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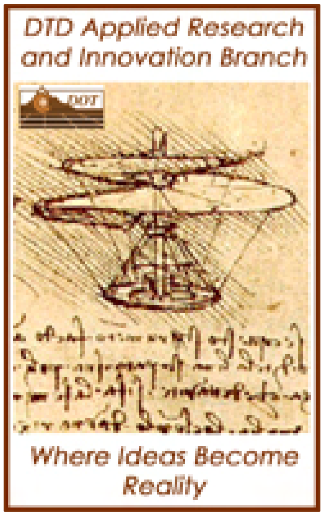

THE FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWet) METHOD – VERSION 1.0

Brad Johnson, Mark Beardsley, and Jessica Doran

February 2009

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16. Abstract

The Functional Assessment of Colorado Wetlands (FACWet) Method is a stressor-based, rapid assessment method developed to address key aspects of CDOT's Clean Water Act permitting needs. FACWet is a collaborative effort involving the Colorado Department of Transportation, Colorado State University, EcoMetrics, LLC, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency. This new mode of wetland assessment is designed to address the regulatory community's need for functional assessment in administration of the Clean Water Act in Colorado, including pre-project assessment, mitigation planning, and post-project evaluation

This document includes the user guide and data sheets for Version 1.0 of the FACWet. This is the current working version of the methodology, but FACWet development is ongoing and the method will be iteratively updated and revised. Updates will be posted on the FACWet website: http://rydberg.biology.colostate.edu/FACWet/

Implementation:

FACWet should be used during the planning stage of projects that may impact wetlands or riparian habitats. Application of the FACWet Method may be required by federal regulatory agencies as part of the Clean Water Act permitting process. It is recommended that staff involved in environmental permitting attend a training course.

17. Keywords
Clean Water Act, natural habitats, rivers, riparian zones, environmental permitting, wetlands assessment

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FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWet) METHOD – VERSION 1.0

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Many talented people aided in the production of the FACWet. First and foremost the authors would like to thank the Colorado Department of Transportation for their generous support of this research project. Of the folks involved in the development of the FACWet, a disproportional amount of the burden fell on the shoulders of a few, and the authors would like to give their special thanks. Rebecca Pierce, of CDOT Headquarters, was more than essential to the successful completion of this study. Ms. Pierce 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 flawlessly-executed roles was absolutely critical to the development of this assessment program whose reach extends far beyond CDOT, and involves every level of government. Patricia Martinek was unhesitantly generous with both her time and patience during this study. 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 Scott Franklin, Tim Carey and Matt Montgomery. The authors greatly appreciate their willingness to look open-mindedly at a novel approach to an old problem. Jill Minter and Rich Sumner of the U.S. Environmental Protection Agency, as always, provided critical insight into the "big" assessment picture and guidance on how to make this piece fit into the larger puzzle. 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 do 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.

FACWet Study Team

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EXECUTIVE SUMMARY

The Clean Water Act (CWA) requires that impacts to wetlands be avoided or minimized to the extent practicable. If impacts to wetlands are unavoidable, compensatory mitigation of those losses is required under Section 404. In particular the CWA calls for impact mitigation to compensate for the wetland functions lost through a federally-permitted action. This requirement necessitates a means of assessing and denominating wetland functioning. To this point, the State of Colorado had no such approach, and provisional methodologies had to be borrowed from other states. The applicability of such methods in Colorado's unique ecological and regulatory environments was uncertain.

In their normal operation, the 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 of Colorado'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.

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. Based on current trends in assessment technology, FACWet was structured around a stressor-based approach to rapid assessment. After preliminary development, the basic approach of the FACWet was tested at number of wetland sites, including 14 sites at which quantitative reference data had been previously collected. The FACWet was revised based on these test results. The methodology was then presented to the U.S. Army Corps of Engineers (US ACE) for their consideration. The US ACE review highlighted a number of areas where the method could be modified to better fit the requirements of Colorado's Clean Water Act Permitting program.

After revision, the method was again reviewed and provisionally accepted by regulatory agencies including US ACE. At that point, the finalization and implementation phase of the FACWet began. To alert other environmental professionals of the existence of this new methodology, the approach was presented at a number of scientific and professional meetings. In the summer of 2008, three training workshops were held for CDOT and federal regulatory staff, as well as consultants who perform work for CDOT. A "beta" release of the user guide and datasheets was used during these workshops in order to test their usability among a varied audience and garner feedback from the participants themselves. Following the workshops, the FACWet was once again revised and presented to the study panel for final review. Version 1.0 of the FACWet included in this document is the result of that final round of revision and review.

Implementation Statement

The FACWet has entered into the implementation phase. It is recommended that FACWet be used by CDOT whenever information on wetland functioning is needed. Moreover, FACWet evaluation may be required by federal regulatory agencies as part of CWA Section 404 permit applications.

It is recommended that the FACWet user training program be continued on an annual basis. As part of the implementation phase, it is recommended that the FACWet approach be validated and scoring guidelines calibrated using independent quantitative data. It is, moreover, suggested that FACWet be utilized during statewide wetland mapping and assessment initiatives whenever possible.

This executive summary concludes the technical reporting section of this document. What follows is the FACWet User Manual Version 1.0, including datasheets which are included 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 cautioned to consult the FACWet webpage to ensure that the most current version will be used. http://rydberg.biology.colostate.edu/FACWet/

Colorado Department of Transportation's

FUNCTIONAL ASSESSMENT OF COLORADO WETLANDS (FACWet) METHOD

USER MANUAL – Version 1.0

February 2009

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EcoMetrics, LLC

Introduction to the FACWet User Guide

Welcome to the Functional Assessment of Colorado Wetlands (FACWet) User Guide! This guide provides an overview of the new mode of wetland assessment in Colorado.

This document represents Version 1.0 of the FACWet user guide. It is a descendent of the user guide versions used during the summer 2008 training workshops. The revisions incorporated into this current draft have been based on input from workshop participants and our experiences with the methodology during the first summer of use. To this point, development of the FACWet has focused on creation of its basic structure and approach, and then on testing the method's usability and utility under a variety of circumstances. The next step in FACWet's development is currently underway through technical validation using independent data derived by intensive, quantitative methods and linkage to the primary scientific literature.

As with all assessment procedures, the development of the FACWet is an evolutionary 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 a first version, FACWet is very much in a stage of active development. Users are cautioned that, at this point, scoring guidelines and functional capacity indices have not been validated with independent data. Scoring guidelines should only be viewed as rough approximations which are simply intended to help calibrate scores between evaluators. They are not to be taken in an absolute or literal sense.

FACWet evaluations should be performed by individuals who have attended a training session. Evaluation scores by those who have not received training should be interpreted with reservation.

During this active development period, updates to the user guide will be relatively frequent. Outdated copies of the method should not be used. 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, (970) 490-1388, bjohnson@lamar.colostate.edu.

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Overview

The key points of the FACWet are that it:

- Is a rapid assessment methodology that formalizes an approach to obtain reliable and consistent professional judgment as to the functional condition of wetlands and allied habitats.
- Rates the condition of the assessment area relative to its natural potential by focusing on stressors: human-caused changes to the wetland's physical or biotic environment that alter its capacity to perform native functions and processes.
- Guides the qualitative assessment of nine state variables that characterize the physical and structural condition of the assessment area using the fundamental assumption that if no stressors can be identified, wetland functions are being performed at natural rates and capacities.
- Considers the severity and extent of stressors to gauge the departure of each state variable from its natural condition.
- Uses the state variables of wetland condition to rate the status of seven important wetland functions relative to an expectation from the natural or reference-standard condition.
- Utilizes a flexible assessment area definition that is adaptable to needs of Colorado's diverse wetlands programs.
- Is designed to integrate with and complement other assessment approaches structured along the U.S. Environmental Protection Agency's 1-2-3 assessment hierarchy.
- Is a tool to aid mitigation planning and design, and increase the effectiveness of compensatory mitigation.
- Is easily integrated into landscape survey, watershed planning and regulatory contexts.
- Is consistent with Federal regulatory guidance and policy mandates.

Introduction to the FACWet Approach

FACWet is a forensically-based method of rating the degree of departure between the current and the natural level of wetland functioning. The method is fundamentally an approach to answering the hypothetical question: “In your professional opinion, what is the ecological condition of the assessment wetland?” The method provides the user with 1) a logical framework for making this determination based on the presence of deleterious, anthropogenic alterations (“stressors”); 2) a systematic means of relating the evidence supporting the judgment; 3) scoring guidelines to improve consistency between evaluators; and 4) an algorithm for calculating actual vs. natural functioning based on the status of nine state variables.

At the outcome of an assessment the evaluator is able to make a statement as to the apparent level of functioning present in the wetland relative to its natural state and support this conclusion with a coherent series of reasons. In other words, FACWet leads evaluators through a framework which constructs an argument in support of their professional judgment of the ecological condition of a site. As is appropriate to this level of analysis, no quantitative data are collected during a normal FACWet assessment. Because the result of a FACWet analysis is a professional opinion, any facet of a FACWet evaluation can be corroborated or modified based on the collection of quantitative data, additional information gleaned from the scientific literature, reliable local knowledge, or subject-specific expertise.

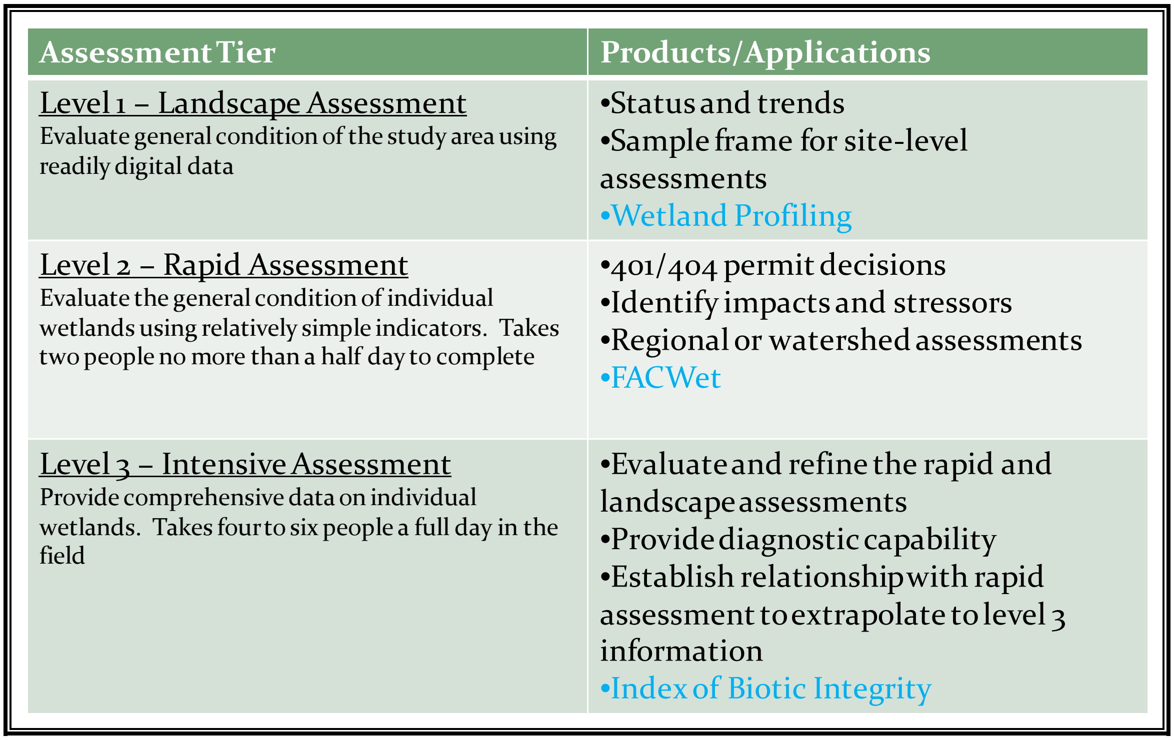
FACWet denominates ecological condition in terms of wetland functioning. Other assessment methods may do this using a different currency, such as biological integrity. That is, other methods build their argument and base their conclusions on different lines of evidence than those used in FACWet. Despite 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.

FACWet evaluates wetland condition by directing the user to consider the effects that stressors 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) using tabular scoring guidelines. An algorithm then relates the degree of state variable alteration to the functions they influence.

The U.S. Environmental Protection Agency (US EPA) has developed a three-tiered hierarchy that structures wetland assessment methodologies (US EPA 2006) (Fig. 1). As a rapid assessment methodology, FACWet is specifically designed to meet the requirements of Level 2 applications. Moreover, being explicitly created to fit within this framework as it has been developed in Colorado, FACWet is compatible with large-scale (“Level 1”) analytical methods such as Hydrogeomorphic Wetland Profiling (Gwinn and Kentula 1999, Johnson 2005), as well as intensive Level 3 methodologies, including the Indices of Biologic Integrity being developed by the Colorado Natural Heritage Program.

The result of FACWet analyses:

- Catalog the stressors impacting an AA.
- Specify which state variable(s) are affected by which specific stressors.
- Rate the relative functional capacity of individual functions and generate a composite score for overall functioning.
- Provide a structure on which to base mitigation planning.
- Facilitate modeling of realistic mitigation goals or best-attainable site condition based on the potential for stressor remediation.
- Provide insights into the functional equivalency of proposed compensatory mitigation.
- Can be used to structure 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 1. 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.).

Structure of the FACWet

Wetland development and functioning stems from the interaction of three primary attributes: 1) Buffer and Landscape Context, 2) hydrology, and 3) Abiotic and Biotic Habitat (Collins et al. 2008) Three state variables per attribute are used to describe the character and condition of the Assessment Area (AA) relative to its natural state (Table1). State variables are then related to the functions over which they have primary control and used to index the capacity of seven critical functions (Table 2).

Table 1. Summary of FACWet attributes and state variables.

Attribute	Variable Number	State Variable Name
Buffer & Landscape Context	**V1**	**Habitat Connectivity - Neighboring Wetland Habitat Loss**
	V2	**Habitat Connectivity - Migration/Dispersal Barriers**
	V3	**Buffer Capacity**
Hydrology	**V4**	**Water Source**
	V5	**Water Distribution**
	V6	**Water Outflow**
Abiotic & Biotic Habitat	**V7**	**Chemical Environment**
	V8	**Geomorphology**
	V9	**Vegetation Structure and Complexity**

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, V3,V9**
2. Support of characteristic fish/aquatic habitat	**V4,V 5,V 6,V 7, V8**
3. Flood attenuation	**V3, V4, V5, V6, V8, V9**
4. Short- and long-term water storage	**V1, V4, V5, V6, V8**
5. Water quality	**V5, V7, V8**
6. Sediment retention/shoreline or bank stabilization	**V3, V8, V9**
7. Production/food web support	**V1, V6, V7, V8, V9**

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 termed **Habitat Connectivity** and is described by two variables, *Neighboring Wetland Habitat Loss* (Variable 1) and *Barriers to Migration and Dispersal* (Variable 2; Fig. 2). Secondly, this attribute concerns the way in which the immediate surroundings help to maintain or impair the AA's ability to perform its characteristic natural functions (Variable 3, *Buffer Condition*).

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 natural processes and ecosystem functions that occur in the watershed.

Wetlands exchange a disproportionate amount of material and energy with the surrounding landscape 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 a variety of plants and animals, wetlands have a disproportionately large influence on the functioning of landscape and ecosystem processes.

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, to a lesser degree, by overland links (Fig 2a).

The FACWet considers two ways in which links to surrounding wetland habitats can be disrupted by defining two habitat connectivity variables: 1) neighboring wetland loss resulting in the removal of potential or pre-existing linkages due to wetland/riparian habitat destruction (Variable 1), and 2) migration/dispersal barriers that disrupt an existing linkage (Variable 2) (Fig. 2b).

The third FACWet variable is buffer capacity. This variable is concerned with the condition of the area immediately surrounding the wetland. Many aspects of wetland functioning can be affected by the degree to which its surrounding area has been altered from its natural state, since they commonly depend on the interactions occurring along the interface of the wetland and neighboring habitats on the landscape.

