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DEVELOPMENT OF METHODOLOGIES TO EVALUATE THE HEALTH OF RIPARIAN AND WETLAND AREAS

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ABSTRACT

Since 1988, we have been developing various assessments to address a wide range of riparian and wetland questions. Throughout this process, we have worked with various USDI Bureau of Land Management and USDI Fish and Wildlife Service personnel. Out of this collaborative effort, the following assessments for riparian and wetland areas have been developed: 1) lotic wetland inventory (detailed inventory), 2) lotic wetland health assessment (derived from the lotic wetland inventory), 3) lotic wetland health assessment for streams and small rivers (survey), 4) lotic wetland health assessment for large river systems (survey), 5) lentic wetland inventory (detailed inventory), 6) lentic wetland health assessment (derived from the lentic wetland inventory), and 7) lentic wetland health assessment (survey). Each of the assessments also includes a discussion on the User Manuals available for each form.

BACKGROUND

In 1986, work began at The University of Montana on developing a statewide riparian and wetland vegetation-based ecological site classification for Montana. This resulted in the document *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen and others 1995). While developing this statewide classification, The University of Montana was asked by the USDI Bureau of Land Management (BLM) in the spring of 1988 to develop and conduct a large scale inventory and assessment for the Upper Missouri National Wild and Scenic River corridor in central Montana. The major goal of the work was to develop a sampling protocol that would allow the BLM to address some basic questions about the location, extent, and health of the various plant communities along 253 km (157 mi) of the Missouri River and its tributaries. In addition, some basic soil and physical site information was collected.

Since 1988, The University of Montana has continually worked with Dan Hinckley of the BLM Montana State Office, and later Karen Rice of the BLM Upper Snake River District in eastern Idaho to develop various assessment protocols to address a wide range of

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management questions. In addition, Bill Haglan of the USDI Fish and Wildlife Service at Charles M. Russell National Wildlife Refuge in central Montana provided invaluable field input and critical review. Out of this collaborative effort, we have developed the following assessments for riparian and wetland areas: 1) lotic wetland inventory (detailed inventory), 2) lotic wetland health assessment (derived from the lotic wetland inventory), 3) lotic wetland health assessment for streams and small rivers (survey), 4) lotic wetland health assessment for large river systems (survey), 5) lentic wetland inventory (detailed inventory), 6) lentic wetland health assessment (derived from the lentic wetland inventory), and 7) lentic wetland health assessment (survey). Each of the forms also includes a discussion on the codes or instructions used with each form. In addition, we utilize the Pfankuch channel assessment (Pfankuch 1975), the BLM's lotic proper functioning condition (PFC) checklist (USDI Bureau of Land Management 1998), and the BLM's lentic proper functioning condition (PFC) checklist (Prichard and others 1994).

INTRODUCTION

Public and private land managers in the United States are being asked to improve or maintain riparian and wetland habitat and water quality. Those who live and work on the land can usually tell which sites support diverse, vigorous plant and animal communities, which sites have lost their capacity to retain spring season waters long into the summer dry season, and which sites are biologically depauperate. While it may be easy for an astute observer to see that a site has been degraded by human use, it is often difficult to quantify such changes. Presented here are methods for rapidly assessing riparian and wetland health. These methods provide an indexed site rating useful for setting management priorities and stratifying segments for remedial or more rigorous analytical attention. These methods are intended to serve as a first approximation, or "coarse filter," by which to identify segments in need of closer attention so that the manager can more efficiently concentrate effort.

Three questions that are generally asked about a riparian or wetland site are: 1) What is the potential of the site (e.g., climax or potential natural community)? 2) What plant communities currently occupy the site? and 3) What is the overall health (condition) of the site? For riparian and wetland sites in Montana, the first two questions can be answered using the *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen and others 1995). Other regions of North America may have similar publications to aid in addressing these two questions. The assessments outlined in this paper address the third question: what is the site's overall health (condition)? These methods provide an indexed site rating useful for setting management priorities and stratifying riparian and wetland sites for remedial or more rigorous analytical attention.

We use the term "health" to mean the ability of a riparian or wetland area to perform certain functions such as adequate vegetation, landform, or woody debris present to dissipate stream and wave energy associated with high water levels, thereby reducing erosion and improving water quality; filter sediment, capture streambed load, and aid floodplain development; improve flood-water retention and ground-water recharge;

develop root masses that stabilize streambanks and shorelines against stream cutting and wave action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and others uses; and support greater biodiversity.

