# RIPARIAN AREA MANAGEMENT

**TR 1737-16 1999, Revised 2003**

## *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas*

**U.S. Department of the Interior**
Bureau of Land Management

**U.S. Department of Agriculture**
Forest Service

USDA NRCS
**U.S. Department of Agriculture**
Natural Resources Conservation Service

Copies available from:

Bureau of Land Management
National Business Center
BC-650B
P.O. Box 25047
Denver, Colorado 80225-0047

BLM/RS/ST-99/001+1737+REV03

# RIPARIAN AREA MANAGEMENT

*A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas*

by

Don Prichard - Work Group Leader
Fishery Biologist/Riparian-Wetland Coordinator
Bureau of Land Management
National Applied Resource Sciences Center, Colorado

**Work Group**

Forrest Berg
Stream Mechanics Engineer
Natural Resources Conservation Service
Riparian/Wetland Technical Team
Bozeman, Montana

Warren Hagenbuck
Regional Wetland Coordinator (retired)
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Russ Krapf
Soil Scientist
Bureau of Land Management
National Training Center
Phoenix, Arizona

Robert Leinard
Plant Ecologist
Natural Resources Conservation Service
Riparian/Wetland Technical Team
Bozeman, Montana

Steve Leonard
Riparian Ecologist/Grazing Management Specialist
Bureau of Land Management
National Riparian Service Team
Prineville, Oregon

Mary Manning
Ecologist
Forest Service
Northern Region
Missoula, Montana

Chris Noble
Soil Scientist
Natural Resources Conservation Service
Riparian/Wetland Technical Team
Bozeman, Montana

Janice Staats
Hydrologist
Forest Service
National Riparian Service Team
Prineville, Oregon

Technical Reference 1737-16
1999, revised 2003

U.S. Department of the Interior
Bureau of Land Management
National Applied Resource Sciences Center
P.O. Box 25047
Denver, CO 80225-0047

# Acknowledgments

The authors would like to thank the following individuals for the time they offered in review, comment, and development of this document: Al Amen, Mark Biddlecomb, Clay Bridges, Pam Clemmer, Mary D'Aversa, Jim Fogg, Karl Gebhardt, Paula Ledford, Ramone McCoy, and Paul Summers from the Bureau of Land Management; Lorena Corzatt and Susan Holtzman from the Forest Service; and Terry Costner, Marcus Miller, and Sandy Wyman from the Natural Resources Conservation Service.

The authors also extend a special thank you to Linda Hill and Jennifer Kapus of the National Applied Resource Sciences Center, and to the National Business Center, for doing a fine job in editing, layout, design, and production of the final document.

# Contents

Page

Acknowledgments . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .iii

I. Introduction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .1

II. Method Development . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .3

III. Definitions . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .5

IV. PFC Assessment Procedure . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .7
A. Review Existing Documents . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .7
B. Analyze the Definition of PFC . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .7
C. Assess Functionality . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .8
1. Attributes and Processes . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .8
2. Capability and Potential . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .10
3. Functioning Condition . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .11
4. Functional Rating . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .13
D. Institute the Process . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .14
1. Planning . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .14
2. Management . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .15
3. Monitoring . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .16

V. Quantification of Checklist Items . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .17
A. Hydrology . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .18
Item 1: Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events . . . . . . .19
Item 2: Fluctuation of water levels is not excessive . . . . . . . . . . . . . . .23
Item 3: Riparian-wetland area is enlarging or has achieve potential extent . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .24
Item 4: Upland watershed is not contributing to riparian-wetland degradation . . . . . . . . . . . . . . . . . . . . . . . . . . .26
Item 5: Water quality is sufficient to support riparian-wetland plants . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .30
Item 6: Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) . . . . . . . . . . . . . . . . . . . . . . . . . . . .31
Item 7: Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway) . . . . . . . . . . . . . . . . . . .32
B. Vegetation . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .33
Item 8: There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) . . . . . . . . . . . . . .34
Item 9: There is diverse composition of riparian-wetland vegetation (for maintenance/recovery) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .36

Item 10: Species present indicate maintenance of riparian-wetland soil moisture characteristics .................. 37
Item 11: Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) .................. 39
Item 12: Riparian-wetland plants exhibit high vigor .................. 40
Item 13: Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows .................. 42
Item 14: Frost or abnormal hydrologic heaving is not present .................. 43
Item 15: Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics .................. 45

C. Erosion/Deposition .................. 47
Item 16: Accumulation of chemicals affecting plant productivity/composition is not apparent .................. 47
Item 17: Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils .................. 48
Item 18: Underlying geologic structure/soil material/permafrost is capable of restricting water percolation .................. 51
Item 19: Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) .................. 52
Item 20: Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies .................. 53

VI. Summary .................. 55

Appendix A: Riparian-Wetland Lentic Checklist .................. 57

Appendix B: Potential and Capability Examples .................. 63

Appendix C: Lentic Riparian-Wetland Examples .................. 77

Appendix D: PFC—What It Is and What It Isn’t .................. 89

Appendix E: Common Wetlands .................. 93

Appendix F: Problem Wetlands .................. 97

Literature Cited .................. 103

Glossary of Terms .................. 109

# *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas*

# I. Introduction

Riparian-wetland areas are some of our most productive resources. They are highly prized for their recreation, fish and wildlife, water supply, cultural, and historic values, as well as for their economic values, which stem from their use for livestock production, timber harvest, and mineral extraction.

This document provides guidance for assessing the condition of any riparian-wetland area other than a lotic (riverine) area. These areas, which are called lentic areas, not only include jurisdictional wetlands as defined by the U.S. Army Corps of Engineers (1987), but also nonjurisdictional areas (e.g., deep water, freshwater, saline, marine, and estuarine) that provide enough available water to the root zone to establish and maintain riparian-wetland vegetation.

Proper functioning condition (PFC) is a qualitative method for assessing the condition of riparian wetland areas. The term PFC is used to describe both the assessment process and a defined, on the-ground condition of a riparian-wetland area.

The PFC **assessment** refers to **a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes** to assess the condition of riparian wetland areas. A checklist is used for the PFC assessment (Appendix A), which synthesizes information that is basic for determining a riparian-wetland area's health.

The on-the-ground **condition** termed PFC refers to **how well the physical processes are functioning**. PFC is a state of resiliency that will allow a lentic riparian-wetland area to hold together during wind and wave action events or overland flow events with a high degree of reliability. This resiliency allows an area to then produce desired values, such as waterfowl habitat, neotropical bird habitat, or forage over time. Riparian-wetland areas that are not functioning properly cannot sustain these values.

PFC is a qualitative assessment based on quantitative science. The PFC assessment is intended to be performed by a trained and experienced interdisciplinary (ID) team. Quantitative techniques support the PFC checklist and should be used in conjunction with the PFC assessment for individual calibration, where answers are uncertain, or where experience is limited. PFC is also an appropriate starting point for determining and prioritizing the type and location of quantitative inventory or monitoring necessary.

The PFC assessment has proven to be an excellent communication tool for bringing diverse groups to consensus. This process provides a common vocabulary for identifying the building blocks for the development of desired condition (DC) and resulting values.

*Again, the method developed for assessing PFC is qualitative and is based on using a checklist to make a relatively quick determination of condition. The purpose of this technical reference is to explain how this methodology was developed for lentic areas and to assist an ID team in answering checklist items by providing examples of and references to methods of quantification where necessary.*

# II. Method Development

The Bureau of Land Management (BLM), the Fish and Wildlife Service (FWS), and the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, worked together to develop the PFC method. The methodology for assessing the condition of running water (lotic) systems is presented in BLM Technical Reference (TR) 1737-9, *Process for Assessing Proper Functioning Condition* (Prichard et al. 1993), and the methodology for standing water (lentic) systems is presented in TR 1737-11, *Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas* (Prichard et al. 1994).

Technical Reference 1737-15, *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (Prichard et al. 1998) provides the background for how the PFC tool was developed. The PFC method has been implemented by BLM and adopted by several other agencies. In 1996, the BLM and the USDA Forest Service (FS) announced a cooperative riparian-wetland management strategy, which would include the NRCS as a principal partner. A National Riparian Service Team was formed to act as a catalyst for implementing this strategy.

This cooperative strategy recognized that if riparian-wetland areas are to be productive, they have to be managed on a watershed basis, which requires working together across ownership boundaries. To be successful, the agencies would need to use common terms and definitions and determine a minimum method for evaluating the condition of riparian-wetland areas. The BLM and the FS identified the PFC method as the starting point—as the minimum level of assessment for riparian-wetland areas.

# III. Definitions

To assess the condition of a riparian-wetland area, there must be a gauge to measure against. The definition of PFC in TR 1737-9 and TR 1737-15 establishes the gauge for assessing lotic systems. This definition has to be adjusted for lentic systems because they are affected by wind and wave energies or overland flow energies versus high flow events, and they typically have a restrictive layer (e.g., geologic structure/soil material/permafrost/manmade restrictive layer) that limits water percolation and maintains the site:

> **Proper Functioning Condition** - Lentic riparian-wetland areas are functioning properly when adequate vegetation, landform, or debris is present to: dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality; filter sediment and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize islands and shoreline features against cutting action; restrict water percolation; develop diverse ponding characteristics *to provide* the habitat and the water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses; and support greater biodiversity.

The components of this definition are in order relative to how processes work on the ground.

When adequate vegetation, landform, or debris is present to dissipate energy associated with wind and wave action or overland flow, then a number of physical changes begin to occur, such as reduced erosion, floodplain development, and improved flood-water retention. As physical aspects of an area begin to function, they start the process of developing wetland characteristics. *These physical aspects have to be functioning properly to sustain characteristics that provide habitat for resource values*.

For areas that are not functioning properly, changes have to be made to allow them to recover (e.g., acquire adequate vegetation). A change such as increasing vegetation cover results in changes that improve function. Recovery starts with having the right elements present to dissipate energy, which puts the physical process into working order and provides the foundation to sustain the desired condition.

Each riparian-wetland area has to be judged against its capability and potential. The capability and potential of natural riparian-wetland areas are characterized by the interaction of three components: 1) hydrology, 2) vegetation, and 3) erosion/deposition (soils).

> **Potential** is defined as the highest ecological status a riparian-wetland area can attain given <u>no</u> political, social, or economical constraints; it is often referred to as the "potential natural community" (PNC).

**Capability** is defined as the highest ecological status a riparian-wetland area can attain given political, social, or economical constraints. These constraints are often referred to as limiting factors.

Examples of how both potential and capability apply to the checklist and rating can be found in Appendix B. A more detailed discussion on potential and capability is found in Appendix B of TR 1737-15.

If a riparian-wetland area is not in PFC, it is placed into one of three other categories:

**Functional—At Risk** - Riparian-wetland areas that are in functional condition, but that have an existing soil, water, or vegetation attribute that makes them susceptible to degradation.

**Nonfunctional** - Riparian-wetland areas that clearly are not providing adequate vegetation, landform, or woody debris to dissipate energies associated with flow events, and thus are not reducing erosion, improving water quality, etc.

**Unknown** - Riparian-wetland areas for which there is a lack of sufficient information to make any form of determination.

# IV. PFC Assessment Procedure

The process for assessing lentic areas involves reviewing existing documents, analyzing the PFC definition, and assessing functionality using an ID team. Each step is important because it provides a foundation and a certain level of understanding necessary to complete the next step.

## A. Review Existing Documents

An ID team should review TR 1737-9, TR 1737-11, and TR 1737-15 before assessing functioning condition of lentic riparian-wetland areas. The ID team should also review the other technical references identified in TR 1737-9 and TR 1737-15, which provide a basis for assessing PFC, as well as thought processes that will be useful in assessing the functional status of any riparian wetland area. *Reviewing these documents helps an ID team develop an understanding of the concepts of the riparian-wetland area they are assessing*.

Other documents to review may include *Classification of Wetland and Deepwater Habitats of the United States* (Cowardin et al. 1979), local riparian-wetland vegetation classifications, soil survey reports, and riparian-wetland ecological site descriptions.

The level of information necessary to assess PFC for lentic riparian-wetland areas will vary. Some will require the magnitude of effort provided by an ecological site inventory (ESI) to assess functionality, while others can be assessed by using the lentic checklist in Appendix A. Information pertaining to ESI applications can be found in BLM's TR 1737-7, *Procedures for Ecological Site Inventory—with Special Reference to Riparian-Wetland Sites* (Leonard et al. 1992a).

When using the PFC method to assess functioning condition, existing files should be reviewed for pertinent information. For some riparian-wetland areas, enough information may exist to assess functionality without having to go to the field. However, field verification is desirable, if not necessary, in most cases. For other areas, the existing information will be useful in establishing capability and potential or trend.

## B. Analyze the Definition of PFC

When assessing PFC for lentic riparian-wetland areas, the definition of PFC must be analyzed. One way to do this is by breaking the definition down as follows:

> Lentic riparian-wetland areas are functioning properly when adequate vegetation, landform, or debris is present to:
>
> - dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality;
> - filter sediment and aid floodplain development;

- improve flood-water retention and ground-water recharge;
- develop root masses that stabilize islands and shoreline features against cutting action;
- restrict water percolation;
- develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses;
- and support greater biodiversity.

Lentic riparian-wetland areas are functioning properly when there is adequate stability present *to provide* the listed benefits *applicable* to a particular area. The analysis must be based on the riparian-wetland area's capability and potential. If, for example, the system *does not have the potential* to support woody vegetation, that criteria would not be used in the assessment.

## C. Assess Functionality

Assessing the condition of a lentic riparian-wetland area requires an ID team to look at the *entire area*. Attributes and processes do not always occur in equal balance throughout a lentic riparian wetland area. For example, overland flow might enter a given riparian-wetland area at one end and exit at the opposite end. In order to answer specific items on the lentic checklist, an ID team is going to have to go to the location where water and sediment are being supplied from the watershed to assess balance, to the location of the outlet to assess safe passage of flows, and look at the entire area to determine if flow patterns are altered by disturbance.

Stratified sampling may be appropriate for lentic areas when you assess and extrapolate from one riparian-wetland area to another area of the same type as long as environmental, management, and other factors relating to the assessment are constant. Even when these factors are constant, current aerial photos need to be checked to ensure conditions are the same. The procedure to do this is explained in BLM's TR 1737-12, *Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas* (Prichard et al. 1996).

### 1. Attributes and Processes

Assessing PFC involves understanding the attributes and processes occurring in a lentic riparian wetland area. *An ID team must determine the attributes and processes important to the riparian wetland area that is being assessed. If they do not spend the time to develop an understanding of the processes affecting an area, their judgement about PFC will be incomplete and may be incorrect.* The attributes and processes for the area being evaluated need to be identified. Table 1 provides a list of attributes and processes that may occur in any given lentic riparian-wetland area.

To understand these processes, an example of an Alaskan palustrine wetland area in both a functional and nonfunctional condition is provided in Figure 1. Applying the

**Table 1.** Attributes/Processes List.*

| Hydrogeomorphic | Erosion/Deposition |
|---|---|
| Ground-Water | Shoreline Stability |
| Discharge | Depositional Features |
| Recharge | |
| Permafrost | **Soils** |
| Continuous | Soil Type |
| Discontinuous | Distribution of Aerobic/ Anaerobic Soils |
| Flood Modification | Annual Pattern of Soil Water States |
| Inundation | Ponding Frequency and Duration |
| Depth | Restrictive Material |
| Duration | |
| Frequency | **Water Quality** |
| Semipermanently Flooded | Temperature |
| Shoreline Shape | pH |
| | Dissolved Solids |
| **Vegetation** | Dissolved Oxygen |
| Community Types | |
| Community Type Distribution | **Biotic Community** |
| Density | Aquatic Plants |
| Cover | Recruitment/Reproduction |
| Community Dynamics and Succession | Nutrient Enrichment |
| Recruitment/Reproduction | |
| Root Characteristics | |
| Survival | |

* This list provides examples of various attributes/processes that may be present in a riparian- wetland area. By no means is it complete.

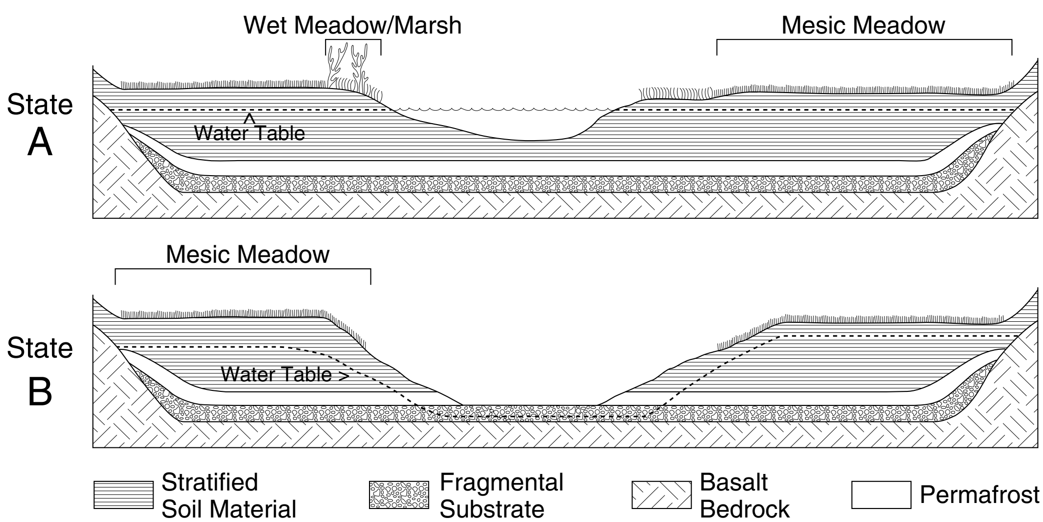



**Figure 1**. Proper functioning condition (State A) and nonfunctional condition (State B) for a lentic palustrine wetland area.

PFC definition, **State A** would be classified as PFC. Important attributes and processes present for **State A** are:

Hydrogeomorphic - Continuous permafrost; shoreline shape; and depth, duration, and frequency of inundation.

Vegetation - Community types and distribution, recruitment and reproduction, root density, community dynamics, and survival.

Erosion/Deposition - Shoreline stability.

Soils - Distribution of anaerobic soil and ponding frequency and duration.

Water Quality - No change.

Biotic Community - Aquatic plant recruitment and reproduction.

Land activities and natural processes that disrupt the permafrost layer would result in **State A** progressing to **State B**. **State B** would be classified as nonfunctional. The following changes in attributes and processes are likely in **State B**:

Hydrogeomorphic - Continuous permafrost (lost); shoreline shape (changed); and depth, duration, and frequency of inundation (decreased).

Erosion/Deposition - Shoreline stability (decreased).

Soils - Distribution of anaerobic soil and ponding frequency and duration (decreased).

Water Quality - Temperature (increased), pH (changed).

Biotic Community - Aquatic plant recruitment and reproduction (decreased).

The previous example is found in Alaska and represents only one of many types of lentic riparian wetlands. However, it is important to remember that there are other types and that:

*Riparian-wetland areas do have fundamental commonalities in how they function, but they also have their own unique attributes. Riparian-wetland areas can and do function quite differently. As a result, most areas need to be evaluated against their own capability and potential. Even for similar areas, human influence may have introduced component(s) that have changed the area's capability and potential. Assessments, to be correct, must consider these factors and the uniqueness of each area.*

## 2. Capability and Potential

Determining functionality of lentic riparian-wetland areas involves determining an area's capability and potential. The approach is:

- Look for reference areas (relic areas, exclosures, preserves, etc.).
- Seek out historic photos, survey notes, and/or documents that indicate historic condition.

- Search out species lists (animals and plants - historic and present).
- Determine species habitat needs (animals and plants) related to species that are/were present.
- Examine the soils and determine if they were saturated at one time and are now well-drained.
- Examine the hydrology; establish the frequency and duration of flooding/ponding.
- Identify vegetation that currently exists and determine if the same species occurred historically.
- Determine the entire watershed's general condition and identify its major landform(s).
- Look for limiting factors, both human-caused and natural, and determine if they can be corrected.

This approach forms the basis for initiating an inventory effort like ESI. For some areas, conducting an ESI effort will be the only way to assess an area's capability and potential.

### 3. Functioning Condition

The steps in Figure 3 of TR 1737-15 provide examples of the relationship between PFC and vegetation community succession for a lotic riparian-wetland area. This relationship can be applied to lentic riparian-wetland areas as well. If vegetation succession continues uninterrupted (Step 1 to Step 2), the riparian-wetland site will progress through some predictable changes from early seral to potential natural community (although not necessarily as linearly as depicted). As the vegetation community progresses, the riparian-wetland area will advance through phases of not functioning, functioning at-risk, and functioning properly.

At various stages within this successional process, the riparian-wetland area will provide a variety of values for different uses (Step 4). Optimal conditions for grazing occur when forage is abundant and the area is stable and sustainable. Wildlife goals depend upon the species for which the area is being managed. If the riparian-wetland area is to provide nesting habitat for songbirds, the optimum conditions might be late seral. If the area is to provide feeding habitat for shorebirds, the optimum condition might be mid-seral. Lentic riparian-wetland areas can function properly before they achieve their potential. The PFC definition does not mean potential or optimal conditions for a particular species have to be achieved for an area to be rated as functioning properly. *The threshold for any goal is at least PFC because any rating below this would not be sustainable. For riparian-wetland areas, PFC may occur from early seral to late seral.* Desired plant community (DPC) is then determined based on management objectives through an interdisciplinary approach (Step 5 in Figure 3, TR 1737-15), eventually achieving the desired condition (Figure 2). *Plant communities and future condition need to be balanced within a watershed(s) and within an ecoregion(s).*

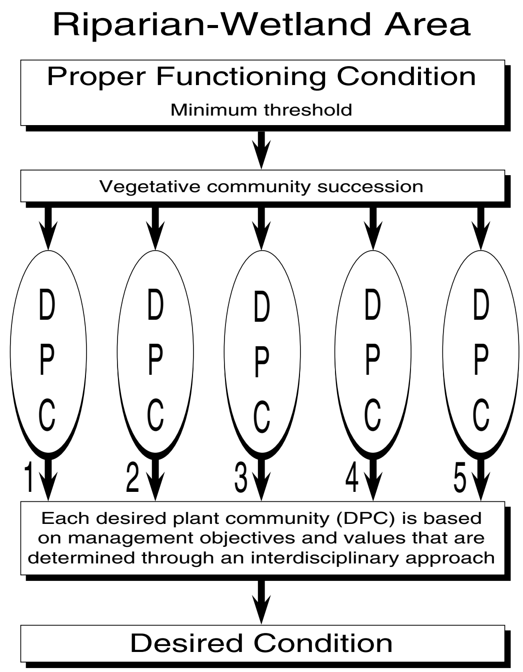



**Figure 2**. A riparian-wetland area in PFC may contain several different plant communities. A desired management condition may include several of these communities in some proportion.