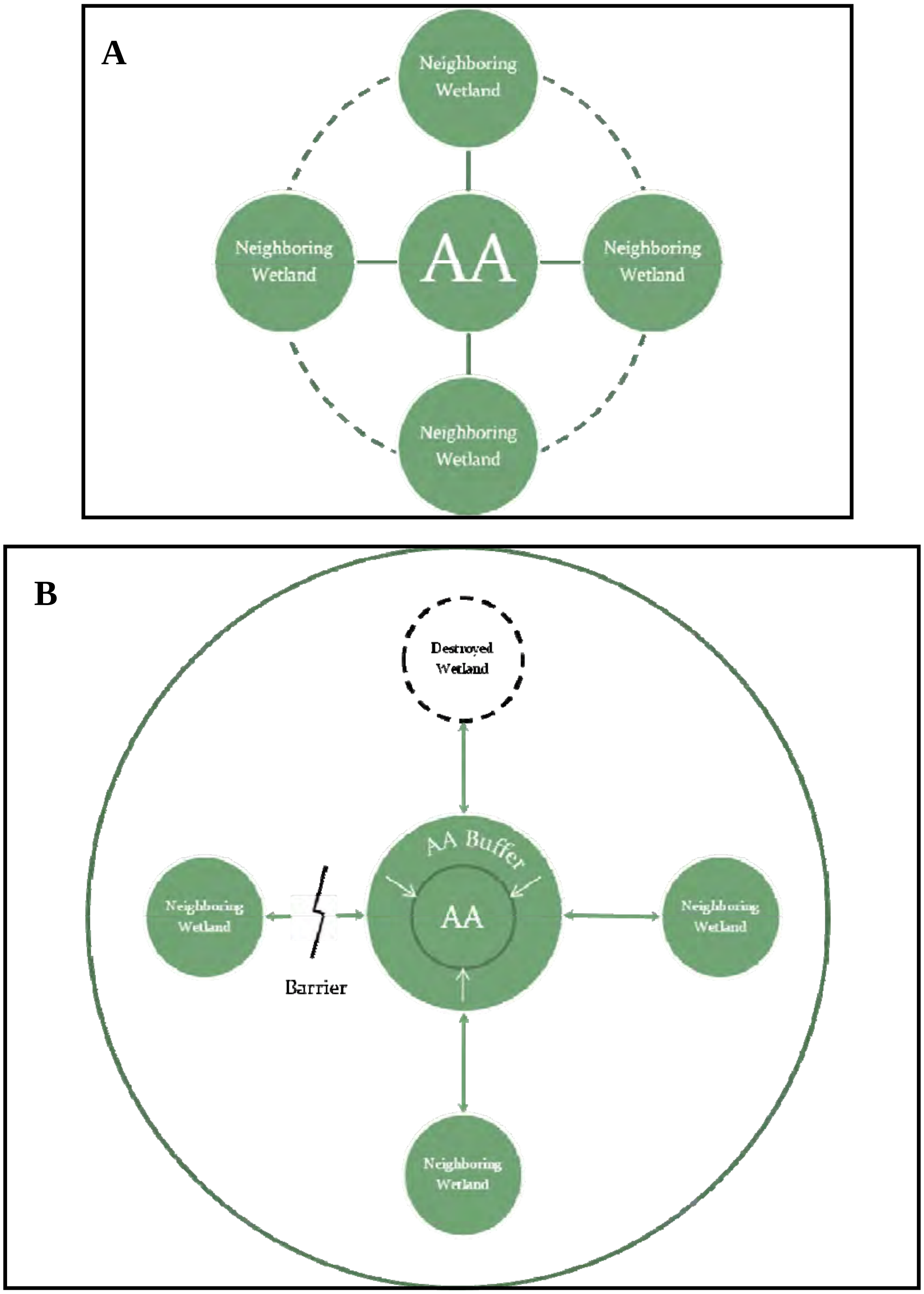


Fig 2. Figure 2a symbolizes the relationship between the AA and neighboring wetland and riparian habitat Solid lines represent strong connections between habitats such as would result from interconnection via riparian corridors. Dotted lines indicate weaker connections such as across upland areas. Figure 2b 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, barriers can disrupt existing connections, and alteration of buffer characteristics can affect the relationship of the wetland to its immediate surroundings.

HYDROLOGY

Almost every unique process attributed to wetlands is driven by the interaction of hydrology and topography. The synthetic effects of these elements control water table behavior, which in turn drives most wetland processes – from nutrient cycling to characteristic wildlife usage. FACWet describes hydrology using three fundamental state variables, water in-flow (i.e., its source, Variable 4), water distribution across the site (Variable 5), and out-flow (Variable 6) (Fig. 3). This allows attention to be focused purely on the characteristics of hydrology rather than a multitude of interactive or resultant effects.

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.

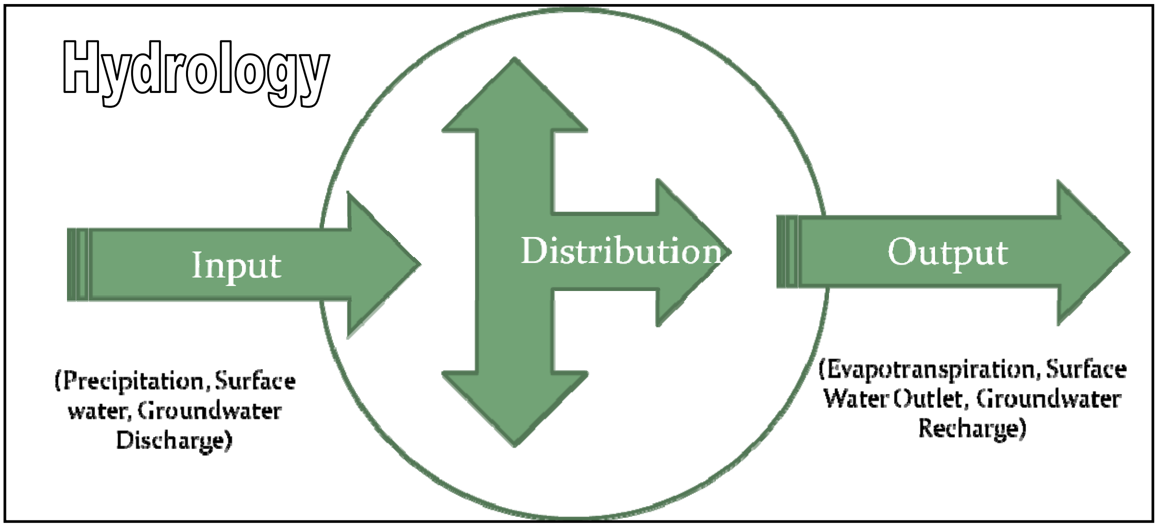
ABIOTIC AND BIOTIC HABITAT

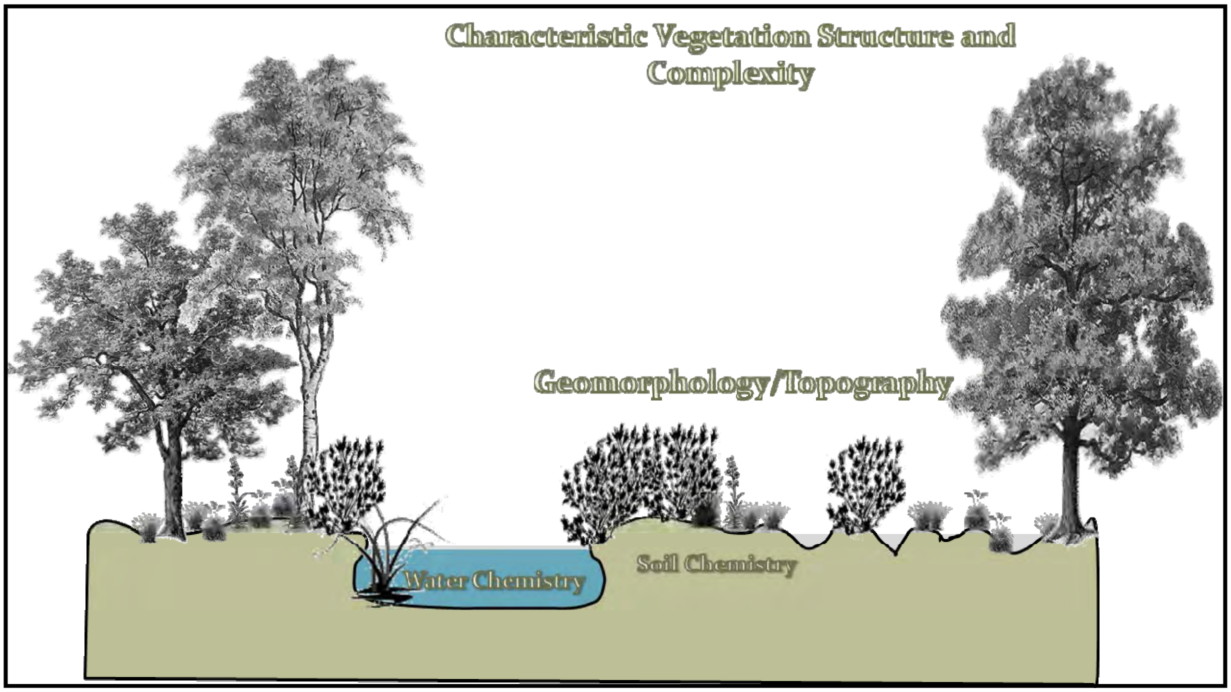
The Abiotic and Biotic Habitat attribute encompasses the morphological, structural, and chemical components of the AA (Fig. 4). The Water and Soil Chemical Environment Variable (Variable 7) addresses man-induced changes to the chemical composition of water in the AA. It also includes alteration of the soil environment which can arise owing to chemical contamination or modification of the redox environment, among other causes. These changes can either result from allocthonous (external to the AA), or autochthonous (within the AA) sources. The Geomorphology Variable (Variable 8) 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 Vegetation Structure and Complexity Variable (Variable 9) considers the synthetic properties of the AA's vegetation.

Vegetation composition is mostly dictated by the eight 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 shoreline stabilization or sediment retention. 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). 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's scores are generated by adding the weighted variable scores and dividing by the total score possible.





Figs. 3 and 4. Figure 3 schematically diagrams the state variables of the Hydrology Attribute. Figure 4 illustrates the relationships between the Abiotic and Biotic Habitat Attribute variables.

Key Concepts of the FACWet

FACWET AS A REFERENCE-BASED STRESSOR ANALYSIS APPROACH

FACWet employs stressor analysis to evaluate the departure of an assessment area (AA) from its natural or reference-standard condition. Assessments are based on the evaluation of impacts to the forcing factors that dictate how a wetland functions. 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 assessment area. The key assumption that forms the basis of FACWet assessments is this: *If the assessment area and its surroundings have not been altered by man, the site is performing its environmental functions at their natural rate and capacity*. 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.

In the FACWet ***stressors*** *are defined as deleterious anthropogenic alterations to a wetland's natural physical, chemical or biological environment – deleterious alterations are those which cause a departure from natural functioning.* It is important to note that not all site alterations are deleterious to wetland functioning. This notion is perhaps best illustrated by the case of wetland restoration wherein site alterations are executed for the expressed purpose of improving functioning.

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 key state variables is solid 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 natural condition. Second, stressor analysis as structured by the FACWet framework allows full advantage to be taken of the hydrogeomorphic scientific paradigm, while 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 estimated. Continuing the riverine example, the evaluator would simply consider how the known changes in stream flow regime, regardless of the specific causation, 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 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 inherently incorporating additional uncertainty in evaluation conclusions, 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. However, FACWet can still be used under such circumstances. First it can be used to identify which state variables (e.g., water quality) about whose ratings questions exist. Second, it can be employed to structure the more rigorous Level 3 investigations or scientific studies. Finally, FACWet structure provides a useful format in which to relate and give context to quantitative findings.

INFERENCE AND APPLICATION OF REFERENCE STANDARDS IN THE FACWET

Implicit or explicit in any evaluation of functioning, quality, condition, health or relative value is a comparison to some standard. In FACWet the benchmark for comparison is called the **Reference Standard.** The reference standard is intended to exemplify the functionality of the target habitat in its native condition. Project success criteria or design practices that are widely-accepted as ecologically-sound may also be used as reference standards in certain cases, as explained below.

The concept of the reference standard is a cornerstone of ecological assessment, and this is true in FACWet evaluations as well. In FACWet the evaluator is asked to infer the natural character of the wetland to be assessed; then based on observed conditions, to rate the degree of departure between the AAs natural and current status on a scale that parallels the academic grading scale. To help facilitate interpretation of condition and tie physical observations to their functional ramifications, wetland condition is parsed into nine state variables that exert primary control over wetland functioning.

The comparison of natural and current conditions is based on the evaluator's interpretation of the site and best professional judgment. FACWet is designed to guide this judgment by directing the evaluator's attention to the critical components (state variables) of the wetland and the stressors acting on them. Identifying stressors aids the evaluator in specifying the pressures that drive the habitat away from reference condition. In other words, FACWet helps the evaluator discern and describe "what's wrong" with a wetland, and what the functional ramifications of that impairment are.

Inference of the reference standard for evaluation can be aided by examination of areas of unimpacted habitat outside the AA boundary, knowledge of an exemplary representative of the same type of habitat located elsewhere in the ecoregion, consultation with local experts or survey of the scientific literature. Ultimately, the FACWet reference standard is a best professional judgment as to the form and function of the AA prior to any anthropogenic alteration.

Thus in order to complete a meaningful FACWet assessment, the evaluator must be familiar enough with the natural characteristics of a habitat type to be able to detect deleterious alterations and, in general terms, judge their probable effects.

FACWet requires the evaluator to infer a site's natural condition to the best of their ability. At times the natural condition of one or more state variables may be difficult to ascertain with certainty. This is where stressor analysis and the method's assumptions play a key role. If there is no direct or circumstantial evidence of anthropogenic alteration, state variables are assumed to be in or near reference standard condition. For example, if no fill or excavation is detectable within an AA, the Geomorphology state variable would be assumed to be at or near reference standard condition, even if its exact natural form of the site is not known for certain.

The FACWet's inferential reference standard is a powerful concept. With it, an AA's reference standard can be formulated rapidly, with no need for prior characterization of a nebulous population of reference wetlands – which themselves may or may not be directly comparable to the target AA. The inferential reference standard allows a *de facto* comparison of the entity to itself (in its inferred pristine condition), which is the most desirable comparison to make in any analytical situation (Fig. 5). While some error will be incorporated in inferring an AA's reference standard, this error level is probably less than the error associated with modeling reference standard conditions across variable reference wetland populations. As always in the FACWet, if aspects of the AA's natural condition are not discernable and precise knowledge is critical, then more intensive, quantitative, Level 3 methods can be employed to remove uncertainties.

INFERENCE OF THE REFERENCE STANDARD UNDER COMMON ASSESSMENT SCENARIOS

Pre-project Assessment

Pre-project (or ambient) assessment is evaluation of an AA prior to a regulated activity or the evaluation of a site as part of a natural resource survey. If there are no detectable impacts to the site or surrounding landscape, the AA represents the reference standard. That is, it is assumed that the AA is performing all of its natural functions at their natural rates and capacities, and thus it would obtain a perfect score. Evaluations of such sites provide baseline information to agencies and individuals, and may serve as the basis of comparison for future evaluations of the site or similar types of habitats. However, most potential AAs have been influenced by the activities of man. That is, some stressors will already be present that cause a decrease in functionality of the AA. Therefore, most AAs will not score as high as the perfect reference standard.

The natural condition of the AA must be inferred from the evidence available at or nearby the site, or less frequently from information available in historical documents. If portions of the landscape or habitat in which the AA is sited have been spared significant alteration, examination of those areas can greatly improve inference of reference condition (Fig. 6).

Post-Project Assessment

Post-project assessment occurs on sites to evaluate the change in wetland function resulting from some specific activity. FACWet will commonly be used to assess

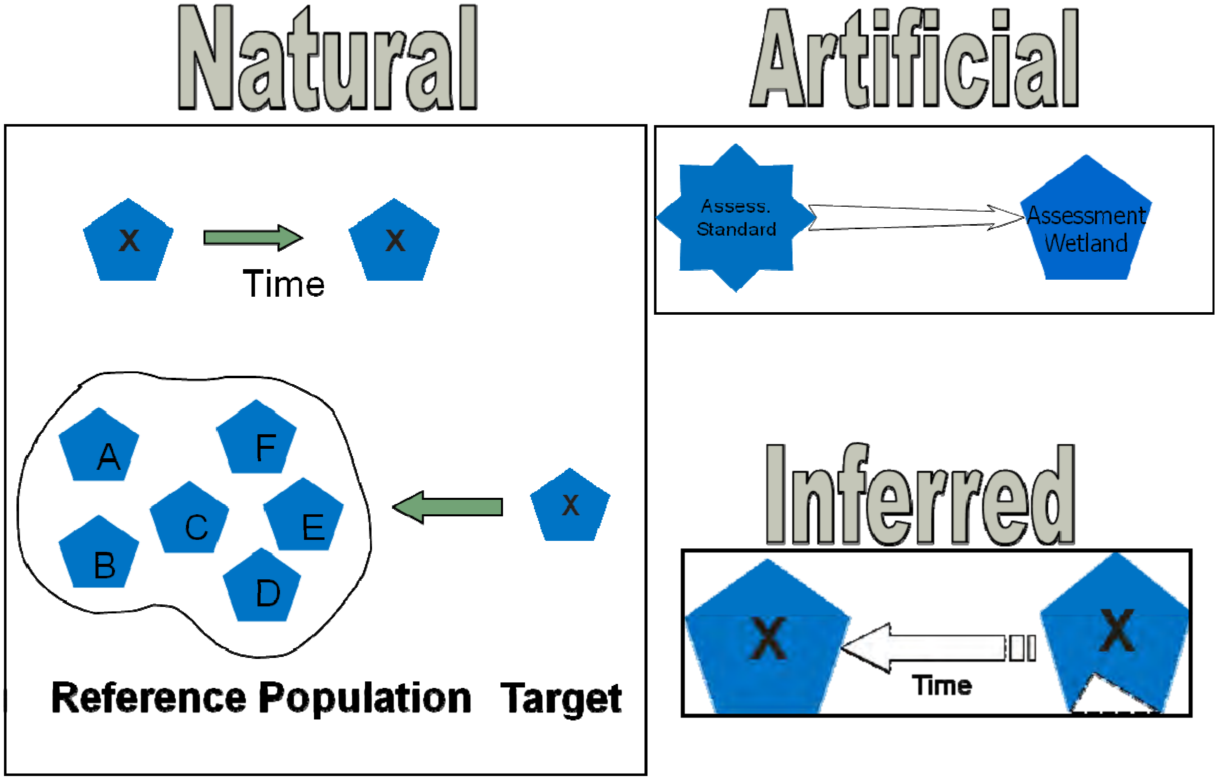


Figure 5. Schematic representation of various approaches to formulating reference conditions in wetland assessment. There are two basic types of “natural” reference. In the first, the same entity is examined through time to characterize changes to the system. This is the most accurate way of evaluating change in a wetland, but it is rarely feasible. In the second example, The characteristics of a target wetland are compared to those of a reference population of the same type of wetland. Such a comparison is analogous to a space-for-time substitution strategy that is often applied in ecology. While powerful and practically applicable, this strategy is data intensive and requires a protracted development period. Moreover, individuals in the reference population may or may not be truly comparable to the target wetland on all criteria.

