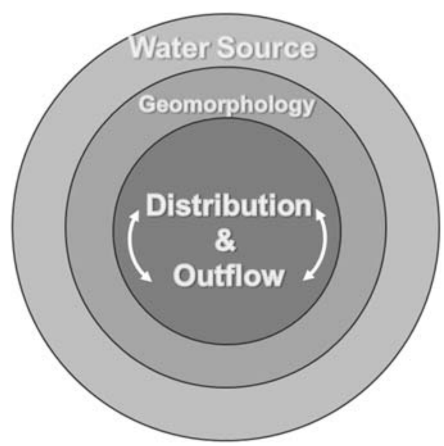


Figure 5. Illustration of the hydrology-geomorphology interaction model used in FACWet.

Figure 6. The water source of this Arkansas River wetland has been removed. Despite intact geomorphology the site has no potential for characteristic water distribution or outflow. All other habitat variables are impaired by the lack of water source, as well.

The effects of hydrologic change in wetlands are far-reaching. Alteration of the soil and chemical environment, materials and energy exchange, habitat structure, and plant species composition are some of the varied direct effects of hydrologic change. These higher-order effects of hydrologic alteration are assessed by the other State Variables. The assessment of the hydrology attribute is limited here to the impact of stressors on water source, distribution, and outflow relative to natural potential of the site.

ABIOTIC AND BIOTIC HABITAT

The Abiotic and Biotic Habitat attribute encompasses the morphological, structural, and chemical components of the AA (Fig. 7). The **Geomorphology Variable** (Variable 6) characterizes the physical form of the AA habitat, in particular the role that topography plays in influencing depth to (of) water relative to ground surface. The **Water and Soil Chemical Environment Variable** (Variable 7) addresses human-induced changes to the chemical composition of water in the AA. It also includes alteration of the soil environment which can

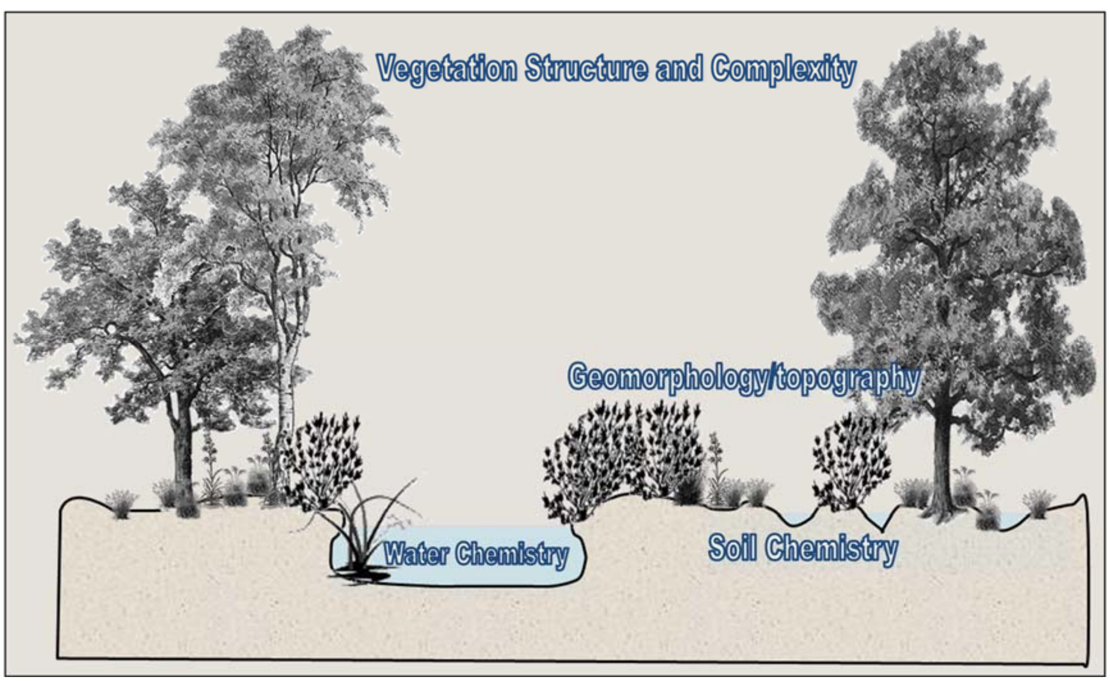


Figure 7. Illustration of the relationships between the Abiotic and Biotic Habitat Attribute variables.

arise owing to chemical contamination or modification of the redox environment, among other causes. These changes can either result from allochthonous (external to the AA), or autochthonous (within the AA) sources. The **Vegetation Structure and Complexity Variable** (Variable 8) considers the synthetic properties of the AA's vegetation.

Vegetation composition is mostly dictated by the seven previous variables as set within the biogeographical context of the region and resultant biotic interactions, including competition and facilitation. Although secondary to physical attributes, Vegetation Structure and Complexity still acts as a State Variable because of its fundamental influence on characteristic wetland functions, such as bank and shoreline stabilization, sediment retention, water balance and light environment. This variable does not seek to capture the details of species composition, but rather alterations to gross vegetation structure that affect functioning.

FUNCTIONAL CAPACITY INDICES

The last section of the FACWet involves the relation of State Variables to seven critical wetland functions using Functional Capacity Indices (FCI's). FCIs relate the degree of departure in functional capacity between the AA and the reference standard. It is critical to understand that a high FCI does not imply a high rate or capacity in absolute terms such as acre feet of water stored or grams/square meter of phosphorous retained. *Different types of wetland perform different functions or the same functions to differing degrees*. Many wetlands naturally have a low absolute capacity for performing various functions. For instance, isolated depressional wetlands have a low natural capacity to improve basin-wide water quality and slope wetlands have a low capacity to hold surface water compared to depressional sites. Increasing the surface water holding capacity of a slope wetland through excavation, for example, is considered a functional impairment in FACWet, despite the fact that the absolute capacity of the wetland to perform the function had been increased. This is because maximizing the capacity of one function virtually always leads to a decrease in the wetland's ability to perform other characteristic functions, even if those functions may be less apparent than the enhanced one(s).

Each FCI is constructed from the State Variables that exert primary control over the performance of that function. Variables are weighted in FCIs to model the relative importance of each in controlling the function. FCI scores are generated by adding the weighted variable scores and dividing by the total score possible.

A composite FCI is generated by averaging the seven individual FCI scores. The composite FCI is therefore a grand weighted average, with weights assigned to each variable according to the schedule in Table 2. In practice, the combination of individual variable scores and the composite FCI (along with cataloged stressors) provides the insight into AA functional condition. The scores for individual FCIs should be thought of "typical" functional responses to impairment. They may not accurately reflect the circumstances in effect during a given assessment.

When to Use FACWet

FACWet has a number of potential applications (Table 3). In general, it should be used when required by federal, state, or local agencies, or anytime characterization of wetland condition is desired. To a large degree FACWet is prescribed in a fashion mirroring the wetland boundary delineation procedure, and optimally it is carried out at the same time boundaries are marked. Like wetland boundary delineation, FACWet is intended to be applied at multiple stages of a project life-cycle, and similarly, the rapidity of the methodology allows it to be employed successively during a permitting action without unduly burdening permit applicants, regulators or agency staff.

Parallel to the goals of wetland boundary delineation, in the regulatory context FACWet is designed to answer three questions that are fundamental to fulfilling goals of the Clean Water Act and related policies (Fig. 8). The extent to which these questions apply to a given project and its information needs dictate when FACWet is applied (Table 3).

FACWet Application	Typical Purposes
Pre-impact	1. Characterization of habitat potentially subject to authorized impacts. 2. Provision of information relative to setting mitigation requirements.
Pre-mitigation	1. Characterization of baseline conditions at a proposed mitigation site. 2. Cataloging of stressors affecting natural or quasi-natural functioning. 3. Identification of remediable stressors and conceptual design of mitigation design requirements. 4. Preliminary evaluation of mitigation potential and its ability to compensate for authorized impacts. 5. Informing design and justification of post-mitigation monitoring plan.
Predicted post-mitigation condition	1. This is an in-office exercise. 2. Modeling expected environmental improvement or "lift" that would result from remediation of treatable stressors under the proposed mitigation plan.
Post-mitigation	1. Preliminary QA/QC of as-built mitigation 2. Documentation of as-built condition and achievement of design goals relative to mitigation plan.
Ambient monitoring	1. Characterization of current functional condition relative to **current HGM subclass** OR 2. Characterization of current functional condition relative to known or inferred **natural HGM subclass**

Table 3. Description of FACWet applications and the typical purposes of each.

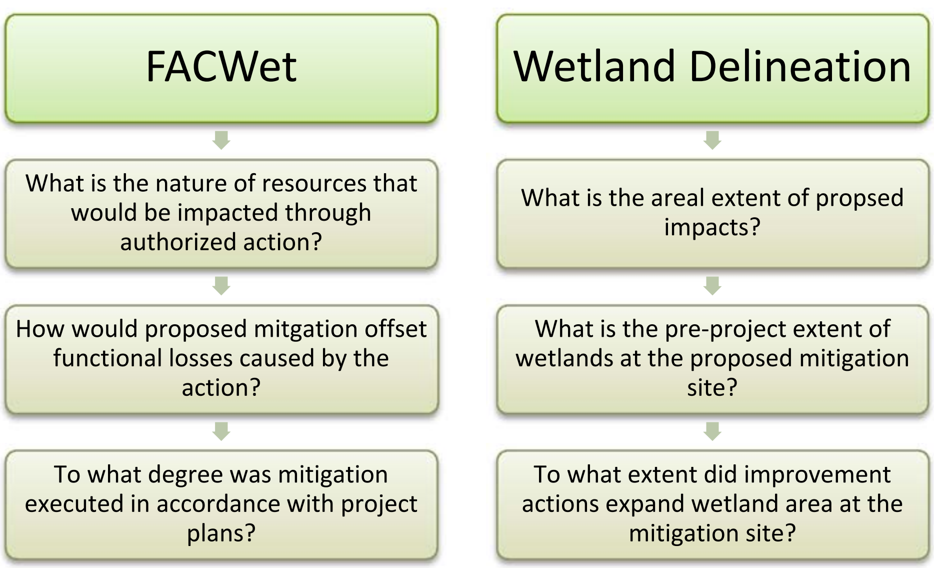


Figure 8. Parallels between application FACWet and wetland delineation during a permitting action, and the questions addressed at each stage in the process.

Comparison of FACWet evaluation results provides much of the key information needed to judge whether proposed mitigation has the potential to offset authorized wetland impacts by documenting the:

- Type and condition of wetlands being impacted
- Current condition of a proposed mitigation site
- Stressors that would need to be remediated to effect site improvement
- Potential environmental benefit or “lift” of proposed mitigation
- Degree to which mitigation, as built, meets design expectations

Key Concepts of the FACWet

FACWET AS A REFERENCE-BASED, RAPID STRESSOR ANALYSIS APPROACH

FACWet is fundamentally a comparative methodology in which an evaluator judges the form and function of the AA against that which was historically present at the site or the range of conditions found within non-impacted or high condition examples of the same wetland type. In this way, FACWet is an approach to impact evaluation.

FACWet employs stressor analysis to evaluate the departure of an assessment area (AA) from Reference Standard conditions. The Reference Standard is the benchmark for comparison in FACWet, as well as other methodologies, although in FACWet the definition is somewhat more expansive. The reference standard represents the natural or a **quasi-natural** condition of the wetland as inferred from characteristics of the wetland itself or through reference to wetlands of the same HGM regional subclass that represent the pinnacle of sustainable functioning across all functions. Colorado’s HGM classes and subclasses are described in Appendix B.

Since a wetland’s physical setting dictates its functioning, functional condition is interpreted through evaluation of parameters dictating physical character; that is, the State Variables which are the ecological forcing factors that drive functioning. A wetland is assumed to be functioning at a natural level unless there is evidence that one or more stressors are impacting the physical-biological condition of the AA. The key assumption that forms the basis of FACWet assessments is this: *If the assessment area and its surroundings have not been altered by humans, the site is performing its environmental functions at their natural rates and capacities*. That is, in the absence of stressors, a wetland is considered to be in pristine or Reference Standard condition. Conversely, when stressors are present, wetland functioning is assumed to be diminished.

Evaluation of stressors imparts significant conceptual and practical advantages to the FACWet. First, it frames assessments on a logical foundation recognizing that different types of wetlands vary naturally in the types and levels of functions they provide. Documentation of the severity and extent of stressors on State Variables is evidence on which the case is made for functional impairment. As such, the method does not require the evaluator to make a subjective valuation of the level of functioning apart from the departure from Reference Standard condition. Second, stressor analysis as structured by the FACWet framework allows full advantage to be taken of the hydrogeomorphic scientific paradigm, while in routine application avoiding the demands of quantitative data collection. Last, the focus on stressors is intuitive. It makes sense to begin an assessment of health by considering the factors which cause harm.

In FACWet, if any factor is known to be negatively impacting the AA it should be included as a stressor in the analysis, **regardless of its spatial proximity to the AA** -- In other words, a given stressor does not need to be found within the AA to be considered. For example, an upstream dam may be several miles from an AA, but if it is known to affect hydrology at the AA then it is recorded as a stressor and its effects taken into account in the evaluation. This strategy is not intended to overly burden evaluators with extensive landscape surveys, though. Since the primary goal of FACWet is determining the alteration of natural site conditions, when multiple stressors such as dams and diversions occur upstream of the AA, the evaluator need not consider each stressor individually. Instead the composite effect of all related stressors on the variable under consideration is judged. Continuing the riverine example from above, the evaluator would simply consider how the known changes in stream flow regime, regardless of the specific causes, affect the AA's water source (and other variables).

While necessary to generate a complete picture of a site's functioning, this lack of spatial dependence also imparts a significant advantage to the FACWet in that AAs can be sized to pinpoint the particular area of interest. They do not need to be sized to contain the actual sources of stress.

As a Level 2 rapid assessment approach, FACWet does not typically utilize quantitative data to generate variable scores. Instead it relies on first principles of wetland ecology and evaluator interpretation guided by a systematic process to generate variable scores. While a rapid assessment format inherently incorporates more uncertainty in evaluation conclusions than intensive or quantitative investigations, this tactic is consistent with the Level 2 intensity of analysis and it imparts the requisite speed needed for the method to be practicable in its intended settings, namely CWA administration and large-scale surveys. If a particular inquiry demands more accuracy than a Level 2 analysis can provide, then more intensive, quantitative approaches must be employed. FACWet can be used to identify the State Variables (e.g., water quality) about whose condition is in question. The information acquired during quantitative studies may be directly incorporated into FACWet to provide more solid support for variable ratings than simple best professional judgment can generally provide.

FACWET AS AN INFORMATION FRAMEWORK

FACWet is designed to provide reviewers with a hierarchical summarization of project information. The FACWet approach places project information in the context of hydrogeomorphic theory providing a critical link to current scientific insight, while the method's structure constitutes a way to organize and deliver information in a systematic and controlled manner. FACWet can incorporate information from the most basic qualitative overview of site condition to detailed quantitative analyses of specific ecological parameters. This is a direct and deliberate response to the identified need for an evaluation tool that can integrate many different types of information into a seamless account of site condition and one that is capable of delivering information to the reviewer in a readily interpretable format. FACWet allows a review of project facts in an orderly fashion, providing the reviewer a structure to sequentially access increasing levels of project detail. This helps avoid the common problem of "information overload", in which the most pertinent details of a project can become buried within pages of data.

Variable Condition = Score + Rationale

In FACWet there are two parts to the assessment of variable condition: The *score* and the *rationale* (Fig. 9). The score provides the evaluator's summary opinion on variable condition and the rationale is the evidence used to justify that score which is acquired at a level of rigor appropriate to project circumstances. For many routine situations, a rapid assessment approach to functional evaluation is sufficient. In more critical situations, measurements of specific parameters may be required to validate functional condition. FACWet incorporates either information source equally well.

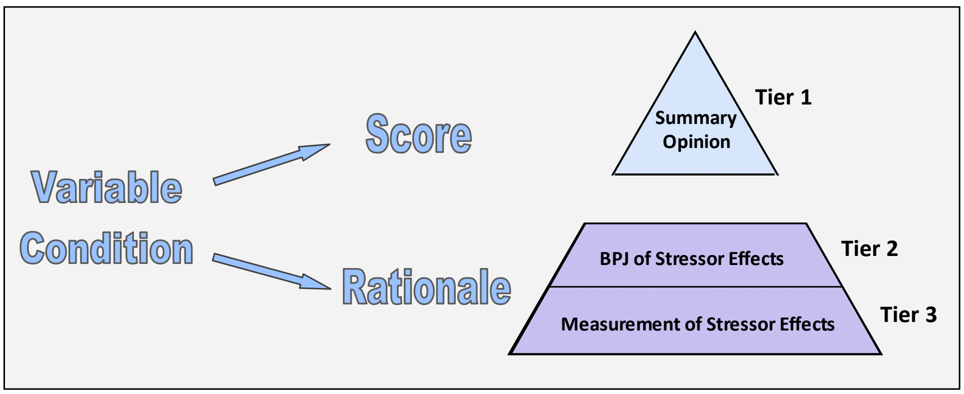


Figure 9. Illustration showing the conceptual structure of the FACWet information framework. Variable condition is comprised of a score and the supporting rationale. The variable score, which relates to an academic letter grade, represents the evaluator's summary opinion on variable. In routine assessments the variable score is supported by a rationale based on stressor inventory and interpretation. When necessary, more intensive methods can be used to form the rationale justifying the variable score.

Tier 1: Variable Scores

The evaluator's summary opinion on variable condition is represented by a numeric score which corresponds to a letter grade based on the academic grading scale of ***A-F*** (Table 4)***.*** Letter grades, in turn, are defined by terms intended to convey information about functional condition – an ***A*** indicating *reference standard* condition with little or no detectable human impact and an ***F*** indicating the highest degree of impact and *nonfunctional* condition.

Thus, each variable score should literally be interpreted as a *very concise narrative description of the condition of one key driver of wetland health*, rather than as a measure of a process rate or unit. A FACWet assessment culminates in a concise, tabular summary of wetland functional condition in the form of a set of variable scores. This summary is akin to a "report card" which serves as a summary description of the AA's condition that can be grasped very quickly. The summary of variable scores forms the first tier of the FACWet information framework, because in many cases, a concise summary of functional condition is all that a reviewer may need.

Table 4. The FACWet grading scale.

Score Range	Letter Grade	Narrative Condition Category	Interpretation
1.0 – 0.9	A	Reference Standard	Pristine or nearly so. Supports highest level of sustainable functioning.
<0.9 – 0.8	B	Highly Functioning	Stressors detectably alter the variable's form in minor ways. The variable still retains its essential qualities and supports a high level of ecological function.
<0.8 – 0.7	C	Functioning	Obvious alteration and degradation of the variable, but it still supports basic, natural, passive wetland functioning.
<0.7 – 0.6	D	Functionally Impaired	Major ecologically harmful alterations to the variable. Active management commonly required to support maintenance of wetland characteristics.
<0.6	F	Non-Functioning	Massive deleterious alteration of the variable. The level of alteration generally results in an inability of the variable to support wetland conditions or it otherwise makes the area biologically-unsuitable.

<u>Tier 2: Stressor-based Rationale for the Variable Score</u>

The FACWet approach encourages a clear articulation of the rationale for variable scoring by requiring transparent documentation of the type and quality of evidence substantiating each variable score. That is, the assessment should provide an answer to the question, "why was that score assigned to the variable?" or more specifically, "what is the evidence of variable impairment?" FACWet always uses observation of stressors and indicators of stress as the primary basis of variable score justification. A variable is assumed to be functioning at or near the *Reference Standard* level unless some evidence can be provided to indicate impairment, and this evidence is framed as the documentation of stressors. Low scores indicate a high degree of impairment and therefore must be accompanied with documentation of severe stressor impact. High scores, on the other hand, indicate little departure from reference condition and would, therefore, be justified by commensurately low levels of documented human impact.

Documentation of stressors and their perceived effects is the second tier of information in the FACWet framework. When employing this tier of information, the evaluator is provided the opportunity to explain the variable score in terms of the perceived severity and extent of stressors. The reviewer of an evaluation, on the other hand, uses the list and description of identified stressors to evaluate whether the evidence of impairment (severity of the combined effects of stressors) is commensurate with the assessed functional score.

In most cases, simple documentation of stressors and interpretation of their effects by best professional judgment is sufficient to justify a variable score; that is, detailed monitoring or measurement is not necessary to further support the rationale for a variables score. This is because stressors and their effects are often obvious to the trained eye. For example, a deep ditch that bisects an AA intercepting and transporting ground and/or surface water away from dependent habitats is an obviously severe stressor to Water Distribution, and mere documentation of its presence (2nd tier of information) may be all that is necessary to justify a low grade for that variable. FACWet provides specific procedures and scoring guidelines that allow rapid and repeatable assessment of wetland condition based on best professional judgment documentation of stressors and their apparent effects.

<u>Tier 3: Intensive Assessment Data</u>

In some cases, the degree of impairment may not be so obvious, or it may be necessary to quantify the severity of a stressor by more objective means. The third tier of information in the FACWet framework allows for the incorporation of more precise or scientific data into the rationale supporting a variable score. Data from intensive studies generally seek to quantify the degree of impairment caused by identified stressors, *i.e.,* the stressor effect. More intensive monitoring studies are often employed when the effect of stressors on variable function is indirect, or when it is critical to document the condition of a variable in wholly quantitative terms such as when appraising project performance to determine satisfactory completion of compensatory mitigation or to trigger release of credits from a mitigation bank.

Documentation of such investigations tends to be extensive, yet the results are readily incorporated into the FACWet framework and they do not complicate higher level explanations of condition. Going back to the previous example, for instance, if visual appraisal of the effects of the ditch (stressor) was not sufficient, the actual degree of impairment could be measured with groundwater wells to more robustly support the score for Water Distribution. In this case, measured hydrographs would bolster the rationale justifying the variable rating. Regardless of the technical complexity of any supporting studies, the results should not muddy the summary opinion on variable condition (tier 1) or the list of causal agents (*i.e.,* stressors; tier 2). They simply provide an additional tier of information to be considered at the higher levels.

The third tier of information is often employed when the effect of stressors on variable function is indirect, or when it is critical to document the condition of a variable in wholly quantitative terms such as when appraising the degree of success achieved to trigger release of credits from a mitigation bank.

In summary, an important advantage of FACWet is that regardless of the depth of information used to assess the condition of a wetland, the information is provided to the reviewer in a controlled fashion according to FACWet's three-tiered information hierarchy:

1. Functional assessment summarized by variable scores;
2. Justification of scores through identification of the severity and extent of stressors; and
3. Technical details and results of quantitative investigations.

EVIDENCE-BASED APPROACH TO VARIABLE SCORING

Development and application of the Reference Standard is the cornerstone of FACWet, and other assessment methods, since all variable scores are defined in relation to it. Thus development of the Reference Standard is the first step in variable rating, and this allows interpretation of stressor effects on functioning. In FACWet, the evaluator is asked to infer the Reference Standard for the wetland to be assessed according to the available evidence; then based on observed conditions and the presence of stressors, to rate the degree of departure between the reference standard condition of state variables and their current status on a scale that parallels the academic grading scale.

In methods such as HGM and IBI, the regional subclass of the assessment wetland is determined and then variables are measured and related to condition-response models developed through scientific research. In FACWet, observation of stressors and interpretation of their effects on State Variables are used to gauge condition rather than quantitative data, and scoring guidelines take the place of condition-response models. Colloquially speaking, FACWet aids the evaluator in discerning and describing “what’s wrong” with a wetland, while variable scoring guidelines calibrate the rating of “how wrong” things are.

Figure 10. A wetland along Sand Creek, near Aurora, CO. This wetland has been modified to the point that its exact natural form and function cannot be inferred with certainty through examination of the site alone. In this case the evaluator must rate variables in reference to the range of conditions expected in highly functioning (i.e., Reference Standard) wetlands of the same type.

Optimally, stressors and their effects can be directly observed within the AA. This is frequently not possible, however, because as sites become increasingly altered the traces of their original form and function become increasingly obscured. Thus, in highly modified sites, it can be difficult to interpret with any certainty which features of the site are original to it and which have been imposed through anthropogenic alteration (Fig. 10). At the extreme of this spectrum are wetlands that have been created in uplands, which exist solely as a consequence of land use change (e.g. urban runoff).

Functional assessment in FACWet is built upon a forensic model in which the evaluator makes a case or argument for a variable rating and supports that rating using the best evidence obtainable within the confines of a rapid assessment timeframe. Thus, FACWet is the formalization of an investigative process. Detection of stressors and observation or deduction of their effects on State Variables is the primary means by which an evaluator makes a case for variable rating.

Three lines of evidence are used to compose a case for variable rating: direct **interpretation** of impacts, **reference** to pristine or minimally-impacted examples of the same **HGM regional subclass** wetland and the **first principles** of sound ecological design (Fig. 11)**.** Any or all lines of evidence may be used during a given evaluation; however, there is a hierarchy of precedence based on the level of certainty associated with each. The most reliable type of rapid assessment evidence is interpretive and the least is principle based. While direct interpretive evidence may be the most compelling, it becomes less and less available as sites become more highly modified or artificial. As wetlands become increasingly human-influenced, a greater dependence on the two lines of indirect evidence is required.

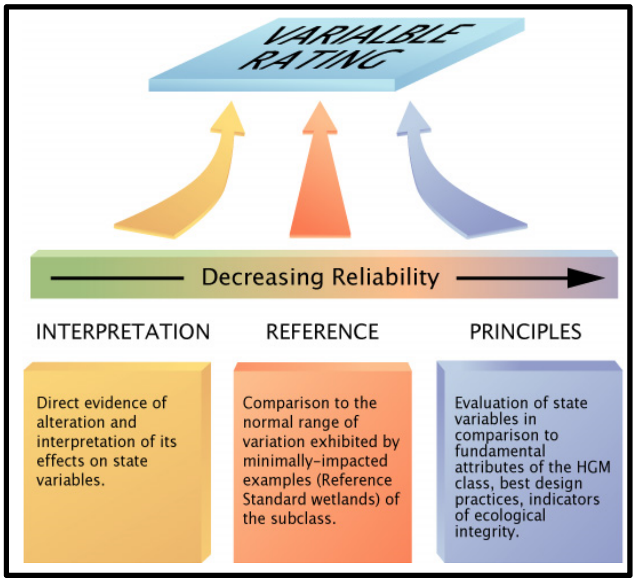


Figure 11. Three lines of evidence support a variable rating.

The following sections describe the development and application of each line of evidence in FACWet evaluations.

Interpretation

In rapid assessment, direct observation and **interpretation** of stressor effects provides the best evidence of functional impairment and support of variable ratings. This type of evidence is comparable to the "smoking gun" or eye-witness testimonial accounts in a trial setting. Here, an evaluator can describe a direct cause-and-effect of stressors and the level of confidence in variable ratings can approach that of quantitative studies. Interpretative evidence is also typically the most straightforward to compile, however, is often only available in relatively intact sites.

With interpretive evidence more-or-less discrete and definable stressors exist and the resultant degradation of wetland conditions is readily evident either as abrupt changes in conditions corresponding to the extent of stressors (Fig.12), or as relic features associated with the previous historical conditions (Fig. 6). Such interpretive evidence generally takes precedence over other forms of evidence since it provides direct indication of ecological impairment; however, care must be taken not to interpret modification of transient conditions as confirmation of impairment. For instance, obvious die-off of hydrophytic vegetation that results from removal of irrigation should not be presented as evidence of functional impairment. Instead, irrigation removal could be indicative of a return to a more natural, upland, hydrologic regime.

Reference

Reference-based evidence comes from comparison of AA characteristics to those of pristine or minimally-impacted examples of wetlands of the same HGM regional subclass which are exemplary of the highest level of condition and sustainable function attainable per the subclass (Fig. 13). Reference-based evidence provides the first tier of indirect evidence used in a FACWet evaluation and can be likened to forensic evidence used in a trial setting that is based on known patterns and properties of the material in question. This line of evidence is generally the one most frequently used in functional assessment. Reference-based evidence is most commonly used in cases where a naturally occurring wetland has been modified to the point that some or all of its natural characteristics have been obscured, or in situations where the wetland or upland has been purposefully modified to recreate the functioning of a specific wetland type, as is commonly the aim of wetland mitigation.

Using reference-based evidence, an evaluator compares existing variable characteristics to the natural range of variability exhibited by **Reference Standard Wetlands** of the same HGM regional subclass, or finer category (See Appendix B).

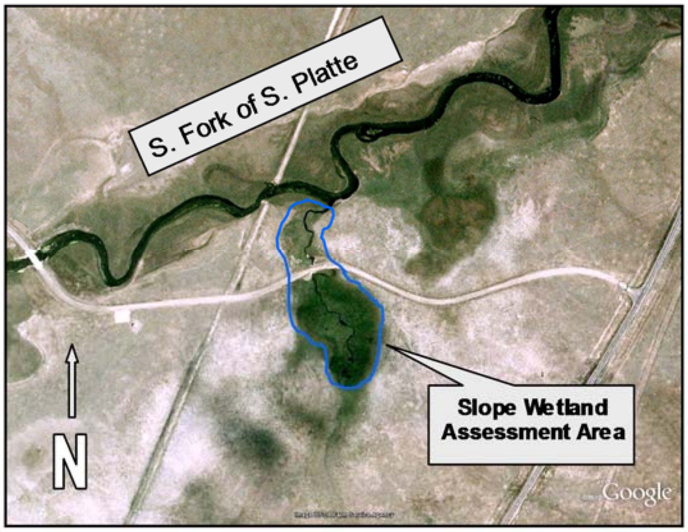
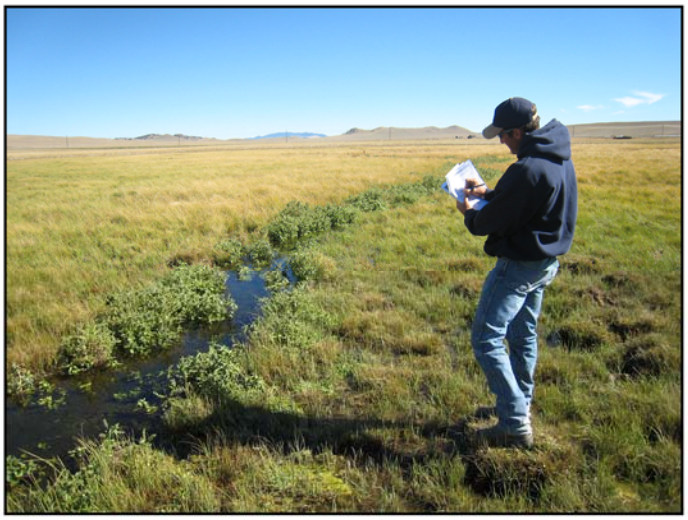


Figure 12.

Interpretive evidence can be highly compelling, but is only available at relatively intact wetlands or those with fairly discrete stressors.

In this example from Park County, a headwater slope wetland bisected by a road (upper pane). Other than this single modification (and grazing impacts) the wetland is intact.



The middle pane is a view south from the road, towards the up-gradient portion of the wetland. Here the wetland is characterized by a narrow channel, diffuse surface water throughout, and mildly quaking soils.