In some cases management steps may have already been taken to remedy a functionally degraded riparian or wetland areas. In many such cases, however, it is unclear how the results of those changes can be assessed. How, for example, can we stratify sites on a large management unit among those functioning well, those functioning with slight impairment, those having lost much of their functional capacity, and those so severely impaired that restoration would be too costly and difficult?

Flowing Water (Lotic) Wetlands vs. Still Water (Lentic) Wetlands
Cowardin and others (1979) point out that no single, correct definition for wetlands exists, primarily due to the nearly unlimited variation in hydrology, soil, and vegetative types. Wetlands are lands transitional between aquatic (water) and terrestrial (upland) ecosystems. Windell and others (1986) state that “wetlands are part of a continuous landscape that grades from wet to dry. In many cases, it is not easy to determine precisely where they begin and where they end.”

In the semi-arid and arid interior western North America, a useful distinction has been made between wetland types based on association with different aquatic ecosystems. Several authors have used lotic and lentic to separate wetlands associated with flowing water (lotic) from those associated with still water (lentic). The following definitions represent a synthesis and refinement of terminology from Shaw and Fredine (1956), Stewart and Kantrud (1972), Boldt and others (1978), Cowardin and others (1979), American Fisheries Society (1980), Johnson and Carothers (1980), Cooperrider and others (1986), Windell and others (1986), Environmental Laboratory (1987), Kovalchik (1987), Federal Interagency Committee for Wetland Delineation (1989), Mitsch and Gosselink (1993), and Kent (1994).

Lotic wetlands are associated with rivers, streams, and drainageways. Such wetlands, also referred to as riparian wetlands, contain a defined channel and floodplain. The channel is an open conduit that periodically or continuously carries flowing water and dissolved and suspended material. Beaver ponds, seeps, springs, and wet meadows on the floodplain of, or associated with, a river or stream are part of the lotic wetland.

Lentic wetlands are associated with still water systems. These wetlands occur in basins and lack a defined channel and floodplain. Included are permanent (i.e., perennial) or intermittent bodies of water such as lakes, reservoirs, potholes, marshes, ponds, and stockponds. Other examples include fens, bogs, wet meadows, and seeps not associated with a defined channel.

Functional vs. Jurisdictional Wetland Criteria
Defining wetlands has become more difficult as greater economic stakes have increased the potential for conflict between politics and science. A universally accepted wetland

definition satisfactory to all users has not yet been developed because the definition depends on the objectives and the field of interest. However, scientists generally agree that wetlands are characterized by one or more of the following features: 1) wetland hydrology, the driving force creating all wetlands, 2) hydric soils, an indicator of the absence of oxygen, and 3) hydrophytic vegetation, an indicator reflecting wetland site conditions. The problem is how to define and obtain consensus on thresholds for these three criteria and various combinations of the three criteria.

In the United States jurisdictional wetlands are those wet areas that are protected by law through Section 404 of the Clean Water Act and the Swampbuster Provision of the Food Security Act (Mitsch and Gosselink 1993). The US Army Corps of Engineers (Federal Register 1982) and the Environmental Protection Agency (Federal Register 1980) jointly define wetlands for purposes of Section 404 of the Clean Water Act as:

> *Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*

Currently, jurisdictional wetlands in the United States are those that meet the criteria defined in the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and part 513 of the National Food Security Act Manual, Third Edition (Conservation Planning Division 1994). These are not inclusive of all wetlands included in the classification of Cowardin and others (1979).

Wetlands are not easily identified and delineated for jurisdictional purposes. Functional definitions have generally been difficult to apply to the regulation of wetland dredging or filling. Although the intent of legislation is to protect wetland functions, delineation of jurisdictional wetlands has relied largely on structural features or attributes. The hydrogeomorphic (HGM) approach being developed by the US Army Corps of Engineers is intended to focus more specifically on wetland functions.