Artificial references compare the characteristics of the assessment wetland to some arbitrary or societally valuable standard. The absolute surface water holding capacity or number of rare species are common examples of artificial reference standards, when wetlands that have more of either are rated more highly. Such approaches are not appropriate for condition assessments, although they may have other valuable applications.

In FACWet an inferred reference standard is used. FACWet focuses on evaluating the way in which the assessment wetland has been changed through anthropogenic alterations (“Stressors”). In this geometric analogy, the missing portion of the pentagon, represents the site changes indicated by the presence of stressors. In FACWet, condition is based on the amount of deleterious alteration the site has been subjected to as indicated by the presence of stressors.

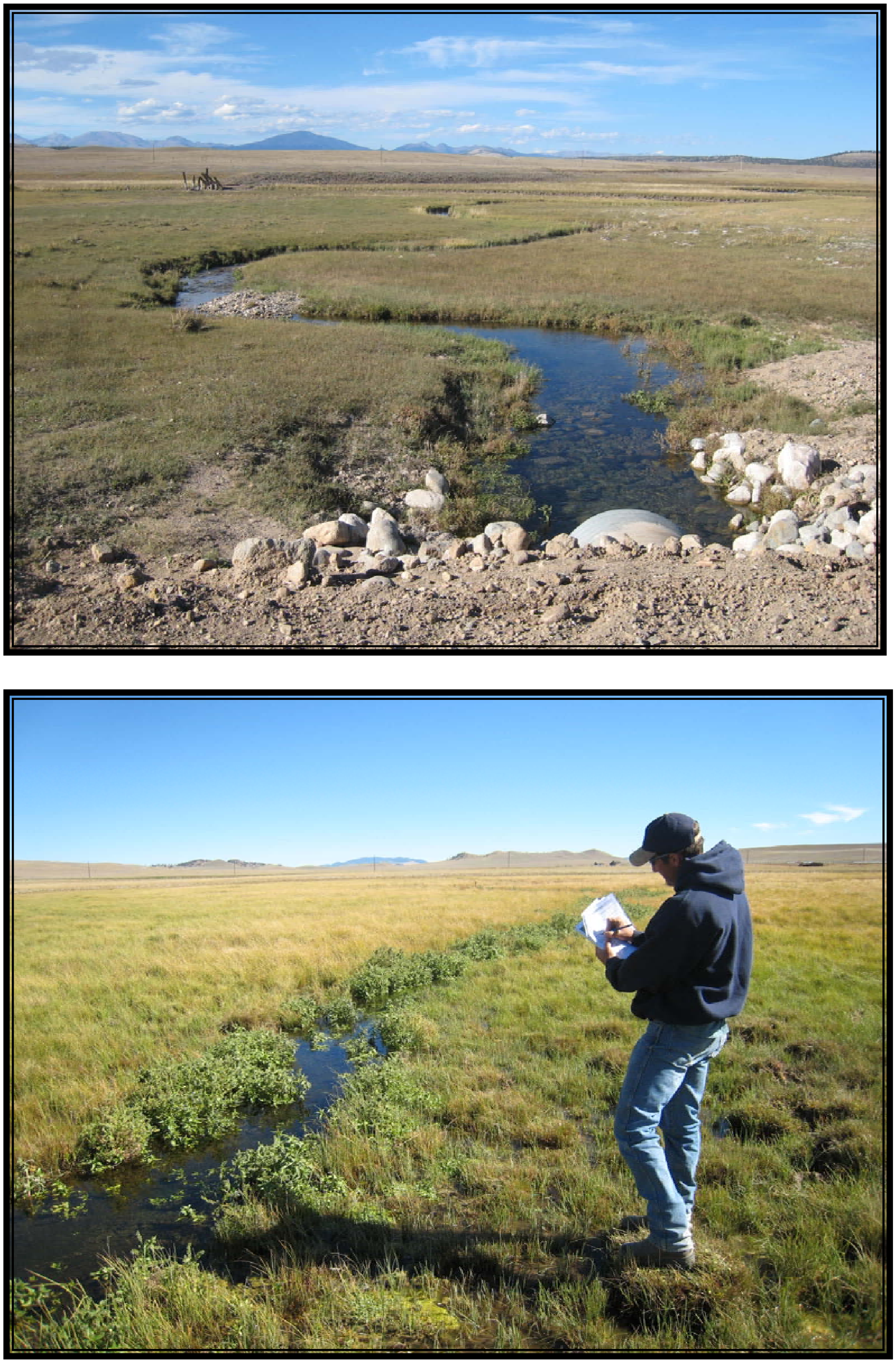


Fig. 6. The upper pane shows a hypothetical AA. Flow direction goes from the foreground to the background. This site may have been affected by stressors such as the culverted road crossing. To infer reference conditions, the segment of the wetland that is up-gradient of the road is examined.

negative impacts that a project has on an AA. Positive impacts may also be assessed by considering the effects of restoration, enhancement or creation of habitat. Each situation is considered below.

Impacts to Existing Habitat, and Habitat Restoration or Enhancement

The same approach to reference standard assignment is used under these scenarios as in pre-project assessment. Namely, the AA in its inferred natural condition is used as the basis of comparison to rate current functioning. The key point here is that comparison is made to inferred natural condition of the habitat, ***regardless of project goals***. In this regard, it is important to recognize that many projects whose goals may be in step with the programmatic mission of government agencies or other entities, and which may have significant societal value, in fact, alter the fundamental natural characteristics of the habitat, and thus are considered ecological stressors in the context of FACWet. Creation of wildlife habitat ponds in terrestrial wetland settings is probably the most prevalent example of this. Wetlands created for water quality improvement is another common case. Although sometimes labeled as habitat “**restoration**” or “**enhancement**”, such actions to do not fit the definition of these terms as related in USEPA/USACE 2008, and as defined in the FACWet assessment. This is largely because such projects maximize the capacity of a small number of functions (e.g., wildlife habitat or surface water storage) at the expense of a diversity of natural functions (e.g., water quality enhancement, maintenance of stream base-flow, sediment transport, plant species habitat, etc.), which can cumulatively cause negative effects at the watershed level (Bedford 1996, Johnson 2005). Thus, projects that unnaturally maximize a small number of functions will tend to score poorly in terms of their compensatory mitigation value despite other potential societal values.

In-kind Wetland Creation for Compensatory Mitigation

The reference standard for in-kind wetland creation for compensatory mitigation (in-kind creation) is the natural condition of the habitat impacted by the permitted project. A pre-project assessment of the impacted area is extremely valuable for formulating the character of the reference standard. If no such information is available, an additional burden is placed on the evaluator in having to define the reference standard. Three primary lines of evidence can be used to formulate the characteristics of the reference standard when a pre-project assessment of the impact site is not available.

1. Adjacent natural habitat – Wetland creation is often used to expand existing habitat. In such cases, the adjacent habitat is used to help conceptualize the target form and function of the AA habitat. Even when adjacent habitat is in less than pristine condition, consideration of it can inform the evaluator as to the type of native habitat that is involved (Fig. 7).

2. Permit Success Criteria – Success criteria should be included with mitigation planning documents. If mitigation was designed to be in-kind, then success criteria should describe the site conditions deemed necessary to induce proper functioning. Success criteria based on previous FACWet analyses or more quantitative studies will be most valuable in this regard.

3. Knowledge of Similar Systems -- If no other evidence is available, the evaluator must use their knowledge of the local landscape, the perceived type of habitat that was impacted and therefore the goal of the creation effort,

the desirable characteristics of wetlands, and generally sound ecological design practices.

Out-of-Kind Wetland Creation for Compensatory Mitigation and Voluntary Creation

If the goal of out-of-kind wetland creation for compensatory mitigation (out-of-kind creation) or voluntary habitat creation is production of a wetland type that is naturally found in the ecoregion, the reference standard is formulated as for in-kind creation. New mitigation guidelines (US EPA/USACE 2008) recognize the potential value of out-of-kind mitigation in certain situations, such as when placing wetland mitigation in the landscape context. Thus out-of-kind creation projects should not be down-graded by comparison to the impacted habitat. They must be rated relative to the agreed-upon goals of the mitigation plan.

Commonly, out-of-kind creation or a voluntary habitat creation projects result in construction of an “exotic” wetland type. **Exotic wetlands** are habitats that do not naturally occur in the ecoregion; thus, there is no natural basis of comparison for these sites. Guidelines for dealing with such situations are detailed in the following section.

URBAN AND EXOTIC WETLANDS

Exotic wetlands by definition have no *true* natural analog, however, they may resemble systems found in other ecoregions. 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. 8). In these cases, the created systems should be rated with reference to the typical characteristics of the broad type of natural wetland they are intended to imitate.

In wholly novel systems, ones that not only do not occur in the ecoregion but do not fit neatly into any natural wetland classification (Fig. 9), evaluators are directed to rate the state variables relative to those attributes generally accepted to be characteristic and desirable of wetlands, and indicative of ecological sustainability, and good health (Mitsch and Gosselink 2007)(Table 1).

Essentially, 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, the level of active maintenance required to perpetuate wetland characteristics etc. (NRC 2001) (Table 1). Whether or not such mitigation truly compensates for wetland losses must be decided by the regulatory agencies involved. Since voluntary projects are not completed to compensate for an actual loss of wetland functions, they are seen as a positive addition to the landscape despite their inherent artificiality and potentially low rating in overall functionality.

Urban wetlands are special cases of exotics. In instances where a site historically held a wetland, the urban habitat tends to be grossly modified. Otherwise, in urban settings, wetlands commonly form as a bi-product of the urban or commercial environment in which they are sited. Depressions and channels receiving runoff from impervious surfaces are prevalent examples of such wetlands. Many of these sites are “volunteers” – that is, they did not form by design – or creation of wetland habitat was not the goal of the construction. Since these wetlands were not designed according to practices of sound-ecological design, most will lack the traits generally accepted as being desirable in wetlands and which support natural and sustainable wetland functioning. As a result of these factors, urban wetlands will commonly score poorly in the FACWet (≤ 0.7).

Table 3. 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, 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

Despite potentially low functional ratings, it is emphasized that urban wetlands are nonetheless important components of the modern landscape, and thus can be disproportionately valuable. To understand this it is important to discern between relative and absolute measures of wetland functioning. For instance, an 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.10). Despite the importance of this wetland for the function of nutrient retention/conversion, its overall condition would no doubt suffer under such a scenario. In this hypothetical, the rate of nutrient retention and conversion may not be sustainable owing to a limited retention capacity. The additional nutrients would likely cause undesirable shifts in species composition by favoring aggressive invasives and 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 almost wholly situation dependent. It measures functioning relative to the wetland's natural levels or to a natural analog, in the case of some exotic wetlands. 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.

In terms of planning and designing compensatory mitigation for impacts to such sites, FACWet can provide valuable insights into the best attainable condition for a site given the constraints of the local setting. This insight can provide useful guidance toward developing realistic, attainable mitigation goals. That is, owing to unalterable changes to character of state variables such as water source or adjacent 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. 11). 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.

THE 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, an evaluator should be able to complete the field portion of a FACWet evaluation in less than two hours. With two hours of additional office preparation, the typical assessment will take less than four hours total (excluding travel time). Therefore, the FACWet is practical for regulatory use as well as for 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. 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.

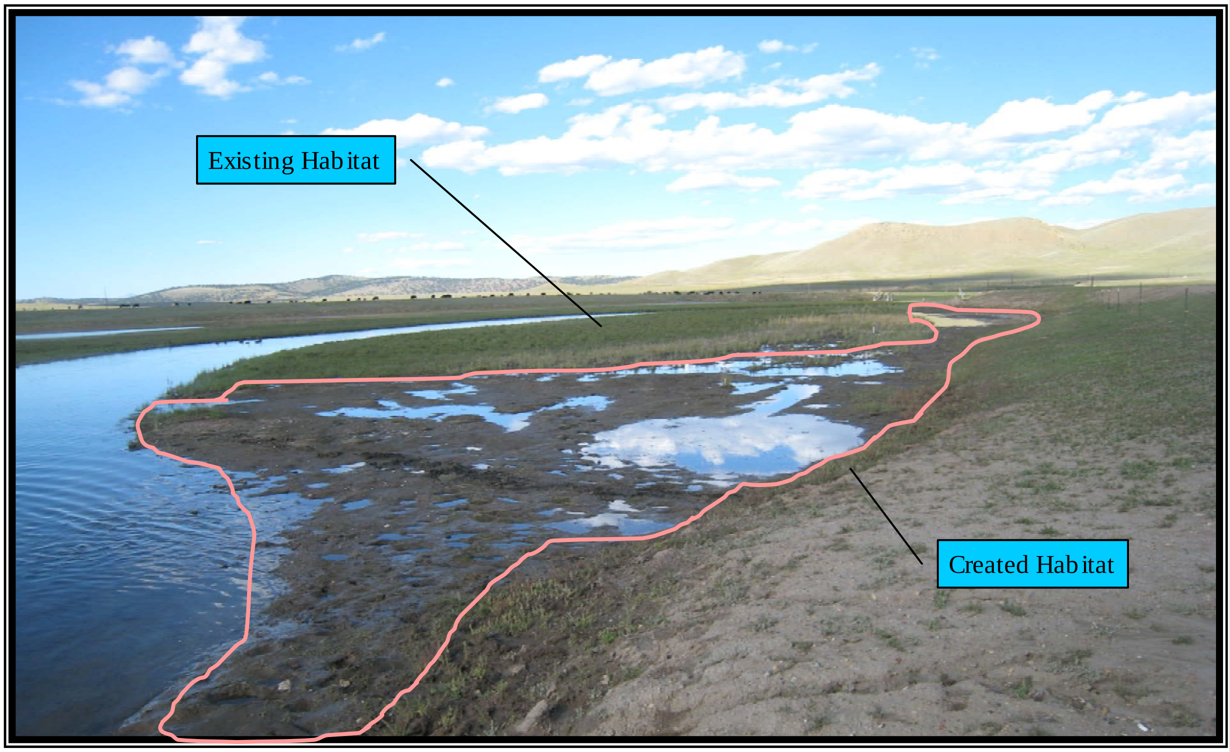


Fig. 7. In this example, wetland was created by expanding an existing habitat. Without other information, examination of adjacent habitat can help infer reference standard conditions.

Fig. 8. A voluntarily-created, "exotic" pond habitat on the arid Colorado Plateau near Loma, CO resembles depressional habitats found in other ecoregions.