When determining whether a lentic riparian-wetland area is functioning properly, it is important to determine the condition of the entire watershed. The entire watershed can influence the quality, size, and stability of a riparian-wetland area by affecting production of sediment, water, and nutrients, influencing inundation/saturation frequency and duration, and modifying the distribution of chemicals.

When rating functionality, it will be easy to categorize many lentic riparian-wetland areas as being in PFC or nonfunctional. For others it will not be easy. Difficulty in rating PFC usually arises in identifying the thresholds that allow a riparian-wetland area to move from one category to another. Using the lentic checklist (Appendix A) helps to ensure consistency in assessing functionality.

This checklist may not answer the question of functionality for all lentic riparian-wetland areas. On occasion, ID teams will find that blending the lentic checklist with the lotic checklist is necessary to assess functionality for some riparian-wetland areas. Some areas may require a more intensive inventory, like ESI. ID teams can add elements to the lentic checklist to address unique riparian wetland attributes and processes. *If an item is added, an ID team needs to make sure this addition can be quantified*. Appendix C provides examples of lentic riparian-wetland areas that depict the categories of PFC, functional—at risk, and nonfunctional to further assist in assessing functionality.

As with any tool, PFC has its limits. Appendix D describes what PFC is and isn't, and what it can and can't do.

### 4. Functional Rating

Following completion of the checklist, a "functional rating" is determined based on an ID team's discussion. When determining the functional rating, it is important for the ID team to understand the type of riparian-wetland being assessed. Appendix E provides examples of some of the more common riparian-wetland types while Appendix F provides examples of some of the more complex riparian-wetland types. The ID team must review the "yes" and "no" answers on the checklist and their respective comments about the severity of the situation, then collectively agree on a rating of proper functioning condition, functional—at risk, or nonfunctional. If an ID team agrees on a functional—at risk rating, a determination of trend is then made whenever possible.

There is no set number of "no" answers that dictate whether an area is at-risk or nonfunctional. This is due to the variability in kinds of lentic riparian-wetland areas (based on differences in climatic setting, geology, landform, and substrate) and the variability in the severity of individual factors relative to an area's ability to withstand wind action, wave action, and overland flow. A **properly functioning** riparian-wetland area will provide the elements contained in the definition:

- dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality
- filter sediment and aid floodplain development
- improve flood-water retention and ground-water recharge
- develop root masses that stabilize islands and shoreline features against cutting action
- restrict water percolation

**in accordance with its capability and potential.**

If a riparian-wetland area possesses these elements, then it has a **high probability to withstand wind action, wave action, and overland flow events.** If all the answers on the checklist are "yes," this area is in proper functioning condition. However, if some answers on the checklist are "no," this area may still meet the definition of PFC. The ID team reviews the "no" answers and determines if any of these answers make this riparian-wetland area susceptible to degradation from wind action, wave action, and overland flow events. If they do, the ID team would rate the area and explain why it is something less than PFC.

A **functional—at risk** riparian-wetland area will possess some or even most of the elements in the definition, but have at least one attribute/process (Table 1) that gives it a **high probability of degradation with wind action, wave action, and overland flow event(s).** Most of the time, several "no" answers will be evident because of the interrelationships between items. If the ID team thinks that these "no" answers collectively provide the probability for degradation from the events mentioned above, then the rating is functional—at risk. If there is disagreement among team members after all comments have been discussed, it is probably advisable to be conservative in the rating (i.e., if the discussion is between PFC and functional—at risk, then the rating should be functional—at risk). One situation where only one "no" answer indicates a lentic riparian wetland area is at risk is when a structure is not accommodating safe passage of flows because a headcut is starting to affect the dam or spillway. The riparian-wetland above the structure is then rated as functional—at risk regardless of other factors. The prairie pothole wetland example in Appendix C provides an example of this.

**Trend** must be determined, if possible, when a rating of functional—at risk is given. Preferably, trend is determined by comparing the present situation with previous photos, trend studies, inventories, and any other documentation or personal knowledge attained in a review of existing documents or interviews prior to the PFC assessment. In the absence of information prior to the assessment, indicators of "apparent trend" may be deduced during the assessment process. Recruitment and establishment of riparian-wetland species (or the absence thereof) that indicate an increase (or decline) in soil moisture characteristics can be especially useful. However, care must be taken to relate these indicators to recent climatic conditions as well as to management. If there is insufficient evidence to make a determination that there is a trend toward PFC (upward) or away from PFC (downward), then the trend is not apparent.

**Nonfunctional** riparian-wetland areas **clearly lack the elements** listed in the PFC definition. Usually nonfunctional riparian-wetland areas translate to a preponderance of "no" answers on the checklist, but not necessarily all "no" answers. A riparian-wetland area may still be saturated at or near the surface or inundated in "relatively frequent" events, but be clearly nonfunctional because it lacks vegetation to protect the area from erosion and deposition. The lack of vegetation and inability to buffer the sediment being supplied greatly reduce the extent of this wetland and prevent it from recovering.

It is imperative for management interpretation of the checklist to document *factors contributing to unacceptable conditions outside management's control* for functional—at risk and nonfunctional ratings where achievement of PFC may be impaired. It is desirable to document any of the factors listed if they occur, even if they don't appear to be affecting the achievement of PFC. Their presence may still affect achievement of desired condition for other values when compared to a natural system.

## D. Institute the Process

### 1. Planning

The process established in TR 1737-15 for incorporating information into a management plan would apply to lentic riparian-wetland areas also:

**Step 1** **Existing Condition** - Determine the existing riparian-wetland and watershed condition using the standard checklist.

**Step 2** **Potential** - Each area is assessed relative to its potential. Determine potential by using reference areas, historic photos, etc. (ESI process).

**Step 3** **PFC** - Determine the minimum conditions required for the area to function properly.

**Step 4** **Resource Values** - Determine existing and potential resource values and the plant communities necessary to support these values.

**Step 5** **Management Goals** - Identify specific objectives to reach management goals for the watershed, PFC, DPC, or DC.

**Step 6** **Planned Actions** - Design management actions to achieve PFC and then DC.

**Step 7** **Monitoring** - Design appropriate monitoring strategies to assess progress towards meeting management goals.

**Step 8** **Flexibility** - Maintain management flexibility to accommodate change based upon monitoring results.

### 2. Management

Successful management of lentic riparian-wetland areas requires implementation of a well-conceived plan. Appropriate strategies and practices that consider the entire watershed should be used. Upland and lentic riparian-wetland areas are interrelated and cannot be managed separately.

Inferences about habitat condition can be made from the PFC assessment. Generally, a lentic riparian-wetland area in nonfunctional condition will not provide quality habitat conditions. One that is in PFC can be expected to provide at least some quality habitat. Additionally, an area in PFC can be managed for improved habitat, if that is an objective.

The PFC assessment can be used as a tool for prioritizing either additional inventory needs or restoration activities. PFC provides a sorting that allows the establishment of priorities. Functional—at risk areas with a downward trend should receive priority for treatment. These areas may be near the threshold of rapidly degrading into a nonfunctional condition. Planned actions to begin recovery can usually be implemented at a much lower cost in these areas. Once an area is nonfunctional, the effort, cost, and time required for recovery may dramatically increase.

Restoration of nonfunctional systems should be reserved for those situations when:

- recovery *is possible,*
- efforts are not at *the expense* of at-risk systems,
- or unique opportunities exist.

At the same time, areas that are functioning properly are usually not the highest priorities for restoration because they are more resilient than the at-risk areas. It is critical to manage PFC areas to retain their resilience and further recovery toward desired condition. Identifying systems in PFC also allows local managers to assess why these systems have fared well in the past and to possibly use them as models for recovery of similar systems.

The PFC assessment can also help determine the appropriate timing and design of riparian-wetland restoration projects (including structural and management changes). It can identify situations where structures are either entirely inappropriate or premature.

The results of the PFC assessment can be used in watershed analysis. While the methodology and resultant data are site-specific, the ratings can be aggregated and analyzed at the watershed scale. The PFC method is most useful when condition is determined based on local information, experience, and knowledge of functions and processes at the watershed scale. Information from the PFC assessment, along with other watershed and habitat condition information, helps provide a good picture of watershed health and the possible causal factors affecting watershed health. Using the PFC method will help to identify watershed-scale problems and suggest management remedies and priorities. *These management decisions are derived by concentrating on the "no" answers on the checklist.* Additional uses for this information can be found in TR 1737-15, Appendix E.

There are other documents that can be helpful in assisting with this process: BLM's TR 1737-14, *Grazing Management for Riparian-Wetland Areas* (Leonard et al. 1997), provides grazing management principles, concepts, and practices that have been effective in improving and maintaining desired conditions on riparian-wetland areas, and *Prescribed Grazing* (USDA NRCS Field Office Technical Guide, Section IV, Practice No. 528) provides guidance for establishing grazing management plans. For other forms of management, such as recreation development, mining opportunities, timber practices, and watershed treatments, BLM's TR 1737-6, *Management Techniques in Riparian Areas* (Smith and Prichard 1992), provides suggested practices. With a change in management, most riparian-wetland areas can achieve PFC in a few years, but some will take many years to achieve the identified DPC or advanced ecological status.

### 3. Monitoring

Management effectiveness and progress can be assessed and documented with monitoring. A good monitoring plan, including a schedule for field visits and the protocol to be used, must be developed as a part of the management plan. For monitoring to be effective, field sites must be revisited on a scheduled basis. Monitoring reflects trends and will show whether the planned objectives are being achieved.

A number of references are available to help when developing monitoring plans. Inventory and Monitoring of Riparian Areas, BLM TR 1737-3 (Myers 1989), provides guidance. The *Integrated Riparian Evaluation Guide* (USDA FS 1992) provides some specific protocols that can be used for monitoring riparian-wetland areas. The *National Range and Pasture Handbook* (USDA NRCS 1998c) provides general guidance for rangeland monitoring, which can also be used for riparian-wetland area monitoring.

# V. Quantification of Checklist Items

As long as the procedure is followed and the definitions are understood, the PFC assessment will work for most sites because it was developed from rigorous science (ESI) and is performed by a trained and experienced ID team. However, there will be times when items from the checklist need to be quantified.

There is a considerable body of literature addressing relationships between soils, vegetation, hydrology, and other riparian-wetland functions, as well as a growing number of "success stories" from which empirical comparisons can (and have) been made. The references presented here are selected as examples of supporting documentation for the PFC assessment. *By no means are these references all-encompassing, as there are many other ways to quantify these items.*

The checklist items are designed to address the common attributes and processes that have to be in working order for a lentic riparian-wetland area to function properly. Each item on the checklist is answered with a "yes," meaning that the attribute or process is working, a "no," meaning that it is not working, or an "N/A," meaning the item is not applicable to that particular area. For any item marked "no," the severity of the condition must be explained in the "Remarks" section and must be discussed by the ID team in determining riparian-wetland functionality. Using the "Remarks" section to also explain items marked "yes" is **encouraged** but not required.

The intent of each checklist item, examples of how each item might be answered, and ways to quantify each item are outlined below. *These examples should not be misconstrued as a cookbook, as there are many riparian-wetland types.* Before assessing condition of any riparian wetland area, its attributes and processes have to be defined to answer the checklist items correctly.

It is important to note that many of the checklist items are closely related. This provides a system of checks and balances for how any one item is answered. For example, if item 6 (natural surface or subsurface flow patterns are not altered by disturbance) is answered "yes" for a recovering system, item 1 should be answered "yes" because the riparian-wetland area is being saturated or inundated in relatively frequent events. It is also important to note the items are numbered for the purpose of cataloging comments and that the numbers do not declare importance. The importance of any one item will vary relative to a riparian-wetland area's attributes and processes. However, there is an order to when some of the items are answered "yes." Any time item 13 is answered "yes," more than likely items 8, 9, 10, and 11 will be answered "yes." For a riparian-wetland area to recover or be maintained, the right plants have to establish themselves and then produce the adequate amount of cover. The supporting science for some of the items is the same or overlapping. Explanations are with the most appropriate items, but some cross-referencing may be required.

## A. Hydrology

Hydrologic attributes and processes are addressed in this section relative to presence and function. The term "wetland hydrology" encompasses all hydrologic characteristics of lentic areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas with evident characteristics of wetland hydrology are those where the presence of water has an overriding influence on characteristics of vegetation and soils due to anaerobic and reducing conditions, respectively. Such characteristics are usually present in areas that are inundated or saturated to the surface for sufficient duration to develop hydric soils and support vegetation typically adapted for life in periodically anaerobic soil conditions. Hydrology is often the least exact of the parameters, and indicators of wetland hydrology are sometimes difficult to identify in the field. However, it is essential to establish that a wetland area is periodically inundated or has saturated soils during the growing season (Prichard et al. 1994).

The Federal Government's standard for classifying wetlands is described in Cowardin et al. (1979), which is available on the Internet at **http://www.nwi.fws.gov**. This system provides ecological and hydrological information for the identification, classification, and mapping of wetlands and deepwater habitats in the United States and its territories. The standard was selected by the Federal Geographic Data Committee in 1996. Systems are the highest level of the classification hierarchy; five are defined—marine, estuarine, riverine, lacustrine, and palustrine. Systems are further divided by subsystems and classes. Water regime, water chemistry, and soil modifiers are used at the class level to further describe wetlands. For riverine systems, the process for assessing PFC for lotic systems should be used (TR 1737-15). Palustrine wetlands that are periodically inundated from overbank flows may occur adjacent to riverine systems, but are not included as part of the riverine system. In those cases, and in others where a mixture of lotic and lentic systems occur, both the lotic and lentic PFC definitions and checklist questions should be examined in order to understand the important attributes and processes of those systems.

BLM's TR 1737-7 (Leonard et al. 1992a) details field procedures for describing and documenting site information (ESI) as it applies to the interaction of soils, hydrology, and vegetation for riparian-wetland resources and uplands. This method is a rigorous science base for classifying riparian-wetland sites and the quantitative measures used in ESI can be used for items 1-7 in the hydrology section of the checklist.

References associated with the hydrogeomorphic model (HGM) (Brinson 1993; Smith et al. 1995; Brinson et al. 1995; and Walton et al. 1995) describe another approach for assessing wetland functions that could also be used for items 1-7 in the hydrology section. The HGM approach includes a development and application phase. In the development phase, wetlands are classified into regional subclasses based on hydrogeomorphic factors. A functional profile is developed to describe the characteristics of the regional subclass, identify the functions that are most likely to be performed, and discuss the characteristics that influence how those functions are performed. Reference wetlands are selected to represent the range of variability exhibited by the regional subclass in a reference domain, and assessment models are constructed and calibrated by an ID team based on reference standards and data from reference wetlands. Reference standards are the conditions exhibited by the undisturbed, or least disturbed, wetlands and landscapes in the reference domain. The functional indices resulting from the assessment models provide a measure of the capacity of a wetland to perform functions relative to other wetlands in the regional subclass. The application phase of the approach or assessment procedure includes characterizing the wetland, assessing its functions, analyzing the results of the assessment, and applying them to a specific project (Smith et al. 1995).

## Item 1: Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events

***Purpose***

Water creates and maintains all wetlands. Cowardin et al. (1979) state, "In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface." The purpose of item 1 is to document that inundation or saturation is long enough in duration and occurs frequently enough to maintain wetland characteristics.

***Examples***

Item 1 would be answered "yes" if evidence of inundation or saturation, such as hydric soils, standing water, or recent deposits of sediment and/or debris on the floodplain from overbank flows, is apparent. Another indicator for a "yes" answer would be if obligate wetland (OBL) species and/or facultative wetland (FACW) species dominate a site. Additional information on how vegetation is used as a wetland indicator is provided in the vegetation section.

Item 1 would be answered "no" if the evidence of saturation or inundation is less than in the past. One indicator of this may be where obligate upland (UPL) and facultative upland (FACU) species are encroaching on OBL and FACW species, indicating a loss of hydrology. Another indicator is a soil with hydric properties, which presently lacks periods of inundation or saturation.

There is a strong relationship between item 1 and items 3, 6, 10, and 17. If item 1 is answered "no," then these items will usually be answered "no" also.

***Supporting Science/Quantitative Methodologies***

Even though the factors influencing the wetness of an area are numerous (e.g., precipitation, topography, soil characteristics, plant cover, ground water), all lentic sites have a source of water consistent enough to cause anaerobic (no oxygen) and reducing (i.e., loss of electrons from metal or metallic element) conditions. The source of water for riparian-wetland areas may be precipitation, runoff, flooding, tidal influence, ground water, or some combination of sources.

Inundation or saturation must occur often enough (frequency) and long enough (duration) to develop and maintain the anaerobic and reducing conditions. Both "measurements" and "field observations" are helpful to document that saturation or inundation is occurring in the "relatively frequent" events within the potential or capability of the site. Local knowledge and historical records should be used as much as possible, especially where problem wetlands are concerned. *If a jurisdictional wetland determination is made, the U.S. Army Corps of Engineers (COE) 1987 Wetlands Delineation Manual should be consulted for information on the criteria, primary indicators, and secondary indicators necessary to meet the wetland hydrology, soils, and vegetation requirements.* However, within the context of PFC, riparian-wetland areas are broadly defined to include nonjurisdictional types that do not meet the hydric soils or wetland hydrology definition in U.S. Army COE (1987) or the Clean Water Act.

Where available, hydrology data from local soil surveys should be used in conjunction with **recorded data**. Gage data, such as lake, tidal, ground water, and stream stage, along with precipitation data, are available from different sources, depending on the location. These sources include the U.S. Geological Survey (USGS); COE District Offices; Bureau of Reclamation (BOR); NRCS; Tennessee Valley Authority (TVA); National Oceanic and Atmospheric Administration (NOAA); Highway Departments; and other State, County, and local agencies.

USDA NRCS (1997) describes a nine-step process for using stream and lake gages to document the timing, duration, and frequency of inundation adjacent to streams and lakes. At least 10 years of gage data during the growing season are needed. The highest stage of each year that is exceeded for a predetermined duration is determined. If the inundation criterion is 7 days, the lowest stage occurring during those 7 days of high flow is recorded. The median recorded stage readings are tabulated in descending order, and the median value computed. Any land in the immediate vicinity of the gage below this median elevation would be inundated for the inundation criterion by out-of bank flooding during the growing season in 50 percent of the years, thus meeting the wetland criterion.

Few riparian-wetland areas have sufficient existing information on ground-water conditions or wells for mapping the water table, so it may be necessary to install well points. Well points are small-diameter (1-1/4- to 3-inch) metal or PVC well casings with short screened intervals to allow water to flow into the casings. The COE has installation procedures for placing monitoring wells in wetlands (Sprecher 1993). The NRCS state geologist or hydraulic engineer can also provide information on specifications for installing, casing, and sealing wells; taking and recording measurements; and local regulations concerning well development (USDA NRCS 1997).

Existing wells were likely drilled into the regional aquifer for water supply, and the water level might not be representative of the shallow ground-water conditions that support the riparian wetland area of interest. Using information from both nearby existing wells and installed well points helps an ID team to determine whether the riparian-wetland area is the result of a perched aquifer or is hydraulically connected to a regional system. This information is crucial for determination of regional versus local effects. Details on well depth, screened interval, and date of drilling for many wells are available from the USGS Water Resources Division. Well information for many wells drilled on public land and assistance in designing/planning ground-water monitoring projects can be obtained from BLM's National Applied Resource Sciences Center.

**Aerial photographs** are useful for documenting evidence and extent of wetland inundation or soil saturation (Clemmer 1994; Prichard et al. 1996). Comparing several years of photos will help in interpreting the effect of very dry or very wet periods. Acquiring photos taken during similar seasons or months will provide a more accurate comparison. Photography can also assist in preliminary identification of lentic sites for further field investigation based on the spectral response of localized vegetation around the site.

USDA NRCS (1997) describes a method using annual rainfall data and aerial photographs to document wetland hydrology. The annual rainfall total for each year is compared to the annual boundaries for wet and dry from the WETS table (see **www.wcc.nrcs.usda.gov** and click on climate for WETS table and associated documentation). The WETS table identifies the boundary where 3 in 10 of the precipitation amounts are wetter than normal value and the boundary where 3 in 10 values are drier than normal. Normal is considered to be values that fall between these two boundaries. Aerial photographs from years of average precipitation are compared with aerial photographs from wet years and dry years. If a wet signature appears for a site only in wet years, a good probability exists that wetland hydrology is not present under normal circumstances. If a wet signature is seen in both dry and wet years, the site may well meet wetland hydrology criteria. Where the wet signatures appear in wet and normal years, further study is needed to determine whether wetland hydrology exists on the site.

While recorded data can provide valuable information, **field observations** are also important. There are a number of hydrologic indicators that can be observed in the field:

- *Inundation*. Seasonal conditions and recent weather conditions should be considered. Surveyed cross sections can be used to document the elevation of high water. Harrelson et al. (1994) is a good reference for surveying basics and surveying cross sections.

- *Soil saturation*. Digging a soil pit to a depth of 16 inches and observing the water level in the hole after sufficient time has been allowed for water to drain into the hole will indicate soil saturation. The time required varies depending on the soil texture. In some cases, the depth to the water table (or upper level at which water is flowing into the pit) can be observed by examining the wall of the hole. Because of the capillary fringe, saturated soils will be nearer the surface (U.S. Army COE 1987).

