DEVELOPMENT AND SUMMARY OF MiST: A CLASSIFICATION SYSTEM FOR PRE-PROJECT MITIGATION SITES AND CRITERIA FOR DETERMINING SUCCESSFUL REPLACEMENT OF FORESTED WETLANDS[1]

T.A. White, R. Lea, R.J. Haynes, W.L. Nutter, J.R. Nawrot, M.M. Brinson, and A.F. Clewell[2]

Abstract. Inconsistency in the evaluation of bottomland hardwood mitigation plans by state and federal agencies often leads to conflict. EPA Region IV and TVA requested the Hardwood Research Cooperative (HRC) of the College of Forest Resources at N.C. State University to conduct a workshop to address this issue. Subsequently, wetland experts representing industry, universities and regulatory agencies across the Southeast were assembled in a workshop to review and refine a mitigation site type classification system proposed by the HRC.

The result of the workshop is the MiST classification system. This system evaluates sites to be mitigated based upon the condition of key site factors controlling productivity. The degree of monitoring intensity required to assess project success depends upon the MiST classification of the site. The system promises to ease project evaluations and provide a conduit for communication between mitigators and commenting agencies. The MiST classification system is reviewed and examples are provided.

Additional keywords: creation, disturbance, enhancement, no-net-loss, reclamation, restoration, restoration ecology, Section 404, surface-mining.

Introduction

The goals of the Clean Water Act (CWA) are to protect and maintain the chemical, physical, and biological integrity of the nation's waters. The Environmental Protection Agency (EPA) and Army Corps of Engineers are given regulatory authority for the discharge of dredged or fill material into waters of the United States. Section 404 of the CWA is the primary mechanism for the protection of wetland by Federal authorities. While "no net loss" of wetlands, including forested wetland ecosystems, has been identified by some groups as a top national priority (The Conservation Foundation 1988), the mechanisms by which such a goal can be achieved have not been developed. In addition to the regulatory and policy problems that a "no net loss" goal presents, there is the fundamental technical challenge of restoring or creating new wetland resources to offset inevitable or unavoidable losses that will continue to occur. This latter concern must be addressed through mitigation. Although the term "mitigation" has come to include avoidance of the wetland impact, for the purposes of this paper mitigation will refer to rectifying the wetland impact by repairing, rehabilitating, or restoring the affected environment or

[1] Paper presented at the 1990 Mining and Reclamation Conference and Exhibition, Charleston, West Virginia, April 23-26, 1990. Paper No. 12538 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, NC.

[2] The authors and their working groups in parentheses are Restoration Ecologist (Workshop coordinator) and Director, Hardwood Research Cooperative, North Carolina State University, Raleigh, NC; Botanist, U.S. Fish and Wildlife Service, Atlanta, GA (Habitat); Professor, School of Forest Resources, University of Georgia at Athens, GA (Hydrology); Associate Scientist, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL (Soils); Professor, Biology Department, East Carolina University, Greenville, NC (Water Quality); and President A.F. Clewell, Inc., Sarasota, FL (Vegetation), respectively.

Proceedings America Society of Mining and Reclamation, 1990 pp 323-338

DOI: 10.21000/JASMR90020323

https://doi.org/10.21000/JASMR90010323

compensating for the impact by replacing or providing substitute resources or environments (CEQ Mitigation Types, 40 CFR Part 1508.20).

Recent bottomland hardwood (BLH) workshops (Roelle et al. 1987a-c) outline the functional attributes of forested wetlands and lay the groundwork for the development of models to assess these functions (Adamus et al. 1987). Yet, regulatory agencies also need an approach for objective, standardized evaluation of forested wetland mitigation plans with respect to their ability to restore functional capacity in disturbed areas. In this document, terms regarding site functions refer to functional effectiveness (Adamus et al. 1987) unless otherwise stated.

Lack of standardization and proven methods has led to inconsistencies in evaluation of mitigation plans by state and federal agencies across EPA Region IV (Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, and Florida). EPA and the Tennessee Valley Authority requested the N.C. State University Hardwood Research Cooperative (HRC) to conduct a workshop to address these problems. The Workshop on BLH Forest Mitigation of Disturbed Sites was held at the Fall Creek Falls State Resort Park near Pikeville, Tennessee on August 13-15, 1989. Individuals from federal and state regulatory agencies, industry, and universities participated.

HRC proposed that consistency in the evaluation of BLH mitigation plans could be reached by initially developing a framework to classify pre-construction mitigation sites[3]. Classification would be based upon the present condition of the mitigation site and the inputs likely to be required to restore the site to a predisturbance functional condition. A prototype system was presented to Workshop participants for their refinement.

