Appendix 8-A

An Overview of Ways to Protect and Manage Wetlands

Introduction

An important component of wetland protection and management is to identify what wetland functions need to be protected, and which wetlands need additional protection because they have other important characteristics. The first section of this appendix discusses ways to protect and manage wetland functions, whereas the second describes what is needed to protect wetlands with other characteristics such as "Natural Heritage" wetlands.

Wetland functions can be grouped into three broad categories: water quality improvement, hydrologic functions, and habitat functions. Each of these can be further divided into more specific functions. For example, habitat functions can be divided into habitat for amphibians, habitat for mammals, etc. At the finest scale, we can consider the function of habitat for an individual species. (Chapter 2 in Volume 1 discusses the functions of wetlands in Washington State in detail.)

In addition to identifying what functions need to be protected, managing wetlands requires an understanding of how the functions are performed. Wetlands in each hydrogeomorphic class (see Chapter 2 of Volume 1) perform a particular set of functions; some are the same and some are different from wetlands in other classes. For example, the functions performed by wetlands in the depressional class are not the same as those performed in the riverine class. In addition, individual wetlands perform each function to a different degree based on a variety of factors. Some functions of wetlands are greatly affected by processes or influences that operate at large scales, while other functions are affected more by site-specific characteristics (see Chapter 2 of Volume 1).

Understanding how each function operates and how human activities can affect that function is critical to determining the appropriate type and level of protection and management that will be achieved through comprehensive plans, critical areas ordinances, and other regulations, as well as non-regulatory tools. Chapter 4 in Volume 1 provides more information on how functions can be changed by human activities.

In spite of the many differences in how wetlands function, one can generalize several approaches that will be effective in protecting each of the three groups of wetland functions (e.g., water quality improvement, hydrologic functions, and habitat functions). This appendix synthesizes the information available on what is needed to protect a wetland and its immediate vicinity to maintain performance of functions or to replace functions if impacts are unavoidable. The discussion is organized by the three major groups of functions and by the different types of wetlands with other characteristics used to categorize wetlands using the Washington State wetland rating systems (Hruby 2004a,b).

The two most common methods for protecting wetland functions have been the use of buffers and compensatory mitigation. Buffers are used to maintain existing functions by reducing the impacts of adjacent land uses. When impacts to wetlands are unavoidable, replacement of lost functions has typically been through compensatory mitigation in which other wetlands are created, restored, or enhanced using specific ratios based on area.

Scientific information regarding buffers and ratios are discussed in detail in Chapters 5 and 6 of Volume 1. The authors have also recommended specific widths for buffers and specific ratios for compensatory mitigation to be used in conjunction with the Washington State wetland rating systems (Hruby 2004a,b) in Appendices 8-C and 8-D of this document. Although the rating systems are referenced frequently in this appendix, the citations are not repeated again.

Wetland protection should encompass more than buffers and compensatory mitigation

The review of recent scientific information (Volume 1) has shown that protecting the functions of wetlands by using only buffers and establishing "mitigation ratios" is not adequate. These measures by themselves will not completely protect many wetland functions from disturbances or replace the functions lost if impacts are unavoidable. Providing protection in the immediate vicinity of a wetland (e.g., buffers, use restrictions, etc.) will not always adequately protect wetland functions from disturbances that may occur elsewhere in the landscape. Other measures that take a larger landscape approach and that use tools outside of the traditional regulatory realm may also be needed to fully protect wetland functions. See Chapters 6, 7, and 9 in this document for more details on additional approaches.

Protecting and Managing Habitat Functions for Animals

Wetlands provide habitat for a large number of animal species and play an integral part in maintaining the richness of species in the environment. Many different environmental factors affect the suitability of wetlands as habitat, the most important being the physical structure of the vegetation in the wetland, the water regime, and the condition of the vegetated and hydrologic connections between the wetland, uplands, and other aquatic resources. More detailed descriptions of how wetlands provide habitat are given in Volume 1.

The main question that arises when protecting and managing wetlands to maintain their capacity to provide habitat is: *What species of vertebrates and invertebrates use the* *wetland and need protection?* The recommendations made here are based on the assumption that wetlands with good structure and good connections to other habitats will provide habitat for a large range of species. In the absence of information on use, or lack of use, of an individual wetland by certain species, adequate protection should be based on the probability that the species are there. Wetlands that score highly for the habitat function in the rating system have a higher probability of providing habitat for a variety of species than those with a low score. High-scoring wetlands have the connections and structure to provide relatively diverse habitat.

