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Baseline Site Assessments for Wetland Vegetation Establishment

PURPOSE: A critical stage in the successful establishment of vegetation for a wetland management project is plan development. The plan should include details on the influence baseline site conditions may have on wetland plant establishment and growth. Many sources are available that list information commonly acquired in baseline assessments, particularly regarding topography, hydrology, and soils (e.g., Kusler and Kentula 1990, Soil Conservation Service 1992, Hammer 1992). The following discussion is intended to help interpret how baseline site conditions will affect vegetation requirements necessary to meet project goals.

BACKGROUND: There are three basic components of wetlands affecting establishment and growth of desired vegetation: hydrology, soils, and existing vegetation. The site hydrology and soils create the physical site conditions. Existing vegetation is a reliable indicator of factors limiting on-site plant growth or may be a limiting factor itself. In addition, vegetation establishment is affected by land uses and off-site influences that can create adverse growing conditions. Potential adverse site conditions that limit plant growth include the following:

- unfavorable season and duration inundation
- unfavorable water depths
- wind and current action
- excessive turbidity
- unstable substrate
- steep slopes
- compaction and cementation of substrate
- extremes of surface temperature
- low nutrient status
- excessive stoniness and absence of fine, soil forming material
- broken, uneven surfaces
- sheet and gully erosion
- high levels of potentially toxic elements
- absence of soil micro-organisms and soil fauna

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- presence of invasive or nuisance vegetation

- harmful levels of herbivory

In addition to identifying limiting conditions, the information gathered in a site assessment can be used to facilitate the wetland project plan development and implementation. For example, plant species growing on natural sites provide a good basic list of potential species for use in the project. These species are adapted to local conditions and are most likely to be successfully established and maintained. In addition, there are several methods by which plants existing on site can be used to vegetate the planned project. These include collecting the topsoil and redistributing it with the plant seeds and roots on the new site or cutting plugs from the existing wetland and moving it into the new wetland area. Both of these techniques require project scheduling to minimize storage time of the native material. Seeds and plant fragments (e.g., rhizomes and tubers) can be collected and grown in a greenhouse or nursery until needed for outplanting.

Determination of project success may be stipulated in some cases as a resemblance to a natural reference wetland. Assessment of wetland site conditions prior to project construction will aid in identification of a reference area. Furthermore, it may be required that physical and biological processes be monitored simultaneously in both the reference and project wetlands. Prior knowledge of project site conditions will aid in interpretations of monitoring results from the reference and project sites.

BASELINE SITE ASSESSMENTS:

- Project Topography. Plant establishment and growth requires stable substrates for anchoring root systems and preserving propagules such as seeds and plant fragments, and slope is a primary factor in determining substrate stability. Establishing plants directly on or below eroding slopes is not possible for most species. In such instances, plant species capable of rapid spread and anchoring soils should be selected or bioengineering techniques should be used to aid the establishment of a plant cover.

  Ground surface slope interacts with the site hydrology to determine water depths for specific areas within the site. Depth and duration of inundation are principal factors in the zonation of wetland plant species. A given change in water levels will expose a relatively small area on a steep slope in comparison with a much larger area exposed on a gradual or flat slope. Narrow planting zones will be delineated on steep slopes for species tolerant of specific hydrologic conditions, whereas gradual slopes enable the use of wider planting zones.

  In addition, soils on steep slopes generally drain more rapidly than those on gradual slopes. This means that soils remain saturated longer on gradual slopes with falling water levels, and roots remain in anoxic conditions even after aerial plant parts are exposed. If soils on gradual slopes are classified as poorly drained, care should be taken that plant species are selected for planting that are tolerant of saturation for longer periods of time than would be determined from surface water levels alone.

  Site topography affects maintenance of plant species diversity. Small irregularities in the ground surface (e.g., hummocks, depressions, logs, etc.) are common in natural systems. More species are found in wetlands with many micro-topographic features than in wetlands without such features. Raised sites are particularly important because they allow plants that would otherwise die while flooded to escape inundation.

A second topographic feature that promotes increased species diversity in littoral wetlands is a convoluted shoreline. Littoral drift along a straight shoreline carries seeds and plant fragments along with sediments, with little opportunity for the propagules to be captured and become established. Concave portions of shorelines trap sediments and propagules enabling more successful establishment and growth of more species.