Below the culverted road, essentially all surface and groundwater becomes confined in a wide, shallow channel. Marginal wetland habitat is almost entirely lacking. Wetland habitat impacts in the lower reaches of this wetland can be ascribed to the road crossing with a high degree of certainty, based on interpretation of the abrupt change in habitat conditions associated with the road crossing, its construction and the presence of relic hydric soils.

Reference-based evidence can provide compelling support for variable rating, and this type of approach is used by many of the most robust evaluation methodologies, including the HGM approach and IBIs.

Using reference-based comparisons to support variable scoring is largely a matter of rating the correspondence between what is observed in a wetland versus what would be expected in pristine or minimally-impacted examples of the wetland type. Expectations of Reference Standard conditions are best developed through direct experience with the wetlands in the AA's ecoregion, especially those in its immediate vicinity. Expectations of Reference Standard conditions can be developed based on knowledge of examples of the same wetland class from other regions, augmented by background reading on the specific conditions expected in the AA habitat, consultation with local experts or examination of known high quality wetlands of the same regional subclass. For instance, an evaluator with a good knowledge of riverine wetlands in Colorado's foothills or plains would likely provide a reliable evaluation of the subalpine system shown in Fig. 13 with a modest amount of preparation. Such preparation is akin to brushing up on local flora before undertaking a wetland boundary delineation. Table 5 provides a list of useful resources describing the characteristics of reference standard examples of Colorado's wetland habitats.

Table 5. Sources of information on Reference Standard wetland characteristics in CO.

Reference	Systems Covered	Notes	Download
CNHP	Numerous	A large number of excellent references on high quality CO wetlands.	http://www.cnhp.colostate.edu/download/reports.asp
Windell et al. 1986	Subalpine and Montane wetlands	Classic reference on CO mountain wetlands	NA
Baker 1989	Riverine systems of western CO		NA
Cooper 1996	Subalpine fen, riverine and depressional system		NA
Johnson 2000	Subalpine Slope wetlands	Reference wetland network developed for HGM	http://rydberg.biology.colostate.edu/FACWet/index_files/Page631.htm
Carsey et al. 2003	All CO wetlands	Extremely useful reference on CO wetlands, particularly their vegetation	http://www.cnhp.colostate.edu/download/reports.asp
Johnson and Steingraeber 2003	Extremely rich fens		http://rydberg.biology.colostate.edu/FACWet/index_files/Page631.htm
Johnson 2005	Subalpine kettle ponds and mountain park playas	Mitigation design specifications based on reference measurements	http://rydberg.biology.colostate.edu/FACWet/index_files/Page631.htm

Figure 13.

In this example a highly modified subalpine riverine wetland in Summit County is being assessed. The original characteristics of the site cannot be directly inferred. In such cases, variables are rated in comparison to the range of conditions expected in Reference Standard Wetlands of the same HGM Subclass (Here R2). This assessment area possesses scarcely any of the habitat conditions associated with highly functioning subalpine riverine wetlands.

The AA is evaluated with regard to the HGM regional subclass to which it belongs. In most cases, evaluations are based on the AA's ***current*** HGM subclass regardless of changes in HGM class or subclass to which the wetland may have been subjected. For instance, the mountain fen (subclass S1/2) in Fig. 14 was converted to a mountain depressional wetland (subclass D1). Under the most common assessment scenarios, this wetland would be evaluated as a mountain depressional wetland. The AA is usually assessed according to its current HGM subclass because most assessments are performed to evaluate the potential loss in wetland functioning that would result from a permitted action, or the gain in functioning that would result from mitigation.

Figure 14. A mountain fen (slope wetland) converted to a depressional pond.

Two important exceptions to this general rule exist. First, if the wetland was the subject of a mitigation project the wetland should be evaluated according to permit success criteria, which should designate a target wetland regional subclass, or otherwise provide adequate description of the target habitat type. For example, the pond in Fig. 14 was constructed as mitigation. If the agreed upon target of mitigation was a mountain depressional wetland, during a post-mitigation assessment it would be evaluated as such (despite its previous class). In this case, the functional condition would rate quite high. If, on the other hand, this mitigation was intended to create, restore or enhance a mountain slope wetland, the site would be evaluated with reference to mountain slope wetlands to which it compares poorly. Consequently, functional scores would be low to reflect the disparity between the intention of mitigation and its actual outcome.

Figure 15. Wetlands along the shore of Dillon Reservoir. These wetlands were previously slope wetlands, but have been converted to lacustrine fringe. As fringe wetlands these are functioning well. If the goal of a study were to evaluate overall trends in wetland functioning in a region, the original slope wetland reference would be used, and the evaluation would reveal that the wetland has been greatly altered from its native form and function, including changes in the dominant water source, hydrodynamics, and water distribution among others.

The second situation in which an AA may evaluated with reference to a previous natural subclass, is in cases where the goal of assessment is to determine the total change in functioning that has resulted from long-term land use change (Table 3 and Fig. 15). Such an approach to determining reference might be taken, for instance, during a study of status and trends in wetland occurrence.

Ten HGM subclasses are currently recognized in Colorado by Colorado Natural Heritage Program (Karsey et al. 2003), with one additional (lake fringe) subclass being recognized in FACWet. Appendix B provides a descriptions of and keys to HGM classes and subclasses. These subclasses are acknowledged to be provisional and may not encompass the entire scope of wetlands in the state. Thus, additional subclasses may be designated in future versions of FACWet or evaluators may devise subclasses to cover the habitat types found in their AA and the surrounding region.

PRINCIPLES

Consideration of AA characteristics in light of basic ecological **Principles,** such as elements of sound ecological design, indicators of ecological integrity and permitted success criteria comprises the final rung of the evidentiary ladder. This line of evidence can be equated to circumstantial evidence in the legal sense. Although it can provide convincing support for a variable rating, principle-based evidence of functional condition is by and large more open to interpretation and uncertainty than that provided by Interpretation or Reference. Nonetheless, this line of evidence can yield key insights into a wetland's functional condition, and it is often the only one available at profoundly modified sites and in created **exotic** and **novel wetlands.**

Exotic wetlands are created habitats that do not naturally occur in the ecoregion, but which may resemble systems found in other ecoregions. Frequently, out-of-kind creation or a voluntary habitat creation projects result in construction of an "exotic" wetland type. For instance, ponds and associated wetlands are commonly created in arid environments where such water bodies do not naturally occur (except perhaps in very unusual circumstances; Fig. 16). Novel wetlands, on the other hand, lack a close correspondence with any naturally occurring wetland type (Fig. 17). Urban wetlands that form spontaneously owing to changes in land use changes and civil infrastructure (e.g., at storm water outlets) are common forms of novel wetlands.

Figure 16. A voluntarily-created, "exotic" pond habitat on the arid Colorado Plateau near Loma, CO resembles depressional habitats found in other ecoregions.

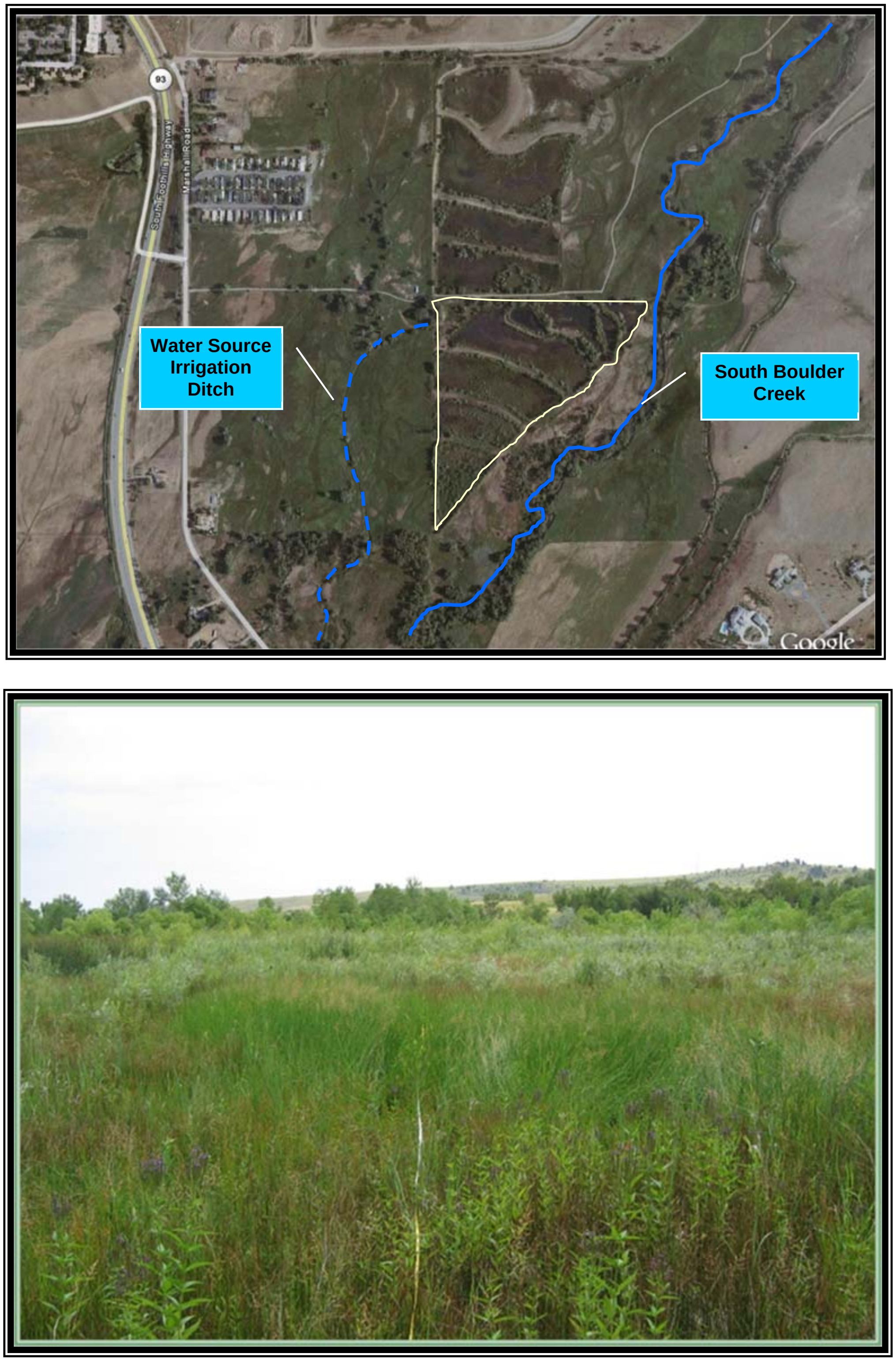


Figure 17. See following page for explanation.

Fig. 17. Case Study near Boulder (Photos on previous page). The upper photograph shows an aerial view of a Mitigation Bank located near Boulder, CO. This wetland was created from filled gravel pits located within the historical South Boulder Creek riparian zone. The created wetland is a novel type that has no real natural analog. It is currently isolated from the channel by a large levee lying between the creek and the wetland. The wetland's sole surface water source (excluding precipitation) is a manually-controlled irrigation ditch. Even though exhibiting an ecologically-beneficial hydrologic regime, the active management required to maintain the wetland represents a serious threat to the wetland's longevity. The Water Source variable was rated as 0.69 to reflect this fact.

Within the four wetland cells (AAs), separated by berms, Water Distribution and Outflow are sustained through both passive and active measures. While capable of sustaining wetland conditions, maintenance of functioning requires active management within the AA as well as at the water source. Because there are not any detectable stressors on Water Distribution *within the AA*, this variable is rated to match the Water Source score (0.7). Water Outflow from the AA occurs passively, but through structures which require active maintenance and which appear to malfunction periodically. To acknowledge the additional impairments to Water Outflow, that score is reduced somewhat relative to benchmark Water Source score (0.68).

Constructed geomorphology is excellent (0.95), and interacting with hydrology, has created a heterogeneous hydrologic environment that has facilitated the development of a mosaic of interspersed vegetational habitats (bottom Photograph) (0.95).

Exotic wetlands are evaluated first in light of the characteristics of their HGM class (Appendix B) and secondarily in comparison to those attributes generally accepted to be characteristic of and desirable in wetlands, and indicative of ecological sustainability and good health (e.g., Mitsch and Gosselink 2007, NRC 2001, France 2003; Table 6).

Novel wetlands are treated in this same way, except they usually will not fit neatly into an HGM category. In the case of both novel and exotic wetlands, the evaluator must judge the degree to which principles of sound-ecological design have been employed in wetland construction, taking into account such factors as the degree of habitat and vegetation diversity, the stability or appropriately cyclic nature of hydrologic regimes, the abruptness of surface elevation changes, or the level of active maintenance required to perpetuate wetland characteristics etc. (NRC 2001; Table 6). Many exotic/novel wetlands are “volunteers” – that is, they formed spontaneously and not by design, or at least creation of wetland habitat was not the goal of the construction (Fig. 18). Since these wetlands were not constructed according to practices of sound-ecological design, most will lack the traits generally accepted as being characteristic or desirable in wetlands and which support natural and sustainable wetland functioning. As a result of these factors, such urban wetlands will commonly score poorly in the FACWet (≤ 0.7).

Despite potentially low functional ratings, it is emphasized that urban wetlands are nonetheless important components of the modern landscape, and relative to their rated functional condition can be disproportionately valuable. To understand this, it is important to discern between relative and absolute measures of wetland functioning. For instance, a low condition urban wetland separating a golf course from a waterway may perform a nutrient retention and conversion function at a greatly accelerated absolute rate. Consequently, the wetland would play a very important and valuable role in protecting and maintaining the water quality in the adjacent stream (Fig. 19). Despite the importance of this wetland for the function of nutrient retention/conversion, its overall condition would be degraded as a result. Under such conditions, the rate of nutrient retention and conversion may not be sustainable owing to a limited retention capacity. Additional nutrients would also likely be the cause undesirable shifts in species composition by favoring aggressive invasives. Geomorphic and edaphic changes may ensue as pools and depressions become filled by the accelerated biomass production, etc. These changes would result in poor FACWet scores.

Users are reminded that FACWet does *not* evaluate societal value, which is subjective, almost wholly situation dependent and which may or may not parallel functional condition for any number of reasons (Fig. 20). FACWet evaluates functional condition relative to the wetland’s natural or quasi-natural capacity. In the FACWet system, valuation of a wetland is appropriately left to the regulatory agencies involved and to the public permit review process which was instituted for this exact purpose.

Table 6. Examples of exotic wetland traits which are generally indicative of ecologically-sound design and those which result in functional impairment or which threaten the long-term viability of the habitat. The former conditions would typically rate scores of 0.8 (B) or greater, while the latter would warrant scores less than 0.7 (D).

State Variable	Desirable Condition (≥ 0.8)	Impaired Condition (< 0.7)
Water Source	Passively supplied; stable or appropriately cyclic inflow level	Actively controlled; erratic or arbitrary changes in supply volume; inappropriate for maintenance or regeneration of desirable species
Water Distribution	Free distribution of water throughout the AA with water table depths resulting from differences in surface elevations	Uneven distribution of water across the site owing to the existence of fill (including road grades and berms) or ditches.
Water Outflow	Direct connection to associated channels; free flowing outlets; unimpeded recharge to aquifers	Dammed outlet; lack of connection to associated channels; imperviously lined ponds
Chemical Environment	Redoxiomorphic features in the soil; lack of negative indicators (e.g. algal blooms, highly turbid water, oxidizing organics, etc.)	Oxidized soils; highly eutrophic or turbid water; sediment plumes; excessive urban/industrial runoff; toxic spills; known impaired water
Geomorphology	Generally gradual elevation changes and gentle slope gradients; presence of surficial features and microtopography; channel with stable morphology and connected to a floodplain	Steeply graded (e.g., 3:1) shoreline; narrow entrenched channels lacking floodplain; physical isolation from associated channels; lack of topographical heterogeneity; fill
Vegetation Structure and Complexity	Multiple canopy layers; diversity of species and guilds; interspersed mosaic of communities	Poor vertical structure; strong dominance by one or a few aggressive invasives; Communities relatively discrete with little interspersion

Figure 18. Examples of exotic and novel wetlands created in urban settings. All photographs (except C) courtesy of Alpine Ecological Resources, LLC.

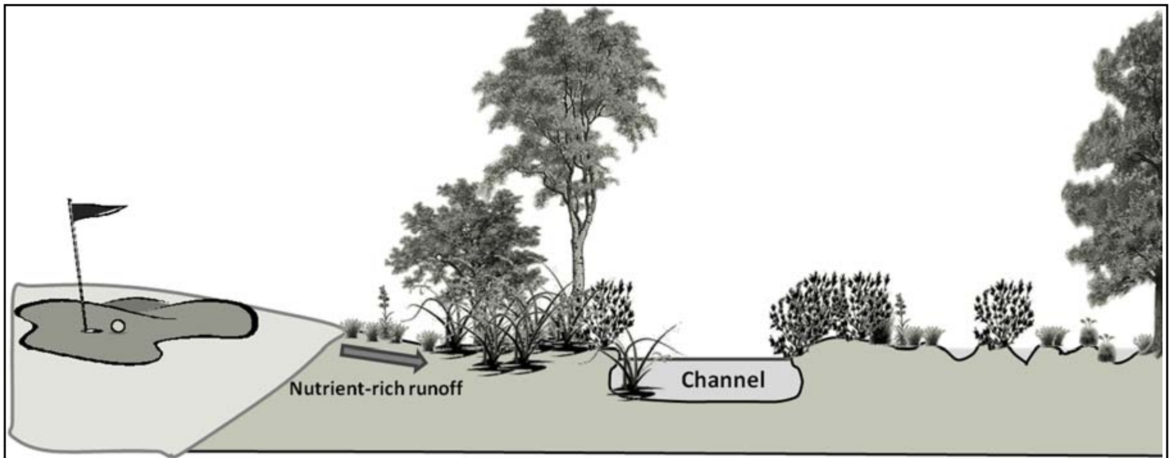
Panels A and B show a common novel type of wetland created by road-side ditches. Despite their linear form these wetlands function mainly as depressions. They are novel because their primary hydrodynamic is unidirectional (flow through). This is not a normal characteristic for depressional wetlands. The condition of these wetlands is relatively low as evidenced by the homogeneous, invasive dominated vegetation, erratic water source and poor water quality.

An exotic slope wetland purposefully-created using irrigation ditch seepage. This wetland is in relatively good condition for a created wetland, as indicated by the water distribution, geomorphology and vegetation structure, for instance.

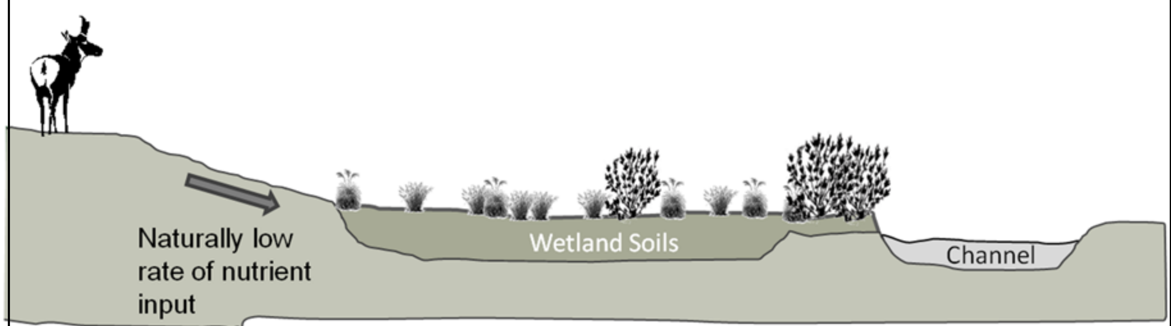
A poor condition, exotic depressional wetland that developed spontaneously as a result of urban runoff. This wetland may be relatively valuable in terms of water quality improvement, however.

Large ditches can develop channels and floodplains and function like riverine wetlands.

Lacustrine fringe wetlands do not naturally occur on the plains of CO (with a few exceptions), thus they are exotics of the ecoregion. This fringe wetland is judged to be in poor condition. Evidence of a highly fluctuating water table supports this assertion.



- Nutrient retention/conversion functions performed at a HIGHLY ACCELERATED RATE
- Long-term sustainability of water quality improvement function questionable
- Degradation of wetland water quality
- Conditions favor aggressive, invasive species
- Negative effects on dependent processes
- General Impairment of wetland condition
- Societal VALUE HIGH relative to the wetland's condition, because of protection of stream water quality



- Nutrient retention/conversion function performed at a LOW RATE relative to the urban setting
- Nutrient input rates permit water quality improvement functions to be sustainable in the long-term
- Site maintains internal water quality while protecting that of the adjacent channel
- Native species composition maintained
- Long-term support of dependent processes
- Condition of the wetland high
- Less direct value to society relative to the high condition
- Social VALUE HIGH owing to the pristine condition and support of watershed-scale processes

Figure 19. Hypothetical example illustrating the contrast between the absolute rate at which a function is performed, the condition of that function, and its perceived societal value. The nutrient retention/conversion function is depicted here, however, the same principles apply to any function. Higher functional rates do not imply "better" functioning or condition. On the contrary high absolute rates or capacities are often are indicative of functional impairment, owing to a lack of long-term sustainability and impairment of dependent processes. In functional assessment "more" does not imply "better. The societal value attributed to a wetland may be independent from its functional condition as evaluated in FACWet.

In terms of planning and designing compensatory mitigation for impacts to exotic/novel wetland types, FACWet can provide valuable insights into the highest attainable condition for a site given the constraints of the local setting. This information can lend useful guidance toward developing realistic, attainable mitigation goals. That is, owing to unalterable changes to the character of State Variables such as Water Source or Surrounding Land Use, an urban landscape may only have the capacity to support wetlands that are relatively low in terms of quality or condition, regardless of the grading or planting that is done (Fig. 21). Since this fact is explicitly acknowledged in FACWet, it can help to check unrealistic projections of mitigation potential and improve the effectiveness of compensatory mitigation. FACWet can also be used to gauge highest attainable function given land use constraints in more rural settings as well (Fig. 22).

Figure 20. Urban wetlands, even when poor in natural condition, can provide important educational opportunities and chances for children to explore nature near to home.

TIME AND EXPERTISE REQUIRED TO COMPLETE A FACWET ANALYSIS

The intuitive nature of this stressor-based approach is one reason why the FACWet is truly rapid. Under a routine assessment scenario, it is recommended that the evaluator devote a maximum of two hours to each the field and office portions of the FACWet evaluation, for a total assessment time of four hours or less (excluding travel time). This rapid application may force the evaluator to accept some uncertainty in their analysis. This is unavoidable in rapid assessment. If for any reason the uncertainty imparted by rapid assessment is unacceptable, or if more detailed information is desired, more time and rigor can always incorporated into a FACWet evaluation.

Figure 21. Despite the appropriate geomorphology, soils and the open space surrounding it, the highest attainable condition of this wetland near Aurora is low owing to landscape constraints on its hydrology (storm water drain) and water quality. The value of the wetland may be judged as relatively high, however, in terms of educational and recreational opportunities it affords, its role as an oasis in an urban landscape, the provision of wildlife habitat and water quality improvement.

This flexibility makes FACWet relevant to the spectrum of regulatory uses as well as regional surveys, project planning and initial mitigation design. Large or complicated assessment scenarios may require additional time and effort.

The FACWet is designed to be applicable by users with varied levels of experience, from a spectrum of professional backgrounds, but no methodology can replace the need for technical competency. At minimum, users should typically possess a bachelor’s degree in the biological or natural resource sciences. Users should possess field experience in wetland delineation or assessment, and should also be familiar with the fundamental tenants of wetlands ecology, in particular the general ways in which wetlands function and how that functioning can be degraded by site alterations. As explained in the sections above, a user must be familiar enough with the habitat involved in the evaluation to make reliable determinations on the natural characteristics of that habitat. Because FACWet is based on best professional judgment, it follows that, in general, the more knowledgeable an evaluator is about wetlands ecology or with the habitat in question, the more accurate and reliable the evaluation will be. If the user is not familiar with the habitat involved, they are urged to either educate themselves on that habitat to the point that judgments can be made with confidence, or to turn the evaluation over to another who possesses the requisite familiarity.

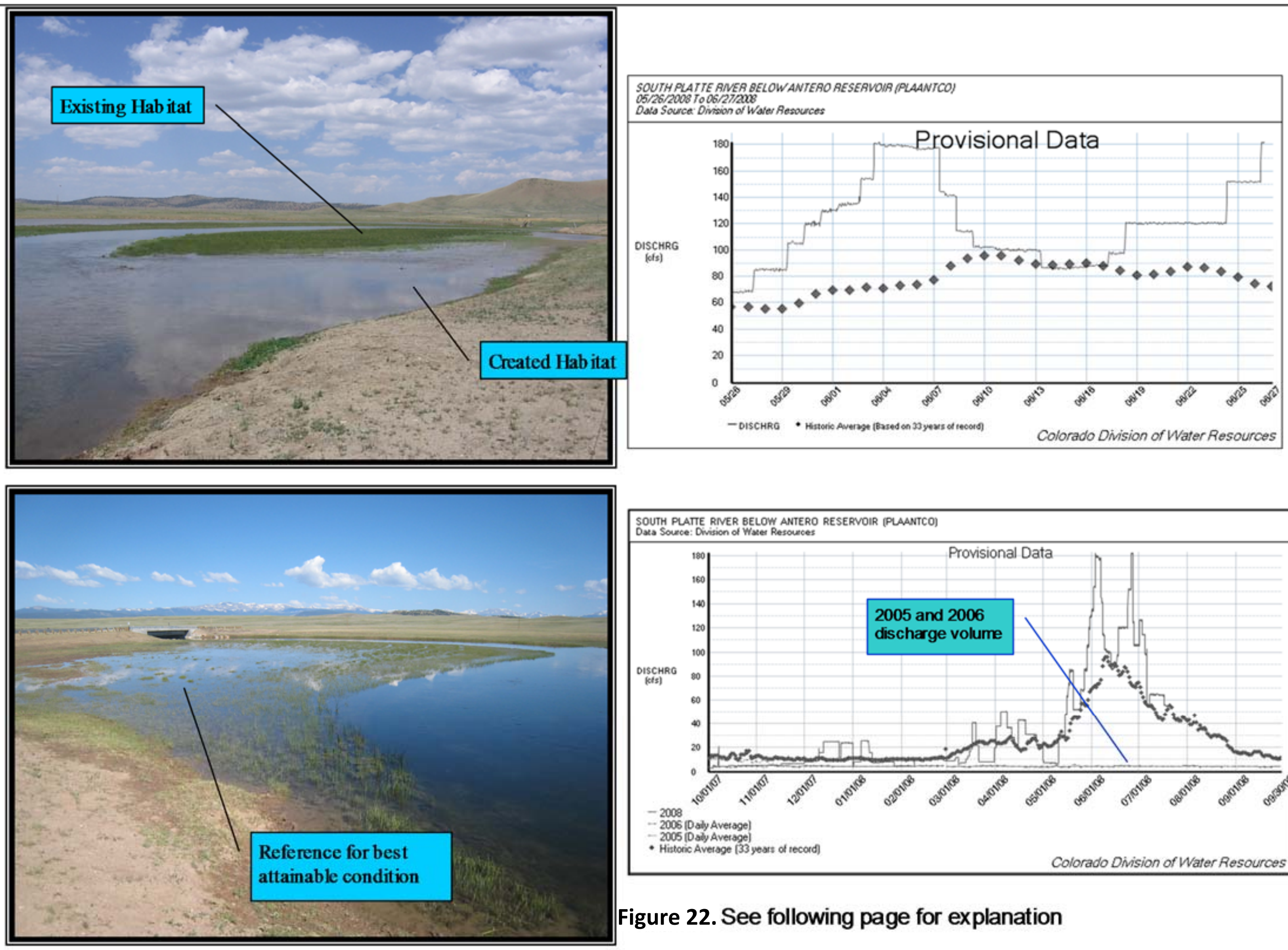


Figure 22. See following page for explanation

Fig. 22. Case Study on the S. Fork of the South Platte. When used in mitigation planning, FACWet can help to identify attainable project goals in light of irreparable changes to the landscape. At this mitigation site on the South Platte, riverine habitat was created by expanding the natural floodplain by cutting back the terrace scarp (upper photo). Created habitat was modeled after adjacent floodplain habitat which was judged to be the best attainable condition given the land use setting (lower photo). Mitigation efforts targeted the reconfiguration of surface topography and elevation (geomorphology variable) with the goal of establishing natural-like patterns of water distribution and outflow, and setting the stage for vegetation establishment and the development of other wetland functions characteristic of the target wetland type.

Through mitigation actions, it was predicted that the Geomorphology variable could attain near reference standard characteristics (score between 0.9 and 0.95). Despite the resulting functional gains, the site sits directly below a reservoir which manually-controls flows on a regime that is foremost regulated according to the needs of water users. The upper chart on the previous page is a segment of the 2008 hydrograph, which displays a stepped pattern indicative of managed flow. Although, exhibiting a strong peak in 2008, the multi-year hydrograph (lower chart) illustrates the variable nature of the water source. In 2005 and 2006, for instance the channel was nearly dry throughout the growing season while the reservoir was being filled.

Thus, regardless of the wetland's potential ability to accept water because of grading, the water source will always be inherently artificial owing to the landscape setting. The Water Source Variable of the adjacent reference wetlands was rated as 0.69 ("D", or functionally impaired), and this was modeled as the highest attainable condition for the mitigation site. Since the water source cannot be improved, the repercussions of an altered water source will be likewise immitigable. For example, as observed in the adjacent reference wetlands, the altered hydrologic regime has caused salt accumulation in the upper soil surface layers. These saline conditions have no doubt resulted in some negative effects on vegetation density, structure and composition. Moreover, the temperature of the source water is known to be elevated because of its residence in the shallow reservoir. Temperature issues may be exacerbated by the lack of shading, but it's a matter of some debate as to whether willow communities historically existed on this channel. Based on these conditions, the highest attainable condition for the Water and Soil Chemical Environment is estimated at 0.77, and 0.75 for vegetation structure and complexity.

Based on examination on the condition of adjacent reference wetlands the overall best attainable condition for mitigation was modeled to be 0.75, in the middle of the functioning category.

Execution of the FACWet Procedure

DEFINING THE AREA OF INTEREST AND ASSESSMENT AREA

Area of Interest

The **Area of Interest** (AOI) is the spatial envelope which encompasses the entire area potentially impacted (directly or indirectly) by a project's proposed activities. The AOI is intended to demarcate the search area for target habitats, namely wetlands and possibly riparian areas. Within the AOI, identified areas of target habitat are defined as Assessment Areas (AAs; Figs. 23 - 25). The AOI will commonly contain only a single wetland, or a portion of a wetland that continues beyond the project area. However, the AOI may also include a number of AAs with any degree of interconnectedness.

Environmental impact statements or environmental assessments may be useful tools for determining the predicted extent of project impacts and thus the AOI boundary. The AOI for large projects with potentially significant impacts may need to be determined in coordination with regulatory agencies involved. In any case, the extent of the AOI is determined on a project-by-project basis, directly in response to the specific circumstances of the project.

On small or moderately sized projects, in general, the AOI should be extended at least 25m outward from the predicted extent of direct and indirect impacts.