Using an auger hole to confirm saturation may be inaccurate or misleading in clayey soils when only macropores are filled with water. Macropores may have filled during a recent rain while the soil matrix remained unsaturated. Tightly sealed piezometers or tensiometers are recommended to confirm saturation. These instruments should be sealed with clay (e.g., bentonite) to prevent surface water from running down the sides of the instruments (Vepraskas 1994).

There are hydric soils indicators that will show that wetland hydrology is present or has been present at some time. Histosols, Histic Epipedon, Black Histic, Hydrogen Sulfide Odor are usually saturated or inundated for much of most years for soil of all textures. Sandy Gleyed Matrix, Polyvalue Below Surface, Thin Dark Surface are the wetter hydric soil indicators for soil with sand or loamy sand soil textures. Loamy Gleyed Matrix, Thick Dark Surface are the hydric soil indicators for wetter soils of soil textures of sandy loam, sandy clay loam, clay loam, loam, silt loam, silty clay loam, sandy clay, and clay. While soils with all other hydric indicators will require a shorter duration of saturation or inundation, they will still have or have had wetland hydrology. See item 17 for more information on hydric soils.

Steel rods (rebar) can also be used to measure the depth to the water table in a wetland (Brigdham et al. 1991). Rebar is pounded into the wetland soil. The oxidation/reduction process that occurs during saturation will change the color of the steel rod and can be measured to indicate the depth to water table.

- *Watermarks*. Watermarks can be observed on fixed objects, such as woody vegetation, bridge pillars, fences, bedrock, or boulders.

- *Drift lines*. Evidence consists of linear deposition of debris or debris entangled in fixed objects such as vegetation. Debris is usually deposited parallel to the direction of water flow and provides an indication of the minimum portion of the area inundated during a flooding event.

- *Sediment deposits* (mineral or organic). Sediment deposition on vegetation and other objects provides an indication of the minimum inundation level.

- *Drainage patterns* (surface evidence of drainage flow into or through an area). Evidence consists of drainage patterns eroded into the soil, debris oriented perpendicular to the direction of water flow, or the absence of leaf litter. Scouring is often evident around roots of persistent vegetation. Because drainage patterns also occur on upland areas (i.e., ephemeral channels), topographic position must also be considered.

- *Oxidized rhizospheres* (zone of soil where living plant root and microorganisms occur). These are associated with living plant roots in the upper 12 inches of the soil.

- *Water-stained leaves* (works better in the eastern United States than in the western United States). Water stains on leaf litter indicate areas that have been inundated with water.

- *Vegetation.* Vegetation can be a useful indicator that an area is being saturated near the surface or inundated often enough. Existing vegetation needs to be compared against the potential for the site using an ecological site description, vegetation classification, or similar reference. When riparian-wetland species are not clearly dominant on a site, the FAC-neutral test (U.S. Army COE 1987) can be used and compared to the potential.

- *Soil Survey Data.* This data provides climatic information, soil classifications, and wetness characteristics of soils, such as frequency, duration, and timing of inundation.

Indicators above are mostly from the U.S. Army COE 1987 Wetland Delineation Manual. For nonjurisdictional riparian-wetland areas, the water table and wetland soil criteria may occur at a greater depth.

## Item 2: Fluctuation of water levels is not excessive

***Purpose***

Riparian-wetland vegetation plays an important role in the stability of most lentic riparian-wetland areas. Periodic flooding or saturation of these areas is necessary to promote and sustain this vegetation, but to do so, these water level changes must be within the range of plant tolerance. The purpose of item 2 is to determine if these water level changes are within the limits that will sustain the riparian-wetland vegetation.

***Examples***

Most lentic riparian-wetland areas require vegetation to function properly. The vegetation on these sites for the most part should be OBL and/or FACW species. If a riparian-wetland area is dominated by OBL and/or FACW species, the answer to item 2 would be “yes.” However, some lentic riparian-wetland areas only have the potential to produce facultative (FAC) species (see Appendix F). The answer to item 2 would be “yes” if these sites are dominated by FAC species. There are some sites that only produce OBL, FACW, FAC species during wet years and are dominated by UPL species during dry years (see Appendix F). The answer to item 2 would be “yes” if these sites are producing OBL, FACW, or FAC species during wet years even though they are dominated by UPL species during dry years, as this is the norm (see playa wetland example from New Mexico in Appendix B). Understanding the potential of the site is critical in order to answer the question correctly.

Item 2 would be answered “no” if bare soil or annual UPL species are present in place of OBL and FACW species as a result of changes in the water level. An example of this is a reservoir with constantly fluctuating water levels resulting in a zone of no vegetation. Other wetlands can also experience this if water is removed or added on an irregular basis. Natural systems will occasionally experience this as a result of irregular water fluctuation. Again, understanding site potential is crucial in these situations.

“N/A” would apply for those wetland types that do not require riparian-wetland vegetation to function properly.

There is a strong relationship between item 3 and items 1, 10, 12, and 17. If item 3 is answered “no,” then these items will often be answered “no” as well.

***Supporting Science/Quantitative Methodologies***

Riparian-wetland plants living along the edges of standing water bodies have adapted so that during drying periods, as long as water levels do not drop drastically, the plants will expand and occupy the newly exposed sites. During wetter periods, as the water body fills up again, some plants may be drowned out around the edges. If the elevation of the water level changes faster than the plants can respond, a “bathtub ring” effect occurs where riparian-wetland plants cannot survive, leaving bare ground. Excessive ground-water fluctuations or the combination of excessive ground-water and surface-water changes can cause similar vegetation effects. The “bathtub ring” effect is very obvious on aerial photos.

The recorded data discussed in item 1 can be used to document water level changes for this item (i.e., lake gage data). Comparing the rate of fill and the rate of with-drawal with similar systems in the region will help determine whether the water fluctuation is appropriate because of site potential or is a problem accelerated by some human-caused disturbance.

## Item 3: Riparian-wetland area is enlarging or has achieved potential extent

***Purpose***

Depending on a lentic area’s site characteristics, degradation can lead either to accel-erated sedimentation (filling in faster) or to loss or lowering of the water table. Either process has a detrimental effect on the riparian-wetland vegetation. Some riparian-wetland areas initially appear to be enlarging as they fill in. Deposition around shorelines provides more shallow water area for emergent vegetation. However, over the long-term, there is a decrease in extent as the circumference shrinks with declining catchment capacity. A loss or lowering of the water table can result in water stress (loss of vigor), lowered production, and eventually a complete loss of riparian-wetland vegetation. Recovery is expressed by an increase in riparian-wetland vegetation. The purpose of item 3 is to determine if a riparian-wetland area is recovering or has recovered.

Item 3 addresses two situations, enlarging or achieving potential extent, in order that a "yes" answer is always applied for a positive attribute or process.

***Examples***

Evidence that a riparian-wetland area is widening/enlarging may include an increase in the amount of appropriate vegetation (i.e., sedges, rushes, willows) that is replacing upland species, a rising water table, and the establishment of riparian-wetland vegetation in soils deposited along a shoreline/soil surface. Any of this evidence would result in a "yes" answer for item 3.

Potential extent can be largely determined by the adjacent topography (e.g., valley bottom width). If a riparian-wetland area has achieved potential extent, the answer to item 3 would be "yes."

Evidence that a riparian-wetland area is shrinking in extent may include an increase in upland vegetation (e.g., sagebrush, rabbitbrush, cheatgrass) and replacement of riparian-wetland species, such as sedges and rushes, with more drought-tolerant species, such as Kentucky bluegrass, western wheatgrass, and cheatgrass (especially on small raised areas). Any of this evidence would result in a "no" answer for item 3. The age of these nonwetland plants should be noted to determine the apparent trend. If they are old and the wetland species present are young and vigorous, the area may be enlarging rather than shrinking.

For areas where there is no potential for vegetation, an "N/A" answer would be given, as landform dictates functionality.

There is a strong relationship between item 3 and items 1, 10, 12, and 17. If item 3 is answered "no," then these items will often be answered "no" as well.

***Supporting Science/Quantitative Methodologies***

The presence of hydric soil and riparian-wetland vegetation are indicators of soil moisture conditions and water table. Soils and vegetation are key in delineating the extent of riparian wetland areas. Some hydric soil indicators, such as redoximorphic features, can persist in the soil even after a water table drops, indicating that the extent of a riparian-wetland area has been reduced. Change in composition from upland species like sagebrush to riparian-wetland species like Nebraska sedge is a good indicator that the riparian-wetland area is widening.

Where available, original survey notes should be obtained. Often the original surveyors made notes about the riparian-wetland areas they saw, and their observations can be very helpful in comparing a site with current riparian-wetland extent.

Aerial photos are a great tool for documenting change over time in riparian-wetland area acreages (Clemmer 1994; Prichard et al. 1996). The National Aerial Photography Program (NAPP) provides coverage of the lower 48 states every 5 to 7 years. Some shrinking and expansion of riparian-wetland areas can be associated with climate fluctuation. However, there may be a time lag for areas that are dependent on ground-water recharge.

To measure riparian-wetland extent in the field, several transects for soils and vegetation information should be established perpendicular to the down valley axis of the riparian complex. For soils, standard identification and delineation procedures (USDA NRCS 1998b and other NRCS soils manuals and handbooks; U.S. Army COE 1987) should be used. Vegetation community complex composition can be assessed using a line intercept transect (USDA FS 1992). Additional detail is included in the supporting science for the vegetation section (the questions are interrelated).

Monitoring wells discussed in item 1 can also be used to measure the expansion or contraction of a riparian-wetland.

### Item 4: Upland watershed is not contributing to riparian-wetland degradation

***Purpose***

The condition of the surrounding uplands can greatly affect the condition of a riparian-wetland area. Changes in upland condition can influence the magnitude, timing, or duration of overland flow events, which in turn can affect a riparian-wetland area. The purpose of item 4 is to determine if there has been a change in the water or sediment being supplied to a riparian-wetland area, and whether it is resulting in *degradation.* Although a correlation can exist, the focus here is on whether uplands are or are not contributing to degradation, and not on the condition of the uplands.

***Examples***

It is possible to have disturbances in the uplands and still not see major changes in magnitude, timing, or duration of overland flows having a negative impact on riparian-wetland areas. If there is no evidence of erosion deposits from the uplands that are *degrading* a riparian-wetland area, the answer to item 4 is "yes," even if the uplands are not in good condition.

Evidence that a riparian-wetland area is being degraded could include the formation of a large delta or sediment plumph where the overland flow enters a riparian-wetland, indicating that the water and sediment are not in balance with the watershed (see item 19). If this characteristic is present, the answer to item 4 would be "no."

Item 4 will never be answered "N/A;" it will always have a "yes" or "no" answer.

There is a strong relationship between item 4 and item 19. If item 4 is answered "no," then item 19 will usually be answered "no" also.

***Supporting Science/Quantitative Methodologies***

The watershed surrounding a riparian-wetland area can influence the hydrologic regime, water quality, sediment supply, and plant community composition. Water quality is discussed in item 5, and plant community composition is discussed in the vegetation section.

The hydrologic functions of riparian-wetland areas are governed by a water budget and a sediment budget. Depending on the type of riparian-wetland area, water enters a wetland as precipitation, incoming channel flow, overbank flow, overland flow from adjacent slopes, ground-water discharge, or some combination of these. Water is stored in a wetland as surface and subsurface storage, and is lost as runoff, evaporation/transpiration, and/or ground-water recharge. Sediments are deposited in a wetland from bedload, filtered from surface runoff, or precipitated from dissolved minerals in runoff and ground-water flows, and are lost through erosion (Zeedyk 1996). When a natural system is in dynamic equilibrium, it maintains a level of stability that permits internal adjustments of variables without producing rapid changes to the system.

Detrimental changes in water supply come from constraining or diverting surface and/or subsurface flows. An example would be upslope road ditches and cross drainage structures installed in a manner that concentrates overland flows away from the riparian-wetland area, causing desiccation of meadow soils (Zeedyk 1996). If human disturbance in a watershed increases the sediment delivery to a riparian-wetland area, the progression of states can be accelerated (Figure 3).

Aerial photos that cover several years or decades can be used to identify riparian-wetland adjustments through time for a particular riparian-wetland complex. Information on the use of aerial photos is provided in Clemmer (1994) and Prichard et al. (1996). Most of the photo interpretive techniques and procedures described in Prichard et al. (1996) for lotic sites can be applied to lentic sites.

A simplified method for analyzing a wetlands water budget and determining the relative importance of hydrologic and hydraulic processes is described in Walton et al. (1995). The processes can be based on the following balance equation:

$$Q_i + R + G = Q_o + ET + I$$

where

$Q_i$ = surface water flow into the system
R = direct rainfall on the wetland
G = ground-water discharge to the wetland
$Q_o$ = surface water flow out of the system
ET = evapotranspiration from the wetland
I = infiltration to the ground water.

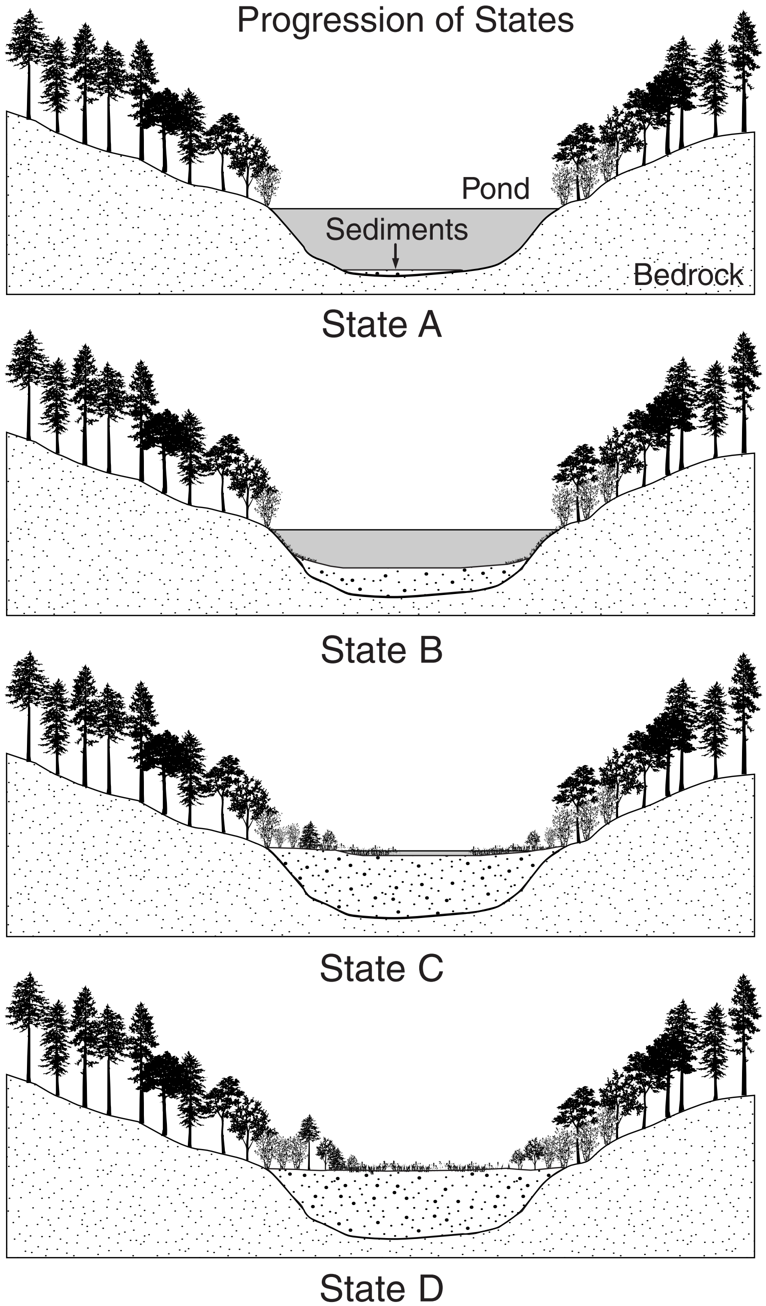



**Figure 3.** Filling and aging of a pond. State A: The pond is recently formed and deep, with steep, rocky walls. The water is very clear and productivity is low, with sparse plankton, no shore vegetation, and no bottom algae. Sediments, primarily silt brought in by streams, are beginning to accumulate on the bottom. State B: The pond has accumulated substantial sediments and is partly filled and the rock walls have eroded and are less steep. There is some shore vegetation and bottom algae, and productivity and the nutrient content of the water are higher. State C: The pond is largely filled by silt and organic sediments. The shores are on gradually sloping sediment; there are extensive marshes and shore vegetation, and algae occur over most of the bottom area. Productivity of the much-reduced volume of water is still high. State D: Filling of the pond and its occupation by terrestrial vegetation are completed. A small central marsh is the only remnant of the pond in an area of forest.

For many wetlands, these variables can be estimated using empirical methods or known data or both. For more information on water budgets, see USDA NRCS (1997) and Chapter 8 of Dunne and Leopold (1978).

Wetlands Research Program Technical Note SD-CP-4.1 describes four methods to measure sedimentation rates in wetland systems. The advantages and disadvantages of each are discussed, and their application to wetland evaluation considered (WRP 1993). The four methods are:

- *Modified sediment trap method.* A sediment trap in limnological and oceanographic research consists of a cylindrical column, which is approximately five times as tall as it is wide, that is submerged into the water body. These 5:1 aspect ratio columns are designed to prevent any resuspension of the trapped material. In situations where the cylinders would not stay submerged for the sampling period and resuspension of materials is a significant aspect of the sedimentation patterns of the wetland type, a method of using "sediment plates" has been developed. These plates are 15-cm-diameter Plexiglas circles. Each disk is anchored a known distance and direction from a known point to aid in relocating the disks later. Sampling frequency is determined by the hydrology of the system. The accumulated material is measured.

- *Feldspar clay marker horizon method.* Feldspar clay is spread out on the wetland surface, at a rate of 2 liters (L) per 0.25 square meter ($m^2$), at a known distance and direction from a known point. Sampling consists of locating the clay pad and taking a small core of the sediments deposited above the clay and the clay itself. The amount of material deposited above the bright white marker horizon can be easily measured. Sampling frequency depends on the hydrology of the wetland system. This method can be used in shallow standing water, as the feldspar clay will sink to the bottom and create a good marker horizon.

- *$^{137}$Cesium atmospheric fallout method.* $^{137}$Cesium is a product of nuclear fission reaction and does not occur naturally in the environment. Widespread global dispersal of $^{137}$cesium began with thermonuclear weapons testing in late 1952 and measurable amounts began to appear in the soil in 1954. Peak quantities occurred in 1963-64. $^{137}$Cesium is rapidly absorbed by suspended particles and the clay components of sediments and soil. Once deposited, it establishes a fairly stable marker. To measure $^{137}$cesium, sediment cores are taken in wetland and are sliced in increments appropriate to the anticipated rate of sedimentation. The sections are dried and $^{137}$cesium activity is counted with a lithium drifted germanium detector and multichannel analyzer. The procedure is expensive.

- *Dendrogeomorphic method.* Cores or cross sections of specific trees are taken to obtain the age relative to geomorphic processes.

Models such as the Pacific Southwest Interagency Committee Sediment Yield Procedure (PSIAC) can be used to estimate sedimentation rates. PSIAC is a sediment prediction model that includes overland production from uplands and channel erodibility.

Discussions on watershed health and riparian-wetland condition and quantitative methodologies for riverine wetlands can be found in Brinson et al. (1995), DeBano and Schmidt (1989), and Prichard et al. (1998) .

## Item 5: Water quality is sufficient to support riparian-wetland plants

***Purpose***

The maintenance of water quality is important for these sites to function properly. The purpose of item 5 is to determine if water quality is being maintained, *thus* allowing these sites to produce the kind of vegetation necessary for proper functioning.

***Examples***

Item 5 would be answered "yes" if multiple riparian-wetland species, such as black grass, salt grass, and salt meadow cord grass, are present in an estuarine intertidal wetland type. Presence of water smartweed, bladderwort, and pondweed in a palustrine emergent wetland would yield a "yes" answer to item 5 (examples of these wetlands can be found in Cowardin et al. 1979).

Item 5 would be answered "no" when a site is dominated by species that indicate poor water quality. An example of this would be when an algae bloom early in the growing season dominates a site. Another example for a "no" answer would be when only one species is present where there should be multiple species. A foul smell or discolored water should be further investigated to determine whether a water quality problem exists, or whether the foul smell is from anaerobic conditions and the discoloration is from a natural accumulation of organics.

If water quality is limiting (a "no" answer) and there are still plants present, they will almost always exhibit low vigor as described in item 12. However, the reverse is not always true; low vigor does not necessarily indicate a water quality problem.

"N/A" would apply for those wetland types that do not require riparian-wetland vegetation to function properly.

There is a strong relationship between items 5 and items 8 through 13. If water quality is so poor that it will not support riparian-wetland vegetation, then items 8 through 13 will usually be answered "no."

***Supporting Science/Quantitative Methodologies***

Lentic areas are "sinks" where water, nutrients, sediments, and other components accumulate as part of the natural processes. But, the presence of **pollutants** in any water body, including ground water, can cause problems with the health and vigor of plant life. A few examples are:

- Freshwater aquatic plants are negatively affected by cadmium (a heavy metal) at concentrations ranging from 2 to 7400 micrograms per liter (µg/l) and cyanide from 30 to 26000 µg/l.
- Abnormal accumulations of salts can stress some plants or change the composition to plants that can tolerate elevated amounts of salts.
- Inorganic suspended materials reduce light penetration into the water body, and can lead to the formation of films on plant leaves, which blocks sunlight and impedes photosynthesis (EPA 1986).

The geology of some watersheds naturally yield salts, calcium carbonates (from limestone), or other components that can inhibit plant growth. Understanding the geology, soils, and water source is important to assess whether the cause is appropriate because of site potential or is a problem accelerated by some human-caused disturbance in the watershed.

Water samples need to be collected and analyzed following each state's protocols (check with the State Department of Water Quality or equivalent), and the results compared against known quality criteria.