Widths of Buffers for Habitat Functions

The review of the literature indicates that there are several aspects of buffers that are important for wildlife. First, the width of vegetated buffers needed to protect habitat functions depends on the individual species needing protection. Some species using wetlands need buffers in excess of 600 feet. Others, however, need only 100 feet. In general, the information available indicates that buffers between 100 and 300 feet are adequate to protect most species closely associated with wetlands in Washington.

Second, most studies on the effectiveness of buffers have been done using buffers that were relatively undisturbed. It is difficult to extrapolate this information to judge the effectiveness of buffers that consist of lawns or tilled fields or that have otherwise been disturbed.

Third, the width of the buffer needed to protect species depends on the type of disturbance the buffer is intended to reduce. Noise, light, or the movement of humans and pets may be reduced by providing a buffer of 100 feet. However, protecting the nesting and breeding of waterfowl from pets or human disturbance generally requires a buffer of at least 200 to 300 feet depending on the type of disturbance and species of waterfowl.

The scientific information summarized in Volume 1 also points out that fragmentation and the disruption of the vegetated corridors between undeveloped areas that provide habitat are major causes of the loss of species richness (biodiversity). Existing connections and corridors between wetlands and other habitats, as well as the structure within the wetland and its buffer, need to be protected to maintain the wetland's habitat functions.

Replacing Habitat Functions Through Compensatory Mitigation

Historically, the loss of habitat functions has been mitigated by creating, restoring, or enhancing wetlands with the physical structure (e.g., vegetation, large woody debris) that provides ecological niches for different species. Studies of mitigation projects have shown, however, that less attention is given to other environmental factors that play an important role in the provision of habitat (i.e., time of ponding, depth of ponding, temperature of water, connectivity with other habitats that provide access for wildlife etc.). The studies of compensatory mitigation also indicate that high mitigation ratios alone will not guarantee that habitat functions will be adequately replaced. Chapter 6 of

Volume 1 summarizes the many factors involved in determining whether a mitigation site is successful or not, and concludes that adequate ratios are only one factor.

At a minimum, a mitigation ratio should compensate for the loss of habitat during the time it takes the habitat structure to develop and the species to colonize the mitigation site (i.e., temporal loss of function). In the case of forested wetlands, this temporal loss can be as long as 100 years or more, and as reported in Volume 1, no studies have found that all functions in a forested wetland have been reproduced through compensatory mitigation. Thus, some functions cannot be replaced within a regulatory time frame.

The authors recommend several strategies to address this difficulty. First, avoidance of the wetland altogether can be emphasized for the wetland types that are most difficult to compensate or take the longest to replace. Another strategy can be to require higher ratios for unavoidable impacts to these types of wetlands. A third strategy can be to require longer monitoring (≥ 10 years) of the compensation site to ensure that the site is on a trajectory to actually replace the habitat functions that were lost.

Protecting and Managing Functions That Improve Water Quality

Wetlands generally improve water quality by trapping pollutants (e.g., sediment) or by chemically transforming some pollutants into compounds that are no longer polluting (e.g., changing nitrates into nitrogen gas). The performance of the water quality functions by wetlands (i.e., removing sediment, removing nutrients, and removing toxic compounds) depends mostly on the structure of the vegetation that reduces water velocities and causes sediments and pollutants to settle and on the chemical and biological properties of the soil in the wetland. It is the geomorphic characteristics of the wetland and the physical structures found therein that control how a wetland improves water quality. Thus, a dense stand of invasive reed canarygrass can be just as effective at trapping pollutants as a dense stand of native sedges. More detailed descriptions of how these functions are performed are available in Volume 1.

The primary question when protecting and managing wetlands to maintain their capacity to improve water quality is: *How much pollution is too much?* Wetlands in watersheds where human activities generate pollutants provide important functions by removing some of these pollutants. Large quantities of pollutants, however, can overwhelm the capacity of a wetland to improve water quality. For example, too much sediment entering a wetland can cover the organic soils that are important in trapping phosphorus and removing nitrogen.