The end result of the workshop is the Mitigation Site Type Classification System (MiST). Early in the Workshop discussions, participants decided to expand the system to include all freshwater forested wetland ecosystems commonly occurring in the Southeast and Southcentral United States. This classification system can be used to sort out the range of potential options available to monitor the success of forested wetland mitigation projects. MiST also can foster better communication regarding forested wetland mitigations throughout Region IV. This paper summarizes the draft MiST document generated from the Workshop (White et al. 1990) and provides examples of its potential utilization.

Background

Wetlands form the interface between terrestrial and aquatic environments and wetland hydrology is the driving force behind their creation (Federal Interagency Committee for Wetland Delineation 1989). Different combinations of wetland hydrologic and soil characteristics within a region contribute to the development of specific wetland plant communities. Yet, while vegetation, soils, and hydrology are the ingredients for wetland ecosystem development, ecosystem attributes derived from these resources are responsible for the ecosystem functions and societal values normally attributed to wetlands.

Wetland attributes of mitigation project sites encompass a wide range of conditions. The HRC proposed that classification of the condition of the vegetation, soils, and hydrology of the preproject mitigation site can form a conceptual framework for assessment of mitigation plans and would facilitate communication among involved parties in forested wetland mitigation.

The classification system for proposed forested wetland mitigation sites is based upon the working hypothesis that the major process controlling functional effectiveness is carbon flow through the ecosystem. Specifically, ecosystem carbon input is initiated through the primary production of plants. One estimate of the quantity of vegetative production is net primary productivity (NPP), defined as the total amount of carbon fixed through photosynthesis minus that consumed by plants in respiration.

The allocation of NPP within the ecosystem forms the basis of numerous forested wetland functions (Figure 1).

The MiST classification system

The MiST classification system is composed of three parts. Part I classifies the proposed forested wetland mitigation site with regard to the condition of its plant community, soils, and hydrology (Table 1) and provides the conceptual framework for classifying the sites with respect to their potential for attaining, returning to, or remaining in a high functionally effective state. Attributes included in the classification system were chosen with several considerations in mind:

1) Each attribute contributes directly to the quantity or quality of NPP or the manner in which it is allocated within the forested wetland ecosystem.

[3] In this document, a mitigation project is considered construction of an ecosystem. Terms such as "construction", "project site", etc. refer specifically to the mitigation and not to the proposed wetland fill activity per se.

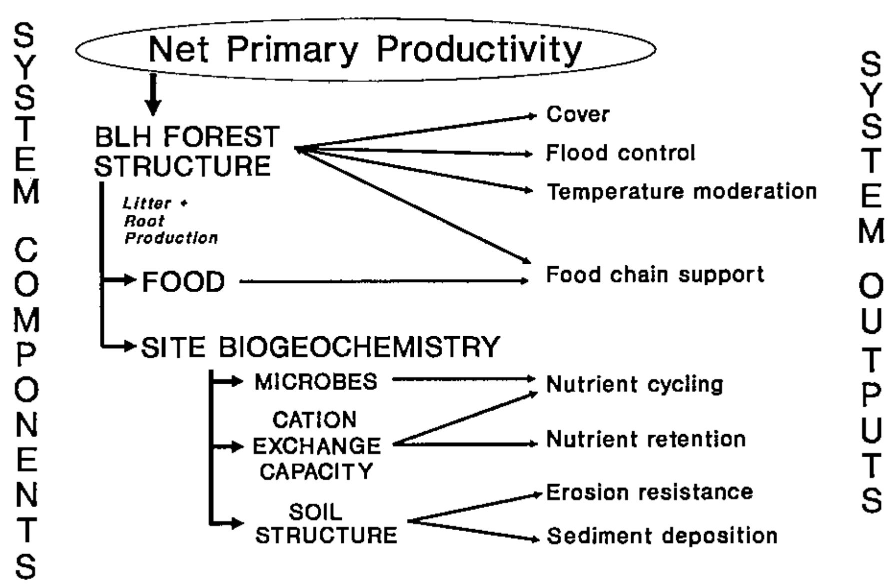

Figure 1. Net primary productivity contribution to selected bottomland hardwood functions.

Table 1. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part I. Component Class Definitions.