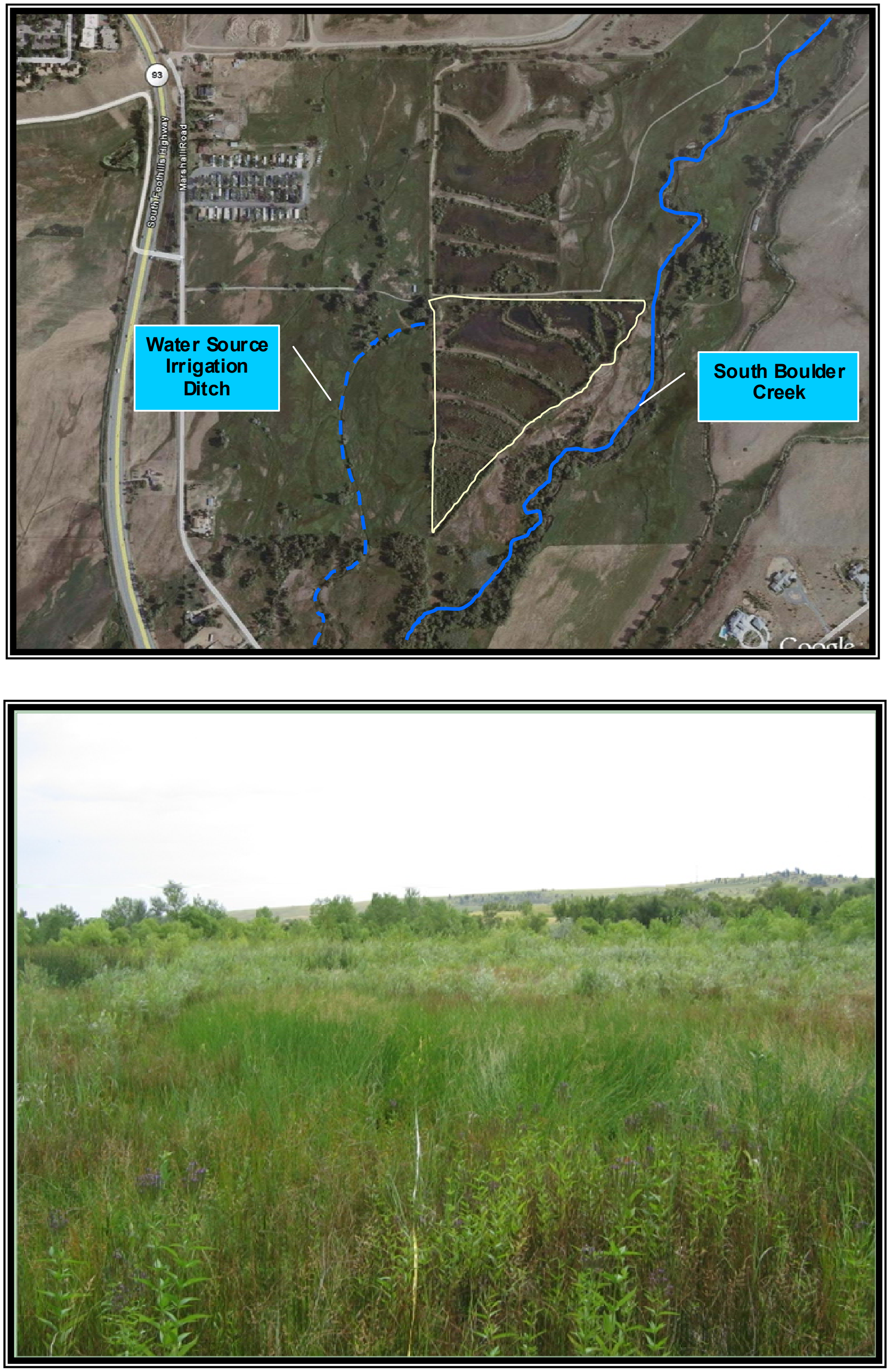
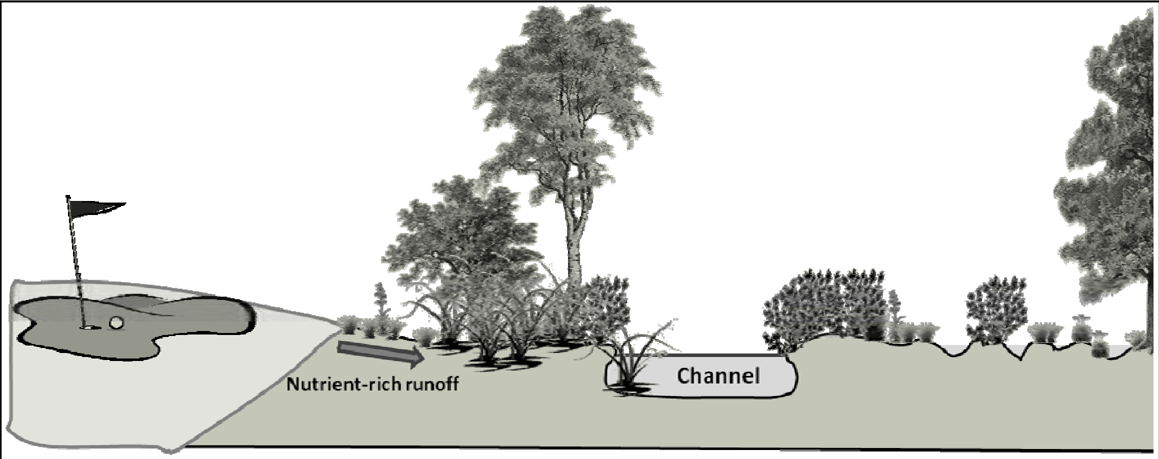


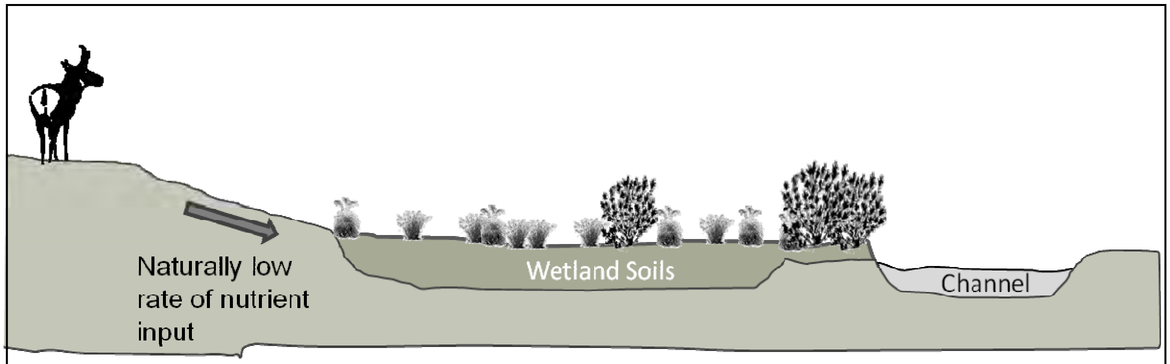
Fig. 9. See following page for explanation.

Fig. 9. 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 S. Boulder Creek riparian zone. The created wetland is an exotic 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 0.7 to reflect this fact.

Within the four wetland cells (AAs), separated by berms, Water Distribution is excellent (0.95) and Outflow is passive and capable of sustaining wetland conditions; although it involves structures which could malfunction and which need occasional maintenance (0.85). Constructed geomorphology is excellent (0.95) and has created a heterogeneous hydrologic environment that has facilitated the development of a mosaic of interspersed vegetational habitats (bottom Photograph) (0.95).

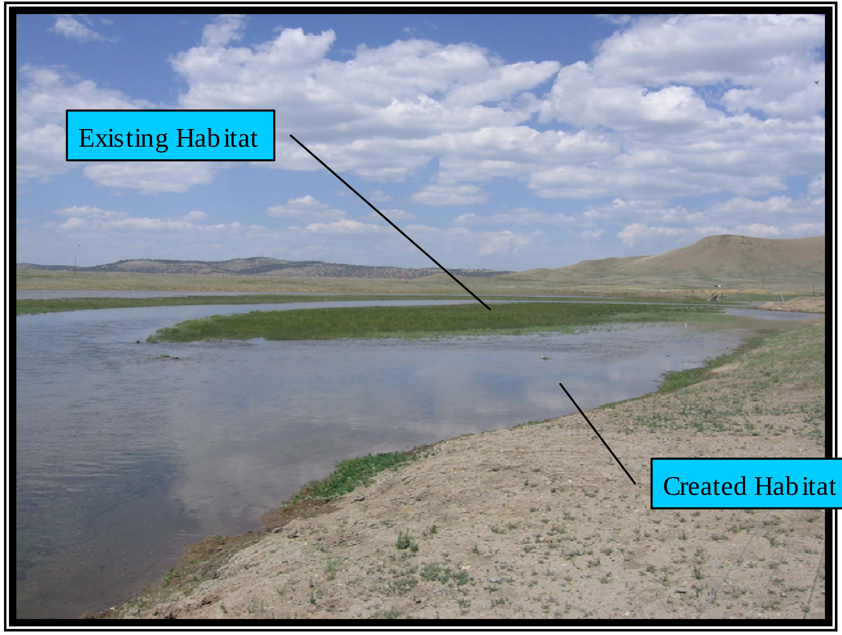


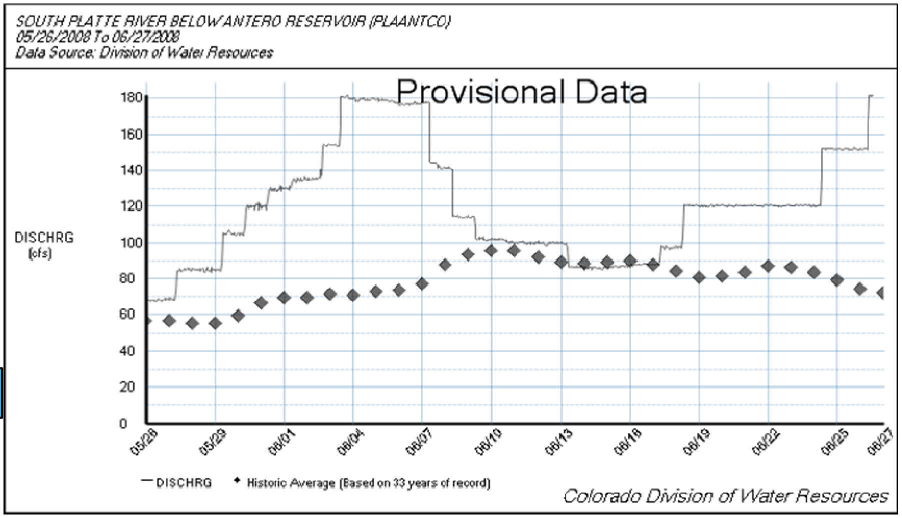
- Nutrient retention/conversion functions performed at a HIGHLY ACCELERATED RATE
- Long-term sustainability of water quality improvement function questionable
- Degradation of wetland water quality
- Conditions favor aggressive, invasive species
- Negative effects on dependent processes
- General Impairment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

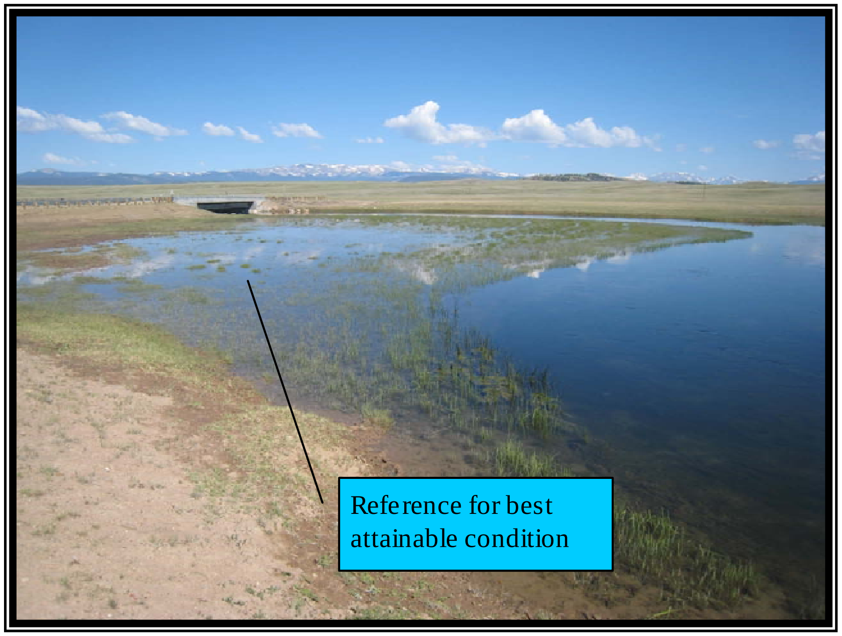


- Nutrient retention/conversion function performed at a LOW RATE relative to the urban setting
- Nutrient input rates permit water quality improvement functions to be sustainable in the long-term
- Site maintains internal water quality while protecting that of the adjacent channel
- Native species composition 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

Fig. 10. Hypothetical example illustrating the contrast between the absolute rate at which a function is performed, the condition of that function, and the 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.







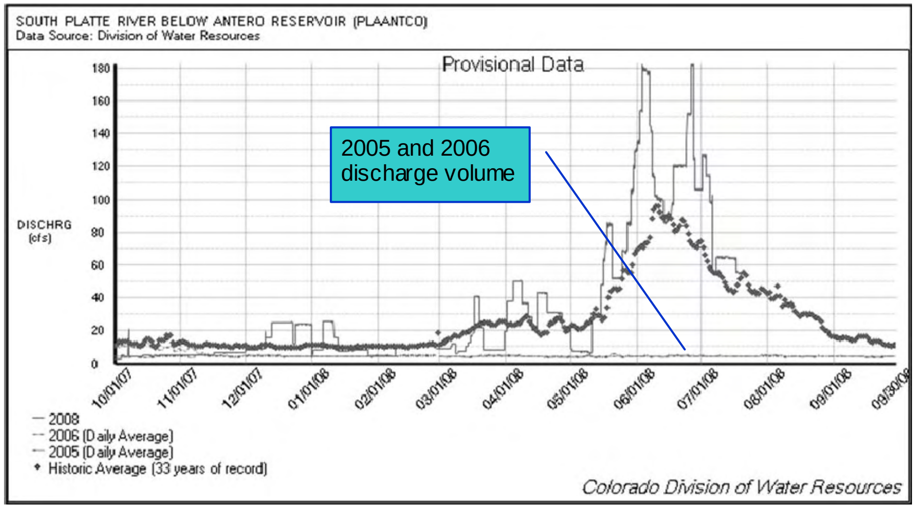


Fig. 11. See following page for explanation

Fig. 11. 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 S. Platte, riverine habitat was created by expanding the natural floodplain by cutting back the terrace scarp (Upper photo. See also Fig. 7). 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, Water Distribution and Water Outflow variables could attain near reference standard characteristics (Scores between 0.9 and 0.95). Despite these 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 0.67 ("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 affects 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 0.8, on the threshold between functioning and highly functioning.

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 purposed activities. The AOI is intended to demarcate the search area for target habitats, namely wetlands and riparian areas. Within the AOI, identified areas of target habitat will be defined as Assessment Areas (AAs). The AOI will commonly contain only a single wetland, or a portion of a wetland that is contiguous with 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 impacts. In many cases, the AOI of large projects with potentially significant impacts may need to be determined in coordination with regulatory agencies involved. Outlined below are ***minimal*** sizing guidelines for AOIs.

General Guidelines

- The AOI for small projects should include the entire project area surrounded by a 25 meter-wide failsafe envelope (Fig. 12a); or

- The total predicted extent of direct and indirect project impacts plus the 25-meter failsafe envelope, whichever is ***greater*** (Fig. 12b).

  Note that the extent of project impacts and the AOI may be asymmetrical relative to the project area; *e.g.*, the AOI for a project crossing a river may extend farther downstream from the project area than up.

- The AOI for a previously-built mitigation wetland is the area that has been restored, established, or enhanced out of a compensatory obligation.

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

Special Cases

Projects including aquatic and deep water habitats

- For projects that directly or indirectly impact areas that include small streams (approximately 1st – 3rd order at 1:24,000 scale), aquatic habitat including the active channel should be included in the AOI (Fig. 13a).

- Projects with impact areas that run parallel to larger channels (4th – 6th order) should have AOIs 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. 13b).

- AOIs 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. 13c).

- 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. (14a 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 normal annual low water mark (Fig. 14c).

If impacts to large or important 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.

Property Evaluations, Master Plans and Mitigation Banks

The FACWet can be used to evaluate the condition of wetlands and ambient stressors present in wetlands across any type of geographic, municipal or planning 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.

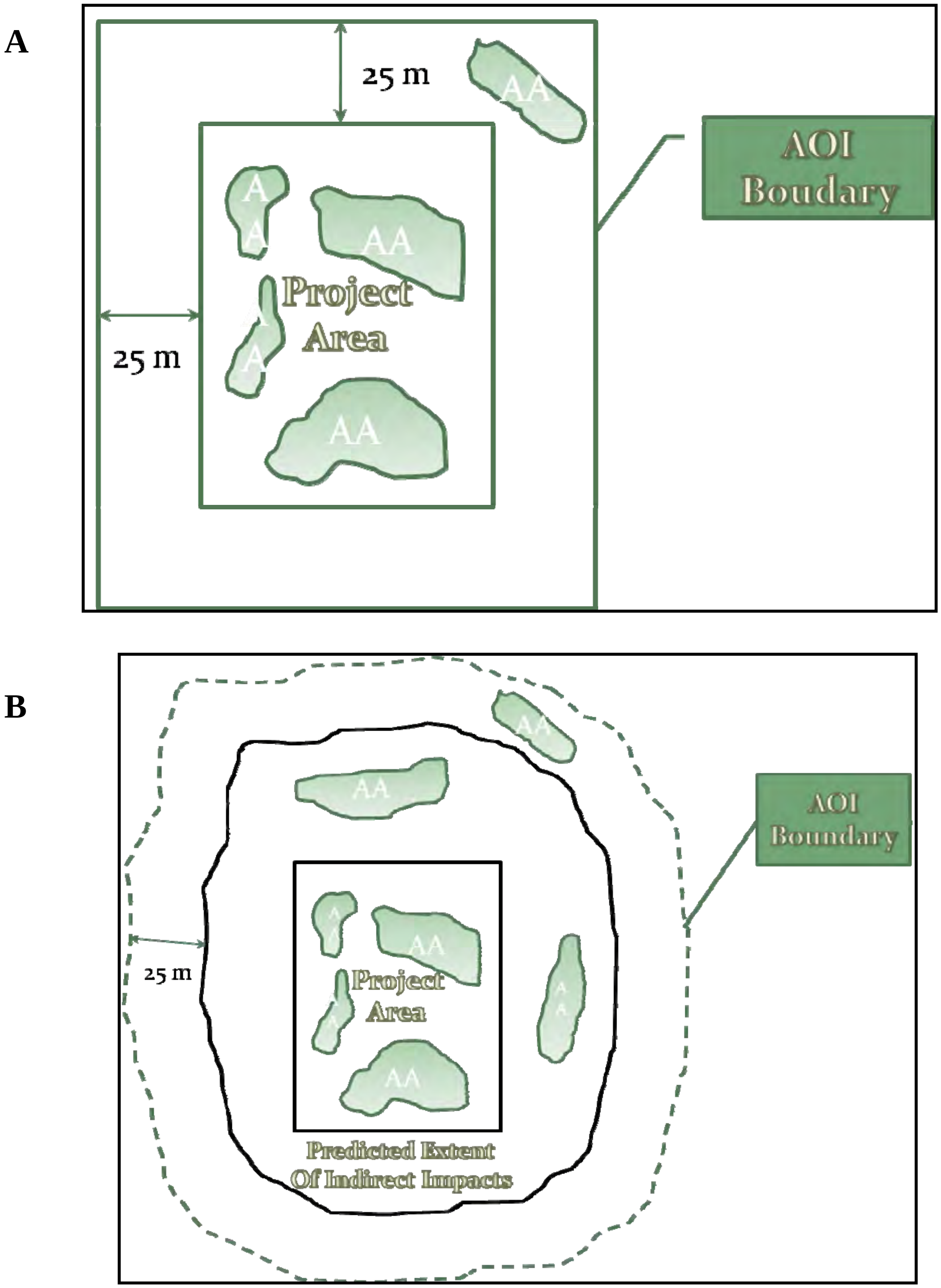


Fig. 12 Two illustrations of AOI determination. The upper drawing shows a project area with a well defined footprint and no predicted indirect wetland impacts. The AOI boundary in this case is defined as the area within 25m (82 ft.) of the project boundary. Shaded polygons show the target habitats that would be designated as 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.