- Hydrology. Wetlands vegetation is primarily limited by hydrology. Water limits diffusion of oxygen to buried seeds and root zones, which restricts germination and growth of most species. Wetland plants differ from terrestrial plants by having various morphological and physiological mechanisms that enable them to tolerate inundation of their roots; different species tolerate longer periods of inundation than others. Too much water, especially during the growing season, will stress plants and limit growth and establishment. Complete inundation of most plant species, even wetland species, can be lethal. Therefore, it is very important to be able to establish that the site will have enough water in the right place at the right time of year to support the plant species targeted for the project.

Hydrologic surveys of project sites should include estimates of water quantity and quality. It is desirable to plan hydrologic regimes with seasonal water level fluctuations similar to local natural wetlands. This enables the placement of local wetland plant species in hydrologic conditions similar to where they are naturally found growing. When water management requirements do not permit a natural analog as a planning guide for species selection and placement, more general planting guidance must be used, such as in the following water depth scheme for still, clear water.

PLANT GROWTH FORM	AVERAGE WATER DEPTH (cm)
Submergents (e.g., water celery, elodea, pondweeds)	>50
Floating leaves (e.g., water lily, spatterdock, lotus)	20-100
Herbaceous emergents (e.g., duck potato, bullrushes, maidencane)	0-50
Shrubs (e.g., buttonbush, wax myrtle)	0-20
Trees (e.g., cypress, green ash, red maple)	0-50

It should be noted, however, that young plants that are just developing from seeds or plant fragments do not have the same flood-tolerance as mature plants of the same species. Young plants are very susceptible to complete inundation, particularly during the growing season. Establishment success of herbaceous emergents, shrubs, and trees is often increased if water levels are managed the first one or two years to allow only short flooding periods and saturated substrates.

Water quality is a secondary factor that determines wetland plant distributions. Site evaluations of water quality usually include nutrients, pH, alkalinity, and turbidity, as well as salinity and toxins where appropriate. The water chemistry parameters are important for defining site-specific conditions for which tolerant plant species must be selected. Since most rooted plants acquire their nutrients from the soil, water chemistry is most important when considering submergent aquatic plants or potential eutrophication problems. Turbidity limits the depth of light penetration. Emergent plant species will grow in shallow turbid water; however, deep turbid water must be treated in order to support submerged aquatic vegetation.

- Soils. Several soil factors impact wetland vegetation. Assessment of site conditions for vegetation management must take into account whether the substrate will provide a stable rooting medium to an adequate depth for the target plant species. As described above, soil texture interacts with the hydrology and ground surface slope to determine the drainage capacities of the site that will affect the period of saturation. The soils must also provide adequate nutrients for plant growth and maintenance.

  Soil stability is dependent upon soil texture, surface slope, eroding forces such as wind and water, and vegetation cover. Vegetation management plans should utilize existing vegetation cover where practicable if stability is likely to be a problem. Target species may grow most successfully if planted through the existing plant cover that is stabilizing soils. Alternatively, competition from existing vegetation may require the use of control treatments. If this is necessary, it is advisable to use a treatment, such as mowing or herbicides approved for aquatic use, that leave the root systems intact to maintain stability until the target species become established. Establishment of a cover of rapidly growing annuals may be desirable to temporarily stabilize soils while the target plant species become established.

  Presence of a dense layer in the soil profile, such as rock, clay, or mineral deposits, needs to be closely examined because root penetration depths may be limited and drainage may be blocked. Root penetration depths differ with plant species. Generally, most fine roots that absorb nutrients occur in the top 30 cm of the soil. If an occluding layer is more than 30 cm deep, rooting depth is not usually a problem for herbs and shrubs. However, trees will require more rooting depth for increased stability against wind and currents. Limitation of drainage may be desirable to help maintain wetland conditions. If, however, an occluding layer is expected to create undesirable standing water conditions, either the layer needs to be broken up to allow drainage or plantings moved to more appropriate locations.