The prevailing view among many wetland scientists is that functional wetlands need to meet only one of the three criteria as outlined by Cowardin and others (1979) (e.g., hydric soils, hydrophytic plants, and wetland hydrology). On the other hand, jurisdictional wetlands need to meet all three criteria, except in limited situations. Even though functional wetlands may not meet jurisdictional wetland requirements, they certainly perform wetland functions resulting from the greater amount of water that accumulates on or near the soil surface relative to the adjacent uplands. Examples include some woody draws occupied by the *Fraxinus pennsylvanica*/*Prunus virginiana* (green ash/common chokecherry) habitat type and some floodplain sites occupied by the *Artemisia cana*/*Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or the *Pinus ponderosa*/*Cornus stolonifera* (ponderosa pine/red-osier dogwood) habitat type. Currently, many of these sites fail to meet jurisdictional wetland criteria. Nevertheless, these sites do provide important wetland functions and may warrant special managerial consideration. The current interpretation, at least in the western United States, is that not all functional wetlands are jurisdictional wetlands, but all jurisdictional wetlands are functional wetlands.

METHODS

Since 1988, we have been continually developing various assessment protocols to address the health of riparian and wetland sites. The first assessment that was developed was the lotic inventory. At the beginning of the process, we evaluated a wide range of inventory procedures. Most were developed for upland sites and not always applicable. Therefore, in many instances, we had to develop new procedures for use in a riparian or wetland site. Through a series of workshops with a large number of natural resource professionals, a lotic inventory assessment began to take shape. We utilized the Delphi approach or expert opinion approach for developing the assessment. The Delphi approach is designed to bring together the experts in the field of study and develop a consensus on a topic.

In the beginning, the protocols evolved at a rapid rate as the field personnel provided invaluable feedback. As the years have progressed, the assessment and the user manual for the form has evolved to where today it contains over 800 data base fields comprising detailed information on vegetation, physical site, and hydrology data.

As work progressed on the lotic wetland inventory assessment, the public and many natural resource professionals began asking questions about the "health" of a riparian or wetland zone. In early 1992, we began the process of developing a methodology that would address the health issue. Once again, through a series of workshops with natural resource professionals, a lotic health assessment was developed.

To-date the collaborative effort has resulted in the development of the following assessments for riparian and wetland areas: 1) lotic wetland inventory (detailed inventory), 2) lotic wetland health assessment (derived from the lotic wetland inventory), 3) lotic wetland health assessment for streams and small rivers (survey), 4) lotic wetland health assessment for large river systems (survey), 5) lentic wetland inventory (detailed inventory), 6) lentic wetland health assessment (derived from the lentic wetland inventory), and 7) lentic wetland health assessment (survey). Each of the assessments also includes a discussion on the codes or instructions used with each form.

RESULTS AND DISCUSSION

The health of a site may be defined as the ability of that system to perform certain wetland functions. A site's health rating may also reflect management considerations. For example, although noxious weeds such as *Centaurea maculosa* (spotted knapweed) or *Euphorbia esula* (leafy spurge) may help to trap sediment and provide soil-binding properties, other functions (i.e., productivity and wildlife habitat) will be impaired; and their presence should be a management concern.

No single factor or characteristic of a wetland site can provide a complete picture of either site health or the direction of trend. For example, the lotic assessment is based on consideration of channel and riparian vegetation factors. It relies extensively on vegetative characteristics as integrators of factors operating on the landscape. Because they are more visible than soil or hydrologic characteristics, plants may provide early indications of riparian health as well as successional trend. These are reflected not only in the types of plants present, but also by the effectiveness with which the vegetation carries out its wetland functions of stabilizing the soil, trapping sediments, and providing wildlife habitat. Furthermore, the utilization of certain types of vegetation by animals may indicate the current condition of the wetland and may indicate trend toward or away from potential natural community (PNC).

In addition to vegetation factors, an analysis of site health and its susceptibility to degradation must consider physical factors (soils and hydrology) for both ecologic and management reasons. Changes in soil or hydrologic conditions obviously affect functioning of a wetland ecosystem. Moreover, changes in physical characteristics are often (but not always) more difficult to remedy than vegetative changes. For example, extensive incisement (down-cutting) of a stream channel may lower the water table and thus change site potential from a *Fraxinus pennsylvanica/Prunus virginiana* (green ash/common chokecherry) habitat type to an *Artemisia cana/Agropyron smithii* (silver sagebrush/western wheatgrass) habitat type or even to an upland (non-riparian) type. Sites experiencing significant hydrologic, edaphic (soil), or climatic changes will likely also have a change in plant community potential.