COMPONENT/CLASS	DEFINITION
VEGETATION	
0	Site has an overstory and understory species composition and physiognomy similar to the Reference Forest Ecosystem (RFE-see glossary).
1	Loss, relative to the RFE, of up to 50% of the: a) tree canopy or species composition AND/OR b) undergrowth cover or species composition.
2	Loss, relative to the RFE, of more than 50% of the a) tree canopy or species composition AND/OR b) undergrowth cover or species composition.
3	Originally not sufficiently populated with hydrophytic vegetation to be delineated as a wetland or an original forested wetland was removed prior to surface-mining.
SOIL	
0	Site is undisturbed by other than natural means.
1	Disturbance limited to the top 12 inches of the soil and/or loss of up to 50% of the top 12 inches of the existing soil.
2	1) Disturbance within the top 12 inches of the soil with loss of greater than 50% of the top 12 inches of the existing soil, AND/OR, 2) Compaction that affects the rooting zone at a degree greater than the reference soil. The significance of the size of the affected area should be determined on an on-site basis.
3	Reconstructed soil: soil horizon replacement.
4	1) Loss of soil profile to a depth greater than 12 inches, OR, 2) Loss of the original subsoil structure, OR, 3) New soils developed from materials other than original forested wet-land soil.
HYDROLOGY	
0	Undisturbed hydrology based on comparison with hydrologic conditions in the RFE.
1	A deviation in the frequency and duration of not greater than 25% from Class 0 without deviation in the dominant season and source of inundation.
2	A deviation in the frequency and duration of not greater than 50% from Class 0 without deviation in the dominant season and source of inundation.
3	A deviation in the frequency and duration of greater than 50% from Class 0 without deviation in the dominant season and source of inundation.
4	A deviation in the frequency and duration of greater than 50% from Class 0 with deviation in the dominant season and source of inundation.

Table 2. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part II. Performance Standards for Sites Undergoing Mitigation.

ATTRIBUTE	PERFORMANCE STANDARDS

Vegetation

Performance standards are attained when the mitigated forested wetland project sites contain:

1) An agency approved composition of canopy and undergrowth species typical of the RFE and represented by self-sustaining species populations.
2) An agency approved tree abundance in terms of overall density and spatial distribution throughout the project site.
3) Well established trees. A well established tree is one that has been rooted at the mitigation site long enough to survive the range of environmental conditions present on the site.

Hydrology

At a minimum, mitigated sites (both in-kind and out-of-kind) should:

1) Obtain the RFE hydrologic conditions dictated in Class 0 which emphasize the establishment of proper seasonality and source and/or;
2) If the vegetative, soil, and water quality conditions performance standards are satisfied within Class I hydrology criteria, hydrologic conditions will be considered successful.

Soil

A soil will be considered restored if it has the physical and chemical properties that are necessary for the successful re-establishment of the desired RFE. At a minimum, the soil has to be classified as a hydric soil as defined in the Federal Wetland Delineation Manual (1989).

Water Quality

The performance criteria for acceptable levels of water quality characteristics following mitigation activities is the same for all MiST Classes (vegetation, soils, and hydrology).

1. Water quality success will be achieved when the individual frequency of monitored parameter values for the constructed/restored site overlaps an agency approved percentage of the frequency distribution of the RFE when graphically represented. Methodology to determine this should be agency approved.
2. Minimally, measured levels of parameters should not violate State standards; it is recognized that applicable, State-established variances for certain wetlands and classes of naturally-deviating surface waters exist.

Habitat

Successful implementation of the specific mitigation measures for replacing vegetation, soils, and hydrology should provide reasonable and acceptable assurance within the monitoring time frames associated with most regulatory permits that a forested wetland similar to the RFE will occur given sufficient time. When this happens, the wildlife species that reside in or use the new forested wetland should correspond, assuming that the forest is not isolated from the surrounding landscape or other unrecognized limiting factors do not exist.

2) Greater disturbance of an attribute should reflect larger:

   a) increments of degradation to forested wetland functions and;

   b) increments of complexity and/or magnitude in ameliorating the disturbance.

3) The attribute must be relatively easy to assess with field and/or historical data.

Part II of MiST defines mitigation performance standards to provide focus to the mitigation effort (Table 2). Performance standards describe the minimum thresholds of acceptable recovery (as defined at the workshop) at mitigation sites and are independent of mitigation site condition. They are a standardized list of forested wetland mitigation goals.

Finally, Part III lists the required monitoring and expected levels of performance of each attribute (Tables 3-7). These requirements are tied to the MiST classification. This section of MiST illustrates how severity of mitigation site condition corresponds to eventual

Table 3. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part III. Measurements required for MiST Success Parameters: VEGETATION[1].

PARAMETERS

Overstory Criteria:
1) 400 TPA[2] overall >= 6 feet tall
2) 400 TPA on every acre
3) Approved species present at >= 10 TPA

Class 1: Determine if all criteria were met at end of the second year.

Class 2:
a) Assess potential for natural recovery. If inadequate, prepare and implement plan for tree planting.
b) If applicable, assess survival of planted trees following first growing season.
c) Assess tree species density and height following subsequent growing seasons.