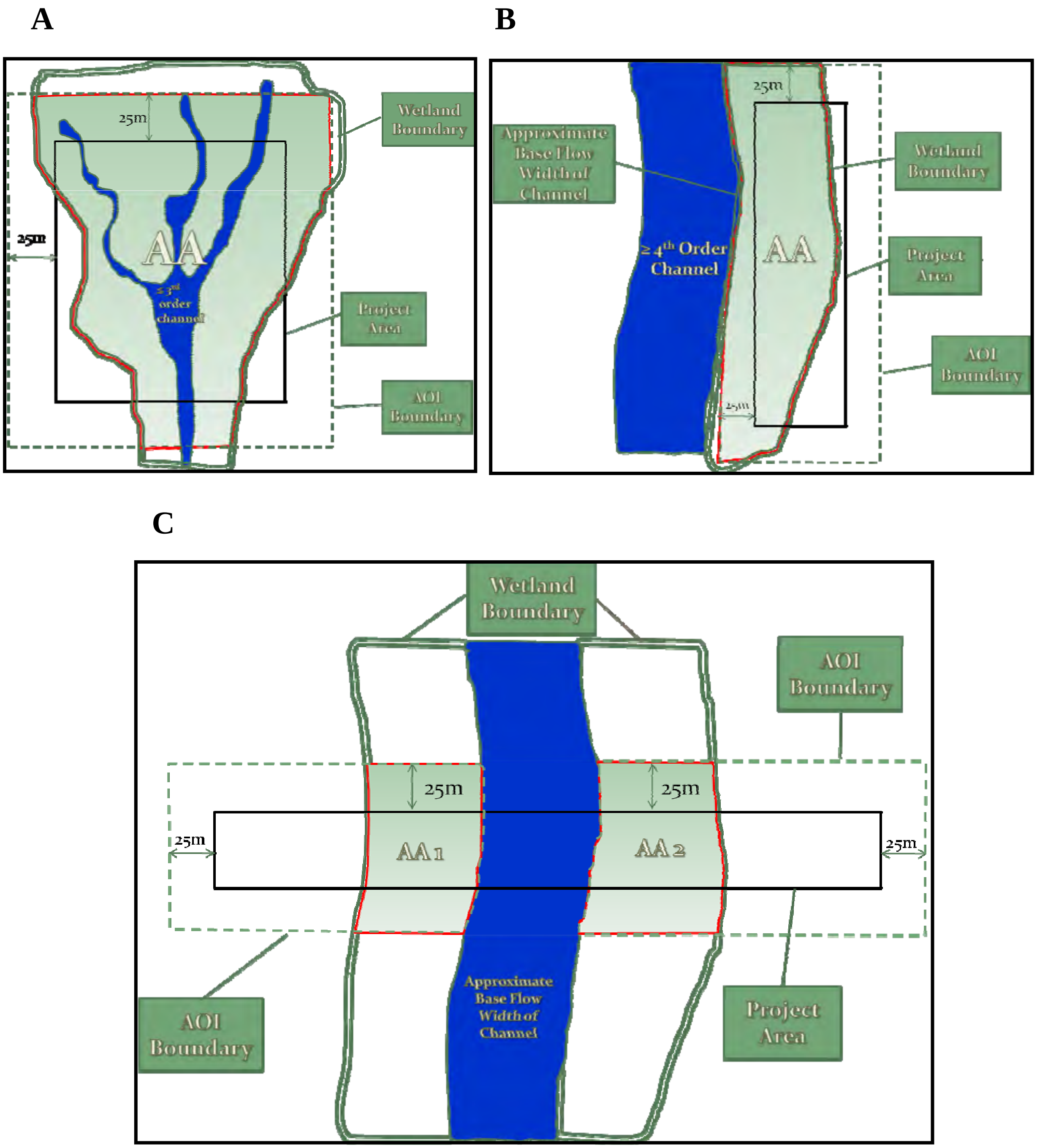


Fig. 13. Delineation of the Area of Interest (AOI) and Assessment Areas (AA) in situations involving stream and river channels. In each case the AOI is symbolized by a dashed green line. AAs are shown as green-shaded areas bordered in red. In panel A, the AOI includes a wetland containing small streams (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 the are delimited on the stream-ward side by the approximate lateral extent of the channel at normal base-flow levels.

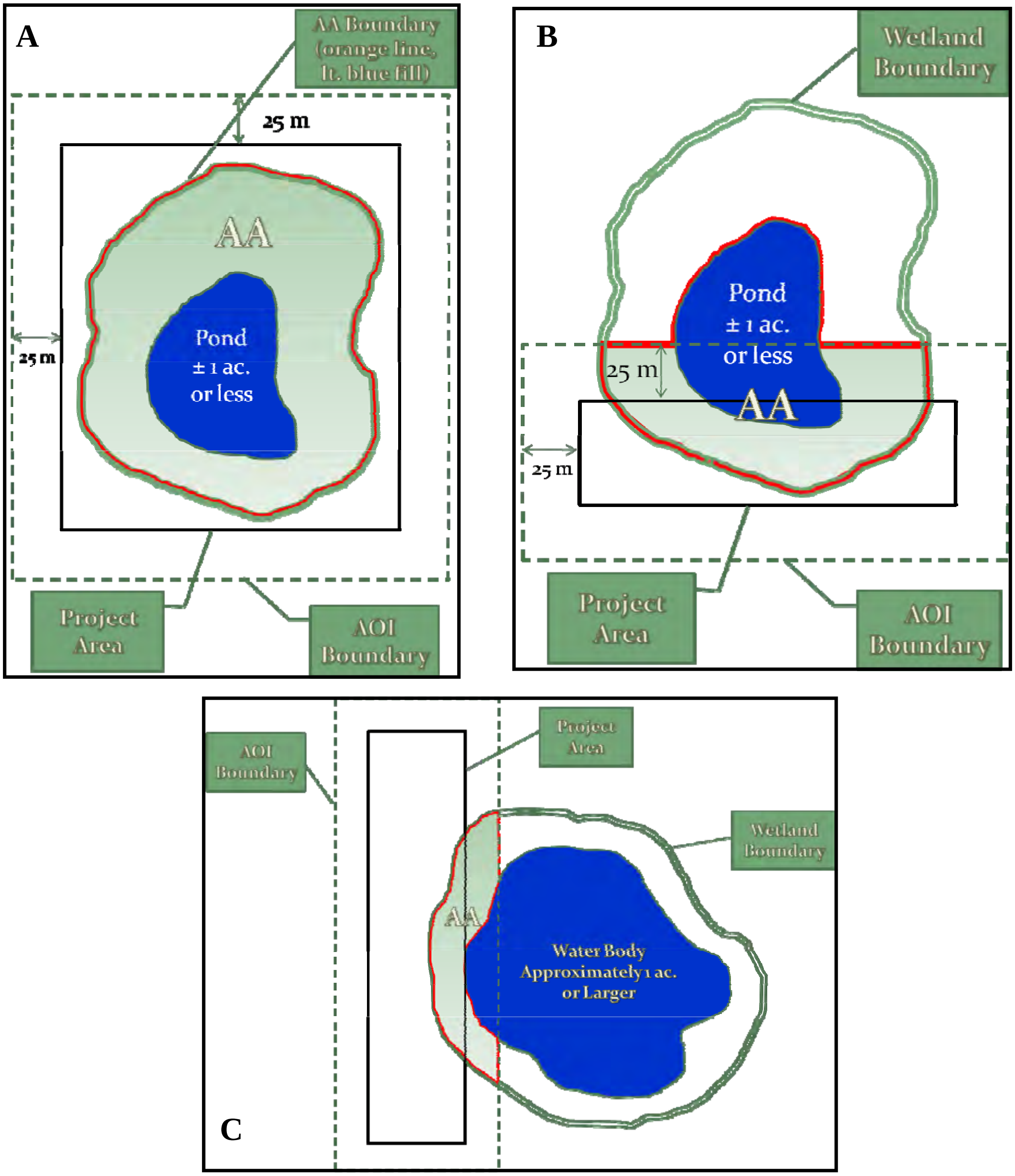


Fig. 14. Delineation of the Area of Interest (AOI) and Assessment Areas (AA) in situations involving ponds and lakes. In each case the AOI is symbolized by a dashed green line. AAs are shown as green-shaded areas bordered in red. In panel A, the AOI includes a single AA holding a pond an acre or less 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 lakeward side at the normal low water level of the water body.

Determination of the Assessment Area

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. 12 - 14 provide examples of AA delineation in a variety of common situations. For most evaluations, AAs will be defined by the total area of delineated wetland within the AOI. Depending on evaluation goals, non-jurisdictional wetland, historical wetland and/or riparian areas may be included as AAs. 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.

In the case of linear or otherwise extensive projects the AOI may contain a number of discrete AAs (Figs. 12 – 14). In this scenario the evaluator must decide if a single analysis will accurately describe the function and conditions of the multiple AAs or if the project requires several assessments. Multiple AAs may be included in a single evaluation under certain circumstances, for instance:

1. When multiple AAs are present and those habitats have been subjected to similar stressors and possess a similar level of impairment.
2. When it is desirable to “average” the condition of the wetland habitat resources within an expansive AOI.

Special Cases

In certain assessment scenarios, such as property assessment, distinct AAs within an individual wetland could be designated using any desired criterion. For instance, AAs could be designated according to the area of influence of some key stressor, by habitat boundaries, or any other feature of interest.

For AAs that encompass or abut aquatic resources use the same guidelines that are utilized in AOI determination.

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 draw the AOI boundary on the image.

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

4) Gather background data on the AOI, such as topographical maps, impaired water status (http://www.cdphe.state.co.us/wq/Assessment/TMDL/tmdlmain.html, http://oaspub.epa.gov/waters/state_rept.control?p_state=CO), Toxic spills (http://oil.cdle.state.co.us/), pollutant discharge/storage sites (http://www.epa.gov/enviro/html/em/index.html), state element occurrences (http://www.cnhp.colostate.edu/), wetland mapping resources, environmental impact/assessment documents, project plans, success criteria, 404 permit or

application, etc. This USGS webpage (http://water.usgs.gov/wsc/map_index.html) contains a wealth of information that could be helpful to the assessment.

5) Determine the Reference Standard for the evaluation using the guidelines provided in the previous section (Formulations and Application of Reference Standards in the FACWet).

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

8) Preliminarily complete the scoring procedure for Variables 1 – 3 (Buffer and Landscape Context Attribute) if desired. Scoring at this point is useful since the procedure will help familiarize the evaluator with the site and surrounding landscape. The state of these variables will be verified during the on-site assessment and scoring could equally well occur after the field 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, binoculars, camera, GPS, a 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 in the following section. This will commonly be the time at which a jurisdictional boundary determination is made.

3) During 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.*

4) Construct a mental image of the reference standards conditions that will be used for the basis of comparison during the evaluation. Referral to project plans,

permit information and/or success criteria will 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, for example latitude and longitude, or universal trans-meridian (UTM) coordinates. These coordinates can be obtained from GPSs, topographical maps or GISs, among other sources.

Geographic Datum Used: This datum can be obtained from any of the Site Location resources. See http://geology.er.usgs.gov/eespteam/GISLab/Cyprus/datums.htm or a GPS unit user guide for additional explanation.

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. 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, USFS, 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 that the AA is part of. 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 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 Assessment Area(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 without having visited sites will be able to understand the types of habitats involved.

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 be valuable in defining possible reference conditions to be used in project evaluation.

***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.

Historical Conditions: If more than 75% of the habitat has been subjected to a shift in HGM class, fill out this table. Otherwise proceed to the *Current Conditions* subsection. 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

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

Hydrodynamics

Indicate the historically prominent 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-oriented hydrodynamics, whereas other flow-through systems will display uni-directional dynamics.

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.

Previous HGM Class

Identify the historical HGM class of wetland present on the site using the above information and the dichotomous key provided below.

HGM class

Identify the current HGM class of the wetland present on the site.

Current Conditions:

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

Water Source

As explained above

Hydrodynamics

As explained above

1a. Wetland is found on the margin of a natural lake or reservoir larger than 0.5 ha with water depth exceeding 2 m, or wetland is located on the margin of an island ……………………..**LACUSTRINE FRINGE WETLAND**

1b. Wetland is not associated with a natural lake or reservoir………… 2

2a. Wetland surrounds and includes a shallow, open water area. 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**

2b. Wetland possesses open-contour topography, with or without surface water inlets or outlets…………… 3

3a. Wetland is within the 100-year floodplain of a perennial stream or river and **not** located at the base of a fluvial terrace… **RIVERINE WETLAND**

3b. 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 dominates hydrologic inputs. Wetland may be on sloping or relatively flat terrain (1 % gradient). Springs or seeps are usually present……….**SLOPE WETLAND**

Dichotomous Key for Determination of HGM Class

Wetland Gradient

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

# of Surface Inlets

Determine the number of surface inlets identified during site familiarization. In riverine situations, the inlet will generally be solely “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 as identified during the site familiarization process. Count outlets that may only function during high water events.

Geomorphic Setting

As explained above

HGM Class

Determine the predominant HGM class of wetland present in the AA using the information recorded above and the dichotomous key provided below.

Notes

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

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 FWS's 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, users unfamiliar with the US FWS system 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 and site modifications. Important features of the AOI and/or buffer area 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.

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 current state variable under scrutiny, record the stressors that negatively affect it. Make notes as to the severity and extent of each stressor, along with the probable effects it has on the variable in question. Next, based on the composite effect of all stressors, informally assign a 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 functional terms (Table 4).

Criteria for scoring based on the overall level of variable alteration are provided on each variable data sheet. 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, however, and at this point they have not been quantitatively validated. Thus, they should be taken literally as guidelines, and not interpreted strictly or in an absolute sense. If the evaluator does not follow the scoring guideline recommendations, a justification should be included in the evaluation.

Table 4. Scoring ranges and equivalents.

Score Range	Letter Grade	Functional Category
1.0 – 0.9	A	Reference Standard
<0.9 – 0.8	B	Highly Functioning
<0.8 – 0.7	C	Functioning
<0.7 – 0.6	D	Functionally Impaired
<0.6	F	Non-Functioning

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.

- Always keep in mind that scoring relates the AA’s current condition to its inferred natural 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 used areas will rate in the “C” range or lower (e.g., urban areas, arid agricultural settings).

Comparison to inferred natural conditions sets a consistent benchmark for all evaluations and provides 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 an area are functioning at a “C” level or lower, it is probably not realistic to expect compensatory mitigation to function at a much higher level. 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 rating variables, be sure to consider the long-term viability of any site modification. As a common example, a manually-controlled water source such as a head-gate may be functioning well at the time of evaluation but such sources have proven unreliable for long-term wetland maintenance. Variable rating must take into account the potential for failure of contrived support features.

- 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 these circumstances, 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.

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

Variable 1 – Neighboring Wetland Habitat Loss

Overview

This variable is a measure of how isolated from other **naturally-occurring** wetland or riparian habitat the AA has become as a result of the loss of that habitat. To score this variable, estimate the percent of naturally-occurring wetland/riparian habitat that has been lost (by filling, draining, development, or whatever means) within a 500-meter-wide belt surrounding the AA. This surrounding area 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, floodplain maps and National Wetland Inventory (NWI) maps can be helpful. 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. This variable is not meant to penalize AAs that are naturally isolated or unique to the landscape. Rather, it should measure the degree to which natural habitat connectivity has been lost.

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 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, water quality, or loss of biodiversity.

The HCE is defined to describe the zone of maximum potential interaction between wetland/riparian sites. Within the HCE, only the loss of *natural* wetland and riparian habitat is considered when scoring Variable 1. This is because the variable implicitly uses natural wetland loss as an index of overall landscape perturbation. Obviously-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 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

Step1: *Consider the geographic resources assembled during office preparation including a current aerial image and topographic map, as well as historical aerials, photographs, and wetland mapping information if it is available.* ***An aerial photograph taken recently enough to accurately portray current landscape conditions is a requirement for variable scoring.***

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 2: On the image, outline the area that is within 500m of the AA boundary (Fig. 15 and 16).

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 digital 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 trace the boundary of the AA with the point of the compass, thus producing an offset line (Fig. 17). Alternately, attach a pencil to a piece of string and measure out the calculated length from the pencil lead. With the end of the string trace the outline of the AA keeping the orientation of the string and pencil perpendicular to the AA boundary line (Fig. 17). Compass lanyards are often designed to facilitate this operation.

Step 3: Identify obvious natural barriers within 500 m of the AA boundary.