## Item 6: Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities)

***Purpose***

Alteration of surface or subsurface flow patterns may affect the functionality of a site. For areas where riparian-wetland vegetation is important, a change in flow patterns may mean a change in vegetation type (wetland species to upland species), creating a site unable to dissipate energies and function properly. For others, it may mean a change in extent of wetland or complete loss. The purpose of item 6 is to determine if surface or subsurface flow patterns are being maintained.

***Examples***

A "yes" answer would be given for item 6 for the PFC prairie pothole example from Montana in Appendix C. No disturbances, such as trailing, roads, or dams, are present that would affect surface flow patterns to the wetland. Disturbance within a watershed does not necessarily mean flow patterns are automatically altered. Roads, trails, dikes, and dams can be built and not affect the amount, time, or frequency of surface or subsurface flows. A key concept for a "yes" answer is whether a riparian-wetland area is receiving a normal range of surface and subsurface flows, even if there is disturbance within its watershed.

Item 6 would be answered "no" for the New Mexico lacustrine wetland example provided in Appendix C. The development of trails has intercepted, diverted, and concentrated overland flows away from the wetland site. This diversion and concentration of flows have initiated a headcut that is draining the site, thus reducing the wetland's ability to dissipate energies and function properly. Another example of a "no" answer would be where a highly variable seasonal wetland was excavated in the center, resulting in a reduction of the extent or the loss of wetland.

Item 6 can never be answered "N/A;" it is always answered "yes" or "no."

There is a strong relationship between item 6 and items 1, 3, 10, 14, and 17. If item 6 is answered "no," then one or more of these items may be answered "no."

***Supporting Science/Quantitative Methodologies***

If the natural surface or subsurface flow patterns of lentic areas are altered, the timing, frequency, magnitude, and duration of inundation or saturation can be affected, with corresponding changes to the soils and vegetation. Some examples are when a riparian-wetland is not inundated because a dike keeps flood waters out; a lentic area is drained by diverting surface or subsurface flow away from the site; or an area has compacted soils, which reduces the infiltration rate and increases runoff.

Surface flow pattern changes can be tracked using aerial photography (Clemmer 1994; Prichard et al. 1996). Also refer to the discussions under item 3 regarding changes in the extent of riparian wetland areas and under item 4 regarding changes in water flow.

## Item 7: Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway)

***Purpose***

Some lentic riparian-wetland areas have been altered through the addition of structures designed to capture more runoff, thus creating a more permanent or larger wetland. The prairie pothole region in eastern Montana and North Dakota provides many examples. However, when structures are placed to alter a riparian-wetland area, it is very important that the structure is designed and maintained to accommodate safe passage of flows. The purpose of item 7 is to determine if these structures are accommodating safe passage of flows.

***Examples***

If the ID team determines the structure is stable and accommodating flows, the answer to item 7 would be "yes." If there is erosion, leakage, or a headcut affecting the integrity of the dam or spillway, the answer to item 7 would be "no." An example is provided in Appendix C. For the functional—at risk prairie pothole example in Montana (Appendix C), item 7 would be answered "no" because a headcut has developed in the spillway and is threatening the integrity of the dam.

If no structures are present, item 7 is answered "N/A."

***Supporting Science/Quantitative Methodologies***

Gully erosion occurs when headcuts form and an area downcuts. As the gully bottom downcuts, it deepens and then widens, thereby endangering the structure. Headcuts extend upstream or upslope into ungullied headwater areas, increasing the number of drainage channels (i.e., by developing additional tributaries) (Heede 1976). If there is a headcut or nickpoint present downstream of a dam or other structure, there is the possibility that the headcut will advance upstream, removing part of the structure and causing the wetland area to be eroded and drained. If left unchecked, a headcut will proceed upstream until some hard point, such as a bedrock outcrop, is encountered or a smooth transition between upstream and downstream gradient is attained (Heede 1980).

When assessing item 7, the presence or absence of any headcuts below a structure should be noted.

## B. Vegetation

Items 8-15 address vegetation attributes and processes that should be in working order for a lentic riparian-wetland system to function properly. Landform can play a major role in defining the riparian-wetland setting. Wide, flat valley bottoms result in mosaics of vegetation, or complexes. The riparian-wetland complex as described in the *Intermountain Region Integrated Riparian Evaluation Guide* (USDA FS 1992) is influenced by the valley bottom setting. The complex is comprised of patches of community types, in various amounts and locations. In assessing functionality, the whole complex should be considered in order to understand such items as age class distribution and species diversity.

The site potential should be evaluated when determining vegetation types that can be found in lentic riparian-wetland areas. Many lentic riparian-wetland areas do not have the soil and hydrology conditions needed to support tree or shrub species. Many of these wetland types do not need tree or shrub species for physical stability. These species may be a component for desired condition, but are not required to designate a lentic riparian-wetland area as functioning properly.

Factors such as the kind, proportion, and amount (cover or density) of vegetation in the riparian wetland community contribute to the assessment of shoreline-forming/soil surface vegetation and the encroachment of upland vegetation. The linear distribution of vegetation is the primary factor affecting the extent of eroded shorelines/soil surfaces, assuming that the right kinds and proportions of species are in the community (or simply the inverse relationship—the amount of shorelines or soil surfaces lacking the right kind and amount of vegetation). Lateral distribution of vegetation determines the riparian-wetland area's ability to accommodate periods of wind action, wave action, and overland flows and drought. In order to persist or improve, the plant species or communities of interest must be both healthy (vigorous) and replacing or increasing their numbers or extent through recruitment into the community.

The level III riparian area evaluation from the USDA FS (1992) provides measurement techniques for cross-section composition of the riparian-wetland complex, vegetation composition within a complex and along the greenline, and woody species regeneration. Each item, except for items 12, 14, and 15, can be quantified or interpreted from quantified information using these techniques.

Riparian-wetland plants are classified into five types based on the likelihood of their occurrence in wetlands or nonwetlands (Reed 1988). These classes are: obligate wetland (OBL), facultative wetland (FACW), facultative (FAC), facultative upland (FACU), and obligate upland (UPL). OBL species are likely to occur in wetlands >99 percent of the time, whereas FACW species occur in wetlands between >67-99 percent of the time. The FAC species are likely to occur in wetlands 33-67 percent of the time; FACU species are likely to occur 1-<33 percent of the time. UPL species almost never (<1 percent) occur in wetlands. The FACW, FAC and FACU categories are subdivided by "+" and "-" modifiers. An FACW- would be closer to an FAC, or would reflect slightly drier conditions based on probability of occurrence (U.S. Army COE 1987).

Plant lists have been compiled by the FWS for each region in the United States. Some species may be listed as a different wetland indicator type, depending on the state and region in which it occurs. Some states have developed localized plant lists as a subset of the national list.

## Item 8: There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)

***Purpose***

In most cases, a riparian-wetland area should have more than one age class of wetland plants present for maintenance and/or recovery. This item is not asking whether all possible age classes are present. It is only asking whether a sufficient number of age classes are present to provide recruitment to maintain an area or to allow an area to recover. Most riparian-wetland areas can do this with two age classes, as long as one is young (for recruitment). Mature woody species (e.g., willow, birch, alder) usually survive due to deep roots. Herbaceous plants can respond to changing site conditions more quickly because they are shallow-rooted. Most herbaceous riparian wetland plants spread vegetatively. A lack of spreading by these plants may indicate a lack of age class diversity, possibly due to a change in site conditions. Many lentic riparian-wetland sites need only the right kind of herbaceous vegetation for stability and proper function.

***Examples***

For riparian-wetland areas that require woody vegetation to achieve functionality, this item would be answered "yes" if there are seedlings and saplings present. It would be answered "no" if these age classes aren't present. However, it is important to determine the mode and timing of regeneration. In some systems, the site conditions may not be favorable (either too wet or too dry) for germination, even though there are many seeds on-site (a long-lived seed bank). Only one young age class may be present when germination occurs infrequently. Willow and cottonwoods have many seeds that are viable for about 2 weeks. If the mineral soil is too dry, the seeds will desiccate. A dense layer of sedges also limits establishment, since the seeds cannot come in contact with wet mineral soils. The seed source is always present, but the site conditions are not always favorable for seedling establishment.

Herbaceous riparian-wetland communities are typically dominated by grasslike (graminoid) plants that regenerate vegetatively by tillering, rhizomes, or stolons. It can be more difficult to distinguish between age classes. However, if you know the habit of these species, i.e., if they are dense mat-forming sedges such as Nebraska sedge, you expect to see continuous, robust cover composed of many stems and blades. In this case, the answer to this item would be "yes." However, if the cover is clumped or there are only scattered individuals, the answer would be "no."

Many riparian-wetland areas have potential for both woody and herbaceous vegetation. For example, wide valley bottoms can be occupied by a complex of geyer and booth willow with continuous cover of beaked sedge in the undergrowth. The answer would be "yes" if young willows and robust cover of the sod-forming sedge are present.

This item is evaluating riparian-wetland vegetation, not upland vegetation. If the area has basin big sagebrush, with all age classes represented, but only has old, decadent willows, then the answer to this item would be "no." The same is true for items 9-13. One exception is "problem wetlands" (see Appendix F), such as highly variable seasonal wetlands, that may be dominated by upland plants during the drier part of the growing season or sometime after drought.

An "N/A" answer would apply for those riparian-wetland areas that occur in bedrock, such as some high mountain lakes.

This item is very closely linked to items 3 and 12.

***Supporting Science/Quantitative Methodologies***

Age-class distribution may vary by the type of life form (tree versus grass) and species, but in general, healthy, expanding populations have many young-age-class individuals, decreasing to fewer individuals of progressively older age classes, due to natural thinning processes. If there are more older age classes, and little or no young age classes represented, then the population is decreasing. Long-lived species, such as woody plants, usually reproduce by seed. The site conditions have to be appropriate during the time that the seeds are viable. If this happens infrequently, the age class distribution will reflect this. Episodic events, such as flooding or drying may create favorable conditions for establishment, resulting in patchy distributions of individuals of the same age.

Age of multistemmed woody species (particularly shrubs such as willows) is difficult to determine, since coring the stems is practically impossible. Single stemmed willows, such as peachleaf and Gooding's willow, could be cored. Most shrubs, however, are "aged" based on the number of stems and proportion of live to dead stems (USDA FS 1992). Myers (1989) recommends using "stem age" for age-class analysis of woody plants. A high correlation between basal stem diameter and age for several riparian-wetlands species is also presented.

Herbaceous species that reproduce vegetatively through tillering, rhizomes, or stolons usually have a less patchy appearance, since the "young" individuals are attached to the "parent" plant. Site conditions likely matter less in this mode of regeneration, since the plant has already established and is simply expanding. Bunch grasses, such as tufted hairgrass, may not be as common in riparian-wetland systems. However, if present, they will regenerate by seed, or by tillering, which enlarges the tuft. Again, age-class distribution is often associated with vigor.

### Item 9: There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)

***Purpose***

In addition to diverse age-class distribution, diverse species composition is generally also important for maintenance and recovery. This item is not asking if all plants are present that an area can potentially support. Rather, the intent is to document that the existing species composition is sufficient for maintenance or recovery. This generally means that two or more riparian-wetland species are present, but varies by the potential of the site to support a given number of species. Some sites are dominated by one species of sedge, such as beaked sedge. This may be due to both site characteristics and the competitive advantage of the species over other species. However, these monospecific sites may be more vulnerable to disease or extreme climate changes, depending on the ecological amplitude of the dominant species. If it can only survive within a narrow range of conditions, any change may lead to loss of that species and degradation of the area. Capability of the site must also be considered. If the hydrology has been altered by some activity in the upper watershed, altered flows into the wetland may limit the types of species that can survive. Typically, sites are occupied by more than one species, unless there is a unique soil property or water regime, or the species is aggressive and outcompetes other species.

***Examples***

If an ID team determines an area can function with either woody or herbaceous vegetation and the area has planeleaf willow and Wolf's willow, the answer to item 9 would be "yes" even though other species may be potentially present on the site. If this same area contained only Wolf's willow, the answer would be "no." If the same area contained Nebraska sedge and Baltic rush and no woody vegetation, the answer would also be "yes."

If however, the ID team determines that an area requires both woody and herbaceous vegetation, and only Nebraska sedge and Baltic rush are present, the answer to item

9 would be "no." Even though two herbaceous species are present to maintain or recover the area, the team determined that both woody and herbaceous components were necessary. At least one woody species and one herbaceous species are required in the species mix for that area.

Some riparian areas have the potential for only one species. If that species is present, then the answer is "yes." Understanding the site potential will help in this determination.

Many riparian-wetland areas function without woody vegetation. Marshes and wet meadows may be completely dominated by sedges, rushes, other graminoids, and mosses. These may form a mosaic where the patches are dominated by a single species. In some cases, woody vegetation may be desired, but the site has limited potential to produce woody species. This system still functions properly. If an upland species or a drier site species, such as silver sagebrush or shrubby cinquefoil, were present, this would likely indicate that the site is drying. The presence of these types of species should not be considered as part of the number of wetland species present when addressing this question. They instead reflect a shift in composition away from riparian wetland species. However, it is important to know the potential of the area before determining whether the species present should or should not be there.

"N/A" would apply to those types of areas that do not require vegetation to function properly.

***Supporting Science/Quantitative Methodologies***

In order to know the potential (i.e., the types of species and associated community types) for a given lentic area, it is critical to consult the local classification or ecological site descriptions (USDA NRCS 1998c) if they exist. Regional riparian-wetland classifications, even those from adjacent states or regions, are a good resource. They provide descriptions of types that may also occur across the Western States, due to the presence of water, regardless of their location. That makes it easier to refer to classifications from adjacent states if you don't have one in your local area. For example, many classifications have a Geyer willow/becked sedge type that are very similar for major species and site characteristics from Montana (Hansen et al. 1995) to Nevada (Manning and Padgett 1995). These classifications have been helpful in evaluating sites in adjoining states where no current classification existed. The type descriptions, along with the constancy/average cover tables help describe the range of characteristics in terms of site, location, hydrology, and species composition and structure. Without these classifications it is difficult to assess potential and determine the number of species that should be present.

## Item 10: Species present indicate maintenance of riparian-wetland soil moisture characteristics

***Purpose***

The intent of this item is to look for those species that indicate the presence of a shallow water table, which maintains riparian-wetland species over time. A persistent water table typically is essential to the maintenance or recovery of a riparian-wetland area. This item is not asking the amount or stabilizing ability of the species, but rather if the presence of these species indicate maintenance of riparian-wetland moisture conditions. Even annuals, such as ovate spikerush (OBL) and rabbit-foot grass (FACW), may indicate maintenance of the water table in the absence of deep-rooted perennials. This depends on how degraded the area appears and the types of species present.

***Examples***

When OBL or FACW plants (e.g., bog birch, baltic rush) are present, this item would be answered "yes" since these plants usually occur under natural conditions in riparian-wetland areas. If FACU or UPL plants (e.g., rabbitbrush, Sandbergs bluegrass) dominated the area, this item would be answered "no" since these species typically occur in upland settings.

Some intermittent/seasonal systems, depending on timing/frequency of precipitation or inundation, could be somewhat different; their potential may be FAC plants, such as chokecherry. In these situations, this item would be answered "yes." However, if these systems are dominated by FACU and/or UPL plants, then this item would be answered "no."

It is important to look at the age of the wetland indicator plants. If there are mature Geyer and Drummond willows (OBL species), but no young willows *and* no OBL herbaceous undergrowth, then the site may be drying out. The mature woody species can access the deep water table, but the herbaceous species are more sensitive to changes in soil moisture. They reflect the depth and duration of the water table and will respond more rapidly. It also helps to know what species one would expect to find in these communities; local classifications help in determining if the undergrowth is appropriate for that riparian-wetland community.

An "N/A" answer would apply for those riparian-wetland areas that are confined in bedrock, such as some high mountain lakes.

There is a strong relationship between item 10 and items 1, 3, 6, and 17. If item 10 is answered "no," then items 1, 3, 6, and 17 will often be answered "no" as well.

***Supporting Science/Quantitative Methodologies***

Most riparian-wetland classifications address those types that reflect drier states (Leonard et al. 1992b). For example, willow types with Kentucky bluegrass undergrowth (Manning and Padgett 1995) usually indicate a shift in undergrowth away from wet site species, such as sedges, due to either disturbance and/or site drying. Myers (1989) also cites an increase in upland plants as indicators of a declining water table. These could initially be undergrowth species, such as Douglas sedge, or woody species, such as rabbitbrush.

In order to address this item, it is recommended that species composition and age-class distribution be assessed. This assessment may show an apparent trend from

which an inference can be made about whether the system is maintaining soil moisture characteristics. For example, if young willow and sedges are present and only old sagebrush remain, then the wetland species would appear to be reoccupying a site that at one time was drier. In particular, expansion of residual clones of rhizomatous sedges will indicate that the water table is probably nearer the surface, and at a longer duration than when the sagebrush dominated the site.
The FAC-neutral test (U.S. Army COE 1987) can be used to calculate whether species indicate maintenance of riparian-wetland soil moisture characteristics.

### Item 11: Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt)

***Purpose***

Lentic riparian-wetland areas such as marshes can have open water or they can be wet meadows that may have standing water some part of the year. In both situations, the root masses anchor the soil and protect either the shoreline or the soil surface from wind and wave action or overland flow. The intent of this item is to document that the shorelines/soil surfaces have the right plants or community types to protect the riparian-wetland area from erosion. It is asking if those species have root systems *capable* of withstanding such events. It is only asking if those species are present, it is not asking for an amount. However, there must be enough (i.e., more than a few scattered individuals) to stabilize exposed soil and shorelines with proper management.

Most perennial plants that are OBL and FACW have root masses capable of withstanding these events, while most FACU and UPL plants do not. Typically, herbaceous species with rhizomes or stolons, which form a continuous mat of roots (rather than isolated individual bunch grasses), are most effective.

***Examples***

Woody riparian-wetland species, such as willow, alder, dogwood, and birch, have a dense root wad that is very effective in armoring shorelines against wave action, ice damage, undercutting, and bank collapse. Coyote willow has a colonizing habit—it expands vegetatively by underground shoots that stabilize bare soil surfaces such as those along pond and marsh margins. Herbaceous wetland species, particularly rhizomatous graminoids, such as cattails, bulrush, sedges, rushes, and some wetland grasses, have dense fibrous root systems that create a stable soil, bound together by an extensive network of fine roots. These roots and rhizomes have such a strong stabilizing effect on the soils that they can armor the soil surfaces and shoreline against extreme events. They are particularly effective in protecting against ice damage, which removes unvegetated soil away from the shoreline and exposes more shoreline to further damage. The ice crystals cannot break apart the root network. If these plants are dominant, then the answer would be “yes.” If, however, a weakly rhizomatous grass such as Kentucky bluegrass, or a tap-rooted shrub such as basin big sagebrush, were dominant, then the answer would be "no." These species do not have a sufficient root system to stabilize the soil surface/shoreline against these events.

Intermittent/seasonal areas would be an exception. For many of these areas, dominance of FAC plants may be all that is required for a "yes" answer. For example, dry meadows that are dominated by Douglas sedge and mat mulhy, with minor amounts of baltic rush, have the potential for only these species to dominate, since they dry out early in the growing season.

There are situations, such as with high mountain lakes surrounded by boulder fields, where vegetation has no influence on shoreline stability. For these, the answer would be "N/A."

***Supporting Science/Quantitative Methodologies***

A good indicator is the presence of OBL and FACW species, because they typically have high erosion control potential, which is determined from the species' rooting habits (Lewis 1958; Manning et al. 1989), or preferably from ratings or discussions of both species and community types, such as in Weixelman et al. (1996), Hansen et al. (1995), Manning and Padgett (1995), USDA FS (1992), and Kovalchik (1987). In general, graminoids with rhizomes or stolons are the best soil binders since they form a continuous, interwoven mat of rhizomes and large, medium, and fine roots. It is the high proportion (both in mass and density) of fine roots (over 90 percent in Nebraska sedge) within this mat, however, that aids in aggregate formation, root turnover, and inputs of organic matter into the soil. These properties aid in soil development, which in turn creates a more favorable environment for wetland plant establishment.

Even though the above publications are for local areas, the species and similar community types occur broadly throughout the Western States. Certain species, such as Nebraska sedge, beaked sedge, and baltic rush, are common throughout the 11 Western States.

Again, there are exceptions (e.g., bedrock-controlled lake) where vegetation contributes little, if any, to shoreline stability. It may provide habitat to many wildlife and invertebrate species, but it doesn't provide stability.

## Item 12: Riparian-wetland plants exhibit high vigor

***Purpose***

The intent of this item is to determine if riparian-wetland plants are healthy and robust or weakened and stressed and being lost from the plant community. The aboveground expression is a reflection of the condition of the root system and the ability of riparian-wetland species to hold an area together. As riparian-wetland plants weaken, they can become decadent and eventually die, making the area subject to degradation.

### *Examples*

This item is very important, but is sometimes difficult to answer. For most riparian-wetland areas, plant size, shape, and leaf color during the growing season can be used to determine vigor. However, variability between site characteristics and climate between years can produce differences as great as those differences between stressed and unstressed plants on similar sites. Knowledge of reference areas is necessary to distinguish effects of site differences from induced stress.

It is useful to separate woody plants and herbaceous plants when assessing vigor. For example, shape and percent of dead stems may be the important indicators for willows, whereas plant height and leaf width may be the important indicators for Nebraska sedge. If willows for a given area are well rounded and robust, and associated (ungrazed) Nebraska sedge plants averaged 80 cm high with leaves 10 mm wide at the base, the answer to item 12 would be "yes." If these same willows were highlined/mushroom-shaped, contained a lot of dead stems, and the (ungrazed) Nebraska sedge plants only averaged 20 cm high with leaf widths of only 5 mm on a similar site, the answer is "no." It is common to have a mixed answer indicated on the form as a "liner" with comments that the willows, for instance, had low vigor but the herbaceous components appeared healthy. Exclosures on similar sites can help in assessing vigor.