Class 3:
a) Prepare and implement plan for tree planting.
b) Assess survival of planted trees following first growing season.
c) Assess tree species density and height following subsequent growing seasons.

Understory/Herbs Criteria:
4) 10% of RFE[3] understory/herbs represented
5) <10% nuisance species cover present

Class 1: Determine if understory/herbs and nuisance species criteria were met after 2 year period.

Class 2: Prepare annual lists of all preferred and nuisance understory/herbs species on a per acre basis.

Class 3: Prepare annual lists of all preferred and nuisance understory/herbs species on a per acre basis. Determine cover for each category.

[1]It is recommended that a report be prepared and submitted to the permitting agency at each assessment. In addition, assessment methods should be agreed upon prior to mitigation activities.

[2]TPA = Trees per acre. Criterion #1 accounts for variation in productivity across the site; Criterion #2 refers to the distribution of stems across the site.

[3]RFE = Reference forest ecosystem (see glossary).

requirements for monitoring, viz, a higher MiST classification level (i.e., greater degradation) generally requires that monitoring be conducted more intensely.

MiST assumes the proposed mitigation project site will be mitigated. That is, permit sequencing procedures have determined the need for compensatory mitigation. MiST can be used for either on-site or off-site mitigation.

Objectives and benefits of MiST

MiST establishes performance criteria for proposed forested wetland mitigations based upon attributes of the pre-project mitigation site. By providing a conceptual framework through which to objectively view the mitigation, MiST assists in standardizing the evaluation of mitigation plans by regulatory authorities.

It was recognized early in the workshop that the concept of a reference forest ecosystem (RFE - see glossary) was fundamental to the process. The RFE provides mitigation plans with specific targets or goals towards which to work (Brinson and Lee 1989). Concurrently, MiST supplies mitigators with an up-front understanding of the expectations of the restored ecosystem. Although MiST establishes standardized objectives, it allows mitigators the freedom to develop innovative mitigation designs.

The relationship of MiST and WET

MiST differs from the Wetland Evaluation Technique (WET, Adamus et al. 1987) in several important ways. WET identifies and ranks current functional opportunity, social significance, and effectiveness of specific sites. In contrast, MiST assesses the potential for restoration of a proposed forested wetland mitigation site by defining the existing conditions of site attributes that contribute to functional effectiveness. MiST also assigns goals for site restoration and requirements for monitoring. MiST is site-

Table 4. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part III. Measurements required for MiST Success Parameters: SOILS.

	CLASS			
	1	2	3	4
REFERENCE FOREST ECOSYSTEM		ABC [1,4]		
INITIAL SITE CHARACTERIZATION[2]	ABC	ABC	ABC	ABC
RESTORATION/ RECLAMATION [3]		<---------- A as needed -----------> <---- B C ----> (min. 2 years)	 <----B C----> (min. 5 years)	

1 For the reference forest ecosystem (Class 0): A factors measured in rooting zone; B and C factors measured at 0 - 9 inch depth.

2 Factor A to be measured in the rooting zone as defined in the RFE. Factors B and C to be measured at:
- Class 1, 2 : 0 - 9 inch depth
- Class 3 : by horizon
- Class 4 : by horizons or depth as determined by backfill placement technique

3 All factors (as defined in footnote 2 above) measured on an annual basis.

4 Code for chemical and physical factors to be measured on the reference and mitigation sites:

A Physical: Bulk density, soil strength, texture, permeability (to assess the ability to establish hydric soil conditions)

B Chemical: Potential phytotoxic/micronutrient conditions: pH, pyritic sulphur, neutralization potential, Al Cu, Zn, B, Mn, base saturation, conductivity, redox potential

C Chemical: Macronutrients: N, P, K, organic C

specific; it does not address functional opportunity or social significance.

MiST assumes <u>by default</u> that the chosen forested wetland mitigation site ranks low in BLH-WET functional effectiveness. A higher WET ranking would reduce the need for or functional payback of restoration. The goals and monitoring requirements assigned to the condition of a mitigated forested wetland attribute are considered to be those needed to return the site to a WET medium or high functionally effective site.

<u>Rationale for the MiST classification hierarchy</u>

For all attributes, Class 0 conditions are those present within a representative RFE possessing a species composition and functional opportunity (Adamus et al. 1987) similar to that present or desired on the site to be mitigated. Each increment in attribute class ranking represents an increase in dysfunction and/or magnitude or complexity of amelioration.

Once the vegetation, soils, and hydrology of a mitigation site are classified, the intensity of monitoring is defined for each attribute. Increasing monitoring intensity is reflected by an increase in: a) the number of variables to be evaluated; b) the frequency and periodicity of data collection and/or; c) the period of time needed for assessment to be completed.