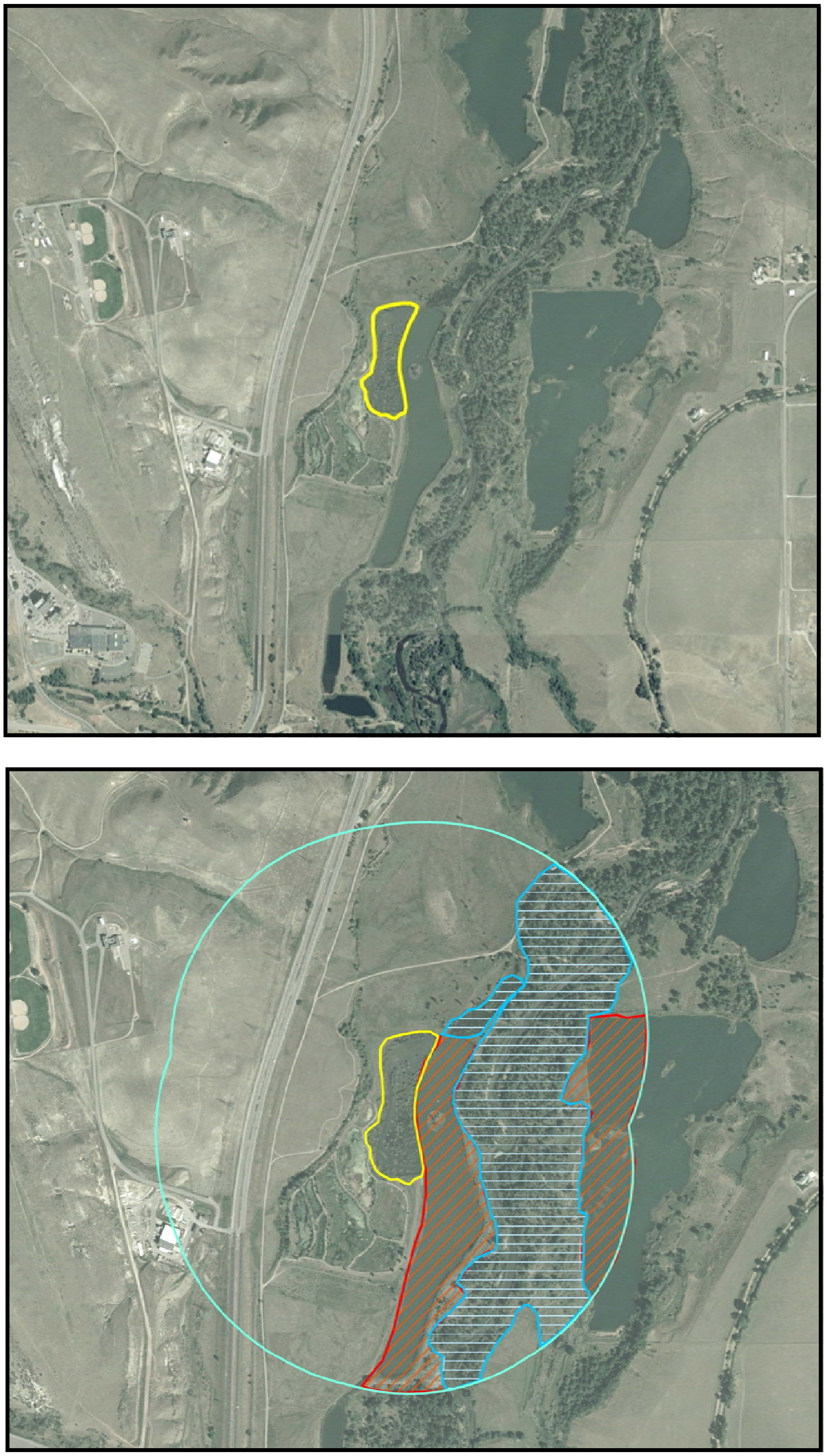
Explanation

Cliff bands, deep open water and other features form natural barriers in the landscape which can largely or entirely decouple neighboring wetlands. Identify **natural** barriers on the image which are judged to functionally isolate any wetlands from the AA (Fig. 18).

Step4: Draw the Habitat Connectivity Envelope (HCE) on the aerial image.

Explanation

The HCE is that part of the 500m zone surrounding the AA which is not isolated from the AA by natural barriers (Fig. 18). Draw boundaries by hand or on the computer that parse out areas of the 500m zone that are isolated from the AA. The HCE may form an irregular polygon within the 500m zone, or it may encompass the whole area (Fig. 16), depending on landscape conditions.



Figs. 15 and 16. Figure 15 shows the AA in its landscape context, the South Platte River corridor near Littleton, CO. Figure 16 shows the area within 500m of the AA boundary. In this case, no natural barriers exist within the envelope so this boundary delimits the HCE. The boundary of existing natural wetland and riparian habitat is shown in blue. Former wetland and riparian habitat is hatched in red.

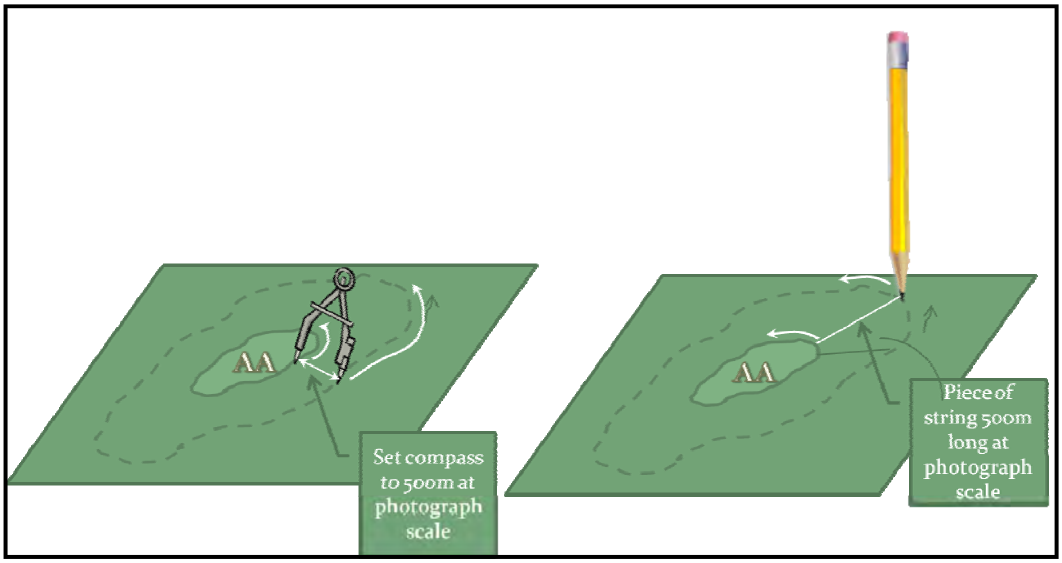


Fig. 17. Two methods of drawing the HCE boundary using either a drafting compass or piece of string.

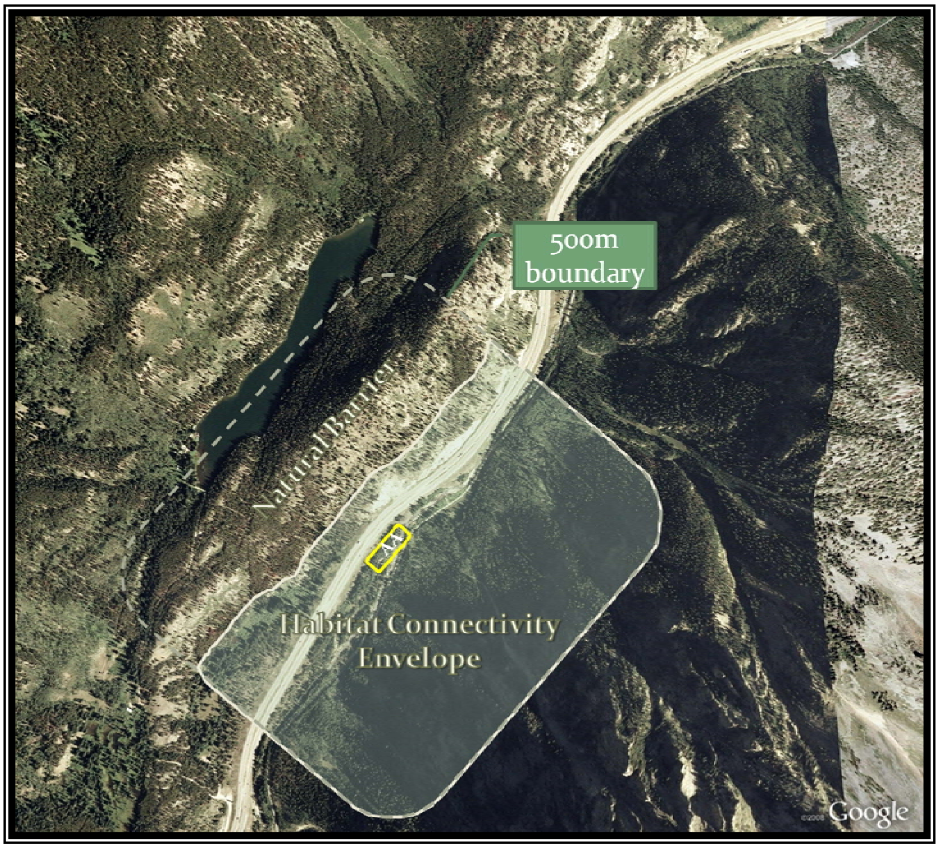


Fig. 18. At the center of the photograph, the AA is shown surrounded by a 500m boundary. In this case, a high ridge essentially isolates the wetlands that occur on the opposite side from the AA. The shaded HCE does not include the isolated area.

<u>*Step 5*</u>: *Outline the current extent of naturally occurring wetland and riparian* habitat. *Then outline areas where these habitats appear to have historically occurred* (Fig. 16).

<u>Explanation</u>

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 is perhaps the most speculative aspect of the assessment. The evaluator must use his best professional judgment to estimate the extents of lost wetland and riparian habitats. In the majority of cases this operation is simpler than it may at first sound. The primary evidence for lost wetland/riparian habitat will come in the form of unnatural breaks in vegetation (Figs. 15 and 16). When such breaks occur landforms can be used to estimate the 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. 19). Other characteristics such as fill, dams or excavated ponds/reservoirs can also signal wetland loss. NWI maps or previous habitat maps can greatly aid in this procedure, but are not required.

<u>*Step 6*</u>: *Calculate the amount of historical wetland/riparian habitat that is still present (or the percent lost).*

<u>Explanation</u>

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

Total acres of existing wetland ÷ (Total acres of existing wetland + Total acres of wetland loss) = % of natural wetland still existing

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. Simply count the number of dots that fit within each wetland polygon and record those values. To determine the percentage of natural wetland remaining, apply the following formula.

Total # of dots contained in existing wetland ÷ Total number of dots counted = % of natural wetland still existing

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.

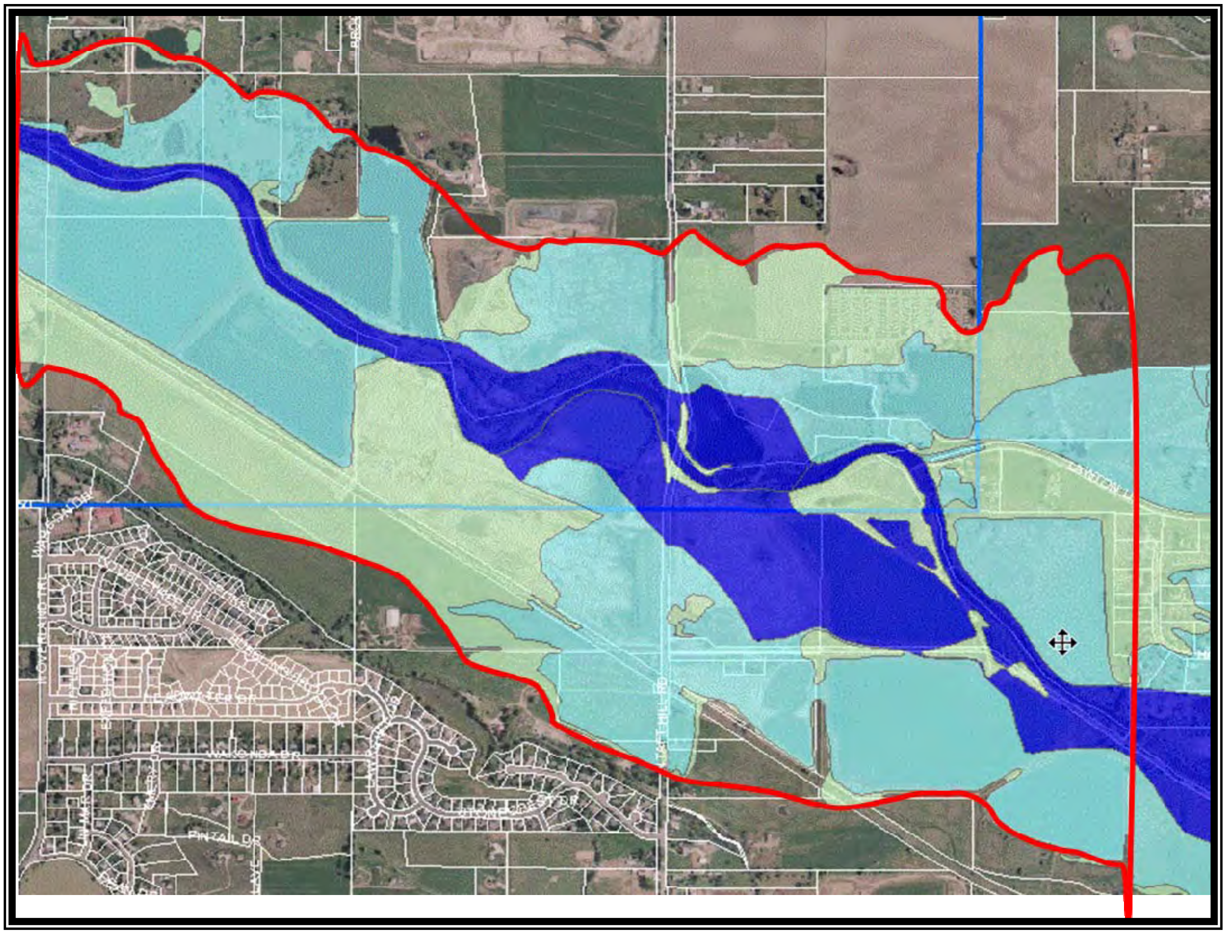


Fig. 19. Aerial photograph of a portion of the Cache la Poudre river in Fort Collins, CO overlain with Federal Emergency Management Agency 100- (blue) and 500-year (green) floodplains. The estimated extent of riparian vegetation is delimited be the red line. The upstream and downstream limits of the zone have been drawn arbitrarily.

Step 7: Score the variable according to the scoring guidelines provided on the data sheet.

Score Interpretation

Variable scores reflect the degree to which wetlands 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.

Variable 2 – Barriers to Migration and Dispersal

Overview

This 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 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 Variable 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

<u>Step 1</u>: On the aerial photo, outline all existing wetland and riparian habitat areas (WHAs) within the HCE (Fig. 20).

<u>Explanation</u>

Using the HCE delineated during Variable 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 Variable 1.

<u>Step 2</u>: Identify artificial barriers to dispersal and migration of organisms within the HCE that intercede between the AA and surrounding habitats (Fig. 20).

<u>Explanation</u>

On the aerial photograph, mark artificial barriers that intercede between the AA and its surrounding habitats. Signify the type of barrier 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 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.

<u>Step 3</u>: 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.

<u>Explanation</u>

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.