Property Evaluations, Master Plans and Mitigation Banks

The AOI can be any type of geographic, municipal or planning unit. FACWet can be used to evaluate the condition of wetlands and the ambient stressors affecting them across the unit. Such an application provides a valuable view of the type, condition and functioning of wetlands in a given area, along with documentation of the specific stressors affecting those wetlands. When combined with GIS, such analyses can provide a powerful picture of wetland resources and help guide the development of integrative restoration or management plans.

The results of FACWet are not sensitive to arbitrary boundaries such as property lines since any stressor affecting the wetland is taken into account, regardless of its proximity to the AA. However, it is cautioned that determining AOI boundaries based on municipal or property boundaries is only appropriate for planning purposes. If the goal of the assessment is to evaluate the effects of a potential project, the AOI must include the full predicted extent of direct and indirect wetland impacts.

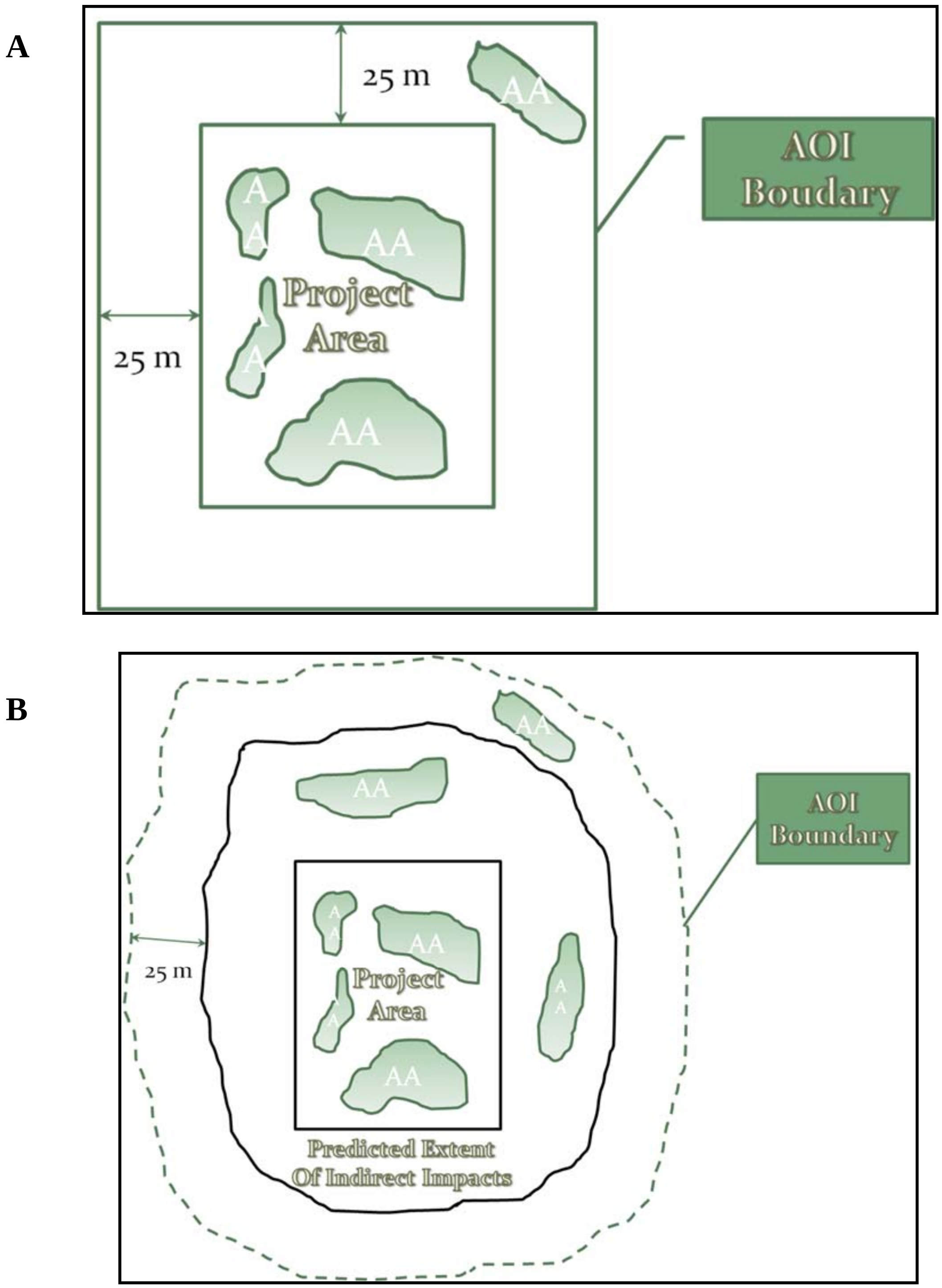


Figure 23. Two illustrations of AOI and AA determination. The upper drawing shows a project area with a well-defined footprint and no predicted indirect wetland impacts. The AOI boundary in this case is defined as the area within 25m (82 ft.) of the project boundary. Shaded polygons show the assessment areas (AA) that would be included under this scenario. The lower drawing depicts a project that is judged to directly affect several target habitats and cause indirect impacts to others. The AOI boundary is drawn 25m (82 ft.) outward from the predicted extent of indirect impacts.

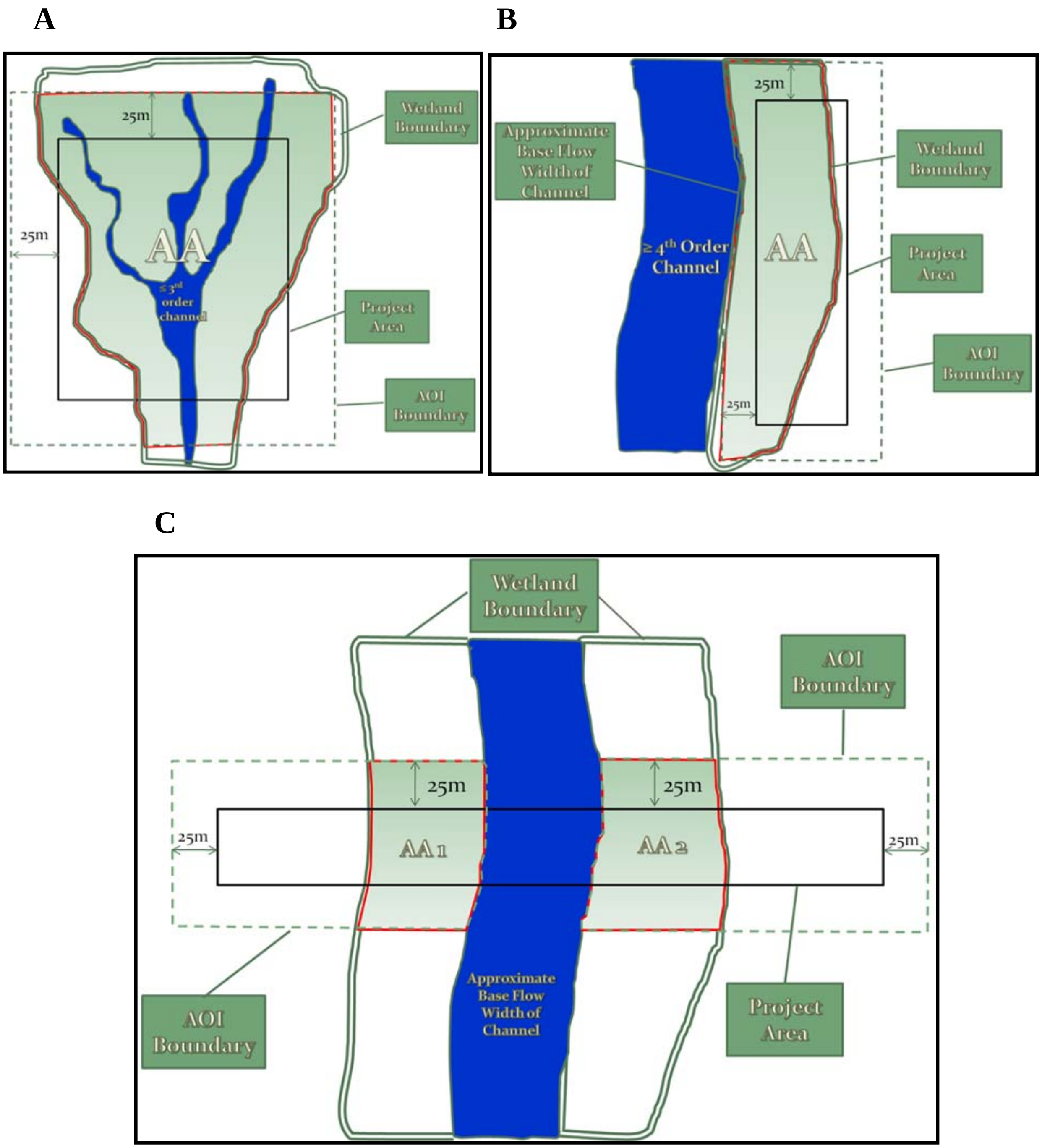


Figure 24. Delineation of the Area of Interest (AOI) and Assessment Areas (AA) in situations involving stream and river channels. In each case the AOI is symbolized by a dashed green line. AAs are shown as green-shaded areas bordered in red. In panel A, the AOI includes a wetland containing small streams (approximately 3rd order or smaller). Such channels are included in the AA. Panels B and C, illustrate situations involving larger rivers (4th order or greater). In these cases, the AOI and AAs are defined in the normal way except they are delimited on the stream-ward side by the approximate lateral extent of the channel at normal base-flow levels.

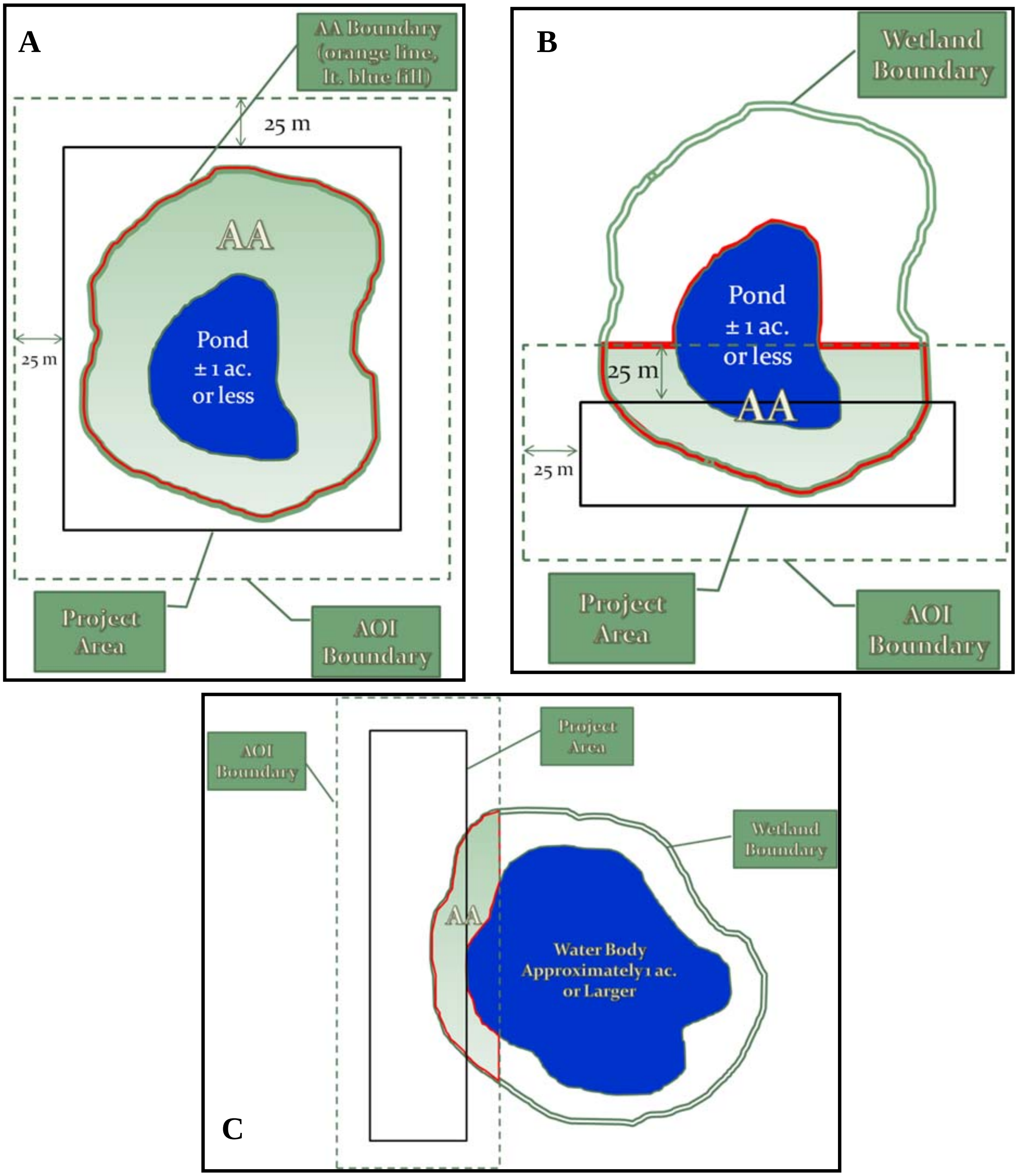


Figure 25. Delineation of the Area of Interest (AOI) and Assessment Areas (AA) in situations involving ponds and lakes. In each case the AOI is symbolized by a dashed green line. AAs are shown as green-shaded areas bordered in red. In panel A, the AOI includes a single AA holding a pond an acre or less in size. In this case, the entire target habit along with the pond is included in the AA. Panel B shows a similar situation, but one in which only a portion of the target habit and pond would be affected by the project. Here the AA is defined in the normal way except the entire pond is included with in the AA boundary. Panel C, represents a scenario where a project area abuts a water body greater than approximately 1 ac. in area. The AA boundary is determined in the normal way, except it is truncated on the shoreward side at the normal low water level of the water body.

<u>Determination of the Assessment Area</u>

Assessment Areas (AAs) are the units of target habitat (e.g., wetlands) within the AOI. AA boundaries are determined by defining the area(s) of target habitat that falls within the AOI. Figs. 23 - 25 provide examples of AA delineation in a variety of common situations. As a rule of thumb, AAs intended to describe a proposed project's impacts will follow the delineated wetland boundary within the AOI. *The evaluated wetland **may or may not** be jurisdictional under §404 of the CWA.* Project circumstances and information needs, **not** jurisdictional status, should dictate the specific habitats included in the evaluation.

On the other hand, AAs associated with proposed mitigation sites and banks will frequently include non-jurisdictional wetland, historical wetland and/or riparian areas. Restoring wetland conditions to areas no longer possessing them is one of the primary approaches to compensatory mitigation, and there is commonly a regulatory preference for it. Baseline assessments of future mitigation areas intentionally encompass non-functioning wetland habitat in order to capture the full range of habitat conditions, including the most severely affected ones.

AAs may be located anywhere within the AOI, and in many cases the AA boundary will closely follow or even be identical to that of the AOI.

<u>Situation Specific Guidelines for AA boundary determination</u>

- The AA for a mitigation wetland is the area that has been or will be restored, established, enhanced or preserved out of a compensatory obligation.

- The AA for a previously evaluated project should be consistent with past evaluations.

- For projects that directly or indirectly impact areas that include small streams (approximately 1^{st} – 3^{rd} order at 1:24,000 scale), aquatic habitat including the active channel should be included in the AA (Fig. 24a).

- Projects with impact areas that run parallel to larger channels (approximately 4^{th} – 6^{th} order) should have AAs in which the up-gradient edge is determined using the general guidelines above and the river-ward boundary determined by approximate base-flow level of the channel (Fig. 24b). Unlike wetland delineation, the AA boundary does not need to be established with great precision.

- AAs for projects crossing large channels should be determined using the general guidelines, excluding the width of the channel at its approximate base flow level (Fig. 24c).

- In project areas which wholly encompass or abut small lakes or ponds (less than approximately one acre), the entire water body should be included in the AOI Figs. (25a and b).

- In project areas that wholly encompass, or abut larger water bodies (>1 acre), the shoreward boundary of the AOI should be delineated at the approximate position of the estimated or observed annual low-water level (Fig. 25c).

If impacts to aquatic resources (streams, rivers, ponds or lakes) may result from a proposed project, application of a habitat-specific assessment methodology may be necessary. The FACWet is *not* designed to evaluate the functioning of wholly aquatic habitats.

Cases when an AOI contains numerous or extensive wetland habitats

Areas of Interest for linear or otherwise extensive projects may contain a number of discrete AAs, or a large heterogeneous one (Figs. 23 – 24c). In these scenarios the evaluator must decide if a single analysis will meet project needs, or if multiple assessments will be required. Multiple AAs may be included in a single evaluation under certain circumstances, for instance:

1. When multiple AAs are present and those habitats are of the same HGM type and have been subjected to similar stressors and possess similar levels of impairment.
2. When it is desirable to "average" the condition of the wetland habitat resources within an expansive AA.

As a rule of thumb, lump multiple AAs into a single assessment when having individual assessments would add little or no additional information and forms would be highly redundant When dealing with large wetland complexes holding diverse habitats, it is generally advisable to divide the site into multiple AAs. In these cases, assessment areas can be defined based on a number of useful criteria such as the area of influence of some key stressor, habitat boundaries, or catchment divides.

Office Preparation and Analysis

1) Determine the Area of Interest (AOI) based on project/study plans and the procedure detailed in the previous section.

2) Obtain aerial imagery covering the AOI and mark the AOI boundary on the image.

3) On the image, identify and delineate potential target habitats (candidate AAs) within the AOI; or add AA polygons if that information already exists, for instance as a result of a jurisdictional delineation.

4) Gather background information on the AOI, such as topographical maps, environmental impact/assessment documents, project plans, success criteria, 404 permit or application, etc. Table 7 provides a number of very useful web-based resources. It is recommended that frequent users of FACWet designate a "favorites" folder in their web-browser dedicated to useful information resources, such as these. This greatly reduces office preparation time.

Table 7. Web resources that may be useful in FACWet evaluations.

Type of Information	Website Address
Topographical maps and other GIS layers	http://datagateway.nrcs.usda.gov/
Historical Aerial Photographs	http://eros.usgs.gov/#/Home
Impaired water status	http://www.cdphe.state.co.us/wq/Assessment/TMDL/tmdlmain.html and http://cfpub.epa.gov/surf/locate/index.cfm
Water Quality	http://waterdata.usgs.gov/nwis http://cfpub.epa.gov/surf/locate/index.cfm
Water Quality Standards	http://www.cdphe.state.co.us/regulations/wqccregs/index.html
Toxic spills	http://oil.cdle.state.co.us/
Pollutant discharge/storage sites	http://www.epa.gov/enviro/html/em/index.html
State element occurrences (rare plants and animals)	http://www.cnhp.colostate.edu/
Wetland mapping resources	http://www.fws.gov/wetlands/Data/Mapper.html
Hydrology and Stream gauge data	http://www.dwr.state.co.us/surfacewater/default.aspx and http://cdss.state.co.us/Pages/CDSSHome.aspx (Map Viewer is particularly helpful)
Various	http://water.usgs.gov/wsc/map_index.html
Hydric soils locations	http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
Flood plain maps	http://www.msc.fema.gov/webapp/wcs/stores/servlet/CategoryDisplay?catalogId=10001&storeId=10001&categoryId=12001&langId=-1&userType=G&type=1&future=false

5) If the AA is a mitigation wetland, use permit success criteria to inform Reference Standard development, determining the expected type of water source (groundwater, surface water, overbank flows, etc.), hydrologic regime, geomorphic position, soils, and vegetation.

6) Identify significant land use changes up-gradient of the AA which would negatively affect the ecological functioning of the AA habitats. Examples of such features could include dams, ditches, mining activity, trans-basin diversions, power plants, etc. This remote survey should consider the watershed area above the AA to the headwaters if possible; otherwise, survey as far upstream as practical.

7) Complete the administrative characterization data sheet as desired. This data sheet can also be largely completed during the field assessment or after it.

8) *Preliminarily* score the two Buffer and Landscape Context variables, V1 and V2. Scoring at this point is useful since the procedure will help familiarize the evaluator with the site and surrounding landscape. The variable ratings will be verified during the on-site assessment.

9) Assemble field assessment gear. A FACWet assessment requires no specialized equipment beyond that required to perform a routine wetland delineation. An aerial image, topographic map, shovel, binoculars, camera, GPS, compass, and an area grid (if landscape variables will be scored manually) are included in the list of recommended field equipment. Pin flagging or ribbon may also be helpful for marking the AA boundary if it has not been previously delineated.

Arrival in the Field

1) Orient yourself to the surroundings using the aerial image and other geographic resources.

2) Identify the boundary of the AA(s) using the procedures described previously. This will commonly be the time at which a wetland boundary delineation is completed.

3) During and after the boundary identification, familiarize yourself with the AA noting salient features such as water sources, water outlets, habitat patches, impacts and general areas of stress or impairment. The familiarization process should include examination of areas outside of the AA, as necessary, to infer Reference Standard conditions and the sources of ecological stress. ***This step must be thorough as it is the primary opportunity to identify stressors acting on the system. If stressors are misidentified or overlooked the evaluation will not be representative of the actual AA condition.***

4) Determine the HGM class and (regional) subclass of the wetland and of the wetland Reference Standard to which it will be compared. Referral to project plans, permit information and/or success criteria may greatly aid in determining the appropriate reference standard.

5) Begin the AA description and variable scoring procedure as described below.

EXPLANATION OF DATASHEETS AND VARIABLE SCORING

Administrative Characterization

Administrative Characterization includes three sections in which to record project-related information:

General Information

This section includes basic information about the AA such as assessment date, project name/identification and evaluator. Form data fields are self-explanatory.

Location Information

Site Location: Enter the geographical coordinates of the site. The format generally preferred by the Corps is latitude and longitude as decimal degrees. These coordinates can be obtained from GPSs, topographical maps, web-based tools or GIS, among other sources.

Geographic Datum Used: This datum can be obtained from any of the Site Location resources, listed above. The 1983 North American Datum (NAD 83) is generally preferred.

Site Location Narrative: Include a brief description of the immediate locale of the site, including details such as road and business names or other prominent landmarks. Inclusion of access directions can be helpful.

USGS Quadrangle: Record the name of the USGS quadrangle map that includes the AA. This can be obtained from the map sheet or quadrangle index.

Sub-basin Name: Record the name of the sub-basin in which the wetland is sited based on the eight-digit Hydrologic Unit Code (HUC 8). This information is included here (http://water.usgs.gov/wsc/map_index.html) or it can be obtained through a number of other sources.

Wetland Ownership: Record the type of land ownership (private, state, US Forest Service, etc.). In the case of private lands, the name and contact information for the owner may be included if desired.

Project Information

For the first three items, indicate the type of assessment scenario by checking the appropriate boxes.

Total Size of Wetland Involved: Record the total size of the contiguous wetland of which the AA is part. If the target habitat is not wetland but rather riparian, record the size of the contiguous habitat patch. Indicate whether the area was measured or estimated by circling the appropriate term. If the area was measured, note the method that was used.

Assessment Area Size: Record the size of the AA. This may coincide with the total wetland size recorded above. This will also commonly equate to the jurisdictional wetland boundary. Record the method of area determination. If multiple AAs are to be considered on a single assessment form, record those areas in the boxes to the right.

Characteristics or Method Used for AA Boundary Determination: Describe how the AA boundary was determined referring to the guidelines provided in the *Key Concepts* section; for example, "Extent of AA determined by jurisdictional wetland boundary".

Ecological Description 1

The goal of the two pages of ecological description is to identify special biological resources ("red-flags") in the AA(s), and generally describe the nature of the resources involved in the assessment**. *None of the items recorded in the Ecological Description section influence scoring*.** The main intention of this section is to produce a description of the AA with sufficient breadth and detail that an individual reviewing the assessment forms will be able to understand the types of habitats involved without having visited sites.

Although not used in the scoring process, this information may be used to inform decisions as to whether proposed mitigation is in-kind, out-of-kind, or otherwise appropriate for compensation for functional losses. This information may also inform review and discussion of the wetland's societal value.

***Special Concerns*:**

Check the boxes next to all "red-flag" conditions that apply. Special concerns do not affect the functional rating of the site as evaluated during variable scoring, but it may indicate that the site has particular societal *value*.

***Hydrogeomorphic (HGM) Setting*:**

This section is used to describe the physical setting and characteristics of the wetland. First indicate whether the wetland was created from an upland setting or if the HGM class has been changed by anthropogenic alteration. If more than 75% of the original area has been so altered, check the latter box.

Current Conditions:

Provide the following information based on the predominant conditions (>75% of AA area) that currently exist, regardless of origin.

Water Source

Record the *dominant* sources of water for the wetland. Precipitation should only be indicated if it plays a key role in habitat maintenance such as in the case of playas or vernal pools.

Hydrodynamics

Indicate the predominant direction of water motion “that generally corresponds to its capacity to do work such as transport sediments, erode soils, flush pore waters in sediments, fluctuate vertically, etc.” (Brinson 1993, p. A6). In most cases, lentic sites (depressional and lacustrine fringe habitat) will possess vertically- or bidirectionally-oriented hydrodynamics, whereas other flow-through systems (riverine and slope wetlands) will display unidirectional dynamics.

Wetland Gradient

Estimate or measure the predominant topographical gradient (i.e., slope) present in the wetland.

# of Surface Inlets

Record the number of surface inlets. In riverine situations, the “inlet” to the wetland will generally be “over-bank” unless additional inlets such as tributaries are also present. Count inlets that may only function during high water events.

# of Surface Outlets

Record the number of outlets present. Count outlets that may only function during high water events.

Geomorphic Setting

Briefly describe the historic geomorphic setting. This could include descriptors such as, closed basin, valley bottom, base of alluvial terrace, and so on.

HGM Class, Subclass and Regional Subclass

Determine the predominant HGM class of wetland present in the AA using the information recorded above and the dichotomous keys/descriptions provided in Appendix B.

Notes

Record atypical or otherwise significant characteristics of the HGM parameters. Include information such as the artificiality of features or other special conditions.

Historical Conditions: If more than 75% of the habitat has been subjected to a shift in HGM class, fill out this table. This information is intended to be used during landscape-scale evaluations of wetland condition to track severe habitat alterations, and to highlight gross changes in functional characteristics. Fill out historical information to the extent possible.

Water Source

As explained above

Hydrodynamics

As explained above

Geomorphic Setting
As explained above

Previous HGM Classification
Identify the historical or natural HGM class of wetland present on the site using the above information and the keys and descriptions included in Appendix B. Continue the classification to the subclass and regional subclass level to the degree possible.

Ecological Description 2

Vegetation Habitat Description:
The purpose of this data sheet is to provide description of the type of habitat present in the AA based on the US Fish and Wildlife's (US FWS) classification system. The focus is on characterization of the biotic rather than physical habitat features. The table is divided into seven columns each listing a hierarchical level or descriptor used in the US FWS classification system. At the bottom of each column the most common possibilities are listed. These lists are not exhaustive and others may apply in a given assessment scenario.

Refer to Cowardin et al. (1979) for additional description of the US FWS classification system. Since this information is not used for scoring but instead for qualitative description, evaluators may use another classification, such as the US National Vegetation Classification (http://www.natureserve.org/explorer/classeco.htm) or they may substitute their own descriptive terms.

Site Map:
Space is provided for users to generate a sketch map of the site. Include pertinent features such as the locations of inlets, outlets, channels, habitat features, site modifications and buffer. Important features of the AOI and/or surrounding landscape may be appropriate to include. Be sure to include a direction arrow to facilitate map orientation. A large-scale (i.e., close-up) aerial photograph with pertinent annotations attached to the datasheets may be substituted for the hand sketch, but in most cases a hand sketch provides a better account of site characteristics.

Variable Scoring

Variable scoring is calibrated to parallel the academic grading scale (Table 4). Specific instructions for scoring each variable are included on the individual FACWet datasheets, but the general procedure is as follows. For the given variable under consideration, record the stressors that negatively affect it. Lists of stressors provided on variable datasheets are intended to capture the most common stressors that effect that variable, however, the lists are not comprehensive. **Additional stressors not listed can be written in.** Make notes as to the severity and extent of each stressor, along with the apparent effects it has on the variable in question. Next, based on the composite effect of all stressors, informally assign a condition category or letter grade to the variable that reflects the condition of the variable relative to its natural state. In academic grading an “A” may translate as “excellent” and “B” as “above average” and so on. In FACWet these grades translate into descriptive terms related to functional condition (Table 4).

Criteria for scoring based on the overall level of variable alteration are provided on the data sheet for each variable. These guidelines are intended to help calibrate evaluators by illustrating the approximate level of impact that would typically warrant a given grade or functional categorization. The scenarios laid out in the guidelines do not cover all conceivable circumstances, and note that they often include quantitative thresholds, yet generally no quantitative data will be acquired during an evaluation. Thus, **scoring criteria should be taken literally as guidelines, and not interpreted strictly or in an absolute sense**. If evaluator does not follow the scoring guideline recommendations, a justification should be included in the evaluation.

Lastly, a decimal value is assigned to the variable based on the assigned letter grade. Letter grades are converted to numbers so that arithmetic operations can be performed on the scores. The decimal scale is consistent with academic grading, of course, and it allows for more detailed subdivision of grade or functional categories (similar to adding a “+” or “-“ after a letter grade).

Here are a few important points about scoring.

- Variable scores will typically range between 0.5 and 1.0. Scores lower than 0.5 will be rare since an “F” or non-functioning rating indicates the total loss of the variable’s ability to support wetland conditions. Once a variable is non-functioning further perturbation of it would not typically result in additional functional losses. Scores lower than 0.5 can occur when the AA has not only lost wetland characteristics, but also those of any type of “natural” habitat, for instance when a former wetland is paved over. If a score lower than 0.5 is assigned, an explanation of the circumstances should be included.

- Scores of 0.95 or greater should be reserved for truly exemplary sites.

- Always keep in mind that scoring relates the AA’s current condition to an inferred Reference Standard condition. The comparison is **not** relative to the typical condition of wetlands in the region. For instance, a variable **would not** warrant a “B” grade (0.8 – 0.9) solely because it is “good for around here”. Commonly, all or most of the wetlands in intensively developed areas will rate in the “C” range or lower (e.g., urban areas, arid agricultural settings).

  Comparison to appropriate reference standards sets a consistent benchmark for all evaluations and can provide critical insight into long-term trends in wetland health. It also helps to develop a consistent picture of the best-attainable condition for compensatory mitigation within regions. That is, if it is acknowledged that all of the wetlands in a region are functioning at a “C” level or lower, it is probably not realistic to expect compensatory mitigation to function at a much higher level. That is, the highest attainable condition is less than 0.8.

If a site does appear to be in better condition than most within a region, such information is important in terms of the relative *value* of the wetland and this should be noted in the “Special Concerns” portion of the *Ecological Description* data sheet.

- Variable scoring is analogous to the legal system in that a variable is “innocent” of degradation unless “proven” guilty, by the evidence at hand. To score a variable low, there must be some evidence of a stressor.