Another example of when this item would be answered "no" would be if plant leaves are turning yellow (chlorosis) during the growing season. This may happen as a result of water being removed or added to a system, which stresses the plants. For plants adapted to prolonged saturation, the stress is usually greatest when water is removed, but plants requiring periodic aeration may suffer stress either way. Change in leaf color can also indicate a disease problem, water chemistry (toxicity) problem, or climatic factors such as temperature stress.

Abundance of herbaceous plants can also be used to assess vigor, but must be used with caution. If Nebraska sedge forms a dense, continuous sod, the answer to item 12 would be "yes." If Nebraska sedge occurs as isolated plants or broken clumps that are not forming communities, the answer is probably "no." However, a recent change in management can result in healthy, vigorous clumps that simply haven't had time to develop into dense swards. Leaf width, plant height, and degree of new tillers can help make that determination.

"N/A" would be used for riparian-wetland areas that have no potential to produce vegetation.

### *Supporting Science/Quantitative Methodologies*

Vigor is difficult to quantify, possibly because the relative health of plants within a community can be expressed in many morphological and physiological forms. The reproductive indicators for herbaceous species discussed in item 8 (unhealthy plants don't reproduce as well), along with plant size or volume; leaf area, number, size, and color; and root growth are all associated with relative plant health or vigor. A review of plant physiological responses to various stresses (Sosebee 1977) indicates that reduced productivity is associated with most, if not all, responses. There is abundant information on the use of production as a measure and its associated advantages and disadvantages (Elzinga 1998). Production can be especially problematic to measure on trees and shrubs. Growth form (morphology), leader length, and the proportion of dead or dying stems in comparison with young leaders (Cole 1958) are longstanding indicators of vigor on shrubs.

Chlorosis (yellowing), necrosis (tissue degeneration), and wilting are also good indicators of loss of vigor from moisture, chemical, temperature, or disease stress. Although there are direct measurements associated with these indicators, the most common field measurements would still be relative productivity, size, or reproduction of plants.

Weixelman et al. (1996) have established procedures for documenting mean rooting depth and expected ranges of rooting depth associated with various ecological conditions of specific riparian community types. Shallower rooting depths associated with the declining status of an ecological type can, in part, be a quantitative measure of the vigor of the community.

## Item 13: Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows

***Purpose***

Vegetation filters sediment, aids floodplain development, protects shorelines, etc., all of which dissipate energies associated with wind action, wave action, and overland flow events. The purpose of this item is to determine if there is an adequate amount of vegetation present to dissipate energies from these events.

This item is crucial for areas where vegetation is required for proper functioning. For a riparian wetland area to recover, composition of the right plants, recruitment, etc., are necessary. However, until the right amount is present, the riparian-wetland area will not cross the threshold that would allow it to function properly.

***Examples***

For a wetland that receives periodic wind and wave action, the shoreline opposite the direction of the prevailing winds may require 90 percent cover. If an area has adequate cover of riparian wetland plants, the answer to item 13 would be “yes.” For other wetland types with different site potential, the shoreline may only need 70 percent cover for the answer to be “yes.”

If a shoreline being assessed is dominated by upland plants, the answer to item 13 would be “no.” If this same shoreline is 50 percent riparian-wetland plants and 50 percent upland plants, the answer to item 13 would still be “no.”

Item 13 would be answered "N/A" for riparian-wetland areas that do not need vegetation to achieve PFC.

It is important to understand that item 13 deals with *amount*, while items 8-12 deal with composition, age class, etc., *not* amount. Generally item 13 will be answered "no" if one or more of the other vegetation items are answered "no."

***Supporting Science/Quantitative Methodologies***

The best protection against excessive erosion is the preservation of adequate vegetative cover to dissipate the erosive forces acting upon a shoreline/soil surface during periods of wind action, wave action, and overland flows. Forces resisting erosion include physical properties of the shoreline/soil surface and vegetative protection from erosive shear. Physical properties of the shoreline/soil surface are primarily related to cohesive strength of shoreline/soil surface materials and other factors increasing tensile strength. Cohesive strength of shorelines/soil surfaces materials is largely a function of soil texture (especially particle size), soil chemistry, and soil structure. However, vegetation root mass and length also increase the tensile strength of the shoreline/soil surface.

Vegetation has the potential to influence the balance of energy during wind action, wave action, and overland flows in at least two ways. First, living or dead vegetation (or any other cover) that extends into the wind action, wave action, and overland flow has the potential to reduce energies, thus reducing erosive shear forces acting upon the shoreline/soil surface.

Vegetation also influences the balance of energy during flow events by increasing resisting forces in the shoreline/soil surface. Particularly in noncohesive soils and sediments, vegetation greatly increases the resistive forces in shoreline/soil surface materials. Tensile strength provided by root masses of riparian-wetland vegetation may be the primary source of resistance in the soil of many western riparian-wetland areas. Tensile strength will be dependent upon both the kind of vegetation present and the extent and density of root masses in the soil. Determination of root mass adequacy will be site-specific, as less cohesive sediments will require greater root mass to achieve the same level of stability as more cohesive soils elsewhere.

*A preferred method of quantification is to calculate a greenline stability rating (USDA FS 1992 and similar documents). A stability rating of 7-10 would generally be considered adequate. However, there may be instances in low-energy systems where a rating of 5-6 might suffice, but these are expected to be rare situations.*

## Item 14: Frost or abnormal hydrologic heaving is not present

***Purpose***

Frost or hydrologic heaving occurs when soil pores contain free water conducive to the development of segregated ice lenses or crystals and when temperatures drop below freezing. Expansion when water changes from a liquid to a solid state and continued growth of ice crystals or lenses over time can expand the soil surface upward. This is a natural process that can be aggravated by impacts that either seal parts of the surface, which restricts water infiltration between plants, or reduces pore space by compaction between plants. Excessive removal of vegetation acting as thermal cover can also exaggerate the effects of freezing. Over time, vegetated hummocks of increasing elevation develop between the sealed or compacted interspaces. Riparian wetland vegetation on the hummocks may be diminished or replaced by upland vegetation as the surface becomes elevated above the water table. Root shearing becomes a problem and interspace areas are exposed to increased erosional forces. Slope wetlands may experience a higher ground water discharge from the site as hummocks increase. The intent of this item is to determine whether frost or hydrologic heaving is occurring, and if so, whether it is occurring at a normal or aggravated rate.

***Examples***

Before answering item 14, the ID team has to determine that frost or hydrologic heaving can occur on the site. Many riparian areas will not experience this attribute/process. For frost or hydrologic heaving to occur, the right amount of moisture, soil conditions, and freezing temperatures must be present to allow water droplets in the soil to form ice crystals. For areas that do not meet these requirements, including most of the riparian-wetlands that occur in the desert Southwest, the answer to item 14 would be "N/A."

When this process does occur, the ID team judges if the rate of frost heaving is normal or aggravated. If the configuration of frost heaves is normal relative to height and density of mounds, the answer to item 14 is "yes." If the mounds are significantly higher than normal or more frequent, then the answer is "no." Appendix C provides an example of a lacustrine wetland in Colorado that shows both. The frost heaving on the left is more column like, with more frequent and often narrower hummocks. Most hummocks on the left are also slightly higher. Also note the higher proportion of non-vegetated interspace. The answer to item 14 would be "no" for the area on the left and "yes" for the area on the right, which is considered to be "natural."

The example provides an easy comparison because of the fenceline contrast across the same valley bottom with presumably the same soil and hydrology. Comparisons of different locations should be assessed on sites with similar soil, moisture, and ambient temperature.

Appendix C provides another example of excessive hydrologic heaving on a wet meadow wetland in Idaho.

***Supporting Science/Quantitative Methodologies***

Frost heaving doesn't typically occur in clean sands and gravels, but does occur as the silt and nonplastic clay content in the soil increases. The proper moisture content and freezing temperatures are also necessary for frost heaving to occur (Hough 1957).

The National Soils Handbook (USDA 1983) describes the basic processes and engineering significance of frost heaving. Empirical evidence indicates that severity of the frost action can be aggravated through management practices such as improper livestock grazing. However, there is little additional literature on the precise mechanisms leading to that result or quantification of ecological consequences in different settings. The hummock topography in wet meadows is different than other frost heave situations. Raised portions of natural frost boils are higher on the barren portion of the heave than vegetated surroundings (Fahey 1974), whereas the raised portion of meadow hummocks are vegetated. The compacted area in vehicle tracks seems to have greater frost heave and subsequent subsidence (Gatto 1997), whereas the probable compacted area between the hummocks appears to have less severe heaving. Differential frost heave (Fowler and Noon 1997) may have some bearing on the differences observed, but the relationship has not been described for the situation here (to our knowledge). *The National Range and Pasture Handbook* (USDA NRCS 1998c) also describes frost heaving of forage plants, but it does not describe the hummock topography. It is possible that downward and outward expansion in the interspace is squeezing the soil and plant tussocks up like squeezing toothpaste out of a tube, but that is speculation by the authors. Our suggestion is that this process is sufficiently common to warrant additional research on management impacts in natural settings subject to frost heave.

Measurement of the hummock topography for comparison purposes can be accomplished using a one-dimensional soil roughness analysis described by Grossman and Pringle (1987). One dimensional soil roughness is the variation in ground surface height along a line. In the procedure used, the distance is measured at regular intervals to the ground surface from a leveled rod. Heights are then corrected for the ground surface slope and the standard deviation of the corrected height is calculated. The procedure can be adjusted to obtain roughness at different scales.

## Item 15: Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics

***Purpose***

Some riparian-wetland areas require very specific conditions to sustain temporal water budgets. If seasonal inflows, outflows, and/or evapotranspiration characteristics are significantly altered, the type and extent of the riparian-wetland area can also be altered. Adjacent site characteristics can directly influence both inflow and outflow by buffering surface runoff. Changes in the type of vegetation can also change evaporation versus transpiration rates. Increases or decreases in one may not be proportional to changes in the other, thus affecting annual patterns of soil water states. In some riparian-wetland areas, adjacent site characteristics can affect vegetation recruitment potential on-site by shading, temperature modification, available seed germination sites, etc. If functionality is dependent on these particular species, then the adjacent site characteristics must also be maintained. The intent of this item is to determine whether microsite conditions are necessary for proper functioning, and if so, whether adjacent site characteristics are maintaining those conditions.

***Examples***

Forested depressional wetland areas in the Pacific Northwest require the presence of nursery logs that provide sites for some plants such as western red cedar to establish. The decaying logs must also maintain adequate moisture and temperature for germination. Trees on adjacent sites can buffer inflows to these sites to prevent excessive inundation. Probably more importantly, a certain density of tall trees provides shade that prevents surface drying during germination. The mature trees surrounding the site are also a greater source of nursery logs than the trees on-site.
In this situation, the absence of large trees for shade and nursery logs within falling distance of the riparian-wetland area would result in a "no" answer for item 15. If there is a mixed age class of trees on adjacent sites with sufficient canopy to provide solar insulation to the site, item 15 would be answered "yes." If they are not present or being maintained, then the answer to item 15 would be "no."

Maintaining favorable microsite conditions may also be necessary for retention of permafrost for some areas such as black spruce wetlands in Alaska (Post 1996).

In many cases, the effects associated with adjacent site characteristics will have already been considered in item 4 (upland watershed) or item 6 (surface or subsurface flow patterns). Before answering item 15, it is important to determine if microsite conditions have to be present to function properly and then identify what these conditions are. Most riparian-wetland areas do not require these special conditions. In sites that do not require these conditions to be present to function properly, the answer to item 15 would be "N/A."

***Supporting Science/Quantitative Methodologies***

Brinson (1993) and Walton et al. (1995) describe wetland hydraulic and hydrological processes including those that may be influenced by adjacent sites. Daily water stage can be measured as a direct indicator. However, effects of overall watershed conditions versus adjacent site and evapotranspiration characteristics is difficult to determine. Surface-level solar radiation and daily maximum and minimum temperatures can also be measured as direct indicators for sites such as the forested wetland described above. There may be other microsite conditions that affect different types of wetlands and their function.

The publication *An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices* (Smith et al. 1995) describes a procedure for characterization, assessment, and analysis that should help identify and model relationships of adjacent sites to microsite conditions where they exist.

## C. Erosion/Deposition

Items 16-20 deal with erosion/deposition attributes and processes that have to be in working order for an area to function properly. Some of the documents referenced in the introductions to the sections on hydrology and vegetation are also appropriate here.

### Item 16: Accumulation of chemicals affecting plant productivity/composition is not apparent

***Purpose***

Maintaining a chemical balance in a lentic riparian-wetland area is necessary for functionality. The accumulation of harmful chemicals can potentially affect plant composition and/or productivity. The intent of this item is to determine if the vegetation is being affected by chemicals in the system.

***Examples***

If a riparian-wetland area shows no accumulation of harmful chemicals and requires vegetation to function properly, the answer to item 16 would be "yes." If there is accumulation of chemicals, the ID team must then determine if the accumulation is affecting productivity/composition of riparian-wetland plants. If this accumulation of chemicals is not affecting plant productivity or composition, the answer to item 16 would still be "yes." But if this accumulation is affecting plant productivity and/or composition, item 16 would be answered "no."

An ID team has the option of taking samples for further evaluation should they be unable to adequately answer this question. Many chemicals that would typically be found in a lentic riparian wetland area, such as phosphates and nitrates, may actually enhance vegetative production. But they may also cause algae blooms, reduction of oxygen in open water systems, and rapid eutrophication that is not necessarily good.

There are situations where the accumulation of chemicals is obviously harmful to vegetation, even to the point of being toxic (in some situations, potentially a health hazard to people). An excellent example would be the established Superfund site near Butte, Montana. The heavy metal content in the water of this area has essentially created such harsh conditions in the riparian-wetland area that no vegetation except a few scattered plants can survive. Flocculated metal salts contained in the water may be deposited on the soil surface. The answer in this situation would be "no."

"N/A" would apply for those riparian-wetland areas that do not require vegetation to function properly.

Item 16 is closely associated to items 8, 9, and 18. When item 16 is answered "no," either item 8 or 9 must also be answered "no." When item 16 is answered "no," item 18 should be viewed as a possible cause.

### *Supporting Science/Quantitative Methodologies*

The amount of accumulation of chemicals that affects plant growth depends on soil texture, distribution and type of salts in the soil, and plant species (USDA NRCS 1998a). Singer and Magnus (1987) found that drainage and high evaporation also promote the accumulation of salts. Salts of sodium, calcium, and magnesium with chloride, sulfate, and bicarbonate are the most common.

Chemicals (salts and heavy metals) are delivered to the soil surface by capillary action, ponded water, ground water, and overland flow. Salts are transported to the soil surface by capillary action and are precipitated out during evaporation of the soil water. The amount of salt that accumulates depends on the soil texture, depth of the water table, and depth of restricting layers. The height of capillary rise in the unsaturated soil above the water table depends on the soil grain size. The predicted height of capillary rise in sediments varies from 750 cm for fine silts to 1.5 cm for fine gravel (Fetter 1994). Evaporation from the pond surface causes salts to precipitate along the shoreline as the surface area of the pond decreases. In these evaporation zones, salts accumulate and salts and other solutes in the soil water lower the osmotic component of the soil moisture. For plants to grow in an environment of increased salts, the plant must change the concentration of the solute in the cells. This process of osmotic regulation costs the plant energy and decreases its growth (Singer and Magnus 1987). Plant growth also decreases in response to toxicity of one or more ions of salt.

Because different plant species have different tolerance levels to salts, the plant community composition changes with the changing concentrations of salt. In addition to changing the osmotic component, high levels of salt alter the pH of soils, thus changing the availability of such micronutrients as Fe, Mn, Cu, and Zn.

Chemical- (salt-) affected areas may be detected by observing: 1) salt crystals or crusts on the surface, 2) zones of accumulation in the soil profile, and 3) reduced plant vigor. The degree of chemical accumulation may be determined from saturated soil paste extracts (USDA U.S. Salinity Laboratory 1954; USDA NRCS 1996). Salinity can be determined in the field by a portable salinity tester.

## Item 17: Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils

### *Purpose*

Hydric soils are developed and maintained through frequent flooding, ponding, or saturation for a long enough time for anaerobic conditions to develop. The intent of item 17 is to determine whether hydric soils are being created or maintained in those areas that should have hydric soils.

### *Examples*

Soils that are regularly flooded usually produce indicators that they are being flooded and are hydric. These indicators are accumulations of iron and manganese oxides (redox concentrations) and/or organic matter, iron and clay depletions (redox depletions), and matrices that have low chroma color *in situ* (reduced matrices). When soils display these characteristics, the answer to item 17 would be "yes." When soils display these characteristic and lack saturation or inundation, the answer to item 17 would be "no."

"N/A" would apply to those riparian-wetland areas where hydric soil conditions do not form, for example, a rocky shore or gravel beach.

Because hydric soils are developed and maintained by inundation or saturation, items 17 and 1 are closely associated. When answering item 17, the ID team should refer to how they answered item 1. A "no" answer to item 1 may result in a "no" answer to item 17.

There is a strong relationship between item 17 and items 3, 6, and 10. If item 17 is answered "no," then one or more of these related items will also be answered "no."

***Supporting Science/Quantitative Methodologies***

A soil is considered hydric if it forms under conditions of saturation, flooding, or ponding long enough during the growing season to form anaerobic conditions in its upper part. Hydric soils are formed by biogeochemical processes that promote the accumulation of organic matter and the reduction, translocation, and accumulation of iron, manganese, sulfur, and carbon compounds. In the wettest soils, a rotten egg odor (hydrogen sulfide) is a strong indicator of hydric soils. Other indicators are either the depletion or concentration of Fe/Mn. Hydric soils with parent materials low in Fe/Mn may have low chroma colors that are not related to the moisture content. In these situations, as well as in the absence of hydrogen sulfide, the accumulation of carbon should be used as an indicator. These indicators include presence of Histosols or Histic Epipedon (Vepraskas 1994).

The presence of a hydric soil indicator is the easiest way to demonstrate that soil saturation is sufficient to develop and maintain hydric soils. In cases where hydric soil indicators are not present, other more complicated measures can be taken to determine soil saturation. Certainly if long-term hydrologic data is available, saturation can be determined. Also, weather data, measurement of redox potential, and dyes, such as alpha alpha dipyridyl, can be used (Vepraskas 1994).

Hydric soils may be difficult to identify in the field if: 1) they are derived from grayish or reddish parent materials, 2) they have a high pH or low organic matter content, 3) they are Mollisols or Vertisols, 4) they have relict redoximorphic features, or 5) they have been disturbed, as in cultivated and filled areas. Artificially drained or protected soils are considered hydric if they have at least one of the indicators.

The hydric soils criteria (1995) can be found in USDA NRCS (1998b):

1. All Histosols except Folists, or
2. Soil in Aquic suborders, great groups, or subgroups, Albolls suborder, Aquisalids, Pachic subgroups, or Cumulic subgroups that are:

a. somewhat poorly drained with a water table equal to 0.0 foot (ft) from the surface during the growing season, or
b. poorly drained or very poorly drained and have either:
   (1) water table equal to 0.0 ft during the growing season if textures are coarse sand, sand, or fine sand in all layers within 20 inches (in), or for other soils,
   (2) water table of less than or equal to 0.5 ft from the surface during the growing season if permeability is equal to or greater than 6.0 in/hour (h) in all layers within 20 in, or
   (3) water table at less than or equal to 1.0 ft from the surface during the growing season if permeability is less than 6.0 in/h in any layer within 20 in, or

3. Soils that are frequently ponded for long or very long duration during the growing season, or
4. Soils that are frequently flooded for long or very long duration during the growing season.

The main purpose for the criteria is to create hydric soil lists. According to the National Technical Committee for Hydric Soils, criteria 1, 3, and 4 can be used to document the presence of a hydric soil; however, proof that anaerobic conditions exist also must be obtained. Either data or best professional judgement may be used to document anaerobic conditions. Criteria 2 cannot be used to document the presence of a hydric soil; hydric soil indicators are used to document the presence of a hydric soil for these saturated soils (Hurt and Carlisle 1997).

Field indicators for hydric soils vary from one land resource region to another (USDA NRCS 1998b). These indicators include color, presence of redoximorphic features, thickness, and depth.

The following steps should be included in any method for identifying hydric soils (USDA NRCS 1998b):

a) All organic materials (leaves, needles, bark, etc.) should be removed to expose the surface.
b) Several holes should be dug to a depth or 50 cm (20 in.) or as deep as needed to make an accurate description. Multiple holes will ensure that the soil profile description is representative of the site and will remove variations caused by small changes in elevation.
c) From the description, field indicators that have been met should be specified.
d) Measurements should be made from muck or mineral soil surface unless instructed otherwise.
e) All colors refer to moist Munsell colors. Soil chroma should not be rounded to meet an indicator. A soil matrix with a chroma between 2 and 3 should be listed as having a chroma of 2+. (If the indicator has a chroma of 2 or less, a chroma of 2+ would not meet the requirements.) Values should be rounded to the nearest color chip. Methods of characterizing redoximorphic features, such as quantity, class, size, contrast, color, and moisture state, are based on established field techniques (USDA NRCS 1998b).

## Item 18: Underlying geologic structure/soil material/per mafrost is capable of restricting water percolation

***Purpose***

Lentic or standing water riparian-wetland areas often have an underlying material that causes a site to persist. This underlying material restricts water percolation, producing permanent or seasonal ponding, saturation, or inundation. This material may be a geologic structure such as bedrock, a soil type like clay, or permafrost. This underlying material has to be maintained for an area to function properly.

The best way to describe the importance of maintaining this underlying material is to compare a riparian-wetland area to a bathtub with a plug. As long as the plug stays in place, the tub can retain water, but as soon as the plug is pulled, it can no longer retain water. When this happens, an area can no longer maintain existing hydrology and associated vegetation because it is being drained and will eventually be lost.

The intent of item 18 is to identify whether this underlying material is being maintained.

***Examples***

If a riparian-wetland area shows no signs that its underlying material has been disturbed and is restricting water percolation, the answer to item 18 would be "yes." If an ID team observes activities such as dredging or the formation of a headcut that is draining an area, the answer to item 18 would be "no." The functional—at risk lacustrine wetland in New Mexico (Appendix C) provides an example of when item 18 would be answered "no." Surface disturbance has initiated a headcut that has disrupted the underlying material and is draining the wetland area.