In addition to vegetation (Table 3), soils (Table 4), and hydrology (Table 5), characteristics for water quality are also monitored (Table 6). This latter attribute is included in monitoring requirements because, along with vegetation, it represents measures of ecosystem functional development that the more basic driving attributes of soil and hydrology do not evaluate.

Water quality performance standards are the same regardless of the MiST attribute class. In practice, a highly degraded site may be expected to require more time to reach an acceptable level of

Table 5. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part III. Measurements required for MiST Success Parameters: HYDROLOGY.

	PARAMETERS
Class 0	No monitoring is required.
Class 1	Frequency and Duration 1) Semi-annual visual observation of site during dormant and early part of growing season. 2) Follow-up visits to determine duration plus visual observation of drift lines, sediment on leaves, silt lines on trees, etc.
Class 2	Frequency and Duration Quarterly monitoring visits coupled with a continuous recording device (combination piezometer/crest gage) with a frequency of recording not greater than seven days; couple recorded data with visual observations.
Class 3	Frequency and Duration Monthly monitoring visits coupled with a continuous recording device.
Class 4	Frequency, Duration, Seasonality and Source. Same as Class 3

Table 6. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part III. Measurements required for MiST Success Parameters: WATER QUALITY.

	PARAMETERS	
Analyses[1,2]	Surface water	Ground water
Field[3]:		
Temperature	X	
pH	X	X
Conductivity	X	X
Dissolved O_2	X	
Redox potential (Eh)		X[4]
Lab:		
Alkalinity	X	X
Suspended solids	X	
TOC\ TOC/TON TON/	X	

1 See Hem (1985) for more detailed descriptions. EPA quality assurance is implied. Minimum required analyses; additional analyses may be added for special cases such as sites formerly occupied by mines, industry, or other intensive land use.

2 The ecosystem parameters listed in this table are to be monitored for all MiST Classes. Where MiST Soils Classification 3 or 4 are determined, additional parameters judged appropriate may be added to this list of mandatory characteristics for ground water and surface water monitoring.

3 Mitigation site and RFE should be treated as a paired watershed comparison. Paired sites should be measured at nearly the same time of day because of anticipated diel fluctuations.

4 Precautions should be taken to assure that in situ values are not altered in the process of measurement.

Table 7. The Forested Wetland Mitigation Site Type (MiST) Classification System: Part III. Measurements required for MiST Success Parameters: HABITAT.

PARAMETERS

PHASE I - REFERENCE FOREST ECOSYSTEM ANALYSIS

A. Determine if endangered/threatened species are present.
B. Develop species lists.
C. Select evaluation species based on perceived importance, indicator status, etc.
D. Evaluate habitat quality for selected species.
E. Determine relationship of reference site to surrounding landscape (interspersion among other habitat types, total area of reference type, etc.)

PHASE II - MONITORING DURING PERMIT REGULATORY PERIOD (Assumed to be at least 5 years, with maximum of 10)

A. Use MiST soils, hydrologic, and vegetation monitoring criteria as acceptable long-term habitat mitigation success; assumes acceptable habitat values for most indicator species will be met.
B. For MiST Class 2 Vegetation or Class 3 or 4 Hydrology, calculate habitat suitability index values (Schamberger et al. 1982) for selected evaluation species and community characteristics known to be important to wildlife (e.g., size of area, interspersion factors) during the following periods:
   1) One year after mitigation plan is implemented.
   2) Midway through regulatory period.
   3) Immediately prior to bond release.
C. For MiST Class 2 Vegetation or Class 3 or 4 Hydrology, ensure that short term habitat improvement practices were implemented (means will vary according to practices employed).

PHASE III - LONG-TERM MONITORING (Optional)

A. Follow-up study by management entity (to be identified in mitigation plan) to compare baseline values with post mitigation values with goal of replacement of habitat type(s) and associated values.

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success. However, there is no *a priori* reason to alter the water quality performance standards because of initial site condition.

Monitoring of wildlife habitat is not specifically required by MiST (Table 7). Selection and use of meaningful criteria for measuring and evaluating the performance of replacing habitat factors for species that use a mature forested wetland are unclear given the typical regulatory time frames associated with wetland permitting. Consequently, the attainment of vegetative, soil, and hydrologic performance standards is assumed to result in the development of appropriate forested wetland habitat provided that habitat isolation problems or other limiting factors do not exist on the mitigation site. Wildlife quantity and diversity will be maximized when the mitigated site is not isolated from the surrounding landscape and has dimensional attributes such as edge length and shape, size, etc. for favored species. Other ecosystem functions should not be compromised in the enhancement of favored species, however.

In lieu of no specific habitat monitoring requirements, some site-specific habitat compensation measures may be requested in conjunction with state fish and wildlife agencies and the USFWS.