To protect the water quality functions of a wetland, the authors of Volume 1 recommend minimizing the local input of any additional pollutants generated by changes in land use. For example, when a forest adjacent to a wetland is changed to a residential development care should be taken to control the new input of sediment from construction and the pollutants coming from lawns, landscaping, septic systems, and pets.

Widths of Buffer for Functions that Improve Water Quality

Buffers trap pollutants before they reach the wetland. This helps to maintain the existing capability of a wetland for improving water quality. Protecting the water quality functions currently performed by a wetland would therefore require that any existing, vegetated buffers be protected from further degradation in the portion of the buffer that is most effective at trapping pollutants.

The review of existing literature in Volume 1 indicates that the effectiveness of buffers at trapping pollutants depends on many different factors, including the type of soils present, the type of vegetation present, and the slope. Furthermore, the effectiveness is not linear. For example, a buffer of approximately 33 feet will remove approximately 60% of the sediment and other pollutants, while it takes a buffer of approximately 150 feet to remove 75% or more of the sediment and other pollutants, and a buffer of 660 feet to remove 90% of the sediment and other pollutants.

Buffers will not adequately protect functions in a wetland if polluted waters bypass the buffer and enter the wetland directly via pipes, ditches, or other channels. To maintain the current levels at which a wetland improves water quality, it may be necessary to limit the introduction of any additional pollutants that might come in through untreated runoff that bypasses the buffer. In most cases, runoff from lawns and landscaped areas adjacent to wetlands will contain pollutants (particularly nutrients and pesticides). This runoff is rarely collected and treated in stormwater treatment facilities and thus, larger well-vegetated buffers are particularly important to protecting wetlands in these situations.

Replacing Functions That Improve Water Quality Through Compensatory Mitigation

The review of the information on mitigation in Volume 1 found very few projects in which the replacement of the water quality functions was an objective. These functions have not been the focus of compensatory mitigation in the past. A study by Johnson et al. (2002), however, found that creation or restoration of wetlands generally resulted in the creation and restoration of the water quality functions to some degree. Enhancement, on the other hand, did not often improve the water quality functions of the wetlands enhanced and may even have reduced them. Over half of the enhanced sites that were evaluated in Washington State had minimal or no increase in the levels of the water quality functions.

If a wetland is created or restored, some of the water quality functions will tend to be established fairly quickly while others may take much longer. The temporal loss of functions incurred during compensatory mitigation is very dependent on site-specific conditions. The structural characteristics and water regime needed to perform the water quality functions can be established early, while the organic soils needed to more effectively trap phosphorus and remove nitrogen can take over 50 years to develop.

At a minimum, a mitigation ratio should compensate for the loss of the water quality functions during the time it takes to build the mitigation site. The study by Johnson et al.

(2002) found that the risks of replacing the water quality functions through restoration and creation are less than those for wildlife habitat. Therefore, replacing lost water quality functions may be possible through mitigation ratios that are lower than those for wildlife habitat functions.

Ratios for enhancement, however, may have to be high because most enhancement projects that require revegetation of disturbed wetlands result in little, if any, increase in water quality functions. Many of the wetlands used for enhancement are degraded in terms of their habitat but actually perform water quality functions at a high level. It is not likely that enhancement will increase the sites effectiveness at improving water quality to mitigate for the loss of those functions. For example, if enhancement increases the water quality functions by only 5%, a ratio of 20:1 (by area) is needed to compensate for the impacts.

Protecting and Maintaining Hydrologic Functions

The group of hydrologic functions characterized in the rating systems include reducing flooding, reducing erosive flows, and recharging groundwater. The performance of these functions depends mostly on the water storage available in the wetland, the density of vegetation that can reduce the velocity of flood waters, the permeability of the soils, and the distance from the wetland surface to groundwater. More detailed descriptions of how these functions are performed are available in Chapter 2 of Volume 1.

Widths of Buffers for Hydrologic Functions

Generally speaking, the factors that control the hydrologic functions in a wetland are not significantly altered by changes in the buffer. The amount of water coming into a wetland, its velocity, and its timing are controlled by processes that occur at the larger scale of the watershed or the contributing basin of that wetland.