"N/A" would be used for a riparian-wetland area that does not have a restricting layer, such as one that is sustained by the upward movement of ground water.

***Supporting Science/Quantitative Methodologies***

An underlying restrictive layer is a prerequisite for most standing water systems. Natural restrictive layers may be caused by geologic materials or activities, compacted soil material such as clay or hardpans, and in some areas, permafrost. In artificial standing water systems, synthetic fabrics, clay layers, or chemical applications may form restrictive layers.

If saturation or inundation hydrology is observed, then the obvious answer to item 18 is "yes." However, if hydrology is not observable at the time of the assessment, then recent aerial photography can be used to observe if an underlying material is being maintained. If direct observation of hydrology or aerial photography at the wet time of year are not available, then local geology or soils information should be used to indicate if a layer restrictive to water movement occurs in the area. Layers that are restrictive to water movement are often too deep for direct observation with hand tools.

Where disturbance is suspected to have altered a restrictive layer, tests should be made by comparing disturbed area attributes to the undisturbed area attributes. Many restrictive layers are not perfectly sealed and disturbance can accelerate the rate of loss, thereby reducing the riparian wetland area extent.

### Item 19: Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

***Purpose***

Over **geologic time**, lentic riparian-wetland areas typically fill with sediment and may even convert to an upland area type, which is natural. However, this conversion rate can be accelerated by activities within a watershed, such as road building, logging, water diversions, farming, or grazing, if not done properly. Too many roads or roads in the wrong location may accelerate erosion within a watershed. This erosion may result in excessive amounts of sediment being supplied to a riparian-wetland area, filling it faster. When this happens, an area will no longer function properly. The intent of item 19 is to identify that water and sediment are being supplied at a natural rate and can function properly.

Also, if flows increase into a riparian-wetland area, increased energy may form headcuts, endangering the area. Increased flows may also change the type of riparian-wetland (i.e., marsh to lake).

***Examples***

If a lentic riparian-wetland area shows no evidence of excessive deposition and is not filling any faster than its normal rate as a result of excess sediment from the watershed, the answer to item 19 would be "yes." If flow has been added from a diversion, and excessive erosion or deposition is taking place as a result of this increased flow, the answer to item 19 would be "no." Indicators of excessive erosion or deposition can include unstable shorelines, deltas extending into a wetland, and loss of open water. The Nevada seep wetland in Appendix C provides an example of a wetland for which the answer to item 19 would be "no."

Item 19 will never be answered "N/A;" it will always have a "yes" or "no" answer.

Since water and sediment are supplied from the watershed, this item is closely tied to item 4.

***Supporting Science/Quantitative Methodologies***

Riparian-wetland areas are constantly adjusting to the water and sediment being supplied by the watershed. Changes in riparian-wetland areas correspond to changes in overland flow and sediment being supplied. Understanding riparian-wetland areas requires an understanding of changes in overland flows and sediment production upslope from the areas. The riparian-wetland balance can be quantified by some of the methods described under item 4.

Adjustment should be evaluated for both time and spatial considerations.

## Item 20: Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies

***Purpose***

Riparian-wetland areas with islands and shorelines have to be able to dissipate energy during wind action and wave action events to function properly. These islands and shorelines need characteristics that create forces resistant to wind action and wave action. While most lentic riparian-wetland areas require riparian-wetland vegetation along islands and shorelines to do this, some do not. The presence of rocks and/or woody material can dissipate energies associated with wind action and wave action, thereby providing the elements necessary for a system to function properly. The intent of item 20 is to address those systems that **do not** require vegetation.

***Examples***

If a palustrine wetland has adequate rock or coarse and/or large woody material along its shoreline to dissipate energies from wind action and wave action, the answer to item 20 would be "yes." If a riparian-wetland area does not have adequate rock material, etc., the answer to item 20 would be "no."

If a palustrine wetland requires riparian-wetland vegetation versus rock material, etc., along its shoreline to dissipate energy from wind and wave action, then item 20 is answered "N/A." The Nevada palustrine wetland (Appendix C) provides an example of when item 20 would be answered "N/A."

Riparian-wetland areas that require vegetation on islands and shorelines to dissipate energy are addressed in item 13. However, there will be systems that have both, such as a high mountain lake where one side is a talus slope and the other side is an extensive wet meadow. If this is the case, both items 13 and 20 have to be addressed. It is important to remember that each riparian wetland area is rated according to its capability and potential.

***Supporting Science/Quantitative Methodologies***

Rocks on or near the surface of shorelines reduce the impact of waves. The amount of rock along islands and shorelines needed to dissipate wind and wave event energies depends on: 1) amount, kind, and size of rock on-site; 2) size and depth of water sources; 3) frequency, timing, direction, and duration of event energies;

4) slope of the shoreline; 5) use of the area; 6) adjacent topography; and 7) length of fetch. On shorelines lacking wave action, unprotected soil could be stable (Wingate 1999).

Loss of shorelines affect lentic areas by: 1) lowering water quality, 2) reducing the capacity to hold water, and 3) altering the plant community.
The impact of wind and wave event energies can be determined by: 1) comparing changes in the riparian-wetland areas over several years using aerial photos (Prichard et al. 1996), 2) establishing photo points, 3) surveying distances from a reference point to the edge of water, 4) measuring the sedimentation rates of the lentic system, and 5) setting markers at the edge of water and comparing changes over time.

# VI. Summary

The BLM and the FS, working with the NRCS, have initiated an effort to restore and manage riparian-wetland areas in 11 Western States. To be effective, these agencies have established common terms and definitions, as well as a method for evaluating the condition of these areas, which has been extensively reviewed and tested. This method is the proper functioning condition assessment (see TR 1737-9, TR 1737-11, and TR 1737-15).

The method for assessing PFC is a qualitative, yet science-based process that considers both abiotic and biotic factors as they relate to physical function. It facilitates communication about the condition of a riparian-wetland area and focuses attention on the physical process before considering values. A standard checklist ensures consistency in evaluating the condition of lentic riparian-wetland areas.

The PFC method is straightforward: *review existing documents, analyze the PFC definition, and assess functionality using the checklist.* The assessment requires the use of an ID team. To assess the condition of a riparian-wetland area, an ID team has to understand its capability and potential and identify its attributes and processes. *If an ID team does not spend the time to develop this understanding, their judgement about PFC will be incomplete and may be incorrect.*

Riparian-wetland areas are rated in four categories: proper functioning condition, functional—at risk, nonfunctional, and unknown. The condition of some riparian-wetland areas will be relatively easy to discern, while the condition of others will be less evident. Occasionally, items on the checklist will have to be quantified to determine how they should be answered. There are numerous ways these items can be quantified, including those summarized in this document.

For areas that are functional—at risk, trend should be identified, as it is a key consideration in interpreting data. At-risk areas with a downward trend are often the highest management priority because a decline in resource values is apparent. Yet these areas often retain much of the resiliency associated with a functioning area. There is usually an opportunity to reverse this trend through changes in management. At-risk areas with an upward trend are often a priority for monitoring efforts. These areas should be monitored to ensure that they continue to improve.

Conversely, trend is not determined for areas that are nonfunctional. While these areas could theoretically still be in decline, most of the riparian values have already been lost. The presence of sufficient riparian-wetland attributes and processes to warrant a determination of trend usually results in a rating of functional—at risk.

*Once proper functioning condition is reached, trend relates to specific objectives.* It is common for an area in PFC to continue to have an upward trend toward other desired conditions. Many sites that are properly functioning must continue to improve to meet site-specific objectives. However, a downward trend may put the area at-risk.

The lack of specific information will place some riparian-wetland areas into the category of unknown. It is imperative that areas for which no data exists be evaluated and added to the database. As information is acquired and resource values are identified, best management practices need to be implemented. Successful management strategies have to address the entire watershed, as upland and riparian-wetland areas are interrelated and cannot be considered separately.

To manage riparian-wetland areas successfully requires a state of resiliency that allows an area to hold together during frequent wind action, wave action, and overland flow events. When a riparian-wetland area's physical aspects are in working order, then characteristics are maintained that sustain the area's ability to produce resource values. *Function comes first, then values (desired condition).*

*Managing riparian-wetland areas does not cease once PFC is achieved—it has just started.* Existing and potential resource values and the plant communities necessary to support these values have to be identified. Once these values have been identified, specific objectives can be derived to ascertain desired condition. Management actions to achieve desired condition can then be designed and implemented.

# Appendix A:
# Riparian-Wetland Lentic Checklist

# General Instructions

1) This checklist constitutes the **Minimum National Standards** required to determine proper functioning condition of lentic riparian-wetland areas.

2) As a minimum, an **ID team** will use this checklist to determine the degree of function of a riparian-wetland area.

3) An ID team **must review existing documents**, particularly those referenced in this document, so that the team has an understanding of the concepts of the riparian-wetland area they are assessing.

4) An ID team **must determine the attributes and processes important** to the riparian wetland area that is being assessed.

5) Mark one box for each element. Elements are numbered for the purpose of cataloging comments. The numbers do not declare importance.

6) For any item marked "**No**," the severity of the condition must be explained in the "**Remarks**" section and must be a subject for discussion with the ID team in determining riparian-wetland functionality. Using the "**Remarks**" section to also explain items marked "**Yes**" is encouraged but not required.

7) Based on the ID team's discussion, "**functional rating**" will be resolved and the checklist's summary section will be completed.

8) Establish photo points where possible to document the area being assessed.

# Lentic Standard Checklist

Name of Riparian-Wetland Area:________________________________________

Date:___________ Area/Segment ID: ________________ Acres:___________

ID Team Observers: __________________________________________________

| Yes | No | N/A | HYDROLOGY |
|---|---|---|---|
| | | | 1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events |
| | | | 2) Fluctuation of water levels is not excessive |
| | | | 3) Riparian-wetland area is enlarging or has achieved potential extent |
| | | | 4) Upland watershed is not contributing to riparian-wetland degradation |
| | | | 5) Water quality is sufficient to support riparian-wetland plants |
| | | | 6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) |
| | | | 7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway) |

| Yes | No | N/A | VEGETATION |
|---|---|---|---|
| | | | 8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) |
| | | | 9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery) |
| | | | 10) Species present indicate maintenance of riparian-wetland soil moisture characteristics |
| | | | 11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) |
| | | | 12) Riparian-wetland plants exhibit high vigor |
| | | | 13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows |
| | | | 14) Frost or abnormal hydrologic heaving is not present |
| | | | 15) Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics |

| Yes | No | N/A | EROSION/DEPOSITION |
|---|---|---|---|
| | | | 16) Accumulation of chemicals affecting plant productivity/composition is not apparent |
| | | | 17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils |
| | | | 18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation |
| | | | 19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) |
| | | | 20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies |

(Revised 1999)

## Remarks

_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________
_______________________________________________________________

## Summary Determination

**Functional Rating:**

Proper Functioning Condition ________
Functional—At Risk ________
Nonfunctional ________
Unknown ________

**Trend for Functional—At Risk:**

Upward _____
Downward _____
Not Apparent _____

**Are factors contributing to unacceptable conditions outside the control of the manager?**

Yes ___
No ___

**If yes, what are those factors?**

___ Dewatering ___ Mining activities ___ Watershed condition
___ Dredging activities ___ Road encroachment ___ Land ownership
___ Other (specify)______________________________________

# Appendix B:
# Potential and Capability Examples

The following examples show how to fill out the checklist and determine functioning condition for a variety of scenarios, and explain how to consider and apply potential and capability:

Example 1: Assessing functionality of a problem wetland.

Example 2: Assessing functionality of a natural lake that is limited by the presence of a pumping station.

Example 3: Assessing functionality of a system that is not at potential.

**Example 1. Assessing functionality of a problem wetland:** This area is a playa wetland, a depressional area that has wetland indicators (i.e., hydrology, soil, vegetation) during wetter portions of its growing season, but normally lacks these indicators during the drier portion of the growing season. In addition, some playa wetlands lack field indicators of hydric soil. OBL and FACW plants are present during the wet season while FACU and UPL plants are present during the dry season. The soils underlying this playa are intact and are capable of restricting water percolation. The watershed for this playa wetland is intact.


Clay Bridges

**Figure B1.** Cocklebur Lakes, New Mexico.

| Yes | No | N/A | HYDROLOGY |
|---|---|---|---|
| X | | | 1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events |
| This wetland is inundated at its normal rate. | | | |
| X | | | 2) Fluctuation of water levels is not excessive |
| The rate of fluctuation of this wetland is normal. | | | |
| X | | | 3) Riparian-wetland area is enlarging or has achieved potential extent |
| It has achieved potential extent. | | | |
| X | | | 4) Upland watershed is not contributing to riparian-wetland degradation |
| The watershed is intact and in good shape. | | | |
| X | | | 5) Water quality is sufficient to support riparian-wetland plants |
| | | | |
| X | | | 6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) |
| Flow patterns have not been altered. | | | |
| | | X | 7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway) |
| No artificial structures are involved. | | | |

| Yes | No | N/A | VEGETATION |
|---|---|---|---|
| X | | | 8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) |
| During the wet growing season, OBL and FACW plants dominate the site; they are of diverse age classes that can maintain this site and they are vigorous. | | | |
| X | | | 9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery) |
| During the wet growing season, OBL and FACW plants dominate the site and are maintaining the site. | | | |
| X | | | 10) Species present indicate maintenance of riparian-wetland soil moisture characteristics |
| See items 8 & 9. | | | |
| X | | | 11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) |
| See items 8 & 9. | | | |
| X | | | 12) Riparian-wetland plants exhibit high vigor |
| See items 8 & 9. | | | |

| | | | |
|---|---|---|---|
| X | | | 13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows |
| See items 8 & 9. | | | |
| | | X | 14) Frost or abnormal hydrologic heaving is not present |
| This process does not occur in the deserts of the Southwest. | | | |
| | | X | 15) Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics |
| Microsite conditions are not necessary for this site to persist. | | | |
| **Yes** | **No** | **N/A** | **EROSION/DEPOSITION** |
| X | | | 16) Accumulation of chemicals affecting plant productivity/composition is not apparent |
| There is no accumulation of chemicals. | | | |
| | | X | 17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils |
| This site does not express hydric soils. | | | |
| X | | | 18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation |
| | | | |
| X | | | 19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) |
| There is no evidence of erosion or deposition. | | | |
| | | X | 20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies |
| Shorelines are protected by vegetation. | | | |

## Summary Determination

**Functional Rating:**

Proper Functioning Condition ___X___
Functional—At Risk ________
Nonfunctional ________
Unknown ________

**Trend for Functional—At Risk:**

Upward ________
Downward ________
Not Apparent ________

**Rationale For Rating:** This system is in proper functioning condition because the checklist items have been answered “yes” or “NA.” This area is functioning “as best it can” within its attributes and processes defined by the current geoclimatic setting.

**Are factors contributing to unacceptable conditions outside the control of the manager?**

Yes ___
No _X_

**If yes, what are those factors?**

___ Dewatering ___ Mining activities ___ Watershed condition
___ Dredging activities ___ Road encroachment ___ Land ownership
___ Other (specify)________________________________________

**Example 2. Assessing functionality of a natural lake that is limited by the presence of a pumping station:** This lake, located in a mountain range in Nevada, is classified as a palustrine wetland. The water rights for this lake are privately owned. A pumping station has been located on this lake to pump water into an irrigation system for agriculture lands in the valley. The pumping activity has limited this lake's ability to maintain riparian-wetland plants along parts of its shoreline.

The presence of the pumping station is a limiting factor that makes it necessary to consider the capability of this riparian-wetland area when completing the checklist. This constraint to the area's potential cannot be changed by the land manager. The checklist items are answered according to the area's potential or its capability. The question "Are factors contributing to unacceptable conditions outside the control of the manager?" is answered "yes," and the factor involved is checked to show that the new capability is beyond the ability of the land manager to change.

Clay Bridges

**Figure B2.** Sonoma Lake, Nevada.

| Yes | No | N/A | HYDROLOGY |
|---|---|---|---|
| X | | | 1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events |
| This lake fills each year from snowmelt and rainfall. | | | |
| | X | | 2) Fluctuation of water levels is not excessive |
| Pumping activities result in excessive fluctuation of water levels. This has affected the ability of riparian-wetland plants to maintain themselves. | | | |
| | X | | 3) Riparian-wetland area is enlarging or has achieved potential extent |
| Pumping activities have reduced the extent of the riparian-wetland area. | | | |
| X | | | 4) Upland watershed is not contributing to riparian-wetland degradation |
| There is no evidence of degradation to the riparian-wetland area from the watershed. | | | |
| X | | | 5) Water quality is sufficient to support riparian-wetland plants |
| There is no evidence of water quality affecting riparian-wetland plants. | | | |
| X | | | 6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) |
| There is no evidence of flow patterns being altered. | | | |
| | | X | 7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway) |

| Yes | No | N/A | VEGETATION |
|---|---|---|---|
| | X | | 8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) |
| A young age class of riparian-wetland plants is lacking due to fluctuating water levels. | | | |
| X | | | 9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery) |
| Several species of riparian-wetland plants exist. | | | |
| X | | | 10) Species present indicate maintenance of riparian-wetland soil moisture characteristics |
| X | | | 11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) |
| Riparian-wetland plants present have root masses that can withstand wind events and wave flow events. | | | |
| | X | | 12) Riparian-wetland plants exhibit high vigor |
| Riparian-wetland vegetation vigor is affected by fluctuating water levels. | | | |

| Yes | No | N/A | |
|---|---|---|---|
| | X | | 13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows |
| A good proportion of the shoreline is bare soil, which is a result of the fluctuating water levels. | | | |
| X | | | 14) Frost or abnormal hydrologic heaving is not present |
| | | | |
| | | X | 15) Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics |
| | | | |
| **Yes** | **No** | **N/A** | **EROSION/DEPOSITION** |
| X | | | 16) Accumulation of chemicals affecting plant productivity/composition is not apparent |
| There is no evidence of accumulation of chemicals. | | | |
| | X | | 17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils |
| Evidence does not exist that hydric soils are being maintained. | | | |
| X | | | 18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation |
| | | | |
| X | | | 19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) |
| There is no evidence of a delta forming in the inlet to indicate excessive depositions. | | | |
| X | | | 20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies |
| Course and large rocks are present on portions of the shoreline and are adequate to dissipate energies. The remaining shoreline requires vegetative cover to dissipate energies, which is addressed in item 13. | | | |

## Summary Determination

**Functional Rating:**

Proper Functioning Condition ____
Functional—At Risk __X__
Nonfunctional ____
Unknown ____

**Trend for Functional—At Risk:**

Upward ____
Downward ____
Not Apparent __X__

**Rationale For Rating:** This system is rated functional—at risk with no apparent trend. The limiting factor (dewatering) has altered this system and is outside of management control. There are no options available to management to improve this system.

**Are factors contributing to unacceptable conditions outside the control of the manager?**

Yes _X_
No ___

**If yes, what are those factors?**

_X_ Dewatering
___ Dredging activities
___ Other (specify)________________
___ Mining activities
___ Road encroachment
___ Watershed condition
___ Land ownership

**Example 3. Assessing functionality of a system that is not at potential:** The hydrology of this riparian-wetland area is intact but there is no riparian-wetland development. Current management is preventing riparian-wetland vegetation from developing. There is no protection to the area from erosion and deposition. As a result, the riparian-wetland area's extent has been greatly reduced.

Clay Bridges

**Figure B3.** Coyote Hole, Nevada.

| Yes | No | N/A | HYDROLOGY |
|---|---|---|---|
| X | | | 1) Riparian-wetland area is saturated at or near the surface or inundated in "relatively frequent" events |
| The hydrology of this system is intact. | | | |
| X | | | 2) Fluctuation of water levels is not excessive |
| See item 1. | | | |
| | X | | 3) Riparian-wetland area is enlarging or has achieved potential extent |
| The extent of this riparian-wetland area is greatly reduced. | | | |
| | X | | 4) Upland watershed is not contributing to riparian-wetland degradation |
| There is evidence of sediment deposits from the uplands that are degrading the riparian-wetland area. | | | |
| X | | | 5) Water quality is sufficient to support riparian-wetland plants |
| There is no evidence of water quality affecting riparian-wetland plants. | | | |
| | X | | 6) Natural surface or subsurface flow patterns are not altered by disturbance (i.e., hoof action, dams, dikes, trails, roads, rills, gullies, drilling activities) |
| Flow patterns have been altered by hoof action. | | | |
| | | X | 7) Structure accommodates safe passage of flows (e.g., no headcut affecting dam or spillway) |
| | | | |

| Yes | No | N/A | VEGETATION |
|---|---|---|---|
| | X | | 8) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery) |
| Most of the riparian-wetland vegetation has been lost from this system as a result of past management practices. This loss of vegetation has resulted in excessive erosion. The remaining vegetation is dominated by upland species. | | | |
| | X | | 9) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery) |
| See item 8. | | | |
| | X | | 10) Species present indicate maintenance of riparian-wetland soil moisture characteristics |
| See item 8. | | | |
| | X | | 11) Vegetation is comprised of those plants or plant communities that have root masses capable of withstanding wind events, wave flow events, or overland flows (e.g., storm events, snowmelt) |
| See item 8. | | | |
| | X | | 12) Riparian-wetland plants exhibit high vigor |
| See item 8. | | | |

| Yes | No | N/A | |
|---|---|---|---|
| | X | | 13) Adequate riparian-wetland vegetative cover is present to protect shoreline/soil surface and dissipate energy during high wind and wave events or overland flows |
| See item 8. | | | |
| X | | | 14) Frost or abnormal hydrologic heaving is not present |
| | | | |
| | | X | 15) Favorable microsite condition (i.e., woody material, water temperature, etc.) is maintained by adjacent site characteristics |
| | | | |
| **Yes** | **No** | **N/A** | **EROSION/DEPOSITION** |
| X | | | 16) Accumulation of chemicals affecting plant productivity/composition is not apparent |
| There is no evidence of accumulation of chemicals that might affect plant productivity. | | | |
| | X | | 17) Saturation of soils (i.e., ponding, flooding frequency, and duration) is sufficient to compose and maintain hydric soils |
| | | | |
| X | | | 18) Underlying geologic structure/soil material/permafrost is capable of restricting water percolation |
| | | | |
| X | | | 19) Riparian-wetland is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition) |
| There is evidence of excessive erosion. | | | |
| X | | | 20) Islands and shoreline characteristics (i.e., rocks, coarse and/or large woody material) are adequate to dissipate wind and wave event energies |
| | | | |

## Summary Determination

**Functional Rating:**

Proper Functioning Condition ________
Functional—At Risk ________
Nonfunctional ___X___
Unknown ________

**Trend for Functional—At Risk:**

Upward ________
Downward ________
Not Apparent ________

**Rationale For Rating:** This riparian-wetland area is rated nonfunctional because it clearly is not providing adequate vegetation to dissipate energies associated with flows and thus is not allowing any wetland development.