- In a routine assessment, variables are scored based on the evaluator’s professional opinion as supported by the best evidence obtainable within the approximately four hours allocated for an evaluation (inclusive of office and fieldwork). Consequently, at times, there will be uncertainties incorporated into variable scores. This is expected given the analytical intensity of the method. Under circumstances of uncertainty, the evaluator is directed to give their best interpretation of the situation and document the unknowns they are confronted with. If, under a given assessment scenario, the level of uncertainty in variable scoring is unacceptable, the variable should be evaluated using more intensive or quantitative methods.

- Variable scores are a forensic summary of best professional opinion. As such, they can always be challenged or modified, particularly when new information comes to light or processes are quantified using intensive methodologies. Modification of variable scores secondary to the introduction of new information is **not** necessarily an indication that the original evaluation was of poor quality. The FACWet is an information framework geared toward incorporating new insights as they are revealed.

- Discussion of the rationales underlying scoring with regulators and stake-holders is beneficial. Consensus among professionals lends strength to evaluation conclusions.

Variable 1 – Habitat Connectivity

Variable Overview

The Habitat Connectivity Variable is described by two sub-variables – Neighboring Wetland and Riparian Habitat Loss and Barriers to Migration and Dispersal. These sub-variables were treated as independent variables in FACWet Version 2.0. The merging of these variables makes their structure more consistent with that of other composite variables in FACWet. The new variable configuration also makes this landscape variable more accurately reflect the interactions amongst aquatic habitats in Colorado's agricultural and urbanized landscapes, which have a naturally low density of wetlands.

The two Habitat Connectivity sub-variables are scored in exactly the same manner as their FACWet 2.0 counterparts. The Habitat Connectivity Variable score is simply the arithmetic average of the two sub-variable scores. If there is little or no wetland or riparian habitat in the Habitat Connectivity Envelope (defined below), then Sub-variable 1.1 is not scored.

SUB-VARIABLE 1.1 – NEIGHBORING WETLAND AND RIPARIAN HABITAT LOSS

Overview

This sub-variable is a measure of how isolated from other **naturally-occurring** wetlands or riparian habitat the AA has become as the result of habitat destruction. To score this sub-variable, estimate the percent of naturally-occurring wetland/riparian habitat that has been lost (by filling, draining, development, or whatever means) within the 500-meter-wide belt surrounding the AA. This zone is called the Habitat Connectivity Envelope (HCE). In most cases the evaluator must use best professional judgment to estimate the amount of natural wetland loss. Historical photographs, National Wetland Inventory (NWI) maps, hydric soil maps can be helpful in making these determinations (see Table 7). Floodplain maps are especially valuable in river-dominated regions, such as the Front Range urban corridor. Evaluation of landforms and habitat patterns in the context of perceivable land use change is used to steer estimates of the amount of wetland loss within the HCE.

Indications

Loss of neighboring wetland/riparian habitat impairs the ability of the assessment wetland to function properly in its landscape context. By limiting the connectivity with other wetland habitats, the exchange of water, nutrients, sediment and organisms is diminished. The potential result of unnatural ecological isolation is a shift in the defining features of wetland function, including alteration of wetland sediment regime, degradation of water quality, or loss of biodiversity.

The HCE is defined to describe the zone of maximum potential interaction between wetland/riparian sites. Only the loss of *naturally-occurring* wetland and riparian habitat from the HCE is considered when scoring Sub-variable 1.1. This is because the variable implicitly uses natural wetland loss as an index of overall landscape-scale perturbation of the aquatic system. Created habitat that lacks the fundamental character of the previous wetland/riparian habitat, or which was created from an upland setting is not considered while scoring this variable because such habitats tend to cumulatively alter the watershed-scale functioning of the aquatic-wetland system (Johnson 2005). It is assumed that created habitats represent an altered landscape condition that does not provide the original characteristic biotic support functions.

Step-by-Step Scoring Instructions

Step 1: On the image, outline the area that is within 500m of the AA boundary (Fig. 26 and 27).

Additional Explanation:

This variable is most easily scored using digital images in conjunction with GIS, or web-based tools such as Google Earth™. Hardcopy images may also be employed, although with some loss of precision.

There are a number of ways to delineate the HCE using software tools. The buffer command of the ArcGIS editor menu is one useful tool. If hard copy images are used, determine the scale of the photograph and the scaled length that would represent 500m. For instance, 2.1cm (0.8 in.) equals 500m at a 1:24,000 scale. Open a drawing compass to that length and keeping the compass perpendicular to the AA boundary, trace the AA boundary with the point of the compass, thus producing an offset line. There are other similar ways in which HCE boundaries can be manually drawn.

Step 2: Examine the geographic resources assembled during office preparation including a current aerial image and topographic map, as well as historical aerials, photographs, and wetland, hydric soils and floodplain mapping information if it is available. ***An aerial photograph taken recently enough to accurately portray current landscape conditions is a requirement for variable scoring.***

Additional Explanation:

Geographic resources are used to identify the location and extent of existing naturally-occurring wetland and riparian habitat, and that which has been lost owing to land use change.

Step 3: Outline the current extent of naturally occurring wetland and riparian habitat. *Then outline areas where evidence suggests these habitats historically occurred (Fig. 27)*.

Additional Explanation:

When mapping current wetland and riparian habitat, identify these areas based on indicators such as obvious patches of hydric vegetation, the extent of forest along channels, drainage pathways and land forms. Existing wetland mapping information can help inform this process, but is not required. The primary aim of this variable is to delineate the mosaic of wetland and riparian zones for the purpose of habitat connectivity evaluation. It is not intended to single out jurisdictional wetland area.

Mapping of lost habitat can be speculative at times, but in practice is usually straightforward especially in riverine settings. To delineate lost wetland and riparian habitat the evaluator simply uses their best professional judgment, augmented by readily available information. The primary evidence for lost wetland/riparian habitat will come in the form of unnatural breaks in vegetation (Figs. 26 and 27). When such breaks occur landforms can be used to estimate the

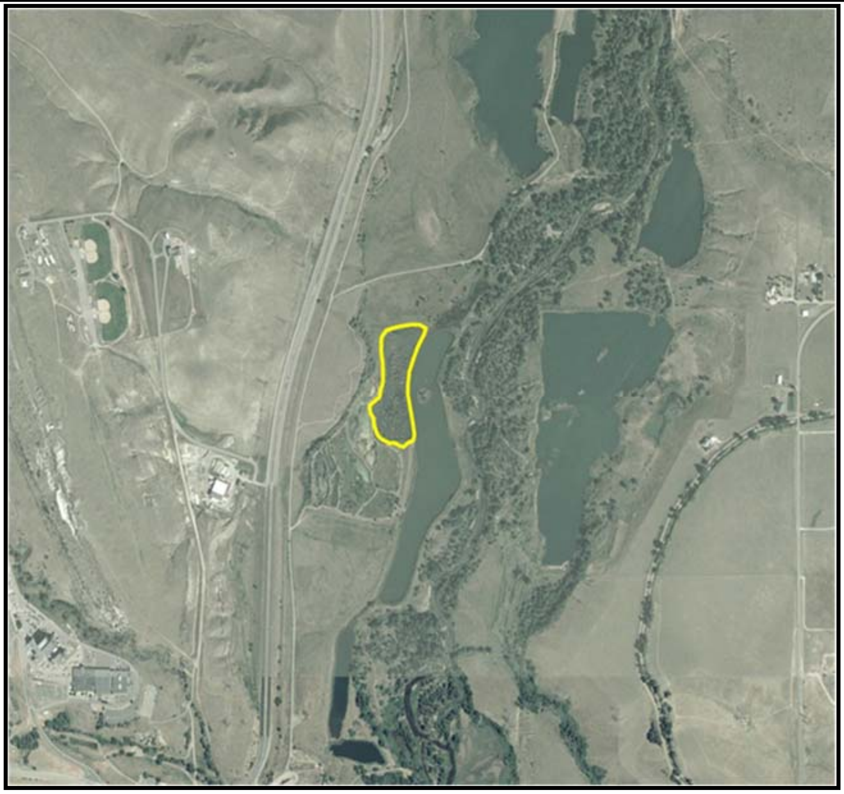


Figure 26. Aerial photograph of an AA in its landscape context in the South Platte River corridor near Littleton, CO.

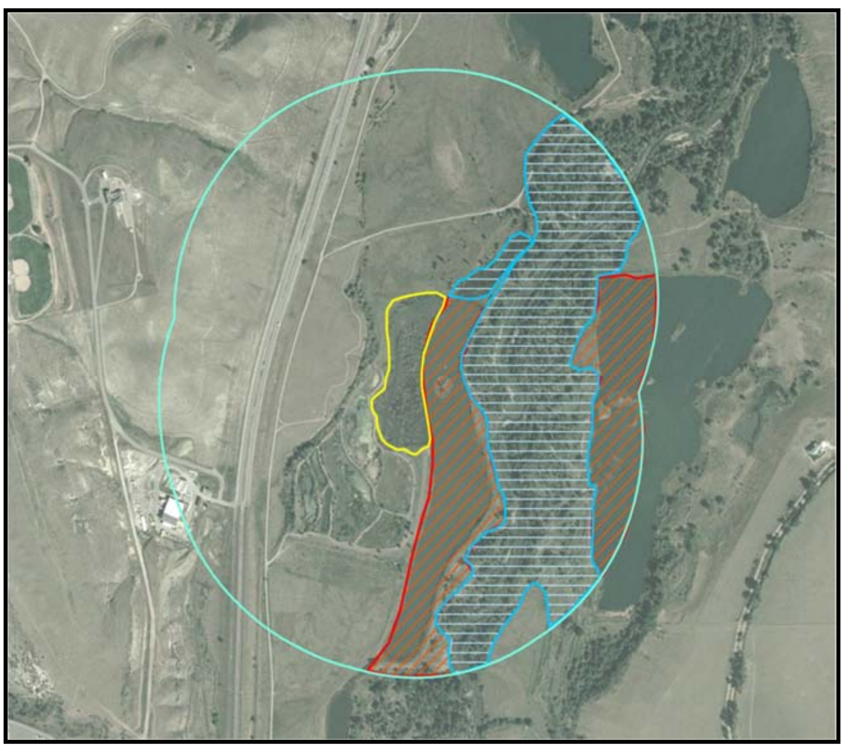


Figure 27. Aerial photograph showing the area within 500m of the AA boundary, or HCE. The boundary of existing natural wetland and riparian habitat is shown in blue. Former wetland and riparian habitat is hatched in red.

historical boundary of the wetland. Federal Emergency Management Agency or city floodplain maps can be used to estimate the natural width of the riparian zone. Use the designated floodplain boundary to guide delineation of the historical extent of riparian habitat, modifying the boundary where obviously unnatural configurations exist (Fig. 28). Other characteristics such as fill, dams or excavated ponds/reservoirs can also signal wetland loss. NWI and hydric soils maps can greatly aid in this procedure, but are not required.

Step 4: Calculate the amount of historical wetland/riparian habitat that is still present (or the percent lost).

Additional Explanation:

Calculate the area of each mapped polygon. This is again most easily done using GIS or web-based tools. In this case simply obtain the area of each polygon and apply the following formula.

$$\frac{\textbf{Total acres of existing habitat}}{\textbf{Total acres of Existing habitat} + \textbf{Acres of habitat lost}} = \%\ \textbf{natural habitat remaining}$$

This operation can also be performed on hardcopy photographs using a Mylar dot sheet or acreage grid. Since the target value is a percentage, the grid does not necessarily have to be the same scale as the photograph. Smaller grid sizes will produce more accurate results.

Finally, the percentage of natural wetland existing can be visually estimated. This is the quickest method; however, it comes at the cost of accuracy. If visual estimation is employed, the evaluator is strongly encourage to “calibrate their eye” by making a number of estimations and then comparing them to measurements obtained using a more rigorous approach. Visual estimations of area are not appropriate for most regulatory uses.

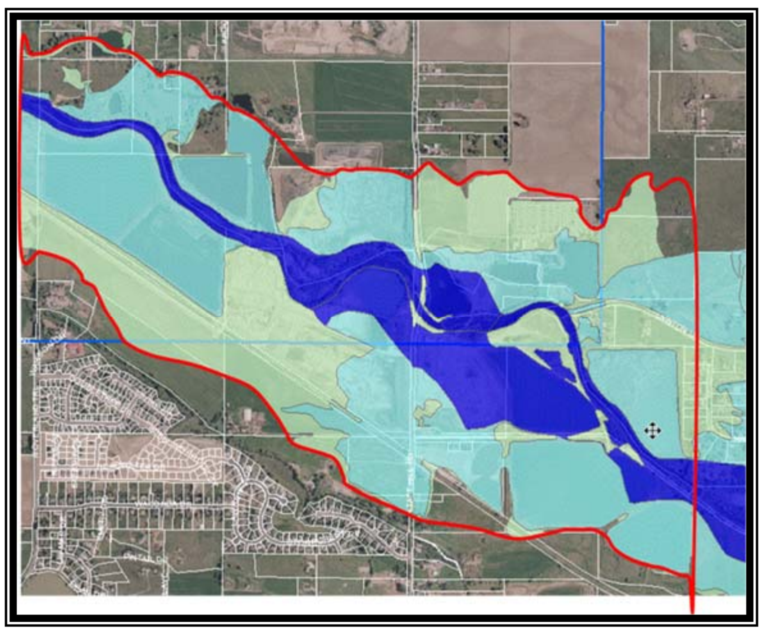


Figure 28. Aerial photograph of a portion of the Cache la Poudre River in Fort Collins, CO overlain with Federal Emergency Management Agency 100- (blue) and 500-year (green) floodplains. The estimated extent of riparian vegetation is delimited be the red line. The upstream and downstream limits of the zone have been drawn arbitrarily.

Step 5: Score the sub-variable according to the scoring guidelines provided on the data sheet.

Score Interpretation

The sub-variable score reflects the degree to which wetlands and riparian habitat surrounding the AA have been extinguished. High scores occur when a wetland is set in a predominately natural landscape or one in which wetlands have been largely or entirely spared destruction from land use changes. Such AAs are still able to maintain their natural connections to surrounding habitats. Low scores indicate the converse. Although an AA may score low on this variable on functional terms, it may indicate a relatively high *value* since the resource has become rare in the landscape and may provide a last refuge for wildlife or an important recreational, educational or aesthetic resource.

SUB-VARIABLE 1.2 – BARRIERS TO MIGRATION AND DISPERSAL

Overview

This sub-variable is intended to rate the degree to which the AA has become isolated from existing neighboring wetland and riparian habitat by artificial barriers that inhibit migration or dispersal of organisms. On the aerial photograph, identify the man-made barriers within the HCE that intercede between the AA and surrounding wetlands and riparian areas, and identify them by type on the stressor list. Score this variable based on the barriers' impermeability to migration and dispersal and the amount of surrounding wetland/riparian habitat they affect.

Indications

This sub-variable considers the ease with which organisms and propagules (*e.g.,* seeds) can move between the AA and surrounding wetland and riparian habitat, relative to the natural condition.

Free passage of biota between habitat sites is paramount to maintenance of the AA's biotic integrity and its ability to provide landscape-scale biotic functions. No matter how high the quality of the habitat, if it has become isolated by man-made barriers then important aspects of its ability to provide characteristic biotic support functions have been severely curtailed.

Unlike Sub-variable 1.1, here, the potential for migration and dispersal among the AA and *all wetland and riparian habitats* in the HCE is considered, regardless of origin. Inclusion of all such habitats, regardless of whether they are natural or artificial, is prescribed here in acknowledgement of the fact that a large percentage of such sites were designed to maximize wildlife habitat value. Also, intact habitats, whether within the AA or an adjacent habitat, form important sources of plant propagules which can aid in habitat recovery following disturbance, or maintenance of biodiversity.

Step-by-Step Scoring Instructions

Step 1: On the aerial photo, outline all existing wetland and riparian habitat areas within the HCE (Fig. 29).

Additional Explanation:

Using the HCE delineated during Sub-variable 1.1 scoring, outline all of the existing wetland and riparian habitat that occurs within that boundary. If no obviously created habitat exists within the HCE, these habitat patches will be identical to those delineated when rating Sub-variable 1.1.

Step 2: Identify artificial barriers to dispersal and migration of organisms within the HCE that intercede between the AA and surrounding habitats (Fig. 29).

Additional Explanation:

Signify the types of barriers that are present with a check in the first column of the data sheet stressor table and describe the general nature, severity and the amount of habitat (extent) affected by each. List any additional stressors in empty rows at the bottom of the table and explain. When evaluating the severity of any barrier, pay particular attention to its effects on less motile organisms, such as small mammals, invertebrates, herpetiles, and hydrochorous (water disseminated) plant species. Also take into account how the barrier affects the at-will passage of organisms and how it could affect flight from predators or escape from other dangers.

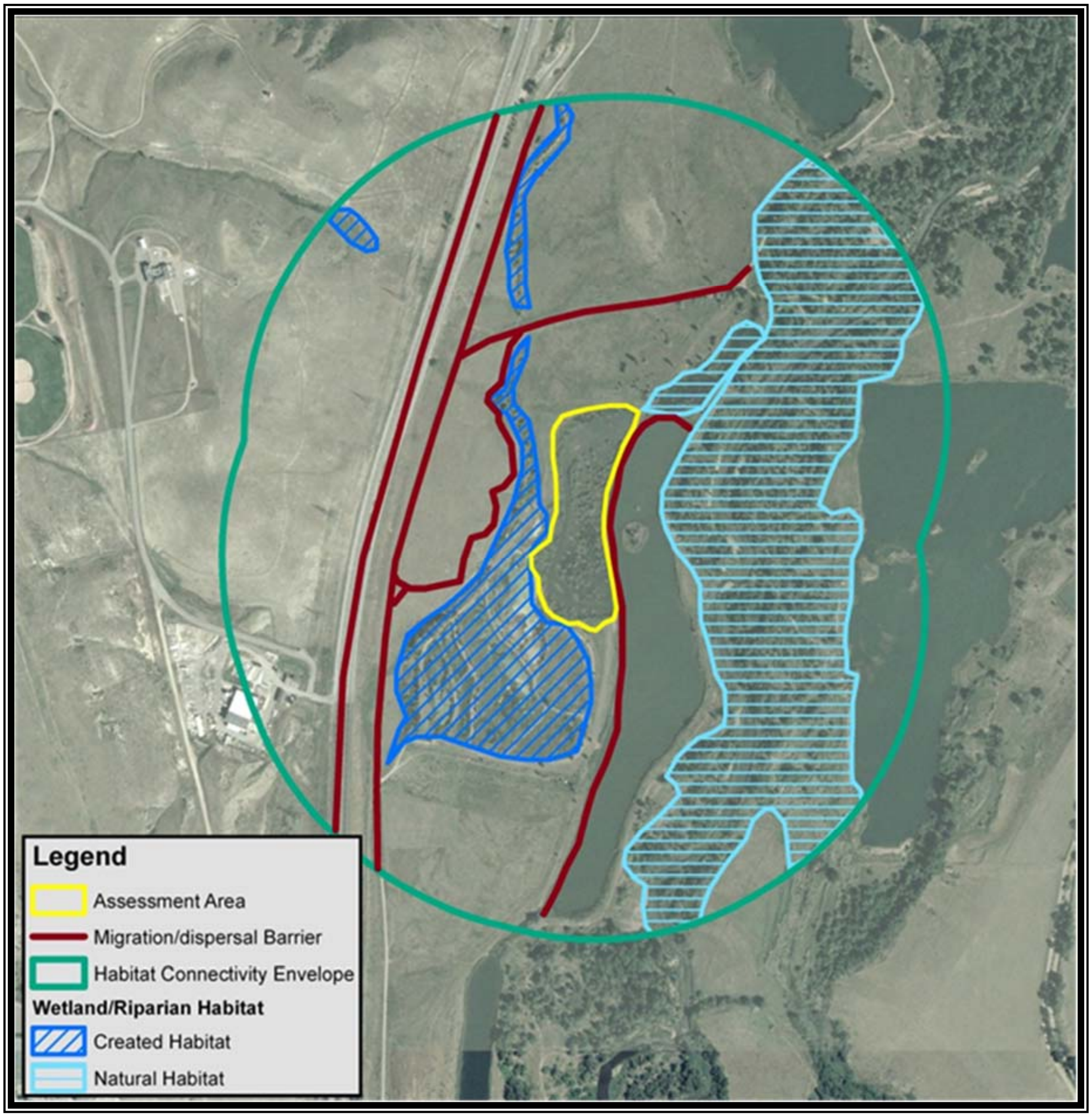


Figure 29. Aerial photograph showing the HCE, natural and created wetland/riparian habitat and man-made barriers to migration and dispersal (note that the artificial water body acts as a significant barrier in this regard).

Step 3: Considering the composite effect of all of identified barriers to migration and dispersal (i.e., stressors), assign an overall variable score using the scoring guidelines.

Additional Explanation:

Consider the approximate percentage of habitat affected by classes of barriers with similar levels of impermeability and devise an overall rating for the wetlands functional isolation based on the scoring guidelines provided on the variable scoring sheet.

SCORING THE LANDSCAPE CONNECTIVITY VARIABLE

Score the **Landscape Connectivity Variable** by averaging the two sub-variable scores. To calculate the score, enter the two sub-variable scores at the bottom of p. 2 of the Habitat Conductivity data form, add the two values together and divide by two. If Sub-variable 1.1 was not scored owing to a lack of natural wetland habitat in the HCE, then the variable score is simply equivalent to the Sub-variable 1.2 score.

Variable 2 – Contributing Area

Overview

The AA's **Contributing Area** is defined as the 250-meter-wide zone surrounding the perimeter of the AA. This variable is a measure of the capacity of that area to support characteristic functions of high quality wetland habitat. Depending on its condition, the contributing area can help maintain wetland condition or it can degrade it. Contributing Area condition is evaluated by considering the AA's Buffer and its Surrounding Land Use. Buffers are strips or patches of more-or-less natural upland and/or wetland habitat ***more than 5m wide*.** Strips of natural habitat less than 5m are not considered buffers, because they lack the capacity to attenuate external stressors to an appreciable degree. Buffers are contiguous with the AA boundary and they intercede between it and more intensively used lands. The AA Buffer is characterized with three sub-variables: *Buffer Condition, Buffer Extent,* and *Average Buffer Width*. These sub-variables closely follow those scored in CRAM 6.0. The *Surrounding Land Use* Sub-variable considers changes within the Contributing Area that limit its capacity to support characteristic wetland functions. Many of the acute effects of land use change in the Contributing Area are specifically captured by Variables 4 - 9.

Indications

A wetland's Contributing Area exerts a strong influence over its functioning and condition. A Contributing Area that retains natural habitats helps support wetland function, and they often attenuate the effects of more distant stressors, such as when preserves of natural habitat exist between the AA and urban developments. Land use changes generally diminish the capacity of the landscape to support high quality wetlands, because of the stresses they introduce to those habitats. Often the stresses of land use change and their effects are subtle, latent or otherwise difficult to detect in the AA wetland itself.

As land use surrounding the AA intensifies, so does the potential that the landscape will make deleterious material contributions to the wetland, increase habitat isolation and/or generally elevate in stress on biota, particularly wildlife. In fact, nearly all stressors originate outside of the wetland and a large fraction of those come from the AA's immediate surrounding area. Buffers provide critical protective envelopes for wetlands, retarding the many of the deleterious effects of local land use changes (Fig. 30).

Ideally the effects of surrounding land use and buffer degradation would be entirely detected by the on-site variables (V3 – V8). For instance, the effects of agricultural runoff on the AA would be entirely captured in the evaluation of the Water and Soil Chemical Environment (V7) and Vegetation (V8) Variables. This is not realistic, though, given the latency of diffuse but often pervasive landscape-scale stressors. Moreover, in FACWet there is no variable that covers atmospheric aspects of the wetland's environment, such as wildlife stress emanating from human visitation or air pollutants. The Contributing Area Variable is intended to account for the

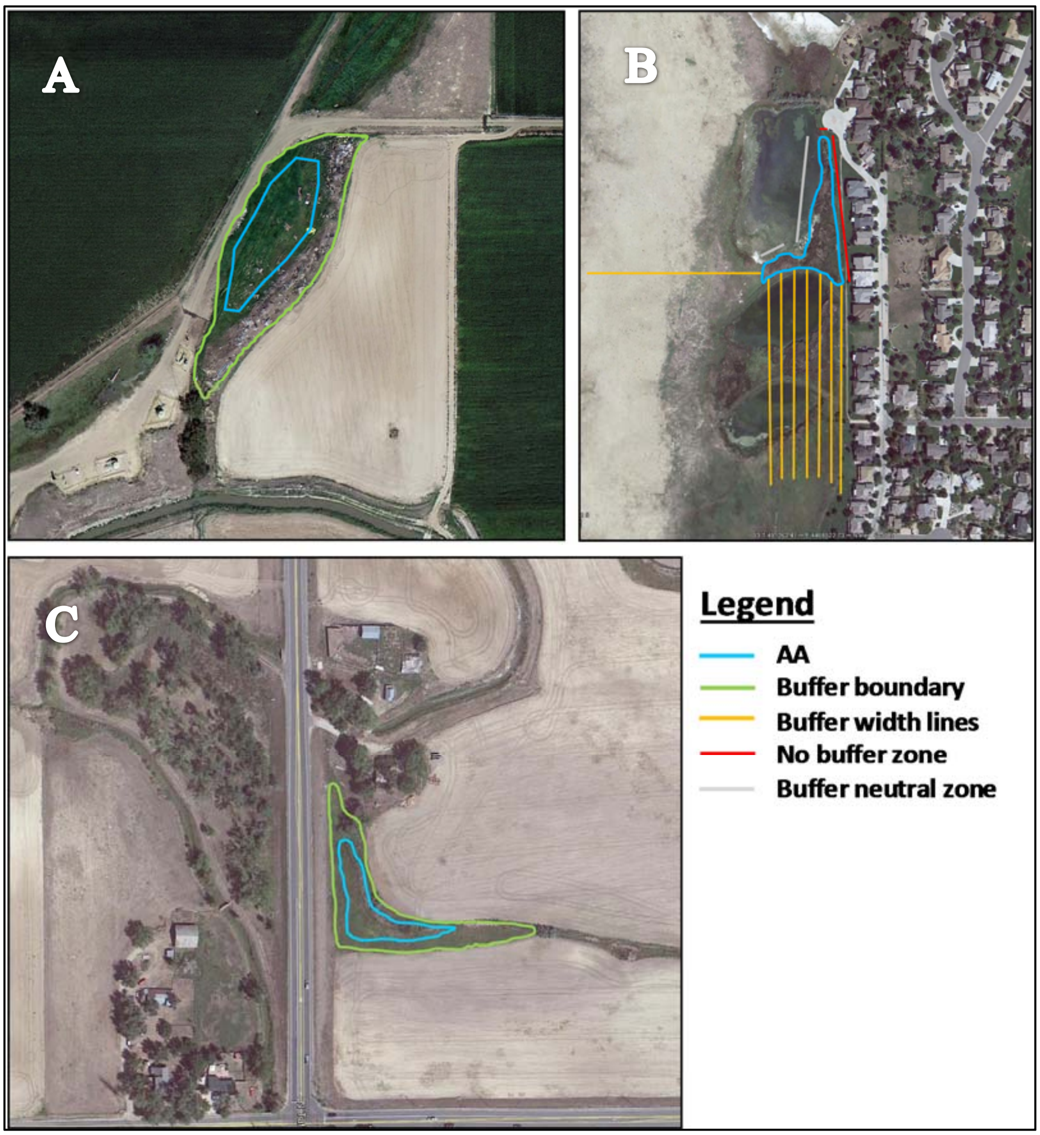


Figure 30. Three illustrations of how a single buffer sub-variable can limit buffer capacity. In panel A, the buffer's functioning is limited by its severely degraded condition despite its complete enclosure of the AA. In panel B, the lines measuring buffer width reach their 250m maximum and buffer condition is functional, but only a small portion of the AA benefits from having any buffer at all. In panel C, the AA is completely enclosed by buffer in functioning condition, but the buffer is too narrow to have much effect on in coming stressors.

real but difficult to discern effects of land use change and to judge the ability of habitat surrounding the AA to mitigate external stressors.

Following CRAM 6.0, Buffer habitat is characterized using three sub-variables: *Buffer Condition*, *Buffer Extent*, and *Average Buffer Width.* A fourth sub-variable describes the *Surrounding Land Use*. The Contributing Area Variable score is the average of the Surrounding Land Use Sub-variable score and **lowest** of the three Buffer sub-variable scores. The lowest Buffer sub-variable score is used to acknowledge that a single sub-variable can act as a limiting factor on the ability of the buffer to attenuate external stressors. For example, a buffer might retain sufficient vegetation such as to qualify as buffer, but the condition of the substrate or water quality could be such that the habitat provides little or no buffering capacity regardless of width or extent (Fig. 30a). Another common situation is when a buffer exists around the entire perimeter of a site, but it is narrow to the point that it has little power to dampen external stressor effects (Fig. 30c). Conversely, existing buffer might have a superior width, but actually enclose only a small percentage of the site (Fig. 30b). This arrangement, too, imparts little buffering capacity to the system. In each of these scenarios, one single overriding characteristic restricts buffer functioning.

Given the proximity of the buffer to the AA and its disproportionately large influence on external stressors, Buffer quality is weighted equally with Surrounding Land Use when calculating the Contributing Area Variable score; this is despite the fact that buffers will frequently represent only a fraction of the total extent of the Contributing Area.

Step-by-Step Scoring Instructions

<u>Step 1</u>: Delimit the Contributing Area on an aerial photograph as the zone within 250 meters of the outer boundary of the AA (Fig. 31).

<u>Additional Explanation:</u>

Draw the Contributing Area boundary using the same approach as was for the HCE, making the appropriate scale adjustments. The Contributing Area boundary will be used to rate the Surrounding Land Use Sub-variable (SV 2.4) and it will set the outer bounds for buffer width measurement (SV 2.3).

Figure 31 Aerial photograph of the Straight Creek AA (blue polygon) set in the context of the Surrounding Area (green polygon). Land use change has been substantial including retail and hospitality developments, infrastructure and low-density urban, but natural areas do remain. In this case the Surrounding Land Use Sub-variable was rate 0.61.

SUB-VARIABLE 2.1 – BUFFER CONDITION

<u>Step 2:</u> Evaluate and then rate the Buffer Condition Sub-variable using the scoring guidelines. Record the score in the cell provided on the datasheet.

Additional Explanation:

Considering alterations to the vegetation and substrate, evaluate the ability of areas identified as buffer to attenuate stressors originating in the surrounding landscape (Fig. 32).

Figure 32. An illustration of the Straight Creek AA showing the zone in which buffer condition will be evaluated. Buffer condition was rated at the upper end of functioning impaired (0.69). Vegetation was dense, but included patches of noxious weeds. The substrate was disturbed throughout the buffer zone. Orange lines indicate where buffer width was measured. Average buffer width was 29m, which places it near the top of the functioning impaired category.

SUB-VARIABLE 2.2 – BUFFER EXTENT

Step 3: Indicate on the aerial photograph zones surrounding the AA which have ≥5m of buffer vegetation and those which do not.

Additional Explanation:

Buffered and non-buffered AA perimeter can usually be identified on aerial images, but aerial interpretation should at least be spot checked during on-site evaluation. Table 8 provides a list of land cover types that do or do not qualify as buffer.