Using MiST: An example

Step 1: Identify Reference Forest Ecosystem

Of primary importance to the use of MiST is the selection of the RFE. The RFE forms the basis for comparison of many monitored characteristics. Selected by the applicant, it is approved by the regulatory agency preferably prior to classifying the site to be mitigated. While not specifically required, ideally the RFE should be located in the same or an adjacent watershed to the mitigation site. If possible, it should lie in a similar landscape position relative to upstream and downstream activities in its watershed and represent similar functional opportunity and significance (Adamus et al. 1987) as the site to be mitigated. However, the potential difficulty of identifying an ideal RFE for particular projects in specific locations render RFE selection as a negotiable item between the mitigator and the regulatory authority.

Selection of the RFE requires characterization of the vegetation, soils, and hydrology. While characteristics to be measured are identified in MiST, the methods used to assess each component are negotiable between the mitigator and agency personnel. Sources of information concerning characterization of the RFE (as well as the mitigation site) can be found in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation 1989).

For the purposes of evaluating water quality, the permit applicant may choose to select more than one RFE. This is recommended if there is a possibility that background conditions (i.e., water quality of source waters to the wetland) may change significantly within regulatory time frames due to changes in land use, point source discharges, or water flow alterations. Also, the wide variation among natural ecosystems and the potential difficulty in identifying an ideal RFE further argues for multiple RFEs.

Step 2: Classify the vegetation, soils, and hydrology of the mitigation site.

Once the RFE has been chosen, the site to be mitigated is classified using the definitions found in Table 1. Combinations of historical and/or field data may be required to classify hydrologic conditions. In the latter case, where historical data is not available, monitoring may be required to accurately classify the site.

Example 1: Bean field conversion

Suppose a forested wetland permit applicant suggests use of an off-site wetland formerly cropped to soybeans for mitigation. Good management practice yielded no significant erosion or compaction, but soil management (plowing, cultivating, etc.) has disturbed the surface layer of the forested wetland soil. Hydrology is undisturbed but complete removal of the forest cover has occurred.

MiST classification:
Vegetation (V) = 2
Soils (S) = 1
Hydrology (H) = 0

Example 2: Surface-mined land

Suppose an applicant wishes to perform on-site mitigation to compensate for a BLH to be surface-mined. Vegetation will be completely removed from the site prior to mining. The soil will be reconstructed with six inches of original A horizon material over graded cast overburden. The A horizon material will be stockpiled for two years prior to replacement. Based upon historical hydrologic data, it is determined that regrading to approximate original contour will yield a site with a flooding frequency that is 40% less than the RFE.

MiST classification:
V = 3
S = 4
H = 2

Although the site was originally BLH, V3 classification is applied since the area will be surface-mined. The rationale for this classification lies in the potential dilution of viable forested wetland propagules following soil handling, stockpiling and transport during the surface-mining operation. This results in a potential reduction of the rate of natural revegetation. Moreover, it is widely held that the substantial impact that surface-mining operations has on a site renders these sites as mitigation creations regardless of the original site status. S4 classification is applied to the rooting medium since complete soil horizon replacement (A + B) will not be exercised and, thus, the medium will not have the original subsoil structure. Moreover, subsoils will be developed from materials other than the original forested wetland soil. H2 classification was derived from historical data of adjacent water flows in conjunction with proposed post-grading contours.

Step 3: Execution of forested wetland mitigation plan

Within certain limits, freedom of mitigation designs is allowed all permittees. Table 2 sets the performance standards of all forested wetland mitigation plans. While innovation in design or approach is encouraged, minimum standards will be applied to all forested wetland mitigations, regardless of original MiST classification. In certain cases, site assessments will be made during the preparation of mitigation plans. For example, V2 sites require evaluation of natural regeneration potential of a site. This would be required prior to the execution of the mitigation project since if natural regeneration is not possible, tree planting will need to be incorporated in mitigation plans.

Step 4: Monitoring of forested wetland mitigation site

The original MiST classification manifests in the level of intensity required during the post-construction monitoring program (Tables 3-7). To illustrate, consider the classification examples given above.

Example #1: Bean field, MiST classification V2, S1, H0

Class 2 Vegetation requires an assessment of natural recovery. All sites require 400 trees per acre (TPA) on every acre and an overall average of 400 TPA that are at least six feet tall of an approved species composition (Table 3). Potential for natural regeneration of an approved species mix is evaluated. Assuming, in the case of a soybean field, that woody seedwalls are too distant and/or coppice stems are not available, tree planting would be required over at least part of this site. Following this assumption, then, survival tallies of planted trees would be required after the first growing season (Table 3). Subsequent growing seasons would require species density and height data to be recorded. Positional records ensure adequate stem distributions across the site. Understory vegetation will be tallied and grouped annually according to negotiated "preferred" and "nuisance" species.