**Are factors contributing to unacceptable conditions outside the control of the manager?**

Yes ___
No _X_

**If yes, what are those factors?**

___ Dewatering
___ Mining activities
___ Watershed condition
___ Dredging activities
___ Road encroachment
___ Land ownership
___ Other (specify)________________________________________

# Appendix C:
# Lentic Riparian-Wetland Examples

# Forested Wetland - Oregon
# Proper Functioning Condition

Clay Bridges

This photo shows an example of a landslide sag pond found in the Coastal Range, Oregon. According to the definition, this lentic form of wetland would be rated ***PFC***. The wetland contains adequate vegetation, landform, and large woody debris to provide root masses that stabilize shoreline features against cutting actions; filter sediment and aid floodplain development; maintain hydric soils; restrict water percolation; and provide favorable microsite conditions that support greater biodiversity.

# Forested Wetland - Oregon
# Functional—At Risk

Clay Bridges

This photo shows an example of a lentic wetland in Oregon that would be rated ***functional—at risk***. Most of the physical attributes/processes (i.e., diverse composition of vegetation for maintenance/recovery, underlying materials that restrict water percolation, etc.) are in place to allow this system to function properly. However, this wetland is rated ***functional—at risk*** because it lacks adjacent site characteristics to control water temperatures and to prevent inundation of the site from excessive erosion.

# Lacustrine Wetland - New Mexico
# Functional—At Risk

Clay Bridges

This photo shows an example of a lacustrine wetland in New Mexico that would be rated ***functional—at risk*** because natural overland flow patterns have been altered by surface disturbance. Surface disturbance, like the trails in this photo, intercept, divert, and concentrate overland flows away from the wetland site. The diversion and concentration of overland flows increases energies, which form headcuts that drain the site, thus reducing the wetland's ability to maintain hydric soils and associated vegetation. If allowed to continue, the wetland eventually will be lost.

## Playa Wetland - New Mexico
## Proper Functioning Condition


Clay Bridges

In New Mexico, depressional areas (playas) such as those in this photo have wetland indicators during the wetter portion of the growing season, but normally lack indicators during the drier portion of the growing season (see Appendix F). Assessing functionality of a playa requires understanding that system's attributes/processes (i.e., ponding frequency and duration, vegetation community dynamics and succession, recruitment and reproduction, etc.). The playa wetland in this photo would normally be rated ***PFC***.

This wetland would be rated ***functional—at risk*** if underlying materials that restricted percolation have been disturbed or if overland flows to the playa have been restricted. Alteration of the natural topography that drains the wetland would result in a rating of ***nonfunctional.***

# Lacustrine Wetland - Colorado
# Functional—At Risk/Proper Functioning Condition

BLM Kremmling Resource Area

The lacustrine wetland in this photo would be rated ***functional—at risk*** on the left side and ***PFC*** on the right side. Most of the attributes/processes on the left side indicate a functioning system (i.e., diverse composition of vegetation, saturation of soils sufficient to compose and maintain hydric soils, no excessive erosion or deposition, etc.). The reason the left side is rated ***functional—at risk*** is due to the presence of abnormal hydrologic heaving. Over time, hydrologic heaving will change the composition of vegetation and may drain the site.

All the attributes/processes on the right side of the above photo indicate a functioning system.

# Seep Wetland - Nevada
# Nonfunctional

Mark Biddlecomb

This photo shows an example of a seep located in Nevada that would be rated as ***nonfunctional*** relative to the definition of proper functioning condition. This wetland **clearly** does not provide adequate vegetation to filter sediment and aid wetland development, lacks adequate cover to protect the area from erosion or deposition as a result of overland flows, lacks diverse age-class distribution and composition of vegetation to allow recovery, and does not provide wetland characteristics necessary to support aquatic or other species. This lack of vegetation and the area's lack of balance with the sediment being supplied has permitted three things to occur: 1) the extent of the wetland has been greatly reduced, 2) the wetland's water quality has been altered, and 3) the wetland's diversity of aquatic vegetation has been greatly reduced. The area provides little biodiversity.

# Palustrine Wetland - Nevada
# Proper Functioning Condition

Clay Bridges

Wetlands that have achieved late seral state or PNC, as Locke's Pond has in this photo, can easily be placed into the appropriate category. Using the definition of proper functioning condition, Locke's Pond would have a rating of ***PFC***. Completing a lentic checklist on this area would result in a "yes" or "N/A" answer for all items. The physical processes are functioning and the wetland is supporting diverse ponding characteristics that provide the habitat and the water depth, duration, and temperature necessary for fish production, waterbird breeding, and other uses. Locke's Pond is providing biodiversity.

# Wet Meadow Wetland - Idaho
# Functional—At Risk

Steve Leonard

The wet meadow in this photo would be rated ***functional—at risk*** relative to the definition of proper functioning condition, even though most of the attributes/processes indicate a functioning system. Currently, most of the wetland is saturated at or near the surface with “relatively frequent events” that maintain its hydric soils, it contains a diverse composition of vegetation that can maintain the wetland, it is comprised of those plants or plant communities that have root masses capable of withstanding overland flow events, and it is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition), etc.

The reason this wetland is rated ***functional—at risk*** is that abnormal frost heaving is present. Hydrologic or frost heaving, allowed to continue over time, will change the vegetation composition. This change in vegetation will reduce the extent of the wetland and may eventually drain the wetland.

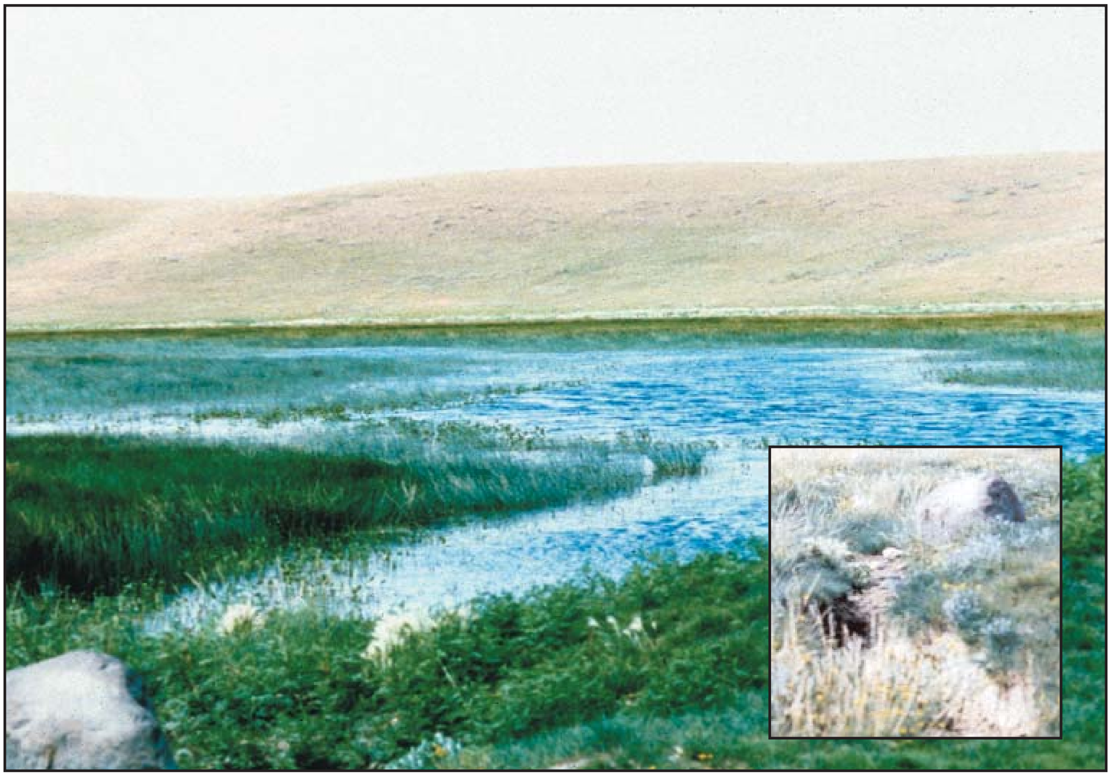
# Prairie Pothole Wetland - Montana
# Proper Functioning Condition

Ramone McCoy

Prairie potholes are classified as highly variable seasonal wetlands. During drier climatic cycles or the drier portion of a growing season, these wetlands may lack hydrology and/or hydrophytic vegetation indicators that would identify them as wetlands. During wet years, they provide a diverse composition of wetland vegetation, but during dry years, the wetland species may be replaced with upland species, which is necessary information for assessing their functionality. Potholes in Montana, on average, are inundated only 1 in 5 years.

This photo shows an example of a Montana prairie pothole wetland that would be rated ***PFC***. This pothole contains adequate vegetation to dissipate energies associated with wind action, wave action, and overland flow from adjacent sites; restricts water percolation; and provides ponding characteristics that provide habitat for waterbird breeding, etc., relative to its capability and potential.

# Prairie Pothole Wetland - Montana
# Functional—At Risk



Photos by: Ramone McCoy

These photos show an example of an artificially enhanced prairie pothole. An earthen dam has been constructed that collects and stores additional overland flow, creating a more permanent site. Previously this pothole would have been classified as a highly variable seasonal wetland, but now it would be classified as a palustrine wetland.

At first glance, this wetland would be rated ***PFC***. The wetland is saturated at or near the surface in relatively frequently events, provides water quality that supports wetland plants, provides a diverse age-class and composition of vegetation, has adequate vegetative cover to protect shorelines during high wind and wave events, and provides greater biodiversity, etc. However, this wetland is not rated ***PFC*** because the structure is no longer accommodating the safe passage of flows. A headcut has developed in the spillway that threatens the integrity of the dam (see insert). The spillway is located to the left of the rock in the main photo. The correct rating would be ***functional—at risk***.

# Appendix D:
# PFC—What It Is and What It Isn't

**PFC is:** A methodology for assessing the physical functioning of riparian-wetland areas. The term PFC is used to describe both the **assessment** process, and a defined, on-the-ground **condition** of a riparian-wetland area. In either case, PFC defines a minimum level or starting point for assessing riparian-wetland areas.

The PFC **assessment** provides a consistent approach for assessing the physical functioning of riparian-wetland areas through consideration of hydrology, vegetation, and soil/landform attributes. The PFC assessment synthesizes information that is foundational to determining the overall health of a riparian-wetland area.

The on-the-ground **condition** termed PFC refers to *how well* the physical processes are functioning. PFC is a state of resiliency that will allow a riparian-wetland area to hold together during a wind action, wave action, or overland flow event, sustaining that system's ability to produce values related to both physical and biological attributes.

*PFC isn't:* The sole methodology for assessing the health of the aquatic or terrestrial components of a riparian-wetland area.

*PFC isn't:* A replacement for inventory or monitoring protocols designed to yield information on the "biology" of the plants and animals dependent on the riparian-wetland area.

**PFC can:** Provide information on whether a riparian-wetland area is physically functioning in a manner that will allow the maintenance or recovery of desired values (e.g., fish habitat, neotropical birds, or forage) over time.

*PFC isn't:* **Desired condition.** It is a prerequisite to achieving desired condition.

*PFC can't:* Provide more than strong clues as to the actual condition of habitat for plants and animals. Generally a riparian-wetland area in a physically nonfunctioning condition will not provide quality habitat conditions. A riparian-wetland area that has recovered to *proper functioning condition* would either be providing quality habitat conditions, or would be moving in that direction if recovery is allowed to continue. A riparian-wetland area that is functioning at-risk would likely lose any habitat that exists during a wind action, wave action, or overland flow event.

**Therefore:** To obtain a complete picture of riparian-wetland area health, including the biological side, one must have information on *both* physical status, provided through the PFC assessment, and biological habitat quality. Neither will provide a complete picture when analyzed in isolation. In most cases, proper functioning condition will be a prerequisite to achieving and maintaining habitat quality.

**PFC is**: A useful tool for prioritizing restoration activities. By concentrating on the "at-risk" systems, restoration activities can save many riparian-wetland areas from degrading to a nonfunctioning condition. Once a system is nonfunctional, the effort, cost, and time required for recovery is dramatically increased. Restoration of nonfunctional systems should be reserved for those situations where the riparian-wetland has reached a point where recovery *is possible,* when efforts are not at *the expense* of "at-risk" systems, or when unique opportunities exist. At the same time, systems that are properly functioning are not the highest priorities for restoration. Management of these systems should be continued to maintain PFC and further recovery towards desired condition.

**PFC is:** A useful tool for determining appropriate timing and design of riparian-wetland restoration projects (including structural and management changes). It can identify situations where structures are either entirely inappropriate or premature.

**PFC is:** A useful tool that can be used in watershed analysis. While the methodology and resultant data is "area based," the ratings can be aggregated and analyzed at the watershed scale. PFC, along with other watershed and habitat condition information helps provide a good picture of watershed health and the possible causal factors affecting watershed health. Use of PFC will help to identify watershed-scale problems and suggest management remedies and priorities.

*PFC isn't*: Watershed analysis in and of itself, or a replacement for watershed analysis.

**PFC is:** A useful tool for designing monitoring plans. By concentrating implementation monitoring efforts on the "no" answers, greater efficiency of resources (people, dollars, time) can be achieved. The limited resources of the local manager in monitoring riparian-wetland parameters can be prioritized to those factors that are currently "out of range" or at risk of going out of range. The role of research may extend to validation monitoring of many of the parameters.

*PFC isn't:* Designed to be a long-term monitoring tool, but it may be an appropriate part of a well-designed monitoring program.

*PFC isn't:* Designed to provide monitoring answers about attaining desired conditions. However, it can be used to provide a thought process on whether a management strategy is likely to allow attainment of desired conditions.

**PFC can:** Reduce the frequency and sometimes the extent of more data- and labor-intensive inventories. PFC can reduce time and cost by concentrating efforts on the most significant problem areas first, thereby increasing efficiency.

*PFC can't:* Eliminate the need for more intensive inventory and monitoring protocols. These will often be needed to validate that riparian-wetland area recovery is indeed moving toward or has achieved desired conditions (e.g., good quality habitat) or simply to establish what the existing habitat quality is.

**PFC is:** A qualitative assessment based on quantitative science. The PFC assessment is intended for individuals with local, on-the-ground experience in the kind of quantitative sampling techniques that support the checklist. These quantitative techniques are encouraged in conjunction with the PFC assessment for individual calibration where answers are uncertain or where experience is limited. PFC is also an appropriate starting point for determining and prioritizing the type and location of the quantitative inventory or monitoring that is necessary.

*PFC isn't:* A replacement for quantitative inventory or monitoring protocols. PFC is meant to complement more detailed methods by providing a way to synthesize data and communicate results.

# Appendix E:

# Common Wetlands

Riparian-wetland systems can be either **nonjurisdictional** or **jurisdictional**. The latter refers to those types that meet the legal requirements of a wetland as defined

by the Wetland Delineation Manual (U.S. Army COE 1987). Activities, such as dredge and fill, in those regulated wetlands are subject to section 404 of the Clean Water Act. These activities are regulated by the COE and NRCS on agricultural lands. The three parameters, vegetation, soils, and hydrology, are used to make the determination. The wetland indicator plant list (Reed 1988) is used to determine wetland species status.

However, not all lentic types of riparian-wetlands are jurisdictional, and the PFC assessment is not intended to be used to make this determination. Several classifications describe various wetland types. The system described by Cowardin et al. (1979) defines wetland types using hydrologic and geomorphic factors, along with chemical and biological factors. The hydrogeomorphic (HGM) system uses geomorphic setting, water sources, and hydrodynamics to classify wetlands. In addition, numerous vegetative classifications have been developed. Windell et al. (1986) describe systems such as marshes, fens, bogs, wet meadows, playas, potholes, willow carrs, and forested wetlands. A comparison of HGM and Cowardin types, as well as some examples, follow:

| **HGM Class** | **Examples** | **Cowardin System** |
|---|---|---|
| Slope | Fen<br>Seep | Palustrine<br>Springs |
| Riverine | Riparian<br>Oxbow | Riverine<br>Palustrine |
| Depressions | Potholes<br>Playas<br>Vernal Pools | Lacustrine<br>Palustrine |
| Tidal Fringe | Estuaries<br>Tidal Ponds | Estuarine |
| Lacustrine Fringe | Lake Edges<br>Marshes | Lacustrine<br>Palustrine |
| Mineral Soil Flats | Broad Interfluves<br>Large Relict Lakes | Palustrine |
| Organic Soil Flats | Extensive Peatlands | Palustrine |

Windell et al. (1986) define the following broad vegetative riparian-wetland types, which are common in the Western States:

Marsh - Open water system, herbaceous (e.g., cattails, bulrush) species dominate.
Peatland - Standing water early in season, organic soils, dominated by herbaceous vascular plants, but also nonvascular (e.g., mosses), and woody species (e.g., bog birch, willows, blueberry)

Fens - Surface- and ground-water fed, mainly herbaceous
Rich (high pH nutrients) and poor (low pH nutrients)

Bog - Receive moisture only from precipitation; they typically occur in Alaska.

Willow Carr - Dominated by willows or other woody OBL species

Wet Meadow - Standing water early in season. Greater variability in water table depth, persistence, and fluctuation. Typically mineral soils, although there are Histic integrades (i.e., they have organic surface horizons). They are not true peatlands. Sedges dominate, along with various forbs, grasses, and mosses.

Depressional Wetland - HGM class. Intermountain and prairie (glacial) potholes. Zones of herbaceous species based on water level. Typically form a complex of potholes within an upland matrix. Some are hydrologically connected; some aren't.

Forested Wetland - Usually in subalpine wet meadows and peatlands, they are dominated by spruce, subalpine fir, silver fir, red fir, and lodgepole pine, with sedge and shrub undergrowths. Cycles of drying and inundation thin out the conifer overstory.

Playa Wetlands - Standing water early in the season, drying rather rapidly. Fine textured clayey soils high in salt and/or sodium content. They typically hold water longer due to fine texture. Salt adapted species, such as greasewood, saltbush, pickleweed, and saltgrass, dominate.

# Appendix F:

# Problem Wetlands

Certain wetlands may be difficult to identify because field indicators of the three wetland identification criteria may be absent, at least at certain times of the year.

These wetlands are considered problem wetlands because the difficulty in identification is generally due to normal environmental conditions and is not the result of human activities or catastrophic natural events, with the exception of newly created wetlands. Because of the difficulty in identifying these areas as wetlands, there will be a degree of difficulty in assessing their functionality. ID teams may need to add elements to the lentic checklist to assess these problem wetlands.

Examples of these problem wetlands are discussed below. Learning how to recognize these wetlands and to understand their attributes/processes is important for assessing functionality.

### 1. Wetlands Dominated by Facultative Upland (FACU) Plant Species

Since wetlands often exist along a natural wetness gradient between permanently flooded substrates and better-drained soils, the wetland plant communities sometimes may be dominated by FACU species. Although FACU-dominated plant communities are usually uplands, they sometimes become established in wetlands. In order to determine whether a FACU-dominated plant community constitutes hydrophytic vegetation, the soil and hydrology must be examined. If the area meets the hydric soil and wetland hydrology criteria, then the vegetation is hydrophytic.

### 2. Evergreen Forested Wetlands

Wetlands dominated by evergreen trees occur in many parts of the country. In some cases, the trees are obligate wetland (OBL) species, facultative wetland (FACW) species, and facultative (FAC) species, e.g., Atlantic white cedar (*Chamaecyparis thyoides*), black spruce (*Picea mariana*), balsam fir (*Abies balsamae*), slash pine (Pinus elliottii), and loblolly pine (*P. taeda*). In other cases, however, the dominant evergreen trees are FACU species, including red spruce (*Picea rubens*), Engelmann spruce (*P. engelmannii*), white spruce (*P. glauce*), Sitka spruce (*P. sitchensis*), eastern white pine (*Pinus strobus*), pitch pine (*P. rigida*), lodgepole pine (*P. contorta*), longleaf pine (*P. palustris*), ponderosa pine (*P. banksiana*), eastern hemlock (*Tsuga canadensis*), western hemlock (*T. heterophylla*), Pacific silver fir (*Abies amabilis*), white fir (*A. concolor*), and subalpine fir (*A. lasiocarpa*). In dense stands, these evergreen trees may preclude the establishment of understory vegetation or, in some cases, the understory vegetation may also be FACU species. Since these plant communities are usually found on nonwetlands, the ones established in wetland areas may be difficult to recognize at first glance. The landscape position of the evergreen forested areas, such as a depression, drainageway, bottomland, flat in sloping terrain, and seepage slope, should be considered because it often provides clues to the likelihood of wetlands. Soils also should be examined in these situations. The wetlands can be identified by following the procedures for FACU-dominated wetlands described above.

### 3. Glacial Till Wetlands

Sloping wetlands occur in glaciated areas where thin soil covers relatively impermeable glacial till or where layers of glacial till have different hydraulic conditions that permit ground-water seepage. Such areas are seldom, if ever, flooded, but downslope ground-water movement keeps the soils saturated for a sufficient portion of the growing season to produce anaerobic and reducing soil conditions. This promotes development of hydric soils and hydrophytic vegetation. Indicators of wetland hydrology may be lacking during the drier portion of the growing season. Hydric soil indicators also may be lacking because certain areas are so rocky that it is difficult to examine soil characteristics within 18 inches.