The relative percentages of buffered and non-buffered AA perimeter are determined by drawing line segments approximately parallel to predominant orientation of the AA boundary (Fig. 33). Coarse lines relate to areal zones within the AA which receive buffer protection, rather than to the amount of buffered perimeter.

Step 4: Calculate the percentage of the AA which has a Buffer and record the value where indicated on the data sheet.

Figure 33. A FACWet test site on Straight Cr. in Summit County, along the I-70 corridor. The blue outlined polygon is the AA. Green lines indicate where buffer land cover exceeds 5m in width. Red lines mark where no buffer exists. Fifty-two percent of this test site had buffer, placing it at the bottom of the functioning category (~0.72).

Additional Explanation:

Measure the length of line segments indicating buffered and non-buffered condition. Line segments can be measured on aerial images using computer-based tools (*e.g.*, GIS, Google Earth), in the field by pacing or using a tape measure, or measurements can be directly taken from hardcopy aerial photographs annotated in the field. Note that in the latter case, photograph scale or measurement units are not important as long as they are used consistently during the evaluation.

Table 8. Examples of land types included or excluded from buffers (modified from CRAM). Note that not all the land covers included within buffers are optimal. The quality of the habitat as buffer is rated in Sub-variable 2.1.

Examples of land covers included in Buffers	Examples of land covers excluded from Buffers
• Natural upland, riparian and wetland habitats • Range and pasture lands • Natural or wild land parks • Bike, foot and horse trails • Railroads with low-intensity use (2 or fewer trains per day) • Forest lands with selective thinning • Minor roads such as unpaved rural, forest service or private roads • Swales and ditches • Vegetated levees	• Commercial developments • Intensive agriculture such as row crops or orchards • Golf courses • Paved roads 2 lanes or larger • Railroads with high intensity use • Lawns • Parking lots • Feed lots, horse paddocks, etc. • Residential areas • Sport fields • Sound walls • Urbanized parks • Pedestrian and bike trails with heavy traffic (frequently paved)

To calculate the amount of the AA that is buffered, first, sum all of line lengths, and then sum the total length of the line segments signaling the presence of buffer. Divide the buffer length by the total length arrive at the percent of the AA which receives buffer protection.

The site map prepared as part of the Ecological Characterization 2 data form can be used to record the location of Buffer Width transects. Record the result of this calculation on p. 1 of the Variable 2 data sheet.

Step 5: Rate the Buffer Extent Sub-variable using the scoring guidelines.

Additional Explanation:

Based on the calculated percentage of the AA with a buffer, determine the sub-variable score using the guidelines provided in the data form.

SUB-VARIABLE 2.3 – AVERAGE BUFFER WIDTH

<u>Step 6:</u> Determine the average Buffer width by drawing a line perpendicularly from the AA boundary to the outer extent of the buffer habitat. Measure the line length and record its value on the data sheet. Repeat this process until a total of 8 lines have been sampled.

<u>Additional Explanation:</u>

Buffer width is the perpendicular distance from the AA boundary out to lateral extent of buffer habitat or 250m whichever is shorter. It is assumed that in terms of buffer capacity, habitats farther out than 250m from the AA boundary exert little influence on buffering capacity. Buffer width is measured at **8** locations distributed throughout the zones that were identified as possessing buffer in Sub-variable 2.2 (see example below). It is most expedient and generally acceptable to measure buffer width using GIS or web-based tools. Buffer widths can also be directly measured on-site using tape measures, pacing, or measuring off an aerial photograph with a known scale.

Line #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Avg. Buffer Width (m)**
Buffer Width (m)	*39*	*72*	*37*	*24*	*20*	*15*	*11*	*17*	29

<u>Step 7:</u> Calculate the average buffer width and its record value on the data form. Then determine the sub-variable score using the scoring guidelines.

<u>Additional Explanation:</u>

Average buffer width is calculated by summing the line lengths recorded in step 5 and dividing by **8** (or otherwise the number of lines measured). Determine the sub-variable score by comparing the measured average buffer width to scoring guidelines.

SUB-VARIABLE 2.4 – SURROUNDING LAND USE

<u>Step 8:</u> Score the Surrounding Land Use Sub-variable by recording land use changes on the stressor list that affect the capacity of the landscape to support characteristic wetland functioning.

<u>Additional Explanation:</u>

Based on the severity and extent of land use changes (stressors) make a judgment as to the condition of the surrounding landscape and its ability to support (or degrade) characteristic functioning of the AA habitats. To help visualize the effects of land use change, it may be helpful to delineate the various land use types on the aerial photograph. Using the scoring guidelines, rate the Surrounding Land Use Sub-variable and enter that value on the data form.

VARIABLE 2 SCORING

<u>Step 9:</u> Enter the lowest of the three buffer sub-variable scores along with the Surrounding Land Use score in the Contributing Area Variable scoring formula at the bottom of p. 2 of the data form. The Contributing Area Variable is the average of the two sub-variable scores.

<u>Additional Explanation:</u>

The Contributing Area Variable represents the interaction of the AA's surrounding landscape and its buffer. Surrounding land use changes are commonly the most important sources of stress to wetlands. The buffer acts to dampen the effects of the external stressors. Ultimately, if landscape stressors become too great or the buffer capacity rendered too low, stressor effects will penetrate into the AA habitats.

The lowest buffer sub-variable score represents the limiting factor on buffer functioning. This score along with the surrounding landscape score are averaged to produce the Contributing Area Variable Score.

Variable 3 – Water Source

Overview

This variable is concerned with ***up-gradient*** hydrologic connectivity. It is a measure of impacts to the AA's water source, including to the quantity and timing of water delivery, and the ability of source water to perform work such as sediment transport, erosion, soil pore flushing, etc. To score this variable, identify stressors that alter the source of water to the AA, and record their presence on the stressor list. Stressors can impact water source by depletion, augmentation, or alteration of inflow timing or hydrodynamics. This variable is designed to assess water quantity, power and timing, ***not water quality***. Water quality will be evaluated in Variable 7.

Indications

The amount and timing of water inflow is the uppermost control on a wetland's potential level of functioning. Without a characteristic source regime a wetland has no ability to function naturally. Implicit in consideration of the water source is the acknowledgement that incoming water is a critical transport mechanism for a broad spectrum of materials and energy. The processes that rely on proper hydrologic functioning are assumed to change linearly with alteration of water source characteristics and are not evaluated directly by this variable, however, overt changes to dependent characteristics (such as wetland vegetation) may be used as evidence of water source alteration and its severity. The ramifications of water source impairment on dependent variables are evaluated separately for each variable affected.

Step-by-Step Scoring Instructions

Step 1: Use the stressor list and knowledge of the watershed to catalog type-specific impairments of the AA's water source.

Additional Explanation:

In this variable, stressors are defined as human-induced factors that lead to the alteration of the quantity or timing of water inflow to the AA ***or*** source water hydrodynamics. Alterations to the latter characteristic are frequently overlooked in wetland condition evaluations. Stressors can cause source depletion, augmentation, or alteration of the characteristics or timing of inflow. In the stressor table, describe the severity of each stressor. By definition, impacts to the water source will affect the entire AA, although the severity of impacts may vary across it.

Evidence for the presence of source impairment may come through the direct observation of structures or diversions causing alteration. Indicators of impairment will also commonly come from review of geographic resources such as topographical maps, GISs and watershed data assembled by management agencies (*e.g.,* http://water.usgs.gov/wsc/map_index.html and http://cdss.state.co.us/onlineTools/Pages/OnlineToolsHome.aspx). These resources can be used to identify dams, ditches, diversions and other impacts up-gradient of the AA that could alter the water regime.

The severity of water source alterations will generally be gauged using indirect indicators within the AA such as changes in species composition or water stress (Fig. 6), soil cracking (Fig. 6), loss of soil redoxiomorphic features, or oxidation of organic soils (Fig. 34).

Gauge data can also help inform judgments on the severity of hydrologic alterations (Fig. 22). These data are readily available on line. The Colorado Division of Water Resources maintains an excellent webpage that includes real-time data and charts for a large number of Colorado's gauged streams (http://www.dwr.state.co.us/SurfaceWater/default.aspx). It is best to review these data before a site visit to give a context to field observations, however, scores derived during an on-site assessment can be modified later as well.

Step 2: Considering the composite effect of stressors on the water source, rate the condition of this variable with the aid of the scoring guidelines.

Figure 34. Cross-section through a hummock showing oxidation of organic material caused by hydrologic alteration.

Additional Explanation:

An estimation of the degree of departure of water source regime from natural conditions is made taking into account the cumulative effects of all observed stressors (Fig. 35). Scoring guidelines provide an "order-of-magnitude" description of the conditions that would warrant a given score range. These guidelines are presented as a means of calibrating best professional judgment between evaluators. Rating values should not be taken in an absolute or literal sense. Rating is ultimately up to the judgment of the evaluator supported by the best available evidence.

While variable rating is predominately qualitative in nature, estimating the percent water table change can help guide variable rating. To do so, simply estimate the average change in the water table caused by identified stressors and divide this value by 12 in. (30 cm) – The depth threshold for hydric conditions in wetland delineation. Multiply the product by 100 to arrive at a percentage.

When assessing riverine systems, evaluators should take note that some of the negative impacts of peak flow suppression can be tempered by presence of additional water sources such as groundwater discharge or interception of the water table. Also, keep in mind that a riverine wetland may still be subject to occasional flooding but this variable may still warrant a low or even non-functioning score if the flooding is not sufficiently frequent to maintain wetland conditions (i.e., being subjected to over bank flooding at least once every two years on average).

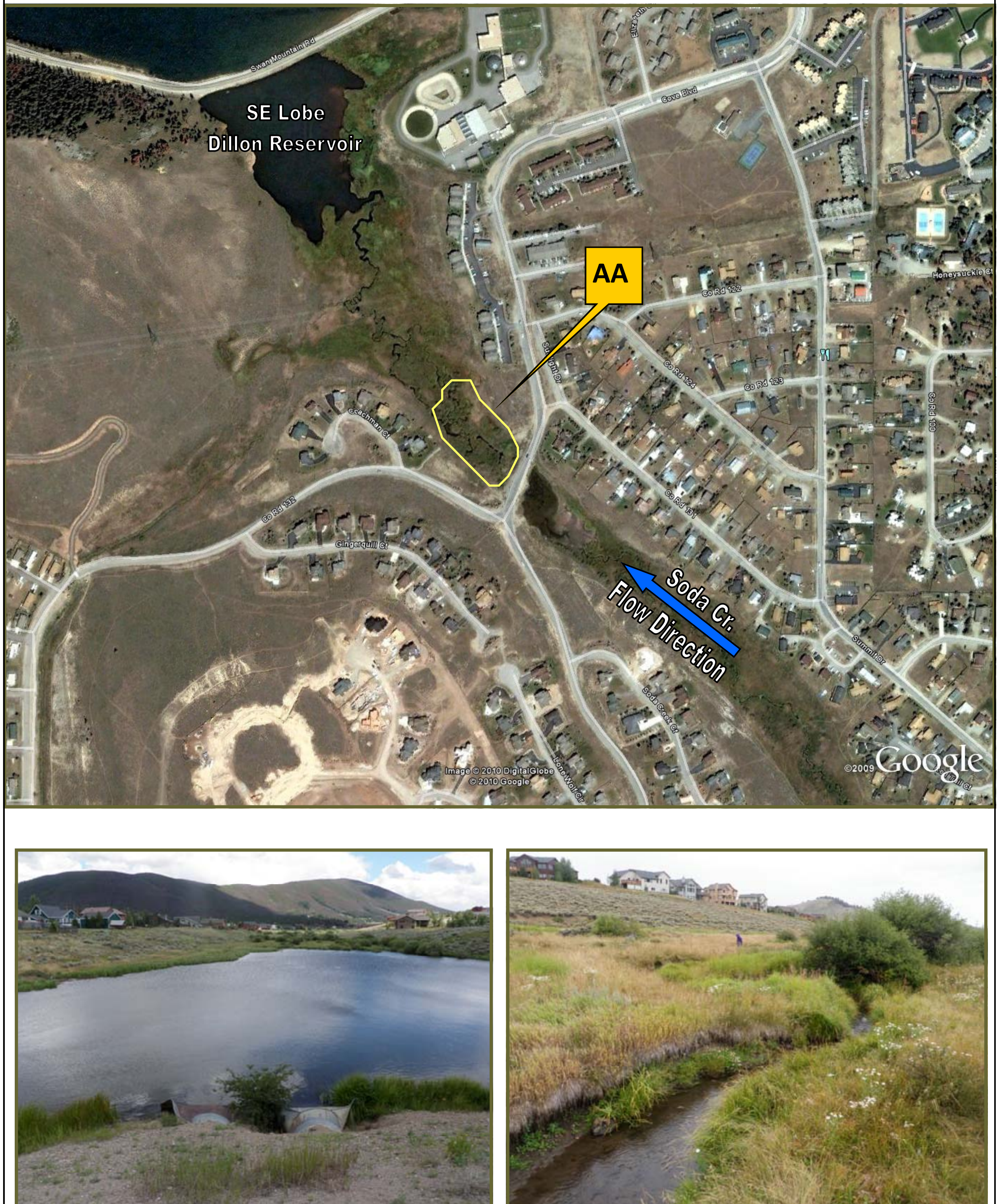


Figure 35. See following page for explanation.

Figure 35. An example of multiple hydrologic and geomorphic stressors affecting a low-order riverine wetland (Subclass R2). The top aerial photograph shows a training AA on Soda Creek which drains into Dillon Reservoir (shown at top). This AA is a natural wetland riverine system that has been subject to significant modification. For this evaluation, the creek channel was included within the AA because of its small size.

In this case, the wetland water source has been severely altered as shown through direct interpretation of site alterations. A road crossing with a fixed-elevation culvert restricts flow to the AA, only allowing water flow when the water surface elevation in the pond is above the outlet elevation. Groundwater passage across the road grade is also severely impaired. The Water Source variable is scored at 0.69 because of the cumulative changes, including to the hydrodynamics.

This channel is a primary means by which water is distributed *within* the AA, through overbank flooding and groundwater migration. In this case, the impairment of the water source removes much of potential for water to be distributed in a characteristic fashion (i.e., for the AA to exhibit a hydrograph characteristic of the HGM regional subclass). The form of the channel in its natural condition, cannot be directly inferred because of site modifications, but reference- and principle-based evidence suggest that geomorphic impairments in the form of channel entrenchment and over-widening exacerbate the impacts of the poorly functioning water source. Prevalence of upland species adjacent to the channel, and the presence of relic hydric soils and fill provide additional evidence of hydrologic impairment. Based on these lines of evidence, it appears that significant portions of the AA have been converted to upland. Water Distribution is rated at 0.65.

Water and material outflow (V5) is not affected by additional stressors other than those listed above, but because of them the AA has a limited capacity to support downstream habitats—through delivery of water, materials and energy—in a manner characteristic of the subclass. Water Outflow is rated 0.69, in parallel to the Water Source rating.

Variable 4 – Water Distribution

Overview

This variable is concerned with hydrologic connectivity ***within*** the AA. It is a measure of alteration to the spatial distribution of surface and groundwater within the AA. These alterations are manifested as local changes to the hydrograph and generally result from geomorphic modifications within the AA. To score this variable, identify stressors ***within*** the AA that alter flow patterns and impact the hydrograph of the AA, including localized increases or decreases to the depth or duration of the water table or surface water.

Because the wetland's ability to distribute water in a characteristic fashion is fundamentally dependent on the condition of its water source, in most cases the Water Source variable score will define the upper limit Water Distribution score. For example, if the Water Source variable is rated at 0.85, the Water Distribution score will usually have the potential to attain a maximum score of 0.85. Additional stressors within or outside the lower end of the AA effecting water distribution (e.g., ditches and levees) will reduce the score from the maximum value. See Figure 35 for an example.

Indications

The internal flow network within a wetland is analogous to an organism's vascular system. If any portion of the wetland is cut off from this system, its functioning becomes impaired or it effectively dies. In depletion situations such as ditching, water distribution will generally be disrupted in a zone down-gradient of the stressor (Fig. 36). Stressors that augment a portion of the AA's water budget can have up- and/or down-gradient effects. Ponding above a dam/barrier (Fig. 37) or flooding below a ditch or pipe outlet provide two common examples.

Step-by-Step Scoring Instructions

Step 1: Identify impacts to the natural distribution of water throughout the AA and catalog them in the stressor table.

Additional Explanation:

Based on the site familiarization process, record the observed stressors that affect the way water flows and is distributed across the AA. These stressors almost always stem from geomorphic modification made to the site that that alters how water flows across and through the AA, features such as ditches, levels, dikes and road grades. Small geomorphic changes can have widespread effects. The magnitude of geomorphic alteration itself is considered in Variable 6. This variable describes the *consequences* of such alterations in terms of within-site impairment of hydrologic flows. For each stressor, take note of the extent of its influence and its overall severity. Record this information in the stressor table.

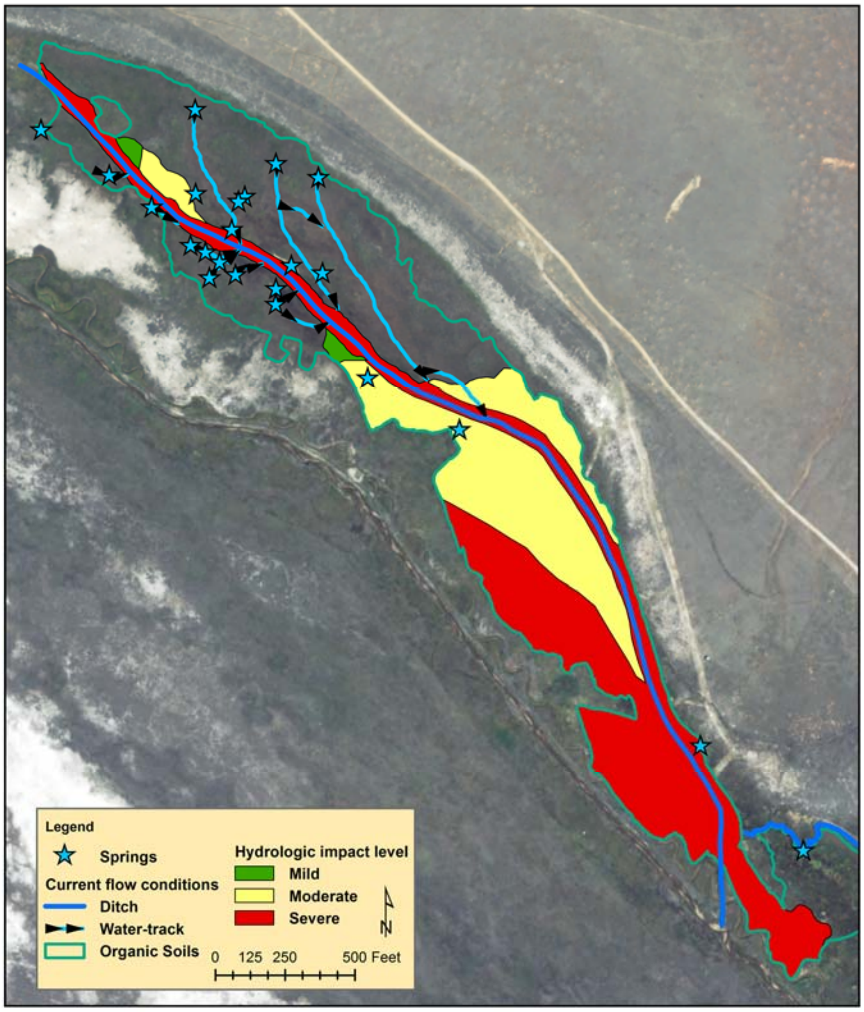


Figure 36. An aerial photograph of the Four-mile Creek Fen showing the locations of springs, flow paths, a major drainage ditch and the degree of dewatering caused by the ditch. This is a fairly typical situation, where a geomorphic modification (ditch shown in lower photograph), has dramatically impaired water distribution across the wetland. It has also caused a major shift in outflow characteristics, from diffuse groundwater flow to channelized surface water, impairing the wetland's ability to support down-gradient habitats.

Figure37. See following page for explanation.

Fig. 37. Case study on Four-Mile Creek. The upper photograph shows a view NW across where Four-mile Creek crosses Park County 24. The lower figure is an aerial photograph of the same area. Here, a road grade out of the AA (geomorphic alteration), has caused gross changes in the following variables (Future sections describe other variables):

- **Water Source** — The water source to the AA is nearly entirely intact, being subjected to only minor diversions.

- **Water Distribution** — The wetland hydrograph has been changed from one of seasonal or semi-seasonal inundation, to a perennially ponded one. This variable was rated at 0.63.

- **Water Outflow** — The rate of outflow has been dramatically altered as evidenced by the ponding. Outflow has also been confined to three culverts rather than the complex surface and groundwater system that historically existed. The export capacity for sediment, materials and energy has also been significantly altered. Variable was rated at 0.62.

- **Geomorphology —** The road has also caused secondary geomorphic impacts in the form of infilling from sedimentation. Here note, if the AA were defined according to the wetland boundary the road would be excluded from it. Since, when evaluating the Geomorphology Variable, only the footprint of the alteration is considered, the road would not be included as a geomorphic modification to the AA. That is, the road would not affect the Geomorphology score. Instead the **resultant effects** of the road are characterized by the other variables (Water distribution, Outflow, etc.). In this example Geomorphology was rated at 0.85, since geomorphology is generally intact within the AA.

  On the other hand, if the AA were set according to a different criterion, such as the extent of the historical wetland boundary, the road would be included in the AA. In this case, its presence would be reflected by a reduction of the Geomorphology score.

- **Soil and Water Chemical Environment** — The only apparent impact to the Chemical environment is a change in the redox potential regime. The duration of flooding would cause the soils to be water-logged and anoxic far longer than would occur under natural conditions. This variable was rated 0.76.

- **Vegetation Structure and Complexity** — The flooding and sediment deposition have caused significant changes to AA vegetation, including a shift towards a more hydrophytic flora and a reduction in cover. This variable was rated 0.67.

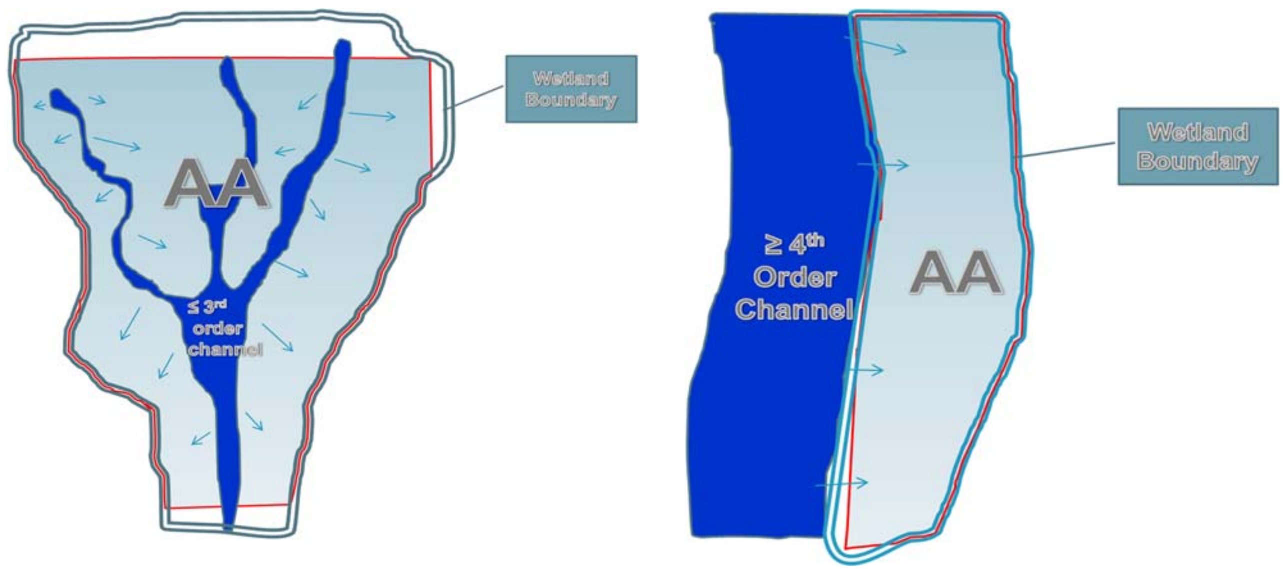


Figure 38. An illustration of the role of differently sized channels play in Water Distribution and Water Source scoring. In the figure at left, small channels *within* the AA contribute to water distribution. Alterations to these channels (such as entrenchment) would be accounted for by the Variable 5 score. In situations involving riverine wetlands adjacent to large channels that are external to the AA, the channel forms the water source. Alterations to the flow or flooding regime are considered in scoring Variable 4.

When scoring this variable in situations involving channels, keep in mind that alterations of small channels that are included within the AA are considered in the water distribution variable (Fig. 38). In large channel situations, in which the channel is not included in the AA, changes in the channel flow regime or the isolation of the AA from overbank flooding is accounted for in the Water Source Variable, since the stressor is external to the AA (Fig. 38).

Step 2: Considering all of the stressors identified, assign an overall variable score using the scoring guidelines.

Additional Explanation:

To score this variable, develop a picture of the cumulative effects of all alterations to water distribution. In doing so, consider the overall degree of departure between existing conditions throughout the AA and those which would have occurred naturally.

In most cases the Water Distribution score will not exceed the Water Source score. The exception to this is in cases where natural processes at within the AA habitat dampen the effects of source water hydrology. Perhaps, the most common example of this is in when the AA is associated with beaver pond habitat. Here a natural component of the ecosystem (the beaver) actively maintains surface and ground water levels in the wetland, and so diminishes the effects of up-gradient hydrologic alterations on the AA (Fig. 39). Keep in mind that exclusion or management of beaver including trapping and blowing up dams, can constitute a significant stressor on riverine systems (Figs. 40 – 41).

As with Variable 3, scoring guidelines provide an "order-of-magnitude" description of the conditions that would warrant a given score range. They are presented as a means of calibrating best professional judgment between evaluators. Scoring guideline thresholds should not be taken in an absolute or literal sense. Rating is ultimately up to the judgment of the evaluator as supported by the best available evidence.

Figure 39. A FACWet training AA on Bear Creek in Lakewood, CO. Here, participants discuss how this approximately 1m high beaver dam attenuate the hydrologic effects of up-stream diversions, and help to maintain characteristic water distribution properties in the AA.

Figure 40. Abandonment of this pond system by beaver and resulting dam failures and channel incision were the proximal causes of water distribution impairment (dewatering) in this subalpine wetland.

Figure 41. Beaver were driven from this floodplain habitat by historical trapping and subsequent land use changes which were focused on ranching and hay production. The result has been a dramatic drying of the floodplain and loss of characteristic habitat.

Variable 5 – Water Outflow

Overview

This variable is concerned with **down-gradient** hydrologic connectivity and the flow of water and water-borne materials and energy out of the AA. In particular it illustrates the degree to which the AA can support the functioning of down-gradient habitats. It is a measure of impacts that affect the hydrologic outflow of water including the passage of water through its normal low- and high-flow surface outlets, infiltration/groundwater recharge, and the energetic characteristics of water delivered to dependent habitats. In some cases, alteration of evapotranspiration rates may be significant enough of a factor to consider in scoring. Score this variable by identifying stressors that impact the means by which water is exported from the AA. To evaluate this variable focus on how water, energy and associated materials are exported out of the AA and their ability it support down-gradient habitats in a manner consistent with their HGM (regional) subclass.

Because the wetland's ability to export water and materials in a characteristic fashion is to a very large degree dependent the condition of its water source, as with the Water Distribution variable, in most cases the Water Source variable score will define the upper limit Water Outflow score.

Indications

There are three ways water can exit a wetland – surface flow, infiltration/groundwater recharge, and evapotranspiration. This variable involves evaluating the departure of any of these processes from Reference Standard conditions. When rating outflow condition, focus on how stressors affect the ability of the AA to transport water, materials and energy out of the AA, and on how these changes affect the AA's capacity to contribute to the support of down-gradient habitats.

Typically, stressors will decrease the capacity of the AA to export water and associated materials, for example when the wetland outlet is blocked or constricted by a dam, berm, road grade, or culvert (Fig. 37). Note that in such cases alteration of outflow characteristics also effects water distribution within the AA. But stressors may instead cause an increase in the capacity of the wetland to export water and materials, such as when an artificial outlet channel is excavated (Fig. 36).

Step-by-Step Scoring Instructions

Step 1: Identify impacts to the natural outflow of water from the AA and catalog them in the stressor table.

Additional Explanation:

Based on the information gained during the site familiarization process, record the observed stressors that affect the way water and associated materials flow out of the AA.

Stressors to outflow will generally be directly observable, and will typically stem from geomorphic alterations within AA or just outside of its lower boundary (Fig. 37).

<u>Step 2</u>: Considering all of the stressors identified, assign an overall variable score using the scoring guidelines.

<u>Additional Explanation:</u>

To score this variable, consider the combined effects of all stressors and estimate the resultant divergence of outflow from Reference Standard conditions.

In scoring the Outflow Variable, it is important to keep the intent of the variable in mind. It seeks to evaluate the relative change in the flow rate, volume, timing or energetic characteristics of water leaving the AA. *It does not concern the on-site impacts caused by alteration of outflow characteristics* – ponding or dewatering, for example. On-site changes are evaluated in Variable 4.

On-site indicators such as unnatural inundation or dewatering can be used to indicate the severity of outflow disruption, however. For example, in Fig. 37 the large flooded area shows that the natural outflow regime has been severely disrupted by the road (an alteration of geomorphology). In this example, the Water Distribution Variable would characterize the severity and extent of the flooding, while the Outlet variable would describe how the road impairs the ability of the AA to contribute to the functioning of the downstream habitats.

Variable 6 – Geomorphology

Overview

This variable is a measure of the degree to which the geomorphic setting has been altered within the AA. Changes to the surface configuration and natural topography constitute stressors. Such stressors may be observed in the form of fill, excavation, dikes, sedimentation due to absence of flushing floods, etc. In riverine systems, geomorphic changes to the stream channel should be considered if the channel is *within* the AA (*i.e*, small is size). Alterations may involve the bed and bank (substrate embeddedness or morphological changes), stream instability, and stream channel reconfiguration. Geomorphic changes are usually ultimately manifested as changes to wetland surface hydrology and water relations with vegetation. Geomorphic alterations can also directly affect soil properties, such as near-surface texture, and the wetland chemical environment such as the redox state or nutrient composition in the rooting zone. In rating this variable, **do not include these resultant effects** of geomorphic change; rather focus on the physical impacts **within the footprint of the alteration** – For example, the width and depth of a ditch or the size of a levee. The secondary effects of geomorphic change are addressed by other variables. All alterations to geomorphology should be evaluated including small-scale impacts such as pugging, hoof sheer, and sedimentation which can be significant but not immediately obvious.

Indications

It is not an overstatement equating water to the life-blood of a wetland, but it is geomorphology that dictates the expression of wetland hydrology. Two wetlands with the exact same hydrologic regimes, can be grossly different due to geomorphologic differences alone (*e.g.,* a groundwater-fed pond as opposed to a fen; Fig. 14).