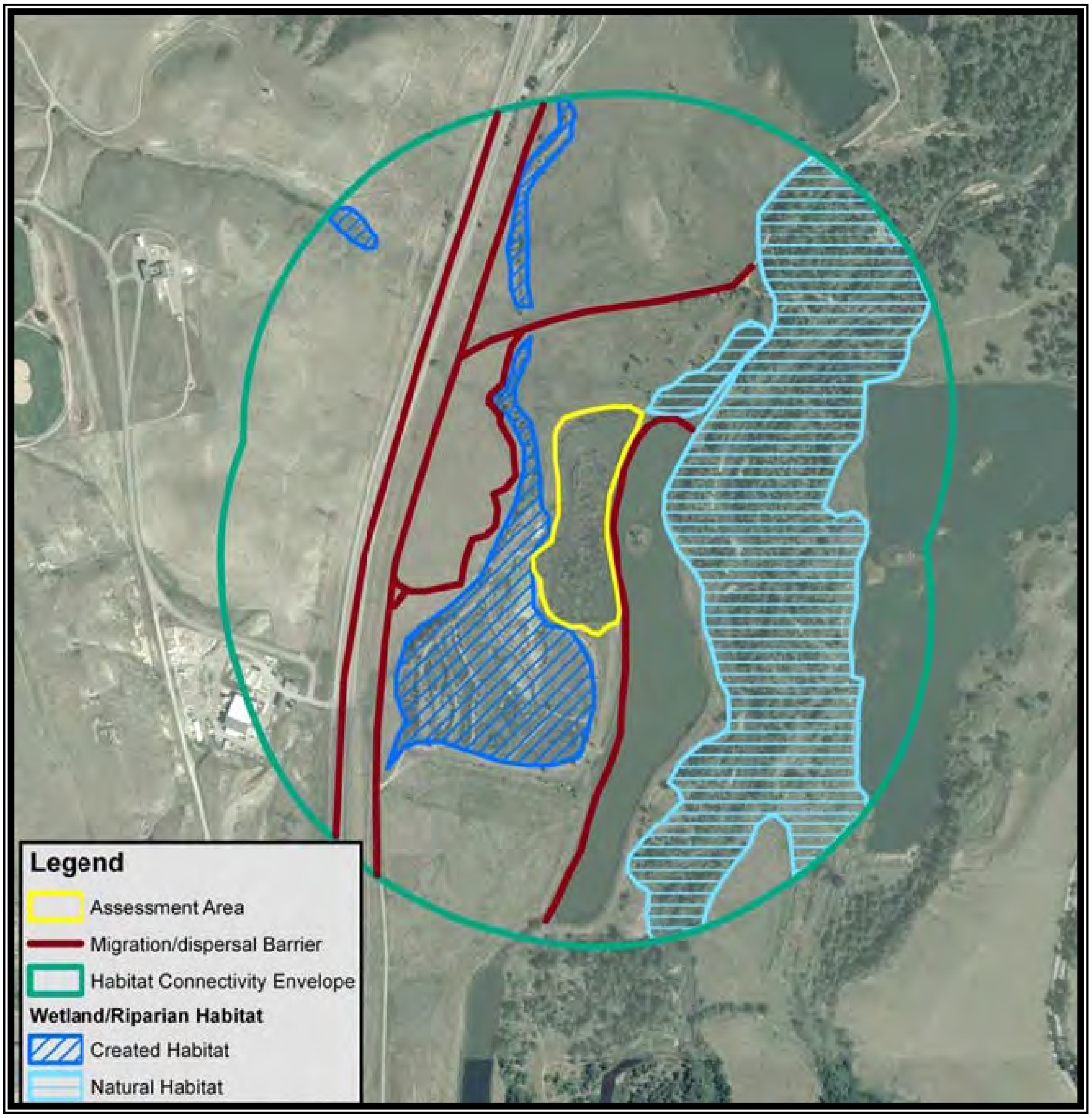


Fig. 20. Aerial photograph showing the HCE, natural and created wetland/riparian habitat and man-made barriers to migration and dispersal (note that the artificial water body acts as a significant barrier in this regard).

Variable 3 – Buffer Capacity

Overview

The buffer area is defined as a 250-meter-wide belt surrounding the perimeter of the AA. This variable is a measure of the capacity of that area to function as an effective buffer for the wetland against the deleterious effects of surrounding land use change. To score the variable, assume that the AA is 100% buffered except where land use changes inside the buffer area have diminished this quality. Identify these land use types as specific stressors in the list. For each stressor, rate severity and extent within the buffer area; then use this list to make an overall rating for the buffer's departure from reference conditions. When rating buffer capacity, consider both the intensity of the impact and the proximity of the stressor to the AA.

Indications

The buffer area performs an important function as adjacent non-wetland habitat. An unimpacted and therefore functioning buffer holds intrinsic value as quality habitat. In addition, a functioning buffer has the capacity to attenuate the deleterious effects of land use change on the AA's condition. An unimpacted and therefore functioning buffer holds intrinsic value as quality habitat. On the other hand, a poorly functioning buffer may itself negatively impact the condition of the AA habitat by contributing toxic compounds, urban runoff, sediment and other substances that diminish wetland functioning.

It is important to note that the concept of a buffer implies the presence of a spatial continuum, wherein the negative effects of land use change are gradually mitigated as distance from the source of stress increases. Basically, the greater the distance from stress (*i.e.,* the wider the buffer zone) the lower the effect that stressor has on the AA habitat. Thus, when contemplating buffer condition and its effects on the AA, be sure to take into account not only the severity and extent of land use changes, but also to the proximity of those changes to the AA.

Step-by-Step Scoring Instructions

<u>Step 1</u>: On the aerial photograph, outline the buffer area as the zone within 250 meters of the outer boundary of the AA (Fig. 21).

<u>Explanation</u>

Use the same methods for buffer delineation as were used in drawing the HCE, making the appropriate scale adjustments.

<u>Step 2</u>: Use the stressor list to catalog land use changes that affect buffering capacity within the buffer area.

<u>Explanation</u>

To help visualize the effects of land use change, it may be helpful to delineate the various land use types on the aerial photograph (Fig. 21). Next, mark the stressors

Fig. 21. An example of the Buffer Capacity scoring procedure. Within the 250 m buffer area the extent of major land use covers are delineated. In this example, the majority of the buffer area is managed as open lands (undelineated), but interspersed within is an area of reclaimed gravel pits, an artificial lake, as well as a strip of more natural riparian habitat. In this case the buffer capacity was rated as 0.7, because of the extensive mineral resource extraction that has occurred onsite, the form of reclamation, and its potential long-term effects on the AA habitat.

present with a check in the first column of the stressor table and describe the general nature, perceived severity and approximate extent of each. List additional stressors in empty rows at the bottom of the table and explain the general characteristics of each.

Step 3: Considering all of the identified stressors, their overall severity, extent and proximity to the AA assign an overall variable score using the scoring guidelines.

Explanation

Based on the severity, extent and proximity of stressors to the AA use your best professional judgment guided by the scoring guidelines to rate the condition of the buffer with regard to its ability to facilitate natural functioning in the AA. When scoring buffer condition, keep in mind the temporal aspects of the variable. For instance, in some regards an artificial water body such as a gravel pond may provide some short- to mid-term buffering functions, but in the longer-term such features pose the threat of catastrophic failure and far-reaching environmental effects. Thus, to the degree possible, variable rating should not only take into account current buffer status, but also the long-term consequences of land use change.

Variable 4 – Water Source

Overview

This variable is concerned with up-gradient hydrologic connectivity. It is a measure of the impacts to the AA's water source, including 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 up-gradient control on a wetland's potential level of functioning. Without a characteristic inflow 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. That is, impairment of water inflow characteristics is indicative of impacts to a host of other dependent wetland processes.

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.

Explanation

In this variable, stressors are defined as man-induced factors that lead to the alteration of the quantity or timing of inflow to the AA, or source water hydrodynamics. These 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 the AA.

Evidence for the presence of source impairment will generally 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). 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, soil cracking, loss of soil redoxiomorphic features, or oxidation of organic soils.

Gauge data can also help inform judgments on the severity of hydrologic alterations. 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.

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 stressors present. 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 have not been scientifically validated and should not be taken in an absolute or literal sense. Rating is ultimately up to the judgment of the evaluator.

Evaluators must estimate the degree to which the water source has been altered. The scoring guidelines provide benchmarks for several factors to consider during variable rating. While such estimates are intended to be qualitative, 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. (20 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.

Variable 5 – 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. To score this variable, identify stressors that alter flow patterns and impact the hydrograph within portions of the AA, including localized increases or decreases to the depth or duration of the water table or surface water. In naturally confined rivers (*i.e.* canyons and gullies) floodplain width is generally very small, so these systems will tend to score high for this variable unless some gross stressor is present.

Indications

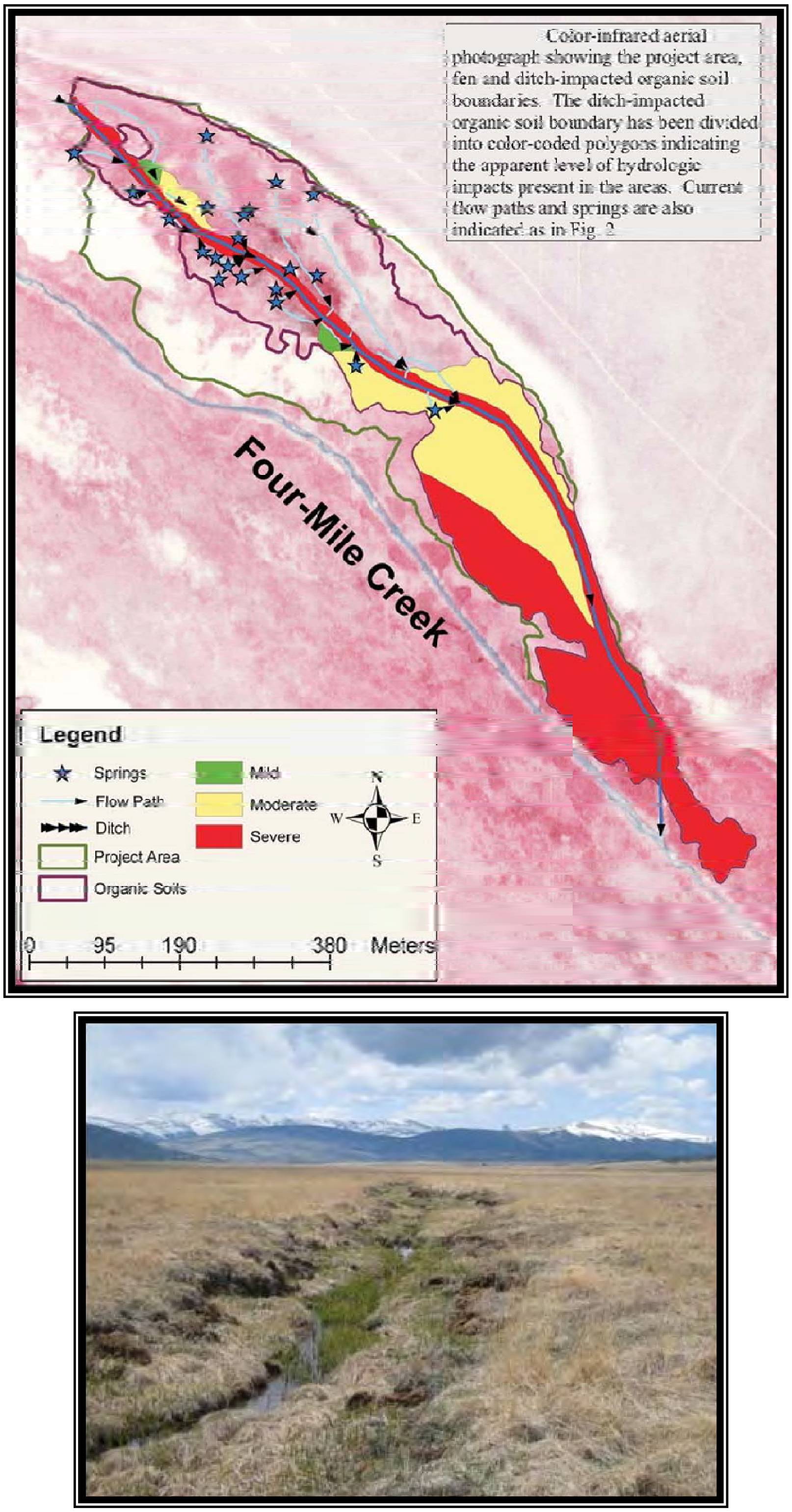
The internal flow network within a wetland is analogous to an organism's vascular system. If any portion of the wetland is cut off from this system, its functioning becomes impaired or it effectively dies. In depletion situations such as ditching, water distribution will generally be disrupted in a zone down-gradient of the stressor (Fig. 22). Stressors that augment a portion of the AA's water budget can have both up- and down-gradient effects. Ponding above a dam/barrier (Fig. 23) 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.

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 are manifested as local changes in the AA hydrograph. For each stressor, take note of the extent of its influence and its overall severity. Record this information in the stressor table.



Color-infrared aerial photograph showing the project area, fen and ditch-impacted organic soil boundaries. The ditch-impacted organic soil boundary has been divided into color-coded polygons indicating the apparent level of hydrologic impacts present in the areas. Current flow paths and springs are also indicated as in Fig. 2.

Fig. 22. A color-infrared aerial photograph of the Four-mile Creek fen, showing the locations of springs, flow paths, a major drainage ditch and the level 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.

Fig. 23. See following page for explanation.

Fig. 23. Case study on Four-Mile Creek. The upper photograph shows a view NW across where Four-mile Creek crosses Park Co. 24. The lower figure is an aerial photograph of the same area. Here, a geomorphic alteration (road grade), has caused gross changes in the following variables (Future sections describe other variables):

- **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 0.6.
- **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.

  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, and, therefore, its presence would be reflected in 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 0.9.
- **Vegetation Structure and Complexity** — The flooding and sediment deposition have caused significant changes to AA vegetation, including a shift towards a more hydrophilic flora and a reduction in cover. This variable was rated at 0.73.

When scoring this variable, keep in mind that hydrologic impacts that result from changes to the water source are not included. The water distribution variable only concerns alterations occurring within the AA. As with the Water Source variable, the severity of disruption of the water distribution system will generally be gauged using indirect indicators such as changes in species composition, uncharacteristic inundation, soil cracking, loss of soil redoxiomorphic features, or oxidation of organic soils. Similarly, the percent water table alteration can be calculated to help determine the stressor severity.

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

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.

As with Variable 4, 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. Rating values have not been scientifically validated and should not be taken in an absolute or literal sense. Rating is ultimately up to the judgment of the evaluator.

Variable 6 – Water Outflow

Overview

This variable is concerned with down-gradient hydrologic connectivity and the flow of water (transporting materials and energy) out of the AA. 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, and infiltration/groundwater recharge. 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.

Indications

There are three basic 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 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. 23). 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. 22).

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.

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 stemming from a geomorphic alteration.

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

Explanation

To score this variable, consider the combined effects of all stressors and estimate the resultant divergence of outflow from reference 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 5.

On-site indicators such as unnatural inundation or dewatering can be used to indicate the severity of outflow disruption, however. For example, in Fig. 23 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 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 quality. 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.

Indications

The chemical environment of the AA is seen as a “refinement” of the conditions created by the overriding effects of the hydrogeologic 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. 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, elevation of the ground surface (*i.e.,* fill) 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 categories which have a similar signature or set of causes.

Explanation

The scoring procedure for this variable has a slightly different structure because impairment of water quality commonly cannot be directly observed. Owing to this difficulty, indirect indicators of impairment must be used in lieu of direct evidence. To contend with these issues, water and soil chemistry stressors are grouped into categories 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 corresponding to the stressor categories are first rated. The sub-variable scores are then summed to produce a final variable score.

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

Explanation

For each stressor category, 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.

Step 3: For each stressor category, determine the sub-variable score using the scoring guideline table provided on the second page of the scoring sheet.

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.

Explanation

Unlike previous variables, scoring of the chemical environment variable entails an additional step of sub-variable rating. Variable scoring is based on individual sub-variable scores and their composite value.

Step 5: Determine the variable score by following the scoring guidelines.

Explanation

Scoring guidelines are based on two aspects of the sub-variable scores, the maximum or minimum value and the total sum. First determine which single-factor category applies to the sub-variable score and circle it on the data sheet. Next, circle the category that includes the composite value of sub-variable scores.

If both scoring rules indicate a single conditional category, choose the variable value in the prescribed range that best fits observed conditions. If the single-factor and composite rules indicate different conditional categories, select the lower of the two to determine the scoring range. Use the degree of departure between the two scoring rules to help determine the best variable score. For instance, if the single factor rule indicates a functioning 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 functioning impaired category for the base range, and then select a variable score at the upper end of the range, such as 0.7.

Variable 8 – 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. Alterations may include bed surface changes (embeddedness or morphology changes), stream instability, and stream channel reconfiguration. Geomorphic changes are usually ultimately manifested as changes to wetland hydrology and water relations with vegetation. Geomorphic alteration 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. The effects of geomorphic change are addressed by other variables. All alterations to the 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).

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 geomorphic variable, consider only the direct effects of geomorphic change which will usually be 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 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. 24). The ramifications of the 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 off-site geomorphic change (fill) is acting as a stressor on the other state variables.

In situations where jurisdictional status is not the basis for AA delineation, such as the 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 within the AA. Such inclusion is very useful since it characterizes 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

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

Explanation

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 condition can be used to support judgments.

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

Explanation

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

Fig. 24. Wetland off of CO Hwy. 9. Fill was placed across a portion of the wetland to form a road grade. Areas so affected are no longer jurisdictional. If the AA was delineated according to the jurisdictional 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. This approach would commonly be taken during the project permitting when the focus is specifically on determining impacts regulated habitats.

If instead, the assessment was being completed to evaluate mitigation potential on 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).

Variable 9 – 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, and sediment retention. Score this variable by listing stressors that have affected the diversity, composition and cover of each vegetation cover class that would normally be present for the wetland type being assessed. For this variable, stressor severity is a measure of how much each vegetation stratum differs functionally from its natural condition.

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 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 in a manner similar to that used in the Water and Soil Chemical Environment Variable. Here, each canopy layer is scored separately as a sub-variable. Those values are then combined to produce an overall picture of vegetation alteration.

<u>*Step 1*</u>*: 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. Check each present or suspected vegetation layer in the third row of the table.*

<u>Explanation</u>

This variable examines vegetation structure and complexity of the AA in light of its historical form. Of primary importance here are the number, type and gross physiognomy of vegetation strata. During this first step indicate existing strata and those 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 natural 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.

Explanation

This variable is not intended to penalize habitat types that naturally lack specific structural diversity components, such as natural meadows with no trees or shrubs.

Step 3: Estimate the percent coverage of each vegetation layer. Aerial photographs can be helpful for this but are not required.

Explanation

Estimate the existing coverage of each stratum or its estimated historical extent if there is evidence of removal. For existing layers, coverage estimations will generally be done by eye, commonly aided by an aerial photograph. Habitats can be delineated in a GIS, and coverages measured directly. Estimation of the historical extent of strata, can be aided by examining nearby areas that have been spared removal. 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.