### 4. Highly Variable Seasonal Wetlands

In many regions (especially in arid and semiarid regions), depressional areas occur that may have indicators of all three wetland criteria during the wetter portion of the growing season, but normally lack indicators of wetland hydrology and/or hydrophytic vegetation during the drier portion of the growing season. In addition, some of these areas lack field indicators of hydric soil. OBL and FACW plant species normally are dominant during the wetter portion of the growing season, while FACU and obligate upland (UPL) species (usually annuals) may be dominant during the drier portion of the growing season and during and for some time after droughts. Examples of highly variable seasonal wetlands are pothole wetlands in the upper Midwest, playa wetlands in the Southwest, and vernal pools along the coast of California. It is important to become familiar with the ecology of these and similar types of wetlands, and to be particularly aware of drought conditions that permit invasion of UPL species (even perennials).

### 5. Interdunal Swale Wetlands

Along the U.S. coastline, seasonally wet swales supporting hydrophytic vegetation are located within sand dune complexes on barrier islands and beaches. Some of these swales are inundated or saturated to the surface for considerable periods during the growing season, while others are wet for only the early part of the season. In some cases, swales may be flooded irregularly by the tides. These wetlands have sandy soils that generally lack field indicators of hydric soil. In addition, indicators of wetland hydrology may be absent during the drier part of the growing season. Consequently, these wetlands may be difficult to identify.

### 6. Vegetated River Bars and Adjacent Flats Wetlands

Along western streams in arid and semiarid parts of the country, some river bars and flats may be vegetated by FACU species while others may be colonized by wetter species. If these areas are frequently inundated for 1 or more weeks during the growing season, they are wetlands. The soils often do not reflect the characteristic field indicators of hydric soils, however, and thereby pose delineation problems.

### 7. Vegetated Flats Wetlands

Vegetated flats are characterized by a marked seasonal periodicity in plant growth. They are dominated by annual OBL species, such as wild rice (*Zizania aquatica*), and/or perennial OBL species, such as spatterdock (*Nuphar luteum*), that have non-persistent vegetative parts (i.e., leaves and stems break down rapidly during the winter, providing no evidence of the plant on the wetland surface at the beginning of the next growing season). During winter and early spring, these areas lack vegetative cover and resemble mud flats; therefore, they do not appear to qualify as wetlands. But during the growing season, the vegetation becomes increasingly evident, qualifying the area as a wetland. In evaluating these areas, which occur both in coastal and interior parts of the country, the time of year of the field observation and the seasonality of the vegetation must be considered. Again, it is important to become familiar with the ecology of these wetland types.

### 8. Newly Created Wetlands

These wetlands include manmade (artificial) wetlands, beaver-created wetlands, and other natural wetlands. Artificial wetlands may be purposely or accidentally created by human activities (e.g., road impoundments, undersized culverts, irrigation, and seepage from earth-dammed impoundments). Many of these areas will have indicators of wetland hydrology and hydrophytic vegetation. But the area may lack typical field characteristics of hydric soils since the soils have just recently been inundated and/or saturated. Since all of these wetlands are newly established, field indicators of one or more of the wetland identification criteria may not be present.

### 9. Entisols (Floodplain and Sandy Soils) Wetlands

Entisols are usually young or recently formed soils that have little or no evidence of pedogenically developed horizons. These soils are typical of floodplains throughout the U.S., but are also found in glacial outwash plains, along tidal waters, and in other areas. They include sandy soils of riverine islands, bars, and banks and finer textured soils of floodplain terraces. Some entisols are easily recognized as hydric soils such as the sulfaquents of tidal salt marshes, whereas others pose problems because they do not possess typical hydric soil field indicators. Wet sandy entisols (with loamy fine sand and coarser textures in horizons within 20 inches of the surface) may lack sufficient organic matter and clay to develop hydric soil colors. When these soils have a hue between 10YR and 10Y and distinct or prominent mottles present, a chroma of 3 or less is permitted to identify the soil as hydric.

### 10. Mollisols (Prairie and Steppe Soils) Wetlands

Mollisols are dark-colored, base-rich soils. They are common in the central part of the conterminous U.S. from eastern Illinois to Montana and south to Texas. Natural vegetation is mainly tall grass prairies and short grass steppes. These soils typically have deep, dark topsoil layers (mollic epipedons) and low chroma matrix colors to considerable depths. They are rich in organic matter due largely to the vegetation (deep roots) and reworking of the soil and organic matter by earthworms, ants, moles, and rodents. The low chroma colors of mollisols are not necessarily due to prolonged saturation, so be particularly careful in making wetland determinations in these soils must be made carefully. It is important to become familiar with the characteristics of mollisols with aquic moisture regimes.

# Literature Cited

Brigdham, S.D., S.P. Faulkner, and C.J. Richardson. 1991. Steel rod oxidation as hydraulic indicator in wetland soils. American Journal of the Soil Science Society, Vol. 55. pp. 856-862.

Brinson, M.M. 1993. A hydrogeomorphic classification for wetlands. U.S. Army Corps of Engineers Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-4. 79 pp.

Brinson, M.M., F.R. Hauer, L.C. Lee, W.L. Nutter, R.D.Rheinhardt, R.D. Smith, and D. Whigham. 1995. A guidebook for application of hydrogeomorphic assessments to riverine wetlands. U.S. Army Corps of Engineers Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-11. Operational draft. 113 pp.

Clemmer, P. 1994. Riparian area management: the use of aerial photography to manage riparian-wetland areas. TR 1737-10. Bureau of Land Management, BLM/SC/ST 94/005+1737, Service Center, CO. 64 pp.

Cole, G.F. 1958. Range survey guide. Montana Fish and Game Dept. 18 pp.

Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. USDI, FWS/OBS-79/31, Washington, DC. 103 pp.

DeBano L.F. and L.J. Schmidt. 1989. Improving southwestern riparian areas through watershed management. General Technical Report RM-182. USDA Forest Service Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 33 pp.

Dunne, T. and L.B. Leopold. 1978. Water in environmental planning. W.H. Freeman and Company, New York. 818 pp.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and monitoring plant populations. TR 1730-1. Bureau of Land Management, BLM/RS/ST-98/005+1730, Denver, CO. 492 pp.

Environmental Protection Agency. 1986. Quality criteria for water 1986. Office of Water Regulations and Standards. EPA/440/5-86/001. 398 pp.

Fahey, B.D. 1974. Seasonal frost heave and frost penetration measurements in the Indian peaks region of the Colorado front range. Arctic and Alpine Research, Vol. 6, No. 1, 1974. pp. 63 70.

Fetter, C.W. 1994. Applied Hydrogeology. Third Edition. MacMillan College Publishing Company, New York. 488 pp.

Fowler, A.C. and C.G. Noon. 1997. Differential frost heave in seasonally frozen soils. In: Iskandar, I.K., E.A. Wright, J.K. Radke, B.S. Sharratt, P.H. Groeneveld, and L.D. Hinzman (Eds.). Special Report 97-10: International Symposium on Physics, Chemistry, and Ecology of Seasonally Frozen Soils, Fairbanks, Alaska, June 10-12, 1997. pp. 247-252.

Gatto, L.W. 1997. Freeze-thaw effects on the hydrologic characteristics of rutted and compacted soils. In: Iskandar, I.K., E.A. Wright, J.K. Radke, B.S. Sharratt, P.H. Groeneveld, and L.D. Hinzman (Eds.). Special Report 97-10: International Symposium on Physics, Chemistry, and Ecology of Seasonally Frozen Soils, Fairbanks, Alaska, June 10-12, 1997. pp. 189-198.

Grossman, R.B. and F.B. Pringle. 1987. Describing surface soil properties - their seasonal changes and implications for management. In: Reybold, W.U. and G.W. Petersen (Eds.). Soil Survey Techniques, SSSA Special Publication No.

20. pp. 57-75.
Hansen, P.L., R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.K. Hinkley. 1995. Classification and management of Montana's riparian and wetland sites. Miscellaneous Publication No. 54, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana. Missoula, MT. 646 pp.
Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field technique. USDA Forest Service Rocky Mountain Forest and Range Experiment Station General Technical Report RM-245. 61 pp.
Heede, B.H. 1976. Gully development and control: the status of our knowledge. USDA Forest Service Research Paper RM-169. Rocky Mountain Forest and Range Experiment Station. Ft. Collins, CO. 42 pp.
____________. 1980. Stream dynamics: an overview for land managers. USDA Forest Service
General Technical Report RM-72. Ft. Collins, CO. 26 pp.
Hough, B. K. 1957. Basic Soils Engineering. The Ronald Press Company, New York. pp. 77- 78, 381-382, and 484-485.
Hurt, G.W. and V.W. Carlisle. 1997. Proper use of hydric soil terminology. Soil Survey Horizons, Vol. 38, No. 4. Madison, WI. page 101.
Kovalchik, B.L. 1987. Riparian zone associations, Deschutes, Ochoco, Fremont, and Winema National Forests. R6 ECOL TP-279-87. USDA Forest Service, Pacific Northwest Region. 171 pp.
Leonard, S., G. Staidl, J. Fogg, K. Gebhardt, W. Hagenbuck, and D. Prichard. 1992a. Riparian area management: procedures for ecological site inventory - with special reference to riparian wetland sites. TR 1737-7. Bureau of Land Management, BLM/SC/PT-92/004+1737, Service Center, CO. 135 pp.
Leonard, S.G., G.J. Staidl, K.A. Gebhardt, and D.E. Prichard. 1992b. Viewpoint: Range site/ecological site information requirements for classification of riverine riparian ecosystems. J. Range Manage. 45:431-435.
Leonard, S., G. Kinch, V. Elsbernd, M. Borman, and S. Swanson. 1997. Riparian area management: grazing management for riparian-wetland areas. Bureau of Land Management, BLM/RS/ST-97/002+1737, National Applied Resource Sciences Center, CO. 80 pp.
Lewis, M.E. 1958. Carex - it's distribution and importance in Utah. Brigham Young Univ. Bull., Biological Series - Vol. I, No. 2. 43 pp.
Manning, M.E., S.R. Swanson, T. Svejcar, and J. Trent. 1989. Rooting characteristics of four intermountain meadow community types. J. Range Manage 42(4):309-312.
Manning, M.E. and W.G. Padgett. 1995. Riparian community type classification for Humboldt and Toiyabe National Forests, Nevada and eastern California. R4-Ecol-95-01. USDA Forest Service, Intermountain Region. 306 pp.

Myers, L.H. 1989. Riparian area management: inventory and monitoring of riparian areas. TR 1737-3. Bureau of Land Management, BLM/YA/PT-89/022+1737, Service Center, CO. 89 pp.

Post, R.A. 1996. Functional profiles of black spruce wetlands in Alaska. EPA 910/R-96-006. Seattle, WA. 170 pp.

Prichard, D., H. Barrett, J. Cagney, R. Clark, J. Fogg, K. Gebhardt, P. Hansen, B. Mitchell, and D. Tippy. 1993. Riparian area management: process for assessing proper functioning condition. TR 1737-9. Bureau of Land Management, BLM/SC/ST-93/003+1737, Service Center, CO. 60 pp.

Prichard, D., C. Bridges, S. Leonard, R. Krapf, and W. Hagenbuck. 1994. Riparian area management: process for assessing proper functioning condition for lentic riparian-wetland areas. TR 1737-11. Bureau of Land Management, BLM/SC/ST-94/008+1737, Service Center, CO. 46 pp.

Prichard, D., P. Clemmer, M. Gorges, G. Meyer, and K. Shumac. 1996. Riparian area management: using aerial photographs to assess proper functioning condition of riparian wetland areas. TR 1737-12. Bureau of Land Management, BLM/RS/ST-96/007+1737, National Applied Resource Sciences Center, CO. 52 pp.

Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian area management: a user guide to assessing proper functioning condition and the supporting science for lotic areas. TR 1737-15. Bureau of Land Management, BLM/RS/ST-98/001+1737. 136 pp.

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands. U.S. Fish and Wildlife Service Biological Report 88. USDI Fish and Wildlife Service, Research and Development. Washington, DC.

Singer, M.J. and D.N. Magnus. 1987. Soils an introduction. MacMillan Publishing Company, New York.

Smith R.D., A. Amman, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. U.S. Army Corps of Engineers Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-9. 72 pp.

Smith, B. and D. Prichard. 1992. Riparian area management: management techniques in riparian areas. TR 1737-6. Bureau of Land Management, BLM/SC/PT-92/003+1737, Service Center, CO. 44 pp.

Sosebee, R.E. (Editor). 1977. Rangeland plant physiology. Range Science Series No. 4. Society for Range Management, Denver, CO. 290 pp.

Sprecher, S.W. 1993. Installing monitoring wells/piezometers in wetlands. Wetland Research Program, Technical Note HY-IA-3.1, U.S. Army Corp of Engineers. Waterways Experiment Station, Vicksburg, MS. 14 pp.

U.S. Army Corp of Engineers. 1987. Wetlands delineation manual. Final report. Wetlands Research Program Technical Report Y-87-1.

United States Department of Agriculture. 1983. National soils handbook, as amended. Soil Conservation Service, Washington DC. 619 p.

USDA Forest Service. 1992. Integrated riparian evaluation guide—Intermountain Region. USDA Forest Service, Intermountain Region, Ogden, UT. 199 pp.

USDA, Natural Resources Conservation Service. 1996. Soil survey laboratory method manual—the soil survey analytical continuum. Soil Survey Investigations Report No. 42, Version 3.0. Washington, DC.

____________. 1997. Hydrology tools for wetland determination, chapter 19, Engineering Field
Handbook. Donald E. Woodward (ed.). USDA, NRCS, Fort Worth, TX. 55 pp.

____________. 1998a. Field book for describing and sampling soils, version 1.1 (March 1998).

____________. 1998b. Field indicators of hydric soils in the United States - a guide for identifying and delineating hydric soils, version 4.0 (March 1998). Wetland Science Institute and Soils Division. Lincoln, NE. 30 pp.

____________. 1998c. National range and pasture handbook. 190-VI.

USDA U.S. Salinity Laboratory. 1954. Diagnosis and improvement of saline and alkali soils. Agr. Hdb. No. 60, Washington DC. 158 pp.

Vepraskas, M.J. 1994. Redoximorphic features for identifying aquic conditions. Technical Bulletin 301. North Carolina Ag. Research Service. North Carolina State Univ., Raleigh, NC. 33 pp.

Walton, R., T.H. Martin, R.S. Chapman, and J.E. Davis. 1995. Investigations of wetlands hydraulic and hydrological processes, model development, and application. Technical Report WRP-CP-6. U.S. Army Corps of Engineers. Vicksburg, MS. 118 pp.

Weixelman, D.A., D.C. Zamudio, and K.A. Zamudio. 1996. Central Nevada riparian field guide.R4-ECOL-96-01. USDA Forest Service, Intermountain Region. 145 pp.

Windell, J.T., B.E. Willard, D.J. Cooper, S.Q. Foster, C.F. Knud-Hansen, L.P. Rink, and G.N. Kiladis. 1986. An ecological characterization of Rocky Mountain montane and subalpine wetlands. U.S. Fish and Wildlife Service. Serv. Biol. Rep. 86(11). 298 pp.

Wingate, G. 1999. Hydrologist, BLM Alturas Field Office, Alturas, CA. Personal communication.

Wetlands Research Program. 1993. Methods for measuring sedimentation rates in bottomland hardwood (BLH) wetlands. WRP Technical Note SD-CP-4.1. 7 pp.

Zeedyk W.D. 1996. Managing roads for wet meadow ecosystem recovery. Report No. FHWA-FLP-96-016. USDA Forest Service Southwestern Region. 73 pp.

# Glossary of Terms

**Advanced Ecological Status** - A community with a high coefficient of similarity to a defined or perceived PNC for an ecological site, usually late seral or PNC ecological status.

**Aerobic** - A condition in which molecular oxygen is a part of the environment.

**Anaerobic** - A condition in which molecular oxygen is absent (or effectively so) from the environment.

**Duration** - A general descriptive term for the average amount of time that inundation lasts per flood occurrence for a geographic area. Categories include: very brief (less than 2 days); brief (2 to 7 days); long (7 days to 1 month); very long (more than 1 month); and flash flooding (less than 2 hours).

**Facultative (FAC) Species** - Plant species that are equally likely to occur in wetlands or nonwetlands (estimated probability 34-66 percent).

**Facultative Upland (FACU) Species** - Plant species that usually occur in nonwetlands (estimated probability 67-99 percent), but that are occasionally found in wetlands (estimated probability 1-33 percent).

**Facultative Wetland (FACW) Species** - Plant species that usually occur in wetlands (estimated probability 67-99 percent), but that are occasionally found in nonwetlands.

**Flooding** - When the soil surface is temporarily covered with flowing water from any source, such as overflowing streams or rivers, runoff from adjacent slopes, and inflow from high tides.

**Frequency** - A general descriptive term for the relative chance of reoccurrence of a flooding event for a geographic area. Categories include: none (0 percent chance); rare (0 to 5 percent chance); occasional (5 to 50 percent chance); and frequent (greater than 50 percent chance).

**Frost (or Abnormal Hydrologic) Heaving** - The lifting of a surface by the internal action of frost or hydrostatic pressure. It generally occurs after a thaw, when the soil is filled with water droplets and when a sudden drop in temperature below freezing changes the droplets into ice crystals, which involves expansion and consequently causes an upward movement of the soil. The process is exacerbated when there is compaction between plant tussocks (e.g., from hoof action) and/or excessive removal of thermal vegetation cover. The result is the hummocked appearance of plants being elevated above the normal ground surface, root shearing between plants, and exposure of interspaces to increased erosional forces.

**Gleyed Matrix** - (USDA NRCS 1998b) Soils with a gleyed matrix have the following combination of hue, value, and chroma, and the soils are not glauconitic: 10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more and chroma is 1; or 5G with value 4 or more and chroma is 1 or 2; or N with value 4 or more; or (for testing only) 5Y, value 4 , and chroma 1. In some places the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of gleyed matrix.

**Histic Epipedon** - A thick (20- to 60-cm) organic soil horizon that is saturated with water at some period of the year unless artificially drained and that is at or near the surface of a mineral soil.

**Histosols** - Organic soils that have organic materials in more than half of the upper 80 cm (32 in), or that are of any thickness if they overlay rock or fragmental materials that have interstices filled with organic soil materials.

**Hydric Soil (1994)** - A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

**Hydrogen Sulfide Odor** - An odor similar to rotten eggs associated with H2S.

**Hydrogeomorphic** - Features pertaining to the hydrology and/or geomorphology of a riparian wetland area.

**Inundation** - A condition in which water from any source temporarily or permanently covers a land surface.

**Obligate Upland (UPL) Species** - Plant species that occur in wetlands in another region, but almost always occur (estimated probability >99 percent) under natural conditions in nonwetlands in the region specified.

**Obligate Wetland (OBL) Species** - Plant species that occur almost always (estimated probability >99%) under natural conditions in wetlands.

**Ponding** - A condition in which water stands in a closed depression. The water is removed only by percolation, evaporation, or transpiration.

**Potential Natural Community** - Represents the seral stage the botanical community would achieve if all successional sequences were completed without human interference under the present environmental conditions.

**Redox Concentration** - Bodies of apparent accumulation of Fe-Mn oxides (Vepraskas 1994).

**Redox Depletions** - Bodies of low chroma (<2) having values of 4 or more where Fe-Mn oxides alone have been stripped out or where both Fe-Mn oxides and clay have been stripped out (Vepraskas 1994).

**Redoximorphic Features** - Features formed by the reduction, translocation, and oxidation of Fe and Mn oxides. Both iron and manganese are used because the two are virtually inseparable in soils.

**Reduced Matrices** - Soil matrices that have a low chroma color in situ because of the presence of Fe(II), but whose color changes in hue or chroma when exposed to air as the Fe(II) is oxidized to Fe(III) (Vepraskas 1994).

**Reduction** - The gaining of electrons by an atom or ion, thereby reducing its variance. For the purpose of hydric soil indicators, it is when the redox potential (Eh) is below the ferric/ferrous iron threshold as adjusted for pH. In hydric soils, this is the point when transformation of ferric iron (Fe+++) to ferrous iron (Fe++) occurs.

**Riparian-Wetland Area** - An area that is saturated or inundated at a frequency and duration sufficient to produce vegetation typically adapted for life in saturated soil conditions. It is also the transitional area between permanently saturated wetlands and upland areas often referred to as a riparian area. This transition area has vegetation or physical characteristics reflective of permanent surface or subsurface water influence. Wetlands and wetland transitions are usually managed as a unit. These systems can be either nonjurisdictional or jurisdictional.

**Riparian-Wetland Ecological Site** - An area of land with a specific potential plant community and specific physical site characteristics, differing from other areas of land in its ability to produce vegetation and to respond to management. Ecological site is synonymous with range site.

**Saturation** - When the soil water pressure is zero or positive. Most all the soil pores are filled with water.

**Vegetation Community Dynamics** - Response of plant communities to changes in their environment, to their use, and to stresses to which they are subjected. Climatic cycles, fire, insects, grazing, and physical disturbances are some of the many causes of changes in plant communities. Some changes are temporary while others are long-lasting.

**Vegetation Community Succession** - A sequence of plant community changes from the initial colonization of a bare soil toward a PNC (primary succession). It may involve sequences of plant community changes from PNC due to perturbations, or a sequence toward PNC again following a perturbation (secondary succession). Vegetation community succession may be accompanied by subtle but significant changes in temporal soil characteristics, such as bulk density, nutrient cycling, and microclimatic changes, but it is differentiated from major physical state changes, such as landform modification or long-term elevation or lowering of a water table, that would change the PNC of an ecological site.

**Woody Debris** - Woody vegetation that enters a riparian-wetland area and is large enough to stay for a period of time and operate as a hydrologic modifier. Often referred to as woody material.