The main goal with geomorphic characterization is to identify changes to the topography which alter the expression of hydrology near the wetland's surface. To evaluate the Geomorphology variable, consider only the direct effects of geomorphic change as delineated by the foot-print of the alteration. Indirect effects or the results of geomorphic change, such as hydrograph impairment, change in species composition, or soil chemical changes, are characterized in their own respective variables.

In scenarios where the jurisdictional wetland boundary is used to define the AA, areas with severe geomorphic alterations will commonly be excluded; for instance when a historical wetland has been filled and no longer meets jurisdictional criteria. In these instances, the geomorphic condition of the AA would be evaluated on its own merits (Fig. 42). The ramifications of such external geomorphic impacts on the condition of the AA are captured by other variables (*e.g.,* water source, distribution or outflow). Another way of looking at this is that the out-of-AA geomorphic change (fill) is acting as a stressor on the other State Variables. Using an extreme but common example to illustrate, a dam upstream of an AA represents a dramatic geomorphic alteration, but it is not a geomorphic alteration of the AA. Instead, it is an external stressor that likely effects water source, distribution, outflow, soil chemistry and vegetation.

In situations where the current jurisdictional status is not the basis for AA delineation, such during assessment of a site's mitigation potential, areas of historical wetland affected by geomorphic alteration can be included in the AA. In this case, the severity and extent of the geomorphic change is included in variable rating, because the footprint of the geomorphic alteration is included within the AA. So to included are impacts to hydrology, vegetation and soils that are part of the footprint of geomorphic alteration. The ability to include non-functional wetland habitat in a FACWet evaluation is very useful since it allows characterization of the spectrum of impacts affecting the historical wetland complex. This information can then be used to prescribe mitigation actions and predict the functional gains that would be brought by restoration activities.

Step-by-Step Scoring Instructions

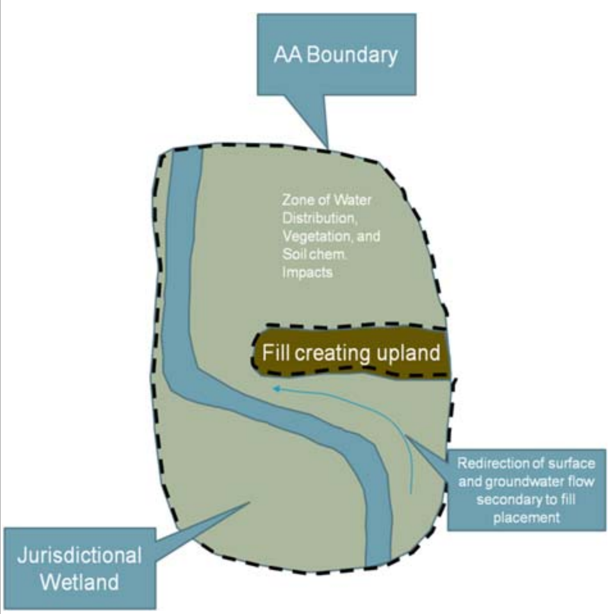
<u>*Step 1*</u>*: Identify impacts to geomorphological setting and topography within the AA and record them on the stressor checklist.*

<u>Additional Explanation:</u>

Based on your field observations, catalog the type, severity and extent of geomorphic alterations. In estimating the extent of impacts, remember to only include the footprint of the modification. Severity should be judged based on the AA's degree of departure from the natural geomorphic condition. This can be inferred using direct lines of evidence such as depth of excavation or height of fill. Or, indirect evidence such as changes in plant species composition or surface water conditions can be used to support judgments.

Figure 42. Wetland off of CO Hwy. 9. Fill was placed across a portion of the wetland to form a road grade. Affected areas are no longer wetland. If the AA was delineated according to the wetland boundary, this geomorphic impact would be excluded and not be taken into account in Geomorphology Variable scoring. The effects of the fill on functioning in the AA would be documented when scoring other variables, such as Water Distribution (see illustration at left). This approach would commonly be taken during the project permitting when the focus is specifically on determining impacts to regulated habitats.

If instead the assessment was being completed to evaluate mitigation potential of a site, the AA could be defined according to the historical extent of the wetland, regardless of jurisdictional status. In this case, the road grade would be included within the AA and its presence would be reflected in a lower Geomorphology score. From this, predictions could be made as to the gains in function that could be brought through mitigation actions (i.e., removing the road).



<u>Step 2</u>: Considering all of the stressors identified, assign an overall variable score using the scoring guidelines.

<u>Additional Explanation:</u>

Scoring guidelines provide narrative descriptions of the degree of geomorphic divergence from reference conditions that would indicate inclusion in a given condition category.

Variable 7 – Water and Soil Chemical Environment

Overview

This variable concerns the chemical environment of the soil and water media within the AA, including pollutants, and water and soil characteristics. The origin of pollutants may be within or outside the AA. Score this variable by listing indicators of chemical stress in the AA. Consider point source and non-point sources of pollution, as well as mechanical or hydrologic changes that alter the chemical environment. Because water quality frequently cannot be inferred directly, the presence of stressors is often detected through the presence of indirect indicators. Five sub-variables are used to describe the Water and Soil Chemical Environment: *Nutrient Enrichment/Eutrophication/Oxygen; Sedimentation/Turbidity; Toxic Contamination/pH; Temperature;* and *Soil Chemistry and Redox Potential*. Utilization of web-based data mining tools is highly recommended to help inform and support variable scores (Table 7).

Indications

The chemical environment of the AA is seen as a "refinement" of the conditions created by the generally overarching effects of the hydrogeologic – geomorphic setting. The chemical environment does not play a role in the creation of wetland habitat, but it is commonly a key factor driving site-to-site biotic diversity and providing the raw materials to support biogeochemical processes. In situations where the chemical environment has been significantly altered, this variable can have far reaching effects, particularly on biotic composition.

The characteristic chemical environment of a wetland is dictated by its hydrogeologic setting as influenced by the local hydrologic regime and up-gradient land uses. Alteration of the chemical environment can result from off-site stressors such as agricultural, urban or road runoff, industrial or power plant discharge, and other point and non-point sources of pollution. It can also arise from sources within the AA. Common examples of this are alteration of the oxidation-reduction (redox) potential in the upper strata of the soil caused by dewatering, elevational changes of the ground surface (*i.e.,* fill), fill with toxic materials or uncharacteristic water-logging. Temperature stress resulting from diminished shade, or salt precipitation stemming from hydrologic alteration are other common on-site sources of impact.

Step-by-Step Scoring Instructions

Step 1: Stressors are grouped into sub-variables which have similar signatures, indicators or causes.

Additional Explanation:

The scoring procedure for this variable includes evaluation of sub-variables because impairment of water quality commonly cannot be directly observed. Owing to this difficulty, indirect indicators of impairment must often be used in lieu of more direct evidence. To contend with these issues, water and soil chemistry stressors are grouped into sub-variables which manifest a similar type of signature or result from the same set of causes.

Instead of directly generating a single variable score, sub-variables are first rated. The sub-variable scores are then considered singly and in composite to produce a final variable score using the process described below.

Step 2: Use the indicator list to identify each stressor impacting chemical environment of the AA.

Additional Explanation:

For each sub-variable, consider the signs that indicate alteration of the characteristic chemical environment. For each stressor present, record its perceived severity and extent based on the indicators present. In judging severity, consider evidence of stressor effects. For instance, if an increase in thermal regime is suspected based on the removal of a canopy layer, consider the extent to which vegetation or biota show signs of temperature stress.

Step 3: For each sub-variable use the scoring guideline table provided on the second page of the scoring sheet. Scoring sub-variables is carried out exactly the same way as variable scoring.

Additional Explanation:

Score sub-variables in the same way that variables are rated, by cumulatively evaluating the indicators of stress. Use the scoring guidelines on the second page of the scoring sheet to help decide sub-variable ratings.

If the AA is known to be part of a water body that is recognized as impaired or recommended for TMDL development for one of the sub-variables, score that sub-variable 0.65 or lower.

Step 4: Transcribe sub-variable scores to the variable scoring page and compute the sum.

Additional Explanation:

Both individual sub-variable scores and their composite score are used to score this variable.

<u>Step 5</u>: Determine the variable score by following the scoring guidelines.

<u>Additional Explanation:</u>

Scoring guidelines are based on two parameters, the lowest sub-variable score and the sum of all sub-variable scores. First determine which condition category applies to the **lowest** sub-variable score and circle it on the data sheet. Next, circle the category that includes the sum value of sub-variable scores.

The single factor score sets the variable's letter grade. This is because ecological systems generally respond to a single limiting factor. For instance, the fact that a water body has excellent water clarity or temperature regime maybe made largely irrelevant to its ability to support aquatic life if the water is highly contaminated with heavy metals or other toxins.

If both scoring rules indicate a single conditional category (e.g., a "B" or highly functional category is indicted by both rules), selected a numeric rating near the center of the scoring range (e.g. 0.85). When a different condition category is assigned using the two rules, use the degree of departure between the two scores to help determine the best variable score within the letter grade range. For instance, if the single factor rule indicates a functionally impaired condition (0.6 – 0.7 variable score range) and the composite rule suggests a highly functioning condition (0.8 – 0.9 variable score), this implies that most aspects of the chemical environment are functioning well, but some single factor has been significantly degraded. In this case, choose the functionally impaired category for the base range, and then select a variable score at the upper end of the range, such as 0.68.

Variable 8 – Vegetation Structure and Complexity

Overview

This variable is a measure of the condition of the wetland's vegetation relative to its native state. It is particularly relevant to the wetland's ability to perform higher-order functions such as support of wildlife populations, although it also affects primary functions such as flood-flow attenuation, channel stabilization and sediment retention. Score this variable by listing stressors that have affected the structure diversity, composition and cover of each vegetation stratum that would normally be present in the HGM (regional) subclass being assessed. For this variable, stressor severity is a measure of how much each vegetation stratum differs functionally from its natural condition or from the natural range of variability exhibited the HGM subclass or regional subclass. This variable has four sub-variables, each corresponding to a stratum of vegetation: *Tree Canopy; Shrub Layer; Herbaceous Layer;* and *Aquatics.*

Indications

Vegetation structure and complexity are the primary components of the terrestrial system that dictate the ability of a habitat to support characteristic animal populations. Owing to biotic interactions, vegetation structure can also have a strong influence on plant species composition and diversity. While the physical habitat primarily determines the potential vegetation for a site, vegetation, in turn, can exert a strong influence over physical processes including water velocity reduction, sediment entrapment, stream bank and shoreline stabilization, thermal regime and transference of water to the atmosphere, to name a few.

To contend with the complexities of vegetation composition and alteration thereof, this variable is broken down into sub-variables each constituting a vegetation stratum. Sub-variable scores are then combined as a weighted average to produce an overall picture of vegetation condition. Stratum weights correspond to the layer's expected or Reference Standard percent cover, which provides an index of the layer's importance in the habitat.

Step 1: Determine the number and types of vegetation layers present within the AA. Make a judgment as to whether additional layers were historically present using direct evidence such as stumps, root wads or historical photographs. Indirect evidence such as local knowledge, expert opinion, and published data can be instrumental in making this determination.

Additional Explanation:

This variable examines vegetation structure and complexity of the AA in light of its Reference Standard form. Of primary importance here are the number, type and gross physiognomy of vegetation strata. During this first step determine which strata exist and whether any which have been removed. Only vegetation layers that are currently present or were historically present are scored in the following steps. Do not score the aquatic layer unless it is a significant feature of the AA.

In created wetlands, determine the expected number of strata by considering what habitat was targeted by the creation effort. Permit success criteria can be an important source of information here. In urban settings involving naturally-occurring wetlands all three terrestrial layers should be assumed to have been historically present. In urban settings involving "voluntary" wetlands (*i.e.,* wetlands that developed spontaneously), the number of layers should reflect actual number that developed at the site. For instance, if an herbaceous and shrub layer formed spontaneously, both should be scored even if the shrub canopy was later removed.

Step 2: Do not score vegetation layers that would not normally be present in the wetland type being assessed.

Additional Explanation:

This variable is not intended to penalize habitat types that naturally lack specific structural diversity components, such as natural meadows which lack trees or shrubs.

Step 3: Estimate and record the current coverage of each vegetation layer at the top of the dataform table.

Additional Explanation:

Estimate the existing coverage of each stratum. For existing layers, coverage estimations will generally be done by eye, commonly aided by an aerial photograph. Habitats can also be delineated in a GIS, and coverages measured directly. Only areas that would normally support vegetation should be included in the estimate. For example, if an assessment area is 90% covered by deep water habitat, with the remaining emergent and terrestrial habitat completely covered by dense marsh vegetation, the percent coverage of the herbaceous layer might approach 100%, despite its low total coverage across the entire AA. Conversely, with the aquatic stratum the evaluation would consider how much of the available open-water habitat is covered by aquatic vegetation.

Step 4: Record the Reference Standard or expected percent coverage of each vegetation layer to create the sub-variable weighting factor. The condition of predominant vegetation layers has a greater influence on the variable score than that of minor ones.

Additional Explanation:

The Reference Standard or expected coverage of each layer describes the layer's importance to the ecosystem. A layer's importance is taken into account in variable scoring by weighting sub-variable scores according to the Reference Standard coverage. Estimation of the historical extent of strata, can be aided by examining nearby areas that have been spared alteration. In general, if there is no clear sign of layer removal, dieback or thickening the current layer coverage represents the Reference Standard or expected coverage. In cases where there is no clear reference, the average cover value for dominant species of every major wetland plant association in Colorado is available from the Colorado Natural Heritage Program (Carsey et al. 2003; http://www.cnhp.colostate.edu/reports.html). Lacking any other information, for most low elevation streams, default values of 45% tree, 15% shrub, and 85% herbaceous coverage can be used, or can form a starting point in developing estimations.

Enter the "Reference/expected Cover of Layer" in the labeled cells on the data sheet. Enter coverages as decimal values (*e.g.,* 0.75) rather than percents (*e.g.,* 75 %). Total vegetation cover will commonly sum to greater than 1.0 (100%) owing to overlap of strata.

Step 5: Determine the severity of stressors acting on each individual canopy layers, indicating their presence with checks in the appropriate boxes of the stressor table. The difference between the expected and observed stratum coverages is one measure of stratum alteration.

Additional Explanation:

Considering each stratum to be scored separately, identifying stratum-specific stressors that alter its structure and composition. For each stressor, record its approximate prevalence within the stratum and the severity of vegetation change it has caused.

Step 7: Determine the sub-variable score for each valid vegetation layer using the scoring guidelines on the second page of the scoring sheet. Enter each sub-variable score in the appropriate cell in the row labeled "Veg. Layer Sub-variable Score". If a stratum has been wholly removed, score it as a 0.5.

Additional Explanation:

Taking into account the total effects of stressors on each canopy layer, score the vegetation layer sub-variable scores. Enter these values in the table cells indicated above.

Step 8: *Multiply each layer's Reference Percent Cover of Layer score by its Veg. Layer Sub-variable scores and enter the products in the labeled cells. These are the weighted sub-variable scores. Individually sum the Reference Percent Cover of Layer and Weighted Sub-variables scores.*

Additional Explanation:

This step weights each canopy's sub-variable score by its coverage value. In cases of stratum removal, the Reference Standard cover value used weights the degree of impairment caused by the removal. For instance, if the tree canopy of a forested wetland had a reference standard coverage of 45%, but these trees cleared, the tree canopy sub-variable would be 0.5. In this case, the weighted sub-variable score would be 0.45 x 0.5 = 0.225. This low score would have an appropriately strong effect on the overall variable score. If on the other hand, the current coverage of trees were used (i.e. 0% cover), the sub-variable score would be calculated as 0 x 0.5 = 0. In this case, the loss of the tree canopy would have no effect on the overall variable score and this would generate an erroneous picture of the degree of alteration of vegetation structure.

Step 9: Divide the sum of Weighted Sub-variable scores by the total reference coverage of all layers scored. This product is the Variable 8 score. Enter this number in the labeled box at the bottom of this page.

Additional Explanation:

This scoring procedure calculates the percentage of the total possible score that the AA vegetation achieves.

Scoring of Functional Capacity Indices

Overview

The last page of the assessment form packet is the FACWet score card. On this sheet, each variable score is transcribed and **Functional Capacity Indices (FCIs)** are calculated. An FCI is a rating of the capacity of the AA to perform a function relative to its Reference Standard (after Smith et al. 1995). FACWet considers seven key functions performed by wetlands: Support of Characteristic Wildlife Habitat, Support of Characteristic Fish/Aquatic Habitat, Flood Attenuation, Short - and Long-term Water Storage, Nutrient/Toxicant Removal, Sediment Retention/Shoreline Stabilization, and Production Export and Flood Chain Support.

Each FCI is comprised of the variables which have the preeminent control over the level of functioning. Additional variables may play some role in creating a given function, but if they are not the primary drivers, they are not included in FCI calculation. Variables that play a more prominent role in a given function are weighted more heavily with multipliers. It is important to note that flexibility is built into the FCI scoring routine. If specific conditions warrant, any variable can be added or removed from the functional capacity indices, or the weighting can be changed (with the necessary adjustment to the formula, as explained below). Any modification of an FCI must be sufficiently justified. Explanation could come in the form of expert opinion, existing scientific studies, or quantitative data.

FCI Calculation Procedure

FCIs are calculated by taking the sum of the weighted variable scores contributing to the function at hand, and dividing by the total number of points possible. For instance, if a given FCI includes four variables, the sum of the variable scores would be divided by four. The scoring procedure is laid out on the FACWet score card. Keep in mind that if a variable is added to or subtracted from an FCI, or the weighting is changed, the total possible points will differ from that presented on the score card and will need to be changed accordingly.

To calculate the Composite FCI Score that rates the overall condition of the AA, follow the same general procedure that is outlined above. The composite FCI score is simply the average of the seven individual FCI.

Score interpretation

FACWet scores relate functional capacity to the same scale used in variable scoring. The result of composite scoring is a numerical value that can be used to guide mitigation planning. It also classifies the AA on the Reference Standard to Non-functioning continuum (Table 9). The precise way in which FCI scores will be used in administration of the Clean Water Act, such as in permitting and designation of mitigation requirements is instituted by regulatory agencies.

Table 9. Functional categories and their general interpretation.

FCI Score	Functional Category	Interpretation
1.0 - 0.9	Reference Standard	AA is functioning at or near its Reference Standard capacity.
<0.9 - 0.8	Highly Functioning	AA retains all of its natural functions. While the capacity of some or all have been altered somewhat, the function of the wetland is still fundamentally sound.
<0.8 - 0.7	Functioning	The capacity of some or all of the AAs functions has been markedly altered, but the wetland still provides the types of functions associated with its habitat type.
<0.7 - 0.6	Functioning Impaired	The functioning of the wetland has been severely altered. Certain functions may be nearly extinguished or they may be grossly altered to be more representative of a different class of wetland (e.g., a fen converted to a depressional system). Despite the profound changes, the AA still supports wetland habitat.
<0.6	Non-functioning	AA no longer possesses the basic criteria necessary to support wetland conditions.

FACWet Applications

Case Study: Using FACWet in a Mitigation Project

FACWet is designed to be a universal scientific assessment methodology that can be applied across Colorado for any purpose where there is a need to understand the ecological condition and function of wetland habitat, and it has now been used during wetland inventories, site assessments, and the watershed approach, and for planning habitat improvement, restoration, and mitigation projects. Aside from other potential applications, FACWet was specifically crafted to meet the needs of Colorado's Clean Water Act (CWA) regulatory program. It is meant to be a tool used to support mitigation planning and agency review of proposed plans and, ultimately, to assist reviewers in determining whether projects are successful or not. In this section we illustrate how FACWet may be used for this purpose by providing an example of its application on an actual mitigation project. The example project is restoration of a degraded fen along Four-mile Creek in Park County (Fig. 36).

There are three basic steps that should be part of any ecological restoration or enhancement project regardless of its intended purpose (not including actual construction): (1) assessment of the project site, (2) planning the project by identifying ecological goals and setting specific design objectives, and (3) monitoring to appraise project success (Fig. 43). Our example illustrates the way that FACWet provides a structure that guides a project through each of these three foundational phases.

Assessment of Ambient Condition

The first phase in the mitigation process is to complete an assessment of the candidate mitigation site. FACWet provides an overall rating of the site's functional condition, expressed as the degree of impairment or departure from the natural reference standard. It also identifies the specific ecological attributes of the site that are impaired and the environmental stressors causing the impairment. This information serves several purposes at this phase of the process. The degree of site impairment provides a first indication of the potential for improvement, or environmental lift that could be brought by site treatments. Variable scores identify which aspects of the site require remediation or treatment (hydrology, geomorphology, vegetation, etc.), and the identification of stressors aids in determination of whether the causes of impairment can be remediated. If the site is, in fact, an appropriate candidate for mitigation then FACWet should document the presence of specific stressors that can be practically alleviated to improve the function of one or more variables and ultimately create environmental lift. In this way, the assessment not only provides the benchmark for evaluating future project effectiveness, but it also guides the prescription of specific treatments and rehabilitative actions.

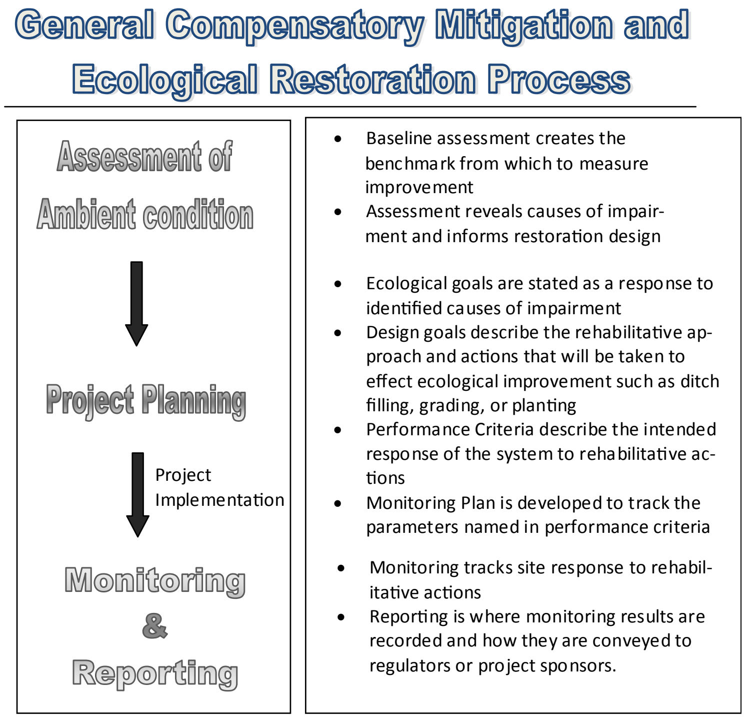


Figure 43. A description of the three basic phases of the mitigation of ecological restoration process.

Table 10 shows an example FACWet summary from the Four-mile Creek Fen prior to mitigation construction. The FACWet summary table condenses a great deal of assessment information into a concise summary that provides essential project information in a form that is easy to grasp. In this example, the variable ratings represent findings from seven years of quantitative baseline data collection. The summary clearly shows that the candidate mitigation site is impaired. The composite score of 0.72 indicates that there could be opportunity to induce substantial environmental lift through restorative actions.

Table 10. An example FACWet summary table from the assessment of Fourmile Creek Fen prior to mitigation construction

Variable Name	Variable Rating	Rationale (Primary Stressors)
Habitat Connectivity	0.78 (C+)	AA is in rural landscape that has seen substantial loss of wetlands
Contributing Area	0.90 (A-)	Surrounding land use is low density grazing
Water Source	0.98 (A+)	Source springs fully intact
Water Distribution	0.63 (D)	Drainage ditch and surface impacts
Water Outflow	0.62 (D-)	Ditch converts groundwater to surface water and channelizes flow
Geomorphology	0.72 (C-)	(1) Ditch, (2) cattle-related soil disturbance.
Chemical Environment	0.65 (D)	(1) Soil oxidation and salt accumulation secondary to dewatering, (2) cattle-related soil disturbance
Vegetation Structure and Complexity	0.68 (D+)	(1) Conversion to upland spp. secondary to dewatering, (2) disturbance/grazing by cattle
Composite Score (FCI)	**0.72 (C-)**	Site holds zonal range of wetland conditions from highly functioning in the upper end, to non-functional in the lower.

The summary also identifies the key stressors and variables that are impacted. It is immediately apparent that the main stressor affecting the wetland is a drainage ditch that impairs Water Distribution, Water Outflow, Geomorphology, Soil/Water Chemistry, and Vegetation. A secondary stressor is heavy cattle grazing which caused further alteration of Geomorphology, Soil/Water Chemistry, and Vegetation. The site was accepted as a promising candidate for mitigation because there is potential for improvement (environmental lift), because the causes of impairment are easily identifiable and feasible to remediate, and because the site is in a setting capable of supporting high quality mitigation (a high Contributing Area scores). The assessment suggested that many of the lost functions could be regained by filling the ditch and managing cattle.

Project Planning

In general, once a mitigation site has been selected and baseline conditions documented, the next phase is to plan the project by identifying ecological goals and setting specific design objectives according to a guiding image of the target habitat type. Under §404 CWA, project goals must be formalized in a mitigation plan which includes performance criteria, and mitigation compliance must be demonstrated through ecological monitoring. All of these project project facts must be related to regulatory agency staff.

FACWet provides a framework for organizing and presenting important facts of a mitigation plan, and it can also aid in the development of the plan itself. Table 11 provides an example mitigation plan summary from Denver Water's Fourmile Creek Fen Bank. This tabular presentation highlights the linkages between predicted FACWet variable conditions, performance criteria and the monitoring parameters used to document habitat improvement. It is intended to provide an overview of the most important ecological facts of a planned project and to bolster understanding and communication of its means and objectives.

In Table 11, each FACWet variable is assigned a target functional class or score range. The functional class concisely describes the condition goals for each variable in easy to understand terms. Design objectives and performance criteria (Table 11) define the characteristics or behavioral limits for target variables that signify when variables have attained sufficiently high condition levels to qualify as being in the target functional classes. As such, performance criteria replace the rapid assessment scoring *guidelines* included on FACWet datasheets used during routine site assessment. Performance criteria are agreed upon *rules,* because they are required for compensatory mitigation under 40 CFR 230.96. For example, for the Water Distribution variable in Table 11, a reference standard condition for this fen habitat is defined as having the water table within 30 cm of the ground surface for at least 66% of the growing season. Performance criteria should drive the design of the mitigation monitoring plan by identifying the particular aspects of the wetland that must be monitored to demonstrate compliance with permit conditions. In Table 11 the monitoring parameters used to document improvement or maintenance of each variable's condition is listed adjacent to the relevant performance criterion.

Table 11. An example of a FACWet-based summary of ecological goals, design objectives, performance criteria, and monitoring parameters used to gauge mitigation success on the Four-mile Fen project.

Variable	Target Functional Class/Score Range	Design Objectives and Performance Criteria	Monitoring Parameters Used to Demonstrate Compliance and Success
Habitat Connectivity	Reference Standard (0.9 – 1.0)	Maintenance of historical land use	Evaluation of aerial photography. Field survey if necessary
Contributing Area	Reference Standard (0.9 – 1.0)	Maintenance of historical land use	As above.
Water Source	Reference Standard (0.9 – 1.0)	Utilization of the natural water source for the wetland (springs)	16 data logging groundwater wells demonstrate functioning of wetland water source
Water Distribution	Reference Standard (0.9 – 1.0)	*Fen wetland* – 66% growing season water table at or above 30 cm, with an avg. depth 37 cm *Mineral* soil wetland – 12.5 to 47% of growing season water table at or above 30cm, with an avg. depth of 50 cm	As variable 4, with 12 additional manually read wells
Water Outflow	Reference Standard (0.9 – 1.0)	Re-establish groundwater outflow characteristics	As in variables 4 and 5, including three flow stations in the ditch (pre-construction)
Geomorphology	Reference Standard (0.9 – 1.0)	• Filling of the ditch and removal of its berm • Microtopographical improvement • Soil surface recovery	69 permanent transects sampled annually and annual survey of 154 benchmarks
Chemical Environment	Reference Standard (0.9 – 1.0)	Restoration of the characteristic redox environment and improvement of soil chemistry characteristics	Annual soil chemistry analysis at 32 plots. Monitoring 30 soil redox probes.
Vegetation Structure and Complexity	Highly Functioning (0.8 – 0.9)	• Trend toward or achievement of reference conditions • Species Richness within range of reference • Weedy and invasives (<10%)	Visual estimation of vegetation coverage by species within 32 5-meter diameter, permanent vegetation plots and 10 transects across the filled ditch.

Monitoring and Reporting

For CWA compensatory mitigation, post-construction monitoring, project appraisal, and reporting are required under 40 CFR 230.96 to demonstrate ecological improvement and the attainment of design objectives and performance criteria as listed in the mitigation plan (40 CFR 230.95). FACWet is expressly designed to meet this need. As described in the *Project Planning* section, the FACWet structure provides an outline for describing performance criteria and identifying the monitoring parameters used to appraise project success. The FACWet framework is also useful for structuring monitoring reports in a way that systematically organizes all the various data and findings according to the specific performance criteria, tying them all back to the original site assessment and mitigation plan (Table 12).

Table 12. An example of a FACWet-based summary of project monitoring and appraisal.

Variable	Performance Criteria	Status
Habitat Connectivity	Maintenance of historical land use	Criterion met criterion 2010 - 2011 based on aerial photography and site visits.
Contributing Area	Maintenance of historical land use	Criterion met criterion 2010 - 2011 based on aerial photography and site visits.
Water Source	Utilization of the natural water source for the wetland (springs)	Achieved design goal. Natural spring sources are used according to design.
Water Distribution	Fen areas – 66% growing season @ 30 cm, avg. depth 37 cm Mineral areas – 47 to 12.5% of growing season, avg. 50 cm	Criterion met in 2011 based on measured water table at 28 sites, except at wells M and L. Habitat around well M has been determined to have been naturally upland. There is clear evidence that historical wetland habitats down gradient from the bank have also met this criterion.
Water Outflow	Re-establish groundwater outflow characteristics	Achieved design goal restored wetland are supporting down-gradient habitats based monitoring wells and observation of wetland conversion.
Geomorphology	• Filling of the ditch and removal of its berm • Attenuation of cattle induced microtopography impacts • Soil surface recovery	Achieved the design objective of filling the ditch to match historic soil profile. Criteria for microtopographical improvement are met, based on hummock surveys. Soil surface elevation has increased 3 cm on average as the result of rewetting and restoration of organic soils.
Chemical Environment	Restoration of the characteristic redox environment, and improvement of soil chemistry characteristics	Criterion met criterion 2010 - 2011 based on soil redox monitoring and chemical analyses.
Vegetation Structure and Complexity	• Trend toward or achievement of reference conditions • Species Richness within range of reference • Weedy and invasives (<10%)	Vegetation development appears progressing towards criterion based on an increasing trend in species richness and similarity to reference community structure, but it is in general too early to tell. Invasive species cover is << 10%. Vegetation establishment on the filled ditch is clearly progressing towards success criteria.