There is one case, however, in which buffers may help protect hydrologic functions. Buffers may protect the storage capacity of depressional wetlands by trapping sediments that might otherwise fill the wetland. In the absence of buffers that trap sediment, a wetland can slowly fill with sediment, reducing the amount of water it can store. In this case, the requirements for a buffer would be similar to those for the water quality functions described above.

Replacing Hydrologic Functions Through Compensatory Mitigation

The review of the information on compensatory mitigation in Volume 1 found very few projects in which the replacement of hydrologic functions was an objective. The study by Johnson et al. (2002), however, found that creation or restoration of wetlands generally resulted in the creation and restoration of hydrologic functions to some degree. Enhancement, on the other hand, did not often improve the hydrologic functions of the wetlands enhanced. Approximately two-thirds of the enhanced sites that were evaluated had no increase in the performance of hydrologic functions.

If a wetland is created or restored, the hydrologic functions will tend to be established fairly quickly because they depend mostly on the physical structure of the wetland (e.g., storage capacity, permeability of soils). Compensation for impacts to these functions is more dependent on the structure and water regime of the mitigation site rather than the mitigation ratio.

Protecting and Managing Wetlands with Other Characteristics

The Washington State wetland rating systems (described in Appendix 5-B) also differentiate between wetlands based on their sensitivity to disturbance, their significance in the landscape, their rarity, and our ability to replace them through compensatory mitigation. These other characteristics were chosen because they can be used to provide additional guidance on the ways in which these wetlands need to be protected and managed. The following discussion provides a general summary of what is needed to protect these types of wetlands.

Natural Heritage Wetlands (Freshwater)

"Natural Heritage" wetlands, as defined by the Natural Heritage Program of the Washington State Department of Natural Resources, contain rare plants or those that are particularly sensitive to disturbance. These types of plant species are very sensitive to nutrient enrichment (*eutrophication*) that results from the input of nutrient-laden waters. The greatest richness of plant species, especially rare species, is found in nutrient-poor wetlands. Rare plant species are outcompeted by large, regionally common species when excess nutrients are introduced to a wetland. Protection of Natural Heritage wetlands should focus on keeping nutrients out of these wetlands, maintaining the natural water regime, and reducing physical disturbance by humans (trampling, cutting vegetation, draining, etc.) within the wetlands.

Widths of Buffers for Natural Heritage Wetlands

The buffer around a Natural Heritage wetland is needed to remove excess nutrients before they reach the wetland. The most efficient vegetated buffer, based on width-to-removal ratios, is about 197 feet for removal of nitrogen and 253 feet for phosphorus. However, a 250-foot buffer alone may not protect the rare or sensitive plants in the wetland if the watershed has high nutrient loadings or a water regime that is unstable.

Buffers will not adequately protect rare plants in a wetland if polluted waters bypass the buffer and enter the wetland directly via pipes, ditches, or other channels. Furthermore, discharges of stormwater and changes in the water regime resulting from development will also change the plant communities in a wetland (see review in Chapter 4 of Volume 1). Such changes might also impact the populations of the rare species in the wetland. Designs for treating stormwater do not reduce the nutrient loads significantly because they do not effectively remove nitrogen. To protect rare plants, it is necessary to limit the introduction of any additional nutrients that might come into the wetland through untreated runoff that bypasses the buffer.

Replacing Natural Heritage Wetlands Through Compensatory Mitigation

To our knowledge, there have been no successful mitigation projects that replaced the rare, threatened or endangered plant species found in a Natural Heritage wetland. The Departments of Ecology and Fish and Wildlife assume that it is impossible to replace a Natural Heritage wetland through compensatory mitigation because the habitat required by rare and sensitive plant species cannot be reconstructed. The reconstruction of the habitat would require an extremely detailed understanding of the geological, biological, chemical, and physical requirements of each rare species found in the wetland. Such an understanding is not currently available in the existing scientific literature and would have to be developed through basic research.

Bogs

Bogs are also particularly sensitive to nutrient enrichment (eutrophication) because they have naturally low levels of nutrients (see discussion in Chapter 2 of Volume 1). Also, bogs often contain a high richness of plant species, especially rare ones, and ones that are found only in nutrient-poor wetlands. The rare plants in bogs, as in Natural Heritage wetlands, can be outcompeted by large, regionally common species when excess nutrients are introduced to a wetland.