Step 4: Enter the percent cover of each stratum in the row of the stressor table labeled "Percent Cover of Layer", sum these values, and enter the result in the cell to the right.

Explanation

Enter the strata coverages estimated in step 3 in the indicated 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.

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 6: 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.*

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 7: Multiply each layer's cover (as a decimal) by its sub-variable score and enter the product in the appropriate cell in the last row of the stressor table labeled "Weighted Sub-Variable Score". Sum these scores and enter the value in the adjacent cell.

Explanation

This step weighs each canopy’s sub-variable score by its coverage value.

Step 8: Divide the sum of the “Weighted Sub-variable Scores” (Step 7) by the sum of the “Percent Cover of Layer” (Step 4). This product is the Variable 9 score.

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 (FCI)** 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. So, 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 5). 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 5. Functional categories and their general interpretation.

FCI Score	**Functional Category**	**Interpretation**
1.0 – 0.9	Reference Standard	AA is functioning at or near its natural capacity.
<0.9 – 0.8	Highly Functioning	AA retains all of it 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 AA's 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.

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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 Location (Lat./Long. or UTM):		Geographic Datum Used (NAD 83	
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)* ☐ Restortation ☐ 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.

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

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				
	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)						
	HGM class	Riverine	Slope	Depressional	Lacustrine		

Notes (include information on charcteristics used to formulate reference standard):

ECOLOGICAL DESCRIPTION 2

Vegetation Habitat Description

*US FWS habitat classification according as reported in Cowardin et. al (1979) - See also Appendix *** of FACWet User Guide.*

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); Perm. flooded(F); Intermittently Flooded(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 - Neighboring Wetland Habitat Loss

This variable is a measure of how isolated from other naturally-occurring wetland or riparian habitat the AA has become as a result of the loss of that habitat. To score this variable, estimate the percent of naturally- occurring wetland/riparian habitat that has been lost (by filling, draining, development, or whatever means) within a 500-meter-wide belt surrounding the AA. This surrounding area is called the Habitat Connectivity Envelope (HCE). Historical photographs and NWI maps can be helpful in scoring this variable. In most cases the evaluator must use best professional judgment in estimating the amount of natural wetland loss. Evaluation of landforms and habitat patterns in the context of perceivable land use change should be used to steer estimates of the amount of wetland loss within the HCE. This variable is not meant to penalize AAs that are naturally isolated, or unique to the landscape. Rather, it should measure the degree to which natural habitat connectivity has been lost.

Rules for Scoring:

1. On the aerial photo outline the area that is within 500 meters of the AA.
2. Identify obvious natural barriers within 500 m of the AA boundary.
   - *Natural barriers include continuous cliff bands, deep open water, etc.*
3. Draw the **Habitat Connectivity Envelope**(HCE) on the aerial image.
   - *The HCE is all the area within 500 meters of the AA that is not separated from it by a natural barrier.*
4. Outline the current extent of naturally occurring wetland and riparian habitat. Then outline areas where the habitats appear to have historically occurred.
   - *Use your knowledge of the history of the area and evident land use change. Additional research could be utilized to increase the accuracy of this estimate including consideratation of floodplain maps, historical aerials, etc.*

Variable Score	Condition Category	Scoring Guidelines
1.0 - 0.9	*Reference Standard*	*Wetland losses are absent or negligible or there is no evidence to suggest the native landscape within the HCE historically contained other wetland habitats*
<0.9 - 0.8	*Highly Functioning*	*More than 80% of historical wetland habitat area within the HCE is still present (less than 20% historical wetland habitat area lost).*
<0.8 - 0.7	*Functioning*	*80 to 60% of historical wetland habitat area within the HCE is still present (20% to 40% historical wetland habitat area lost).*
<0.7 - 0.6	*Functioning Impaired*	*Less than 60 to 30% of historical wetland habitat area within the HCE is still present (more than 30 to 70% historical wetland habitat area lost).*
<0.6	*Non-functioning*	*Less than 30% of the historical wetland habitat area from within the HCE is now no longer in existence (more than 70% historical wetland habitat area lost).*

Variable 1 Score ☐

Notes:

Variable 2: Habitat Connectivity - Migration/Dispersal Barriers

This 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 (WHAs) within the HCE.

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**	**Comments/description**
Stressors = artificial barriers		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 Class**	**Scoring Guidelines**
1.0 - 0.9	*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	*Highly Functioning*	Barriers impeding migration/dispersal between the AA and up to 33% of surrounding WHA 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 WHA.
<0.8 - 0.7	*Functioning*	Barriers to migration and dispersal retard the ability of many organisms/propagules to pass between the AA and up to 66% of WHA. 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 WHA.
<0.7 - 0.6	*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 WHA. 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 WHA could be functionally isolated from the AA.
<0.6	*Non-functioning*	AA is essentially isolated from surrounding WHA 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 a WHA.

Variable 2 Score

Variable 3: Buffer Capacity

The buffer area is defined as a 250-meter-wide belt surrounding the perimeter of the AA. This variable is a measure of the capacity of that area to function as an effective buffer for the wetland against the deleterious effects of surrounding land use change. To score the variable, assume that the AA is 100% buffered except where land use changes inside the buffer area have diminished this quality. Identify these land use types as specific stressors in the list. For each stressor, rate severity and extent within the buffer area; then use this list to make an overall rating for the buffer's departure from reference conditions. When rating buffer capacity, consider both the intensity of the impact and the proximity of the stressor to the AA.

Rules for Scoring:

1. On the aerial photograph, outline the buffer area as the zone within 250 meters of the outer boundary of the AA.
2. Use the stressor list to record land use changes that affect buffering capacity within the buffer area. 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 all of the identified stressors, their overall severity, extent and proximity to the AA assign an overall variable score using the scoring guidelines.

	✓	**Stressors**	**Comments/description**
Stressors = Land Use Changes		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 Class**	**Scoring Guidelines**
1.0 - 0.9	*Reference Standard*	No appreciable land use change has been imposed within the TBA and it provides the full buffering capacity.
<0.9 - 0.8	*Highly Functioning*	Some land use change has occurred in the BA, but such changes little impair the area's ability to provide a buffering function, either because land use is not intensive, for example haying, light grazing, or nurseries, or more substantial changes occur in approximately less than 10% of the BA.
<0.8 - 0.7	*Functioning*	BA has been subjected to a marked shift in land use, however, the land retains much of its original buffering capacity. 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	*Functioning Impaired*	Land use within the BA has been substantial including the a moderate to high coverage (up to 50%) of impermeable surfaces, bare soil, or other artificial surface; considerable in-flow urban runoff or fertilizer-rich waters common. While, the buffering capacity of the land has been greatly diminished it is not extinguished. Intensively logged areas, low-density urban developments, some urban parklands and some cropping situations would commonly rate a score within this range.
<0.6	*Non-functioning*	The area within the BA provides essentially no buffering capacity. Many Commercial developments or highly urban landscapes would rate a score of less than 0.6.

Variable 3 score ☐

Variable 4: Water Source

This variable is concerned with up-gradient hydrologic connectivity. It is a measure of the impacts to the AA's water source, including 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. For riverine systems, this variable is primarily concerned with the connection of the channel to the floodplain.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 Class**	**Depletion**	**Augmentation**
1.0 - 0.9	*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	*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 natural 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 natural capacity of water to perform work.
<0.8 - 0.7	*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 natural 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 reduction of peak flows or natural capacity of water to perform work.
<0.7 - 0.6	*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 natural 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 natural capacity of water to perform work. **Wetlands with actively managed or wholly artificial hydrology will usually score in this range or lower.**
<0.6	*Non-functioning*	Water source diminished enough to threaten jurisdictional classification of the AA.	Frequency, duration or magnitude of unnaturally high-water great enough to change the fundamental characteristics of the wetland.

Variable 4 Score ☐

Variable 5: 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. To score this variable, identify stressors that alter flow patterns and impact the hydrograph within portions of the AA, including localized increases or decreases to the depth or duration of the water table or surface water. In naturally confined rivers (i.e. canyons and gullies) floodplain width is generally very small, so these systems will tend to score high for this variable unless some gross stressor is present.*

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.

✓	**Stressors**	**Comments/description**
☐	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 Class	Non-riverine	Riverine
1.0 - 0.9	*Reference Standard*	Little or no alteration has been made to the way in which water is distributed throughout the wetland.	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	*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	*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	*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	*Non-functioning*	More than 66% of the AA is affected by hydrologic alteration which changes the fundamental functioning of the wetland system	Historical active floodplain areas are almost never wetted from overbank flooding, and/or groundwater infiltration is effectively cut off.

Variable 5 Score ☐

Variable 6: Water Outflow

This variable is concerned with down-gradient hydrologic connectivity and the flow of water (transporting materials and energy) out of the AA. 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, and infiltration/groundwater recharge. 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. In Variable 5, the stressors were evaluated in light of their impact on water distribution within the AA. To evaluate this variable focus on how water, energy and associated materials are exported out of the AA.

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

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

Variable Score	Condition Class	Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Stressors have little to no effect on the magnitude, timing or hydrodynamics of the AA water outflow regime.
<0.9 - 0.8	*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	*Functioning*	High- or low-water outflows are moderately affected, mild alteration of intermediate level outflow occurs; or hydrodynamics mildly to moderately affected.
<0.7 - 0.6	*Functioning Impaired*	Outflow at all stages is moderately impaired resulting in persistent flooding of portions of the AA or unnatural drainage; or outflow hydrodynamics significantly disrupted.
<0.6	*Non-functioning*	The natural outflow regime is severely disrupted. Down-gradient hydrologic connection severed or nearly so. Alterations may cause widespread unnatural persistent flooding or dewatering of the wetland system.

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 and water quality. The origin of pollutants may be in the AA or delivered from up-gradient or surrounding areas. 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 many stressors is identified via indirect indicators.

Scoring rules:

1. Stressors are grouped into categories 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 stressor category, determine the sub-variable score using the scoring guideline table provided on the second page of the scoring sheet.
   -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. Determine the variable score by following the scoring guidelines.

Stressor Category	Stressor Indicator	✓	Comments	Sub-variable Score
Nutrient Enrichment/ Eutrophication/ Oxygen (D.O.)	Livestock			
	Agricultural Runoff			
	Septic/Sewage			
	Excessive Algae or Aquatic Veg.			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
Sedimentation/ Turbidity	Excessive Erosion			
	Excessive Deposition			
	Fine Sediment Plumes			
	Agricultural Runoff			
	Excessive Turbidity			
	Nearby Construction Site			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
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			
Temperature	Excessive Temperature Regime			
	Lack of Shading			
	Reservoir/Power Plant Discharge			
	Industrial Discharge			
	Cumulative Watershed NPS			
	CDPHE Impairment/TMDL List			
Soil chemistry/ Redox potential	Unnatural Saturation/Desaturation			
	Mechanical Soil Disturbance			
	Dumping/introduced Soil			
	CDPHE Impairment/TMDL List			

Variable 7: Water and Soil Chemical Environment

Sub-variable Scoring Guidelines

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

Input each factor score from the stressor list 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 Class	Scoring Rules		
		Single Factor		**Composite Score**
1.0 - 0.9	*Reference Standard*	No single factor scores < 0.9	or	The factor scores sum > 4.5
<0.9 - 0.8	*Highly Functioning*	Any single factor scores ≥ 0.8 but < 0.9	or	The factor scores sum >4.0 but ≤4.5
<0.8 - 0.7	*Functioning*	Any single factor scores ≥ 7.0 but < 0.8	or	The factor scores sum >3.5 but ≤ 4.0
<0.7 - 0.6	*Functioning Impaired*	Any single factor scores ≥ 0.6 but <0.7	or	The factor scores sum >3.0 but ≤3.5
< 0.6	*Non-functioning*	Any single factor scores < 0.6	or	The factor scores sum < 3.0

Variable 7 Score

Variable 8: 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, diking, sedimentation due to absence of flushing floods, etc. In riverine systems geomorphic changes to stream channel should be considered if the channel is within the AA. Alterations may include bed surface changes (embeddedness or morphology changes), stream bank instability, and stream channel reconfiguration. Geomorphic changes are usually ultimately manifested as changes to wetland hydrology and water relations with vegetation. Geomorphic alteration 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. The effects of geomorphic change are addressed by other variables. All alterations to the geomorphology should be evaluated including small-scale impacts such as pugging, hoof sheer, and sedimentation which can be significant, but not immediately apparent, impacts.

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 Class	Scoring Guidelines
1.0 - 0.9	*Reference Standard*	Topography essentially unaltered from the natural state, or alterations don't 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	*Highly Functioning*	Alterations to topography result in small but detectable changes to habitat conditions throughout all or most of the AA; or changes causing more significant impacts but affecting less than 10% of the AA.
<0.8 - 0.7	*Functioning*	Changes to AA topography may be pervasive but generally mild. May include patches of more significant habitat alteration; or more significant alteration affecting less than 20 % of the AA.
<0.7 - 0.6	*Functioning Impaired*	At least one important surface type or landform has been eliminated or created; microtopography has been moderately altered throughout most or all of the AA, or more severe alterations affect less than 50% 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	*Non-functioning*	Geomorphic alterations have rendered the AA essentially unusable by *characteristic* wildlife species, or the physical setting no longer supports native plant communities.

Variable 8 Score

Variable 9: Vegetation Structure and Complexity

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. Score this variable by listing stressors that have affected the diversity, composition and cover of each vegetation cover class that would normally be present for the wetland type being assessed. For this variable, stressor severity is a measure of how much each vegetation stratum differs functionally from its natural condition.

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. Check each present or suspected vegetation layer in the third row of the table.

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

3. Estimate the percent coverage of each vegetation layer. Aerial photographs can be helpful for this but are not required.

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

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.

6. 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".

7. Add the "Veg. Layer Sub-variable Scores" and enter the sum in the labled cell to the right of the individual scores. Follow this same process for the "Percent Cover of Layer".

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

	Vegetation Layers				
Layers Scored *(check boxes to right to indicate scored layers)*					
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					

Percent 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 9 Score ☐

Sub-variable 9 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 Class	Scoring Guidelines
1.0 - 0.9	*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	*Highly Functioning*	Stressors present at an 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 much as 33% if stressors are confined to patches comprising less than 10% of the wetland.
<0.8 - 0.7	*Functioning*	Stressors present with enough intensity to cause significant changes in the character of vegetation, including alteration of layer coverage, structure 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% if stressors are confined to patches comprising less than 25% of the wetland.
<0.7 - 0.6	*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% if stressors are confined to patches comprising less than 50% of the wetland.
<0.6	*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, howe 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 - Neighboring Wetland Habitat Loss**	
	Variable 2:	**Habitat Connectivity - Migration/Dispersal Barriers**	
	Variable 3:	**Buffer Capacity**	
Hydrology	**Variable 4:**	**Water Source**	
	Variable 5:	**Water Distribution**	
	Variable 6:	**Water Outflow**	
Abiotic and Biotic Habitat	**Variable 7:**	**Chemical Environment**	
	Variable 8:	**Geomorphology**	
	Variable 9:	**Vegetation Structure and Complexity**	

Functional Capacity Indices

Function 1 -- Support of Characteristic Wildlife Habitat

$V1_{wetloss}$	+ $V2_{barriers}$	+ $V3_{buffer}$	+ (2 x $V9_{veg}$)			Total Functional Points		Functional Capacity Index
	+	+	+	+ ▨	+ ▨	=	÷ 5 =	

Function 2 -- Support of Characteristic Fish/aquatic Habitat

(3 x $V4_{source}$)	+ (2 x $V5_{dist}$)	+ 2 x $V6_{outflow}$	+ $V7_{chem}$	+ $V8_{geom}$		Total Functional Points		Functional Capacity Index
	+	+	+	+	+ ▨	=	÷ 9 =	

Function 3 -- Flood Attenuation

$V3_{buffer}$	+ 2 x $V4_{source}$	+ (2 x $V5_{dist}$)	+ 2 x $V6_{outflow}$	+ $V8_{geom}$	+ $V9_{veg}$	Total Functional Points		Functional Capacity Index
	+	+	+	+	+	=	÷ 9 =	

Function 4 -- Short- and Long-term Water Storage

V_{source}	+ (2 x $V5_{dist}$)	+ 2 x $V6_{outflow}$)	$V8_{geom}$			Total Functional Points		Functional Capacity Index
	+	+	+	+ ▨	+ ▨	=	÷ 6 =	

Function 5 -- Nutrient/Toxicant Removal

(2 x $V5_{dist}$)	+ $V7_{chem}$	+ $V8_{geom}$				Total Functional Points		Functional Capacity Index
	+	+	+ ▨	+ ▨	+ ▨	=	÷ 4 =	

Function 6 -- Sediment Retention/Shoreline Stabilization

$V3_{buffer}$	+ (2 x $V8_{geo}$)	+ (2 x $V9_{veg}$)				Total Functional Points		Functional Capacity Index
	+	+	+ ▨	+ ▨	+ ▨	=	÷ 5 =	

Function 7 -- Production Export/Food Chain Support

$V1_{wetloss}$	+ 2 x $V6_{outflow}$	+ $V7_{chem}$	+ $V8_{geo}$	+ (2 x $V9_{veg}$)		Total Functional Points		Functional Capacity Index
	+	+	+	+	+ ▨	=	÷ 7 =	

Sum of Individual FCI Scores ______

Divide by the Number of Functions Scored (usually 7) **÷ 7**

Composite FCI Score ______