  There is little guidance available about what nutrient concentrations are desirable for wetland vegetation. Fertilizer application rates were developed for agricultural crops and do not necessarily apply to wetlands. Tolerance ranges of target plant species can be compared with soil analyses, particularly pH and cation exchange capacity (CEC). Nitrogen is the most common limiting nutrient for wetland plant growth because it is highly soluble and rapidly lost from the site through drainage and percolation. In addition, nitrogen is rapidly transformed into gases by microorganisms and is lost to the atmosphere before being utilized by plants. Surface application of nitrogen fertilizers in flooded conditions has proved to be less effective than subsurface applications and may lead to eutrophication problems. By applying a slow-release fertilizer in the planting hole with the plant, it is directly accessible to the roots and the rates of nutrient loss to the atmosphere and water column are reduced.

- Vegetation. A primary objective for characterizing vegetation on site is to determine whether or not plantings will be required. Species dominance and/or quantities should be determined for all strata (i.e., canopy, shrub, and herbaceous) on the project site. The environmental tolerances of the naturally occurring species can then be compared with the projected conditions of the managed wetland. If species are not present in adequate amounts that meet project goals and that will tolerate the managed site conditions, appropriate plant species will have to be acquired and planted.

Maps of existing vegetation associations can be helpful in assessing management options. The plants themselves are good indicators of environmental conditions such as frequency and duration of inundation or soil conditions, and project plans can be optimized by "reading" the plant distributions. It should be recognized that different growth forms of plants indicate site conditions over different periods of time. Tree life spans are longer than herbs, and the conditions under which mature trees were established may have changed over time, whereas short-lived herbs are more likely to reflect recent conditions. Therefore, disparities between environmental tolerance ranges between herbs and canopy strata indicate that a change has occurred in site conditions. For example, a herb layer dominated by mesic species can be located under a facultative-wet tree overstory. Impacts to unique or sensitive vegetation should be avoided, particularly if alternate areas are available for project development.

Baseline site assessments will help determine whether or not site preparation is necessary and define which site preparation methods will be most appropriate to meet project goals. Site preparation methods can utilize the existing vegetation to maintain site stability until a managed suite of species becomes established. For example, a project objective may be the maintenance of cover by existing herbaceous species while planted trees mature, but competition must be reduced for adequate tree growth. Strips can be disked where trees will be planted while maintaining the value of existing vegetation as the target trees grow.

Site preparation for wetland vegetation management may require that site conditions be ameliorated, particularly if the site has been damaged (i.e., substrate instability, nutrient losses, or high toxin concentrations) or neglected. Poor site conditions can be accepted as they are (e.g., absence of topsoil, erosion, unstable substrate, etc.), and species can be planted that are tolerant of these conditions, such as early colonizing or "pioneer" species that are often annuals. Attempts can be made to incorporate soil amendments into the substrate (e.g., organic matter, lime, or fertilizer). Material brought to a site can be brought from a donor site with similar characteristics to the desired managed wetland. Plant seeds and propagules in this material will help to rapidly develop a species rich ground cover.

- Wildlife Survey. Animals affect vegetation in several ways. Plants can be stimulated to grow with fertilization or limited browsing. However, animals can eradicate plants that are too heavily browsed or that cannot grow in soil compacted by trampling. Plant species diversity can be decreased if browsers favor some species and leave unpalatable species. Seeds of volunteer species can be brought on site by animals.

  Control measures can be planned to limit access of animals to a project area if the baseline assessment indicates there may be problems. For example, fences can be erected to keep large animals, such as deer, off the site. Some animals, like beaver and nutria, can be periodically trapped and removed. Insect infestations should be treated on an as-needed basis. If practicable, it is preferable to limit access of nuisance fish species to aquatic sites with net or fence enclosures than to kill and remove all fish in an area.

CONCLUSION: Baseline site assessments should include historical, physical, chemical, and biological information that must be considered for successful establishment and management of wetland vegetation. A basic familiarity with how pre-project site conditions will affect plant growth can be used to improve project plans and the chances of attaining project goals.

ADDITIONAL SOURCES OF INFORMATION: For more details about baseline site assessments consult the following references:

Goodman, G. T. and S. A. Bray. 1975. Ecological Aspects of the Reclamation of Derelict and Disturbed Land: an Annotated Bibliography. Geo Abstracts, Norwich, England.

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