Width of Buffers for Bogs

The buffer needs to remove excess nutrients before they reach the bog. The most efficient vegetated buffer, based on width-to-removal ratios, is about 197 feet for removal of nitrogen and 253 feet for phosphorus.

Buffers will not adequately protect the functions of a bog if polluted waters bypass the buffer and enter the wetland via pipes, ditches, or other channels. To protect the bog it is necessary to limit the introduction of any additional nutrients and excess water that might come in through untreated runoff that bypasses the buffer.

Replacing Bogs Through Compensatory Mitigation

Bogs are characterized by their highly organic soil conditions, unique water regimes, and water chemistries. Studies of bog and fen restoration in Northern Europe and Canada (reviewed in Volume 1) concluded that restoration may not be possible due to irreversible changes of the characteristics of a bog. No information was available on the success of bogs or fens that were restored or created as wetland compensation. However, the literature suggests that even if it is possible to recreate the appropriate environmental conditions, bogs and fens cannot be reproduced within a regulatory time frame. In Washington, Rigg (1958) reports that peat accumulates naturally in the Puget Sound lowlands at an average rate of 1 inch per 41 years. For 55 bogs studied in eastern and northeastern Washington, Idaho, and British Columbia, Rigg reported an average rate of accumulation of 1 inch per 48.5 years. The Departments of Ecology and Fish and Wildlife therefore assume that it is not feasible to replace bogs through compensatory mitigation.

Mature or Old-Growth Forested Wetlands

Mature or "old-growth" forested wetlands are given extra consideration because they are difficult to replace through compensatory mitigation. The protection they need is based on the functions they provide. Buffers and other measures to protect the functions, therefore, should be determined based on how well the wetland performs these functions rather than on the presence of a forested community.

Replacing Forested Wetlands Through Compensatory Mitigation

Though the studies reviewed in Volume 1 have found that trees can be planted in Washington State wetlands and they will grow, mature forested wetlands have not been successfully reproduced simply because of the time necessary for the trees and the structural characteristics of the forest to mature. Enhanced and created sites that have been planted often have a high density of stems to rapidly provide woody cover and shade out invasive species in the understory. Unless these sites are thinned, they will not reproduce the attributes of mature forested wetlands.

Alkali Wetlands

Alkali wetlands are characterized by the occurrence of shallow saline water. These wetlands provide the primary habitat for several species of migrant shorebirds and are also heavily used by migrant waterfowl. They also have unique plants and animals that are not found anywhere else in eastern Washington. The salt concentrations in these wetlands have resulted from a relatively long-term process of groundwater surfacing and evaporating.

Width of Buffers for Alkali Wetlands

The ecological process that maintains an alkali wetland is the dynamic between the inflow of groundwater and evaporation. Buffers have little impact on maintaining this process. The width of buffer needed for an alkali wetland should therefore be based on the wetland's habitat functions. Alkali wetlands in eastern Washington are a major resource for migratory shorebirds and other water-dependent birds, and the buffers are needed to protect the shorebirds and waterfowl from disturbance.

The routing of additional surface water to alkali wetlands will change the balance between inflow of groundwater and evaporation. No information was found, however, on the impacts this may have on the ecosystem in the alkali wetland. There is a significant risk, therefore, that the ecosystem may be impacted if discharges into alkali wetlands are allowed.

Replacing Alkali Wetlands Through Compensatory Mitigation

The salt concentrations in alkali wetlands have resulted from a relatively, long-term process of groundwater surfacing and evaporating. These conditions cannot be easily reproduced through compensatory mitigation because the balance of salts, evaporation, and water inflows is hard to reproduce. No references were found suggesting that alkali wetlands have ever been created or restored. Until alkali wetlands have been successfully created, the departments of Ecology and Fish and Wildlife view any proposed creation project as highly experimental.

Vernal Pools

Vernal pools in the scablands of eastern Washington are the first areas of open water to melt in the early spring even though they dry out by late spring. This open water provides areas where migrating waterfowl can find food while other, larger bodies of water are still frozen. Furthermore, the open water provides areas for pair bonding of waterfowl. Thus, vernal pools are very important for migratory waterfowl during a short period in the early spring. The rest of the time the vernal pools provide little habitat for larger animals that need larger buffers.