In some cases, Corps permit conditions require only simple visual assessment of a mitigation site to document success. In these cases FACWet can serve as a useful systematic “checklist” during site visits to assure that the relevant parameters are being checked. FACWet can always be used after construction to document whether basic design objectives of a project have been met, but in most cases a simple rapid assessment is not sensitive enough to be used as the primary approach to mitigation monitoring. For compensatory mitigation, and for most voluntary habitat projects, detailed monitoring of quantitative parameters is necessary for an objective appraisal of project performance. In these cases, FACWet provides the framework for organizing data according to specific performance criteria outlined in the planning phase.

Table 12 is an example of how the FACWet structure was used to report an appraisal of project success at the Fourmile Fen mitigation project two years after construction. As in the previous tables, the FACWet variables are listed in the first column. Information in the second column reminds the reviewer of the performance criteria that were agreed upon in the planning phase, prior to construction. The last column summarizes the status of the project relative to performance criteria for each variable based on the monitored information. Notice that in the summary table monitoring results are condensed to a simple statement about the observed condition, but that statement is backed up by an analysis of the parameters measured. If the rest of the monitoring report is structured according to the FACWet outline in this table, it is easy for reviewers to check the accuracy of these appraisals by finding the corresponding report section in which that particular parameter data is presented. In this way, the tabular summary forms a menu from which a reviewer can pick and choose the topics they wish to pursue in greater detail.

While FACWet was specifically designed with CWA mitigation in mind, the approach is applicable for any type of habitat improvement efforts in that it can aid such efforts by helping to clarify linkages between site assessment, planning, design, and monitoring. The ease of applying FACWet is intended to encourage more voluntary project sponsors to include monitoring and project appraisal in their habitat improvement efforts. This is because many voluntary habitat improvement projects are not effectively monitored after construction, and this practice has allowed many underperforming or failed projects to go unnoticed. Failed attempts at habitat improvement often leave wetlands and streams in worse condition than they were in prior to construction, and the lack of effective monitoring means that many of these same mistakes are made time and time again. When effectively monitored, each habitat project is a potential valuable learning experience and, in general, projects are better conceived and more carefully designed when it is known up front that performance will be monitored and reported.

Glossary of Key Terms

Area of Interest (AOI) – The spatial envelope which encompasses the entire area potentially impacted (directly or indirectly) by a project's proposed activities. The AOI demarcates the search area for target habitats; that is, wetlands and/or riparian areas.

Assessment Area (AA) – The defined area of habitat being evaluated using FACWet. The AA may be comprised solely of jurisdictional wetland, ecological wetland or riparian habitat, or it may also include areas of historical wetland that have been converted to upland.

Attribute – One of three defining characteristics of a wetland including its landscape context, hydrology and physical-biological habitat. In FACWet, each attribute is described by three State Variables.

Condition – A measure of the physical and biological form and function of a wetland relative to its native state or that of reference standard wetlands of the same type. Condition is often described as the "health" of an ecological system.

Exotic Wetland – A type of wetland not naturally found within the ecoregion, or a wetland type which does not have a direct natural analog.

Functional Capacity – The magnitude to which an area of wetland performs a function. Functional capacity is dictated by physical and biological properties of a wetland ecosystem, its surrounding landscape and interaction between the two (after Smith et al. 1995).

Functional Capacity Index (FCI) –An index of the capacity of wetland to perform a function relative to the Reference Standard. Functional capacity indices are by definition scaled from 0.0 to 1.0 in a manner paralleling the academic grading scale. An FCI of 1.0 indicates that a wetland performs a function at a level equivalent to the Reference Standard (after Smith et al. 1995). It is critical to understand that, in FACWet the FCI is a purely relative measure. It does not imply an actual rate or capacity apart from the similarity to or departure from the reference standard.

Functional Impairment – Alteration of a wetland's functional capacity relative to its Reference Standard. Functional impairment may be manifested as a decrease *or increase* in the absolute rate or capacity at which a function is performed. For example, functional impairment would result from exaggerated sediment retention caused by land use change (e.g. nearby construction), despite the fact that absolute rates of sediment retention in terms of kg/sq. meter increased relative to Reference Standard conditions.

Habitat Conductivity Envelope (HCE) – The 500m-wide zone surrounding an AA. The HCE is intended to describe the zone of maximum potential interaction among wetland/riparian sites

Highest Sustainable Functional Capacity – The level of functional capacity achieved ***across the suite of functions*** by a wetland under reference standard conditions in a reference domain. This approach assumes that the highest sustainable functional capacity is achieved when a wetland ecosystem and the surrounding landscape are undisturbed (from Smith et al 1995). In general, the artificial maximization of one function (such as excavation to increase surface water storage or an increase in sediment retention) comes at the expense of other functions and thus reduces the wetland's overall functional capacity.

Hydrodynamics – The motion of water that generally corresponds to its capacity to do work such as transport sediments, erode soils, flush pore waters in sediments, fluctuate vertically, etc. Velocities can vary within each of three flow types: primarily vertical, primarily bidirectional and horizontal, and primarily unidirectional and horizontal. Vertical fluxes are driven by evapotranspiration and precipitation. Bidirectional flows are driven by astronomic tides and wind-driven seiches. Unidirectional flows are down-slope movements that occur from seepage slopes and on floodplains (from Brinson 1993).

Natural Condition – The actual level of functioning exhibited by a wetland in its native, pristine or pre-European settlement condition.

Quasi-Natural Condition – An induced condition in which the functioning of a restored, enhanced or established wetland replicates that of a wetland that is, in fact, natural and in Reference Standard condition.

Reference Domain – The geographic area from which reference wetlands are selected. A reference domain may or may not include the entire geographic area in which a regional wetland subclass occurs (from Smith et al. 1995). Reference domains will typically be described by Level 3 or 4 Ecoregions (http://www.epa.gov/wed/pages/ecoregions/co_eco.htm).

Reference Standard – The benchmark for comparison in FACWet ratings. The reference standard can be developed from the inference of the natural conditions of a wetland, through comparison to reference standard wetlands or by evaluation in light of principles of sound ecological design, in descending order of precedence.

Reference Standard Wetland(s) – Wetland sites that encompass the natural range of variability of a regional wetland subclass in a reference domain. Conditions exhibited by reference wetlands correspond to the highest level of functional capacity (highest sustainable level of functioning) across the suite of functions performed by the regional wetland subclass. The highest level of functional capacity is assigned an index value of 1.0 by definition (modified from Smith et al. 1995).

Region – A geographic areas that is relatively homogenous with respect to large-scale factors such as climate and geology that may influence how wetlands function.

Regional Wetland Subclass – Wetlands within a region that are similar based on hydrogeomorphic classification factors. There may be more than one regional wetland subclass identified within each hydrogeomorphic wetland class, depending on the diversity of wetlands in a region and assessment objectives.

Scoring Guidelines – Narratives used in variable rating to describe the general level of departure from Reference Standard conditions that would warrant placement within a variable condition class or score range. Scoring guidelines are intended to calibrate variable ratings between evaluators. They are not to be interpreted in the strict sense as rules, but rather to be indicative of the order of magnitude of impairment that is associated with conditional classes.

State Variable – One of a set of variables that describes the fundamental properties of the wetland system. In FACWet State Variables are ecological forcing factors that determine the form and function of a wetland.

Stressor – A deleterious anthropogenic modification of the wetland or its watershed that contributes to functional impairment.

Value - The goods and services resulting from wetland functions as perceived to be "worthy, desirable, or useful to humanity (after Mitsch and Gosselink 2007)".

Variable Score – The rating of the degree of departure between a variable and its Reference Standard condition.

Wetland Function – The normal activities or actions that occur in wetland ecosystems, or simply, the things wetlands do. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape and their interaction (Smith et al. 1995).

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Appendix A – FACWet Data Sheets

ADMINISTRATIVE CHARACTERIZATION

General Information

		Date of Evaluation:	
Site Name or ID:		Project Name:	
404 or Other Permit Application #:		Applicant Name:	
Evaluator Name(s):		Evaluator's professional position and organization:	

Location Information:

Site Coordinates (Decimal Degrees, e.g., 38.85, -104.96):		Geographic Datum Used (NAD 83):	
		Elevation	
Location Information:			
Associated stream/water body name		Stream Order:	
USGS Quadrangle Map:		Map Scale: (Circle one)	1:24,000 1:100,000 Other 1:
Sub basin Name (8 digit HUC):		Wetland Ownership:	

Project Information:

This evaluation is being performed at: *(Check applicable box)*

- ☐ *Project Wetland*
- ☐ *Mitigation Site*

Purpose of Evaluation (check all applicable):

- ☐ *Potentially Impacted Wetlands*
- ☐ *Mitigation; Pre-construction*
- ☐ *Mitigation; Post-construction*
- ☐ *Monitoring*
- ☐ *Other (Describe)*

Intent of Project: *(Check all applicable)* ☐ Restoration ☐ Enhancement ☐ Creation

Total Size of Wetland Involved: (Record Area, Check and Describe Measurement Method Used)	ac.	☐ Measured ☐ Estimated				
Assessment Area (AA) Size (Record Area, check appropriate box. Additional spaces are used to record acreage when more than one AA is included in a single assessment)	ac.	☐ Measured	ac.	ac.	ac.	ac.
		☐ Estimated	ac.	ac.	ac.	ac.
Characteristics or Method used for AA boundary determination:						

Notes:	

ECOLOGICAL DESCRIPTION 1

Special Concerns

Check all that apply

- ☐ Organic soils including Histosols or Histic Epipedons are present in the AA (i.e., AA includes core fen habitat).
- ☐ Project will directly impact organic soil portions of the AA including areas possessing either Histosol soils or histic epipedons.
- ☐ Organic soils are known to occur anywhere within the contiguous wetland of which the AA is part.
- ☐ The wetland is a habitat oasis in an otherwise dry or urbanized landscape?
- ☐ Federally threatened or endangered species are **KNOWN** to occur in the AA? List Below.

____

____

- ☐ Federally threatened or endangered species are **SUSPECTED** to occur in the AA?

____

____

____

____

- ☐ Species of concern according to the Colorado Natural Heritage (CNHP) are known to occur in the AA?
- ☐ The site is located within a potential conservation area or element occurrence buffer area as determined by CNHP?
- ☐ Other special concerns (please describe)

____

HYDROGEOMORPHIC SETTING

- ☐ AA wetland maintains its fundamental natural hydrogeomorphic characteristics
- ☐ AA wetland has been subject to change in HGM classes as a result of anthropogenic modification
  If the above is checked, please describe the original wetland type if discernable using the table below.
- ☐ AA wetland was created from an upland setting.

Current Conditions

Describe the hydrogeomorphic setting of the wetland by circling all conditions that apply.

HGM Setting	**Water source**	Surface flow	Groundwater	Precipitation	Unknown		
	Hydrodynamics	Unidirectional	Vertical	Bi-directional			
	Wetland Gradient	0 - 2%	2-4%	4-10%	>10%		
	# Surface Inlets	Over-bank	0	1	2	3	>3
	# Surface Outlets		0	1	2	3	>3
	Geomorphic Setting (Narrative Description. Include approx. stream order for riverine)						
	HGM class	Riverine	Slope	Depressional	Lacustrine		

Historical Conditions

Previous wetland typology	**Water source**	Surface flow	Groundwater	Precipitation	Unknown
	Hydrodynamics	Unidirectional	Vertical		
	Geomorphic Setting (Narrative Description)				
	Previous HGM Class	Riverine	Slope	Depressional	Lacustrine

Notes (include information on the AA's HGM subclass and regional subclass):

ECOLOGICAL DESCRIPTION 2

Vegetation Habitat Description

US FWS habitat classification according as reported in Cowardin et al. (1979).

System	Subsystem	Class	Subclass	Water Regime	Other Modifiers	% AA
Lacustrine	Littoral; Limnoral	Rock Bot. (RB) Uncon Bottom(UB) Aquatic Bed(AB) Rocky Shore(RS) Uncon Shore(US) Emergent(EM) Shrub-scrub(SS) Forested (FO)	Floating vascular; Rooted vascular; Algal; Persistent; Non-Persistent; Broad-leaved deciduous; Needle-leaved evergreen; Cobble - gravel; Sand; Mud; Organic	**Examples** Temporarily flooded(A); Saturated(B); Seasonally flooded(C); Seas.-flood./sat.(E); Semi-Perm. flooded(F); Intermittently exposed(G); Artificially flooded(K); Sat./semiperm./Seas. (Y); Int. exposed/permenant(Z)	Hypersaline(7) ; Eusaline(8); Mixosaline(9); Fresh(0); Acid(a); Circumneutral(c); Alkaline/calcareous(i); Organic(g); Mineral(n); Beaver(b); Partially Drained/ditched(d); Farmed(f); Diked/impounded(h); Artificial Substrate(r); Spoil(s); Excavated(x)	
Palustrine	Palustrine					
Riverine	Lower perennial; Upper perennial; Intermittent					

Site Map

Scale: 1 sq. =

Draw a sketch map of the site including relevant portions of the wetland, AA boundary, structures, habitat classes, and other significant features.

Variable 1: Habitat Connectivity

The Habitat Connectivity Variable is described by two sub-variables – Neighboring Wetland and Riparian Habitat Loss and Barriers to Migration and Dispersal. These sub-variables were treated as independent variables in FACWet Version 2.0. The merging of these variables makes their structure more consistent with that of other composite variables in FACWet. The new variable configuration also makes this landscape variable more accurately reflect the interactions amongst aquatic habitats in Colorado's agricultural and urbanized landscapes, which have a naturally low density of wetlands. The two Habitat Connectivity Sub-variables are scored in exactly the same manner as their FACWet 2.0 counterparts, as described below. The Habitat Connectivity Variable score is simply the arithmetic average of the two sub-variable scores which is entered on the second page of the Variable 1 data form. If there is little or no wetland or riparian habitat in the Habitat Connectivity Envelope (defined below), then Sub-variable 1.1 is not scored.

SV 1.1 - Neighboring Wetland and Riparian Habitat Loss
(Do not score if few or no wetlands naturally exist in the HCE)

This sub-variable is a measure of how isolated from other naturally-occurring wetlands or riparian habitat the AA has become as the result of habitat destruction. To score this sub-variable, estimate the percent of naturally-occurring wetland/riparian habitat that has been lost (by filling, draining, development, or whatever means) within the 500-meter-wide belt surrounding the AA. This zone is called the Habitat Connectivity Envelope (HCE). In most cases the evaluator must use best professional judgment to estimate the amount of natural wetland loss. Historical photographs, National Wetland Inventory (NWI) maps, hydric soil maps can be helpful in making these determinations. Floodplain maps are especially valuable in river-dominated regions, such as the Front Range urban corridor. Evaluation of landforms and habitat patterns in the context of perceivable land use change is used to steer estimates of the amount of wetland loss within the HCE.

Rules for Scoring:

1. On the aerial photo, create a 500 m perimeter around the AA.
2. The area within this perimeter is the **Habitat Connectivity Envelope (HCE)**.
3. Within the HCE, outline the current extent of naturally occurring wetland and riparian habitat. Do not include habitats such as excavated ponds or reservoir induced fringe wetlands.
4. Outline the historical extent of wetland and riparian habitats (i.e., existing natural wetlands plus those that have been destroyed).

   - Use your knowledge of the history of the area and evident land use change to identify where habitat losses have occurred. Additional research can be utilized to increase the accuracy of this estimate including consideration of floodplain maps, historical aerial photographs, soil maps, etc.

5. Calculate the area of existing and historical wetlands. Divide the area of existing wetland by the total amount of existing and historical wetland and riparian habitat, and determine the variable score using the guidelines below. Enter sub-variable score at the bottom of p.2 of the Habitat Connectivity data form.

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Very little or no loss of wetlands in the HCEor negligible.
<0.9 - 0.8	***B*** *Highly Functioning*	More than 80% of historical wetland habitat area within the HCE is still present (less than 20% of habitat area lost).
<0.8 - 0.7	***C*** *Functioning*	80 to 60% of historical wetland habitat area within the HCE is still present (20% to 40% of habitat area lost).
<0.7 - 0.6	***D*** *Functioning Impaired*	Less than 60 to 25% of historical wetland habitat area within the HCE is still present (more than 40 to 75% of habitat area lost).
<0.6	***F*** *Non-functioning*	Less than 25% of the historical wetland habitat area within the HCE still in existence (more than 70% of habitat lost).

Notes:

Variable 1: Habitat Connectivity p. 2

SV 1.2: Migration/Dispersal Barriers

This sub-variable is intended to rate the degree to which the AA has become isolated from existing neighboring wetland and riparian habitat by artificial barriers that inhibit migration or dispersal of organisms. On the aerial photograph, identify the man-made barriers within the HCE that intercede between the AA and surrounding wetlands and riparian areas, and identify them by type on the stressor list. Score this variable based on the barriers' impermeability to migration and dispersal and the amount of surrounding wetland/riparian habitat they affect.

Rules for Scoring:

1. On the aerial photo, outline **all** existing wetland and riparian habitat areas within the HCE. This includes naturally occurring habitats, as well as those purposefully created or induced by land use change.

2. Identify artificial barriers to dispersal and migration of organisms within the HCE that intercede between the AA and surrounding habitats. Mark the stressors present with a check in the first column and describe the general nature, severity and extent of each. List additional stressors in empty rows at the bottom of the table and explain.

3. Considering the composite effect of all of identified barriers to migration and dispersal (i.e., stressors), assign an overall variable score using the scoring guidelines.

Stressors = artificial barriers	✔	Stressors	Comments/description
		Major Highway	
		Secondary Highway	
		Tertiary Roadway	
		Railroad	
		Bike Path	
		Urban Development	
		Agricultural Development	
		Artificial Water Body	
		Fence	
		Ditch or Aqueduct	
		Aquatic Organism Barriers	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	No appreciable barriers exist between the AA and other wetland and riparian habitats in the HCE; or there are no other wetland and riparian areas in the HCE.
<0.9 - 0.8	***B*** *Highly Functioning*	Barriers impeding migration/dispersal between the AA and up to 33% of surrounding wetland/riparian habitat highly permeable and easily passed by most organisms. Examples could include gravel roads, minor levees, ditches or barbed-wire fences. More significant barriers (see "functioning category below) could affect migration to up to 10% of surrounding wetland/riparian habitat.
<0.8 - 0.7	***C*** *Functioning*	Barriers to migration and dispersal retard the ability of many organisms/propagules to pass between the AA and up to 66% of wetland/riparian habitat. Passage of organisms and propagules through such barriers is still possible, but it may be constrained to certain times of day, be slow, dangerous or require additional travel. Busy two-lane roads, culverted areas, small to medium artificial water bodies or small earthen dams would commonly rate a score in this range. More significant barriers (see "functioning impaired" category below) could affect migration to up to 10% of surrounding wetland/riparian
<0.7 - 0.6	***D*** *Functioning Impaired*	Barriers to migration and dispersal preclude the passage of some types of organisms/propagules between the AA and up to 66% of surrounding wetland/riparian habitat. Travel of those animals which can potential negotiate the barrier are strongly restricted and may include a high chance of mortality. Up to 33% of surrounding wetland/riparian habitat could be functionally isolated from the AA.
<0.6	***F*** *Non-functioning*	AA is essentially isolated from surrounding wetland/riparian habitat by impermeable migration and dispersal barriers. An interstate highway or concrete-lined water conveyance canal are examples of barriers which would generally create functional isolation between the AA and wetland/riparian habitat in the HCE.

SV 1.1 Score	
SV 1.2 Score	

Add SV 1.1 and 1.2 scores and divide by two to calculate variable score

Variable 1 Score [ ]

Variable 2: Contributing Area

The AA's Contributing Area is defined as the 250-meter-wide zone surrounding the perimeter of the AA. This variable is a measure of the capacity of that area to support characteristic functions of high quality wetland habitat. Depending on its condition, the contributing area can help maintain wetland condition or it can degrade it. Contributing Area condition is evaluated by considering the AA's Buffer and its Surrounding Land Use. Buffers are strips or patches of more-or-less natural upland and/or wetland habitat more than 5m wide. Buffers are contiguous with the AA boundary and they intercede between it and more intensively used lands. The AA Buffer is characterized with three sub-variables: Buffer Condition, Buffer Extent, and Average Buffer Width. The Surrounding Land Use Sub-variable considers changes within the Contributing Area that limit its capacity to support characteristic wetland functions. Many of the acute, on-site effects of land use change in the Contributing Area are specifically captured by Variables 3 - 8.

Rules for Scoring:

1. Delimit the Contributing Area on an aerial photograph as the zone within 250 meters of the outer boundary of the AA.
2. Evaluate and then rate the Buffer Condition sub-variable using the scoring guidelines. Record the score in the cell provided on the datasheet.
3. Indicate on the aerial photograph zones surrounding the AA which have ≥5m of buffer vegetation and those which do not.
4. Calculate the percentage of the AA which has a Buffer and record the value where indicated on the data sheet.
5. Rate the *Buffer Extent* Sub-variable using the scoring guidelines.
6.Determine the average Buffer width by drawing a line perpendicularly from the AA boundary to the outer extent of the buffer habitat. Measure line length and record its value on the data sheet. Repeat this process until a total of 8 lines have been sampled.
7. Calculate the average buffer width and record value on the data form. Then determine the sub-variable score using the scoring guidelines.
8.Score the Surrounding Land Use sub-variable by recording land use changes on the stressor list that affect the capacity of the landscape to support characteristic wetland functioning.
9. Enter the **lowest** of the three Buffer sub-variable scores along with the Surrounding Land Use Sub-variable score in the Contributing Area Variable scoring formula at the bottom of p. 2 of the data form. The Contributing Area Variable is the

SV 2.1 - Buffer Condition

☐ ***SV 2.1 - Buffer Condition Score***

Subvariable Score	Condition Grade	Buffer Condition Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Buffer vegetation is predominately native vegetation, human-caused disturbance of the substrate is not evident, and human visitation is minimal. Common examples: Wilderness areas, undeveloped forest and range lands.
<0.9 - 0.8	*Highly Functioning*	Buffer vegetation may have a mixed native-nonnative composition, but characteristic structure and complexity remain. Soils are mostly undisturbed or have recovered from past human disturbance. Little or only low-impact human visitation. Buffers with higher levels of substrate disturbance may be included here if the buffer is still able to maintain predominately native vegetation. Common examples: Dispursed camping areas in national forests, common in wildland parks (e.g. State Parks) and open spaces.
<0.8 - 0.7	*Functioning*	Buffer vegetation is substantially composed of non-native species. Vegetation structure may be somewhat altered, such as by brush clearing. Moderate substrate distrbance and compaction occurs, and small pockets of greater disturbance may exist. Common examples: City natural areas, mountain hay meadows.
<0.7 - 0.6	*Functioning Impaired*	Buffer vegetation is substantially composed of non-native species and vegetation structure has been strongly altered by the complete removal of one or more strata. Soil disturbance and the intensity of human visitation are generally high. Common examples: Open lands around resource extraction sites (e.g., gravel mines), clear cut logging areas, ski slopes.
<0.6	*Non-functioning*	Buffer is nearly or entirely absent.

SV 2.2 - Buffer Extent

☐ Percent of AA with Buffer

☐ ***SV 2.2 - Buffer Extent***

Subvariable Score	Condition Class	% Buffer Scoring Guidelines
1.0 - 0.9	*Reference Standard*	90 - 100% of AA with Buffer
<0.9 - 0.8	*Highly Functioning*	70-90% of AA with Buffer
<0.8 - 0.7	*Functioning*	51-69% of AA with Buffer
<0.7 - 0.6	*Functioning Impaired*	26-50% of AA with Buffer
<0.6	*Non-functioning*	0-25% of AA with Buffer

Variable 2: Contributing Area (p. 2)

SV 2.3 - Average Buffer Width

Record measured buffer widths in the spaces below and average.

Line #	1	2	3	4	5	6	7	8	Avg. Buffer Width (m)
Buffer Width (m)									

SV 2.3 - Average Buffer Width Score

Subvariable Score	Condition Grade	Buffer Width Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Average Buffer width is 190-250m
<0.9 - 0.8	*Highly Functioning*	Average Buffer width is 101-189m
<0.8 - 0.7	*Functioning*	Average Buffer width is 31-100m
<0.7 - 0.6	*Functioning Impaired*	Average Buffer width is 6-30m
<0.6	*Non-functioning*	Average Buffer width is 0-5m

SV 2.4 - Surrounding Land Use

SV 2.4 - Surrounding Land Use Score

Catalog and characterize land use changes in the surrounding landscape and score.

Stressors = Land Use Changes

✓	Stressors	Comments/description
	Industrial/commercial	
	Urban	
	Residential	
	Rural	
	Dryland Farming	
	Intensive Agriculture	
	Orchards or Nurseries	
	Livestock Grazing	
	Transportation Corridor	
	Urban Parklands	
	Dams/impoundments	
	Artificial Water body	
	Physical Resource Extraction	
	Biological Resource Extraction	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	No appreciable land use change has been imposed Surrounding Landscape.
<0.9 - 0.8	***B*** *Highly Functioning*	Some land use change has occurred in the Surrounding Landscape, but changes have minimal effect on the the landscape's capacity to support characteristic aquatic functioning, either because land use is not intensive, for example haying, light grazing, or low intensity silviculture, or more substantial changes occur in approximately less than 10% of the area.
<0.8 - 0.7	***C*** *Functioning*	Surrounding Landscape has been subjected to a marked shift in land use, however, the land retains much of its capacity to support natural wetland function and it is not an overt source of pollutants or sediment. Moderate-intensity land uses such as dry-land farming, urban "green" corridors, or moderate cattle grazing would commonly be placed within this scoring range.
<0.7 - 0.6	***D*** *Functioning Impaired*	Land use changes within the Surrounding Landscape has been substantial including the a moderate to high coverage (up to 50%) of impermeable surfaces, bare soil, or other artificial surfaces; considerable in-flow urban runoff or fertilizer-rich waters common. Supportive capacity of the land has been greatly diminished but not totally extinguished. Intensively logged areas, low-density urban developments, some urban parklands and many cropping situations would commonly rate a score within this range.
<0.6	***F*** *Non-functioning*	The Surrounding Landscape is essentially comletely developed or is otherwise a cause of severe ecological stress on wetland habitats. Commercial developments or highly urban landscapes generally rate a score of less than 0.6.

Buffer Score **(Lowest score)** | **Surrounding Land Use**

(☐ + ☐) ÷ 2 = **Variable 2 Score** ☐

Variable 3: Water Source

This variable is concerned with ***up-gradient*** *hydrologic connectivity. It is a measure of impacts to the AA's water source, including the quantity and timing of water delivery, and the ability of source water to perform work such as sediment transport, erosion, soil pore flushing, etc. To score this variable, identify stressors that alter the source of water to the AA, and record their presence on the stressor list. Stressors can impact water source by depletion, augmentation, or alteration of inflow timing or hydrodynamics. This variable is designed to assess water quantity, power and timing, not water quality. Water quality will be evaluated in Variable 7.*

Scoring rules:

1. Use the stressor list and knowledge of the watershed to catalog type-specific impairments of the AA's water source. Mark the stressors present with a check in the first column and describe the general nature, severity and extent of each. List additional stressors in empty rows at the bottom of the table and explain.

2. Considering the composite effect of stressors on the water source, rate the condition of this variable with the aid of the scoring guidelines.

✔	Stressors	Comments/description
	Ditches or Drains (tile, etc.)	
	Dams	
	Diversions	
	Groundwater pumping	
	Draw-downs	
	Culverts or Constrictions	
	Point Source (urban, ind., ag.)	
	Non-point Source	
	Increased Drainage Area	
	Storm Drain/Urban Runoff	
	Impermeable Surface Runoff	
	Irrigation Return Flows	
	Mining/Natural Gas Extraction	
	Transbasin Diversion	
	Actively Managed Hydrology	

Variable Score	Condition Grade	Depletion	Augmentation
1.0 - 0.9	***A*** *Reference Standard*	Unnatural drawdown events minor, rare or non-existent, very slight uniform depletion, or trivial alteration of hydrodynamics.	Unnatural high-water events minor, rare or non-existent, slight uniform increase in amount of inflow, or trivial alteration of hydrodynamics.
<0.9 - 0.8	***B*** *Highly Functioning*	Unnatural drawdown events occasional, short duration and/or mild; or uniform depletion up to 20%; or mild to moderate reduction of peak flows or capacity of water to perform work.	Occasional unnatural high-water events, short in duration and/or mild in intensity; or uniform augmentation up to 20%; or mild to moderate increase of peak flows or capacity of water to perform work.
<0.8 - 0.7	***C*** *Functioning*	Unnatural drawdown events common and of mild to moderate intensity and/or duration; or uniform depletion up to 50%; or moderate to substantial reduction of peak flows or capacity of water to perform work.	Common occurrence of unnatural high-water events, of a mild to moderate intensity and/or duration; or uniform augmentation up to 50%; or moderate to substantial increase of peak flows or capacity of water to perform work.
<0.7 - 0.6	***D*** *Functioning Impaired*	Unnatural drawdown events occur frequently with a moderate to high intensity and/or duration; or uniform depletion up to 75%; or substantial reduction of peak flows or capacity of water to perform work. **Wetlands with actively managed or wholly artificial hydrology will usually score in this range or lower.**	Common occurrence of unnatural high-water events, some of which may be severe in nature or exist for a substantial portion of the growing season; or uniform augmentation more than 50% or capacity of water to perform work. **Wetlands with actively managed or wholly artificial hydrology will usually score in this range or**
<0.6	***F*** *Non-functioning*	Water source diminished enough to threaten or extinguish wetland hydrology in the AA.	Frequency, duration or magnitude of unnaturally high-water great enough to change the fundamental characteristics of the wetland.

Variable 3 Score ☐

Variable 4: Water Distribution

*This variable is concerned with hydrologic connectivity **within** the AA. It is a measure of alteration to the spatial distribution of surface and groundwater within the AA. These alterations are manifested as local changes to the hydrograph and generally result from geomorphic modifications within the AA. To score this variable, identify stressors within the AA that alter flow patterns and impact the hydrograph of the AA, including localized increases or decreases to the depth or duration of the water table or surface water.*

*Because the wetland's ability to distribute water in a characteristic fashion is fundamentally dependent on the condition of its water source, **in most cases the Water Source variable score will define the upper limit Water Distribution score**. For example, if the Water Source variable is rated at 0.85, the Water Distribution score will usually have the potential to attain a maximum score of 0.85. Additional stressors within or outside the lower end of the AA effecting water distribution (e.g., ditches and levees) will reduce the score from the maximum value.*

Scoring rules:

1. Identify impacts to the natural distribution of water throughout the AA and catalog them in the stressor table.

2. Considering all of the stressors identified, assign an overall variable score using the scoring guidelines. In most cases, the Water Source variable score will set the upper limit for the Water Distribution score.