The assessments attempt to balance the need for a simple, quick index of health against the reality of an infinite range of wetland situations. Although this approach will not always work perfectly, we believe that in most cases it will yield a usefully accurate index of riparian health. Some more rigorous methods to determine status of a stream's channel morphology are Dunne and Leopold (1978), Pfankuch (1975), and Rosgen (1996). These relate their ratings to degree of channel degradation, but do not integrate other riparian functions into the rating. Other methods are available for determining condition from perspectives that also include vegetation, most notably the USDI Bureau of Land Management (BLM) proper functioning condition (PFC) methodology (1998).

Potential Uses

The rapid lotic wetland health assessment (survey) procedure has been tested in Montana, surrounding states, and western Canada since 1992. Currently, over 10,000 people have been trained using the assessment. Some potential uses for this health rating include: 1) stratifying streams or wetlands by degree of ecologic dysfunction, 2) identifying ecologic problems, and 3) when repeated over time, monitoring to detect functional change. A less direct, but also important, value of an environmental assessment of this kind is its educational potential. By getting land managers to focus on individual riparian functions and ecologic processes, they may come to a better understand how the parts work together and are affected by human activities.

Once land managers have determined health of the stream reach in question, they next need to determine the appropriate course of action, if any. If the stream reach rated Proper Functioning Condition (Healthy), then no action may be needed. If the stream reach rated Functional At Risk (Healthy, but with problems) or Nonfunctional (Unhealthy), the manager needs to determine what remedy is appropriate. The form is divided into two categories: vegetation and physical site factors. The land manager should review the assessment to see which category rated low. This will indicate the prime area of focus. *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen and others 1995) offers assistance in this area. Suppose, for example, a stream reach was rated at 54%, and a review of the health assessment form revealed major problems in these areas: 1) altered streambanks, 2) lateral cutting of the streambank, 3) cover of undesirable herbaceous species, 4) utilization of trees and shrubs, and 5) tree and shrub regeneration. (These are determined by comparing the actual value against the possible value for each factor.) This tells the manager that the banks are eroding because high use is impacting the banks and reducing woody species cover. If potential for the site is woody species (determined from the habitat types or community types recorded on the lotic inventory form), and there are low values for both utilization and regeneration of woody species, the manager may accelerate the restoration process by planting woody species to help stabilize the streambanks. The appropriate woody species and methods for planting them can be found in *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen and others 1995) or another appropriate publication. If livestock are causing the problem, changes in grazing regime are needed before planting to prevent new plants from being browsed. Management change can include measures designed to discourage livestock from spending long periods along the streambanks.

Types of Assessments

Through the years we have developed a variety of assessments for both lotic (flowing water) systems and lentic (still water) systems. The following is a brief description of the assessment protocols.

Lotic Wetland Inventory (detailed inventory)—A comprehensive inventory of a stream segment and its associated riparian area, including detailed vegetation data, physical site data, some wildlife data, trend commentary, and photographs. The inventory form contains over 800 data base fields. The vegetation data collected includes species identification and canopy cover estimations, as well as age class breakdowns for each tree and shrub species. Physical site data includes channel morphology and condition, substrate composition, disturbance degree and kind, amount and cause of bare ground, and commentary. Wildlife data includes details of beaver activity and observations of fishery, amphibian, and reptile data. Currently, this approach has been used on over 6,440 km (4,000 mi) of streams and rivers in western North America.

Lotic Wetland Health Assessment (derived from the Lotic Wetland Inventory)—An evaluation of riparian functional health derived from data collected in the Lotic Wetland Inventory form. An array of vegetation (biotic) and physical site (abiotic) items are weighted and rated for calculation of a health evaluation index score. The items include information on hydric soils, hydrophytic vegetation, and wetland hydrology.

Lotic Wetland Health Assessment for Streams and Small Rivers (survey)—A rapid assessment of lotic site functional health based on a similar set of factors as the Lotic Wetland Health Assessment, but derived from on-site estimation instead of from the detailed Lotic Wetland Inventory form. This assessment has been taught to over 10,000 land owners/managers in Montana, Idaho, North Dakota, Colorado, Utah, and the four western Canadian Provinces of Alberta, Saskatchewan, Manitoba, and British Columbia.

Lotic Wetland Health Assessment for Large River Systems (survey)—A rapid assessment of river functional health based on a set of factors similar to the Lotic Wetland Health Assessment for Streams and Small Rivers (survey), but with some differences to take into account differences of a river system vs. a stream system.