Width of Buffers for Vernal Pools

The review of the literature indicates that waterfowl need at least 200-foot buffers to protect them from disturbance. In a vernal pool that is currently undisturbed, such a buffer would protect the birds from disturbance while they feed and use the pool for courtship activities.

Replacing Vernal Pools Through Compensatory Mitigation

Vernal pools are characterized by the short duration of their inundation. Thus, in order to reproduce a vernal pool, a site with a suitable substrate must be found and the correct depth and water regime must be created or restored. The literature as reviewed for Volume 1, Chapter 6, suggests that, in California, vernal pools may be reproduced under the right conditions. No information was found on the reproducibility of vernal pools in Washington.

Wetlands in Estuaries and Coastal Lagoons

Wetlands in areas where the water has salinity higher than 0.5 parts per thousand are classified as *estuarine* or *coastal lagoons* for the purposes of rating and management. The ecological process that maintains estuarine wetlands and those in coastal lagoons is the mixing of marine waters coming from the ocean and fresh waters coming from land. Both types of wetlands are found along the coast and in the mouths of rivers.

Width of Buffers for Estuaries and Lagoons

Although wetlands in estuaries and coastal lagoons are not the focus of this synthesis as described in Chapter 1 of Volume 1, we are including some information about these wetlands because they are included in the Washington State wetland rating systems. Please note, therefore, that the information presented here is not as detailed as for freshwater wetlands.

Estuarine wetlands and coastal lagoons are a major resource for migratory shorebirds and other water-dependent birds, and buffers are definitely needed to protect the shorebirds and waterfowl from disturbance. In estuarine systems, buffers also provide a source of wood and sediment that nourish the beaches. In addition, estuaries and coastal lagoons have a high density of fish and wildlife and high species diversity, provide important breeding habitat, and serve as movement corridors (see Washington Department of Fish and Wildlife web page, http://wdfw.wa.gov/hab/phshabs.htm). Both types of wetlands are also a habitat that has been significantly impacted by human activities and are highly vulnerable to alteration. Therefore, the width of buffers needed to protect these wetlands will have to be based on protecting a wide range of functions.

Replacing Wetlands in Estuaries and Coastal Lagoons Through Compensatory Mitigation

The main focus of Volume 1 was freshwater wetlands. Information on mitigating impacts to estuaries and coastal lagoons was not compiled, so no recommendations can be made. Decisions about compensating for impacts to these types of wetlands will have to be made on a case-by-case basis.

Also, it is not possible to specify in advance what other tools or non-regulatory approaches are needed to protect these types of wetlands because of the many different habitat functions they provide. Protecting the functions of these wetlands will require considering each wetland on a case-by-case basis.

Interdunal Wetlands

Interdunal wetlands form in the *deflation plains* and *swales* that are geomorphic features in areas of coastal dunes. These dune forms are the result of the interaction between sand, wind, water, and plants. Interdunal wetlands provide critical habitat in this ecosystem (Wiedemann 1984), but no methods have been developed to characterize how well these wetlands function.

Width of Buffers for Interdunal Wetlands

Although we have little detailed information on how interdunal wetlands function as habitat, the information does show that these wetlands provide an important resource for many species. In the absence of more detailed information about the needs of species using interdunal wetlands, the width of buffers should be based on the assumption that these wetlands provide a moderately high level of habitat. It is assumed that species using interdunal wetlands will need some protection from disturbance, but not the 300 feet needed by the more sensitive species. Interdunal wetlands are physically highly dynamic and exposed, and it is assumed that species using these wetlands do have some adaptations to disturbance.

Replacing Interdunal Wetlands Through Compensatory Mitigation

One of the mitigation sites assessed by Johnson et al. (2002) was an interdunal wetland that was found to be moderately successful. Other undocumented observations would also suggest that creating wetlands in the interdunal ecosystem is usually fairly successful (P. Lund, Department of Ecology, personal communications 2003). As a result, the recommended ratios for creating these types of wetlands are lower than for other types. The one stipulation, however, is that losses of interdunal wetlands should be compensated only by creating other interdunal wetlands. The interdunal ecosystem in Washington and elsewhere along the Pacific Coast covers a very limited area. Any further losses of this resource should be minimized.

References

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