✔	Stressors	Comments/description
	Alteration of Water Source	
	Ditches	
	Ponding/Impoundment	
	Culverts	
	Road Grades	
	Channel Incision/Entrenchment	
	Hardened/Engineered Channel	
	Enlarged Channel	
	Artificial Banks/Shoreline	
	Weirs	
	Dikes/Levees/Berms	
	Diversions	
	Sediment/Fill Accumulation	

Variable Score	Condition Grade	Non-riverine	Riverine
1.0 - 0.9	***A*** *Reference Standard*	Little or no alteration has been made to the way in which water is distributed throughout the wetland. AA maintains a natural hydrologic regime.	Natural active floodplain areas flood on a normal recurrence interval. No evidence of alteration of flooding and subirrigation duration and intensity.
<0.9 - 0.8	***B*** *Highly Functioning*	Less than 10% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in less than a 2 in. (5 cm) change in mean growing season water table elevation.	Channel-adjacent areas have occasional unnatural periods of drying or flooding; or uniform shift in the hydrograph less than typical root depth.
<0.8 - 0.7	***C*** *Functioning*	Between 10 and 33% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in a 4 in. (5 cm) or less change in mean growing season water table elevation.	In channel-adjacent area, periods of drying or flooding are common; or uniform shift in the hydrograph near root depth.
<0.7 - 0.6	***D*** *Functioning Impaired*	33 to 66% of the AA is affected by *in situ* hydrologic alteration; or more widespread impacts result in a 6 in. (15 cm) or less change in mean growing season water table elevation. Water table behavior must still meet jurisdictional criteria to merit this rating.	Adjacent to the channel, unnatural periods of drying or flooding are the norm; or uniform shift in the hydrograph greater than root depth.
<0.6	***F*** *Non-functioning*	More than 66% of the AA is affected by hydrologic alteration which changes the fundamental functioning of the wetland system, generally exhibited as a conversion to upland or deep water habitat.	Historical active floodplain areas are almost never wetted from overbank flooding, and/or groundwater infiltration is effectively cut off.

Variable 4 Score | |

Variable 5: Water Outflow

*This variable is concerned with **down-gradient** hydrologic connectivity and the flow of water and water-borne materials and energy out of the AA. In particular it illustrates the degree to which the AA can support the functioning of down-gradient habitats. It is a measure of impacts that affect the hydrologic outflow of water including the passage of water through its normal low- and high-flow surface outlets, infiltration/groundwater recharge, and the energetic characteristics of water delivered to dependent habitats. In some cases, alteration of evapotranspiration rates may be significant enough of a factor to consider in scoring. Score this variable by identifying stressors that impact the means by which water is exported from the AA. To evaluate this variable focus on how water, energy and associated materials are exported out of the AA and their ability it support down-gradient habitats in a manner consistent with their HGM (regional) subclass.*

*Because the wetland's ability to export water and materials in a characteristic fashion is to a very large degree dependent the condition of its water source, as with the Water Distribution variable, **in most cases the Water Source variable score will define the upper limit Water Outflow score**.*

Scoring rules:

1. Identify impacts to the natural outflow of water from the AA and catalog them in the stressor table.

2.Considering all of the stressors identified, assign an overall variable score using the scoring guidelines. Take in to account the cumulative effect of stressors on the wetland's ability to export water and water-borne materials. In most cases the Water Source variable will set the upper limit for the Water Outflow score.

✔	Stressors	Comments/description
	Alteration of Water Source	
	Ditches	
	Dikes/Levees	
	Road Grades	
	Culverts	
	Diversions	
	Constrictions	
	Channel Incision/Entrenchment	
	Hardened/Engineered Channel	
	Artificial Stream Banks	
	Weirs	
	Confined Bridge Openings	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stressors have little to no effect on the magnitude, timing or hydrodynamics of the AA water outflow regime.
<0.9 - 0.8	***B*** *Highly Functioning*	High- or low-water outflows are mildly to moderately affected, but at intermediate ("normal") levels flow continues essentially unaltered in quantity or character.
<0.8 - 0.7	***C*** *Functioning*	High- or low-water outflows are moderately affected, mild alteration of intermediate level outflow occurs; or hydrodynamics moderately affected.
<0.7 - 0.6	***D*** *Functioning Impaired*	Outflow at all stages is moderately to highly impaired resulting in persistent flooding of portions of the AA or unnatural drainage; or outflow hydrodynamics severely disrupted.
<0.6	***F*** *Non-functioning*	The natural outflow regime is profoundly impaired. Down-gradient hydrologic connection severed or nearly so. Alterations may cause widespread unnatural persistent flooding or dewatering of the wetland system.

Variable 5 Score [ ]

Variable 6: Geomorphology

This variable is a measure of the degree to which the geomorphic setting has been altered within the AA. Changes to the surface configuration and natural topography constitute stressors. Such stressors may be observed in the form of fill, excavation, dikes, sedimentation due to absence of flushing floods, etc. In riverine systems, geomorphic changes to the stream channel should be considered if the channel is within the AA (i.e, small is size). Alterations may involve the bed and bank (substrate embeddedness or morphological changes), stream instability, and stream channel reconfiguration. Geomorphic changes are usually ultimately manifested as changes to wetland surface hydrology and water relations with vegetation. Geomorphic alterations can also directly affect soil properties, such as near-surface texture, and the wetland chemical environment such as the redox state or nutrient composition in the rooting zone. In rating this variable, ***do not*** *include these resultant effects of geomorphic change; rather focus on the physical impacts* ***within the footprint*** *of the alteration* ***within the AA*** *– For example, the width and depth of a ditch or the size of a levee* ***within the AA*** *would describe the extent of the stressors. The secondary effects of geomorphic change are addressed by other variables. All alterations to geomorphology should be evaluated including small-scale impacts such as pugging, hoof sheer, and sedimentation which*

Scoring Rules:

1. Identify impacts to geomorphological setting and topography within the AA and record them on the stressor checklist.

2.Considering all of the stressors identified, assign an overall variable score using the scoring guidelines.

✔		Stressors	Comments
	General	Dredging/Excavation/Mining	
		Fill, including dikes, road grades, etc	
		Grading	
		Compaction	
		Plowing/Disking	
		Excessive Sedimentation	
		Dumping	
		Hoof Shear/Pugging	
		Aggregate or Mineral Mining	
		Sand Accumulation	
	Channels Only	Channel Instability/Over Widening	
		Excessive Bank Erosion	
		Channelization	
		Reconfigured Stream Channels	
		Artificial Banks/Shoreline	
		Beaver Dam Removal	
		Substrate Embeddedness	
		Lack or Excess of Woody Debris	

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Topography essentially unaltered from the natural state, or alterations appear to have a minimal effect on wetland functioning and condition. Patch or microtopographic complexity may be slightly altered, but native plant communities are still supported.
<0.9 - 0.8	***B*** *Highly Functioning*	Alterations to topography result in small but detectable changes to habitat conditions in some or all of the AA; or more severe impacts exist but affect less than 10% of the AA.
<0.8 - 0.7	***C*** *Functioning*	Changes to AA topography may be pervasive but generally mild to moderate in severity. May include patches of more significant habitat alteration; or more severe alterations affect up to 20 % of the AA.
<0.7 - 0.6	***D*** *Functioning Impaired*	At least one important surface type or landform has been eliminated or created; microtopography has been strongly impacted throughout most or all of the AA; or more severe alterations affect up to 50% of the AA. Evidence that widespread diminishment or alteration of native plant community exist due to physical habitat alterations. Most incidentally created wetland habitat such as that created by roadside ditches and the like would score in this range or lower.
<0.6	***F*** *Non-functioning*	Pervasive geomorphic alterations have caused a fundamental change in site character and functioning, commonly resulting in a conversion to upland or deepwater habitat.

Variable 6 Score

Variable 7: Water and Soil Chemical Environment

This variable concerns the chemical environment of the soil and water media within the AA, including pollutants, water and soil characteristics. The origin of pollutants may be within or outside the AA. Score this variable by listing indicators of chemical stress in the AA. Consider point source and non-point sources of pollution, as well as mechanical or hydrologic changes that alter the chemical environment. Because water quality frequently cannot be inferred directly, the presence of stressors is often identified by the presence of indirect indicators. Five sub-variables are used to describe the Water and Soil Chemical Environment: Nutrient Enrichment/Eutrophication/Oxygen; Sedimentation/Turbidity; Toxic Contamination/pH; Temperature; and Soil Chemistry and Redox Potential. Utilization of web-based data mining tools is highly recommended to help inform and support variable scores.

Scoring rules:

1. Stressors are grouped into sub-variables which have a similar signature or set of causes.
2. Use the indicator list to identify each stressor impacting the chemical environment of the AA.
3. For each sub-variable, determine its score using the scoring guideline table provided on the second page of the scoring sheet. Scoring sub-variables is carried out in exactly the same way as normal variable scoring.
 -If the AA is part of a water body that is recognized as impaired or recommended for TMDL development for one of the factors, then score that sub-variable 0.65 or lower.
4. Transcribe sub-variable scores to the following variable scoring page and compute the sum.
5. The lowest sub-variable score sets the letter grade range. The composite of sub-variables influences the score within that range.

Sub-variable	Stressor Indicator	✔	Comments	Sub-variable Score
SV 7.1 Nutrient Enrichment/ Eutrophication/ Oxygen (D.O.)	Livestock			
	Agricultural Runoff			
	Septic/Sewage			
	Excessive Algae or Aquatic Veg.			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.2 Sedimentation/ Turbidity	Excessive Erosion			
	Excessive Deposition			
	Fine Sediment Plumes			
	Agricultural Runoff			
	Excessive Turbidity			
	Nearby Construction Site			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.3 Toxic contamination/ pH	Recent Chemical Spills			
	Nearby Industrial Sites			
	Road Drainage/Runoff			
	Livestock			
	Agricultural Runoff			
	Storm Water Runoff			
	Fish/Wildlife Impacts			
	Vegetation Impacts			
	Cumulative Watershed NPS			
	Acid Mine Drainage			
	Point Source Discharge			
	CDPHE Impairment/TMDL List			
	Metal staining on rocks and veg.			
SV 7.4 Temperature	Excessive Temperature Regime			
	Lack of Shading			
	Reservoir/Power Plant Discharge			
	Industrial Discharge			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
SV 7.5 Soil chemistry/ Redox potential	Unnatural Saturation/Desaturation			
	Mechanical Soil Disturbance			
	Dumping/introduced Soil			
	CDPHE Impairment/TMDL List			

Variable 7: Water and Soil Chemical Environment p.2

Sub-variable Scoring Guidelines

Variable Score	Condition Class	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stress indicators not present or trivial.
<0.9 - 0.8	***B*** *Highly Functioning*	Stress indicators scarcely present and mild, or otherwise not occurring in more than 10% of the AA.
<0.8 - 0.7	***C*** *Functioning*	Stress indicators present at mild to moderate levels, or otherwise not occurring in more than 33% of the AA.
<0.7 - 0.6	***D*** *Functioning Impaired*	Stress indicators present at moderate to high levels, or otherwise not occurring in more than 66% of the AA
<0.6	***F*** *Non-functioning*	Stress indicators strongly evident throughout the AA at levels which apparently alter the fundamental chemical environment of the wetland system

Input each sub-variable score from p. 1 of the V7 data form and calculate the sum.

Nutrient enrichment/ Eutrophication/ Oxygen (D.O.)		Sedimentation/ Turbidity		Toxic contamination/ pH		Temperature		Soil chemistry/ Redox potential		Sum of Sub-variable Scores
	+		+		+		+		=	

Use the table to score the Chemical Environment Variable circling the applicable scoring rules.

Variable Score	Condition Grade	Scoring Rules		
		Single Factor		**Composite Score**
1.0 - 0.9	***A*** *Reference Standard*	No single factor scores < 0.9		The factor scores sum > 4.5
<0.9 - 0.8	***B*** *Highly Functioning*	Any single factor scores ≥ 0.8 but < 0.9		The factor scores sum >4.0 but ≤4.5
<0.8 - 0.7	***C*** *Functioning*	Any single factor scores ≥ 7.0 but < 0.8		The factor scores sum >3.5 but ≤ 4.0
<0.7 - 0.6	***D*** *Functioning Impaired*	Any single factor scores ≥ 0.6 but <0.7		The factor scores sum >3.0 but ≤3.5
< 0.6	***F*** *Non-functioning*	Any single factor scores < 0.6		The factor scores sum < 3.0

Variable 7 Score [ ]

Variable 8: Vegetation Structure and Complexity

This variable is a measure of the condition of the wetland's vegetation relative to its native state. It particularly focuses on the wetland's ability to perform higher-order functions such as support of wildlife populations, and influence primary functions such as flood-flow attenuation, channel stabilization and sediment retention. Score this variable by listing stressors that have affected the structure, diversity, composition and cover of each vegetation stratum that would normally be present in the HGM (regional) subclass being assessed. For this variable, stressor severity is a measure of how much each vegetation stratum differs functionally from its natural condition or from the natural range of variability exhibited the HGM subclass or regional subclass. This variable has four sub-variables, each corresponding to a stratum of vegetation: Tree Canopy; Shrub Layer; Herbaceous Layer; and Aquatics.

Rules for Scoring:

1. Determine the number and types of vegetation layers present within the AA. Make a judgment as to whether additional layers were historically present using direct evidence such as stumps, root wads or historical photographs. Indirect evidence such as local knowledge and expert opinion can also be used in this determination.

2. Do not score vegetation layers that would not normally be present in the wetland type being assessed.

3. Estimate and record the current coverage of each vegetation layer at the top of the table.

4. Record the Reference Standard or expected percent coverage of each vegetation layer to create the sub-variable weighting factor. The condition of predominant vegetation layers has a greater influence on the variable score than do minor components.

5. Enter the percent cover values as decimals in the row of the stressor table labeled " Reference/expected Percent Cover of Layer". Note, percentages will often sum to more than 100% (1.0).

6. Determine the severity of stressors acting on each individual canopy layers, indicating their presence with checks in the appropriate boxes of the stressor table. The difference between the expected and observed stratum coverages is one measure of stratum alteration.

7. Determine the sub-variable score for each valid vegetation layer using the scoring guidelines on the second page of the scoring sheet. Enter each sub-variable score in the appropriate cell of the row labeled "Veg. Layer Sub-variable Score". If a stratum has been wholly removed score it as 0.5.

8. Multiply each layer's *Reference Percent Cover of Layer* score by its Veg. Layer Sub-variable scores and enter the products in the labled cells. These are the weighted sub-variable scores. Individually sum the *Reference Percent Cover of Layer* and *Weighted Sub-variables scores.*

9. Divide the sum of "Veg. Layer Sub-variable Scores" by the total coverage of all layers scored. This product is the Variable 8 score. Enter this number in the labeled box at the bottom of this page.

	Vegetation Layers				
Current % Coverage of Layer					
Stressor	**Tree**	**Shrub**	**Herb**	**Aquatic**	**Comments**
Noxious Weeds					
Exotic/Invasive spp.					
Tree Harvest					
Brush Cutting/Shrub Removal					
Livestock Grazing					
Excessive Herbivory					
Mowing/Haying					
Herbicide					
Loss of Zonation/Homogenization					
Dewatering					
Over Saturation					
DIFFERENCE BETWEEN CURRENT COVERAGE AND REFERENCE/EXPECTED					

	Tree		Shrub		Herb		Aquatic		Total
Reference/Expected % Cover of Layer		+		+		+		=	
	x		x		x		x		÷
Veg. Layer Sub-variable Score									
	=		=		=		=		
Weighted Sub-variable Score		+		+		+		=	

See sub-variable scoring guidelines on following page

Variable 8 Score [ ]

Variable 8: Vegetation Structure and Complexity p. 2

Sub-variable 8 Scoring Guidelines:

Based on the list of stressors identified above, rate the severity of their cumulative effect on vegetation structure and complexity for each vegetation layer.

Variable Score	Condition Grade	Scoring Guidelines
1.0 - 0.9	***A*** *Reference Standard*	Stressors not present or with an intensity low enough as to not detectably affect the structure, diversity or composition of the vegetation layer.
<0.9 - 0.8	***B*** *Highly Functioning*	Stressors present at intensity levels sufficient to cause detectable, but minor, changes in layer composition. Stress related change should generally be less than 10% for any given attribute (e.g., 10% cover of invasive, 10% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as high as 33% for a given attribute if stressors are confined to patches comprising less than 10% of the wetland.
<0.8 - 0.7	***C*** *Functioning*	Stressors present with enough intensity to cause significant changes in the character of vegetation, including alteration of layer coverage, structural complexity and species composition. The vegetation layer retains its essential character though. AA's with a high proportion of non-native grasses will commonly fall in this class. Stress related change should generally be less than 33% for any given attribute (e.g., 33% cover of invasive, 33% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as much as 66% for a given attribute if stressors are confined to patches comprising less than 25% of the wetland.
<0.7 - 0.6	***D*** *Functioning Impaired*	Stressor intensity severe enough to cause profound changes to the fundamental character of the vegetation layer. Stress-related change should generally be less than 66% for any given attribute (e.g., 66% cover of invasive, 66% reduction in richness or cover) if the stressor is evenly distributed throughout the wetland. Stress related change could be as much as 80% of a given attribute if stressors are confined to patches comprising less than 50% of the wetland.
<0.6	***F*** *Non-functioning*	Vegetation layer has been completely removed or altered to the extent that is no longer comparable to the natural structure, diversity and composition.

FACWet Score Card

Scoring Procedure:

1. Transcribe variable scores from each variable data sheet to the corresponding cell in the variable score table.
2. In each Functional Capacity Index (FCI) equation, enter the corresponding variable scores in the equation cells. Do not enter values in the crossed cells lacking labels.
3. Add the variable scores to calculate the total functional points achieved for each function.
4. Divide the total functional points achieved by the functional points possible. The typical number of total points possible is provided, however, if a variable is added or subtracted to FCI equation the total possible points must be adjusted
5. Calculate the Composite FCI, by adding the FCI scores and dividing by the total number of functions scored (usually 7).
6. If scoring is done directly in the Excel spreadsheet, all values will be transferred and calculated automatically.

VARIABLE SCORE TABLE

Buffer & Landscape Context	**Variable 1:**	**Habitat Connectivity (Connect)**	
	Variable 2:	**Contributing Area (CA)**	
Hydrology	**Variable 3:**	**Water Source (Source)**	
	Variable 4:	**Water Distribution (Dist)**	
	Variable 5:	**Water Outflow (Outflow)**	
Abiotic and Biotic Habitat	**Variable 6:**	**Geomorphology (Geom)**	
	Variable 7:	**Chemical Environment (Chem)**	
	Variable 8:	**Vegetation Structure and Complexity (Veg)**	

Functional Capacity Indices

Function	Equation	Total Functional Points	÷	FCI
Function 1 -- Support of Characteristic Wildlife Habitat	$V1_{connect}$ + $V2_{CA}$ + (2 x $V8_{veg}$)		÷ 4 =	
Function 2 -- Support of Characteristic Fish/aquatic Habitat	(3 x $V3_{source}$) + (2 x $V4_{dist}$) + (2 x $V5_{outflow}$) + $V6_{geom}$ + $V7_{chem}$		÷ 9 =	
Function 3 -- Flood Attenuation	$V2_{CA}$ + (2 x $V3_{source}$) + (2 x $V4_{dist}$) + (2 x $V5_{outflow}$) + $V6_{geom}$ + $V8_{veg}$		÷ 9 =	
Function 4 -- Short- and Long-term Water Storage	$V3_{source}$ + (2 x $V4_{dist}$) + (2 x $V5_{outflow}$) $V6_{geom}$		÷ 6 =	
Function 5 -- Nutrient/Toxicant Removal	(2 x $V2_{CA}$) + (2 x $V4_{dist}$) + $V6_{geom}$ $V7_{chem}$		÷ 6 =	
Function 6 -- Sediment Retention/Shoreline Stabilization	$V2_{CA}$ + (2 x $V6_{geom}$) + (2 x $V8_{veg}$)		÷ 5 =	
Function 7 -- Production Export/Food Chain Support	$V1_{connect}$ + (2 x $V5_{outflow}$) + $V6_{geom}$ + $V7_{chem}$ + (2 x $V8_{veg}$)		÷ 7 =	

Sum of Individual FCI Scores [ ]

Divide by the Number of Functions Scored **÷ 7**

Composite FCI Score [ ]

Appendix B

Keys and descriptions for Colorado HGM Classes and Subclasses

KEY TO HYDROGEOMORPHIC CLASSES OF COLORADO

1a. Wetland is topographically flat, or nearly so; lacking a defined inlet or outlet; precipitation is the main source of water; hydrodynamics predominately vertical…………………………………………………………………………….**MINERAL SOIL FLAT**

1b. Wetland not as above……….(2)

2a. Wetland is found on the margin of a natural lake or reservoir larger than approximately 10 acres………**LACUSTRINE FRINGE**

2a. Wetland setting other than the above……………………………………………………………………………………………………….(3)

3a. Wetland wholly or partially surrounds a shallow, open water area less than 10 ac. in size. Wetland is **not** located in an active alluvial floodplain, nor is it a beaver pond (these wetlands are classified as Riverine). Wetland is located in an area of closed contour topography and may be hydrologically isolated, have a surface inlet, have a surface outlet, or be a through-flow system (inlet and outlet present). Surface water inflow and outflow may be strongly seasonal……..**DEPRESSIONAL WETLAND**

3B. Wetland not as above……….(4)

4a. Wetland is associated with a channel or channel network and is subject to overbank flooding on the average once every two years, or is supported by the alluvial groundwater system.…………………………………………………………**RIVERINE**

4b. Wetland is not located within the 100-year floodplain of a perennial stream, **or** if it is within the 100-year floodplain, wetland is located at the base of a fluvial terrace. Groundwater discharge dominated the water source. Wetland may be on steeply sloping or relatively flat terrain – as little as 1% in the mountain parks…….**SLOPE**

KEY TO HYDROGEOMORPHIC SUBCLASSES OF COLORADO

The keys to Colorado subclasses are reproduced from Karsey et al. 2003, with slight modifications. The user is cautioned that other logical subclasses may exist in Colorado. Users may describe additional subclasses if necessary. *The Mineral Soil Flats and Lacustrine Fringe Class are not further divided at the subclass level, so subclass keys are not provided.*

Key to Riverine Subclasses

1a. Associated stream is 1st or 2nd order, typically occurs at mid-to high elevations but can also be in the plains …….(2)

1b. Associated stream is 3rd order or higher, typically occurs at lower elevation in the foothills, plains or plateaus……. (3)

2a. Stream is typically in the alpine or upper subalpine and has a steep gradient and coarse-textured substrate……… **Riverine subclass 1 (R1)**

2b. Stream is in the subalpine or montane zone, has a moderate gradient and coarse or fine-textured substrate, often dominated by willows…………………………………………………………………………………………………… **Riverine subclass 2 (R2)**

3a. Mid-to-high order streams at montane and lower elevations in the foothills plains or plateaus, often dominated by shrubs or trees…………………………………………………………………………………….**Riverine subclasses 3 and 4 (R3/4)**

3b. Low elevation floodplains with fine-textured substrate, dominated by shrublands, grasslands or deciduous woodlands………**Riverine subclass 5 (R5)**

Key to Depressional Subclasses

1a. Wetland occurs in mid-to-high elevation basins with peat soils or on lake fringes with or without peat soils…… **Depressional subclass 1 (D1)**

1b. Wetland occurs at lower elevations and is either permanently or intermittently flooded ....(2)

2a. Wetland is permanently or semi-permanently flooded, includes pond margins and marshes. ………**Depressional subclasses 2 and 3 (D2/3)**

2b. Wetland is temporarily or intermittently flooded, includes playas and similar precipitation supported wetlands ……………………………………………………………………………………………..**Depressional subclasses 4 and 5 (D4/5)**

Key to Slope Subclasses

1a. Wetland occurs in the montane or foothills zone or on the plains and has a seasonally high water table…… **Slope subclasses 3 and 4 (S3/4)**

1b. Fen or wet meadow in the alpine or subalpine zone, with saturated soils..(2)

2a. Fen (peatland) or wet meadow (mineral soils) on non-calcareous substrate………………………**Slope subclass (S1)**

2b. Extremely rich fen on calcareous substrate, found mainly in South Park……………………………**Slope subclass (S2)**

Table 9. Narrative descriptions of Colorado's HGM classes, with common examples of each and exotic types. Descriptions of the defining characteristics are slightly modified from Brinson et al. (1995).

HGM Class	Defining Characteristics	Common Examples	Common Exotic Types
Riverine	Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. Additional water sources may be interflow or occasional overland flow from adjacent uplands, tributary inflow, and precipitation. When overbank flow occurs, surface flows down the floodplain may dominate hydrodynamics. In the headwaters, riverine wetlands often intergrade with slope or depressional wetlands as the channel (bed) and bank disappear, or they may intergrade with poorly drained flats or uplands. Perennial flow is not required. Riverine wetlands lose surface water via the return of floodwater to the channel after flooding and through surface flow to the channel during rainfall events. They lose subsurface water by discharge to the channel, movement to deeper groundwater (for losing streams), and evapotranspiration. Peat may accumulate in off-channel depressions (oxbows) that have become isolated from riverine processes and subjected to long periods of saturation from groundwater sources.	Cottonwood gallery forest on the plains, headwater streams, beaver complexes (associated with a channel)	Large, old irrigation ditches may develop fluvial features and function as riverine systems
Slope	Slope wetlands are found in association with the discharge of groundwater to the land surface, or at sites with saturated overland flow with no channel formation. They normally occur on sloping land ranging from very gentle (appearing flat) to steep. The predominant source of water is groundwater or interflow discharging to the land surface. Direct precipitation is a secondary contributing source of water. Hydrodynamics are dominated by downslope unidirectional water flow**. Slope wetlands can occur in nearly flat landscapes** if groundwater discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturated subsurface flows, surface flows, and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland. Slope wetlands are distinguished from depression wetlands by the lack of a closed topographic depression, and the predominance of the groundwater/interflow water source. Fens are a common example of slope wetlands.	Fens, seep wetlands, spring wetlands, wet meadows (not associated with channels)	Seeps created by irrigation return flow; wetlands created by irrigation ditch seepage
Depressional	Depressional wetlands occur in topographic depressions (i.e., closed elevation contours) that allow the accumulation of surface water. Depression wetlands may have any combination of inlets and outlets or may be closed basins that lack them completely. The water source may come from one or any combination of the following: precipitation, overland flow, streams, or groundwater/interflow from adjacent uplands. The predominant direction of flow is from the higher elevations toward the center of the depression, but may come from a deep aquifer, or subsurface springs. The predominant hydrodynamics are vertical fluctuations that range from diurnal to seasonal. Depressional wetlands may lose water as evapotranspiration, through intermittent or perennial	Kettle ponds, playas, alpine snowmelt basins, montane ponds	Road side ditches, water fowl ponds, smaller gravel mine pits, most spontaneously formed urban wetlands

HGM Class	Defining Characteristics	Common Examples	Common Exotic Types
	outlets, or as recharge to groundwater.		
Mineral Soil Flat	Mineral Soil Flats Mineral soil flats are most common on interfluves, extensive relic lake bottoms, or large floodplain terraces where the main source of water is precipitation. They receive virtually no groundwater discharge, which distinguishes them from depressions and slopes. Dominant hydrodynamics are vertical fluctuations. Mineral soil flats lose water by evapotranspiration, overland flow, and seepage to underlying groundwater. They are distinguished from flat upland areas by their poor vertical drainage due to impermeable layers (e.g., hardpans), slow lateral drainage, and low hydraulic gradients.	Greasewood flats in San Luis Valley, Salt grass flats of the mountain parks	Storm or industrial runoff-induced wetlands in flat areas.
Lacustrine Fringe	Fringe Lacustrine fringe wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. In some cases, these wetlands consist of a floating mat attached to land. Additional sources of water are precipitation and groundwater discharge, the latter dominating where lacustrine fringe wetlands integrade with uplands or slope wetlands. Surface water flow is bidirectional, usually controlled by water-level fluctuations resulting from wind or seiche. Lacustrine wetlands lose water by flow returning to the lake after flooding and evapotranspiration. Organic matter may accumulate in areas sufficiently protected from shoreline wave erosion. Unimpounded marshes bordering the Great Lakes are an example of lacustrine fringe wetlands.	Montane, subalpine or alpine lake fringe	Reservoir fringe

Table 10. Description of the naturally-occurring HGM subclasses found in Colorado, and examples of Regional subclasses. Subclasses and their descriptions follow the Colorado Natural Heritage Program classification (Karsey et al. 2003), with the exception that a lacustrine fringe subclass is recognized. These wetlands were previously placed in the Depression Class, mainly in the D1 subclass.

HGM Class	HGM Subclass	Characteristics	Examples of Regional Subclasses
Riverine	R1	Steep gradient; low stream order; coarse-textured substrates; found at 7,700 to 12,000 ft. of elevation, but most commonly found in the subalpine zone.	Coniferous Front Range subalpine headwater streams, headwater cars with a channel system
	R2	Moderate gradient; low to mid stream order; coarse- and fine-textured substrates; found between 6,100 to 12,300 ft. of elevation, but most common in the montane to subalpine zones. Beaver pond complexes are a common feature. Shrubs may or may not dominate, but are always present.	Meadow streams of the mountain parks, subalpine beaver pond complex
	R3/R4	Moderate to steep gradient, but steeper than R5; low to mid stream order; moderately- to coarsely-textured substrates, but coarser than R5; found in lower elevation canyons in the foothills and plateaus from approximately 6,000 to 8,000 ft. of elevation. Commonly dominated by tall shrubs and trees.	Streams of the Flatirons, montane conifer forest streams, aspen forest streams, western CO boxelder forest
	R5	Low gradient; high stream order; fine-textured substrate; found at between 9,800 to 4,500 ft. in elevation, but most common below 7,000 ft. Flow is typically perennial, but may be occasionally seasonal. Dominated by shrublands, grasslands and deciduous forests.	Cottonwood gallery forest of plains (permanent or seasonal), desert cottonwood gallery forest, sandbar willow shrubland
Slope	S1/S2	Montane, subalpine or alpine fens and wet meadows between 7,900 and 13,100. Sites may be dominated by herbaceous vegetation, shrubs, coniferous trees or a mixture.	Moderate fens, calcareous fens, swamp forest, headwater carr lacking a channel
	S3/S4	Montane, foothills and plains seeps and springs; mostly below 9,500 ft. of elevation.	Montane spring wetlands, plains seeps
Depression	D1	Upper montane - to alpine basins; very often with peat soils; Permanently to semi-permanently flooded; Snowmelt and groundwater; very commonly associated with morainal land formations in the subalpine zone.	Alpine snow-melt ponds, kettle ponds
	D2/D3	Montane to plains; Ponds with fringe wetlands and marshes; semi-permanently to permanently flooded, with draw-downs being more common than in D1; Includes cattail, bulrush and other tall reed, sedge, grass, or rush dominated wetlands.	Tall-reed marsh, montane ponds
	D4/D5	Subalpine to plains; shallow basins are typical; temporary or intermittently flooded; clay soils usually required to prevent infiltration; hydrology supported by precipitation and hill-slope runoff; forb and graminoid dominated; playas are a typical example.	Eastern plains playas, subalpine playas
Mineral Soil Flat	F1	Subalpine to plains; topographically flat areas in broad extremely shallow depressions or gentle undulations of terrain; occasionally flooded but more often possessing a high water table; precipitation driven; characteristically saline; may intergrade with playas.	Salt-grass flats of San Luis Valley, South Park salt flats
Lacustrine Fringe	L1	Montane to alpine; organic or mineral soils; typically located in broad glacial valleys. Open water habitats are larger than 10 ac. which distinguishes them from depressions. This subclass was included in D1 in CNHP classification (Karsey et al. 2003).	Subalpine lake fringe, alpine lake fringe