Lentic Wetland Inventory—A comprehensive inventory of a lentic site and its associated functional wetland area, including detailed vegetation data, physical site data, some wildlife data, trend commentary, and photographs. The inventory form contains over 800 data base fields. The vegetation data collected includes species identification and canopy cover estimations, as well as age class breakdowns for each tree and shrub species. Physical site data includes shoreline morphology and condition, substrate composition, disturbance degree and kind, amount and cause of bare ground, and commentary. Wildlife data includes observations of fishery, amphibian, and reptile data.

Lentic Wetland Health Assessment (derived from the Lentic Wetland Inventory)—An evaluation of wetland functional health derived from data collected in the Lentic Wetland Inventory form. An array of vegetation and physical site items are weighted and rated for calculation of a health evaluation index score. The items include information on hydric soils, hydrophytic vegetation, and wetland hydrology.

Lentic Wetland Health Assessment (survey)—A rapid assessment of lentic site functional health based on a similar set of factors as the Lentic Wetland Health Assessment, but derived from on-site estimation instead of from the detailed site inventory.

Table 1 compares the various assessments in terms of type of data collected (vegetation vs. physical data), level of effort required, and potential miles/day.

Table 1. Type of data collected (vegetation vs. physical data), level of effort required, and potential miles/day

Assessment	Detailed Veg. Data	Detailed Physical Data	Level of Effort Required	Potential Km/Day by Evaluator

Lotic Wetlands				
Lotic Inventory (detailed inventory)	Yes	Yes	High	Low
Lotic Health Assessment (derived from lotic inventory form)	No	No	High	Low
Lotic Health Assessment for Streams and Small Rivers (survey)	No	No	Moderate	Moderate
Lotic Health Assessment for Large River Systems (survey)	No	No	Moderate	Moderate
Lentic Wetlands				
Lentic Inventory (detailed inventory)	Yes	Yes	High	Low
Lentic Health Assessment (derived from lentic inventory form)	No	No	High	Low
Lentic Health Assessment (survey)	No	No	Moderate	Moderate

The current assessment protocols can be obtained at the web site www.rwrp.umt.edu. The forms and their User Manuals are available for downloading using the free program from Adobe(R) called Acrobat(R). The files are PDF (Portable Document Format) files.

Limitations

These assessments are not designed for an in-depth and comprehensive analysis of ecologic processes. Such analysis may be warranted on a site and can be done after this evaluation has identified areas of concern.

These assessments attempt to balance the need for a simple, quick index of health against the reality of an infinite range of situations. There are some visible changes to site health for which we have no simple way to measure. An obvious and commonly encountered example is excess entrained sediment. This may indicate serious degradation, but we leave it out of the assessment due to difficulty in knowing how much is normal. Instead, we address on-site causes of sediment production: bare ground, banks with poor root mass protection, and human-caused structural damage to the banks. Another potentially serious degrading factor for which we have no simple measurement yet is dewatering of the system by irrigation diversion/pumping and by upper drainage retention dams.

Although these approaches will not always work perfectly, we believe that in most cases they will yield a usefully accurate index of riparian or wetland health.

No single factor or characteristic of a riparian site can provide a complete picture of either site health or the direction in which it might be heading. Because of inherent dynamics of such systems, riparian sites often contain a mix of indicators. Moreover, characteristics that in traditional evaluations of ecological sites have been considered negative may not be so in riparian sites. For example, bare soil, which often reflects overgrazing or erosion on upland sites, may be only a reflection of normal riparian activity, such as recent sediment deposits resulting from spring runoff or a high water event. The ratings in the evaluation form have been weighted to take such situations into consideration. Thus, only human-caused bare ground is rated negatively, although naturally occurring bare ground can be considered an indicator of susceptibility to impacts such as erosion and weed invasion.

A single evaluation provides a rating at only one point in time. Due to the range of variation possible on a riparian or wetland site, a single evaluation cannot define absolute status of site health or reliably indicate trend (whether the site is improving, degrading, or stable). To measure trend, health assessments should be repeated in subsequent years during the same time of year. Evaluation should be conducted when most plants can be identified in the field and when hydrologic conditions are most nearly normal (e.g., not during peak spring runoff or immediately after a major storm).

Each assessment has its strengths and weaknesses. Our overall goal has been to provide land managers with a variety of “tools” to choose from in their “toolbox” (e.g., different tools for different needs). Which tool is the best for the job? This can only be answered after the specific goals and objectives are determined for the project (e.g., a needs assessment). Once this has been completed, the proper or best tool(s) can then be chosen.

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