Soil restoration requires that physical and chemical properties necessary for successful re-establishment of the desired RFE be present and that, at a minimum, the soil should be hydric (Table 2).

Soil monitoring occurs in two phases. Phase I is the initial characterization of the site. This activity occurs following the impact to the site and establishes a baseline for project site soils prior to the execution of the mitigation plan. Comparison of the post-impact soil conditions with RFE soils serves as a guide for developing soil-specific mitigation procedures. Phase II monitors soil properties after the mitigation project has been completed. Class 1 soil classification requires the mitigator to monitor numerous physical characteristics as needed and chemical parameters for a minimum of 2 years following the completion of the project (Table 3).

Since hydrology is undisturbed, no hydrologic monitoring is necessary during construction or after the mitigation project has been completed.

A primary function of forested wetland ecosystems is the removal of sediments, nutrients, and toxins from floodwaters and overland flows thereby improving water quality. Water quality monitoring will always occur regardless of the MiST classification (Table 2). Measured parameters are listed in Table 6. Water quality standards will be considered achieved when the individual frequencies of each parameter overlap an accepted proportion of the frequency distribution of the RFE when graphically represented. At a minimum, all parameters must meet established state water quality standards. Methodology for determining the overlap criterion is negotiable, but data are to be acquired monthly for at least two years and must include at least four peak flows.

Habitat compensation measures would be site and project specific (Haynes et al. 1990). For example, mitigators might be expected to install and maintain nesting boxes for wood ducks, or establish brush piles for cover. Other compensation measures might include leaving buffer zones near streams, or establishing food plots within the mitigation site.

Example #2: Surface-mined land: MiST classification

V3, S4, H2

V3 classification assumes that tree planting will be required; the potential for adequate natural regeneration is considered minimal. Otherwise, vegetation monitoring would be identical to a V2 classification.

Following reconstruction, soil monitoring will consist of measurements of physical and chemical properties (Table 4) on an annual basis for a minimum of five years. These characteristics include physical properties that could be potentially limiting to such things as root elongation and water infiltration as well as toxic and nutrient chemical levels. Class S4 requires that these properties be measured throughout the reconstructed soil profile. The exact depths would be dictated by the backfill placement technique that was used during reconstruction.

Hydrologic monitoring of the site would require quarterly visits coupled with a continuous recording device such as a combination piezometer/crest gage with a frequency of data recording not greater than seven days. Monitoring schedules assume that the RFE is paired with the proposed mitigation site in a manner similar to a paired catchment study. Quantitative data should be coupled with visual observations to demonstrate the establishment of RFE hydrological conditions found in Class 0. These conditions emphasize re-establishment of proper seasonality and source. When local stream gaging data are available and correlation of the gaging data can be made with at least one year of reference and mitigation site monitoring data, gaging station data may be substituted for on-site monitoring.

Since water quality and habitat monitoring are not tied to the site conditions, monitoring of these site attributes following the execution of the mitigation plan are identical to those found in the requirements for Example #1.

Ramifications of MiST

What impact will MiST have on forested wetland compensatory mitigation? Importantly, MiST does not attempt to dictate mitigation designs. Thus, the mitigator is free to choose the methods for re-establishment of the ecosystem. For example, while MiST does require 400 TPA, it does not set the protocol for obtaining this result. The mitigator could choose to plant seedlings or saplings, use direct-seeding, natural regeneration, or combinations of these techniques to produce the desired vegetation. Similarly, while MiST requires that chemical and physical conditions of the soil must agree with those present on the RFE, it does not establish how the soil must be reconstructed to ensure that this occurs. Selective mixing or complete replacement of soil horizons would be two of several options available to meet soil requirements depending on the site and the materials found there.

While some may prefer strict standardization in MiST, the need to foster innovation in this new field of forested wetland mitigation technology requires flexibility in mitigation design in order to compare the suitability of different plans. An important caveat, however, is that it is incumbent upon the mitigator to ensure that the methodology is adequate to produce a fully functional forested wetland ecosystem. This is the only acceptable end result of forested wetland mitigation. Thus, the mitigator must carefully consider the advantages of specific designs with their risk of not attaining performance standards.

Conclusions

This summary of the MiST classification system is the result of collaboration between industry, regulatory agencies and academic experts across the Southeast. It summarizes a more extensive draft document currently in review by EPA Region IV. The MiST system will require extensive testing prior to its adoption to ensure that the variety of conditions that exist on the natural landscape are properly represented and to streamline field procedures during its use.

Regardless of the refinements made to the system following field testing, a major strength of MiST is that it provides an avenue for communication between regulators and mitigators by establishing a standard approach for evaluation of mitigation plans. And, important to restoration ecologists, it provides a framework for illuminating the most pressing needs for restoration research relating to forested wetland ecosystems.

While MiST addresses concerns related specifically to Section 404 of the CWA, an additional benefit of MiST is the potential for its use outside of CWA regulatory programs. Classification of mitigation sites and development of performance criteria and monitored characteristics can lead to better restoration of lands such as those currently under consideration for conversion to wetland forest ecosystems through programs initiated in the Conservation Reserve Program and the "Swampbuster" provision of the Food Security Act of 1985 (Farm Bill). Thus, use of MiST may not only assist in mitigation of wetland disturbances but may also contribute to increasing the quality and quantity of the nation's wetland resource.

Acknowledgements

The authors gratefully acknowledge the work of the participants of the Workshop on BLH Forest Mitigation of Disturbed Sites whose deliberations are summarized in this paper. Also, Region IV EPA is thanked for their support of this effort. Finally, the senior author thanks Drs. Doug Frederick and David Adams of the NCSU Department of Forestry for their insightful review of the draft manuscript.

GLOSSARY

CANOPY: The uppermost stratum of trees in the reference forest ecosystem.

COMPACTION: Degree of firmness in the soil. When present at a high degree, it reduces water movement and limits plant root penetration. Relative degrees can be determined by comparing bulk density and/or soil strength (e.g., as measured with a constant rate penetrometer).

DURATION: The average length of time in months that inundation and/or saturation occurs each year.

FREQUENCY: The number of inundation and/or saturation events that occur on the average each year. At least one inundation / saturation event must occur on the average each year to meet Federal guidelines.

HABITAT: The total of environmental conditions of a specific place occupied by a wildlife species or a population of that species. It can be described in terms of food, water, cover, and any other recognized life requisites and their relative location (interspersion) within a given area.

HABITAT SUITABILITY INDEX (HSI): A habitat quality measure defined as a value between 0.0 and 1.0, with 1.0 representing the optimum habitat quality in a defined area for the evaluation species.

PRINCIPAL HYDROLOGIC CONDITIONS: Frequency, duration, seasonality and source of site inundation and/or saturation.

NATURAL DISTURBANCE: Physical processes (i.e., soil scouring, sediment deposition) normally associated with inundation of floodplain zones.

NEW SOIL: Recently deposited or drastically altered soil profiles atypical of undisturbed soils within the reference area (e.g., dredge spoil, mine tailings, mixed mine soil, overburden, construction backfill material).

NO NET LOSS: The suggested interim goal of a national wetlands protection policy emphasizing achievement of no overall net loss of the existing wetlands resource base. No net loss is achieved when wetland gains equal wetland losses (Conservation Foundation, 1988).

NUISANCE SPECIES: Plant species having the potential to threaten success prior to or following project release.

PREFERRED SPECIES: Plant species typical of the reference forest ecosystem to be mitigated. Those preferred species upon which project success is to be determined will generally exclude:

1) Exotics
2) Aggressive colonizing weeds of open environments
3) Non-persisting canopy gap herbs
4) Off-site species that are more typical of other ecosystems
5) Rhizomatous grasses with the propensity to form turfs.

REFERENCE FOREST ECOSYSTEM: The kind of forest selected for creation or restoration, as it is represented locally (same or nearby watershed) in terms of species composition and physiognomy. It is incumbent upon the applicant to characterize the reference forest type to the satisfaction of the regulatory authority.

REFERENCE SOIL: Soil type(s) associated with the reference forest ecosystem.

SEASONALITY: The season or seasons (growing and dormant) during which the dominant period of inundation and/or saturation occurs. The dominant season of inundation cannot be different from the reference forest ecosystem, otherwise a different forest ecosystem would develop over time.

SOURCE: The principal source of inundation and/or saturation such as riparian (upland) discharge, overbank flow and rising groundwater. The dominant source of inundation cannot be different from the reference forest ecosystem.

UNDERGROWTH: All vascular plants that do not contribute to the canopy of the reference forest ecosystem, except as vines or epiphytes, including herbs, vines, shrubs and small trees.

UNDISTURBED NATURAL AREAS: Forested wetland communities that do not exhibit evidence of an adverse impact by man-made activities (e.g., logging, grazing, agriculture, construction runoff and sedimentation).

WETLAND HYDROLOGY: The hydrologic factors such as frequency, duration, seasonality, and source of inundation and/or soil saturation resulting in maintenance of a reference forest ecosystem (as further defined in the Vegetation Criteria Section). By definition, the reference forest ecosystem must meet Federal criteria for jurisdictional delineation as a wetland.

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